Global Journal of Fisheries and Aquaculture

ISSN: xxxx-xxxx Vol. 1 (1), pp. 001-010, November, 2013. © Global Science Research Journals

Full Length Research Paper

Length-weight relationships, physical state factors and gut contents of Syncrossus helodes (Sauvage, 1876) and Yasuhikotakia modesta (Bleeker, 1864) from the Mekong River, Muang District, Nong Khai Province, Northeastern Thailand

Sarawut F, Kanokwan B and Thawatchai A

Department of Biology, Faculty of Science, Webster University, Thailand.

Accepted 3 October, 2013

Length-weight relationships (LWR), physical state factors (K) and gut contents of *Syncrossus helodes* (Sauvage, 1876**) and *Yasuhikotakia modesta* (Bleeker, 1864) from the Mekong River, Muang District,**

Nong Khai Province, Northeastern Thailand were investigated in the dry-hot and dry-cool season 2010. The LWR results indicated that *S. helodes* exhibited negative allometric growth in both seasons, whereas *Y. modesta* exhibited positive and negative allometric growth in the dry-hot and the dry-cool season, respectively. The K values for *S. helodes* in the dry-hot season and *Y. modesta* in both seasons were greater than one, showing that they were in above good condition, whereas the K for *S. helodes* in the dry-cool season was lower than one, which indicated that the fish was in poor condition. The percentage of point method (%P) results indicated that *S. helodes* fed on the same 7 categories of food items in both seasons, which were dipteran larvae (64.48%), trichopteran larvae (17.82%), ephemeropteran larvae (6.73%), Hemiptera (2.95%), terrestrial dipteran adults (2.31%), green algae and zooplankton (1.10% each). *Y. modesta* also fed on the same 7 categories of food items in both season, corresponding to dipteran larvae (59.78%), trichopteran larvae (16.37%), zooplankton (12.87%), molluscs (5.51%), terrestrial dipteran adults (3.30%), plant materials (1.18%) and green algae (0.59%). Plant parts and filamentous algae were also found in the analyzed gut contents; these materials may have been accidentally ingested along with the principal food item, Chironomid larvae. The %P of the food items depended on both the season and the fish species (chi-squared test, $p<0.05$). From the present study, it was concluded that *S. helodes* and *Y. modesta* are carnivores.

Key words: Length-weight relationships, condition factors, gut contents, *S. helodes*, *Y. modesta*, the Mekong River.

....

INTRODUCTION

The Mekong River is the largest river in Southeast Asia. It covers a distance of more than 4,200 km and flows through six countries: China, Myanmar, the Lao People's Democratic Republic (Lao PDR), Thailand, Cambodia and Vietnam. The river is enriched with a remarkable diversity of fish and is inhabited by an estimated 1,200 species (Poulsen and Valbo-Jørgensen, 2000). It plays important roles as a water source for irrigated agriculture,

*Corresponding author. E-mail: sarawutf@wu.ac.th

hydropower production, navigation and domestic and industrial water uses, and local people also depend heavily on its aquatic resources for their nutrition (Ahmed et al., 1996; Baird et al., 1998, 2001; Shoemaker et al., 2001). *Botia, Syncrossus* and *Yasuhikotakia* are genera of freshwater fish belonging to the family Botiidae (Kottelat, 2012) that are of great commercial values in the Mekong River, as it is a delicacy in the diet of local communities and they are popular species in the aquarium trade (Arkathaweewat, 2002; Vidthayanon, 2003). *Syncrossus helodes* (Sauvage, 1876) synonyms to *Botia helodes* Sauvage 1876 and *Yasuhikotakia modesta* (Bleeker, 1864) synonyms to *Botia modesta* Bleeker 1864, which were considered by Kottelat (2012). Both *B. helodes* (now *S. helodes*) and *B. modesta* (now *Y. modesta*) are found in most flowing rivers of all sizes in the Chao Praya and Mekong basins (Rainboth, 1996; Vidthayanon, 2003; Arkathaweewat, 2004). To advance current knowledge about the ecology, length-weight relationships (LWR), condition factors (K) and gut contents of these species, individual fish were analyzed to determine their feeding habits. Analysis of the LWR is important in fishery management because it can be used to estimate the weight of fish of a given length and is also used as an index of the fatness of fish. In addition, information on the LWR is essential for assessing the relative well-being of a fish population (Lagler, 1956; Abowei, 2009) and is also useful in predicting the condition of growth pattern, reproductive biology, and life history of fish species (Wootton, 1992). Knowledge of the condition factor is helpful for comparing the well-being of the fish based on the hypothesis that heavier fish of a given length are in better condition (Bagenal and Tesch, 1978). Many workers have stated that food is the main source of energy and it plays an important role in determining the population levels, rate of growth and condition of fish (Lagler, 1956; Begum et al., 2008).

The existing data on the diet composition of *S. helodes* and *Y. modesta* from the Mekong River in Nong Khai Province are scarce. Some information is available on the habits of these species in other rivers in Thailand (Vidthayanon, 2004), and Rainboth (1996) provided a brief note on the gut contents of these two species from the Mekong River in Cambodia. Therefore, this study is an attempt to determine (1) the length-weight relationship, condition factor, gut fullness, niche breadth and niche overlap of *S. helodes* and *Y. modesta*, and (2) their diet composition in different seasons in the Mekong River in Nong Khai Province.

MATERIALS AND METHODS

Study area

The study was conducted in the Mekong River in Tambon Hadkham in the Muang District, Nong Khai Province, northeastern Thailand, located approximately at a latitude of 17°55'N and longitude of 102°47'E (Figure 1).

Fish sampling

Fish were captured by fishermen using gill nets from the Mekong River in the dry-hot season (mid-February to mid-May 2010) and the dry-cool season (mid-October 2010 to mid-February 2011). Fish could not be captured in the rainy season (mid-May to mid-October 2010) due to flooding. The total length (TL) and fork length (FL) of individual fish were measured to the nearest 0.1 cm, and their weight (W) was measured to the nearest 0.1 g. The fish samples were preserved in a 10% formalin solution, and their abdomens were slit open to facilitate the preservation of their visceral organs. The fish were identified following Rainboth (1996), Arkathaweewat (2004), Vidthayanon (2004), and Kottelat (2012). The guts from individual fish were removed, and the gut length (GL, cm) was measured.

The LWR of fish was estimated using the equation $W = aL^b$ and a linear regression equation in the form of $\log W = \log a + b \log L$ (Lagler, 1956; Wootton, 1992; Ayoade and Ikulala, 2007), where W= fish weight (g); L = total length of fish (cm); a = the intercept (constant); and b = the slope (growth exponent). The slopes of the length-weight regressions (b) were compared to a value of 3 (the cube law) (Lagler, 1956; Wootton, 1992) using Student's t-test (Zar, 1999) to determine whether each species exhibited isometric growth. The condition factor (K) was calculated using the formula $K = 100\ W/L^b$ (Lagler, 1956; Swingle and Shell, 1971), where W = fish weight (g); L= total length of fish (cm); and b = the growth exponent.

The significance of K was also analyzed using Student's t-test (Zar, 1999) to compare the well-being of the species between the two seasons. The relative length of the gut (RLG) was also calculated as a possible indicator of the major diet components using the equation RLG = GL/FL (Yamagishi et al., 2005), where GL = gut length (cm), and FL = fork length (cm). The relationship between the RLG and season was tested using the chi-squared test (χ^2) for independence (Zar, 1999).

The gut was opened to observe the gut fullness, which was scored as 0 (empty), 1 (¼ full), 2 (½ full), 3 (¾ full) or 4 (full) based on Begum et al. (2008). Due to the guts of fish are too long to examine in one time, so we divided into the anterior, mid, and posterior portions for easy examination. However, the results of gut contents were combined for each fish. Each portion of the gut was then prepared as a semi-permanent slide according to Somnark et al. (2011). The resulting semi-permanent slides showing the diet composition were examined under a light microscope (Olympus CH03) and identified to the lowest possible taxonomic level according to Sangpradub and Boonsoong (2006).

Individual food items in the gut contents were counted to determine, for each food type, the frequency of occurrence (%F) and the percentage of gut contents based on the point method (%P) (Hyslop, 1980). Under the point method, 9 groups consisting of dipteran larvae (Chironomidae and Simuliidae), trichopteran larvae, ephemeropteran larvae, terrestrial dipteran adults, zooplankton (Cladocera and Ostracoda), molluscs (Gastropoda and Bivalvia), hemipterans, green algae, and plant materials were defined. In the calculation of %P, sand, fish scales, aquatic insect fragments and unidentified food items were not included. The chi-squared test for independence was used to test the significance of the relationships between %P and the season (Zar, 1999). Levin's measure was employed to determine niche breadth, and the Morisita-Horn index was applied to determine niche overlap (Krebs, 1999).

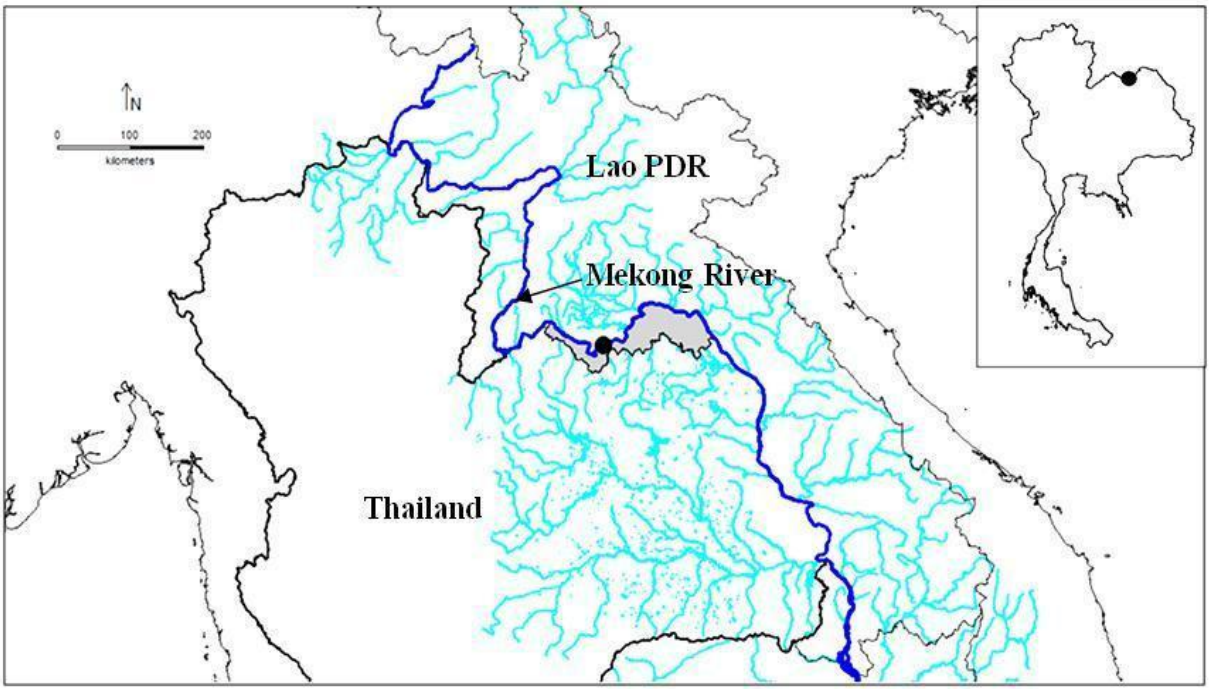

Figure 1. Map showing the location of the sampling site (●) in the Mekong River in Tambon Hadkham, Muang District, Nong Khai Province, northeastern Thailand.

RESULTS

Length-weight relationship (LWR)

As shown in Table 1, the estimated values of b for *S. helodes* ranged from 1.669 (in the dry-hot season) to 2.163 (in the dry-cool season), both of which were significantly lower than 3 (t-test = -19.02066, -12.91238, $p<0.05$). This result indicates that *S. helodes* was undergoing negative allometric growth in both seasons. The b value for *Y. modesta* in the dry-hot season was 4.051, which was significantly greater than 3 (t-test = -10.03351, $p<0.05$), whereas the b value for the dry-cool season was 2.197, which was significantly lower than 3 (t-test = -8.91411, $p<0.05$). This indicates that *Y. modesta* experienced positive allometric growth in the dry-hot season and negative allometric growth in the dry-cool season.

Condition factor (K)

As summarized in Table 1, *S. helodes* exhibited a higher K value (1.04 ± 0.27) in the dry-hot season and a lower K value (0.88±0.19) in the dry-cool season, with a significant difference detected between seasons ($p<0.05$). In contrast, *Y. modesta* presented a lower K value (1.29 ± 0.30) in the dry-hot season and a higher K value (1.34 ± 0.35) in the dry-cool season, and no significant difference was observed between seasons ($p>0.05$). The comparison of K values between the two species showed that *S. helodes* exhibited a higher K value in the dry-hot season than in the dry-cool season, whereas the K value for *Y. modesta* was approximately the same in both seasons.

Relative length of the gut (RLG)

As shown in Table 1, for *S. helodes,* the mean RLG ± standard deviation (S.D.) in the dry-hot and dry-cool seasons were 0.99 ± 0.17 and 0.89 ± 0.17, respectively. For *Y. modesta,* mean RLG ± S.D. were 0.94 ± 0.17 and 0.99 ± 0.19 in the dry-hot and dry-cool season, respectively. The mean RLG values for *S. helodes* and *Y. modesta* were lower than one for both seasons, which indicates that these species are carnivorous.

Gut fullness

A summary of the gut fullness results is presented in Table 2. Of the 24 of *S. helodes* guts wrew tthtexamined in the dry-hot season, 11 were empty (45.83%), and the mean gut fullness score was 1.04. Among the 49 samples collected in the dry-cool season, 12 were empty (24.47%), and the mean gut fullness score was 1.86. The lowest proportion of empty guts (4/35, 11.43%)

Table 1. Length-weight relationships (LWR), Condition factor (K) values, Relative length of the gut (RLG) for *S. helodes* and *Y. modesta* from the Khai Province, Northeastern Thailand.

Fish species	Season	N	TL (cm)		BW (g)		W = aL^b					*t* value (difference of *b* from 3)	K=100W/L^3	*P* va be s
			Min	Max	Min	Max	Mean ± S.D.	b	S.E.	r	R_2		Mean ± S.D.	
S. helodes	Dry-hot	24	9.50	27. 00	10.00	60.00	0.318	1.669	0.145	0.954	0.910	-19.02066*	1.04 ± 0.27	<
	Dry-cool	49	12.00	25.00	15.00	90.00	0.089	2.163	0.199	0.846	0.715	-12.91238*	0.88 ± 0.19	
Y. modesta	Dry-hot	35	9.50	18.50	10.00	150.0	0.001	4.051	0.213	0.957	0.916	-10.03351*	1.29 ± 0.30	
	Dry-cool	45	10.00	17.50	10.00	90.00	0.095	2.197	0.270	0.778	0.606	-8.91411*	1.34 ± 0.35	

*significant at $p<0.05$; (N = number of fish examined, min = minimum, max = maximum, a = constant, b = slope (growth exponent), S.E. = standard coefficient of determination, S.D. = standard deviation).

Table 2. Gut fullness of *S. helodes* and *Y. modesta* from the Mekong River, Muang District, Nong Khai Province, Northeastern Thailand.

Fish species	Season	No.	Empty gut	Non-empty gut	No. of fish showing a particular gut fullness/total no. fish			
					Empty (0)	¼ Full (1)	½ Full (2)	¾ Full (3)
S. helodes	Dry-hot	24	11	13	11/24 (45.83)	8/24 (33.33)	0/24 (0.00)	3/24 (12.50)
	Dry-cool	49	12	37	12/49 (24.47)	13/49 (26.33)	8/49 (16.33)	2/49 (4.08)
Y. modesta	Dry-hot	35	4	31	4/35(11.43)	6/35 (17.14)	1/35 (2.56)	8/35 (22.86)
	Dry-cool	45	12	33	12/45 (26.67)	12/45 (26.67)	4/45 (8.89)	9/45 (20.00)

was found for *Y. modesta* examined in the dry-hot season, which presented an average gut fullness score of 2.74. The 45 samples of *Y. modesta* collected in the dry-cool season exhibited a mean gut fullness score of 1.76, with 12 empty guts being recorded (26.67%).

Diet composition

Frequency of occurrence (%F)

A summary of the frequency of occurrence (%F) of various food items in the guts of S. helodes and Y. modesta is presented in Table 3. A total of 11 different food items were found in the guts of S. helodes in the dry-hot season. Fragments of aquatic insects were present at the highest frequency (60.00% of examined guts), followed by Chironomid larvae (40.00%), unidentified items (33.33%), Hemiptera, green algae and terrestrialdipteran adults (26.67% each), Cladocera, trichopteran larvae, ephemeropteran larvae and sand (20.00% each), and plant materials (6.67%). The *S. helodes* guts included 13 food items in the dry-cool season: Fragments of aquatic inse and trichopteran (22.45%), ephe and Gastropoda (12.24%), terre plecopteran larv fish scales (4.0 food items we Thefragments o frequent occurre second most f trichopteran larv ephemeropteran

Table 3. Frequency of occurrence (%F) of different dietary categories in *S. helodes* and *Y. modesta* from the Mekong River, Muang District, Nong Khai Province, northeastern Thailand.

Dietary categories	*S. helodes*			*Y. modesta*		
	Dry-hot (N=15) %F	Dry-cool (N=49) %F	Mean %F	Dry-hot (N=35) %F	Dry-cool (N=45) %F	Mean %F
Ephemeropteran larvae	20.00	20.41	20.21	0.00	0.00	0.00
Plecopteran larvae	0.00	6.12	3.06	0.00	0.00	0.00
Trichopteran larvae	20.00	30.61	25.31	8.57	11.11	9.84
Chironomid larvae	40.00	30.61	35.31	31.43	37.78	34.61
Simuliid larvae	0.00	0.00	0.00	5.71	11.11	8.41
Simuliid pupae	0.00	0.00	0.00	5.71	8.89	7.30
Terrestrial dipteran adults	26.67	8.16	17.42	14.29	6.67	10.48
Hemiptera	26.67	22.45	24.56	0.00	4.44	2.22
Aquatic insect fragments	60.00	67.35	63.68	71.43	53.33	62.38
Green algae	26.67	6.12	16.40	14.29	8.89	11.59
Filamentous algae	0.00	0.00	0.00	0.00	2.22	1.11
Plant materials	6.67	0.00	3.34	11.43	4.44	7.94
Cladocerans	20.00	2.40	11.2	31.43	15.56	23.5
Ostracods	0.00	0.00	0.00	2.86	2.22	2.54
Bivalves	0.00	0.00	0.00	11.43	2.22	6.83
Gastropods	0.00	18.37	9.19	22.86	2.22	12.54
Fish scales	0.00	4.08	2.04	5.71	4.44	5.08
Sand	20.00	18.37	19.19	14.29	26.67	20.48
Unidentified items	33.33	12.24	22.79	40.00	13.33	26.67

adults, green algae and Cladocera.

Plant materials were only found in the dry-hot season, and Gastropoda, plecopteran larvae and fish scales were only found in the dry-cool season. *Y. modesta* guts included 15 food items in the dry-hot season, of which fragments of aquatic insects were again the most frequent occurrence (34.17%), followed by unidentified items (40.00%), Cladocera and Chironomid larvae (31.43% each), Gastropoda (22.86%), green algae, terrestrial dipteran adults and sand (14.29% each), plant materials and Bivalvia (11.43% each), trichopteran larvae (8.57%), Simuliid larvae and pupae, and fish scales (5.71% each) and Ostracoda (2.86%).

Additionally, *Y. modesta* guts included 17 food items in the dry-cool season, with fragments of aquatic insects occurring at the highest frequency (37.77%) followed by Chironomid larvae (37.78%), sand (76.63%), Cladocera (43.36%), unidentified items (13.33%), Simuliid larvae and trichopteran larvae (11.11% each), Simuliid pupae and green algae (8.89% each), terrestrial dipteran adults (6.67%), Hemiptera, fish scales and plant materials (4.44% each), Gastropoda, Bivalvia, filamentous algae and Ostracoda (2.22% each).

Fifteen food items were consumed in both seasons, and the species fed primarily on fragments of aquatic insects followed by Chironomid larvae, unidentified items, Cladocera, sand, Gastropoda, green algae, terrestrial dipteran adults, trichopteran larvae, Simuliid larvae, plant materials, Simuliid pupae, Bivalvia, fish scales, and Ostracoda. Hemiptera and filamentous algae were only found in the dry-cool season.

Percentage of gut contents (%P)

As shown in Figure 2, food categories were found in the gut contents of *S. helodes* in the dry-hot season. Dipteran larvae (including Chironomid larvae and Simuliid larvae and pupae) contributed the highest proportion of the gut contents (64.56%), followed by trichopteran larvae (17.06%), ephemeropteran larvae (5.29%), plant materials (4.72%), Hemiptera (2.50%), terrestrial dipteran adults (2.35%), green algae and zooplankton (consisting of Cladocerans and Ostracods) (1.76% each). In the dry-cool season, food categories were recorded, and *S. helodes* also fed predominantly on dipteran larvae (64.40%) at this time, followed by trichopteran larvae (18.59%), ephemeropteran larvae (8.16%), Hemiptera (3.40%), terrestrial dipteran adults and molluscs (consisting of Gastropoda and Bivalvia) (2.27% each), green algae (0.46%) and zooplankton (0.45%). Comparative gut analyses showed that *S. helodes* fed on 7 of the same categories of food items in both season, specifically dipteran larvae, trichopteran larvae,

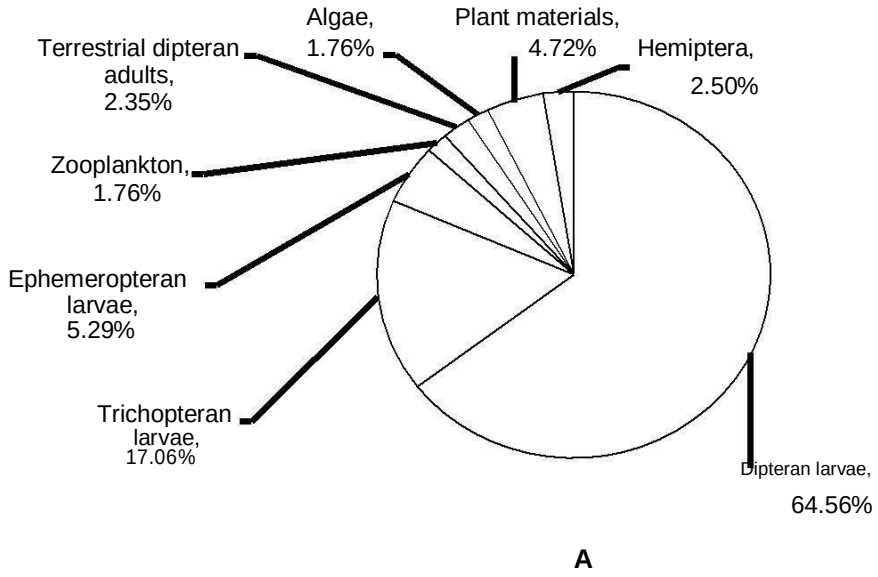

Figure 2. Percentage of point method of *S. helodes* from the Mekong River, Muang District, Nong Khai Province, Northeastern Thailand; (A) Dry-hot season; (B) Dry-cool season.

ephemeropteran larvae, Hemiptera, terrestrial dipteran adults, green algae and zooplankton. Plant material was only found in the gut contents of this species in the dry-hot season, whereas molluscs were only found in the dry-cool season. The chi-squared test for independence showed that %P was related to the season (χ^2 = 2.000, df = 13, p<0.05).

In the case of *Y. modesta*, 7 food categories were found in the gut contents in the dry-hot season. Dipteran larvae constituted the highest percentage of the gut contents (54.80%), followed by trichopteran larvae (15.79%), zooplankton (15.48%), molluscs (5.88%), terrestrial dipteran adults (5.57%), plant materials (1.86%), and algae (0.62%). Eight food categories were found in the dry-cool season samples. Dipteran larvae were also the most dominant group in the dry-cool season (64.77%), followed by trichopteran larvae (16.96%), zooplankton (10.27%), molluscs (5.13%), terrestrial dipteran adults (1.03%), Hemiptera (0.77%), algae (0.57%) and plant materials (0.50%). It was found that *Y. modesta* consumed 7 categories of food items in both seasons, which included dipteran larvae, trichopteran larvae, zooplankton, molluscs, terrestrial dipteran adults, plant materials and algae, whereasHemiptera were only recorded in the dry-cool season, as shown in Figure 3. The chi-squared test for independence showed that %P was related to the season (χ^2 = 2.020, df = 14, p<0.05).

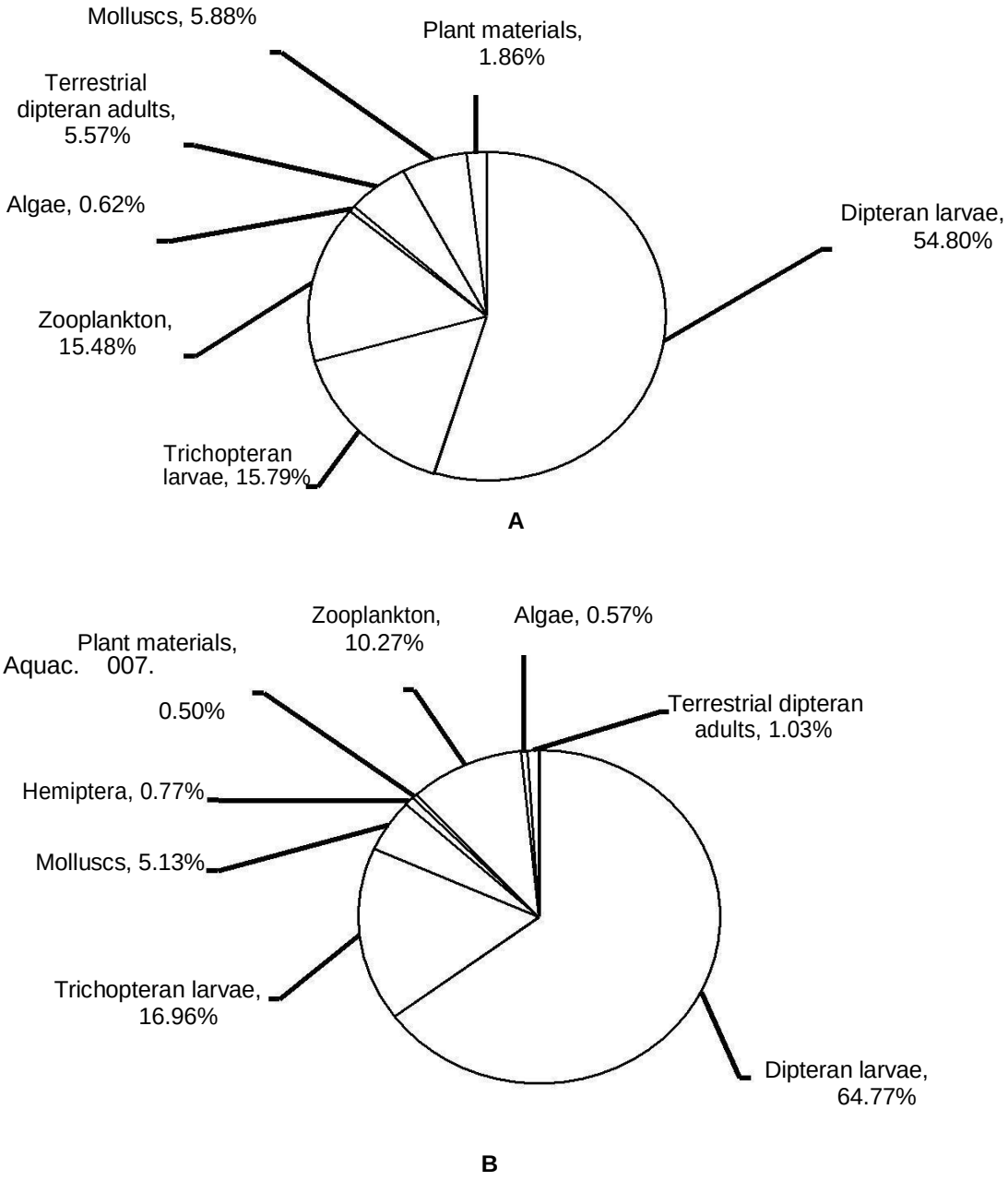

Figure 3. Percentages of different items in the gut contents of *Y. modesta* from the Mekong River, Muang District, Nong Khai Province, northeastern Thailand, based on the point method (A) Dry-hot season; (B) Dry-cool season.

Niche breadth and niche overlap

S. helodes exhibited a greater niche breadth (B = 2.81, B_A = 0.30) than *Y. modesta* (B = 2.21, B_A = 0.17) in the dry-hot season, whereas the niche breadths were similar for *S. helodes* (B = 2.17, B_A = 0.17) and *Y. modesta* (B = 2.18, B_A = 0.17) in the dry-cool season. The niche overlap between *S. helodes* and *Y. modesta* was high in both the dry-hot (0.95) and the dry-cool seasons (0.98), which indicated that these species exhibit a high level of similarity that is biologically significant.

DISCUSSION

Based on the LWR results, it was found that the b (growth exponent) values for *S. helodes* were 1.669 and 2.163 in the dry-hot and dry-cool season, respectively; both values were significantly lower than 3 (p<0.05) indicating negative allometric growth. In contrast, the b value for *Y. modesta* in the dry-hot season was 4.051, which was significantly greater than 3 (p<0.05), indicating positive allometric growth (Wootton, 1992). However, the b value of *Y. modesta* in the dry-cool season was 2.197,

which is significantly lower than 3 (p<0.05) and indicates negative allometric growth. The b values for both species are within the limits (two to four) established as the range of b values for an ideal fish by Tesch (1971), except for the b value for *S. helodes* in the dry-hot season, which was 1.669. In the present study, the b values for *S. helodes* and *Y. modesta* differed between the seasons and species (p<0.05), which is in agreement with the findings of Qasim (1973), who indicated that the values of a and b vary not only between different species but also within the same species between sexes, stages of maturity and food habits. According to Wootton (1992), the b value associated with the LWR of fish can be used as an indicator of food intake and growth patterns and may differ according to such biotic and abiotic factors as water temperature, food availability and habitat type.

The mean K values obtained for *S. helodes* and *Y. modesta* between different seasons only showed a significant difference in *S. helodes*, whose mean K was 1.04, which is likely equal to one in the dry-hot season. This result indicated that *S. helodes* was in good condition. In contrast, the mean K value for *S. helodes* was lower than one in the dry-cool season (0.88), showing that *S. helodes* presented a poorer average condition. The mean K values for *Y. modesta* were higher than one in both the dry-hot (1.29) and dry-cool season (1.34), which shows that *Y. modesta* was in above average condition, implying that the *Y. modesta* populations were in excellent condition. According to Swingle and Shell (1971) and Wootton (1992), the K value can be used to estimate the condition of fish. If the K value of a fish is higher than one, it means that the fish is in above average condition and receives sufficient natural food for its growth. In the case of a K value that is less than one, the fish is in below average condition. In the present study, it was found that only the mean K values for *S. helodes* differed between seasons (p<0.05), which was in agreement with the findings of Braga (1986), who reported that the value of the condition factor varies among seasons and is influenced by environmental conditions. In addition, Wootton (1992) and Parihar and Saksena (2010) showed that the condition factor can also vary with the age, sex, season, habitat, stage of maturity, gut fullness, type of food items consumed and feeding activity of fish.

The results of the analysis of gut fullness showed that the fullness status was not likely to be related to the condition factor. The mean gut fullness score for *S. helodes* was low (40.1) during the dry-hot season and high (40.1) in the dry-cool season. In contrast, *Y. modesta* presented a rather high mean gut fullness score (40.1) during the dry-hot season and a lower one (40.1) during the dry-cool season. These findings agree with those of Fagade and Olaniyan (1972), who have shown that the fluctuation in the gut fullness of fish varies with the season depending on the quantity of food available in the habitat where fish live at any given time. Results regarding feeding intensity obtained through analysis of gut fullness have also been correlated with the season, as stated by Dadzie (2007).

The gut content analyses performed in the present study showed that *S. helodes* consumes a wide variety of food items, which is in agreement with the findings of Rainboth (1996), who reported that *B. helodes* (now *S. helodes*) from the Mekong River in Cambodia fed primarily on benthic aquatic insects and molluscs. In addition, Vidthayanon (2004) reported that the food items consumed by *S. helodes* in Thailand consisted of benthic organisms, shrimps and insects. In the current study, it was found that *Y. modesta* consumed similar categories of food items, primarily consisting of dipteran larvae, followed by trichopteran larvae, terrestrial dipteran adults, zooplankton and algae.

Statistical analyses indicated significant relationships between %P, seasons and fish species (p<0.05). These findings agreed with those of Schafer et al. (2002), who stated that the feeding habits of fish vary with the quantity and type of available food items in the habitat where the fish are found at a particular time. Islam et al. (2004) have also shown that the foods and feeding habits of fish species vary from season to season and that fish consume different types of food. According to Ayoade and Ikulal (2007), the foods consumed by fish differ within individual species with age, locality and season.

In the present study, it was found that the preferred food items for *S. helodes* and *Y. modesta* are commonly dominated by aquatic insect larvae, especially Chironomid larvae, which concurrs with the findings of Hanjavanit and Sangpradub (2012) for *Botia eos* in the Chi River in Thailand. According to Courney and Merritt (2008), Chironomid larvae are often abundant near vegetation and dwell in sandy bottoms. In this study, plant parts and filamentous algae were also found in the gut contents of the studied fish, which may be due to the accidental ingestion of plant parts along with the principal food item, Chironomid larvae. The results of the diet composition analysis revealed that *S. helodes* and *Y. modesta* are carnivorous predatory fish. This finding was based partly on the values obtained regarding the RLG, which were less than one. According to Yamagishi (2005), an RLG of less than one indicates that a fish is carnivorous, whereas an RLG greater than one indicates that the fish is an herbivore or omnivore.

A comparison of the food items consumed by *S. helodes* and *Y. modesta,* which belong to the different genus, with those consumed by morphologically similar species that occur in the same habitat, that is, the Mekong River, indicates that they do not ingest various prey types in the same relative amounts, which may be partly related to differences in feeding behavior. The two species shared 6 food items in the dry-hot season, which included dipteran larvae, trichopteran larvae, terrestrial dipteran adults, zooplankton, plant material and green algae. These two species also fed on 7 of the same

categories of food items in the dry-cool season, which were dipteran larvae, terrestrial dipteran adults, trichopteran larvae, Hemiptera, molluscs, zooplankton and algae. This similarity is supported by the Morisita-Horn index, which was used to determine the niche overlap in both the dry-hot (0.95) and the dry-cool season (0.98). It was observed that the two species showed an overlap in diet. This is an important strategy for survival and represents an advantage over fish species that specialize in a specific food item (Begum et al., 2008). The results of the present study show that in the Mekong River, *Y. modesta* feeds on more food items than *S. helodes.* It is evident that the primary food items of both fish are typically benthic macroinvertebrates, which are widely distributed throughout the bottom of this water body. Thus, both *S. helodes* and *Y. modesta* can be considered a demersal fish, which is in agreement with the findings of Froese and Pauly (2011), who have reported that they are demersal and native to the Chao Praya River in Thailand and the Mekong River.

Analyzing both the quality and quantity of fish diets is important for indicating patterns in fish survival (Islam et al., 2004). Additionally, Ferrareze and Nogueira (2007) have stated that research on the food sources of fish could provide data about their habitat and food availability in the environment as well as allow an improved ecological and behavioral understanding of the fish species. The information on the specific food sources and feeding habits of *S. helodes* and *Y. modesta* obtained in this study contributes to the baseline data on the ecology of these species, which could be important for the effective management of the riverine fisheries of other commercially important species in the Mekong River.

Conclusion

From the analysis of LWR, it may be concluded that *S. helodes* had negative allometric growth in both seasons. This result was correlated with mean K value (1.04) in the dry-hot season, which was showed that *S. helodes* was in the good condition. In contrast, the mean K value for *S. helodes* was lower than one in the dry-cool season (0.88), which indicated that *S. helodes* had the poorer average condition. Whereas, *Y. modesta* had positive allometric growth and negative allometric growth in the dry-hot and dry-cool seasons, respectively, which were correlated with greater mean K values than one (1.29, 1.76). This result indicated that *Y. modesta* was in above average condition. Due to food plays an important role in determining the population levels, rate of growth and condition of fish. From the result of gut content analyses, it showed that *S. helodes* and *Y. modesta* are carnivorous and diet compositon was depended on season and fish species (p<0.05). Therefore, the results of LWR from the present study may reflect to K value of fish, which was associated with availability of food items in the natural environment among seasons.

ACKNOWLEDGEMENTS

The authors wish to express their gratitude to the Department of Biology, Faculty of Science, Khon Kaen University, Thailand for providing the facilities used in this study and thanks to KKU Publication Clinic for providing professional editing service from American Journal Experts. They also thank the fishermen who assisted in the fish sampling.

REFERENCES

Abowei JFN (2009) 0The condition factor ,length- weight relationship and abundance of *Ilisha africana* (Block, 1795) from Nkoro River Niger Delta, Nigeria*0* J. Food Sci. Technol. 2(1):6-11.

Ahmed MT, Tana S, Thuok N (1996). Sustaining the gifts of the Mekong: Fisheries in Cambodia. Watershed 1(3):33-38.

Arkathaweewat S (2002). Illustration of fish and aquatic animals of Thai. Department of Fisheries, Ministry of Agriculture and Cooperative. 4th ed. Kdurusapa Ladprao Printing Press, Bangkok, (in Thai) pp. 198-199.

Arkathaweewat S (2004). Knowledge of Thai freshwater fish. Vol. I Kdurusapa Ladprao Printing Press, Bangkok, (in Thai) pp. 200-213.

Ayoade AA, Ikulala AOO (2007). Length weight relationship, condition factor and stomach contents of *Hemichromis bimaculatus, Sarotherodon* melanotheron and Chromidotilapia guentheri (Percifermes: Cichlidae) in Eleiyele Lake, Southwestern Nigeria. Rev. Biol. Trop. 55(3-4): 969-977.

Bagenal TB, Tesch AT (1978). Conditions and growth patterns in fresh water habitats. Blackwell Scientific Publications, Oxford, pp. 75-89.

Begum M ,Alam MJ ,Islam ,MJ, Pal HK (2008). On the food and feeding habit of an estuarine catfish (*Mystus gulio* Hamilton)in the south-west coast of Bangladesh. Univ. J. Zool. Rajshahi Univ. 27:91-940

Braga FMS (1986). Estudo entre o factor de condicao e relacao peso/comprimento para alguns peixes marinhos. Rev. Bras. Biol. 46(2):339-346.

Baird IG, Hogan Z, Phylavanh B, Moyle P (2001). A communal fishery for the migratory catfish *Pangasius macronema* in the Mekong River. Asian Fish. Sci. 14:25-41.

Baird IG, Inthaphaisy V, Phylavanh B, Kisouvannalat P (1998). A rapid fisheries survey in Khong District, Champasak Province, Southern Lao PDR. Technical Report. Environmental Protection and Community Development in Siphandone Wetlands Project, CESVI, Pakse, Lao PDR, P. 31.

Courney GW, Merritt RW (2008). Aquatic Diptera. Part One. Larvae of Aquatic Diptera. In Merritt RW, Cummins KW, Bery MB (eds.) An Introduction to the aquatic insects of North America. 4th ed. Kendall Hunt Publishing Company, USA, pp. 687-690.

Dadzie S (2007). Food and feeding habits of the black pomfret, *Parastromateus nider* (Carangidae) in the Kuwaiti waters of the Arabian Gulf. Cybium. 31(1):77-84.

Fagade SO, Olaniyan CIO (1972). The biology of the West African shad *Ethmalosa fimbriata* (Bowditch) in the Lagos lagoon, Nigeria. J. Fish Biol. 4:519-533.

Ferrareze M, Nogueira MG (2007) . Zooplankton feeding selective by fishes. Anais do VIII Congresso de Ecologia do Brasil, 23 a 28 de Setembro de 2007, Caxambu-MG. pp. 1-3.

Froese R, Pauly D (2001). Fishbase. Available Source: http://fish mongabay.com/data/ecosystems/ Chao%20Praya%20River.htm. June 14, 2012,

Hanjavanit C, Sangpradub N (2012). Stomach contents of Zigzag Eel (*Mastacembelus armatus* Lecepede, 1800), Bagrid Catfish (*Mystus mysticetus* Roberts, 1992) and Red-Tail Botia (*Botia eos* Taki, 1972) from the Chi River, Kosum Phisai District, Mahasarakham Province, Northeastern Thailand. KKU Sci. J. 40:59-71.

Hyslop EJ (1980). Stomach contents analysis -a review of methods and their application. J. Fish. Biol. 17:411-429.

Islam MN, Parvin S, Hyder F, Flowra FA, Masud AA (2004). Food and

feeding habit of juvenile *Channa punctatus* (Bloch) from a semi-closed water body in Chalan Beel floodplain, Bangladesh. J. Biol. Sci. 4(3):352-356.

Kottelat M (2012). Conspectus Cobitidum. An Inventory of the loaches of the world (Teleostei: Cypriniformes: Cobitoidei). Raff. Bull. Zool. Supplement. 26:1-199.

Krebs CJ (1999). Ecological methodology. 2nd ed. Benjamin/Cummings imprint, Menlo Park, California, pp. 466-474.

Lagler KF (1956). Freshwater fishery biology. WM.C. Brown Company, Dubugue, Iowa, pp. 120-130.

Parihar D, Saksena DN (2010). The food, feeding habits and condition factor of three freshwater fishes from Tighra reservoir, Gwalior. J. Ecophysiol. Occup. Health 10:13-19.

Poulsen , albo- rgensen J (2000). Fish migrations and spawning habits in the Mekong Mainstream-a survey using local knowledge. AMFC Technical Report. Mekong River Commission 4:65-66.

Qasim SZ (1973). An appraisal of the studies on maturation and spawning in marine telosts from the Indian water. Indian J. Fish. 20(1):166-181.

Rainboth WJ (1996). Fishes of the Cambodian Mekong. FAO, Rome, pp. 132-134.

Sangpradub N, Boonsoong B (2006). Identification of freshwater invertebrates of the Mekong River and its tributaries. Mekong River Commission. Vientiane, Lao PDR, P. 274.

Schafer LN, Platell ME, Valesini FJ, Potter IC (2002). Comparison between the influence of habitat type, seasonal and body size on dietary compositions of fish species in nearshore marine water. J. Exp. Mar. Biol. Ecol. 278:67-92.

Shoemaker B, Baird IG, Baird M (2001). The people and their river: a survey of river-based livelihoods in the Xe Bang Fai River Basin in Central Lao PDR. The Lao PDR/Canada Fund for Local Initiatives, Vientiane, Lao PDR. P. 65.

Somnark R, Sangpradub N, Hanjavanit C (2011). Stomach contents of the grey featherback (*Notopterus notopterus* (Pallas, 1780)) and the bagrid catfish (*Mystus mysticetus* Roberts, 1993)) in Kaeng Lawa, Khon Kaen Province, Northeastern Thailand. Laos J. Appl. Sci. 2(1):491-498.

Swingle WE, Shell EW (1971). Tables for computing relative conditions of some common freshwater fishes. Agricutural Experiment Station Auburn University, pp. 1-23.

Tesch W (1971). Age and growth. In: Richer WE (ed) Methods for assessments of fish production in freshwater. International Biological Programme. Oxford, pp. 97-130.

Wootton RJ (1992). Fish ecology. Blackie Academic and Professional, London, pp. 121-130.

Vidthayanon C (2003). Thai freshwater fish. 4th ed. Nanmee Book Publication, Bangkok, (in Thai). pp. 60-61.

Vidthayanon C (2004). Freshwater fish manual. Sarakadee Press, Bangkok, (in Thai). pp. 162-164.

Yamagishi Y, Mitamura H ,Arai N ,Mitsunaga Y, Kawabata Y, Khachapicha M, Viputhanumas T (2005). In: Arai N (ed) Feeding habit of hatchery-reared young Mekohg giant catfish in a fish pond and in Mae Peum reservoir: Proceedings of the 2nd International symposium on SEASTAR 2000 workshop and Asian Bio-logging Science, pp. 17-22.

Zar JH (1999). Biostatistical analysis. 4th ed. Prentice Hall International Inc., New Jersey, pp. 461-485.