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Preliminary note on the morphological characters of *penja* (amphidromous goby postlarvae) in West Sulawesi and Gorontalo Bay

Nurjirana¹, A Haris², F M Sahami³, P Keith⁴ and A I Burhanuddin²

¹Departement of Fisheries, Faculty of Marine Science and Fisheries Hasanuddin University

²Departement of Marine Science, Faculty of Marine Science and Fisheries Hasanuddin University

³Study Program Aquatic Resources Management, Faculty of Fisheries Science and Marine State University of Gorontalo

⁴National Museum of Natural History, Paris, France

Email: nurjirana181@student.unhas.ac.id

Abstract. *Penja* is the local name for the postlarvae of fish belonging to the Gobioidaei, whose appearance at certain times is an amphidromous migration process from the sea to rivers. This group of fish is generally referred to as amphidromous gobies. This study aimed to reveal some facts related to the species diversity of *penja* based on morphological characteristics. The study was conducted from October 2017 to March 2019 in West Sulawesi and Gorontalo Bay, Indonesia. Amphidromous goby samples at the *penja* (postlarval) stage were obtained from fishermen's catches and from traditional markets in each location. The samples obtained were measured and described based on morphological differences. The total length of the sampled *penja* ranged from 18 mm to 58 mm. All *penja* were identified as belonging to one of two families, the Gobiidae and Eleotridae. Although the species obtained from the waters of West Sulawesi and Gorontalo Bay were similar, there were variations in species composition (relative abundance) based on observed morphology of *penja* postlarvae from these two locations.

1. Introduction

Penja is one local name used for amphidromous gobies in Sulawesi, Indonesia. These *penja* are one of the most popular fishes for local consumption, because their emergence from the sea to the river mouth in large numbers occurs at predictable intervals, and *penja* fishing has long been a routine activity for communities in the coastal area and from the river estuary to the upper reaches of many rivers. The appearance of dense schools of *penja* is a process of migration from the sea to the river. These gobies have an amphidromous migration pattern associated with both reproduction and foraging [1–3]. Amphidromous gobies such as the *penja* of Sulawesi have a life-cycle which begins with adults spawning in the river. The eggs and embryos are then carried by river currents, generally hatching before arriving at the sea, and spend their larval and postlarval phases in the sea for 3-5 months, before returning to the river to grow and eventually reproduce.

Penja fishing in Sulawesi is generally carried out monthly around the full moon, which seems to serve as a time indicator, triggering mass migrations of amphidromous gobies returning to their natal



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riverine habitat. *Penja* can be found in many places, with many different local names. For example, in West Sulawesi, people generally refer to them as *penja* or *ikan penja* [4], while in Gorontalo and much of Central Sulawesi they are called *nike* or *duwo* [5,6]. All these local names have one thing in common, which is that they refer collectively to all species of amphidromous gobies. The local communities and the general public believe that *penja* (or *nike*) are a single species. However, the results of a study in 2016 [6] which used DNA Barcodes to compared the *penja* from West Sulawesi with *nike* from Gorontalo concluded that *penja* differed from *nike*. The *nike* from Gorontalo were identified as *Awaous melanocephalus*, while the sequences obtained from *penja* specimens did not align with data in the various genetic databanks. These *penja* sequences were sufficiently different from those of other known species to justify new species status. However, as the specimens were all still in the postlarval phase the species could not be described morphologically.

Based on the situation outlined above, it is considered necessary to carry out an assessment of the amphidromous gobies known as *penja* and *nike* based on morphological differences. This study aimed to contribute to the identification and classification of *penja* postlarvae from West Sulawesi and Gorontalo Bay based on morphological characteristics.

11 2. Materials and methods

This study was conducted from October 2017 to March 2019 in West Sulawesi and Gorontalo Bay. Samples of *penja* (amphidromous goby postlarvae) were collected from the catches of fishermen who were catching *penja* in the river using nets, and *penja* fishing methods were observed. Several samples were also obtained from traditional markets in each location. The *penja* samples were documented using a camera, then preserved in 70% alcohol. The preserved samples were taken to the Hasanuddin University Laboratory of Marine Biology. Morphological analysis of the samples was based on [7]. The total length of each specimen was measured using callipers and the specimens were described based on differences in morphology.

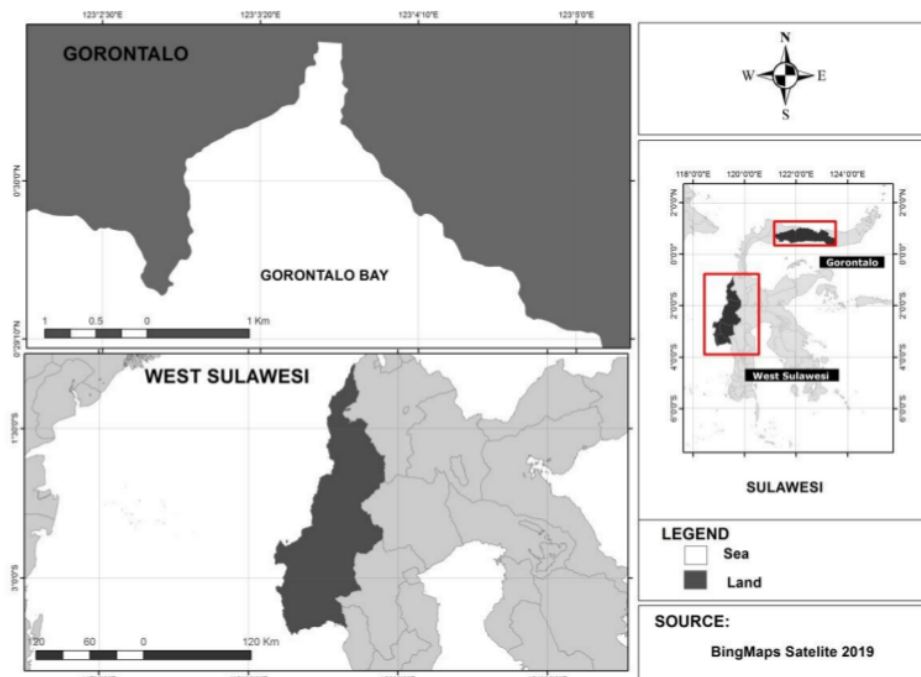


Figure 1. Study Locations: West Sulawesi and Gorontalo Bay

3. Results

Penja fishing activities are routinely carried out on both West Sulawesi and Gorontalo Bay, especially in coastal areas that have rivers which serve as migration routes for a variety of migratory fishes including glass eels (*Anguilla* sp.) and *penja*. The fishermen from both regions carrying out fishing activities when *penja* migrate using similar fishing gear. The most commonly used fishing gear in both locations was a type of mini purse seine which is spread out in the river estuary, while some fishermen use small nets including scoop nets and push nets. Some of the specimens collected are shown in Figure 2 (West Sulawesi) and Figure 3 (Gorontalo).

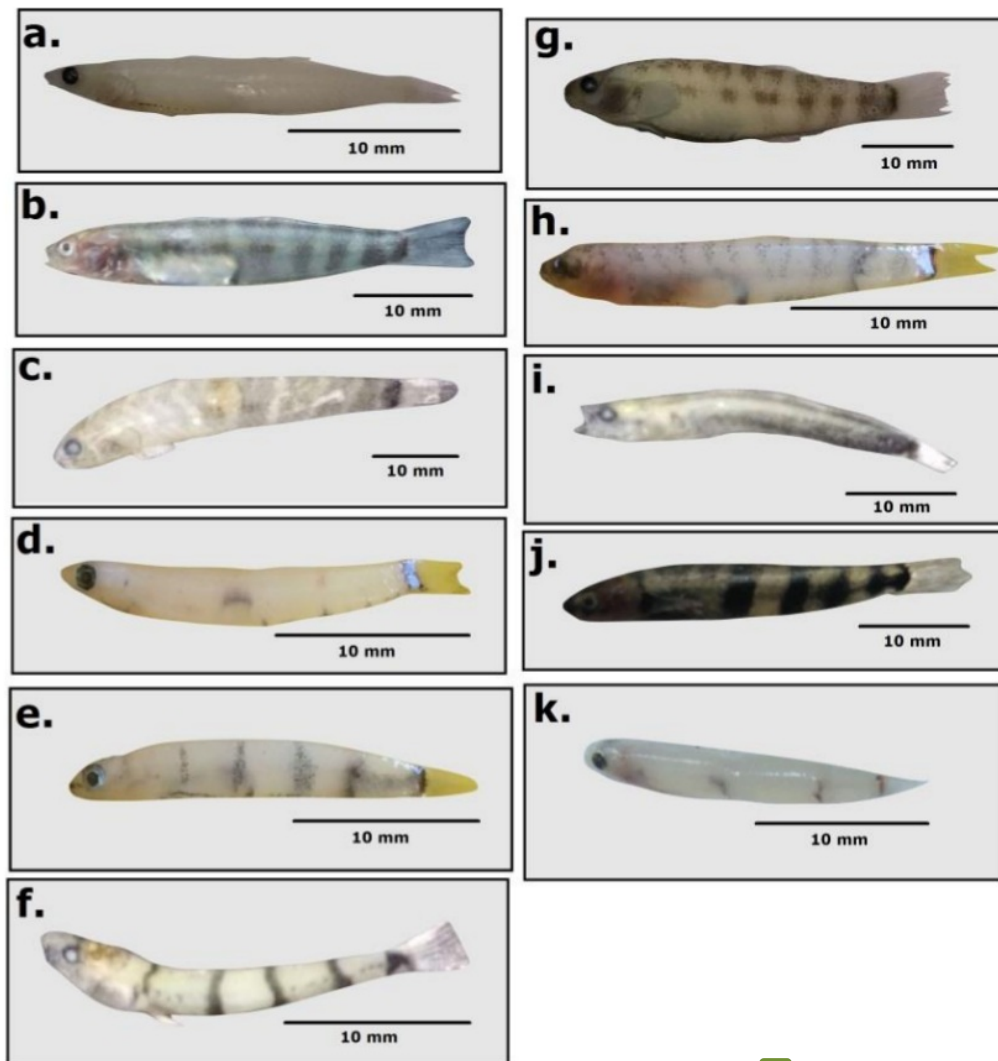


Figure 2. Penja postlarvae specimens collected in West Sulawesi: Gobiidae (b,c,d,e,f,h,j,k), Eleotridae (a,g,i)

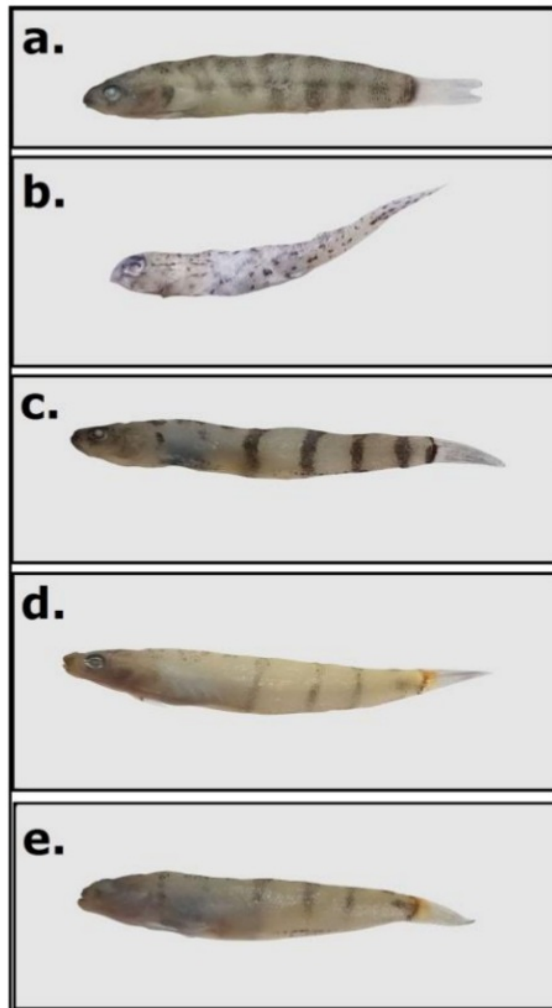


Figure 3. Penja postlarvae in Gorontalo Bay: Gobiidae (a,b,c), Eleotridae (d,e)

The migration period of *penja* in the study location could not always be predicted with certainty because, even when the moon has entered the full moon phase, schools of *penja* are not always found, especially at the Gorontalo site. However, in the waters of West Sulawesi, *penja* migration occurs every month in areas with wider rivers where there is a strong discharge into the sea, even though in some months there are only a few *penja* that migrate. The numbers and size of the *penja* specimens collected are shown in Table 1.

Table 1. Penja postlarvae specimens collected

Study Location	n	Total Length Range
West Sulawesi	362	18 - 58 mm
Gorontalo	184	15 - 46 mm

The morphological analysis of *penja* amphidromous goby postlarvae obtained from West Sulawesi (Figure 2) and Gorontalo Bay (Figure 3) gave broadly similar results, with collected specimens identified as belonging to two families within the Gobioidi, the Gobiidae and Eleotridae. The size range was also similar, despite slightly higher minimum and maximum total length (TL) values in West Sulawesi compared to Gorontalo Bay. There appeared to be several species within each family present in each region. In terms of relative abundance, sample composition differed between the two regions, both at the family level and for morphological phenotypes likely to be different species.

4. Discussion

When *penja* migrate from the sea, they initially approach coastal areas close to the river estuary, and schools of postlarvae will gather along the coast before entering the river mouth. The *penja* postlarvae gather in seagrass areas and beneath rocks in coastal areas, which are the habitat types in which the fishermen in the study areas often caught *penja*. Certain species such as the genus *Sicyopterus* and *Siphodon* from the Gobiidae and the family Eleotridae [8,9] can be found from the downstream area to the upstream areas, so that when they migrate, some groups will stay in areas close to the mouth of the river, while other groups will continue to migrate until they find suitable habitat in the upper reaches of the river system.

The *penja* migrating to the rivers in the study area were identified as amphidromous gobies from the families Gobiidae and Eleotridae, both of which belong to the Suborder Gobioidi. Two fundamental differences in the morphology of Gobiidae and Eleotridae are the shape of the pelvic fins and the relative length of the base of the dorsal fin (Figure 4). The pelvic fins of fishes in the Gobiidae family are fused together and modified to a sucker-like form which enables the fish to attach themselves to rocks. These suckers are used when climbing waterfalls and rapids during their upstream migration to the upper reaches of the river systems. In addition, in the Gobiidae the base of the second dorsal fin is generally longer than the distance from the end of this fin to the base of the caudal fin [7]. Distinguishing features of the Eleotridae include separate pelvic fins similar to most fishes, while the length of the base of the dorsal fin is generally similar to the length of the caudal peduncle [7].

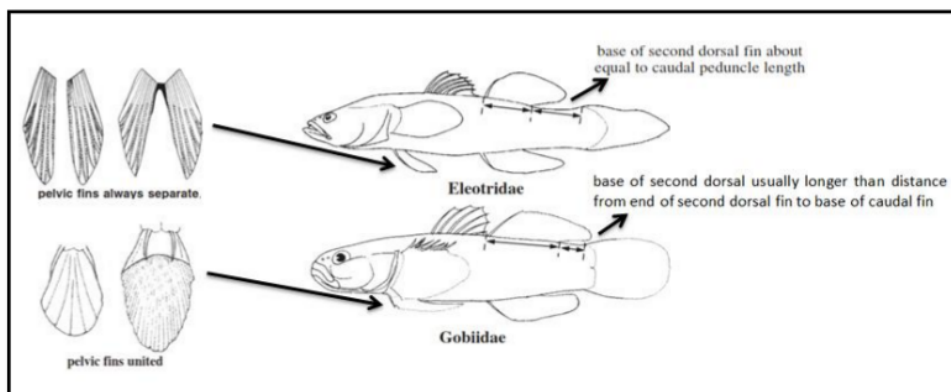


Figure 4. Distinguishing features of the gobioid families Gobiidae and Eleotridae [7]

Identification to species level based on morphology at the postlarval *penja* stage is problematic, considering that amphidromous gobies will change shape as they undergo metamorphosis from the postlarval phase to the juvenile phase [1,2,8]. A study in French Polynesia and New Caledonia [9] observed postlarvae of amphidromous gobies *in vivo* and then succeeded in raising them to adulthood. These adults were identified to species level and included *Awaous ocellaris*, *Awaous guamensis*, *Lentipes rubrofasciatus*, *Sicyopterus marquesensis*, *Sicyopterus lagocephalus*, *Stenogobius yateiensis*,

Stenogobius genivittatus, and *Eleotris fusca*. However, most references (e.g. [10–12]) only provide details sufficient for species identification for adult fish, making it difficult to perform identification to the species level based on the morphology of specimens still in the postlarval phase.

Based on specimens in the juvenile/adult phases, 9 amphidromous goby species have been identified in one river in West Sulawesi: seven species of Gobiidae (5 genera: Sicyopterus, Stiphodon, Sicyopus Smilosicyopus, Schismatogobius) and two species of Eleotridae (genus *Eleotris*) [4]. These are the same two families identified in this study, and it is likely that several of the 11 morphotypes identified in West Sulawesi penja postlarvae correspond to these species. One way to identify the penja postlarvae would be to adopt a similar approach to [9], capturing and rearing live specimens of penja. Another approach would be the use of molecular biology tools, in particular so-called "DNA barcodes" [13]. Such methods have the potential to be very helpful in the identification to species level of larval and postlarval stages [14]. The limitation on this method is that it can only identify the species for which reference sequences for reliably identified adult specimens have been deposited in appropriate data repositories such as GenBank. Although a number of Gobiidae and Eleotridae have been barcoded [11], further barcoding of amphidromous gobies is recommended in order to build a comprehensive database for this group of fishes.

5. Conclusion

The apparent diversity of postlarval penja collected from West Sulawesi and Gorontalo Bay was similar, and included an as yet undetermined number of species belonging to two families, the Gobiidae and Eleotridae. Composition (relative abundance of each morphological phenotype) differed between the two regions. Further research including molecular (DNA) analysis is needed to determine the number and identity of the species of amphidromous goby postlarvae present in each region.

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