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Feeding habit and length weight relationship of keureling fish, *Tor tambra* Valenciennes, 1842 (Cyprinidae) from the western region of Aceh Province, Indonesia

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Abstract. *Muchlisin ZA, Batubara AS, Siti-Azizah MN, Adlim M, Hendri A, Fadli N, Muhammadar AA, Sugianto S. 20015. Feeding habit and length weight relationship of keureling fish,* Tor tambra *Valenciennes, 1842 (Cyprinidae) from the western region of Aceh Province, Indonesia. Biodiversitas 16: 89-94.* The objective of the present study was to describe the aspects of feeding habit and length-weight relationship of keureling fish *Tor tambra*, this information is crucial to plan a conservation startegy for this species. A series of samples were taken between June and September 2012 and February 2014 in the two main rivers of western Aceh i.e. the Sikundo and Nagan Rivers. A total of 48 and 38 fish were caught during the study in Nagan and Sikundo Rivers, respectively. Stomach content analysis suggested that freshwater green algae and earthworms were the main food items for *T. tambra*, indicating an omnivorous feeding habit. In addition, the length-weight relationship revealed that *T. tambra* has an allometric negative growth pattern from all populations, and the condition factors indicate the rivers are still in good condition and support fish life.

Key words: Allometric, LWS, green algae, threatened, proponderance

INTRODUCTION

The Aceh Province Indonesia has many aquatic resources including coastal waters, marshes, rivers and lakes and rain forests in the Leuser and Ulu Masen ecosystems (Muchlisin et al. 2012). According to Muchlisin and Siti-Azizah (2009) there are at least 114 freshwater fishes in Aceh waters Indonesia, of these 14 species have high economical value. In addition, a total of 73 species were recorded in the Tripa peat swamp forest in the western coast of Aceh Province where 46 species are categorized as fish consumption and 17 have potential for aquaculture, for example *Tor tambra*, *Anabas testudineus, Anguilla bicolor, Channa* spp.*, Clarias* spp.*, Anematichthys repasson, Cyclocheilichthys* spp., *Osteochilus* spp., *Oxyeletris* sp., and *Barbonymus* sp. (Muchlisin et al. 2015). In particular, the Genus *Tor* or locally know as keureling, it is belonging to the family Cyprinidae, forms the basis of a wild fishery and has high potency for aquaculture industry (Muchlisin 2013). This genus is an important group of freshwater cyprinids in Indonesia and Malaysia which inhabits fast flowing stream throughout the trans-Himalayan and South-east Asian regions (Ambak et al. 2007). There are 20 species of *Tor* in Asia (Kiat 2004) and at least four (*T. soro, T. tambra, T. douronensis* dan *T. tambroides)* are found Indonesian (Haryono 2006), three of these were recorded in Aceh; *T. soro, T. tambroides* and *T. tambra* (Muchlisin et al. 2009) and presumed one other species of *T. douronensis* was also occurred in Aceh waters (Muchlisin et al. 2014). Of these four species, *T. tambra* is is the most abundant and the most highly target fish due to its good taste and higher price of upto USD35^{-kg}.

The keureling is one of the largest freshwater fishes in Aceh, reaching upto 30-45 kg. Therefore, this species has always been the predominant target of local fishermen using various fishing gears, including destructive fishing gears, such as electric fishing, poison and dynamite. This has resulted in declining wild population over the last ten years (Personal communication with local fishermen). According to local fishermen, it is very difficult to catch large wild mahseer any more. Presently, *T. tambra* is currently listed as endangered in the IUCN red list (IUCN 1990). According to Kottelat et al. (1993) and Singh (2007) the Genus *Tor* is threatened by over-explotation, pollution and ecological perturbation. This is supported by Decamps (2011) who stated that most large freshwater fish species are threatened by overfishing and habitat degradation on a global scale.

Fishing keureling in the wild should be reduced and possibly be prohibited in the future to protect this species; hence the fishermen have to shift their business to aquaculture. For this purpose, breeding and feeding technologies need to be developed. Therefore, information on biological aspects such as feeding, reproduction and

growth are crucially important to support these programs. Information of feeding habit of fish in their natural habitat is crucial in order to support the domestication process and to develop feeding practices and breeding technologies to support the aquaculture industry and to plan an effective conservation strategy. Indonesia is known as a mega biodiversity country second in fish species richness only to Brazil (Muchlisin and Siti-Azizah, 2009); however, there is very limited information on the biology and ecology of fishes in particular threatened species from Aceh waters for example within genus *Tor*. To date only two threatened species of *Rasbora tawarensis* and *Poropuntius tawarensis* from this region have been studied comprehensively (Muchlisin et al. 2010a; 2010b; 2011b). Hence, the objective of the present study was to desribe important aspects of the biology of *T. tambra* in particular, diet and growth pattern from western region of Aceh Province, Indonesia.

MATERIALS AND METHODS

Study site and sampling

The study was conducted for four months between June and September 2012 plus February 2014 at two different locations in western region of Aceh Province, Sumatra, Indonesia. The first location was Nagan River, Nagan Raya District at seven sampling sites: (1) $04^0.14'.34,9$"N, $96^0.29'.36,7$"E; (2) $04^0.14'.39,6$" N, $96^0.30'.44,1$" E; (3) $04^0.14'.40,20$"N, $96^0.30'.24,20$"E; (4) $04^0.14'.44,3$"N, $96^0.31'.00,1$" E; (5) $04^0.16'.50,7$" N, $96^0.26'.0$"E; (6) $04^0.16'.34,2$" N, $96^0.27'.13,7$"E; (7) $04^0.16'.19,4$"N, $96^0.27'.42,6$" E, and the second location was Sikundo River, Aceh Barat Distric at two sampling sites: (8) $04^0.28'.36,5$"N, $96^0.21'.52,1$"E; (9) $04^0.13'.29,6$"N, $96^0.10'.24,4$"E. Site selection was based on information by local residents. Gillnets (mesh size of 0.75, 1, 2 and 3 inch-normally metric), hooks and casting nets (mesh size of 1, 2 and 3 inch) were used to collect the fish samples.

The collected fishes were counted, rinsed and anesthetized in a solution of tricaine methanesulfonate (MS 222), prepared by dissolving 4 g of MS 222 in 5L tap water, then preserved in 10% formalin in a plastic bag with which was tagged with the location, date and habitat characteristics. The fish samples longer than 10 cm in total length were injected with absolute formalin in their body cavity prior to preservation in 10% formalin to unsure that internal organs (gonad and alementary organs) did not decay. Fishes were identified based on Kottelat et al. (1993). Samples were transported to the laboratory for further evaluation.

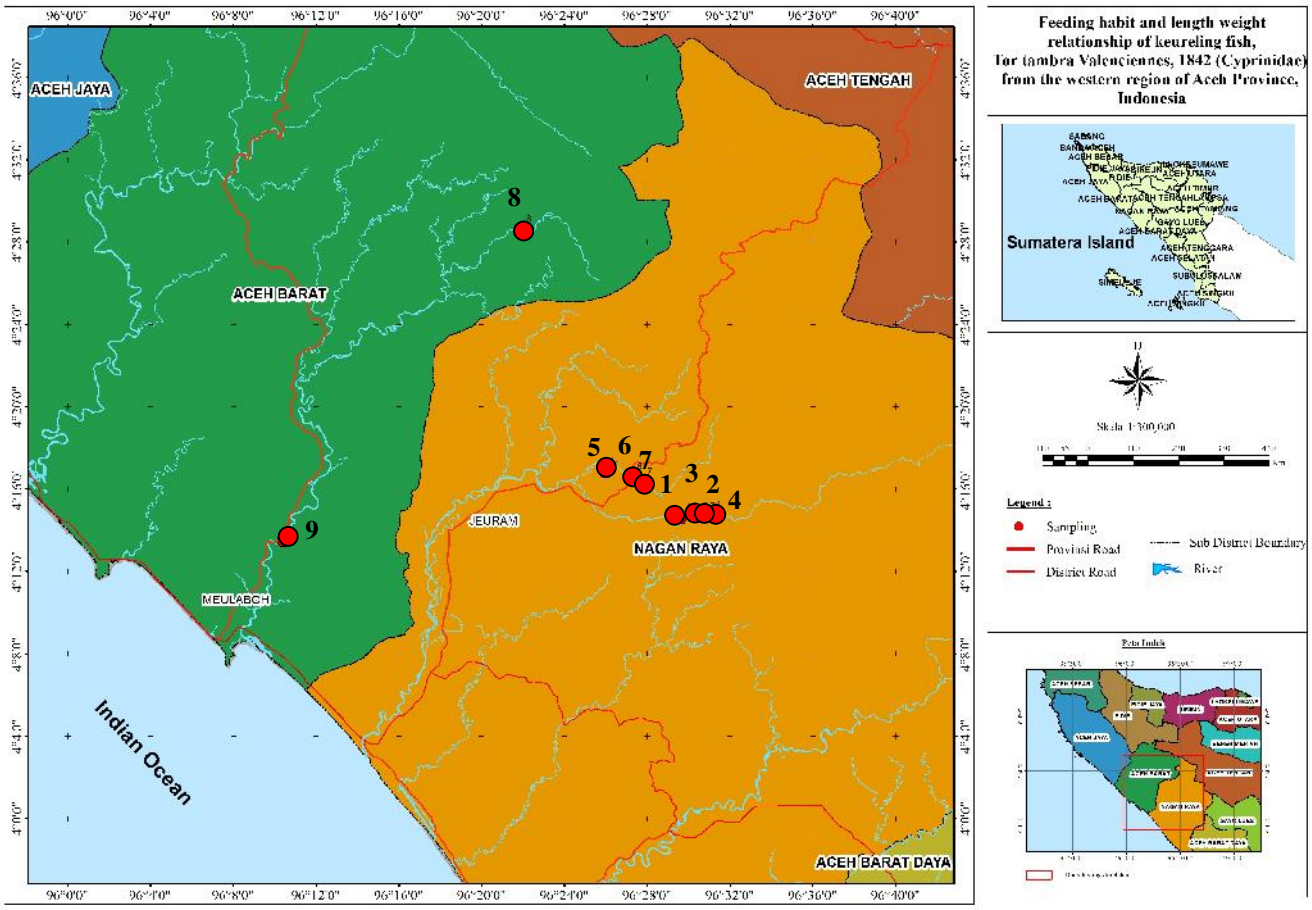

Figure 1. Map of Aceh Barat and Nagan Raya Districts of Aceh Province showing sampling sites

Diet analysis

The specimens were abdominal dissected by using a surgical scissors, and then their stomachs were taken and weighed nearest to 0.01 g. The stomachs were dissected and the contents emptied into a petri-dish. The larger foods were isolated, counted and weighed. The food items were observed by the nake eye.

Food occurrence

The occurrence of each food item was scored and then converted to a percentage by multiplying the ratio of the number of times an item occurred to the total number of stomachs analyzed by a hundred. The percentage abundance of each food item was also computed by multiplying the ratio of the number of a particular item in the stomach to the total number of items in the stomach by a hundred.

Index of proponderance

Index of preponderance is a combination of volumetric and frequency of occurrence methods, and it is used to identify the most important food items eaten by fish. The index proponderance of fish was calculated based on Biswas (1993) as follow:

$$Ii = \frac{Vi \times Oi}{\sum Vi \times Oi} \times 100\%$$

Where Ii= Index of preponderance, Vi = Percentage of volume of each food item, Oi = percentage of occurence of each food item, ∑Vi is total percentage of occurence of food items, ∑Oi is total percentage of volume for all food items.

Dietary shifts

To evaluate the ontogenic shift in dietary preference, the sampled fishes were divided into three length classes i.e. 100-175 mm, 176-250 mm, and 251-325 mm. The food compositions of each class were evaluated and compared.

Lenght weight relationship and condition factor

The Linear Allometric Model (LAM) was used to estimate the parameters *a* and *b* by log-transformed weight and length measurements. A correction for bias attributable to the back-transformation of mean weights from logarithmic units was applied to predict weight at length from parameters fitted to the allometric equation following De-robertis and William (2008):

$W = e^{0.56} (aL^b)$

where W is the weight (g), L is the length (mm), *a* the intercept of the regression, *b* the regression coefficient and e is the variance of the residuals from the LAM regression. 0.56 is the correction factor of the data sets.

The relative weight (W_r) and Fulton condition coefficient (K) were used to evaluate the condition factor of *T. tambra*. Relative weight (W_r) was determined according to Rypel and Richter (2008) as follows:

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

where W_r is relative weight, W the weight of a particular fish and W_s the predicted standard weight for the same fish as calculated from a composite of length-weight regression throughout the range of the species: $W_s = aLb$.

The Fulton condition coefficient (K) was determined according to Okgerman (2005) as follows:

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

where K is the condition factor, W is weight (g), L is length (mm), and -3 is coefficient of length to ensure that the K value tend to one.

RESULTS AND DISCUSSION

Diets

A total of 48 and 38 keureling fish were caught from Nagan and Sikundo Rivers, respectively, of these stomach content was examined for 45 and 35 fishes. The stomach contents of fish from Nagan containing 69.6% of earthworms, 27.8% of green algae, 2.1% of leafage and 0.5% of sands. The keureling from Sikundo has stomach contents of green algae (77.60%) and earthworms (22.4%) (Table 1). The analysis of food occurance showed that earthworms found in 80.8% and 81.3% of the fish samples from Nagan River and Sikundo, respectively. While, green algea was found in 73.1% and 93.8% of fish samples from Nagan and Sikundo, respectively (Table 2). However, the preponderance index analysis showed that green algae was the most important food item for keureling fish from both populations (Table 3).

Th results revealed that the younger fish prefer earthworms, but this shifted to green algae after the fish reached bigger size (Table 4). Change in feeding habit was associated with an increase in the length of the alimentary tract. For example, fish 100-175 mm in lenght (137.5 mm average) had an alimentary tract length of157 mm (1.2 times of alimentary tract). This increased to 377 mm with an average total length of 288 mm (1.3 times of alimentary tract).

Our results showed that the *T. tambra* eat both plants and aquatic animal, indicating an omnivorous diet. Further evidence in support of omnivory is the fact that their alimentary tract length was slightly longer than the body length (1.25 times of the total length). According to Smith (1989),omnivorous fish have a digestive tract 1.5 to 2 times their total body length. Haryono (2006) studied the feeding habit of *T. tambroides* from the Barito River, Central Kalimantan, Indonesia and the alimentary tract of this species was 1.5 times of the total body length. Green algae and earthworms were the foremost food items for mahseer in Sikundo and Nagan Rivers, Western Aceh, Indonesia. According to local fishermen, in addition to green algae mahseer also eats figs, small crabs and mollusks. In addition, the local fishermen in Sikundo River frequently use chopped cassava for catching mahseer. The diet of the keureling fish also changed with ontogeny where smaller fish fed preferentially on earthworms, and this changed to a diet of mainly green algae above 175 mm body length. According to Kolkovski (2001) and Mai (2005) that at early life of fish, the alimentary tract is rudimentary and insufficient digestive enzyme capacity so they are unable to digest algae. However, in several marine fishes the

alimentary tract has been present at first day hatching larvae, but not well developed (Infante and Cahu 2001; Putra et al 2012).

Length weight relationship and condition factors

The total lengths ranged between 117 mm to 194 mm (mean 149.89±19.33 mm) and 120 mm to 505 mm (mean 228.32±99.66 mm) for Nagan and Sikundo population, respectively. There were no fish greater than 200 mm lengthin Nagan River. The relative weight condition factors were closed to 100, while the Fulton's condition factor ranged from 1.75 to 2.67.

The length weight relationship showed that the tambra has ***b*** value between 2.34 to 2.84 (Table 5). Growth is considered isometric when ***b*** value is equal to 3 or allometric if otherwise (positive allometric if $b>3$ and negative allometric if $b<3$). However, generally exponent *b* values lie between 2.5 to 3.5 (Froese 2006). The exponent ***b*** values irrespective populations were lower than 3 ($b<3$). Thus, both populations could be categorized as displaying allometric negative growth. The allometric negative growth pattern has been observed in several freshwater fish species in Southeast Asia for example; *Garra cambodgiensis* from Ulu Dungun, Malaysia (Mazlan et al. 2007), *Rasbora sumatrana* in Bukit Rengit, Malaysia (Shukor et al. 2008), *R. tawarensis* and *Poropuntius tawarensis* (Muchlisin et al. 2010b). On the other hand, *Mystacoleucus marginatus* (Mazlan et al. 2007) displayed allometric positive growth pattern. In contrast, isometric growth pattern was observed in *Leiognathus jonesi* and *L. decorus* sampled from the coastal waters of Pulau Sibu-Tinggi, Malaysia (Mazlan and Seah 2006) and serandang (*Channa pleurophthalmus*) in Musi River, Indonesia (Said 2007).

The predicted growth was relatively similar to actual growth trend (Figure 2), indicate the fish is growing in optimum performance in both Sikudo and Nagan Rivers. However, unfortunately, no large mahseer were caught, suggesting the species is overfished in these rivers. In general, population ***b*** values are dependent on physiological growth condition such as gonad development and food availability (Jenning and Kaiser 2001), biological and environmental conditions, geographical, temporal and sampling factors (Froese 2006). According to Shukor et al. recorded in this study where the Sikundo and Geumpang Rivers have higher speed of water flow compared to Nagan (2008) fast flowing streams result in lower ***b*** value as River resulted in lower in ***b*** values relatively. Besides the above stated factors, it is speculated that the ***b*** value is also

Table 1. Volume of food items consumed by keureling fish (*T. tambra)* in Nagan and Sikundo Rivers, Aceh Province, Indonesia.

Food items	Nagan River n=45		Sikundo River n=35	
	Total volume (mL)	(%)	Volume (mL)	(%)
Green algae	5.3	27.8	20.1	77.6
Earthworm	13.3	69.6	5.8	22.4
Leafage	0.4	2.1	-	-
Sand	0.1	0.50	-	-
Total	19.1	100	25.9	100

Table 2. Food items occurance in keureling fish (*T. tambra)* stomach from Nagan and Sikundo Rivers, Aceh Province, Indonesia.

Foo items	Nagan River n= 45		Sikundo River n=35	
	Occurance	%	Occurance	%
Green algea	19	73.1	15	93.8
Earthworm	21	80.8	13	81.3
Leafage	3	11.5	-	-
sand	1	3.9	-	-

Table 3. Index preponderance of keureling fish (*T. tambra)* fish from western region of Aceh Province (Nagan and Sikundo Rivers).

Food item	Vi		Food item occurance		Vi × Oi	Ii (%)
	mL	%	Occur.	%		
Green algea	20.1	77.6	15	93.8	7275.94	78
Earthworm	5.8	22.4	13	81.3	1819.19	22
Total	25.9	100	-	-	9095.13	100

Table 4. Dietary shift of the keureling fish (*T. tambra)* according to the length classes

Fish size (mm)	Food occurance			Length of alimentary tract	
	Erath-worm (%)	Green algae (%)	Others (%)	Range (mm)	Average (mm)
100 - 175	81.25	75	12.5	118-214	157
176 - 250	100	100	-	190-294	273
251 - 325	33.3	100	-	312-396	377

Table 5. Lenght weight relationship and condition factors of two populations of keureling fish (*T. tambra*) from western region of Aceh

Parameter	Population	
	Nagan River (n=48)	Sikundo River (n= 38)
Total lenght, TL (mm)	117.0 - 194.0 (149.9±19.3)	120.0 - 505.0 (228.3±99.7)
Measured weight, W (g)	17.4 - 70.9 (33.4±13.2)	28.0 - 1390.0 (201.7±340.4)
Predicted weight, W_s (g)	15.7 - 66.1 (33.2±12.4)	22.8 - 1000.1 (177.0±243.6)
Relative weight, W_r (g)	74.5 - 123.9 (100.6±10.9)	55.9 - 139.0 (102.3±20.8)
Fulton condition factor, K	2.5 - 2.9 (2.7±0.1)	2.7 - 3.1 (3.0±0.1)
b value	2.84	2.63

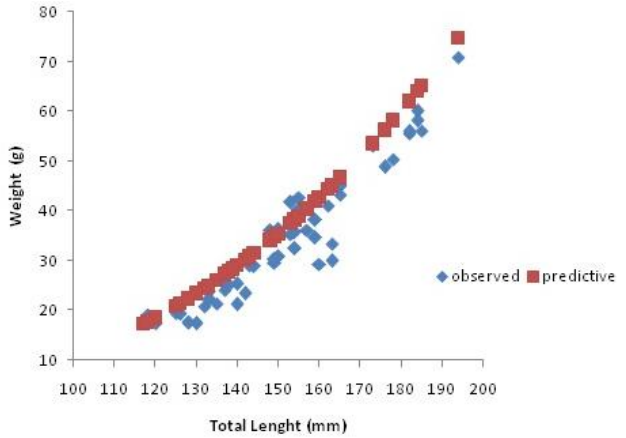

Figure 2. Comparison between observed and predicted growth for keureling fish (*T. tambra*) catches in Nagan and Sikunod Rivers (growth curve of predicted, y= 0.723x-71.50, R^2= 0.983 and observed growth, y= 0.648x-63.86, R^2=0.906)

affected by fish behaviour, for example active swimming fish (mostly pelagic fishes) have lower ***b*** value compared to passive swimming fishes (mostly demersal fishes). This is related to the energy allocation for movement and growth (Muchlisin et al. 2010b). Our results suggest that *T. tambra* is an active fish.

The relative weight condition factors were closed to 100 indicating the population is stabile with sufficient food and a lack of predation. The condition factor is regularly calculated to assess the overall health, productivity and physiology of fish population (Richter 2007; Blackwell et al. 2000). It reflects the fish physiological characteristic such as body morphology, lipid content and growth rate (Bister et al. 2000; Rypel and Richter 2008; Stevenson and Woods, 2006). The ***b*** value and condition factor of *T. tambra* from Sikundo River were relatively lower than those Nagan River (Table x). According to Anderson and Neumann (1996), values of Relative Weight (W_r condition factor) falling below 100 for an individual or population suggest problems such as low prey availability or high predatory density, whereas values above 100 indicate prey surplus or low predatory density. In addition, Porath et al. (2003) stated that changes in body condition could be interpreted as a measure of predation success i.e. fish of greater weight body condition and thus greater utilization of prey. Besides the availability of feed and predator, biotic and abiotic factors and fisheries management also affect various condition factors (Murphy et al. 1991; Blackwell et al. 2000). The results showed that the condition factor values of *T. tambras* were moderate (tend to 100). This reflected that the availability of feed relative to the presence of predator is balanced in this community indicating that the water quality of the lake is still adequate to support fish communities specifically the species investigated. A similar finding was found in others freshwater fishes in Aceh waters such as *R. tawarensis* and *P. tawarensis* (Muchlisin et al. 2010b).

Generally the mahseer fish caught in Nagan and Sikundo Rivers were young and small, much smaller than average size reported elsewhere (Asih and Setijaningsih 2011; Sarkar et al. 2012; Haryono 2006). According to the local fishermen of Nagan Raya and Aceh Barat districts it is very difficult to find larger fish over the last decade, suggesting the keureling fish has been over exploited and is highly threatened in Nagan and Sikundo Rivers. This finding is in agreement with Haryono and Subagja (Haryono and Subagja 2008) who studied the *T. tambroides* in Muller Mountains, Central Kalimantan where the the population were dominated by juvenile fish. Similarly, Ogale (2002) reported that the mahseer (Genus *Tor*) population in India has been declining in number and size and is in serious danger of extinction due to indiscriminate fishing of brood and juvenile fish and the adverse effect on the habitat of of the river valley development projects. Clearly, the mahseer has a number of life history traits that make if vulnerable to overfishing and accordingly much more information on the ecology and biology of these species are required to ensure the sustainability of the resource.

The stomach content analysis indicated that earthworms and freshwater green algae were the most important food for keureling *T. tambra* in western Aceh region, indicates an omnivorous feeding habit. In addition *T. tambra* had an allometric negative growth pattern, both relative weight index and Fultons condition factor showed that the rivers can still support the presence of *T. tambra*.

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