

MORPHOMETRIC CHARACTERISTICS, MERISTICS, AND GROWTH PATTERNS OF SAILFIN CATFISH (*Pterygoplichthys* sp.) IN SIDENRENG LAKE

Karakteristik Morfometrik, Meristik, dan Pola Pertumbuhan Ikan Sapu-Sapu (*Pterygoplichthys* sp.) di Danau Sidenreng

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ABSTRACT

*The sailfin catfish (*Pterygoplichthys* sp.) is an invasive species that has rapidly proliferated in Lake Sidenreng and poses ecological threats through food competition, habitat degradation, and disruption of native fish communities. This study aims to analyze the morphometric, meristic, and growth characteristics of sailfin catfish as a basis for understanding its biological traits and for developing management strategies to control its invasive population in Lake Sidenreng. The research was conducted from January to March 2025 using a quantitative descriptive method with a total sample of 400 individuals, all of which were used for the length–weight relationship analysis. From this total sample, 100 individuals were randomly selected for morphometric measurements (24 body characters) and meristic observations (counts of dorsal, pectoral, pelvic, anal, and caudal fin rays). The results showed an average total length of 30.09 cm (range 15.7–39.4 cm), with relatively narrow meristic variation, indicating population homogeneity. The length–weight analysis revealed negative allometric growth for both sexes. Males exhibited a low R^2 value (0.2134), indicating high variability in body weight associated with territorial behavior, whereas females showed a high R^2 value (0.8955), reflecting a more stable and controlled growth pattern. These findings highlight the strong adaptive capacity of *Pterygoplichthys* and its potential for population expansion in Lake Sidenreng, underscoring the need for effective management strategies to mitigate its ecological impacts.*

Keywords: Growth Patterns, Lake Sidenreng, Meristic, Morfometric, Sailfin Catfish

ABSTRAK

Ikan sapu-sapu (*Pterygoplichthys* sp.) merupakan spesies invasif yang telah berkembang pesat di Danau Sidenreng dan mengancam ekosistem perairan melalui kompetisi pakan, degradasi habitat, serta gangguan terhadap spesies ikan lokal. Penelitian ini bertujuan menganalisis karakter morfometrik, meristik, serta pola pertumbuhan ikan sapu-sapu sebagai dasar pemahaman biologis dan strategi pengelolaan populasi invasif di Danau Sidenreng. Penelitian

dilakukan pada Januari–Maret 2025 menggunakan metode deskriptif kuantitatif dengan total sampel 400 ekor, yang seluruhnya digunakan untuk analisis hubungan panjang–berat. Dari total sampel tersebut, 100 ekor dipilih secara acak untuk dilakukan pengukuran morfometrik (24 karakter tubuh) dan pengamatan meristik (jumlah jari-jari sirip punggung, dada, perut, anal, dan ekor). Hasil penelitian menunjukkan rata-rata panjang total ikan 30,09 cm (rentang 15,7–39,4 cm) dengan karakter meristik yang relatif sempit, mengindikasikan homogenitas populasi. Analisis hubungan panjang–berat memperlihatkan pertumbuhan alometrik negatif pada kedua jenis kelamin. Ikan jantan menunjukkan nilai R^2 rendah (0,2134), menandakan variasi berat yang tinggi terkait aktivitas teritorial, sedangkan betina memiliki R^2 tinggi (0,8955) yang mencerminkan pertumbuhan lebih stabil dan terkontrol. Temuan ini menegaskan kemampuan adaptasi tinggi *Pterygoplichthys* serta potensi ekspansi populasi di perairan Danau Sidenreng, sehingga diperlukan strategi pengelolaan yang tepat untuk menekan dampak ekologisnya.

Kata Kunci: Danau Sidenreng, Ikan Sapu-Sapu, Meristik, Morfometrik, Pola Pertumbuhan

INTRODUCTION

Lake Sidenreng is one of the largest natural lakes in South Sulawesi, playing a crucial role in maintaining ecological stability and supporting the socio-economic activities of the surrounding community. It serves as a habitat for various native fish species with ecological and economic value, most of which are exploited through traditional capture fisheries (Sudirman *et al.*, 2019). However, the ecological balance of Lake Sidenreng has been under pressure in recent years due to high levels of eutrophication, changes in land use in the catchment area, and the presence of invasive alien species that increasingly dominate the aquatic ecosystem.

One invasive species exhibiting rapid population growth is the sailfin catfish (*Pterygoplichthys* sp.). This species originates from South America and was first introduced to various countries as an aquarium cleaner. However, its release into the natural environment—whether intentional or unintentional—has led to its rapid spread to various tropical waters, including Indonesia (Ndobe *et al.*, 2016; Mettee *et al.*, 2005). Its success as an invasive species is closely linked to its biological characteristics, such as extreme tolerance to environmental conditions, additional air-breathing abilities, efficient reproductive strategies, and opportunistic use of food sources (Garcia-Berthou, 2007; Hoover *et al.*, 2004).

In various regions of Indonesia, *Pterygoplichthys* has been reported to disrupt the structure of local fish communities through food competition, benthic habitat degradation due to nest-digging activities, and increased water turbidity (Elfidasari, 2020; Ortega *et al.*, 2015). A similar trend was observed in Lake Sidenreng, where the population explosion of sailfin catfish has the potential to reduce capture fisheries productivity, alter native species composition, and accelerate the degradation of aquatic substrates. Research by Hasrianti *et al.* (2020) showed a decline in the abundance of economically important species such as carp, tilapia, and several members of the Cyprinidae family, which is strongly suspected to be correlated with the increasing population of *Pterygoplichthys* in these waters. In addition, the results of the analysis of Lake Sidenreng fisheries production over the past five years show production fluctuations that indicate disruption to ecosystem stability (Mukhlis *et al.*, 2021).

The study of morphometric and meristic traits is a fundamental step in understanding morphological variation, population structure, and the potential for adaptation of invasive species to their new environments. Morphometric traits describe body proportions and potential for functional adaptation, while meristic traits are used to detect genetic variation and population differences (Yusuf & Amalia, 2018; Ahmad *et al.*, 2020). This analysis is crucial for identifying whether *Pterygoplichthys* populations in a given location originate from a single genetic source or from multiple different introductions, as this variation can influence growth

rates and invasion success (Iskandar & Putri, 2019; Wibowo *et al.*, 2018). Furthermore, analysis of length-weight relationships and growth patterns provides critical information regarding the physiological conditions and energy strategies of fish species. According to Weatherley & Gill (1987) and Effendie (1997), allometric growth patterns can indicate the level of food availability, habitat conditions, and environmental pressures experienced by fish in an ecosystem. In invasive species, research on growth patterns can help predict potential population expansion and the level of physiological adaptation to new environments (Hidayat *et al.*, 2022; Muthmainnah *et al.*, 2019). Several international studies (Hossain *et al.*, 2024; Ortega *et al.*, 2015) also show that variations in *Pterygoplichthys* growth patterns can differ across ecosystems, depending on water quality, competition, and resource availability.

Although various studies on sailfin catfish have been conducted in Indonesia and other countries, comprehensive studies integrating morphometric, meristic, and growth patterns of *Pterygoplichthys* in Lake Sidenreng are still very limited. To date, research has focused primarily on ecological aspects and socio-economic impacts. These include studies on the impact of the *Pterygoplichthys* population explosion on gillnet fisherman's catch (Hasrianti *et al.*, 2020), its impact on fishermen's income (Hasrianti *et al.*, 2020), and the estimation of gonad maturity as a basis for controlling the reproduction of invasive populations (Permatasari *et al.*, 2024). Furthermore, fishing gear engineering efforts have also been studied, such as determining mesh size and net height to suppress the sailfin catfish population, as reported in the study Height and mesh size of gill nets to reduce sailfin catfish (*Pterygoplichthys* spp.) population: a case study in Lake Sidenreng (Hasrianti *et al.*, 2024). Despite their important contributions, these studies have not yet included morphological characteristics and growth patterns that form the biological basis for understanding the dynamics of invasive populations. This information is crucial for developing long-term management strategies, including population control, restoration of local fish habitats, and formulation of aquatic conservation policies. Based on this urgency, this study was conducted to examine the morphometric, meristic, and growth patterns of *Pterygoplichthys* sp. in Lake Sidenreng. The results are expected to provide a comprehensive biological picture of this invasive fish population and serve as a scientific basis for efforts to control and sustainably manage the aquatic ecosystem of Lake Sidenreng.

METHODS

Research Time and Location

The research was conducted from January to March 2025 at Lake Sidenreng, Sidenreng Rappang Regency, South Sulawesi. Sample identification and measurement were conducted at the Basic Laboratory of the Faculty of Science and Technology, Muhammadiyah University of Sidenreng Rappang.

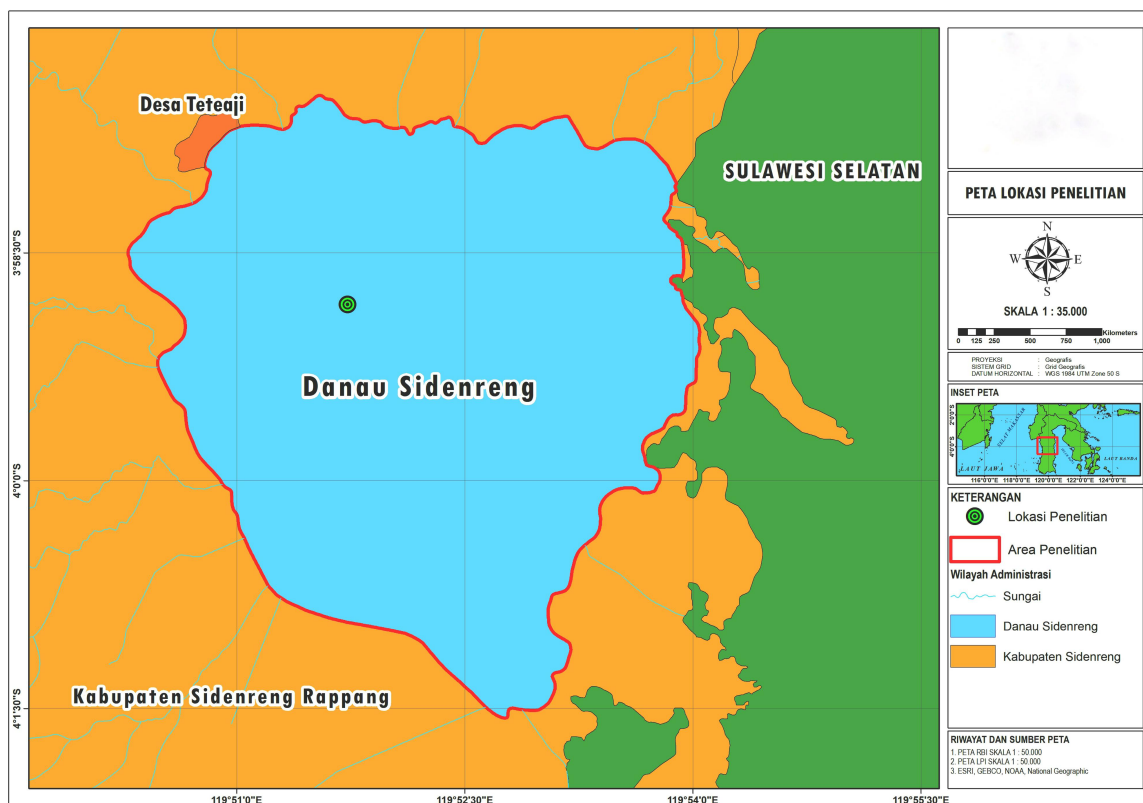


Figure 1. Research Location Map

Tools and Materials

This study utilized several tools and materials to support the morphometric and meristic measurements, as well as the length-weight analysis of fish. The tools used included a digital caliper with an accuracy of 0.01 cm, a metal ruler with an accuracy of 1 mm, a digital scale, a magnifying glass, a plastic tray, a scalpel, a digital camera/smartphone, label paper, and a permanent marker. The materials used included the sailfin catfish used as research samples, distilled water, and tissues/rags.

Fish Sampling

The sailfin catfish (*Pterygoplichthys* sp.) samples were obtained from catches by fishermen using gillnets with various mesh sizes to ensure a representative representation of diverse body sizes. The total sample size was 400 individuals, all of which were used in the length-weight relationship analysis. Of these, 100 individuals were randomly selected for morphometric and meristic measurements. Simple random sampling was used to ensure there was no size or sex bias in the morphometric samples.

Sex Identification

Fish sex was determined by observing external morphological characteristics: males have more pointed genital papillae and a slimmer body, while females have blunted genital papillae and a more rounded abdomen. This identification was used in analyzing male and female growth patterns.

Morphometric Parameter Measurement

A total of 24 morphometric characters were measured using a digital caliper (accuracy of 0.01 cm) and a ruler. These characteristics include:

1. Total length (TL)
2. Fork length (FL)
3. Standard length
4. Head length (HL)
5. Snout length (SnL)
6. Caudal peduncle length
7. Body height (BD)
8. Caudal peduncle height
9. Head height
10. Head width (HW)
11. Body width (BW)
12. Nose length
13. Length of head behind eyes
14. Interocular space width
15. Eye diameter
16. Maxillary jaw length
17. Lower jaw length
18. Mouth opening width
19. Height below eyes
20. Dorsal fin base length
21. Anal fin base length
22. Dorsal fin height (DFL)
23. Pectoral fin length (PFL)
24. Pelvic fin length (PVFL)

All measurements followed standard fish morphometric procedures according to Effendie (1997) and Kottelat *et al.* (1999).

Meristic Characteristic Observations

Meristic observations were conducted on 100 samples, including the number of dorsal fin rays (D), pectoral fin rays (P), pelvic fin rays (V), anal fin rays (A), and caudal fin rays (C).

Length–Weight Measurements

Length–weight measurements were conducted on all 400 sailfin catfish samples. Body length was measured using a ruler with an accuracy of 1 mm, the fork length (FL), which is the distance from the tip of the snout to the point where the tail forks. Meanwhile, body weight (W) was measured using a digital scale with an accuracy of 0.01 g. All measurements were conducted on fresh fish immediately after capture to minimize tissue shrinkage or weight changes that could affect data accuracy. The length and weight data obtained were then used to analyze the length–weight relationship and fish growth patterns.

Data Analysis

Data analysis in this study included growth patterns, morphometrics, and meristics. The length–weight relationship was analyzed using the general fish growth equation:

$$W = aL^b$$

W is body weight (g), L is fork length (cm), a is the condition coefficient, and b is the growth exponent. To obtain accurate parameter values, the equation was transformed logarithmically to $\log W = \log a + b \log L$. The interpretation of the b value refers to Effendie (1997), where $b=3$ indicates isometric growth, while $b>3$ and $b<3$ indicate positive allometric and negative allometric growth, respectively. In addition, the coefficient of determination (R^2) value was used to assess the strength of the length–weight relationship. Analysis was conducted

separately for male and female fish to observe differences in growth strategies in each sex. Morphometric data were analyzed descriptively, including calculating the mean, range, and standard deviation for each body character. Meanwhile, meristic data were processed to determine the minimum, maximum, mode, and variation patterns that appeared in the fish fin structure. All results of morphometric, meristic, and length-weight analyses are presented in the form of tables and graphs to facilitate the identification of patterns, population characteristics, and variations between individuals in the research sample.

RESULTS

Morphometrics and Meristics

Morphometric and meristic character measurements were conducted on 100 sailfin catfish to describe the variation in morphology and fin structure that represents the population conditions in Lake Sidenreng. The results showed inter-individual variation in morphometric parameters, while meristic characters showed a relatively stable range of values. The results of the morphometric and meristic measurements of sailfin catfish in Lake Sidenreng, compared with the results of previous research (Hossain et al., 2024), are presented in Table 1.

Table 1. Morphometric and Meristic Characteristics of Sailfin Catfish

Morphometric characters	<i>Pterygoplichthys</i> sp. in this study				<i>Pterygoplichthys</i> sp. (Hossain et al., 2024)			
	Mean ± STDV	Range	Meristic characters	Range	Mean ± STDV	Range	Meristic characters	Range
Weight (g)	209.05 ± 72.91	37-403	Number of dorsal fin rays	12 - 13	332.22 ± 161.94	90-540	Dorsal Fin (DF)	12-13
Total length (TL; cm)	30.09 ± 4.68	15.7 - 39.4	Number of pectoral fin rays	6-7	21.22 ± 3.29	17.78-26.16	Anal Fin (AF)	4-5
Fork length - Standard length (SL; cm)	25.00 ± 4.00	12 - 34	Number of pelvic fin rays	6	18.40 ± 3.16	14.22-23.37	Caudal Fin (CF)	6-15
Standard length - Predorsal length (PDL; cm)	22.21 ± 3.61	11.9 - 30	Number of anal fin rays	5	6.21 ± 1.14	4.06-7.62	Pectoral Fin (PF)	5-7
Head length - Head length (HL; cm)	4.87 ± 1.10	2.6 - 11.2	Number of caudal fin rays	13 - 16	3.44 ± 0.73	2.03-4.83	Pelvic Fin (PVF)	5-8
Anterior dorsal fin length - Snout length (SnL; cm)	8.12 ± 1.63	1.8 - 11.7			1.41 ± 0.42	0.76-2.03	Lateral Plate (LP)	25-29
Caudal peduncle length - Mouth length (ML, cm)	7.3 ± 1.42	2.6 - 9.7			1.07 ± 0.25	0.76-1.27		

Morphometric characters	<i>Pterygoplichthys</i> sp. in this study				<i>Pterygoplichthys</i> sp. (Hossain et al., 2024)			
	Mean ± STDV	Range	Meristic characters	Range	Mean ± STDV	Range	Meristic characters	Range
Body height - Barrel length (BL; cm)	4.09 ± 0.74	1.9 – 5.7			0.58 ± 0.19	0.25– 0.76		
Caudal peduncle height - Pectoral spine length (PSL; cm)	3.45 ± 0.76	1.7 – 5.5			3.75 ± 0.79	2.29– 4.57		
Head height - Pelvic spine length (PVSL; cm)	5.17 ± 0.85	1.8 – 5.6			1.67 ± 1.11	0.05– 3.05		
Head width - Anal fin spine length (ANSL; cm)	5.17 ± 0.85	2.8 – 7.8			2.48 ± 1.34	0.76– 4.32		
Body width - Dorsal spine length (DSPL; cm)	5.43 ± 0.79	3.1 – 6.8			3.47 ± 0.44	2.54– 4.06		
Nose length - Head depth (HD; cm)	3.22 ± 0.76	1 – 6.8			3.47 ± 0.85	2.29– 4.32		
Head length behind the eyes - Mouth width (MW; cm)	1.91 ± 0.49	1 – 3.8			0.99 ± 0.35	0.51– 1.52		
Interocular space width	2.85 ± 0.52	1 – 4.6						
Eye diameter	0.76 ± 0.20	0.5 – 1.9						
Upper jaw length	1.26 ± 0.39	0.6 – 2.7						
Lower jaw length	2.07 ± 0.60	1 – 3.5						
Mouth opening width	1.85 ± 0.62	0.9 – 3.7						
Height below the eyes	3.2 ± 2.05	1.2 – 11						
Doral fin base length	6.5 ± 1.88	1.5 – 10.8						
Fin base length Anal	3.63 ± 1.00	1.4 – 7.6						

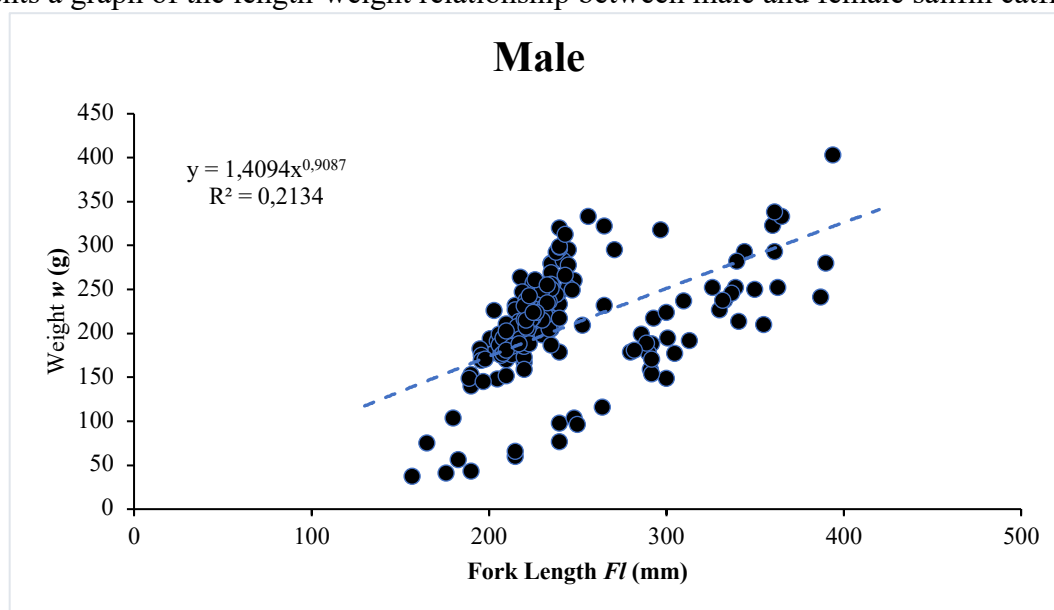
Morphometric characters	<i>Pterygoplichthys</i> sp. in this study				<i>Pterygoplichthys</i> sp. (Hossain et al., 2024)			
	Mean ± STDV	Range	Meristic characters	Range	Mean ± STDV	Range	Meristic characters	Range
Doral fin height	5.06 ± 1.12	1.9 – 8.2						
Pectoral fin length	6.06 ± 1.11	3.2 – 8.4						
Pelvic fin length	4.48 ± 1.15	0.4 – 7.7						



Figure 2. Sailfin Catfish (*Pterygoplichthys* sp.)

Growth Patterns

The analysis of the length-weight relationship of sailfin catfish grouped by sex revealed distinct growth patterns between males and females. Regression parameter values, including the growth coefficient (b) and the coefficient of determination (R^2), were used to identify the growth pattern and the strength of the relationship between body length and weight. Figure 3 presents a graph of the length-weight relationship between male and female sailfin catfish.



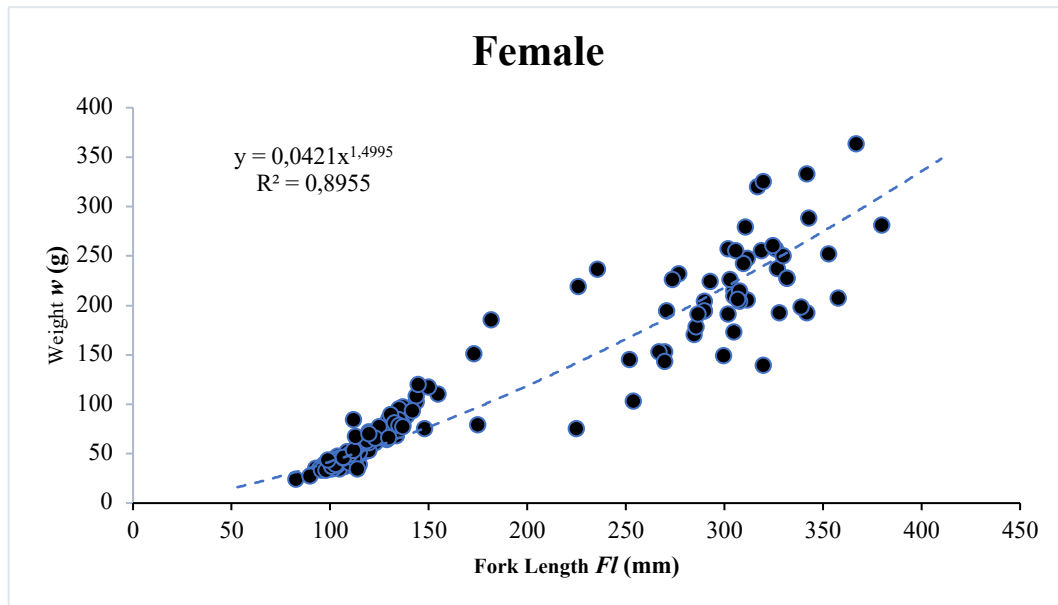


Figure 3. Relationship Between Length and Weight of Male and Female Sailfin Catfish

DISCUSSION

The results of this study indicate that the morphometric and meristic characteristics of the sailfin catfish (*Pterygoplichthys* sp.) in Lake Sidenreng exhibit a wide range of size variations, reflecting its high adaptability to lentic aquatic environments. The average total length of the fish was 30.09 cm, with a range of 15.7–39.4 cm, consistent with the size range commonly found in *Pterygoplichthys* populations across various tropical regions. A study by Hossain et al. (2024) reported smaller sizes in the Bangladesh population, suggesting that the larger size in the Lake Sidenreng population may reflect more abundant food availability or lower predation pressure, as also explained by Nico et al. (2009) that environments with minimal ecological pressure allow invasive species to reach their optimal size.

Morphometric characteristics such as head length, snout length, and mouth width obtained in this study are consistent with the diagnostic characteristics of Loricariidae reported by Armbruster (2004). The wide head structure and sucker-shaped ventral mouth play a crucial role in this fish's ability to scrape off detritus, biofilm, and algae from the substrate. Hoover et al. (2004) explained that this feeding mechanism is a key factor in *Pterygoplichthys*'s success as an invasive species, as it is able to utilize food sources that do not directly compete with native fish. Lake Sidenreng's rich organic matter, resulting from domestic and agricultural activities, may enhance the availability of these food sources.

The meristic characteristics in this study—12–13 dorsal fin rays, 6–7 pectoral fin rays, 6 pelvic fin rays, 5 anal fin rays, and 13–16 caudal fin rays—show a narrow range of variation. Relatively homogeneous meristics may indicate that the population originated from one or a few initial introductions with a uniform genetic background. This phenomenon is consistent with the findings of Wakida-Kusunoki et al. (2007) and the USGS report by Nico et al. (2009), which stated that *Pterygoplichthys* populations outside their native range generally originate from repeated releases of aquarium fish from the same genetic source. This strengthens the suspicion that the population in Lake Sidenreng is an invasion and not a native population.

From an ecological perspective, the presence of large numbers of *Pterygoplichthys* has the potential to seriously disrupt the structure of local fish communities. Nest-digging activities by males during the breeding season can accelerate bank erosion and increase water turbidity, as reported by Capps & Flecker (2013) and Wakida-Kusunoki et al. (2007). Increased turbidity can reduce light penetration, affect phytoplankton productivity, and ultimately degrade the

quality of native fish habitat. In Indonesia, Ndobe *et al.* (2016) noted that increasing *Pterygoplichthys* populations correlated with a decline in the abundance of several native species that are sensitive to environmental change.

Analysis of growth patterns indicates that b values <3 for both males and females indicate negative allometric growth, where length increases are not accompanied by a proportional increase in weight. This condition is common in fish living in environments with fluctuating food quality or ecological stress (Effendie, 1997; Weatherley & Gill, 1987). Low R^2 values in males indicate large weight variations between individuals, likely related to territorial behavior and the energy-intensive nest-digging activity. A study by Gibbs *et al.* (2008) showed that *Pterygoplichthys* males invest heavily in nest-guarding behavior, which can reduce energy reserves for body growth. Conversely, high R^2 values in females indicate a more stable length-weight relationship, consistent with female energy allocation to gonadal development and reproductive success. This suggests that the environmental conditions of Lake Sidenreng are sufficiently conducive to the reproductive success of this invasive population, as also suggested in the study of *Pterygoplichthys* reproduction by Gibbs *et al.* (2008).

Overall, the integration of morphometric, meristic, and growth results indicates that the *Pterygoplichthys* population in Lake Sidenreng has adapted well and has the potential to continue to thrive. These findings emphasize the need for more robust management strategies, including population control through selective fishing gear, regular monitoring, and public education regarding the dangers of releasing invasive fish. Similar recommendations were also proposed by Capps & Flecker (2013) and Nico *et al.* (2009) in the context of global freshwater invasive species management.

CONCLUSION

This study shows that the sailfin catfish (*Pterygoplichthys* sp.) found in Lake Sidenreng exhibits relatively homogeneous morphometric and meristic characteristics but exhibits a wide range of body sizes, indicating high adaptability to the lake environment. The large variation in body size is likely related to abundant food availability and low predation pressure. The narrow meristic characteristics indicate that this population was introduced from a uniform genetic source, as is common in invasive species. Negative allometric growth patterns in males and females indicate that increases in body length are not accompanied by proportional increases in weight, with differences in R^2 values indicating different energy strategies between the sexes. Overall, the morphometric, meristic, and growth pattern data confirm that *Pterygoplichthys* has adapted well and has the potential to continue to thrive in Lake Sidenreng, thus requiring serious attention in terms of management and conservation of native fish resources.

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REFERENCES

- Ahmad, T., Fadli, Z., & Mustofa, R. (2020). Analisis morfometrik ikan invasif sebagai dasar pengelolaan sumber daya perairan. *Jurnal Biologi Perairan*, 18(3), 211-220.
- Armbruster, J. W. (2004). *Phylogenetic relationships of the suckermouth armored catfishes (Loricariidae), with emphasis on the Hypostominae and the Ancistrinae*. *Zoological Journal of the Linnean Society*, 141(1), 1–80. <https://doi.org/10.1111/j.1096-3642.2004.00120.x>

- Capps, K. A., & Flecker, A. S. (2013). Invasive *armored catfish* alter nutrient dynamics in a tropical stream. *Freshwater Biology*, 58(6), 1161–1173. <https://doi.org/10.1111/fwb.12120>
- Effendie, M. I. (1997). *Biologi Perikanan*. Yayasan Pustaka Nusatama.
- Elfidasari, D. (2020). Dampak ekologis ikan sapu-sapu terhadap ekosistem air tawar di Indonesia. *Jurnal Ekologi Perairan Tropis*, 14(1), 45-56.
- Garcia-Berthou, E. (2007). The characteristics of invasive fishes: What has been learned so far? *Journal of Fish Biology*, 71(Suppl. D), 33–55. <https://doi.org/10.1111/j.1095-8649.2007.01668.x>.
- Gibbs, M. A., Shields, J. H., Lock, D. W., Talmadge, K. M., & Farrell, T. M. (2008). Reproduction in an invasive catfish, *Pterygoplichthys disjunctivus*, in Volusia Blue Spring, Florida, U.S.A. *Journal of Fish Biology*, 73(7), 1562–1572. <https://doi.org/10.1111/j.1095-8649.2008.02031.x>
- Hasrianti, A., Syamsuddin, S., & Firman, F. (2020). Dampak ledakan populasi ikan sapu-sapu terhadap spesies ikan lokal di perairan Sulawesi. *Jurnal Ekologi Perairan*, 15(2), 78-88.
- Hasrianti, S., Permatasari, D., Damis, & Putri, R. S. (2024). *Height and mesh size of gill nets to reduce sailfin catfish (Pterygoplichthys spp.) population: a case study in Lake Sidenreng, South Sulawesi, Indonesia*. (Artikel penelitian – jurnal resmi KKP Indonesia, 2024).
- Hasrianti, S., Surlanti, & Rahmat, M. R. (2020). *Pengaruh ledakan populasi ikan sapu-sapu (Pterygoplichthys spp.) terhadap produksi hasil tangkapan jaring insang di perairan Danau Sidenreng*. *Albacore*, 4(1), 13–19.
- Hasrianti, S., Surlanti, R. S. P., Damis, & Rahmat, M. R. (2020). *Analisis pengaruh ledakan populasi ikan sapu-sapu terhadap pendapatan nelayan jaring insang di perairan Danau Sidenreng*. *EnviroScienteeae*, 16(3), 382–388.
- Hidayat, N., Kurniawan, T., & Safitri, D. (2022). Variasi Pola Pertumbuhan Ikan di Sungai Konaweaha: Studi Kasus pada Ikan Sapu-Sapu (*Pterygoplichthys* SPP). *Jurnal Manajemen Sumber Daya Perikanan*, 9(1), 55-62. <https://ojs.uho.ac.id>
- Hoover, J. J., Killgore, K. J., & Conner, J. V. (2004). Feeding ecology of suckermouth catfishes (*Loricariidae: Pterygoplichthys*) in the lower Rio Grande Valley, Texas. *Reviews in Fisheries Science*, 12(1), 23–30. <https://doi.org/10.1080/10641260490273055>.
- Hossain, M. S., Kouba, A., Salam, M. A., Rahman, M. L., & Patoka, J. (2024). Morphometric and meristic study of freshwater fish species across ecological gradients. *Asian Journal of Fisheries and Aquatic Research*, 26(7), 45–58. <https://journalajfar.com/index.php/AJFAR/article/view/785>
- Indrayani, E., Sari, R., & Wulandari, N. (2017). Hubungan panjang–berat dan faktor kondisi ikan betina di perairan rawa Sumatera Selatan. *Jurnal Ilmu-Ilmu Perairan dan Perikanan Indonesia*, 24(2), 67–75.
- Iskandar, A., & Putri, N. R. (2019). Kajian meristik ikan sapu-sapu pada habitat alami dan buatan. *Jurnal Ekologi Perairan Tropis*, 12(4), 123-131.
- Kottelat, M., Whitten, A.J., Kartikasari, S.N., & Wirjoatmodjo, S. (1999). *Freshwater fishes of Western Indonesia and Sulawesi*. Periplus Editions.
- Mettee, M. F., O'Neil, P. E., & Pierson, J. M. (2005). Exotic fishes in North American waters. In M. G. Mesa (Ed.), *Fisheries Impacts of Non-native Fishes* (pp. 125–135). *American Fisheries Society*.
- Mukhlis, M., Abdullah, B., & Setiawati, H. (2021). Dampak Restocking Terhadap Nilai Produksi Ikan Di Danau Sidenreng Kabupaten Sidenreng Rappang. *Jurnal Ilmiah Ecosystem*, 21(2), 245-259. <https://doi.org/10.35965/eco.v21i2.1073>

- Muthmainnah, D., Sari, R. P., & Setiawan, H. (2019). Karakteristik pertumbuhan dan adaptasi ikan introduksi di perairan tawar Indonesia. *Jurnal Riset Akuakultur*, 14(3), 221–230.
- Ndobe, S., Rahim, M., & Barus, T. A. (2016). Invasive alien fish species in Indonesian freshwaters: Impacts and management approaches. *Indonesian Fisheries Research Journal*, 22(2), 91–102. <https://doi.org/10.15578/ifrj>.
- Nico, L. G., Jelks, H. L., & Tuten, T. (2009). *Non-native suckermouth armored catfishes in Florida: Description of nest borrows and burrow-associated spawning behavior*. U.S. Geological Survey Scientific Investigations Report 2009–5041.
- Ortega, H., Hidalgo, M., & Ráez-Luna, E. F. (2015). Impacts of the invasive armored catfish *Pterygoplichthys* SPP. (Siluriformes: Loricariidae) in tropical freshwater ecosystems. *Science of the Total Environment*, 524–525, 211–220. <https://doi.org/10.1016/j.scitotenv.2015.03.114>
- Permatasari, D., Hasrianti, H., Damis, & Putri, R. S. (2024). *Estimating the size of sailfin catfish (Pterygoplichthys sp.) at first gonad maturity in Lake Sidenreng, South Sulawesi, Indonesia*. *Bawal Widya Riset Perikanan Tangkap*, 17(2), 111–122.
- Sudirman, A., Nurdin, M., & Rahman, M. (2019). Keanekaragaman hayati Danau Sidenreng dan potensi ekonominya. *Jurnal Lingkungan dan Perikanan*, 12(3), 45-56.
- Wakida-Kusunoki, A. T., Amador-del-Angel, L. E., Medina-Nava, M., & Ruiz-Luna, A. (2007). Growth and reproduction of the invasive sailfin catfish (*Pterygoplichthys pardalis*) in southeastern Mexico. *Journal of Applied Ichthyology*, 23(6), 616–620.
- Weatherley, A. H., & Gill, H. S. (1987). *The Biology of Fish Growth*. Academic Press.
- Wibowo, H., Susilo, P., & Aditya, R. (2018). Studi komprehensif karakteristik morfometrik dan meristik ikan di Danau Indonesia. *Jurnal Bioteknologi Perairan*, 11(2), 145-157.
- Yusuf, A., & Amalia, S. (2018). Morfometrik dan meristik sebagai alat identifikasi ikan lokal dan invasif. *Jurnal Perikanan dan Biologi*, 13(4), 89-97.