



Freshwater Neritidae in Southeast Sulawesi, Indonesia

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Abstract. The present research was conducted from March 2019 to August 2020 in the natural and artificial inland waters of Southeast Sulawesi Province. The purpose of this research was to determine the species diversity of the freshwater Neritidae family in Southeast Sulawesi. It is expected that this research will reveal the biodiversity potential of freshwater Neritidae snails as a form of exploration in optimizing the utilization of the Neritidae commodity in Southeast Sulawesi. Determination of the locations for the Neritidae sampling was done through the purposive sampling method and the sampling of the biota used the simple random sampling method at locations that had been predetermined based on the distinctive habitat characteristics of rocky rivers and fast currents. Neritidae samples were collected manually with gloves. As Neritidae live attached to rocks and other hard objects in the river, their collection was relatively easy. Neritidae snails in the fresh waters of Southeast Sulawesi consist of 22 species from 4 genera which are generally distributed in river waters with currents and rocky substrates. The types of Neritidae snails found in Southeast Sulawesi include: *Clithon castaneus*, *Clithon corona*, *Clithon diadema*, *Clithon dominguense*, *Clithon faba*, *Clithon flavovirens*, *Clithon fuliginosum*, *Clithon oualaniense*, *Clithon sowerbianus*, *Neritina canalis*, *Neritina cornuta*, *Neritina knorri*, *Neritina labiosa*, *Neritina petiti*, *Neritina pulligera*, *Neritina punctulata*, *Septaria borbonica*, *Septaria luzonica*, *Septaria porcellana*, *Vittina coromandeliana*, *Vittina pouchetii*, and *Vittina variegata*. Southeast Sulawesi Neritidae snails have very large and diverse polymorphism, making the Neritidae family to be one of the largest snail communities that make up the freshwater ecosystem.

Key Words: freshwater, Neritidae, polymorphism, rocky river, Southeast Sulawesi.

Introduction. Southeast Sulawesi Province is an administrative area located in the southeastern peninsula of Sulawesi Island. One of the major sectors in Southeast Sulawesi is the fishery and marine sector. Not limited to the wealth of the coastal, marine, and large island resources (sea area = 110,000 km² or 11,000,000 ha) and inland fisheries (land area = 38,140 km² or 3,814.000 ha), Southeast Sulawesi also possesses a vital potential if managed in a sustainable manner (potential fish and non-fish resources in inland waters) (Central Bureau of Statistics Southeast Sulawesi Province 2019).

Important economic commodities in the freshwaters of Southeast Sulawesi include fishes (*Colossoma macropomum*, *Cyprinus carpio*, *Oreochromis niloticus*, *Clarias* sp., *Oreochromis mossambicus*, *Pangasius pangasius*, *Channa striata*, *Anguilla anguilla* and *Monopterus albus*), pelecypods or shellfish, and gastropods or snails. In addition to their fondness in consuming fish, the local people also consume gastropod commodities, such as *Bellamya javanica* and *Filopaludina javanica* or better known as the Javanese tutut snail. The locals call it boiku. Various types of gastropods from the *Melanoides* genus are

also widely consumed by the people of Southeast Sulawesi, especially those in the archipelago, making them highly sought-after as the characteristic freshwater commodity of Southeast Sulawesi (Tjakrawidjaja 2006; Purnama et al 2019a, b, c).

Among the many gastropod resources found in Southeast Sulawesi's freshwater, the Neritidae family is one of the largest groups inhabiting the natural and artificial land waters (rivers, lakes, swamps, dams, ponds, and drainage/embankments). Their presence can be linked to the major characteristics of the rivers in the southeastern mainland of Sulawesi Island, with their rock type and relatively fast currents. Similarly, artificial inland waters such as dams, ponds, embankments/drainage, and reservoir have hard and flat structure with flow of current. These habitat characteristics create nice suitable niches for the Neritidae snails. Rocky and flat substrate structures provide natural attachment media for the gastropod from the Neritidae family (Mujiono 2016; Purnama et al 2019a; Sarong & Mursawal 2018).

No previous research has been done specifically on the freshwater Neritidae snails in Southeast Sulawesi, consequential of the absence of empirical information or scientific data regarding this polymorphic shell commodity, particularly in relation to their use and management. Meanwhile, the Neritidae snails are a group of gastropods that have high economic value within the world trade commodity as ornamental gastropods (Mackie 2000; FAO 2005; Duggan 2010; Ng et al 2016) and as a healthy and filling form of food (Purnama et al 2019a). Therefore, research on the diversity of freshwater Neritidae snails in Southeast Sulawesi is very important to be conducted.

Material and Method. This research was carried out from March 2019 to August 2020 in stages, both in natural land (rivers, lakes, swamps) and man-made (dams, lakes, reservoirs, and drainage/embankments) water locations in Southeast Sulawesi Province. Systematically, this research was initiated with a preliminary survey or field observation to ascertain the typology or characteristics of the inland waters of the research stations or sampling locations. This process would ease the classification of inland waters to select suitable sampling locations. Field observation activities were carried out for \pm 2 months. The locations of the Neritidae sampling was determined using the purposive sampling technique with research stations established in land waters with rocky substrate or hard, flat, and smooth structures accompanied by fast currents. The Neritidae sampling process used the simple random sampling technique at the stations or sampling points that had been determined. Neritidae snails that stick to rock surfaces and hard structures at the research locations were collected manually with gloves. Sample observations were carried out at the Laboratory of Aquatic Resources Management, Faculty of Fisheries and Marine Sciences, Halu Oleo University, Kendari. The Neritidae snails found at the research sites were identified using the identification keys from: van Benthem Jutting (1959), Edmondson (1966), Burch (1982), Carpenter & Niem (1988), Dharma (1988), Haynes (1988, 1990, 2001, 2005), Subba Rao (1989), FAO (2005), Strong et al (2008), Easton et al (2012), Eichhorst (2016a, b), and General Shell Portal (2020). Apart from textbooks, several journal articles were also used to strengthen the identification results (double checklist), such as Bunje (2004), Tan & Clements (2008), Marwoto & Isnainingsih (2011); Tan et al (2012); Abdou et al (2015, 2017), Seddon & Rowson (2015), Chee & Siti Azizah (2016); Ng et al (2016). The identification results were then tabulated and interpreted qualitatively using pictures of each type of Neritidae along with a detailed description of the characteristics of the habitat and its niche. The map of the research location is presented in Figure 1.

Results. The freshwater Neritidae snails of Southeast Sulawesi have diverse interspecific and intraspecific characteristics. Polymorphic morphologies and high adaptability to dynamic habitats have made the Neritidae family one of the largest snail families that make up the freshwater ecosystem in Southeast Sulawesi. Especially in rivers with currents and rocky bottom substrates. The identification results show that, in the fresh waters of Southeast Sulawesi, there are 22 species of snails from 4 genera of the Neritidae family with very high morphological diversity (polymorphism). The following is a

detailed tabulation of the types of snails from the Neritidae family found in Southeast Sulawesi Province (Table 1).

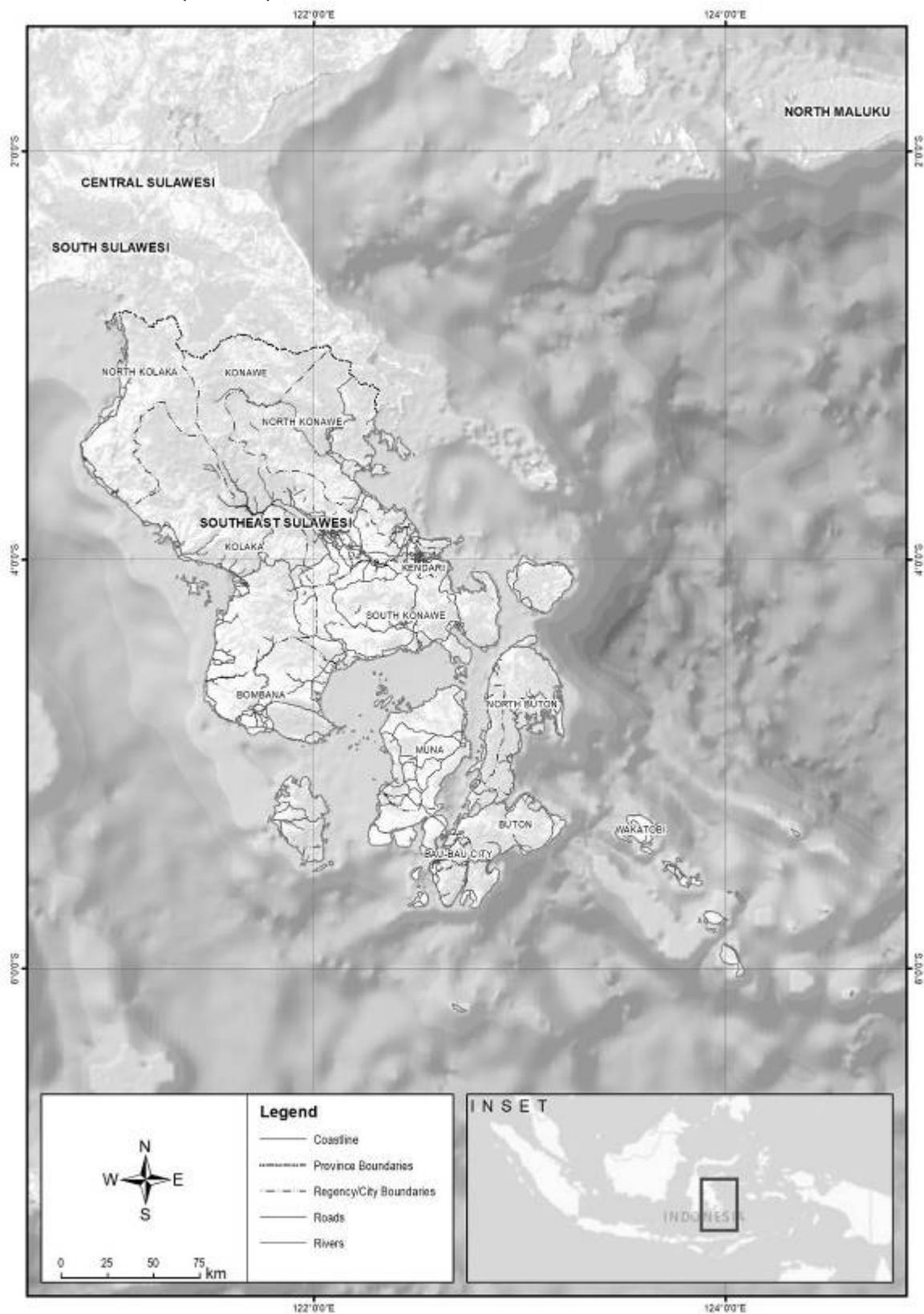


Figure 1. Map of the research location.

Table 1

Types of snails from the Neritidae family in Southeast Sulawesi Province

No.	Genus	Species
1	<i>Clithon</i>	<i>Clithon castaneus</i> (Hombron & Jacquinot, 1854)
2		<i>Clithon corona</i> (Linnaeus, 1758)
3		<i>Clithon diadema</i> (Récluz, 1841)
4		<i>Clithon dominguense</i> (Lamarck, 1822)
5		<i>Clithon faba</i> (Sowerby I, 1836)
6		<i>Clithon flavovirens</i> (Von dem Busch, 1843)
7		<i>Clithon fuliginosum</i> (Von dem Busch, 1843)
8		<i>Clithon oualaniense</i> (Lesson, 1831)
9		<i>Clithon sowerbianus</i> (Récluz, 1843)
10	<i>Neritina</i>	<i>Neritina canalis</i> Sowerby, 1825
11		<i>Neritina cornuta</i> Reeve, 1856
12		<i>Neritina knorri</i> (Récluz, 1841)
13		<i>Neritina labiosa</i> Sowerby, 1836
14		<i>Neritina petiti</i> Récluz, 1841
15		<i>Neritina pulligera</i> (Linnaeus, 1767)
16	<i>Neritina punctulata</i> Lamarck, 1816	
17	<i>Septaria</i>	<i>Septaria borbonica</i> (Bory de Saint-Vincent, 1804)
18		<i>Septaria luzonica</i> (Souleyet, 1841)
19		<i>Septaria porcellana</i> (Linnaeus, 1758)
20	<i>Vittina</i>	<i>Vittina coromandeliana</i> (Sowerby I, 1836)
21		<i>Vittina pouchetii</i> (Hombron & Jacquinot, 1848)
22		<i>Vittina variegata</i> Lesson, 1831

Identification source: Eichhorst (2016a, b).

Polymorphisms in Neritidae snails exist for each species. The *Clithon* genus was found to be the largest group with very diverse morphological characteristics, among them those with spine and those without spines. Just one type of the *Clithon* snail such as *C. corona* has very high polymorphic characteristic (Figure 4), as with other types from the *Clithon* genus (Figure 5). Apart from *Clithon*, there are also other genera such as *Neritina*, *Vittina* and *Septaria* (Figures 2, 3 and 6 respectively). Some of these genera have varied forms, but not as many as the *Clithon* genus.

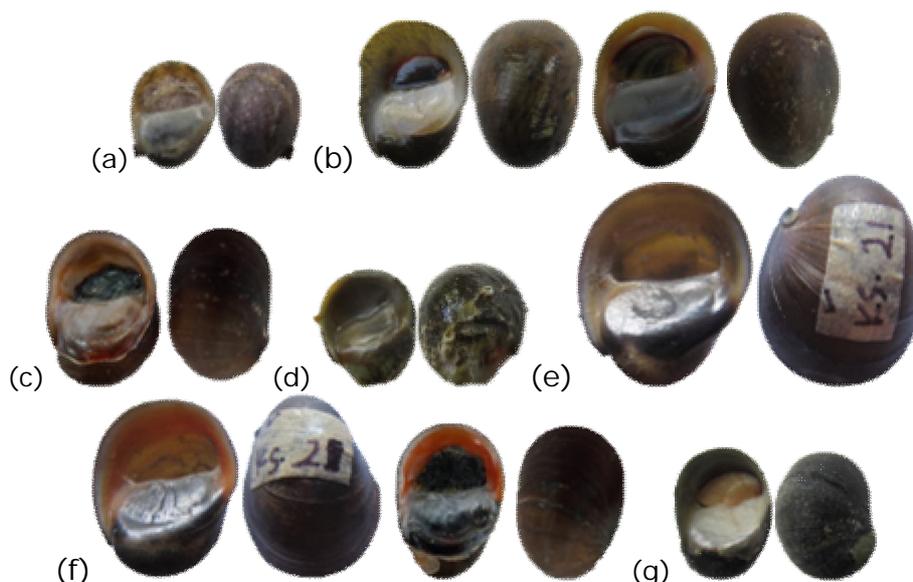


Figure 2. (a) *N. canalis*; (b) *N. cornuta*; (c) *N. knorri*; (d) *N. labiosa*; (e) *N. petiti*; (f) *N. pulligera*; (g) *N. punctulata*.



Figure 3. (a) *V. coromandeliana*; (b) *V. pouchetii*; (c) *V. variegata*.



Figure 4. Polymorphic of *C. corona*.

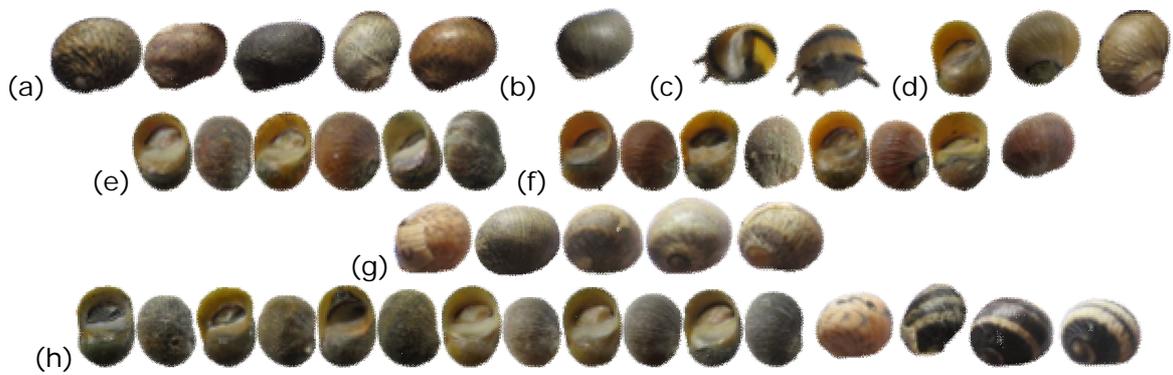


Figure 5. (a) *C. castaneus*; (b) *C. dominguense*; (c) *C. diadema*; (d) *C. fuliginosum*; (e) *C. faba*; (f) *C. flavovirens*; (g) *C. oualaniense*; (h) *C. sowerbianus*.



Figure 6. (a) *S. borbonica*; (b) *S. luzonica*; (c) *S. porcellana*.

Discussion. The diversity of species and high morphological variations of the Neritidae family make this group of snails one of the largest biotic components that make up the aquatic ecosystem of the snail kind. The Neritidae snails are polymorphic with diverse and aesthetic characteristics, that apart from being traded as a food commodity (Purnama et al 2019a), they are traded in the world community as ornamental biota (Ng et al 2016). In this research, 22 species from 4 genera (*Neritina*, *Vittina*, *Clithon* and *Septaria*) were found in the fresh waters of Southeast Sulawesi province, as provided in Table 1. Southeast Sulawesi Neritidae snails occupy a unique and dynamic freshwater habitat, namely streams with rock substrates. Neritidae snails are scattered in the upstream, downstream, and to the estuary areas in rocky rivers and attaching their bodies to rocks. Generally, each genus in the Neritidae family lives in streamed rivers, but differences exist in the conditions of their niches related to the rock substrate occupied. The *Septaria* and *Neritina* genera attach to large boulders on a flat surface, while the genera *Clithon* and *Vittina* are predominantly attached to small rocks or gravel. This is linked to their adaptation to the special characteristics of their respective habitats, where the *Septaria* and *Neritina* genera live in freshwater streams or high-water zones, located upstream in mountainous areas or highlands, while the *Clithon* and *Vittina* genera live in a relatively moderate-conditioned river (Odum 1988; Purnama et al 2019a). The findings are in accordance with Odum (1996) wherein the swift water zone is the shallow area with a high current velocity and is inhabited by specially adapted benthos or ferritic biota which can firmly adhere to a solid bottom. Furthermore, Purnama et al (2019a) stated that the Neritidae snails of the *Clithon* and *Neritina* genera are also a group of Gastropods in the fresh waters on the mainland of Southeast Sulawesi. The two genera are the euryhaline Gastropods. These genera live attached to rocks in rivers and estuaries with rocky textures and swift currents. According to Tan & Clements (2008) the snails found are euryhaline snails, whereby *Nerita* lives in marine waters, while *Neritina* and *Clithon* prefer to live in estuaries and freshwaters. Dharma (1988) and Marwoto et al (2011) stated that the Neritidae family can live in fresh, brackish, and marine waters. Members of the Neritidae that live in these three types of water include *Clithon oualaniense*, *Nerita maxima*, *Nerita polita*, *Nerita signata*, *Neritopsis radula*, *Septaria porcellana* and *Septaria tessellata*. Siamtupang et al (2017) stated that the Gastropod class (Neritidae and Tegulidae families) are benthic groups that are very tolerant or have high enough body resistance to be able to live in the estuary of the Nipah River compared to the Bivalvian class. This is because the Gastropod class has a watertight shell that functions as a barrier, so that at low tide, the shell can be closed tightly with the operculum. In addition, in their respective habitats, Gastropods consume microorganisms or soil organic matter for their survival. Purnama et al (2019a) also found various patterns and colors in the shells of the Neritidae family (polymorphism), which had made the identification process more complicated. It is thus the case that the Neritidae family has a lot of species that have unidentified status or are only identified to their genus level. The results of this study are in line with the statements of Tan & Clements (2008) and Mujiono (2016) that the Neritidae family has polymorphic shells, meaning that one species type can have many variations in patterns and colors. Consequently, this has led to a lot of different naming in within that particular species, leaving many inconsistencies in the validity and usage of species. Neritidae snails also have important economic value much like other types of gastropods. The majority of these types of snails are traded around the world as ornamental gastropods for aquariums because of the shell shapes with diverse colors and characteristics. The color and aesthetic that the shells have make this snail family one of the most sought after aquarium commodities (Mackie 2000; FAO 2005; Duggan 2010; Ng et al 2016). Additionally, these gastropods, which are also known as the ogong snail, are also a consumable commodity that is very easy to obtain in river waters because they are relatively sessile that tend to have limited movement. In Indonesia, this gastropod group (Neritidae) is known by the local name "Ogong snail" and generally this biota is widely used as food for consumption and raw material for making souvenirs (Ridzwan & Kaswandi 1995; Purnama et al 2019a).

Conclusions. The snails of the Neritidae family in the fresh waters of Southeast Sulawesi Province consist of very diverse species and morphologies (polymorphism). There were 22 species from 4 genera recorded and were dominantly located in rivers with currents and rocky substrates. This biota is one of the potential freshwater non-fish resources that needs to be optimized for use, both as food consumption and the main raw material for making souvenirs.

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Conflict of interest. The authors declare that there is no conflict of interest.

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