A note on Gobiidae from some rivers in Luwuk Banggai, Central Sulawesi, Indonesia

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Abstract. Luwuk Banggai in Central Sulawesi Province, Indonesia, is a part of Sulawesi Island in the Wallacea Region with many rivers. These rivers host a high diversity of aquatic species, but this diversity is poorly known. This calls for taxonomic exploration, in particular for the fishes belonging to the Order Gobioidei, commonly called gobies. This study aimed to identify gobies present in rivers Luwuk Banggai, both as a contribution to scientific knowledge on goby biodiversity and distribution and to inform the management of (hitherto unregulated) aquatic resources by the local government agencies involved. The establishment of effective, science-based management is especially important and urgent for those gobies which have economic potential, in particular as freshwater ornamental commodities. The study was conducted from January to July 2019 in several Luwuk Banggai rivers: Mendono River, Mendono Village; Koyoan River; Simpong River; Soho River; Biak River; Honduhon River; Matanyo River; and Salodik River. The specimens obtained (n = 203) were measured and identified based on species-specific characteristics. Species belonging to the Family Gobiidae were more abundant (161 individuals from 20 species) than those in the Family Eleotridae (42 individuals from 6 species). One species commonly found in these rivers was *Lentipes mekonggaensis* (30 individuals).

1. Introduction

Sulawesi Island is the largest land-mass in the Wallacea Region, which is a transitional biogeographical area at the meeting of the Asian and Australasian regions [1]. Sulawesi is renowned

for its high level of endemicity [2], including freshwater fishes [3]. Within this region, the Order Gobioidei, commonly called gobies, is a relatively poorly researched taxon. However, several endemic species have been reported from islands around Sulawesi [4], and some species are of local importance as food fishes [5]. In addition, some gobies have attractive coloration and are in great demand as ornamental fish by the aquarium hobby in various countries around the world, sometimes to the point of threatening wild populations with extinction [6], although species identification is often unclear [7]. Taxonomically, gobies are divided into two families, Gobiidae and Eleotridae. Hubert et al. reported that the Gobiidae is the second largest group of fishes in Indonesia after the Cyprinidae [6]. Furthermore, according to Hadiaty and Sauri, while the freshwater ichthyofauna in the western part of Indonesia is dominated by fish groups from the Cyprinidae family, the Gobiidae is the dominant family in the eastern part of Indonesia [8].

The Luwuk Banggai area in Banggai District, Central Sulawesi Province, is one area of the Wallacea region with many rivers. Luwuk is known as *kota berair*, literally the watery city, because of the large number of rivers and streams which flow into the sea in Luwuk Bay. The major rivers in Banggai District (with their length and watershed area) are the Balingara River (126.758 km/495.122 Ha, Bunta River (57.610 Km/189.935 Ha, Toima River (30.743 Km/98.598 Ha, Lobu River (25.286 km/98.58 Ha/88.899 Ha), Mentawa River (76.580 km/191.892 Ha, Minahaki River (382.50 km/67.875 Ha, Sinorang River (98.728 km/229.914 Ha, Kalumbangan River (55.25 km/167.175 Ha) and Kintom River (20.200 km/36.675 Ha) (https://banggaikab.bps.go.id). These rivers all host a varied but poorly known ichthyofauna, including freshwater gobies. Therefore, this study aimed to identify the gobies present in selected rivers in the Luwuk Banggai area, thus adding to the body of knowledge on freshwater fish biodiversity in the region. The study also aimed to raise awareness of these fishes, in particular at the local government level, and contribute to the scientific basis for aquatic resource management in Luwuk Banggai, in particular with regards to riverine fauna with potential as freshwater ornamental commodities.

2. Methods

This research was conducted from January to July 2019 at sites within eight villages (Desa) along eight rivers in the Luwuk Banggai area (Figure 1). These were:

1. Sungai Mendono, Desa Mendono, Kintom Sub-District
2. Sungai Koyoan, Desa Koyoan, Nambo Sub-District
3. Sungai Simpong, Kelurahan Hanga-Hanga, Luwuk Selatan Sub-District
4. Sungai Soho, Kelurahan Soho, Luwuk Sub-District
5. Sungai Biak, Desa Biak, Luwuk Utara Sub-District
6. Sungai Honduhon, Desa Honduhon, Luwuk Timur Sub-District
7. Sungai Matanyo, Desa Baya, Luwuk Timur Sub-District
8. Sungai Salodik, Desa Salodik, Luwuk Utara Sub-District

Goby specimens were collected at sampling stations along these rivers using electroshocking equipment and a scoop net. Specimens were selected to be photographed using a digital camera based on their condition (undamaged) and coloration in live or fresh (unfaded) conditions. Special efforts were made to record specimens that appeared (visually) different from specimens collected previously. Data were also collected on the habitat from which the sampled specimens were taken. The specimens were preserved in 70% ethanol. The samples were identified based on several references, including [9,10] and FishBase, the global database of fishes [11].

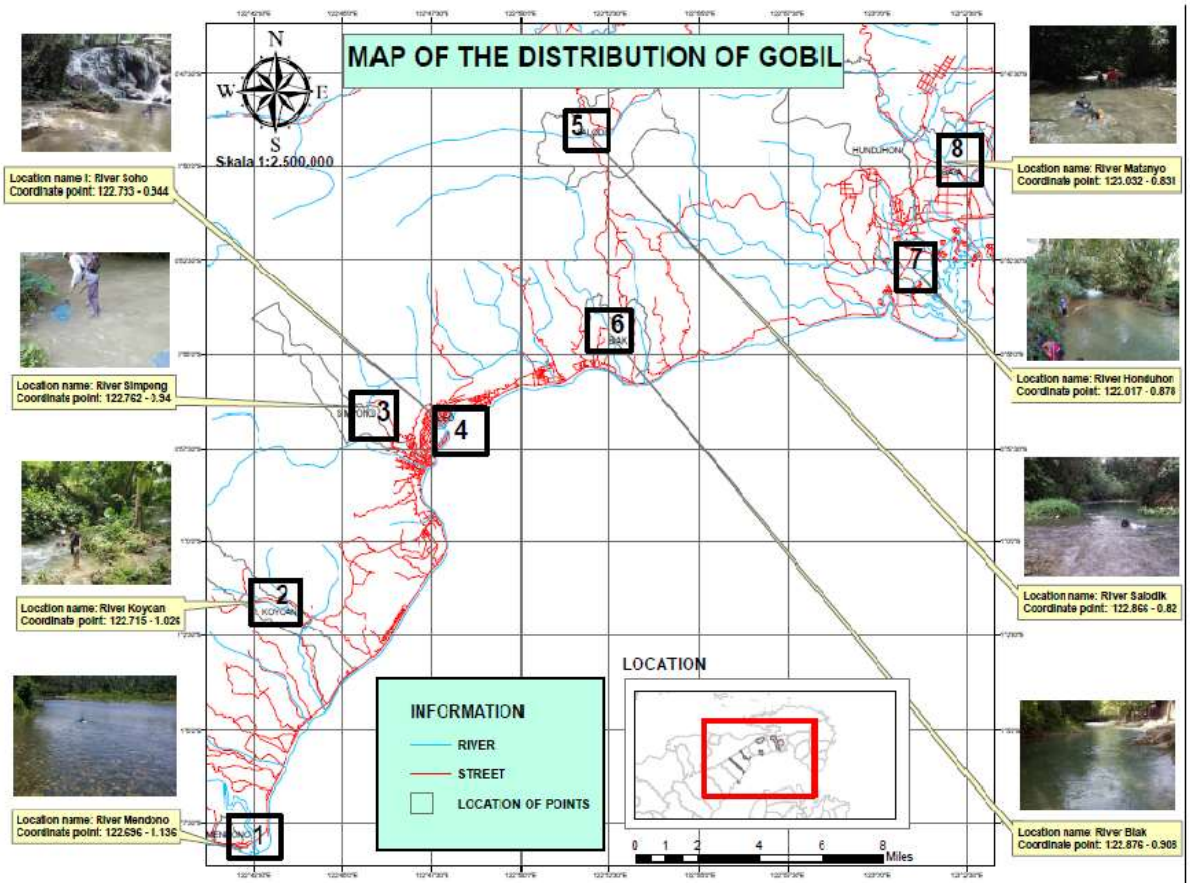

Figure 1. Map of the eight Gobioidei sampling sites in the Luwuk Banggai area.

3. Results

A total of 203 specimens were collected from the eight rivers sampled in the Luwuk Banggai area. These fishes belonging to the Order Gobioidei were identified as 20 species of the Family Gobiidae (161 specimens) and six species of the Family Eletroidae (42 specimens). The most frequently observed species was *Lentipes mekonggaensis*, with a total of 30 specimens collected. In the Luwuk Banggai are, *L. mekonggaensis* was found in fast-flowing rivers with rapids at an elevation of 200-400 meters above sea level. Some of the species identified are illustrated in Figure 2.

Table 1. List of the gobies (Order Gobioidei) collected from eight rivers in the Luwuk Banggai area, Banggai District, Central Sulawesi Province, Indonesia.

Family	Species	n
Eleotridae	*Belobranchus belobranchus*	10
	Belobranchus segra	5
	Eleotris fusca	8
	Eleotris acanthopoma	5
	Oxyeleotris marmorata	6
	Giuris sp.	8
Gobiidae	*Stiphodon semoni*	20
	Stiphodon rutilaureus	1
	Stiphodon atropurpureus	2
	Stiphodon pelewensis	2
	Sicyopterus lagocephalus	10
	Sicyopterus longifilis	5
	Sicyopterus cynocephalus	3
	Sicyopterus microcephalus	3
	Sicyopus zosterophorus	20
	Sicyopus discordipinis	1
	Sicyopus spp.	1
	Smilosicyopus sp.	1
	Lentipes mekonggaensis	30
	Lentipes whittenorum	15
	Lentipes ikeaea	1
	Lentipes cf *armatus*.	1
	Schismatogobius spp.	15
	Stenogobius sp.	10
	Awaous grammepomus	10
	Glossogobius celebius	10
Total number of specimens collected		203

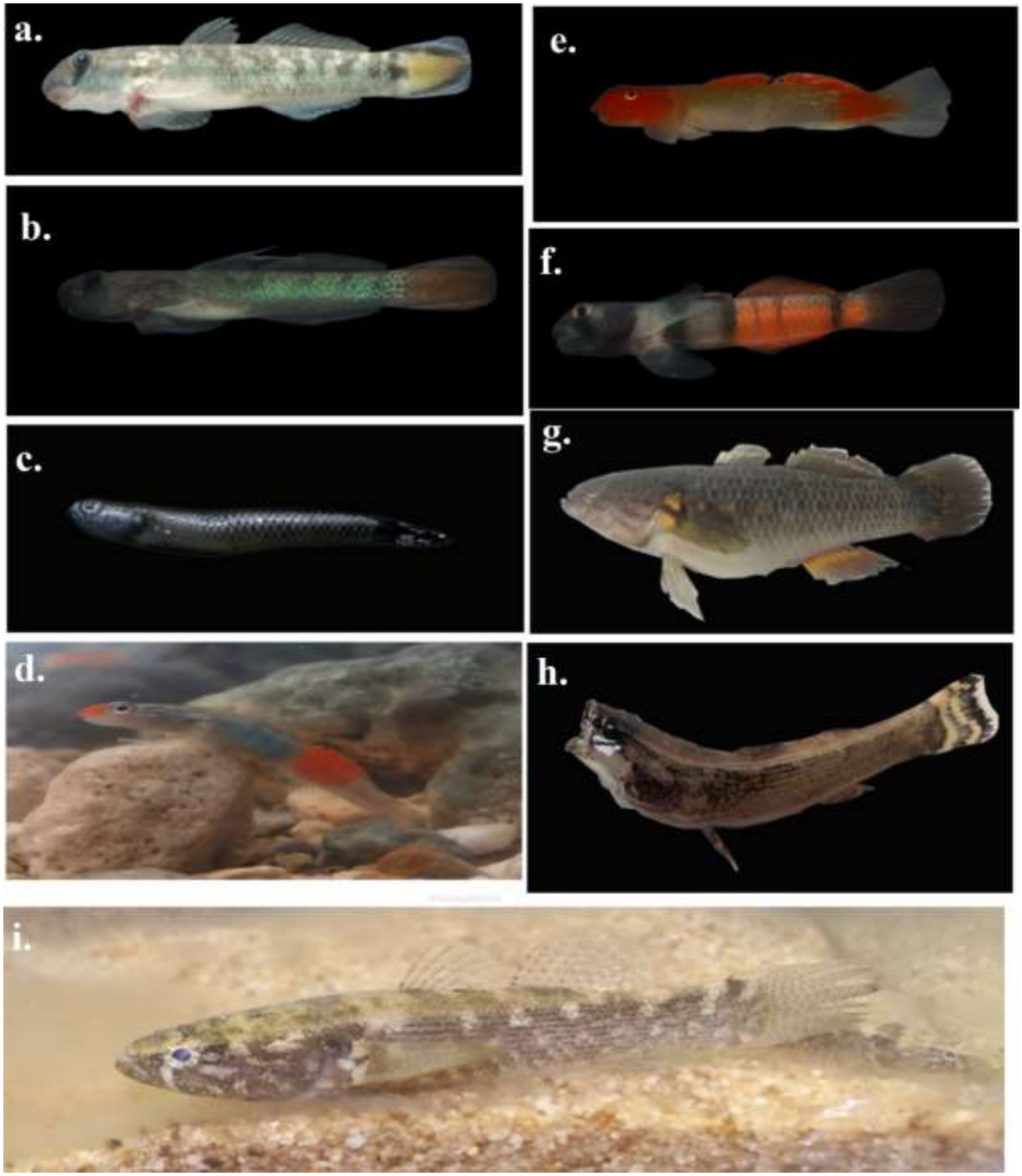

Figure 2. Some Gobiidae collected from rivers in the Luwuk Banggai area, Banggai District, Central Sulawesi Province, Indonesia. a. *Sicyopterus lagocephalus*, b. *S. longifilis*, c. *Stiphodon pelewensis*, d. *Lentipes* sp., e. *L. mekonggaensis*, f. *Sicyopus zosterophorum*, g. *Giuris* sp. h. *Eleotris fusca*, i. *Stenogobius* sp.

4. Discussion

The species group, including the genera *Lentipes, Sicyopterus, Sicyopus, Stiphodon*, and *Smilosicyopus* (subfamily Sycidiinae), were frequently observed at the study sites and were most commonly found in fast-flowing rivers with rapids and waterfalls. Habitat with similar characteristics is considered typical of the Sicydiinae, a group of amphidromous gobies [12]. These amphidromous gobies spawn in the sea, and their young migrate into rivers, where they can occupy riverine habitats throughout the watershed; however, for many, areas around rapids and waterfalls are the preferred habitat [12].

Gobies of the genus *Schismatogobius* were also found at many sites. However, species-level identification based on external morphology was not possible, and will require the use of molecular biology methods (DNA Barcoding). The genus *Schismatogobius* forms a species complex known to contain cryptic species. So far, such cryptic species have been identified in several regions within Indonesia, including Sumatra, Jawa, Bali, Lombok, Ambon, and Sulawesi [13,14].

Lentipes mekonggaensis is a goby of the Gobiidae family, which was first discovered in the Mekongga mountains in Southeast Sulawesi in 2014 [15]. The specific characteristics enabling the identification of *L. mekonggaensis* include the following: brightly colored pectoral fins with 19-20 rays; first dorsal fin (d1) with six flexible spines, second dorsal fin (d2) with one flexible spine and ten segmented rays (d Vi-i,10). Anal fin with one flexible spine and ten segmented rays (a i,10) and directly opposite to second dorsal fin with a gap between the two dorsal fins; caudal fin (C) with 13 branched rays; lateral scales 28-33; urogenital papilla retractable into a sheath-like groove in both sexes, slender and pointed distally without associated lobes or expanded tissue in males, rectangular in appearance in females. Sexual dimorphism includes ctenoid scales on anterior body region strongly ossified in males, each with 3-5 prominent spines; scales on the posterior part of the body with fewer, but larger ctenoid than those of females. Males have 10-16, and females have 24-32 upper jaw teeth distinctly tricuspid anteriorly. Pre-maxilla in males have 2-6 recurved canines posterior to tricuspid teeth, while females do not have teeth posterior to tricuspid teeth. The body color of males and females is also very different. Females are predominantly dull-colored with brownish/greyish mottled patterns and a black longitudinal stripe. Males have a pale body with bright red coloration on the side of the head and close to the caudal peduncle, predominantly orange dorsal fins and a blue-edged black spot in the middle of the membrane between the first two dorsal rays of the second dorsal fin.

The characteristics of *L. mekonggaensis* habitat in Luwuk Banggai seem similar to those reported from Southeast Sulawesi in 2014. Keith, et al. [15] first found this species in the Tepasa River, Southeast Sulawesi Province, in a clear, fast-flowing stretch of the river with predominantly stone and gravel substrate, close to the edge of a palm oil plantation, at 388 meters above sea level. There is a need for further research to determine the conservation status of *L. mekonggaensis*, which appears to be a species endemic to Sulawesi. With a still unknown but presumably limited distribution within Sulawesi, the total *L. mekonggaensis* population is probably quite small, and could be threatened by human activities, both directly through destructive or over-fishing and indirectly through environmental degradation.

5. Conclusion

During this study, a total of 203 goby (Gobioidei) specimens were collected and identified as belonging to two families: the Gobiidae (20 species) and the Eleotridae (6 species). The most frequently encountered species was *Lentipes mekonggaensis* (30 specimens). Further research is required to determine the conservation status of *L. mekonggaensis* and the other species identified and to support the sustainable management of gobies in Sulawesi, especially in the Luwuk Banggai area.

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