Stock assessment of fourfinger threadfin (*Eleutheronema tetradactylum* Shaw, 1804) based on length-weight relationship and condition factors from the coastline of North Sumatra Province and Riau Province, Indonesia

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Abstract. Four-finger threadfin (*Eleutheronema tetradactylum*) has been over-exploited by fishing activities. The IUCN Red List of Threatened Species (Motomura et al 2015) issues the threat level for this species into the endangered category. This indicates that this species needs attention due to significant population decline in recent decades. The fish conservation efforts need to be carried out through data analysis on fish stocks in the wild. This study aims to carry out a stock assessment of *E. tetradactylum* through the length-weight relationship (LWR) and fish condition factors analysis approach. The research was conducted at four locations, three locations in North Sumatra Province (Tanung Balai, Bagan Serdang, and Pangkalan Brandan) and one location in Riau Province (Bagansipapiapi), Indonesia from June 2022 to July 2023. Fish sampling was carried out at the fish landing site (TPI) where the fish was found. The results of the analysis showed that the fish growth pattern was allometric negative in three locations, namely Tanjung Balai, Bagan Serdang, and Pangkalan Brandan with values of 2.84, 2.58, and 2.89, while the fish growth pattern in Bagansiapiapi tended to be isometric (2.99). The highest average size of *E. tetradactylum* caught was at Bagan Serdang station reaching 196.39 mm, followed by Tanjung Balai station (182.68 mm), Pangkalan Brandan station (149.57 mm), and Bagansiapiapi station (134.75 mm). However, the average size of the fish caught is not yet suitable for catching, as indicated by the size of immature fish (TL<250 mm).

Key Words: allometric, decline, endangered, isometric.

Introduction. Fourfinger threadfin (*Eleutheronema tetradactylum*) is an economically important fish in the world (Moore et al 2011). *E. tetradactylum* are widely distributed including the waters of Australia, Belgium, China, Indonesia, Japan, Papua New Guinea, and Thailand (Horne et al 2011; Breine et al 2017; Motomura et al 2001; Zhong et al 2021; Xiao et al 2022). This species can live in saltwater, brackish water and freshwater (Zischke et al 2009). However, over-exploitation by fishermen causes *E. tetradactylum* to be threatened. The IUCN Red List of Threatened Species classifies this species in the endangered category (Motomura et al 2015). This indicates that this species needs attention due to significant population decline in recent decades. The effort to conserve this species is set to analyze data about fish stocks in the wild.

Fish stock assessment is an effort to identify the condition of fish in the wild. So far, the stock valuation has been carried out using the length-weight relationship (LWR) analysis approach and condition factors. Analysis of the LWR and fish condition factors aims to reveal fish growth, environmental conditions and the abundance of predators (Batubara et al 2019). By assessing fish stocks, researchers are able to reveal the feasibility of fish caught based on growth patterns and condition factors and can conclude whether the fish are over-exploited (overfishing) or not. In addition, the results of fish stock assessment studies can be used as a reference for the formation of fishing regulations in an area (Punt & Hilborn 1997). Fish that are threatened with extinction can be limited in their fishing activities, such as limiting the size of the mesh, the fishing gear allowed, the time of catching and the size of the fish that can be caught (Hilborn 1992). This strategy is needed to optimize the selective exploitation of fish so that fish resources remain sustainable (Chen et al 2003).

It is recorded that research has been conducted on *E. tetradactylum* including stock assessments in Australia (Zischke et al 2009; Moore et al 2011; Newman et al 2011), ecology (Horne et al 2011), genetic distribution in China (Wang et al 2014; Qu et al 2020), morphology of fish in the Persian Gulf (Jaferian et al 2010), fish parasites in India (Bharadhirajan et al 2013; Gautam et al 2018), fish reproduction in Malaysia and Bangladesh (Zamidi et al 2012; Nesarul et al 2014), bio-economy of fish farming in Taiwan (Huang et al 2022), while research in Indonesia is still limited, including analysis of feeding habits (Titrawani et al 2013), fishing technology (Kholis et al 2017), and growth (Gebze & Latupeirissa 2017), while a study of the stock assessment of *E. tetradactylum* has never been reported. Therefore, this research has a high urgency to manage fish resources so that they can be utilized in a sustainable manner. In addition, the stock assessment of *E. tetradactylum* is important to study as a conservation effort because this species is already in an endangered condition (Motomura et al 2015).

Material and Method. This research was conducted in Pangkalan Brandan (4°4'39.12''N, 98°18'53.01''E), Bagan Serdang (3°42'19.45''N, 98°50'26.09''E), Tanjung Balai (3°2'39.22''N, 99°51'56.77''E) North Sumatra Province, and Bagansiapiapi (2°14'1.54''N, 100°37'18.8''E) Riau Province, Indonesia from June 2022 to July 2023. Sampling of *E. tetradactylum* was conducted at the fish landing sites. The collected samples were then brought to the Biology Laboratory of the Faculty of Mathematics and Natural Sciences, Universitas Negeri Medan for further analysis.

The fish samples collected were then measured for total length using a digital caliper (error 0.01 mm) and weighed using a digital balance (error 0.01 g). The LWR was analyzed using the linear allometric model (LAM) with the equation based on De-Robertis and William (2008) as follows:

$$W = e^{0,56}(aL^b)$$

where W is the weight, L is the total length of fish, a is constant, b is geometric for fish body proportion, e is variance of residuals of LAM, and 0.56 is the correction factor.

In this study, two types of condition factors were calculated, namely the relative weight (Wr) and Fulton’s (K) condition factors, to determine the relative weight condition factor using the formula of Rypel and Richter (2008) as follows:

$$W_r = (W/W_s) \times 100$$

where Wr is the relative weight, W is the weight of the fish, Ws is the predicted standard fish weight for the same fish based on the linear allometric model (LAM).

Furthermore, to determine the Fulton’s condition factor we used Muchlisin et al (2010) formula as follows:

$$K = WL^{-3} \times 100$$

where K is Fulton’s condition factor, W is the weight of the fish, L is the total length of the fish and $^{-3}$ is the length coefficient or correction factor.

The provisions for the value of K refer to Morton and Routledge (2006), where:
0.8 -1.0 Very bad condition, where the head looks big, and the body looks thin.
1.0-1.2 Bad condition, where the fish looks long and thin.
1.2-1.4 Balanced condition, where length and weight are appropriate.
1.4-1.6 Good condition, the fish maintains a good proportion.
>1.6 Very good condition, the fish looks plump.

Results and Discussion. Based on the size of the fish collected, Bagan Serdang had the highest average size of 196.39 mm, followed by Tanjung Balai (182.68 mm), Pangkalan Brandan (149.57 mm), and Bagansiapiapi (134.75 mm). The results of the dominant analysis of the growth pattern of *E. tetradactylum* were allometric negative (b<3) at three sampling locations and only samples from Bagansiapiapi showed an isometric growth pattern (2.99) (Figure 1 left). The Fulton's (K) and relative weight (Wr) condition factors indicated stable fish conditions at each study site with values >1.6 for K and >100 for Wr respectively (Table 1).

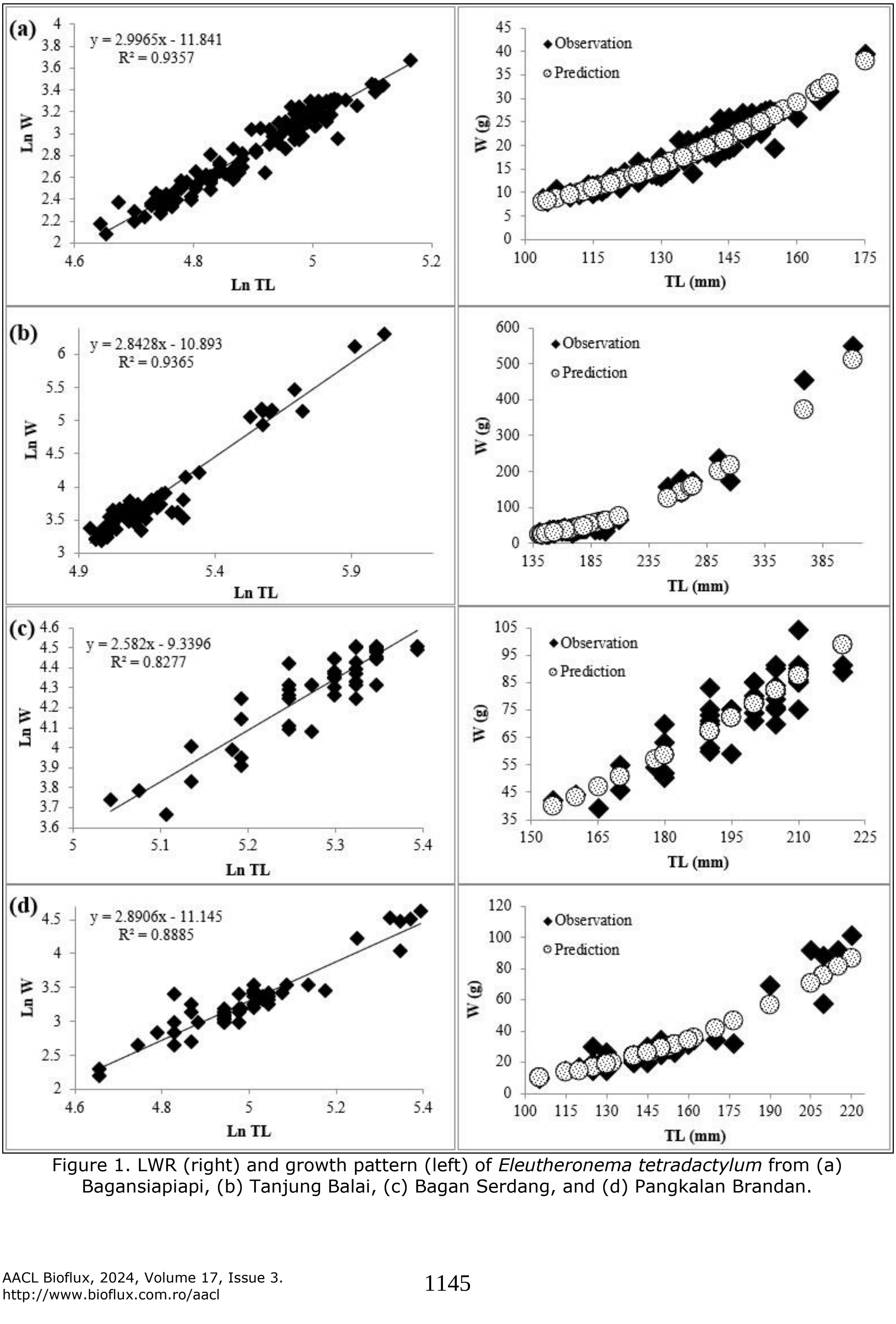

Figure 1. LWR (right) and growth pattern (left) of *Eleutheronema tetradactylum* from (a) Bagansiapiapi, (b) Tanjung Balai, (c) Bagan Serdang, and (d) Pangkalan Brandan.

Table 1

LWR, Fulton's (K), and relative weight (Wr) condition factors values of *Eleutheronema tetradactylum* (values displayed as ranges and average ± standard deviation)

No	*Site*	*Ind*	*Total length (mm)*	*b*	*R^2 (%)*	*K*	*Wr*
1	Bagansiapiapi	119	104-175 134.75±15.44	2.99	93.57	2.07-2.67 2.40 ±0.15	72.89-123.76 100.46±9.07
2	Tanjung Balai	73	140-412 182.68±51.64	2.84	95.65	2.40-2.99 2.73±0.12	55.56-129.31 101.35±15.91
3	Bagan Serdang	49	155-220 196.39±15.12	2.58	82.77	2.75-3.05 2.91±0.07	82.06-123.44 100.42±9.48
4	Pangkalan Brandan	51	105-220 149.57±26.02	2.89	88.85	2.18-3.02 2.62±0.17	70.37-180.30 101.43±18.56
	Average	292	165.85	2.83	90.21	2.67	100.92

Based on the value of the coefficient of determination (R^2), it is showed a close relationship between the addition of length and weight in fish with respective values of 95.65% in Tanjung Balai, and 93.57% Bagansiapiapi, 88.85% Pangkalan Brandan and 82.77% Bagan Serdang. Furthermore, the growth pattern scatter plots, show that the observed data is similar to the predicted results (Figure 1 right). The results of predictions that form growth patterns are conditions where the addition of fish weight and length is ideal.

Based on the results of the LWR analysis, *E. tetradactylum* collected from the Tanjung Balai, Bagan Serdang and Pangkalan Brandan had a negative allometric growth pattern (b<3), while *E. tetradactylum* in Bagansiapiapi tended to be isometric (b=3). The value of b in this study is lower than for *E. tetradactylum* in the Chilika Lagoon, India which reached 3.01 (Panda et al 2016). Another study conducted by Kazemi et al (2013) in the Persian Gulf and Oman Sea showed an isometric growth pattern of *E. tetradactylum* (b=2.96). These results indicate that *E. tetradactylum* collected in Tanjung Balai, Bagan Serdang and Pangkalan Brandan has been under stress. The negative allometric growth pattern indicates an unbalanced increase in fish weight and length, resulting in slender fish (asymmetrical growth) (Cuadrado et al 2019). This phenomenon can occur due to minimal food sources, polluted environments, and high competition (Gurkan et al 2010). The isometric growth pattern shows a balanced growth pattern between weight and length, which indicates sufficient food is available (Batubara et al 2019).

Furthermore, according to Nieto-Navarro et al (2010) and Camargo et al (2018) LWR information represents the growth pattern of fish species in an environment and can be used as a reference for conservation efforts and management strategies for fish that are threatened with extinction. This fish growth pattern is influenced by competitors, diet, habitat, health, season, and sex (Froese 2006). In addition, environmental damage due to fishing activities also has a significant effect on fish growth (Heino & Godø 2002; Huntingford et al 2006). Another factor affecting fish growth is climate change, which has a significant impact on fish physiology and behavior (Ficke et al 2007; Brander 2010; Little et al 2020).

Based on the analysis of the condition factors (K and Wr), the average values at all sampling locations were >1.6 and >100, which indicated that the fish population was in a stable condition (Muchlisin et al 2015; Muchlisin et al 2017). It is important to reveal the Wr value because it can be used as a reference in research and management of fish resources (Blackwell et al 2000). In addition, the Wr value can be used as a predictor of growth, abundance of prey and environmental conditions of a fish species (Liao 1994; Muchlisin et al 2010).

The highest average size of *E. tetradactylum* caught was at Bagan Serdang station reaching 196.39 mm, followed by Tanjung Balai with 182.68 mm, Pangkalan Brandan with 149.57 mm, and Bagansiapiapi with 134.75 mm. However, the average size of fish caught was not feasible (immature size) from all research locations, where the appropriate size for catching fish is if the fish was of adult size, which is represented by the first time the gonads matured (Yusfiandayani 2013). According to Soe et al (2023) *E.*

tetradactylum first matured at a size >250 mm, so this study indicated that the fish caught were not viable. It is estimated that if done in a prolonged manner, the fish will experience overfishing. As a result, *E. tetradactylum* is unable to match its regeneration capacity with the rate of capture. The pattern and ratio of exploitation of immature fish has a significant effect on the sustainability and stocks of fish in the wild, where if the catch of immature fish exceeds half of the adult fish, the fish population is in a condition that exceeds the exploitation limit (Mangi & Roberts 2006; Vasilakopoulos et al 2011).

It is important to implement eco-friendly fishing efforts to conserve *E. tetradactylum* stocks. The strategy is to determine the appropriate size for catching, net size, the prohibition of destructive fishing gear, marine protected areas (MPAs) designation, and limiting catches during the spawning season (Hard et al 2008). Fishing activities during the spawning season has a significant impact on the death of fish offspring which has the potential to maintain sustainable fish stocks (Van-Overzee & Rijnsdorp 2015). MPAs are areas established to conserve habitat and fish populations, where human activities are restricted, and fishing is prohibited (Balmford et al 2004).

Conclusions. The exploitation of *E. tetradactylum* is already worrying as shown by the condition of dominant catches of immature fish. Three research sites for *E. tetradactylum* showed negative allometric growth and one other location was isometric. Fulton's and relative weight condition factors indicated that the fish were in a stable condition and the habitat was still adequate.

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Conflict of interest. The authors declare that there is no conflict of interest.

References

Balmford A., Gravestock P., Hockley N., McClean C. J., Roberts C. M., 2004 The worldwide costs of marine protected areas. Proceedings of the National Academy of Sciences 101(26):9694-9697.

Batubara A. S., Muchlisin Z. A., Efizon D., Elvyra R., Irham M., 2019 Length-weight relationships and condition factors of the naleh fish, *Barbonymus gonionotus* (Pisces, Cyprinidae) harvested from Nagan Raya Waters, Indonesia. Vestnik Zoologii 53(1):75-82.

Bharadhirajan P., Gopalakrishnan A., Raja K., Murugan S., Vijayakumar R., Rahman M. M., 2013 Prevalence of copepod parasite (*Lernaeenicus polynemi*) infestation on *Eleutheronema tetradactylum* from Pazhayar coastal waters, southeast coast of India. Journal of Coastal Life Medicine 1(4):278-281.

Blackwell B. G., Brown M. L., Willis D. W., 2000 Relative weight (Wr) status and current use in fisheries assessment and management. Reviews in Fisheries Science 8(1):1-44.

Brander K., 2010 Impacts of climate change on fisheries. Journal of Marine Systems 79(3-4):389-402.

Breine J. J., Lambeens I., Maes Y., De Bruyn A., Galle L., 2017 First record of the fourfinger threadfin, *Eleutheronema tetradactylum* (Shaw, 1804) in Belgium. Estuarine, Coastal and Shelf Science 187:28-30.

Camargo M. P., Aranha J. M. R., Menezes M. S., 2018 Length-weight relationship (LWR) of fish species in the Morato River, Paraná, Brazil. Journal of Applied Ichthyology 34(5):1186-1187.

Chen Y., Chen L., Stergiou K. I., 2003 Impacts of data quantity on fisheries stock assessment. Aquatic Sciences 65(1):92-98.

Cuadrado J. T., Lim D. S., Alcontin R. M. S., Calang J. L. L., Jumawan J. C., 2019 Species composition and length-weight relationship of twelve fish species in the two lakes of Esperanza, Agusan del Sur, Philippines. FishTaxa 4(1):1-8.
De-Robertis A., William K., 2008 Weight-length relationship in fisheries studies: the standard allometric model should be applied with caution. Journal of Transactions of the American Fisheries Society 137:707-719.
Ficke A. D., Myrick C. A., Hansen L. J., 2007 Potential impacts of global climate change on freshwater fisheries. Reviews in Fish Biology and Fisheries 17:581-613.
Froese R., 2006 Cube law, condition factor and weight–length relationships: history, meta-analysis and recommendations. Journal of Applied Ichthyology 22(4):241-253.
Gautam N. K., Mohapatra A., Saxena A. M., 2018 On a new species of *Neoechinorhynchus* Hamann, 1892 (Neoechinorhynchinae Travassos, 1926) from *Eleutheronema tetradactylum* (Shaw, 1804) from Digha coast, West Bengal, India. Journal of Parasitic Diseases 42(3):462-466.
Gebze A. K., Latupeirissa I. L., 2017 [Growth of kuro fish (*Eleutheronema tetradactylum* Shaw, 1804) at the Kumbe River Estuary, Merauke Regency]. Agricola 7(2):129-135 [In Indonesian].
Gurkan S., Bayhan B., Akcinar S. C., Taskavak E., 2010 Length-weight relationship of fish from shallow waters of Candarli Bay (North Aegean Sea, Turkey). Pakistan Journal of Zoology 42(4):495-498.
Hard J. J., Gross M. R., Heino M., Hilborn R., Kope R. G., Law R., Reynolds J. D., 2008 Evolutionary consequences of fishing and their implications for salmon. Evolutionary Applications 1(2):388-408.
Heino M., Godø O. R., 2002 Fisheries-induced selection pressures in the context of sustainable fisheries. Bulletin of Marine Science 70(2):639-656.
Hilborn R., 1992 Current and future trends in fisheries stock assessment and management. South African Journal of Marine Science 12(1):975-988.
Horne J. B., Momigliano P., Welch D. J., Newman S. J., Van Herwerden L., 2011 Limited ecological population connectivity suggests low demands on self-recruitment in a tropical inshore marine fish (*Eleutheronema tetradactylum*: Polynemidae). Molecular Ecology 20(11):2291-2306.
Huang C. T., Afero F., Lu F. Y., Chen B. Y., Huang P. L., Lan H. Y., Hou Y. L., 2022 Bioeconomic evaluation of *Eleutheronema tetradactylum* farming: a case study in Taiwan. Fisheries Science 88:437-447.
Huntingford F. A., Adams C., Braithwaite V. A., Kadri S., Pottinger T. G., Sandøe P., Turnbull J. F., 2006 Current issues in fish welfare. Journal of Fish Biology 68(2):332-372.
Jaferian A., Zolgharnein H., Mohammadi M., Salari-Aliabadi M. A., Hossini S. J., 2010 Morphometric study of *Eleutheronema tetradactylum* in Persian Gulf based on the truss network. World Journal of Fish and Marine Sciences 2(6):499-504.
Kazemi S. H., Paighambari S. Y., Daliri M., Naderi R. A., 2013 Length-weight and length-length relationships, condition factors and optimal length of some fish species from the Persian Gulf and Oman Sea. International Journal of Aquatic Biology 1(4):167-174.
Kholis M. N., Wahju R. I., 2017 Selection of Kurau fishing technology units *Eleutheronema tetradactylum* which competitive and sustainable. Jurnal Ilmu dan Teknologi Kelautan Tropis 9(2):521-535.
Liao H., 1994 The Relative weight (Wr) condition index as a predictor of growth, prey abundance and environmental conditions. Theses, Eastern Illionis University, USA. 57 pp.
Little A. G., Loughland I., Seebacher F., 2020 What do warming waters mean for fish physiology and fisheries? Journal of Fish Biology 97(2):328-340.
Mangi S. C., Roberts C. M., 2006 Quantifying the environmental impacts of artisanal fishing gear on Kenya’s coral reef ecosystems. Marine Pollution Bulletin 52(12):1646-1660.

Moore B. R., Stapley J., Allsop Q., Newman S. J., Ballagh A., Welch D. J., Lester R. G., 2011 Stock structure of blue threadfin *Eleutheronema tetradactylum* across northern Australia, as indicated by parasites. Journal of Fish Biology 78(3):923-936.

Morton A., Routledge R. D., 2006 Fulton's condition factor: is it a valid measure of sea lice impact on juvenile salmon? North American Journal of Fisheries Management 26(1):56-62.

Motomura H., Matsuura K., Bishop J., Kaymaram F., 2015 *Eleutheronema tetradactylum* (Persian Gulf assessment). The IUCN Red List of Threatened Species 2015: e.T46087646A57168342. www.iucnredlist.org/species/46087646/57168342 [Last accessed on 28 December 2022].

Motomura H., Senou H., Iwatsuki Y., 2001 A record of a threadfin, *Eleutheronema tetradactylum*, from Aomori Prefecture, northern Japan, and description of a newly-recognized diagnostic character for the species (Perci-formes: Polynemidae). Japanese Journal of Ichthyology 48(1):41-47.

Muchlisin Z. A., Fransiska V., Muhammadar A. A., Fauzi M., Batubara A. S., 2017 Length-weight relationships and condition factors of the three dominant species of marine fishes caught by traditional beach trawl in Ulelhee Bay, Banda Aceh City, Indonesia. Croatian Journal of Fisheries 75(3):104-112.

Muchlisin Z. A., Batubara A. S., Azizah M. N. S., Adlim M., Hendri A., Fadli N., Muhammadar A. A., Sugianto S., 2015 Feeding habit and length weight relationship of keureling fish, *Tor tambra* Valenciennes, 1842 (Cyprinidae) from the western region of Aceh Province, Indonesia. Biodiversitas Journal of Biological Diversity 16(1):89-94.

Muchlisin Z. A., Musman M., Siti Azizah M. N., 2010 Length-weight relationships and condition factors of two threatened fishes, *Rasbora tawarensis* and *Poropuntius tawarensis*, endemic to Lake Laut Tawar, Aceh Province, Indonesia. Journal of Applied Ichthyology 26(6):949-953.

Nesarul H. M., Abu Hena M. K., Saifullah S. M., Idris M. H., 2014 Breeding biology of *Eleutheronema tetradactylum* (Shaw, 1804) from the Bay of Bengal, Indian Ocean. World Applied Sciences Journal 30(2):240-244.

Newman S. J., Pember M. B., Rome B. M., Mitsopoulos G. E. A., Skepper C. L., Allsop Q., Saunders T., Ballagh A. C., Van-Herwerden L., Garrett R. N., Gribble N. A., Stapley J. M., Meeuwig J. J., Moore B. R., Welch D. J., 2011 Stock structure of blue threadfin *Eleutheronema tetradactylum* across northern Australia as inferred from stable isotopes in sagittal otolith carbonate. Fisheries Management and Ecology 18(3):246-257.

Nieto-Navarro J. T., Zetina-Rejón M., Aguerrin-Sanchez F., Arcos-Huitron N. E., Pena-Messina E., 2010 Length-weight relationship of demersal fish from the eastern coast of the mouth of the gulf of Califonia. Journal of Fisheries and Aquatic Sciences 5(6):494-502.

Panda D., Karna S. K., Mukherjee M., Manna R. K., Suresh V. R., Sharma A. P., 2016 Length–weight relationships of six tropical fish species from Chilika Lagoon, India. Journal of Applied Ichthyology 32(6):1286-1289.

Punt A. E., Hilborn R. A. Y., 1997 Fisheries stock assessment and decision analysis: the Bayesian approach. Reviews in Fish Biology and Fisheries 7:35-63.

Qu Z., Nong W., Yu Y., Baril T., Yip H. Y., Hayward A., Hui J. H., 2020 Genome of the four-finger threadfin *Eleutheronema tetradactylum* (Perciforms: Polynemidae). BMC Genomics 21:726. doi: 10.1186/s12864-020-07145-1

Rypel A. L., Richter T. J., 2008 Empirical percentile standard weight equation for the blacktail redhorse. North American Journal of Fisheries Management 28(6):1843-1846.

Soe K. K., Iqbal T. H., Lim A., Wang W. X., Tsim K. W., Takeuchi Y., Petchsupa N., Hajisamae S., 2023 Reproductive characteristics of the hermaphroditic four-finger threadfin, *Eleutheronema tetradactylum* (Shaw, 1804), in tropical coastal waters. 8(1):22. doi: 10.1186/s40850-023-00181-w

Titrawani T., Elvyra R., Sawalia R. U., 2013 [Analysis of stomach contents of sengin fish (*Eleutheronema tetradactylum* Shaw) in Dumai waters]. Al-Kauniyah 6(2):85-90 [In Indonesian].
Van-Overzee H. M., Rijnsdorp A. D., 2015 Effects of fishing during the spawning period: implications for sustainable management. Reviews in Fish Biology and Fisheries 25:65-83.
Vasilakopoulos P., O'Neill F. G., Marshall C. T., 2011 Misspent youth: does catching immature fish affect fisheries sustainability? ICES Journal of Marine Science 68(7):1525-1534.
Wang J., Sun P., Yin F., 2014 Low mtDNA Cytb diversity and shallow population structure of *Eleutheronema tetradactylum* in the East China Sea and the South China Sea. Biochemical Systematics and Ecology 55(11):268-274.
Xiao J., Lyu S., Iqbal T. H., Hajisamae S., Tsim K. W., Wang W. X., 2022 Molecular phylogenetic and morphometric analysis of population structure and demography of endangered threadfin fish *Eleutheronema* from Indo-Pacific waters. Scientific Reports 12(1):3455. doi:10.1038/s41598-022-07342-w
Yusfiandayani R., 2013 Fish aggregating devices in Indonesia: past and present status on sustainable capture fisheries. Galaxea Journal of Coral Reef Studies 15:260-268.
Zamidi I., Samat A., Zaidi C. C., Mazlan A. G., Gazi M. A., Abul Q., Simon K. D., 2012 Fecundity and temporal reproductive cycle of four finger threadfin (*Eleutheronema tetradactylum*) in Malaysian coastal water. Asian Journal of Animal and Veterinary Advances 7(11):1100-1109.
Zhong L., Wang M., Li D., Tang S., Chen X., 2021 Mitochondrial genome of *Eleutheronema rhadinum* with an additional non-coding region and novel insights into the phylogenetics. Frontiers in Marine Science 8:746598. doi:10.3389/fmars.2021.746598
Zischke M. T., Cribb T. H., Welch D., Sawynok W., Lester R. J. G., 2009 Stock structure of blue threadfin *Eleutheronema tetradactylum* on the Queensland east coast, as determined by parasites and conventional tagging. Journal of Fish Biology 75(1):156-171.

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