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Diversity report of freshwater gastropods in Buton Island, Indonesia

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Abstract. *Purnama MF, Sirza LOMJ, Sari SF, Salwiyah, Haslianti, Abdullah, Suwarjoyowirayatno, Findra MN, Nurhikma, Agriansyah A, Hidayat H, Syukur, Anwar K. 2022. Diversity report of freshwater gastropods in Buton Island, Indonesia. Biodiversitas 23: 1938-1949.* This study was located in Buton Island consisted of 5 administrative districts/cities (Baubau City, Buton District, South Buton District, Muna District and North Buton District) and was conducted for 1 year (August 2019-August 2020). The output is to reveal the potential richness of the biodiversity of freshwater gastropods as a first step to optimize the utilization of freshwater gastropod resources in the Buton Islands. Determination of sampling location for gastropods was carried out by purposive sampling method and the selection of gastropod samples using simple random sampling method at a predetermined location based on the presence of gastropods. Gastropod samples (epifauna/infauna) were collected manually without special fishing gear with gloves, paralone pipes (3.5 inches), and filter (1 mm). The gastropods found in Buton Island consist of 18 genera and 40 species. Freshwater gastropods spread over 8 families, namely Cyclophoridae, Planorbidae, Lymnaeidae and Thiaridae. Among the species, there are several invasive alien species (IAS) such as *Tarebia granifera*, *Melanoides tuberculata* and *Achatina fulica*. These three species always dominate the habitat space where they are found. Most gastropod communities in 5 districts/cities live in fast-flowing rivers with rock, gravel and sand substrates. Only a few of them are found in artificial inland waters such as rice fields, embankments, dams and drainage. This study became a first step to optimize the utilization of gastropod resources and sustainable management, especially related to the conservation of native species from the threat of IAS.

Keywords: Buton Island, diversity, freshwater, Gastropods, polymorphism

INTRODUCTION

Buton Island is one of the largest administrative areas in Southeast Sulawesi Province, Indonesia, consisting of 5 districts/cities i.e., Buton, North Buton, South Buton, Muna and Baubau City. This island has large biodiversity of aquatic resources, both freshwater and brackish water, as well as coastal and marine waters. In addition to the large potential of marine resources possessed by the Buton Island, inland fisheries are also a vital source of endemic mega-biodiversity in this island (Central Bureau of Statistics Southeast Sulawesi Province 2019). One of the important economic commodities typical of inland waters is the gastropod resources classified as snails (Mollusca: Gastropoda).

Gastropod, a class of the phylum Mollusks, belongs to a soft-bodied invertebrate that moves by using its abdominal legs and generally has a shell (Febiansi et al. 2018). Only a small part of gastropods, e.i. nudibranhians do not have the shell. Gastropods are one of the largest groups of organisms that contribute to the diversity of germplasm in freshwater ecosystems. Ecologically, gastropods have an important role in the food chain in freshwater ecosystems, as they generally are herbivores, carnivores, detritivores, deposit feeders, suspension feeders, and parasites (Susintowati et al. 2019). Most of them eat detritus and litter from the fallen leaves and circulate suspended substances in the water to obtain food, such as moss and various algae. Several types of gastropods are commonly consumed by humans as food, helping in the process of the

food chain and nutrient cycle (Andriati et al. 2020). Gastropods are also a benthic fauna community that live on the bottom of the water found inland waters such as in the rivers, lakes, swamps, dams, ponds and drainage/embankments) as recorded in Southeast Sulawesi Province (Purnama et al. 2019). However, there is still a lack of information regarding the bio-ecology of those gastropods, especially their species diversity, therefore a research investigation is required.

Freshwater gastropods in the mainland of Southeast Sulawesi (8 districts/cities including Kendari City, Konawe, South Konawe, North Konawe, Bombana, East Kolaka, Kolaka, North Kolaka) have a very high diversity of habitat types, niches, and species (Purnama et al. 2019). This may indicate that Buton Island might also have various types of endemic local gastropods based on the unique characteristics of natural and artificial inland waters as the habitat and niches of gastropod commodities. The large potential of inland waters in Buton Island is an empirical indication of the existence of gastropod populations in nature. Therefore, research on the diversity of freshwater gastropods is important on this island as it has not been recorded, except those gastropods that have economic value. A recent study by Purnama et al. (2019) indicated that the mainland cluster of Southeast Sulawesi has a high diversity of freshwater gastropods and potential prospective uses. This research will show the great potential of Southeast Sulawesi's freshwater gastropods, so that it becomes the main basis for this research to be carried out on Buton Island, as a medium in revealing the high diversity of freshwater gastropods in Southeast Sulawesi in general and Buton Islands in particular, as a first step to optimize resource utilization, and management in a sustainable manner.

MATERIALS AND METHODS

This research was conducted for 1 year (August 2019-August 2020) in natural and artificial inland waters (rivers, lakes, swamps, dams, lakes, reservoirs and drainages/embankments) in Buton Islands, Southeast Sulawesi Province, Indonesia. The sampling locations were in all freshwater areas. This study was initiated by a survey or in-depth field observation to ascertain the morphological characteristics of the inland waters in Buton Island. The survey aimed to classify inland waters as a reference to select the sampling location. Fieldworks (observations) were carried out for 1-2 months. The sampling location for gastropods was determined using purposive sampling method (placed inland waters that had gastropod commodities), while gastropod sampling collection was carried out using simple random sampling (quantitative sampling method) at the sampling point. Gastropod samples (epifauna and infauna) were collected manually using gloves, paralone pipes (3.5 inch) and filter (1 mm). This research did not assess the gastropod's density but rather identified their types/species that existed on this island.

Identification of collected gastropods was carried out at the Laboratory of Water Resources Management, Faculty of Fisheries and Marine Sciences, Halu Oleo University, Kendari. Their size dimensions were measured using a caliper (0.5 mm) and they were identified referring to Dharma (1988) (*Siput dan Kerang Indonesia*); Strong et al. (2008) (Global Diversity of gastropods (Gastropoda; Mollusca) in Freshwater); Eichhorst (2016) (Neritidae of the World); Subba (1989) (Handbook of Freshwater Molluscs of India), Haynes (1988, 1990, 2001, 2005) (Gastropda; Prosobranchia; The Numbers of Freshwater Gastropods on Pacific Islands and The Theory of Island Biogeography; Freshwater Snails of the Tropical Pacific Islands; An Evaluation of Members of the Genera Clithon Montfort, 1810 and Neritina Lamarck 1816), Easton et al. (2012); Edmondson (1966); Burch (1982); Carpenter and Niem (1988); General Shell Portal (http://www.idscaro.net/sci/index.htm) (2020); Haynes (2001) (Freshwater Snails of the Tropical Pacific Islands); Tryon (1888) (Manual of Conchology); van Benthem (Catalogue of the Non-marine Mollusca of Sumatra and of Its Satellite Islands); Butot (1954) (*Planorbis exustus* and *Amerianna carinata* (Adams) in Java) dan FAO (2005, 2009) (Species Catalogue). Apart from textbooks, several reputable journals were also used to strengthen the identification results (double checklist), such as Liu et al. (1979); Brown (1983); Kristensen and Oggunnowo (1987); Haynes, (1988); Haynes (1990); Pointier JP and Marquet (1990); Charoenchai et al. (1997); Köhler and Glaubrecht (2001); Zilch (2002); Appleton (2003); Facon et al. (2003); Bunje (2004); Glaubrecht and Köhler (2004); Global Invasive Species Database (2005); Haynes (2005); Strong et al. (2008); Tan and Clements (2008); Steinke et al. (2009); Marwoto and Isnaningsih (2011); Collins et al. (2012); Tan et al. (2012); Cowie and Hayes (2012); von Rintelen et al. (2014); Abdou et al. (2015); Appleton and Miranda (2015); Rosenberg (2015); Seddon and Rowson (2015); Chee and Siti (2016); Ng et al. (2016); Abdou et al. (2017); Harding et al. (2019); Sutcharit et al. (2019). The data identifications were then tabulated and interpreted (qualitative descriptive) using the original (authentic) image of each gastropod species along with a detailed and systematic description of the habitat characteristics and their niches. The following image is a map of the research location in 5 districts/cities in Buton Island, Southeast Sulawesi.

RESULTS AND DISCUSSION

Results

Gastropods found in Buton Island consist of 8 families, 18 genera and 40 species. They have various forms and morphological characteristics (polymorphic). This result is scientific evidence of the biodiversity of snails (Mollusca: Gastropoda) on Buton Island, especially in Baubau City, South Buton District, Buton District, Muna District and North Buton District. This can be seen from the geomorphological characteristics of the unique habitat on this island. Their habitats across the administrative districts

were relatively the same, where they lived on rocky rivers and waterfalls with rocky contours. The characteristic of these niche spaces is the main factor in the endemicity of the environment and the gastropods population of Buton Island. The mainland's gastropods are generally smaller (in terms of size) than those found in the island clusters. One example gastropod from genus *Melanoides* has a length of ±90 mm and a width of 12 mm. This size is not common in inland areas, which are generally ±40-60 mm (length) and ±5-7 mm (width). In addition, some gastropods were rarely found in mainlands, such as *Thiara cancellata*, *Cyclotus taivanus*, *Cyclotus tubuliferus*, and *Naninia citrina citrina*. The majority of the gastropods' population observed in Buton Island is relatively the same as found in other 8 districts/cities for mainland clusters, both in natural inland and artificial waters (North Kolaka, Kolaka, East Kolaka, Bombana, Konawe, South Konawe, and North Konawe). Similar to the mainland cluster, the families Neritidae and Thiaridae are the largest groups observed in the freshwater ecosystem of the island. The large population of these families is probably due to their ability to tolerate the various physical characteristics of freshwater habitats (natural and artificial). They have polymorphic shell shapes with various shell colors (Neritidae) that were sometimes quite difficult to be identified. In addition, Neritidae has diverse characteristics, both interspecific and intraspecific. The polymorphic body morphology and high adaptability to dynamic habitats make the Neritidae community one of the largest snail families that make up freshwater ecosystems in Southeast Sulawesi, especially flowing river waters with rocky bottom substrates. Polymorphisms in Neritidae snails exist in every species. *Clithon* genus belonging to Neritidae family is the largest group with very diverse morphological characteristics, both those with and without spines. One species from this genus, for example, *C. corona*, has very high polymorphic properties, as well as in other species. Apart from *Clithon*, Other genera such as *Neritina*, *Vittina*, and *Septaria* also have various forms but not as many as *Clithon* genus. Neritida also has varied color characters, and the combination of color and shape became a challenge during the identification process. As a consequence, many samples belonging to this group were unidentified and a further investigation addressing genetic diversity is urgently required. The detailed and systematic composition of gastropods based on family is presented in the following images.

Polymorphic snails of freshwater Neritidae family in Buton Island, Southeast Sulawesi Province, are presented in Table 1 and Figures 3-7.

The following figure is a map of the distribution of the existing gastropods areas in 5 districts/cities on Buton Island (Figure 2). Figure 2 shows that spatially the gastropod population is evenly distributed in all districts/cities in Buton Island. This shows the existence of the gastropod community in the freshwater and they potentially become aquatic resources that need to be optimized. Typically, the sampling locations (freshwater) are rocky rivers. Several places in Baubau City and Buton District are artificial freshwater areas such as rice fields, embankments, dams, and waterways. These locations are also a habitat for various types of gastropods such as *P. ampullacea*, *P. canaliculata*, *B. javanica*, *F. javanica*, and other species from the Thiaridae family. The details of the locations and habitat types of freshwater gastropods observed in Buton Island are represented in Table 2.

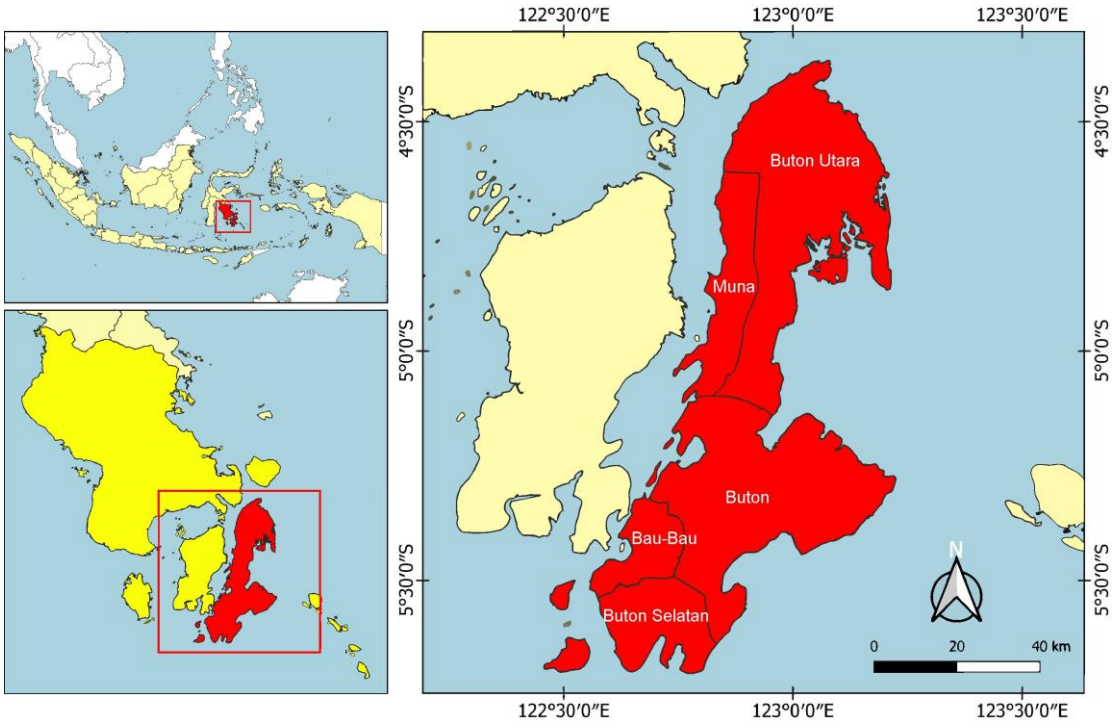
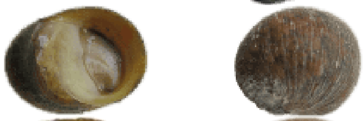
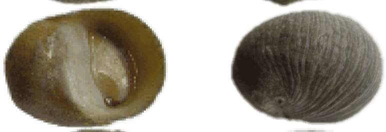
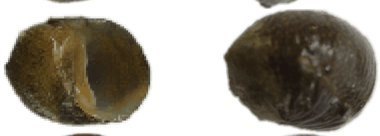
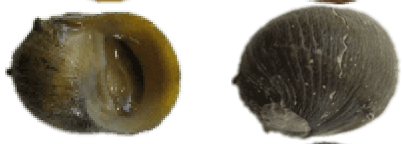
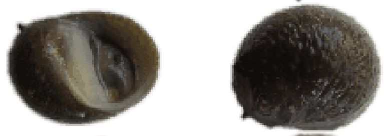
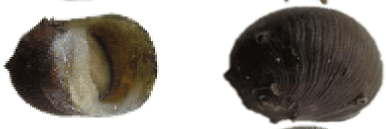
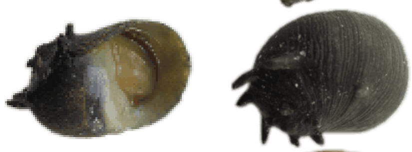
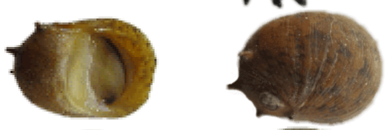
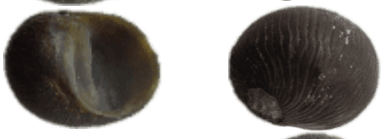
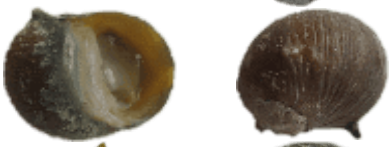
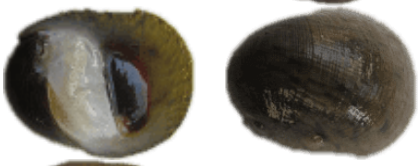


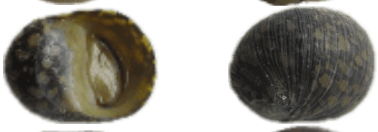
Figure 1. Map of research location in Buton Islands, Southeast Sulawesi Province, Indonesia

Table 1. Various neritidae snails from freshwater area in Buton Island, Indonesia

Species	Specimen
Neritina punctulata Lamarck, 1816	
Clithon cf. faba Sowerby II, 1836	
Clithon cf. faba Sowerby II, 1836	
Clithon cf. faba Sowerby II, 1836	
Clithon sowerbianus Récluz, 1843	
Clithon sowerbianus Récluz, 1843	
Clithon sowerbianus Récluz, 1843	
Clithon sowerbianus Récluz, 1843	
Clithon sowerbianus Récluz, 1843	
Clithon sowerbianus Récluz, 1843	
Clithon corona Linnaeus, 1758	
Clithon corona Linnaeus, 1758	
Clithon corona Linnaeus, 1758	
Clithon corona Linnaeus, 1758	

Species	Specimen
Clithon corona Linnaeus, 1758	
Clithon corona Linnaeus, 1758	
Clithon corona Linnaeus, 1758	
Clithon corona Linnaeus, 1758	
Clithon corona Linnaeus, 1758	
Clithon corona Linnaeus, 1758	
Clithon corona Linnaeus, 1758	
Clithon corona Linnaeus, 1758	
Clithon corona Linnaeus, 1758	
Clithon corona Linnaeus, 1758	
Clithon corona Linnaeus, 1758	
Clithon corona Linnaeus, 1758	
Clithon corona Linnaeus, 1758	
Clithon corona Linnaeus, 1758	

Species	Specimen
Clithon corona Linnaeus, 1758	
Clithon corona Linnaeus, 1758	
Clithon corona Linnaeus, 1758	
Clithon corona Linnaeus, 1758	
Neritina labiosa Sowerby, 1836	
Neritina pettiti Récluz, 1841	
Neritina cornuta Reeve, 1855	
Neritina cornuta Reeve, 1855	
Neritina canalis Sowerby, 1825	
Vittina pouchetii Hombron & Jaquinot, 1854	
Clithon diadema Recluz, 1841	
Clithon flavovirens Von dem Busch, 1843	
Clithon flavovirens Von dem Busch, 1843	
Clithon flavovirens Von dem Busch, 1843	

Species	Specimen
Clithon flavovirens Von dem Busch, 1843	
Clithon fuliginosus Von dem Busch, 1843	
Neritina variegata Lesson, 1831	
Neritina variegata Lesson, 1831	
Neritina variegata Lesson, 1831	
Neritina sp. Rafinesque, 1815	
Neritina knorri Recluz, 1841	
Neritina pulligera Linnaeus, 1767	
Septaria porcellana Linnaeus, 1758	
Septaria porcellana Linnaeus, 1758	
Septaria luzonica Recluz C, 1841	
Septaria borbonica Bory,1803	
Septaria borbonica Bory,1803	

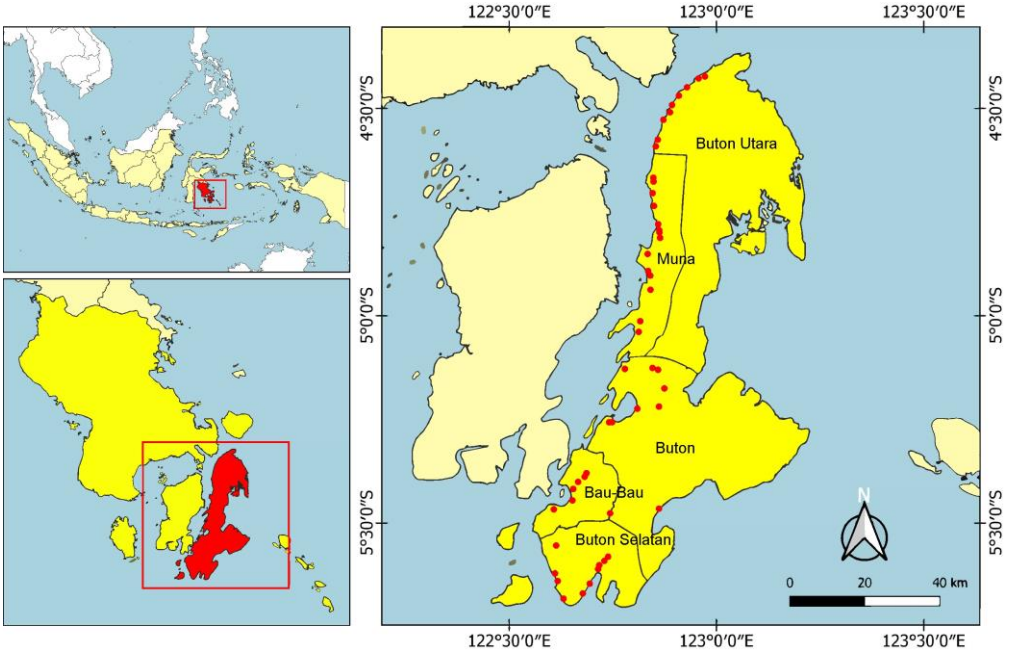


Figure 2. Map of distribution of the existing gastropod in Buton Island, Southeast Sulawesi Province, Indonesia

Table 2. Matrix habitats/niches freshwater gastropods in Buton Island, Southeast Sulawesi Province, Indonesia

Existing location	Coordinate	Habitat/niche
Baubau City		
Bungi River, Lakologau Village, Kokalukuna Sub-district	-5.4186413,122.6532229	Rocky river (Dams)
Rice fields/dams, Waliabuku Village, Bungi Sub-district	-5.3891978,122.6811073	Rice Fields/Embees
Rice fields, dikes and the Ngkari-ngkari River, Ngkari-ngkari Village, Bungi Sub-district	-5.3819613,122.6850279	Rice Fields, Embankments and Rivers
South Buton District		
Bola Village Waterfall, Batauga Sub-district	-5.6832426,122.6295445	Waterfall
Watershed of Katilombu Village, Sampolawa Sub-district	-5.648162,122.6914696	Rocky river
TPI Watershed, Katilombu Village, Sampolawa Sub-district	-5.6459146,122.692435	River
Wandoke Watershed, Gunung Sejuk Village, Sampolawa Sub-district	-5.5817969,122.7369227	Rocky river
Buton District		
Wakoko Watershed, Wakoko Village, Pasar Wajo Sub-district	-5.4663136,122.8597785	Rocky river
Kaongkea Watershed, Kaongkea Village, Pasar Wajo Sub-district	-5.4771894,122.7418421	Rocky river
Watershed of Wakalambe Village, Kapontori Sub-district	-5.2569881,122.7471174	Sand/Gravel Substrate River
Drainage and Rivers in Bukit Asri Village, Kapontori Sub-district	-5.1268598,122.8445677	Drainage and River
Watershed of Tumada Village, Kapontori Sub-district	-5.1306287,122.7779594	Sand/Gravel Substrate River
Muna District		
Watershed of Kamosope Village, Pasir Putih Sub-district	-5.0423026,122.8141782	Rocky river
Watershed of Kamosope Village, Pasir Putih Sub-district	-5.039747,122.8124467	Rocky river
Watershed of Bumbu Village, Pasir Putih Sub-district	-5.0145936,122.8157215	Rocky river
Watershed of Wakorumba Village, South Wakorumba Sub-district	-4.9378853,122.8399234	Rocky river
Watershed of Pure Village, South Wakorumba Sub-district	-4.9045159,122.8383363	Sand/Gravel Substrate River
Big Watershed of Wambona Village, South Wakorumba Sub-district	-4.851451,122.8325438	Sand/Gravel Substrate River
Moolo Village Watershed, Batukara Sub-district	-4.8132803,122.8623753	Sand/Gravel Substrate River
Moolo Village Watershed, Batukara Sub-district	-4.8000399,122.8607919	Sand/Gravel Substrate River
Watershed of Lanobake Village, Batukara Sub-district	-4.7799715,122.8585829	Sand/Gravel Substrate River
Watershed of Pohorua Village, Maligano Sub-district	-4.7365631,122.8481865	Sand/Gravel Substrate River
Watershed of Maligano Village, Maligano Sub-district	-4.7048198,122.8446271	Sand/Gravel Substrate River
Watershed of Latompa Village, Maligano Sub-district	-4.6769688,122.8467225	Sand/Gravel Substrate River
Watershed of Langkoroni Village, Maligano Sub-district	-4.6681353,122.8461626	Sand/Gravel Substrate River
North Buton District		
Watershed of Matalagi Village, North Wakorumba Sub-district	-4.5924071,122.8524992	Sand/Gravel Substrate River
Watershed of Matalagi Village, North Wakorumba Sub-district	-4.5767612,122.8562651	Sand/Gravel Substrate River
Watershed of Matalagi Village, North Wakorumba Sub-district	-4.5761046,122.8564783	Sand/Gravel Substrate River
Watershed of Labuan Bajo Village, North Wakorumba Sub-district	-4.4770369,122.90418	Sand/Gravel Substrate River
River (on the Embankment) Labuan Bajo Village, North Wakorumba	-4.4724857,122.9071467	Sand/Gravel Substrate River
Watershed of Labuan Bajo Village, North Wakorumba Sub-district	-4.4700202,122.9078342	Muddy Sand Substrate River

Figure 2. Various morphology of thiaridae snail (*Melanoides tuberculata*)

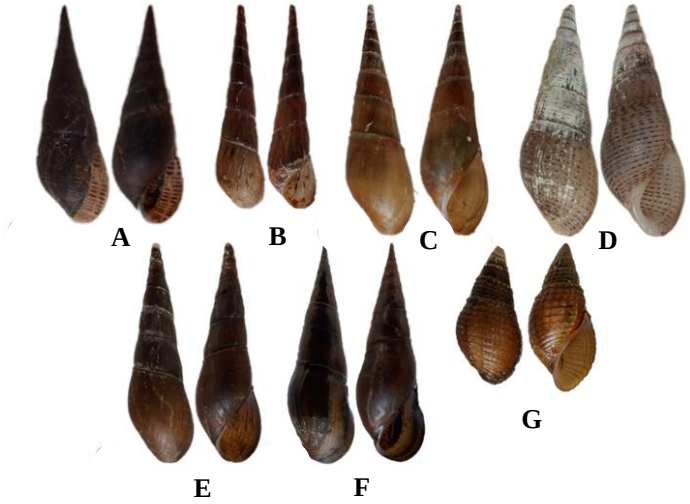


Figure 3. Various of thiaridae snail: (A) *Melanoides cf. Maculata,* (B) *Stenomelania offachiensis,* (C) *Stenomelania offachiensis,* (D) *Melanoides cf. maculata,* (E) *Stenomelania plicaria,* (F) *Stenomelania rufescens,* (G) *Tarebia granifera*

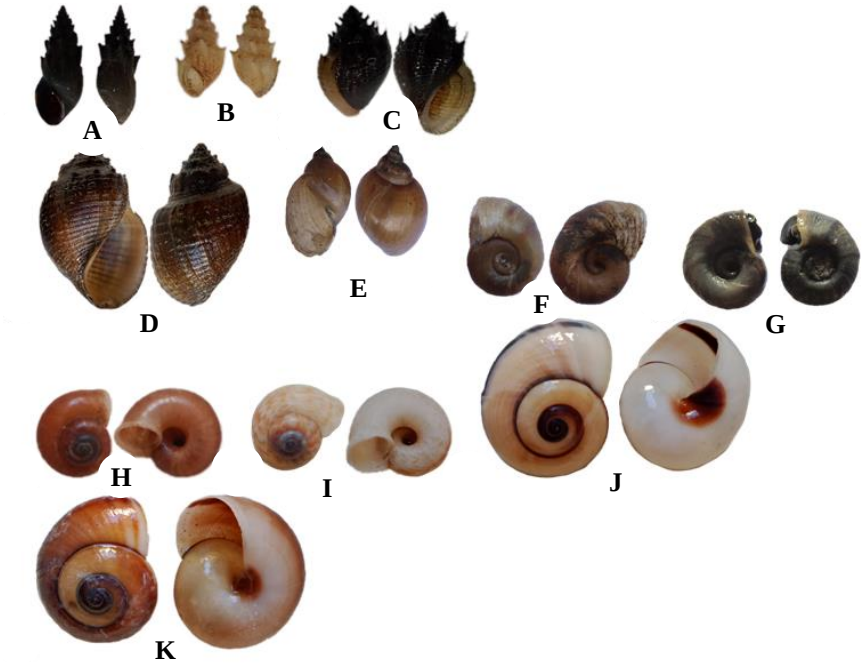


Figure 4. Various of freshwater snails. (A) *Thiara scabra* (b) *Thiara winteri*, (C) *Thiara cancellata* (Juvenile), (D) *Thiara cancellata*, (E) *Lymnaea rubiginosa,* (F) *Amerianna carinata,* (G) *Indoplanorbis exustus,* (H) *Cyclotus taivanus* (I) *Cyclotus tubuliferus,* (J) *Naninia citrina citrina,* (K) *Naninia citrina citrina*

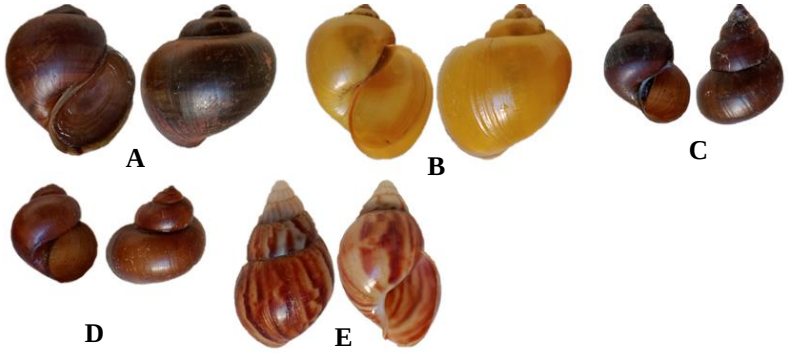


Figure 5. Various Morphology of freshwater snails. (A) *Pila ampullacea*, (B) *Pomacea canaliculata*, (C) *Bellamya javanica*, (D) *Filopaludina javanica*, (E) *Achatina fulica*

Discussion

Inland waters of Buton Island are habitats and niches of aquatic germplasm, especially the gastropod community (Mollusca: Gastropods). As many as 40 species and 8 families were identified and scattered in 5 districts/cities (Baubau, South Buton, Buton, North Buton and Muna). The terrestrial gastropods of Buton Island occupy all inland waters, in both natural waters (rivers/waterfalls, lakes and swamps) and artificial waters (rice fields, dams, embankments and drainage). Generally, the type of inland waters of Buton Island is a river with a rock/gravel/sand substrate, therefore the gastropod community is dominated by the population of Neritidae and Thiaridae (sticking snails). This is due to the fact that these ecological characteristics are the optimal habitat type for the Neritidae and Thiaridae family. Also, these families have a high adhesion ability to the rocky substrates. This finding in line with previous studies indicating that the rivers with strong current and a rocky bottom substrate become the habitat for most of the gastropods from Thiaridae and Neritidae families (Dharma 1988; Subba Rao 1989; Appleton 2003, 2015; Abdou et al. 2015; Harding et al. 2019; Purnama et al. 2019; Sirza et al. 2020).

In addition, these two families are resistant to environmental changes and some species are known to be invasive alien species. Among the various types of gastropods, the Neritidae family is always found together with Thiaridae family, such as *Thiara winteri*, *Thiara scabra*, *Thiara cancellata* and invasive types like *Tarebia granifera* and *Melanoides tuberculata*. The gastropods were found in rice fields and dams (*Pila ampullacea*, *Pomacea canaliculata*, *Bellamya javanica* and *Filopaludina javanica*), embankments and drainage (*Lymnaea rubiginosa*, *Amerianna carinata* and *Indoplanorbis exustus*), and some of them were climbing gastropod where they were in trees or river vegetations, for example, *Cyclotus taivanus*, *Cyclotus tubuliferus*, *Naninia citrina citrina* and *Achatina fulica*. More detail, the gastropods observed in Buton Island include, (i) Famili Neritidae: *Neritina punculata*, *Clithon cf. faba*, *Clithon sowerbianus*, *Clithon corona*, *Neritina labiosa*, *Neritina petiti*, *Neritina cornuta*, *Neritina canalis*, *Vittina pouchetii*, *Clithon flavovirens*, *Clithon diadema*, *Clithon fuliginosus*, *Neritina variegata*, *Neritina* sp., *Neritina knorri*, *Neritina pulligera*, *Septaria porcellana*, *Septaria borbonica* dan *Septaria luzonica* (ii) Famili Achatinidae: *Achatina fulica* (iii) Famili Ampullariidae: *Pila ampullacea*, *Pomacea canaliculata*, *Bellamya javanica* and *Filopaludina javanica* (iv) Famili Helicarionoidea: *Naninia citrina citrina* (v) Famili Cyclophoridae: *Cyclotus taivanus* dan *Cyclotus tubuliferus* (vi) Famili Planorbidae: *Amerianna carinata* dan *Indoplanorbis exustus* (vii) Famili Lymnaeidae: *Lymnaea rubiginosa* (viii) Famili Thiaridae: *Melanoides tuberculata*, *Melanoides* cf. *maculata*, *Stenomelania offachiensis*, *Stenomelania offachiensis*, *Stenomelania plicaria*, *Stenomelania rufescens*, *Tarebia granifera*, *Thiara scabra*, *Thiara winteri*, *Thiara cancellata*. These gastropods (interspecific/intraspecific) have various forms/morphological characteristics (polymorphism). This finding indicates that Buton Island has a high biodiversity of freshwater gastropods, both in terms of taxon and bioecological aspects. Also this diversity cannot be separated from the threat of the phenomenon of alien species invasion (IAS), especially from the gastropod group itself.

This study noted several invasive alien species that were confirmed to threaten the sustainability of local species, namely *M. tuberculata*, *A. fulica* and *T. granifera*. Among the three alien species, *T. granifera* or *operculum snail*, become an invasive snail that dominates the gastropod community in the waters where they were always observed in every type of freshwater habitat in Buton Island. This result is similar to what has been found by Moon et al. (2021), where the invasive alien species, i.e., *T. granifera* observed in all freshwater habitats in Buton Island and they always dominate the niche space that they occupy. Furthermore, Sirza et al. (2020) stated that *T. granifera* could eliminate the existence of native species in the ecosystem with 2 things: high adaptability to environmental changes and dynamic characteristics of inland waters and the ability to reproduce by parthenogenesis or egg development without going through copulation first with males. As a consequence, *T. granifera* has an uncontrolled population, particularly in Buton Island, including in Southeast Sulawesi (Purnama et al. 2020; Sirza et al. 2020; Purnama et al. 2021). A serious

threat is also shown by the invasive alien species *M. tuberculata* (Facon et al. 2005; Daniel et al. 2019). Although the level of invasion is not as big as *T. granifera*, this species was also found throughout the freshwater area in Buton Island with various forms and morphological characteristics.

In addition, Purnama et al. (2019) revealed that *M. tuberculata* was observed in all types of freshwater habitats (rivers, lakes, swamps, embankments, dams, rice fields and drainage areas) inland clusters of Southeast Sulawesi (8 districts/cities: Kendari, South Konawe, Bombana, Kolaka, North Kolaka, East Kolaka, Konawe and Konawe Utara). Its population densities are quite high (25-67 ind.m^{-2}), invading the entire freshwater area of Southeast Sulawesi (Purnama et al. 2020; Purnama et al. 2021) and also the world due to its ability to reproduce via parthenogenesis, like another invasive alien species *T. granifera* (Murray 1964; Livshits and Fishelson 1983; Livshits and Fishelson, 1984; Heller and Farstey 1990; Rader et al. 2003; Facon et al. 2005; Daniel et al. 2019; Murray, 1964).

Finally, conservative efforts and management strategies are needed to control the invasive alien species (IAS), in order to protect freshwater gastropod resources found in Buton Island. Therefore, as a scientific basis for the appropriate development of regulations and conservation methods for gastropod commodities, the study can serve as a reference and empirical basis in determining them.

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