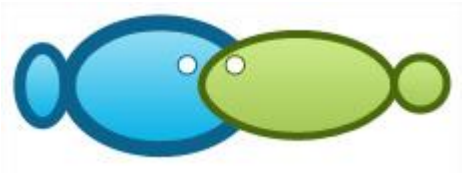

Condition factors and food habits of *Tominanga sanguicauda* at Lake Towuti, South Sulawesi, Indonesia

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Abstract. Lake Towuti is one of the lakes in the Wallacea region which has endemic fish species such as *Tominaga sanguicauda*. This fish was registered in 2019 at the IUCN on the red list of threatened species. Therefore, it is necessary to have a management policy to protect and preserve *T. sanguicauda* in Lake Towuti. To support these activities, restocking and aquaculture is necessary. However, this activity is still difficult to carry out due to limited information on *T. sanguicauda*. The main objective of present study was to analyze the condition factors and food habits of *T. sanguicauda* in Lake Towuti. The results of this study can be used for the domestication of *T. sanguicauda*. The research was conducted from June to August 2023 in the Lake Towuti, South Sulawesi, Indonesia; the fish sampling locations were: Tanjung Bakara, Tanjung Saone, and Tanjung Tominanga. The obtained condition factors were of 0.47-1.14 for male fish and of 0.89-1.20 for female fish, classifying these as flat fish. The relative length of intestines (RGL) of males ranged from 1.04 to 1.10, with a total length of 5.44-5.87 cm, and the RLG of females ranged from 1.04 to 1.09 with a total length of 3.55-4.90 cm, which is consistent with omnivorous species. The food of *T. sanguicauda* in Lake Towuti consists of the following species: *Ochterra humilis*, *Skeletonema* sp., *Limulus* sp., *Chlorella* sp., *Sinedra* sp., *Anabaena* sp., *Thalassionema* sp., *Coscinodiscus* sp., *Navicula* sp., *Rhyzosolenia* sp., *Merismopedia* sp. *and Diatoma* sp.
Key Words: endemic fish, Malili Lake, omnivorous, *Ochterra humilis*, relative gut length.

Introduction. The Malili Lake complex is located in East Luwu Regency, South Sulawesi, consisting of the Lake Matano, Lake Mahalona, Lake Towuti, Lake Wawantoa/lanto and Lake Masapi. Lake Matano and Lake Towuti are ancient lakes in Indonesia (Nasution et al 2015). Lake Towuti is located in the Malili Complex, South Sulawesi. Lake Towuti has an area of 561.1 km^2 and is an ancient, oligotrophic lake (Haffner et al 2001). Lake Towuti is one of the lakes in the Wallacea region which has a variety of endemic fish species (Kottelat et al 1993; Parenti 2011; Parenti & Ebach 2013). Endemic fish in Lake Towuti have distinctive and unique characteristics (Wijaya et al 2009; Nasution et al 2015); The endemic fish in Lake Towuti include a diversity of species that are ecologically and climatologically different and cannot be found anywhere else in the world (Hutama et al 2016). The Lake Towuti has several endemic fish species from the genera: *Telmatherina*, *Paratherina*, *Glossogobius*, *Dermogenys*, *Mugilogobius*, *Oryzias and Tominanga* (Jayadi et al 2019). Endemic fish species of the *Tominanga* genus were also found in Lake Towuti, such as *Tominaga sanguicauda* and *Tominanga aurea* (Hadiaty 2018; Jayadi et al 2021).

T. sanguicauda has been listed as Threatened in the IUCN Red List since 2019 (Lumbantobing 2019). Consequently, management actions improving its protection, preservation and sustainability are required. The endemic fish from Lake Towuti sharply declined during the last decade, due to an excessive and intensive exploitation (Samuel et al 2009), but also to the introduction of alien species (Herder et al 2006), habitat perturbation and destructive fishing practices (Prianto et al 2014; Syafei & Sudinno

2018). Therefore, it is necessary to have a management policy to protect and preserve the *T. sanguicauda* in Lake Towuti. To support these activities, it is necessary to do restocking and aquaculture. However, this activity is still difficult to carry out due to limited information on *T. sanguicauda*.

Information on *T. sanguicauda* is limited to taxonomic status and description (Said & Hidayat 2015), as ichthyofauna of the endemic fish in Lake Towuti (Hadiaty 2018; Jayadi et al 2021). Information on biological aspects including of condition factors and food habits of *T. sanguicauda* has not been reported. Examining the food habits of a species is important for evaluating the ecological role and position of the species in the food web of ecosystems (Allan & Castillo 2007). The condition factor (K) is an important quantitative parameter to determine the relative degree of robustness and nourishment in fish (Mortuza & Al-Misned 2013). The main objective of the present study was to analyze the condition factors and food habits of *T. sanguicauda* in Lake Towuti. The results of this study can be used as a basic concept to determine the direction of the management of *T. sanguicauda* to ensure its sustainability in the Lake Towuti, especially through domestication.

Material and Method

Study site and sampling. The research was conducted for 3 months from June to August 2023 in Lake Towuti, South Sulawesi, Indonesia. Fish sampling locations were: Tanjung Bakara (Station I), Tanjung Saone (Station II), and Tanjung Tominanga (Station III) (Figure 1). The geographical coordinates for the sampling stations are shown in Table 1.

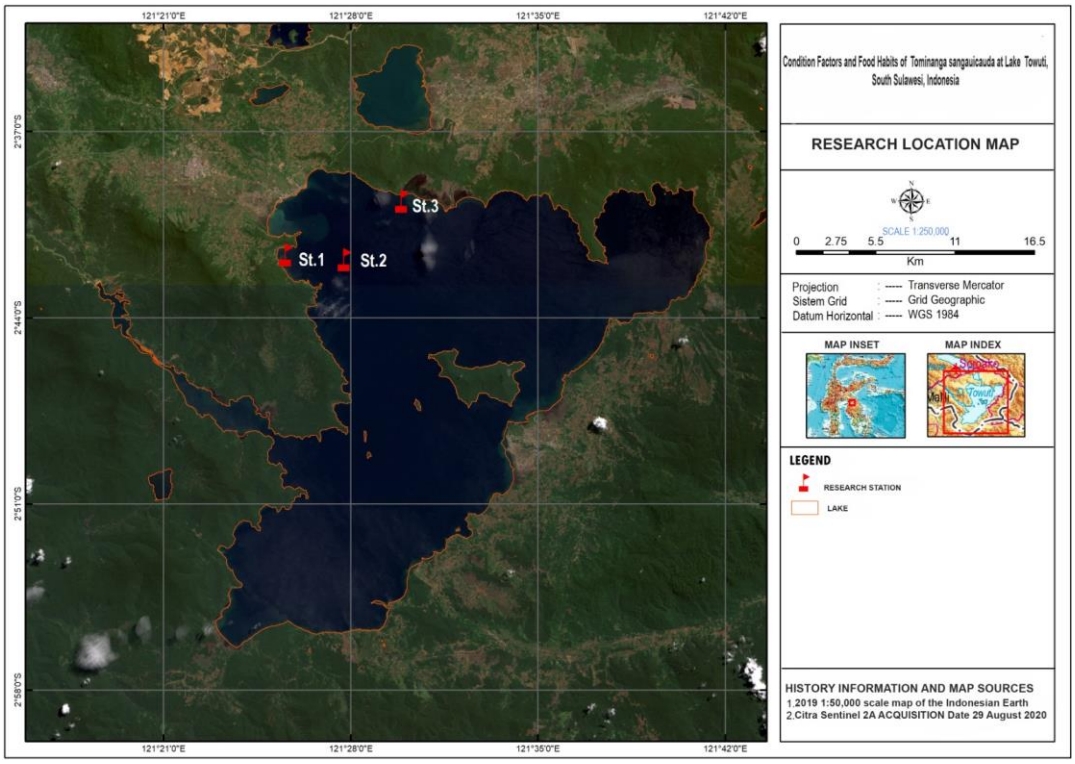

Figure 1. Sampling locations in Lake Towuti.

Table 1

Sampling sites and their coordinates

Sampling locations	*GPS coordinates*
Station 1 Tanjung Bakara	121° 25' 35.720" E 2° 41' 38.489" S
Station 2 Tanjung Saone	121° 27' 46.984" E 2° 38' 49.247" S
Station 3 Tanjung Tominanga	121° 29' 56.101" E 2° 39' 36.957" S

The tools used to take samples of *T. sanguicauda* were "seser nets" with a mesh size of 3/4 inches, a length of the net of 15 m, a height of 1.50 m and the length of the bag of 3 m. The number of fish caught every month was counted and the females and males were separated. Furthermore, the fish were preserved using 3% formalin for analysis of condition factor and feeding habits. Meanwhile, fish samples for proximate analysis of fish bodies were immediately stored in a cool box with the addition of ice to keep the temperature cool during transportation to the laboratory.

Fish measurement. The total length of *T. sanguicauda* was measured using a digital caliper, and the total weight was measured using a scale with an accuracy of 0.01 g.

Measurement of relative length of intestines. Measurement of the relative length of the intestine is one method used to distinguish fish based on the type of food. The relative length of the intestine can be calculated according to the following formula (Zuliani et al 2016):

$$RLG = GL / TL$$

Where:
RLG - relative length of intestines;
GL - length of intestines (cm);
TL - total length (cm).

Analysis of food habits. Food habits used the numerical method of Effendie (1979), namely by dissecting the stomach contents. Then the gastric contents were diluted with 2 ml of water. The diluted gastric contents were placed on a Sedwick rafter to be observed under a 100x magnification microscope. Identification of the type of food was carried out using the plankton identification book of Sachlan (1981). The types of organisms which were found in the fish stomach were analyzed according to the following formula of Kefas et al (2020):

Percentage number of a food item= Total number of the particular item / Total number of all food items X 100

The condition factor (CF), showing the physiological wellbeing of the fish, was determined according to the relationship of King (1995):

$$CF = W_{cal} / W_{pred}$$

Where:
CF - condition factor;
Wc_{al} - body weight of fish in gram;
W_{pred} - the average weight of the fish obtained from the length-weight relationship ($W=aL^b$).
If CF>1, it means that the individual or population is in a better condition, and CF<1 means that the individual or population is in a less good condition.

Results and Discussion

Condition factor. In fisheries science, the condition factor is used to compare the fitness or wellbeing of fish and it is based on the hypothesis that heavier fish of a particular length are in a better physiological condition (Bagenal & Teseh 1978). The condition factor can also be useful in monitoring the fishing intensity, ontogenetic population structure, and growth rates (Ahmed et al 2011). The results of the study on the analysis of the condition factors of the *T. sanguicauda* in Lake Towuti are presented in Table 2, showing that the range of condition factors of male fish is between 0.47-1.14, while in female fish the range is between 0.89-1.20.

Table 2

Condition factor of *Tominanga sanguicauda* fish in Lake Towuti

Month	*Number of fish*		*Condition factor*	
	Male	*Female*	*Male*	*Female*
June	352	415	0.56±0.09	0.98±0.22
July	319	514	0.99±0.13	1.01±0.19
August	295	654	1.00±0.14	0.93±0.14

According to Effendie (1979), fish whose condition factor is 0-1were classified as flat or not fat fish. Table 5 shows that there are differences in the condition factors of male and female *T. sanguicauda*, allegedly due to the influence of the weight of the food contained in the digestive tract as well as the size, age of the fish and the environmental conditions in which the fish are located. The variation in the value of condition factors in *T. sanguicauda* is thought to be influenced by food, age and gonad maturity. The condition factor of the fish is strongly affected by biotic and abiotic environmental variables related to the physiological condition of fish (Saliu 2001; Faradonbeh et al 2015). The variation of condition factors in fish is strongly influenced by body size, age, sex, gonad maturity and behavior before and after spawning (Effendie 2002). Furthermore, Abowei (2009) suggests that the condition factor can also be affected by factors like sex, season, age and maturity stages of fish.

Relative length of the intestine. Data on the average relative length of the intestine (RGL) of *T. sanguicauda* in Lake Towuti is presented in Table 3, showing that the RLG of males ranged from 1.04 to 1.10, with a total length of 5.44-5.87 cm, and the RLG of females ranged from 1.04 to 1.09, with a total length of 3.55-4.90 cm. The RLG at station 1 (Tanjung Bakara) was 1.10 in males and 1.04 in females, at station 2 (Tanjung Saone) it was of 1.18 in males and 1.09 in females, and at station 3 (Tanjung Tominanga) it was of 1.04 in males and 1.08 in females. Table 3 shows that the RLG at each station is relatively the same between males and females of *T. sanguicauda*.

Table 3

Relative gut length of male and female *Tominanga sanguicauda* fish in Lake Towuti

Station	*Total length (cm)*		*Length of gut (cm)*		*RLG*	
	Male	*Female*	*Male*	*Female*	*Male*	*Female*
Tanjung Bakara	5.87	3.86	7.95	4.01	1.10	1.04
Tanjung Saone	5.87	3.55	6.98	3.92	1.18	1.09
Tanjung Tominanga	5.44	4.90	5.65	5.27	1.04	1.08

The internal morphology (e.g., stomach shape and size, gut length) provide important information on a species' feeding ecology (Juanes & Conover 1994). The relative gut length or the relative length of intestines (RGL) analysis can be used to determine the food habits of fish, based on their diet. The results of the analysis assign fish to the class of herbivores, omnivores or carnivores. An RGL value smaller than 1 indicates a carnivorous diet, an RGL value between 1 and 3 indicates an omnivorous feeding, and an RGL value bigger than 3 suggests a diet based on vegetative material or detritus (Ward-Campbell et al 2005; Karachle & Stergiou 2010). The ratio of gut length to body length of fish can change with the body size and diet (Karachle & Stergiou 2010; Phan et al 2021). The RGL of *T. sanguicauda* ranged from 1.04 to 1.18 in males and from 1.04 to 1.09 in females in Lake Towuti is shown in Table 3. RGL values between 1 and 3 indicate omnivorous feeding habits (Ward-Campbell et al 2005; Karachle & Stergiou 2010). Therefore, since for *T. sanguicauda* the RLG is between 1.04-1.10, these are omnivores. Susilo et al (2021) showed that the gut length ratio of yellow rasbora (*Rasbora lateristriata* Blkr.) ranged from 0.53 to 0.81, characteristic for an omnivorous fish with a short intestine. Gurkan & Taskavak (2017) found an RGL for *Syngnathus acus*

of 0.097±0.08, for *Syngnathus typhle* of 0.137±0.02 and for *Nerophis ophidion* of 0.106±0.04, classifying these species as carnivorous. Novalina et al (2019) showed that the relative gut length of *Oryzias nigrimas* was in the range of 2.48-3.26, which corresponds to an omnivorous-herbivorous fish. Furthermore, Icas et al (2019) found that *Osteochilus* sp. is a herbivore fish with a relative gut length of 3.57. The relative length of the gut of *Oryzias profundicola* fish ranged from 1.77 to 1.79 for males and 1.71 to 1.79 for females, in the Lake Towuti (Nursyahran et al 2022).

Food habits. The results of the stomach analysis of male and female *T. sanguicauda* are presented in Table 4 and Table 5. The type of found food consists of: *Ochterra humilis*, *Skeletonema* sp., *Limulus* sp., *Chlorella* sp., *Sinedra* sp., *Anabaena* sp., *Thalassionema* sp., *Coscinodiscus* sp., *Navicula* sp., *Rhyzosolenia* sp., *Merismopedia* sp. and *Diatoma* sp.

Table 4

Types of food in the stomach of male *Tominanga sanguicauda* fish at the sampling stations, in the Lake Towuti

Type of food	*Station 1 Tanjung Bakara*		*Station 2 Tanjung Saone*		*Station 3 Tanjung Tominanga*	
	N (fish)	*(%)*	*N (fish)*	*(%)*	*N (fish)*	*(%)*
Ochterra humilis	140	19.97	111	18.78	134	19.59
Skeletonema sp.	74	10.56	65	11.00	79	11.55
Limulus sp.	85	12.13	66	11.17	90	13.16
Chlorella sp.	81	11.55	55	9.31	84	12.28
Synedra sp.	58	8.27	42	7.11	44	6.43
Anabaena sp.	45	6.42	27	4.57	36	5.26
Thalassionema sp.	49	6.99	42	7.11	40	5.85
Coscinodiscus sp.	33	4.71	38	6.43	43	6.29
Navicula sp.	48	6.85	37	6.26	47	6.87
Rhizosolenia sp.	47	6.70	39	6.60	24	3.51
Merismopedia sp.	36	5.14	30	5.08	35	5.12
Diatoma sp.	5	0.71	39	6.60	28	4.09
	701	100	591	100	684	100

N-Number of food (pieces) in the stomach; %-Proportion of total food (pieces).

Table 5

Types of food in the stomach of female *Tominanga sanguicauda* at the sampling stations in the Lake Towuti

Type of food	*Station 1 Tanjung Bakara*		*Station 2 Tanjung Saone*		*Station 3 Tanjung Tominanga*	
	N	*(%)*	*N*	*(%)*	*N*	*(%)*
Ochterra humilis	134	19.17	132	20.63	147	19.52
Skeletonema sp.	72	10.30	65	10.16	95	12.62
Limulus sp.	89	12.73	72	11.25	89	11.82
Chlorella sp.	64	9.16	60	9.38	97	12.88
Synedra sp.	71	10.16	33	5.16	36	4.78
Anabaena sp.	44	6.29	34	5.31	39	7.17
Thalassionema sp.	46	6.58	54	8.44	29	5.18
Coscinodiscus sp.	24	3.43	40	6.25	75	3.85
Navicula sp.	51	7.30	43	6.72	75	9.96
Rhizosolenia sp.	44	6.29	35	5.47	28	3.72
Merismopedia sp.	38	5.44	33	5.16	36	4.78
Diatoma sp.	13	1.86	39	6.09	28	3.72
	695	100	640	100	753	100

N-Number of food (pieces) in the stomach; %-Proportion of total food (pieces).

The type of food most commonly found in male fish at all stations was *O. humilis*, in the range of 18.78-19.97%, *Lumnulitus* sp., in the range of 11.17-13.16%, *Skeletonema* sp., in the range of 10.65-11.55% and *Chlorella* sp., ranging from 9.31 to 12.28%. Meanwhile, the types of food that were mostly found in female fish at all stations were as follows: *O. humilis*, in the range of 19.17-20.63%, *Lumnulitus* sp., in the range of 11.25-12.73%, *Chlorella* sp., in the range of 10.16-12.62% and *Skeletonema* sp., which ranged from 9.16 to 12.88%. There is no difference in the composition of the food eaten by both males and females (Table 4).

A previous research of Chadijah et al (2020) on the food habits in endemic fish studied food groups in the stomach of *Telmatherina prognatha*, in the Lake Matato, in particular insects, debris and plankton pieces (*Nitzschia sp., Navicula sp.*, and *Eunotia sp*.). According to Sulistiono et al (2006), *Telmatherina celebensis* consume insects and zooplankton consisting of *Closterium* sp., *Navicula* sp., *Nitzchia* sp., *Pinnularia* sp., and *Synedra* sp. in the Lake Towuti. Furthermore, Gani et al (2015) reported that *Oryzias sarasinorum* in the Rono Lindu had diet components in the stomach such as *Melosira* sp., *Synedra* sp., *Rhizosolenia* sp*.* and *Thalassionema nitzschionides*.

Based on the analysis of the stomach contents of *Telmatherina ladigesi*, it was found that its food habit includes: insects (*Plecoptera, Ephemenoptera, Diaptera, Chironomus, Hemiptera*), crustaceans (*Branchiopods, Cladocera*), protozoa, rotifers, Bascillariophyceae, Chorophyceae (Andriani 2000). Furthermore, Furkon (2003) reported that *Telmatherina celebensis* in the Lake Towuti consumed insects, diatoms, desmids and litter. Furthermore, Furkon (2003) reported that *T. celebensis* in Lake Towuti consumed insects, diatoms, desmids and litter. The natural food of *Mystacoleucus padangensis* fish in the Toba Lake was the phytoplankton of the class Bacilariopiceae (*Rhizosolenia*, *Synedra*, *Gonatozygon*, *Closterium, Surirella*, *Pinnularia*, *Oscillatroria, Melosira*, *Gyrosigma*, *Aulacoseira*) and the zooplankton (*Creseis*, *Tubifex and Daphnia*) (Suryanti et al 2017). The food habits of fish were determined by the type, size, color, taste, behavior, condition, age, food availability, feeding time (WHO 1987). The food habits of a fish species usually depend on age, place and time (Effendie 2002). The availability of the food in nature is one of the factors that determine the population, growth, reproduction and population dynamics as well as the condition of fish (Lagler et al 1977).

Conclusions. The range of condition factors of male fish was between 0.47 and 1.14 and in female fish it was in the range of 0.89-1.20. The relative length of the gut of male fish ranged from 1.04 to 1.18 and in female fish it ranged from 1.04 to 1.09, in the Lake Towuti. The type of fish food eaten by male and female fish is not different, consisting of: *O. chterra humilis, Skeletonema* sp*., Limulus* sp*., Chlorella* sp*., Sinedra* sp*., Anabaena* sp*., Thalassionema* sp*., Coscinodiscus* sp*., Navicula* sp*., Rhyzosolenia* sp*., Merismopedia* sp. and *Diatoma* sp*. T. sanguicauda* are omnivores.

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Conflict of interest. The authors declare no conflict of interest.

References

Abowei J., Davies O., Eli A. A., 2009 Study of the length-weight relationship and condition factor of five fish species from Nkoro River, Niger Delta, Nigeria. Current Research Journal of Biological Sciences 1(3):94-98.

Ahmed E. O., Ali M. E., Aziz A. A., 2011 Length-weight relationships and condition factors of six fish species in Atbara River and Khashm El- Girba Reservoir, Sudan. International Journal Agriculture Sciences 3(1):65-70.

Allan J. D., Castillo M. M., 2007 Stream ecology: structure and function of runing waters, 2nd edition, Springer, 372 p.

Andriani I., 2000 [Bio-ecology, morphology, caryotipe, and ornamental fish reproduction rainbow Sulawesi (*Telmatherina ladigesi*) in the River Maros, South Sulawesi]. MSc Thesis, Post Graduate School, Bogor Agricultural University, Bogor, 98 p. [In Indonesian].
Bagenal T. B., Teseh F. W., 1978 Methods for assessment of fish production in freshwaters. I.B.P. Handbook No. Edn 33. Oxford Blackwell Publications, 365 p.
Chadijah A., Sulistiono, Affandi R., Haryani G. S., Mashar A., 2020 Food habits of endemic opudi fish (*Telmatherina prognatha*, Kottelat 1991) in Matano Lake, South Sulawesi, Indonesia. Biodiversitas 21(4):1373-1378.
Effendie M. I., 1979 [Fishery biology method]. Yayasan Dewi Sari, Cetakan I, Bogor, 112 p. [In Indonesian].
Effendie M. I., 2002 [Fisheries biology]. Yayasan Pustaka Nusatama, Yokyakarta, 163 p. [In Indonesian].
Faradonbeh, Zamani M., Eagderi S., Ghojoghi F., 2015 Length-weight relationship and condition factor of seven fish species of Totkabon River (Southern Caspian Sea basin), Guilan, Iran. International Journal of Aquatic Biology 3(3):172-176.
Furkon, 2003 [Food habits and growth of the opudi fish *Telmatherina celebensis* in Lake Towuti, South Sulawesi]. Aquatic Resources Management Study Program, Faculty of Fisheries and Marine Sciences, Bogor Agricultural Institute, Bogor, 53 p. [In Indonesian].
Gani A., Nilawati J., Rizal A., 2015 [Habitat study and food habit of Rono Lindu Fish (*Oryzias sarasinorum* POPTA, 1905)]. Jurnal Sains dan Teknologi Tadulako 4(3):9–18. [In Indonesian].
Gurkan S., Taskavak E., 2017 The relationships between gut length and prey preference of three pipefish (*Syngnathus acus*, *Syngnathus typhle*, *Nerophis ophidion* Linnaeus, 1758) species distributed in Aegean Sea, Turkey. Iran. Journal of Fisheries Science 18(4):1093-1100.
Hadiaty R. K., 2018 [Taxonomic status of the endemic ichthyofauna of Sulawesi fresh waters]. Journal Iktiology Indonesia 18(2):175-190. [In Indonesian].
Haffner G. D., Hehanussa P. E., Hartoto D. I., 2001 The biology and physical processes of large of Indonesia: Lakes Matano and Towuti. In: The Great Lakes of the World (GLOW): Food-web, health and integrity. Munawar M., Hecky R. E. (eds), pp. 183-192, Michigan State University Press.
Herder F., Schwarzer J., Pfalender J., Hadiaty R. K., Schliewen U. K., 2006 Preliminary checklist of sailfin silversides (Teleostei: Telamtherinidae) in the Malili Lakes on Sulawesi. Verbandlungen der Gesellschaht for Ichthyologie Band 5:159-163.
Hutama A. A., Hadiaty R. K., Hubert N., 2016 Biogeography of Indonesia freshwater fishes: Current progress. Treubia 43:17-30.
Icas U. D., Syarif A. F., Prasetiyono E., Kurniawan A., 2019 [Stomach content identification of Kepaet fish *Osteochilus* sp. from Bangka Island for principle of domestication development]. Jurnal Aquacultur Tropis Asia 4(1):16–19. [In Indonesian].
Jayadi J., Ilmiah I., Hadijah S., Kasnir M., Roslim D. I., 2019 DNA barcoding of Telmatherinidae family in Lake Towuti, South Sulawesi, Indonesia. AACL Bioflux 12(4):1208-1215.
Jayadi, Nessa M. N., Tamsil A., Harlina, Ernaningsih, Nursyahran, Muqtadir A., 2021 Ichthyofauna of endemic fish in Towuti Lake, Luwu Timur regency, South Sulawesi, Indonesia. Asian Journal Fisheries and Aquatic Research 12(3):20–30.
Juanes F., Conove, 1994 Piscivory and prey size selection in young-of-the-year bluefish: predator preference or size-dependent capture success? Marine Ecology Progress Series 114:59–69.
Karachle P. K., Stergiou K. I., 2010 Intestine morphometrics of fishes: A compilation and analysis of bibliographic data. Acta Ichthyologica Et Piscatoria 40(1):45–54.
Kefas M., Jidauna S. B., Michael K. G., Wasa G. F., 2020 The Length-Weight relationship, condition factor and feeding habits of *Oreochromis niloticus* from Lake Geriyo, Yola, Adamawa State, Nigeria. International Journal of Research in Agriculture and Forestry 7(3):13-20.

King M., 1995 Fisheries biology; assessment & management. Fishing News Books in UK, 341 p.
Kottelat M., Whitten A. J., Kartikasari S. N., Wirjoatmodjo S., 1993 Freshwater fish in western Indonesia and Sulawesi. The State Ministry for Population and Environment of the Republic of Indonesia, Periplus Edition, Jakarta, 293 p.
Lagler K. F., Bardach J. E., Miller R. R., Passini D. R. M., 1977 Ichtiology. John Wiley and Sons, London, 528 p.
Lumbantobing D., 2019 *Tominanga sanguicauda*. The IUCN red list of threatened species 2019: e.T21980A90980344.
Mortuza M. G., Al-Misned F. A., 2013 Length-weight relationships, condition factor and sex-ratio of Nile Tilapia, *Oreochromis niloticus* in WadiHanifah, Riyadh, Saudi Arabia. World Journal of Zoology 8(1):106-109.
Nasution S. H., Sulastri S., Muchlisin Z. A., 2015 Habitat characteristics of Lake Towuti, South Sulawesi, Indonesia-the home of endemic fishes. AACL Bioflux 8(2):213-223.
Novalina S., 2019 Food habits of the endemic ricefishes (*Oryzias Nigrimas*, Kottelat 1990) in Poso Lake, Central Sulawesi of Indonesia. Russian Journal of Agricultural and Socio-Economic Sciences 87(3):125–130.
Nursyahran, Jayadi, Tamsil A., Harlina, 2022 Food Habit and Condition Factor of the Yellow-Finned Medaka (*Oryzias profundicola*) from Lake Towuti, South Sulawesi, Indonesia. Egyptian Journal of Aquatic Biology & Fisheries 26(6):1021–1033.
Parenti L. R., 2011 [Endemism and conservation of the native freshwater fish fauna of Sulawesi, Indonesia]. In: Proceeding Seminar Nasional Ikan VI & Congress Masyarakat Iktiologi Indonesia III. Simanjuntak C. P. H., Zahid A., Rahardjo M. F., Hadiaty K. H., Krismono, Haryono, Tjakrawidjaja A. H. (eds), pp. 1-10. [In Indonesian].
Parenti L. R., Ebach M. C., 2013 Evidence and hypothesis in biologeography. Journal of Biogeography 40:813-820.
Phan G. H., Dinh Q. M., Truong N. T., Tran N. S., Nguyen T. H. D., 2021 Factors affecting relative gut length and fullness index of *Glossogobius giuris* living along Hau River, Vietnam. AACL Bioflux 14(5):2708-2717.
Prianto E., Kartamihardja E. K., Husnah, Umar C., Kasim K., Zulfia N., Budi E. K., 2014 [Policy to increase fish production and conservation of resources in the public waters of the Zone Wallacea]. Fisheries Management Research Center and Fish Resource Conservation, Technical report, 70 p. [In Indonesian].
Sachlan M., 1981 [Planktonology]. Directorate General of Fisheries, Ministry of Agriculture, Jakarta, 56 p. [In Indonesian].
Said D. S., Hidayat, 2015 [101 Freshwater ornamental fish of the archipelago]. LIPI Press, Jakarta, pp. 121-166. [In Indonesian].
Saliu J. K., 2001 Observation on the condition factor of *Brycinus nurse* (Pisces: Cypriniformes, Characidae) from Asa Reservoir, Ilorin, Nigeria. Tropical Freshwater Biology 10(1):9-17.
Samuel, Husnah, Makmur S., 2009 [Capture fisheries in Lake Matano, Mahalona, and Towuti, South Sulawesi]. Jurnal Penelitian Perikanan Indonesia 15(1):123-131. [In Indonesian].
Syafei L. S., Sudinno D., 2018 [Invasive alien fish, a challenge to aquatic biodiversity sustainability]. Jurnal Penyuluhan Perikanan dan Kelautan 12(3):149-165. [In Indonesian].
Sulistiono, Furkon A., Affandi R., 2006 [Study on stomach contents of opudi fish (*Telmatherina celebensis*) in Towuti Lake, South Sulawesi]. Jurnal Akuakultur Indonesia 5 (2):149-156. [In Indonesian].
Suryanti A., Sulistiono, Muchsin I., Kartamihardja E. S., 2017 [Food and feeding habits of bilih fish *Mystacoleucus padangensis* (Bleeker, 1852) in Naborsahan River, Toba Lake, North Sumatera]. Omni-Akuatika 13 (2):80-88. [In Indonesian].
Susilo J., Sukardi P., Affandi R., 2021 Length ratio, histological structure, feed composition, and enzyme activity in the gut of yellow rasbora (*Rasbora lateristriata* Blkr.) E3S Web of Conferences 322:01039.

Ward-Campbell B. M. S., Beamish F. W. H., Kongchaiya C., 2005 Morphological characteristics in relation to diet in five coexisting Thai fish species. Journal Fish Biolody 67(5):1266–1279.
Wijaya D., Samue, Masak P. R. P., 2009 [Study of water quality and production potential of fish resources in Towuti Lake, South Sulawesi]. Bawal 2(6):291–297. [In Indonesian].
Zuliani, Muchlisin Z., Nurfadillah, 2016 [Food Habits and Long-weight Relationship of Julung-Julung fish (*Dermogenys* sp.) in the Alur Hitam River, Bendahara District, Aceh Tamiang Regency]. Jurnal Ilmiah Mahasiswa Kelautan dan Perikanan Unsyiah 1(1):12–24. [In Indonesian].
*** WHO, 1987 Fish feeds and feeding. Rome, FAO, ADCP Report 87/26. https://www.fao.org/fishery/docs/CDrom/FAO_Training/FAO_Training/General/x6709e/.!17816!x6709e10.htm

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