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Species Composition and Morphometric Characteristics of Nike Fish in Marisa Waters, Gulf of Tomini, Indonesia

Femy M. Sahami[1], Aziz Salam*[2]

[1,2]Department of Aquatic Resources Management, Faculty of Fishery and Marine Sciences, Universitas Negeri Gorontalo, Indonesia

ABSTRACT: Nike fish are juveniles of amphidromous gobies species known for their intricate morphological features and high ecological significance found in the Gulf of Tomini, Indonesia. This study aimed to investigate the species composition and morphometric characteristics of Nike schools in the waters of Marisa District, Pohuwato Regency, Gorontalo Province. A total of 5.223 individuals were collected from four catch efforts by fishers. Samples were observed and grouped based on melanophore patterns for species identification, and morphometric measurements were performed using Image-J software application. The results show that there were 6 species of Nike in the schoolings, namely: *Sicyopterus longifilis*, *Belobranchus segura*, *Stiphodon semoni*, *Belobranchus belobranchus*, *Sicyopterus parvei*, and *Sicyopterus cynocephalus*. Apparently *S. longifilis* 98,24% dominating the schools. These findings provide valuable insights into the population structure and biodiversity of Nike fish, which are essential for their conservation efforts, management, and future studies.

KEYWORDS: Nike fish, species composition, morphometrics, Marisa Waters, Gulf of Tomini, Indonesia

INTRODUCTION

Fish biodiversity and its ecological significance are crucial aspects of estuarine ecosystems. The Nike fish, which have a transparent, colourless, and scale less body, in the Gulf of Tomini, especially along the coast of Gorontalo Province, play an important role in the local aquatic food webs. The larvae drift from upstream to the river mouth and hatch in the sea. Nike occurs as juvenile schooling in the last ten days of each lunar month of the Hijri calendar in estuarine waters along the coastline, including Marisa, Tilamuta, Paguyaman, and Taludaa (Salam et al., 2016; 2017). Nike fish has high protein and mineral content, especially calcium and magnesium, and is one of the favorite menus for human consumption (Yusuf, 2011). Nike fish in the Gulf of Tomini exhibit relatively high genetic and morphological diversity (Sahami et al. 2020; Sari & Kusumawati, 2019).

The Gulf of Tomini, where the research took place, is the largest gulf in Indonesia, covering an area of approximately 6 million hectares, and is known for its diverse marine resources, including seaweed, milkfish, tiger prawns, pearl oysters, baronang fish, and groupers (Albasri & Pratama, 2019). It is located at the equator and is known for its fertility and rich potential for marine resources (Pramudji, 2018; Fauzi & Kurniawan, 2021). The high biodiversity of the Nike fish in the Gulf of Tomini highlights the importance of this region for the conservation of marine resources in Indonesia. The province of Gorontalo, which encompasses the Gulf of Tomini, has significant fishery resources in its waters, including the Gulf of Tomini, Sulawesi Sea, and Indonesian Exclusive Economic Zone (ZEEI) waters (Olii et al. 2017).

Research on Nike fish has been conducted by various researchers, including Olii et al. (2017) on larvae distribution; Pasisingi & Abdullah (2018) on occurrence; Sahami et al. (2019a) on morphological alteration based on molecular analysis and melanophore pattern; Sahami et al. (2020) on morphometric and genetic variations and Hasana (2020) on spacial and temporal abundance. Pasisingi et al. (2021) on morphometric characteristics, and Olii and Pasisingi (2022) on daily growth and morphometric body ratios.

Understanding the species composition and morphometric characteristics of the Nike fish in this region is essential for effective conservation efforts and sustainable management practices. However, there is limited information available on the species composition and morphometric characteristics of Nike fish in the waters of the Marisa District. Therefore, this study aimed to investigate the species composition and morphological variation of Nike fish in Marisa waters, thereby enhancing our knowledge of local fish fauna and supporting biodiversity conservation efforts, management, and future studies. Therefore, this

study aimed to investigate the species composition and morphometric characteristics of Nike schools in the waters of the Marisa District, Pohuwato Regency, Gorontalo Province.

MATERIALS AND METHODS

1. Study Area

Marisa Waters in Marisa District, Pohuwato Regency, Gorontalo Province, was selected as the study area due to its rich aquatic biodiversity, important habitat for various fish species and the presence of Nike fish species. This research was conducted from December 2022 to March 2023 in the study area, which encompasses diverse aquatic habitats in the estuary of the Marisa River.

Marisa Town is the capital of Pohuwato Regency which is on the coastal line of the Tomini Gulf, located on: Latitude: 0° 26' 57.12" N and Longitude: 121° 56' 20.4" E (see Fig.1). The Marisa River Basin, with an area of 248.43 km2 is one of the watersheds of the Paguyaman River area. The upstream area of the Marisa Taluduyunu River, which is located in the Marisa District, has been converted from forest land to corn fields (Wolok et al., 2014).

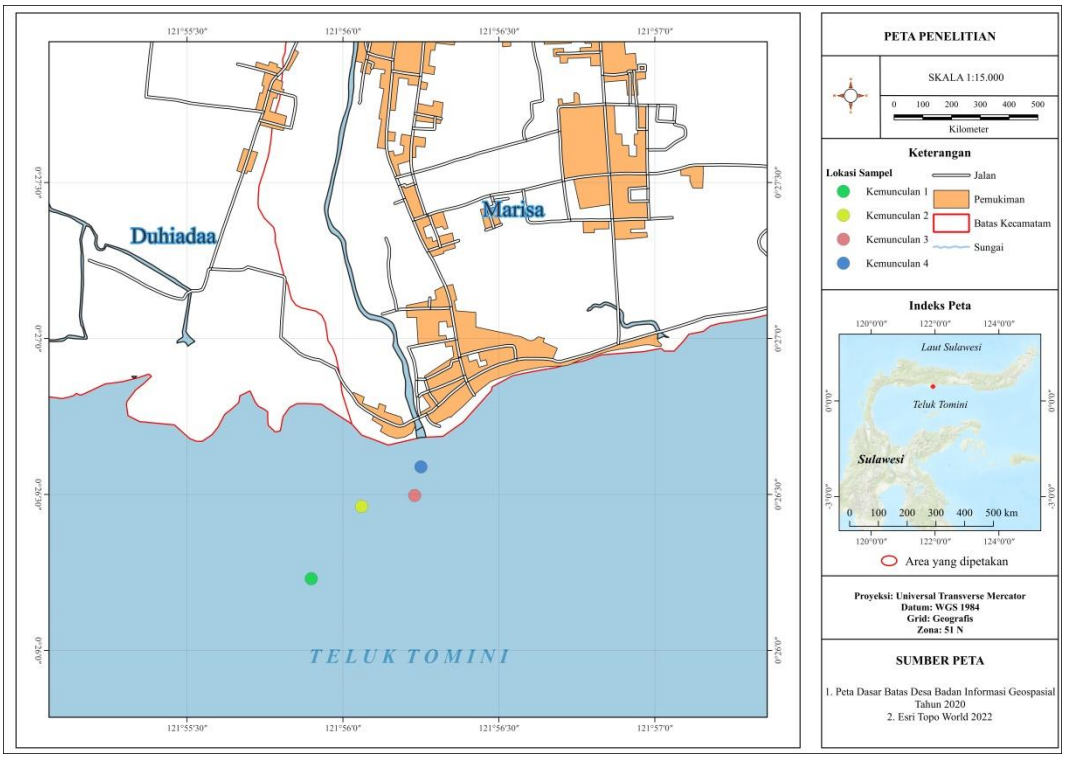

Fig. 1 Map of research site

2. Sample Collection

A total of 5.223 individuals of Nike fish were collected from Marisa Waters. Sampling in this study followed the fishing season and was performed randomly from the fishermen's catch. Nike fish samples of up to 220 ml were collected using used plastic cups for mineral water from each catch (see Table 1 for sample quantity). The collected specimens were handled carefully to avoid damage during transportation. The samples were placed in a cool box and given ice, brought from the research site to the laboratory, and stored in a freezer before analysis.

Between December 2022 and March 2023, Nike fish appeared on four days in the Marisa River Estuary. Fishermen catch nike fish for only one day in each season. The first sampling (SI) was on 21 December 2022 (26 of Jumadil Awal 1444 H), the second sampling (SII) was on 21 January 2023 (27 of Jumadil Akhir 1444 H), and the third sampling (SIII) was on 21 February 2023 (29 of Rajab 1444 H) was carried out at noon, while the fourth sampling (SIV) was on 19 March 2023 (26 of Sha'ban 1444 H) taken at night. Fishermen in Marisa use *tagahu* to catch nike fish, a traditional fishing gear that is a purse seine with a very fine mesh size operated by two boats in shallow waters on the shoreline (Salam et al., 2016).

3. Species Identification

The collected specimens were examined for taxonomic identification using relevant taxonomic keys by sorting and grouping based on differences in melanophore patterns. Nike fish sample examination was carried out of Nike with reference to Sahami et al. (2019b), Sahami et al. (2020) and Sahami et al. (2020a) (Fig. 2).

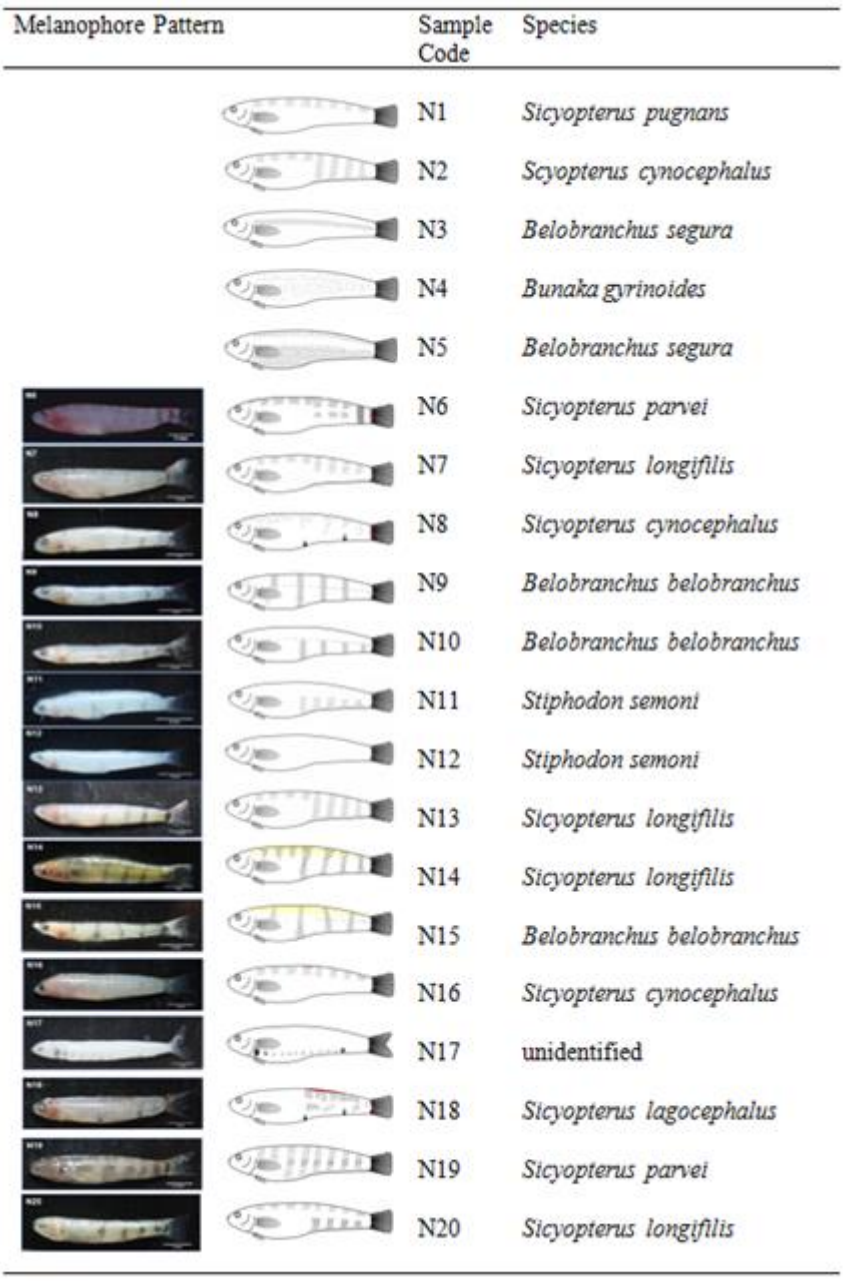

Fig. 2. Species identification sheet adapted from Sahami *et al.* (2020a)

4. Species Composition

The composition of the species that made up the Nike fish was calculated by counting the number of individuals from each sample species obtained and then dividing it by the total number of samples. Arsyad (2022) uses the following equation to calculate species composition:

$$pi = (ni/N) \times 100\%$$

where pi is the species composition (%), ni is the number of individuals in each species, and N is the number of samples. A descriptive analysis was carried out to describe the species composition of the Nike schools in Marisa Waters, Marisa District, Pohuwato Regency during four fishing seasons.

5. Morphometric Analysis

Morphometric analysis was used to study the kinship relationships between species. This is because species that have similarities or close kinship relationships will have similar characteristics; otherwise, different species will have different characteristics (Zakaria, 2017). Morphometric measurements in this study were used to assess physical characteristics. These measurements were based on a diagram modified by Sahami et al. (2020), following Benbow et al. (2004). Physical characteristics included total length (TL), standard length (SL), preorbital length (PL), eye diameter (ED), head length (HL), body depth (BD), and

peduncle depth (PD) (Fig. 3). Each individual Nike fish that was examined was photographed using a camera with a 58 mm pro Digital Wide Converter 0.45X Lens. The resulting photos were then measured using Image-J software application.

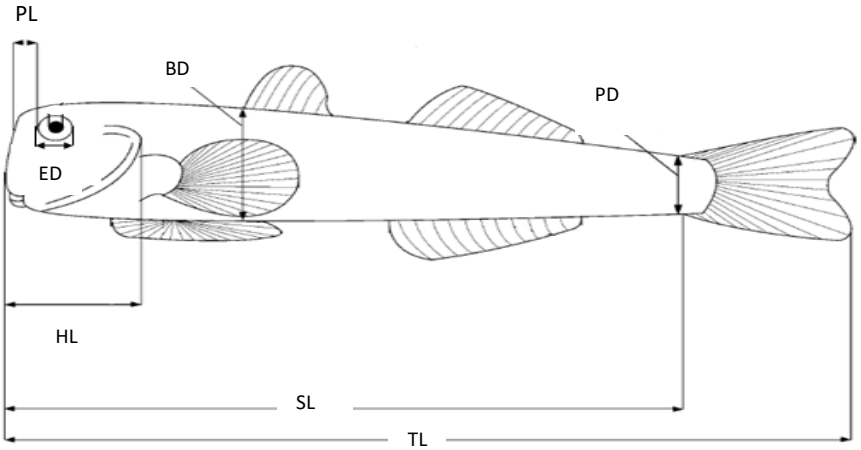

Fig. 3 Morphometric characters of Nike fish (Sahami *et al*., 2020)

SL represents the length from the tip of the snout to the end of the last vertebra, and TL represents the entire length of the fish. BD represents the height at the highest part of the body, excluding the fleshy part and scales belonging to the fins. The preorbital length (PL) was used to describe the length of the snout of a fish. It is the distance from the tip of the snout to the anterior margin of the orbit or eye socket. Eye diameter (ED) is the diameter of the eye of a fish. It is measured as the widest diameter of the eyeball transverse to its axis. Head length (HL) is a morphometric measurement used to describe the head length of a fish.

It is measured as the distance from the tip of the snout to the posterior margin of the operculum or the gill cover. Peduncle depth (PD) is the depth of the caudal peduncle of a fish. The caudal peduncle is the narrow part of the fish body that connects the tail fin to the rest of the body. PD was measured as the depth of the caudal peduncle at its narrowest point.

In this study, 50 individuals of each species found in the sample were measured. If the number of individuals of a species was less than 50, then all individuals of that species were measured morphometrically. As a result, 292 Nike fish specimens were analysed morphometrically, as shown in Table 2. Morphometric measurements were tabulated in a spread sheet. Based on the tabulated data, the average of each character from each species and important morphometric ratios were calculated. There are no specific morphometric ratios commonly used for small fish. However, traditional morphometric analyses rely on the measurement of shape indicators, such as length, area, angle, and ratio (Caillon & Lecomte-Finiger, 2018). Morphometric measurements are widely used to identify differences between fish populations, determine sex, and evaluate the body yields of rounded fish (Le Cren, 1951).

The most important morphometric ratios to be measured for Nike fish are the standard length (SL) to total length (TL) ratio (SL:TL), head length (HL) to SL ratio (HL:SL), body depth (BD) to SL ratio (BD:SL), and eye diameter (ED) to HL ratio (ED:HL). These ratios are commonly used in morphometric analyses to assess the size, shape, and proportion of small fish. They provide valuable information about the morphology and body proportions of fish, which can be used to understand their ecology, behaviour, and population dynamics, as well as to develop effective conservation strategies to maintain the biodiversity of aquatic ecosystems (Caillon & Lecomte-Finiger, 2018; Mojekwu & Anumudu, 2015; Marr, 1955; Neto et al., 2012).

RESULTS

1. Species Composition

The systematic sampling efforts resulted in the collection of various Nike fish specimens from Marisa Waters. Through taxonomic identification, it was determined that the Nike fish population in the study area primarily consisted of 6 species as can be seen in Table 1.

Table 1. Species composition of Nike fish taken in Marisa Waters

No.	Species	Samples taken				*N*	Compo.
		SI	SII	SIII	SIV	*ni*	*pi (%)*
1.	*Sicyopterus longifilis*	+1173	+1197	+1375	+1386	5131	98,24
2.	*Belobranchus segura*	+45	+3	+5	+4	57	1,09

3.	*Sicyopterus parvei*	+16	+4	-	-	20	0,38
4.	*Stiphodon semoni*	-	-	+3	+4	7	0,13
5.	*Belobranchus belobranchus*	+5	-	-	-	5	0,10
6.	*Scyopterus cynocephalus*	+1	+2	-	-	3	0,06
		1240	1206	1383	1394	5223	100,00

Remarks : (+xxxx) = present with number; (-) = None; Compo. = Species Composition

Approximately 1300 individuals contain in a 220ml used plastic cup of mineral water. The occurrence of the species varied during each fishing season. Species *S. longifilis* and *B. segura* appeared in every fishing season, but in terms of quantity, *B. segura* was not significant. *S. semoni* appears in two seasons, namely in February and March 2023, in a very small number. Species *B. belobranchus* appears only once in December 2022, also in a very small number. Species *S. parvei* and *S. cynocephalus* each appear twice in December 2022 and January 2023, in a very small number for each occurrence.

The data show that *S. longifilis* is obviously the dominant species, with a percentage of 98.24%, followed by *B. segura*, *S. parvei*, *S. semoni*, *B. belobranchus*, and *S. cynocephalus* with percentages ranging from 1.09% to 0.06%. Some species, such as *S. longifilis* and *B. segura*, are more consistently present, while others, like *S. semoni* and *B. belobranchus*, have limited occurrences. The information provided suggests that the occurrence and abundance of different Nike fish species vary across fishing seasons.

2. Morphometric Characteristics

The data collected on the morphometric characteristics of these species can provide valuable insights into the population dynamics and ecological roles within the Marisa River water. Morphometric measurements revealed significant variations in the size and shape of the Nike fish specimens. The collected data allowed for the calculation of various morphometric ratios and indices, providing insights into the body proportions of Nike fish in the Marisa Waters.

The results of the measurements of all Nike fish samples taken from the waters of Marisa show that range of their Total Lenght is 1,7 – 2,99 cm and range of Body Depth is 0,17 – 0,54 cm. S. cynocephalus had the highest values for most morphometric characters, whereas *S. semoni* had the lowest values for most morphometric characters. *S. cynocephalus* had the highest Total Lenght with an average of 2.85 cm within the range of 2.74 to 2.99 cm. *S. semoni* has the lowest Total Length with an average of 1.84 cm within the range of 1.7 to 2.0 cm (Table 2). Based on visual morphology observations, *S. cynocephalus* has a relatively large body, whereas *S. semoni* has a small body with a slightly white color.

Table 2. Morphometric characteristics of Nike fish

Species	n	Morphometric characters (cm)						
		TL	SL	PL	ED	HL	BD	PD
S. longifilis	200	2,374	1,931	0,090	0,164	0,417	0,363	0,200
B. segura	57	2,099	1,765	0,094	0,113	0,374	0,281	0,155
B. parvei	20	2,655	2,214	0,105	0,129	0,467	0,413	0,209
S. semoni	7	1,840	1,515	0,067	0,083	0,261	0,191	0,119
B. belobranchus	5	2,114	1,796	0,109	0,110	0,385	0,252	0,152
S. cynocephalus	3	2,853	2,364	0,118	0,147	0,480	0,473	0,267

*Figures in grey sheet have less accountability due to shortage in number of samples measured

The number of specimens obtained for four species (*B. parvei, S. semoni, B. belobranchus*, and *S. cynocephalus*) did not meet the required number of 50 individuals for measurement. Extra attention was given to the top two specimen those fulfil the minimum required number of samples for measurement. i.e. *S. longifilis* and *B. segura*. Seems that *S. longifilis* is at the modest size among the Nike fish species as indicate by its morphometric characters. The average TL of *S. longifilis* is 2.374 cm within ranges from 2.0 to 2.8 cm and its BD is 0.363 within ranges from 0.25 to 0.5 cm. While *B. segura*, which is smaller in size has average TL of 2.099 within a range from 1.9 to 2.4 cm and has average BD of 0.281 within a range from 0.2 to 0.4 cm (see Table 2). Further analysis of morphometric ratios was only conducted on the two species (*S. longifilis* and *B. Segura*), which will be presented in Table 3.

Table 3. Ratios of morphometric characteristics

Species	n	Ratios			
		SL:TL	HL:SL	BD:SL	ED:HL
S. longifilis	200	0,814	0,216	0,188	0,394
B. segura	57	0,841	0,212	0,159	0,302

Both species showed morphometric ratios that were not significantly different, indicating that they have similar body postures, although *B. segura* has a smaller average size for almost all morphometric characteristics except for PL, which is slightly larger or can be considered the same (see Table 2). Only the SL:TL ratio of B. segura was slightly larger than that of *S. longifilis*, while the other ratios (HL:SL; BD:SL; and ED:HL) possessed by *B. segura* were smaller.

DISCUSSION

There were four appearances of Nike fish in the Marisa River estuary during the research and fishermen only catch at one day in each season. In contrast to several other places, such as at the mouth of the Bone River, where fishing can take up to 5 days in each appearance period (Olii *et al*., 2017) and even up to 9 days (Pasisingi & Abdullah, 2018). In Paguyaman Bay, fishing for Nike is up to 3 days in one appearence period (Sahami & Habibie, 2021). In Taludaa Village (Damopolii, 2021) and in Bilungala Village (Arsyad, 2022) Nike fishing takes 1-2 days in one appearance period.

In this study, 6 species that make up the Nike school were obtained. This is slightly different from previous studies in several places such as in Taludaa (Damopolii, 2021) and Bilungala Village (Arsyad, 2022), there were 7 species that make up the nike fish, with extra presence of *S. lagocephalus*. Nike fish in Paguyaman Bay were found of 7 species with extra presence of *E. melanosoma* (Sahami & Habibe, 2021). In Taludaa, Bilulanga Village and Paguyaman Bay *S. longifilis* and *B. segura*, just like in Marisa Waters, were always present in each seasons. Molecular identification results show that the melanophore pattern of Nike fish in Gorontalo Bay consists of 6 species, with extra presence of *S. lagocephalus*, and lack of *B. segura* (Sahami *et al.*, 2020).

Results of this study and some of the results of previous studies show that the Nike fish that were found the most and appeared in every catch were from the genus Sicyopterus. According to Nurjirana *et al*. (2022) the genus Sicyopterus has a wide distribution in Indo-Pacific waters consisting of 26 species, however only 12 species are found in Indonesian waters. This is in line with research conducted by Sahami & Habibie (2021) in Paguyaman Bay, at certain times the species *S. longifilis* has a dominating composition value. According to Nurjirana *et al*. (2022) in the sea and river waters of Lariang Village which are dominated by *Scyopterus* species, in this case *S. longifilis*. Different results showed by Arsyad (2022) in Bilungala Village whereas *S. parvei* was dominant (54.14%) in a season and *S. lagocephalus* was dominant (39.09%) in another season.

The dominance of *S. longifilis* in the Nike fish assemblages in Marisa Waters is consistent with previous studies on Nike fish in Gorontalo Bay waters (Olii *et al*., 2017; Sahami *et. al*., 2020). The high abundance of *S. longifilis* in the region may reflect its ecological importance as a primary consumer and prey item for higher trophic levels in the food web (Olii *et al*., 2017). The presence of other species of Nike fish in Marisa Waters, although in lower abundance, highlights the need for further research on the ecological roles and conservation status of these species in the region.

The dominance of *S. longifilis* in the population of Nike fish in the Marisa Waters suggests that this species may play a crucial role in the ecological dynamics of the region. The high abundance of this species may have implications for the population dynamics of other species in the ecosystem, as well as for the overall health and sustainability of the ecosystem. Further research is needed to understand the ecological roles of different species of Nike fish in the Marisa waters and to develop effective conservation strategies to maintain the biodiversity of the region.

The morphometric measurements of different species of Nike fish can provide valuable insights into their population dynamics and ecological roles within the Marisa Waters. The high abundance of *S. cynocephalus* in the population of Nike fish in the Marisa waters suggests that this species may play a crucial role in the ecological dynamics of the region. Further research is needed to understand the ecological roles of different species of Nike fish in the Marisa waters and to develop effective conservation strategies to maintain the biodiversity of the region (Bell *et al*. 2021; Sahami *et al*. 2020a; Sahami & Habibie 2020).

The differences in the morphometric characters of the Nike fish found in Marisa Waters and those in several other waters in Tomini Bay, Gorontalo are most likely influenced by environmental factors. Pasisingi & Abdullah (2018) stated that species identification through a morphometric approach require extra precision because environmental factors can determine the life and development of larvae. The same species may exhibit different morphometric performance if they inhabit different water conditions as an adaptation for survival. Gobies species are capable of developing various morphological specificities as adaptation strategies to their environment (Roesma et al., 2020).

Morphometric measurements such as TL, SL, PL, ED, HL, BD, and PD are commonly used to assess the size, shape, and proportions of fish species. These measurements can provide insights into the ecological roles, swimming performance, and sensory capabilities of fish. For example, the caudal peduncle depth factor (CPdDF) is strongly related to the swimming speed and an important determinant of the swimming ability of fish (de Assumpção *et al*., 2012).

The findings of this study highlight the diverse morphometric characteristics and species composition of Nike fish in the Marisa Waters of Marisa District, Pohuwato Regency, Gorontalo Province. The presence of multiple Nike fish species indicates a rich and diverse fish community in this region. The morphometric measurements provided valuable insights into the body proportions of Nike fish. The calculated ratios and indices can help assess the functional adaptations and ecological roles of these fish species. For example, variations in body depth and caudal peduncle length may indicate differences in swimming abilities and habitat preferences among the identified species.

Morphometric measurements and ratios are important for understanding the ecology, behavior, and population dynamics of fish species, as well as for developing effective conservation strategies to maintain the biodiversity of aquatic ecosystems. Some studies have used specific morphometric ratios for determining fish sex, such as the ratio of the anal fin length to the standard length in chinook salmon (Mojekwu & Anumudu, 2015). Other studies have used various morphometric ratios to evaluate swimming performance, muscle ratio, and caudal fin area in different fish species (Ribeiro & Santos, 2014).

The morphometric data presented in Table 2 provide important information on the physical characteristics of Nike fish, which can be used to identify and distinguish different species, as well as to understand their ecology, behaviour, and population dynamics. The differences in the morphometric characters among the species may reflect their adaptations to different habitats and ecological niches, as well as their genetic and evolutionary relationships. Further research is needed to explore the morphological and genetic variations of Nike fish in different regions of Indonesia, as well as to develop effective conservation strategies to maintain the biodiversity of these species.

Both species *S. longifilis* and *B. segura* have high SL to TL ratios indicate a relatively longer body compared to the total length, suggesting a more elongated body shape (Caillon, & Lecomte-Finiger, 2018; Le Cren, 1951). SL to TL ratio is used in taxonomic studies, as different species may exhibit distinct body proportions and ratios (Mojekwu & Anumudu, 2015; Ribeiro & Santos, 2014).

Both species *S. longifilis* and *B. segura* have low HL to SL ratios suggest a relatively smaller head compared to the standard length, indicating a more compact or rounded head shape (Caillon, & Lecomte-Finiger, 2018; Le Cren, 1951). HL to SL ratio is used to understand feeding habits, sensory capabilities, and ecological roles. A lower HL to SL ratio may suggest a fish species with a more generalized feeding strategy or reduced reliance on visual cues (Mojekwu & Anumudu, 2015; Ribeiro & Santos, 2014).

Both species *S. longifilis* and *B. segura* have a low BD to SL ratios suggest a relatively shallower body compared to the standard length, indicating a more slender body shape (Caillon, & Lecomte-Finiger, 2018; Le Cren, 1951). BD to SL ratio is used to understand swimming performance, buoyancy, and hydrodynamics. a lower BD to SL ratio may suggest a fish species with a more flattened body shape and increased surface area, which may improve its buoyancy and stability (Ribeiro & Santos, 2014).

Both species *S. longifilis* and *B. segura* have a low ED to HL ratio suggests a relatively smaller eye compared to the head length, indicating a fish species with reduced reliance on visual cues (Caillon & Lecomte-Finiger, 2018). A lower ED to HL ratio may suggest a fish species with a more herbivorous or detritivorous diet or a preference for well-lit environments (Ribeiro & Santos, 2014).

CONCLUSION

In conclusion, this study provides valuable insights into the species composition and morphometric characteristics of Nike fish in the Marisa Waters of Marisa District, Pohuwato Regency, Gorontalo Province. The observed variations in morphometric characteristics highlight potential adaptations to different ecological niches, while the identified species composition emphasizes the richness and diversity of the Nike fish community in this region.

This diversity highlights the importance of preserving the habitat and maintaining suitable environmental conditions for the Nike fish population and other cohabitating species. Conservation efforts in the Marisa Waters should consider the unique morphometric characteristics and species composition of Nike fish and ecological requirements of each species to ensure their long-term survival and sustainability. By preserving the diverse habitats and maintaining the water quality, we can protect the habitats necessary for the survival and reproduction of these fish species. Furthermore, continued researches on the population dynamics and reproductive biology of Nike fish will contribute to their long-term conservation. Additionally, long-term monitoring of the Nike fish population and other cohabitating species is necessary to assess their population dynamics and responses to environmental changes. Such knowledge will aid in the development of conservation strategies that promote the sustainable management of Marisa Waters and the preservation of its diverse fish community.

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Conflict of Interest: The authors declare no conflict of interest related to this research .

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