AACL BIOFLUX
Aquaculture, Aquarium, Conservation & Legislation
International Journal of the Bioflux Society

Food preference and diet overlap of two endemic and threatened freshwater fishes, depik (*Rasbora tawarensis*) and kawan (*Poropuntius tawarensis*) in Lake Laut Tawar, Indonesia

[1]Zainal A. Muchlisin, [1]Fakhrurrazi Rinaldi, [2]Nur Fadli, [3]Muhammad Adlim, [4,5]Mohd N. Siti-Azizah

[1] Department of Aquaculture, Faculty of Marine and Fisheries, Syiah Kuala University, Banda Aceh 23111, Indonesia; [2] Department of Marine Sciences, Faculty of Marine and Fisheries, Syiah Kuala University, Banda Aceh 23111, Indonesia; [3] Department of Chemistry, Faculty of Teaching Training and Education, Syiah Kuala University, Banda Aceh 23111, Indonesia; [4] School of Biological Sciences, Universiti Sains Malaysia, Penang, Malaysia; [5] Centre for Marine and Coastal Studies, Universiti Sains Malaysia, Penang, Malaysia. Corresponding author: Z. A. Muchlisin, muchlisinza@unsyiah.ac.id

Abstract. Depik (*Rasbora tawarensis*) and kawan (*Poropuntius tawarensis*) are endemic and threatened fishes occurring in Lake Laut Tawar, Indonesia. The populations of both depik and kawan have been declining sharply over the last few decades. Several biological aspects of both species have been previously reported. However, there is no information on the feeding biology of depik and kawan, hence here we present the evaluation of feeding biology of these fishes. Sampling was conducted in July 2013 using gillnets. A total of 42 depik and 45 kawan fishes were examined. The food occurrence, dietary shift, diet similarity and diet overlap were evaluated in this study. Phytoplankton (especially algae) and zooplankton were the primary and secondary food sources, respectively. However, their favorite food were *Closteriopsis longissima* and *Arcella vulgaris*. Higher food similarity was observed between length classes of 55-70 mm and 71-85 mm for depik; and between 71-85 mm and 101-115 mm for kawan. It was concluded that the depik and kawan are plankton feeder (planktonphagous). Based on diet overlap index, there is a moderate degree of overlapping of food preference between depik and kawan.
Key Words: plankton feeder, food similarity, diet overlap, stomach content, *Closteriopsis longissima*, *Arcella vulgaris*.

Introduction. At least 11 species of freshwater fishes have been recorded in Lake Laut Tawar where two of them are endemic to this lake namely depik - *Rasbora tawarensis,* and kawan - *Poropuntius tawarensis* (Muchlisin & Siti-Azizah 2009). Laut Tawar is the biggest lake in the Aceh Province originating from an old volcanic caldera. The lake is a focal point of the local people providing water resources for domestic needs, agricultural, and aquaculture activities as well as industries. Economic and conservation evaluations have shown that both species are economically and ecologically important fishes in Aceh waters, Indonesia (Muchlisin 2013). However, both fishes are listed in the IUCN red list as vulnerable (IUCN 1990) and updated by CBSG as critically endangered (CBSG 2003) due to ecological perturbation, pollution, introduced species and unfriendly fishing practices in Lake Laut Tawar. The depik population has been decreasing sharply during the last two decades (Muchlisin et al 2011b) and according to local fishermen; kawan is also becoming very rare and difficult to catch in recent times.

Depik and kawan have the potential to be cultured as food and ornamental fishes, hence information on the bio-ecology of these fishes is crucial in the food and aquarium fishery industries. The growth pattern and reproductive biology of these species have been extensively investigated (Muchlisin et al 2010a; 2010b; 2011a; 2011b). However, there is no report on their feeding habits. In the aquaculture point of view, information

on the feeding habit is crucially needed when intiating a systematic programme for the development of feeding and breeding technologies starting from wild populations (Vine 1998).

Feeding provides the source of nutrition and energy for growth, reproduction and other physiological activities in most living organisms including fish. Nyunja et al (2002) reported that besides influence on growth, feed also plays an essensial role in fish abundance, migration and distribution, and therefore information on the feeding habit and feeding interaction among species are crucially important in relation to strategize a better conservation program (Balik et al 2003). In fish as in many other organisms, feeding habits show ontogenetic variation (Weliange & Amarasinghe 2003) and seasonal changes in food availability and ontogenetic dietary shifts can affect both predator–prey and competitive interactions amongst size-structured fish communities (Winemiller 1989). Diet analysis is also necessary to demonstrate the trophic overlap among species within a community (Bascinar & Saglam 2009). This information is essential in determining the intensity of the interspecific interaction in fish community (Morte et al 2001). The knowledge of feeding biology is useful to select such species of fish for developing culture program and produce an optimum yield by utilizing all the available potential food sources in the water bodies without any competition or predation (Manon & Hossain 2011) and also useful in determining of policy on the introducing fish species into a new environment for fishing or recreational purposes (Muchlisin 2011c, 2012).

The study of the food and feeding habits of fish is a subject of continuous research because it constitutes the basis for the development of a successful fisheries management program on fish capture and culture (Oronsaye & Nakpodia 2005). The feeding biology of several tropical fishes have been well documented, for example: *Sardinella gibbosa* (Nyunja et al 2002), *Sargochromis codringtonii* (Moyo 2004), *Chrysichthys nigrodigitatus* and *Brycinus nurse* (Oronsaye & Nakpodia 2005), *Oreochromis niloticus* and *Sarotherodon galilaeus* (Oso 2006), *Garra cambodgiensis* and *Mystacoleucus marginatus* (Mazlan et al 2007), *Loricaria lentiginosa* (Salvador et al 2009). Here, we report preliminary observations of feeding habits of the two endemic fishes (depik and kawan) in Lake Laut Tawar, Indonesia.

Material and Method

Sampling. Fish samples were collected on July 2013 using a series of mesh size of experimental gillnets (1-3 cm) from several sites in the lake at 04°36′43″N 096°55′25″E (Figure 1).

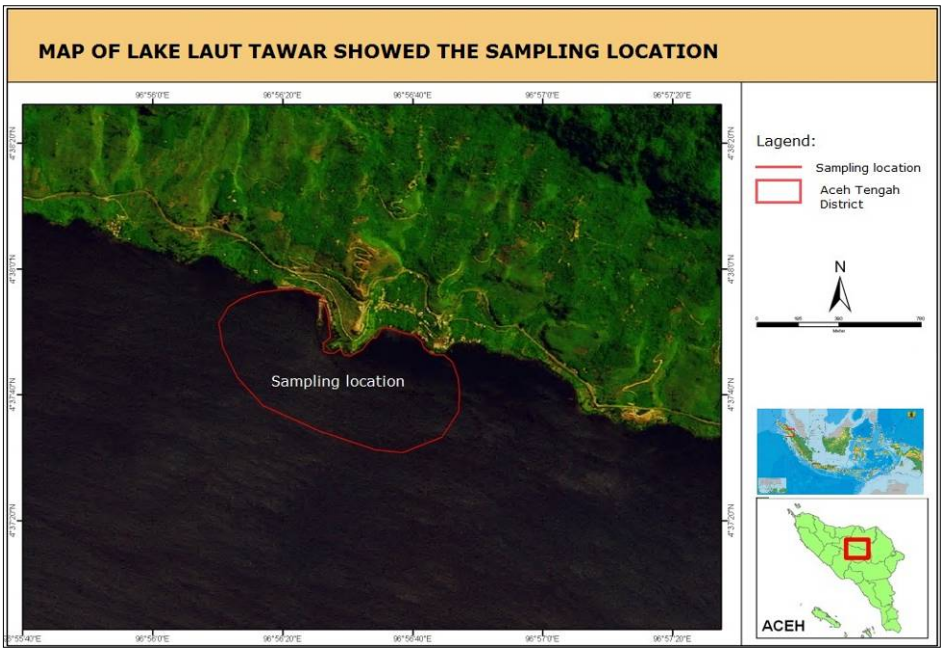

Figure 1. The map of northern part of Lake Laut Tawar showing the sampling location.

A total of 32 depik and 35 kawan fishes were caught during the sampling. Collected fishes were counted, rinsed and anesthetized in a solution of Tricaine Methanesulfonate (MS222), then after preserved in 10% formalin. The sampled fishes were transported to laboratory for further analysis.

Stomach content analysis. All fish samples were analyzed for stomach contents in Laboratory of Ichthyology of Syiah Kuala University, Indonesia. The total lengths of fish samples were measured and weighed to the nearest 0.1 mm and 0.01 g, respectively. The specimens were abdominally dissected by using a pair of surgical scissors, and then their stomachs were taken and weighed to the nearest to 0.01 g and then dried at room temperature for two hours. The stomachs were measured for the length and then dissected, and the contents emptied into a petri-dish. The stomach contents were added with 10 mL sterile tap water and thoroughly mixed. One drop of stomach content solution was transferred into a sedge wick rafter cell using a teat pipette. The food items were then enumerated under a compound microscope. Each food item was identified to the lowest possible taxonomic level. The identification of food item (plankton) was based on Prescott (1978), Verlencar & Desai (2004), and Bellinger & Sigee (2010).

Food occurrence. The food items were isolated and grouped based on their types and enumerated using a microscope. The occurrence of each food item was scored and then converted to a percentage of the ratio of the number of times an item occurred to the total number of guts analyzed. The percentage abundance of each food item was also computed from the ratio of the number of a particular item in the stomach to the total number of items in the stomach.

Dietary shifts, diet overlap and food similarity. To evaluate the ontogenic shift in dietary preference, the sampled fishes were divided into four length classes i.e. (a) 55-70 mm, (b) 71-85 mm, (c) 86-100 mm, and (c) 101-115 mm. The food compositions of each class were evaluated and compared. Diet overlap between depik and kawan was determined using Schoener's diet overlap index (Schoener 1970):

$$C_{xy} = 100–0.5\ (\Sigma|p_{xi}-p_{yi}|),$$

where C_{xy} is the degree of overlap, p_{xi} is the proportion of the i^{th} resource (in this case, prey type) used by species x, and p_{yi} is the proportion of the i^{th} prey type used by species y, and the vertical bars indicate absolute positive values of the difference. Index values range from 0 to 100; with a value of 0 indicating no overlap and a value of 100 indicating complete overlap. Diet overlap values above 60 were considered biologically significant overlap (Wallace 1981). The food similarity between length classes of every species were examined using Plymouth Routines in Multivariate Ecological Research package (PRIMER-E) software (Clarke & Gorley 2006).

Results and Discussion. The results showed that depik and kawan fed primarily on planktons; both phytoplankton and zooplankton, therefore these fishes can be categorized as plankton feeders or planktonphagous. A total of 21 species of planktons were identified in the stomachs of kawan where algae were predominant, while 16 species of planktons were recorded in the depik stomach. Similarly, algae were also the predominant food items for depik. The food occurrence analysis in depik showed that *Closteriopsis longissima* was the most frequently found (50% of fish samples), followed by *Arcella vulgaris* (28.6% of fish samples). *C. longissima, Cocconeis* sp. and *A. vulgaris* were the major food items in the stomachs of kawan with occurrence of 48.57%, 45.71% and 40.0%, respectively (Table 1).

The predominant food item in the length class of 55-70 mm and 71-85 mm of depik was *C. longissima.* However, the food preference was for *Trachelomonas curta* at the length class of 86-100 mm and *A. vulgaris* at the length class of 101-115 mm. *C. longissima* was found at all length classes, moreover *Alona guttata* was also recorded at all length classes except at 101-115 mm length class. In addition, *Dinophysis* sp. was found at length class of 86-100 mm and 101-115 mm, while *Aphanothece nidulans* was only found at 101-115 mm length class (Table 2). In the kawan fish, *A. vulgaris, C.*

longissima and *Cocconeis* sp. were predominant food items at length class of 71-85 mm, 86-100 mm and 101-115 mm. Several food items were specific to certain length classes; *Didymosphenia geminata* was only found at 71-85 mm length class, *Biddulphia* sp. and *Canthocamptus* sp. were only found at 86-100 mm, while *Anuraeopsis fissa* was found at length classes of 86-100 mm and 101-115 mm (Table 2).

The higher similarity of food items in the depik was found between length class of 55-70 mm and 71-85 mm (54.86%; Table 3). In the kawan, the highest food similarity was found between 71-85 mm and 101-115 mm (59.11%), followed by 86-100 mm and 101-115 mm (57.03%; Table 4). Diet overlap index between depik and kawan was 62.15 indicating a moderate degree of competition in food preference of both endemic species. Detailed information of diet overlap is presented in Table 5. Observation on the gill structures of depik and kawan revealed that both species have high densities of gill rakers; probably the gill rakers function to filter planktons from the water which enters through the mouth and out through the gills. The favorite food of depik and kawan were *C. longissima* and *A. vulgaris*. *Cocconeis* sp. was also preferred by kawan fish, in contrast to the depik where this food item was not found in its stomach. This indicates that depik and kawan prefer *C. longissima* and *A. vulgaris* as their primary food sources. We postulate that these planktons were the most abundant in Lake Laut Tawar as had been reported by Nurfadillah et al (2012).

Table 1

Occurence of food items (planktons) in the depik and kawan stomachs

Food items (plankton)	*Depik (n = 32)*		*Kawan (n = 35)*	
	Occurence	*%*	*Occurence*	*%*
Alona guttata	4	12.50	-	-
Amphora normani	1	3.13	-	-
Amphorellopsis sp.	-	-	1	2.86
Anuraeopsis fissa	-	-	3	8.57
Aphanothece nidulans	1	3.13	-	-
Arcella vulgaris	9	28.13	14	40.00
Biddulphia sp.	-	-	1	2.86
Brachionus sp.	2	6.25	-	-
Canthocamptus sp.	-	-	1	2.86
Chalotrix sp.	1	3.13	1	2.86
Closterium gracile	1	3.13	-	-
Closteriopsis longissima	16	50.00	17	48.57
Cocconeis sp.	-	-	16	45.71
Cyclotella sp.	-	-	1	2.86
Cymatopleura sp.	-	-	1	2.86
Dictyosphaerium sp.	-	-	1	2.86
Didymosphenia geminata	-	-	1	2.86
Dinophysis sp.	2	6.25	1	2.86
Fragilaria sp.	-	-	1	2.86
Melosira italica	1	3.13	-	-
Microcystis aeruginosa	1	3.13	2	5.71
Netrium oblongum	1	3.13	-	-
Oscillatoria sp.	-	-	1	2.86
Paramecium caudatum	2	6.25	-	-
Peridinium sp.	-	-	1	2.86
Phacus curvicauda	2	6.25	1	2.86
Pleurotaenium trabecula	1	3.13	-	-
Stephanodiscus sp.	-	-	10	28.56
Tetmemorus laevis	-	-	1	2.86
Trachelomonas curta	3	9.38	3	8.57

Table 2

The stomach content of depik and kawan according to length classes

Length classes	*Food items of depik*	*Food items of kawan*
50-70 mm	*Alona guttata*, *Amphora normani*, *Arcella vulgaris*, *Chalotrix* sp., *Closterium gracile*, *Closteriopsis longissima*, *Netrium oblongum*, *Parамecium caudatum*, *Pleurotaenium trabecula*	n/a
71-85 mm	*Alona guttata*, *Arcella vulgaris*, *Closteriopsis longissima*, *Melosira italica*	*Arcella vulgaris*, *Didymosphenia geminata*, *Closteriopsis longissima*, *Cocconeis* sp., *Stephanodiscus* sp., *Trachelomonas curta*
86-100 mm	*Alona guttata*, *Closteriopsis longissima*, *Dinophysis* sp., *Microcystis aeruginosa*, *Phacus curvicauda*, *Trachelomonas curta*	*Amphorellopsis* sp., *Anuraeopsis fissa*, *Arcella vulgaris*, *Biddulphia* sp., *Canthocamptus* sp., *Closteriopsis longissima*, *Cocconeis* sp., *Cyclotella* sp., *Dictyosphaerium* sp., *Dinophysis* sp., *Microcystis aeruginosa*, *Peridinium* sp., *Phocus curvicauda*, *Stephanodiscus* sp., *Tetmemorus laevis*, *Trachelomonas curta*
101-115 mm	*Aphanothece nidulans*, *Arcella vulgaris*, *Closteriopsis longissima*, *Dinophysis* sp., *Phocus curvicauda*, *Trachelomonas curta*	*Anuraeopsis fissa*, *Arcella vulgaris*, *Chalotrix* sp., *Closteriopsis longissima*, *Cocconeis* sp., *Dictyosphaerium* sp., *Fragilaria* sp., *Microcystis aeruginosa*, *Oscillatoria* sp., *Stephanodiscus* sp., *Trachelomonas curta*

Table 3

The similarity of food items (%) of depik fish among length classes

Length classes (mm)	*55-70*	*71-85*	*86-100*	*101-115*
55-70	–			
71-85	54.86	–		
86-100	18.1	29.44	–	
101-115	34.64	44.92	46.47	–

Table 4

The similarity of food items (%) of kawan fish among length classes

Classes length (mm)	*71-85*	*86-100*	*101-115*
71-85	–		
86-100	51.67	–	
101-115	59.11	57.03	–

Table 5

Diet overlap between depik and kawan fish in Lake Laut Tawar. P_{xi} is the proportion of the i^{th} prey type fed by kawan fish, p_{yi} is the proportion of the i^{th} prey type fed by depik fish

Food items	*P_{xi} (kawan)*	*P_{yi} (depik)*
Alona guttata	-	12.50
Amphora normani	-	3.13
Amphorellopsis sp.	2.86	-
Anuraeopsis fissa	8.57	-
Aphanothece nidulans	-	3.13
Arcella vulgaris	40.00	28.13
Biddulphia sp.	2.86	-
Brachionus sp.	-	6.25
Canthocamptus sp.	2.86	-
Chalotrix sp.	2.86	3.13
Closterium gracile	-	3.13
Closteriopsis longissima	48.57	50.00
Cocconeis sp.	45.71	-
Cyclotella sp.	2.86	-
Cymatopleura sp.	2.86	-
Dictyosphaerium sp.	2.86	-
Didymosphenia geminata	2.86	-
Dinophysis sp.	2.86	6.25
Fragilaria sp.	2.86	-
Melosira italica	-	3.13
Microcystis aeruginosa	5.71	3.13
Netrium oblongum	-	3.13
Oscillatoria sp.	2.86	-
Paramecium caudatum	-	6.25
Peridinium sp.	2.86	-
Phacus curvicauda	2.86	6.25
Pleurotaenium trabecula	-	3.13
Stephanodiscus sp.	28.57	-
Tetmemorus laevis	2.86	-
Trachelomonas curta	8.57	9.38
Total	225.74	150.05
$Cxy = 100 - 0.5 (\sum \lvert Pxi - Pyi \rvert)$	$Cxy = 100 - 0.5 (75.69)$	
$Cxy = 100 - 37.85$	$Cxy = 62.15$	

Comparison of total body length to alimentary tract length of depik fish was 1.2 (i.e. the alimentary tract length was 1.2 times of total body length), while in the kawan fish was 1.5, indicating an omnivorous feeding habit pattern where both kawan and depik consume zooplankton and phytoplankton, while algae were predominant in stomachs of the fish samples. According to Huet (1971), omnivorous fishes have alimentary tract slightly longer than their body length as observed in this study. A similar study on bada fish - *Rasbora argyrotaenia* from Musi River, South Sumatera was conducted by Arsyad & Syaefudin (2010). They reported that bada fish fed on algae especially *Ulothrix* sp. as its primary food item. This report corresponds to our study in that both depik and kawan fed on algae but the preferred food item were different; *C. longissima* and *A. vulgaris* were

the foremost food items for depik and kawan, probably due to these food items being the most abundant in Lake Laut Tawar as mentioned earlier.

While the feeding habit of fishes are species dependent, the availability of food in the environment, also plays a major role. However, some species show selectivity on one or two types of food. According to Nikolsky (1963) food availability determines the population size, population dynamic, growth and condition of fish. Based on food item occurrence of food, it is shown that depik and kawan fed on algae more frequently than on other food items. Therefore, algae is the primary food for depik and kawan. The highest food similarity in depik was found between length class 55-70 mm and 71-85 mm (54.86%), while the food similarity of kawan was highest between 71-85 mm and 101-115 mm (59.11%) length classes. According to Cohen et al (2002), food similarity was affected by fish size, food availability and its abundance. However, some fishes are selective in their food preferences, meaning that although available in low quantities in the waters, these foods are often found in the alimentary tract of the fish.

Winemiller (1989), stated that when fish reached a bigger size it would change its feeding habit. However, no significant changes in feeding habit were detected in the depik and kawan at all length classes. A similar finding was found in the zooplanktivorous *Hemirhamphus limbatus* in Sri Lanka reservoirs where the feeding habit of this fish did not vary with body size (Weliange & Amarasinghe 2003). In contrast, significant changes in feeding habit were detected between adult and juvenile of the European anchovy *Engraulis encrasicolus* and the European pilchard *Sardina pilchardus* in the Gulf of Lions (Costalago et al 2012), *Diapterus rhombeus* and *Micropogonias furnieri* (Pessanha & Araujo 2014). Furthermore, while food preference may also change seasonally (Manon & Hossain 2011) in several fishes such as *Moenkhausia icae* and *Leporinus fasciatus* (Ropke et al 2014), other species have a constant feeding habit as recorded in *Oreochromis mossambicus*, *O. niloticus* and *Amblypharyngodon melettinus* (Weliange & Amarasinghe 2003). However this was not evaluated in our study due to limitation of sampling duration.

Based on the diet overlap analysis, *A. vulgaris, Chalotrix* sp.*, C. longissima, Cocconeis* sp.*, Dinophysis* sp.*, Microcystis aeruginosa, Phacus curvicauda, T. curta* were the foremost food items for both depik and kawan (Table 5). Wootton (1998) stated that utilisation of the same types of foods illustrates the overlap of the food resources by two or more species of fish in the same habitat. The diet overlap index of depik and kawan was 62.15 indicating a moderate degree of overlapping. Hilderbrand & Kershner (2004) reported that the degree of diet overlapping was related to food availability, type of habitat, drift timing and the ability of fish to utilize the food available in the waters. In addition, the diet overlap would be higher when the fish fed a similar type of food items in the same relative amounts. Furthermore, Krebs (1978) stated that when higher degree of diet overlapping occurred, it would eliminate one competing species. If the food sources in the waters become a limiting factor it will affect the growth of fish and only fish that can compete and utilize the available food can grow well.

Conclusions. The depik and kawan fishes are plankton feeders (planktonphagous), feeding on phytoplankton and zooplankton, where the favorite food items were *C. longissima* and *A. vulgaris*. Hence, algae was the primary food item for depik and kawan. The highest food similarity in depik was found between class length of 55-70 mm and 71-85 mm; and between 71-85 mm and 101-115 mm for kawan. The diet overlap index showed that there was a moderate degree of overlapping of food resources between depik and kawan.

References

Arsyad M. N., Syaefudin A., 2010 Food and feeding habit of rasbora (*Rasbora argyrotaenia,* Blkr) in the down stream of Musi River. The 2nd Proceedings of International Conference on Indonesian Inland Waters. Research Institute for Inland Fisheries, Palembang, pp. 217-224.

Balik I., Karasahin B., Ozkok R., Cubuk H., Uysal R., 2003 Diet of silver crucian carp *Carassius gibelio* in Lake Egirdir. Turkish Journal of Fisheries and Aquatic Sciences 3:87-91.
Bascinar N. S., Saglam H., 2009 Feeding habits of black scorpionfish *Scorpaena porcus*, in the South Eastern Black Sea. Turkish Journal of Fisheries and Aquatic Sciences 9:99-103.
Bellinger E. G., Sigee D. C., 2010 Freshwater algae: identification and use as bioindicators. John Wiley & Sons, Ltd, New Jersey, 254 pp.
CBSG, 2003 Conservation assessment and management plan for Sumatran threatened species. IUCN-SSC Conservation Breeding Specialist Group, Apple Valley, USA, 117 pp.
Clarke K. R., Gorley R. N., 2006 Primer V6: User manual and tutorial. Playmouth Marine Laboratory, UK, 192 pp.
Cohen J. E., Jonsson T., Carpenter S. R., 2002 Ecological community description using the food web, species abundance, and body size. Proceedings of National Academy of Sciences USA 100:1781-1786.
Costalago D., Navarro J., Álvarez-Calleja I., Palomera I., 2012 Ontogenetic and seasonal changes in the feeding habits and trophic levels of two small pelagic fish species. Marine Ecology Progress Series 460:169-181.
Hilderbrand R. H., Kershner J. L., 2004 Influence of habitat type on food supply, selectivity and diet overlap of bonneville cutthroat trout and non native brook trout in Beaver Creek, Idaho. North American Journal of Fisheries Management 24:33-40.
Huet M., 1971 Textbook of fish culture: breeding and cultivation of fish. Fishing News (Book) Ltd, London, 436 pp.
IUCN, 1990 IUCN red list of threatened animal. IUCN, Gland and Cambrige.http://www.iucnredlist.org/.
Krebs C. J., 1978 The experimental analysis of distribution and abundance. 2nd edit., Harper and Row Publisher, New York, US, 678 pp.
Manon M. R., Hossain M. D., 2011 Food and feeding habit of C*yprinus carpio* var. *specularis.* Journal of Science Foundation 9:163-169.
Mazlan A. G., Samat A., Amirrudin., Anita T., 2007 Aspects on the biology of *Garra cambodgiensis* and *Mystacoleucus marginatus* (Cyprinidae) from Ulu Dungun, Terengganu. Malaysian Applied Biology 36:67-72.
Morte S., Redon M. J., Sanz-Brau A., 2001 Diet of *Scorpaena porcus* and *Scorpeana notata* (Pisces: Scorpaenidae) in the Western Mediteranean. Cahiers de Biologie Marine 42:333-344.
Moyo N. A. G., 2004 The feeding habits of *Sargochromis codringtonii* in Lake Kariba, Zimbabwe. Hydrobiologia 522:321-327.
Muchlisin Z. A., 2013 Study on potency of freshwater fishes in Aceh waters as a basis for aquaculture and conservation development programs. Jurnal Iktiologi Indonesia 13:91-96.
Muhclisin Z. A., Siti-Azizah M. N., 2009 Diversity and distribution of freshwater fishes in Aceh waters, northern Sumatra Indonesia. International Journal of Zoological Research 5:62-79.
Muchlisin Z. A., Musman M., Siti-Azizah M. N., 2010a Spawning seasons of *Rasbora tawarensis* (Pisces: Cyprinidae) in Lake Laut Tawar, Aceh Province, Indonesia. Reproductive Biology and Endocrinology 8:49.
Muchlisin Z. A., Musman M., Siti-Azizah M. N., 2010b 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 26:949-953.
Muchlisin Z. A., Musman M., Fadli N., Siti-Azizah M. N., 2011a Fecundity and spawning frequency of *Rasbora tawarensis* (Pisces: Cyprinidae) an endemic species from Lake Laut Tawar, Aceh, Indonesia. AACL Bioflux 4:273-279.
Muchlisin Z. A., Fadli N., Rudi E., Mendo T., Siti-Azizah M. N., 2011b Estimation of production trend of the depik, *Rasbora tawarensis* (Teleostei,Cyprinidae), in Lake Laut Tawar, Indonesia. AACL Bioflux 4:590-597.

Muchlisin Z. A., 2011c [Policy analysis of introducing alien species of fish in inland waters of Aceh Province]. Jurnal Kebijakan & Riset Sosek Kelautan dan Perikanan 1(1):79-89 [in Indonesian].
Muchlisin Z. A., 2012 First report on introduced freshwater fishes in the waters of Aceh, Indonesia. Archives of Polish Fisheries 20(2):129-135.
Nikolsky G. V., 1963 The ecology of fishes. Academic Press, London, 352 pp.
Nurfadillah, Damar A., Adiwilaga E. M., 2012 [Community of phytoplankton in Lake Laut Tawar, Aceh Tengah District, Aceh Province]. Depik 1:93-98 [in Indonesian].
Nyunja J. A., Mavuti K. M., Wakwabi E. O., 2002 Tropic ecology of *Sardinella gibbosa* (Pisces: Clupeidae) and *Atherinomorous lacunosus* (Pisces: Atherinidae) in Mtwapa Creek and Wasini Channel, Kenya. Western Indian Ocean Journal of Marine Science 1:181-189.
Oronsaye C. G., Nakpodia F. A., 2005 A comparative study of the food and feeding habits of *Chrysichthys nigrodigitatus* and *Brycinus nurse* in a tropical river. Pakistan Journal of Scientific and Industrial Research 48:118-121.
Oso J. A., Ayodele I. A., Fagbuaro O., 2006 Food and feeding habits of *Oreochromis niloticus* (L.) and *Sarotherodon galilaeus* (L.) in a tropical reservoir. World Journal of Zoology 1:118-121.
Pessanha A. L. M., Araujo F. G., 2014 Shifts of the feeding niche along the size dimension of three juvenile fish species in a tidal mudflat in southeastern Brazil. Marine Biology 161:543-550.
Prescott D. W., 1979 How to know the freshwater algae. M.W.C. Brown Company Publishers, Iowa, 348 pp.
Ropke C. P., Ferreira E., Zuanon J., 2014 Seasonal changes in the use of feeding resources by fish in stands of aquatic macrophytes in an Amazonian floodplain, Brazil. Environmental Biology of Fishes 97:401-414.
Salvador Jr. L. F., Salvador G. N., Santos G. B., 2009 Morphology of the digestive tract and feeding habits of *Loricaria lentiginosa* Isbrucker, 1979 in a Brazilian reservoir. Acta Zoologica 90:101-109.
Schoener T. W., 1970 Non-synchronous spatial overlap of lizards in patchy habitats. Ecology 51:408-418.
Verlencar X. N., Desai S., 2004 Phytoplankton identification manual. National Institute of Oceanography, Dhargalkar V. K., Ingole B. S. (eds), Dona Paula, Goa, 40 pp.
Vine N. G., 1998 Aspects of the biology of the doublesash butterflyfish *Chaetodon marleyi* (Pisces: Chaetodontidae). Master Thesis, Rhodes University, USA, 198 pp.
Wallace R. K. Jr., 1981 An assessment of diet-overlap indexes. Transactions of the American Fisheries Society 110:72-76.
Weliange W. S., Amarasinghe U. S., 2003 Seasonality in dietary shifts in size-structured freshwater fish assemblages in three reservoirs of Sri Lanka. Environmental Biology of Fishes 68:269-282.
Winemiller K. O., 1989 Ontogenetic diet shifts and resource partitioning among piscivorous fishes in the Venezuelan llanos. Environmental Biology of Fishes 26:177-199.
Wootton R. J., 1998 Fish ecology. Blackie and Sons Ltd., Glasgow, 212 pp.

Received: 11 January 2015. Accepted: 01 February 2015. Published online: 04 February 2015.
Authors:
Zainal A. Muchlisin, Department of Aquaculture, Faculty of Marine and Fisheries, Syiah Kuala University, Banda Aceh 23111, Indonesia, e-mail: muchlisinza@unsyiah.ac.id.
Fakhrurrazi Rinaldi, Department of Aquaculture, Faculty of Marine and Fisheries, Syiah Kuala University, Banda Aceh 23111, Indonesia, e-mail: rinaldi_fn@yahoo.com
Nur Fadli, Department of Marine Sciences, Faculty of Marine and Fisheries, Syiah Kuala University, Banda Aceh 23111, Indonesia, e-mail: ivad29@yahoo.com
Muhammad Adlim, Department of Chemistry, Faculty of Teaching Training and Education, Syiah Kuala University, Banda Aceh 23111, Indonesia, e-mail: adlimbandang@yahoo.com
M. Nor Siti-Azizah, School of Biological Sciences Universiti Sains Malaysia Penang 11800, Malaysia, and Centre for Marine and Coastal Studies Universiti Sains Malaysia, e-mail: sazizah@usm.my

How to cite this article:
Muchlisin Z. A., Rinaldi F., Fadli N., Adlim M., Siti-Azizah M. N., 2015 Food preference and diet overlap of two endemic and threatened freshwater fishes, depik (*Rasbora tawarensis*) and kawan (*Poropuntius tawarensis*) in Lake Laut Tawar, Indonesia. AACL Bioflux 8(1):40-49.