

## Size Related Dietary Variations and Morphological Correlates in Three Freshwater Fishes from Shatt Al-Arab River, Basrah, Iraq

Salah M. Najim<sup>\*</sup>, Rajaa A.A. Al-Modhaffar and Furat K. Jasim

Department of Fisheries and Marine Resources, College of Agriculture, University of  
Basrah, Basrah, Iraq.

\* e-mail: salahm63@yahoo.com

**Abstract.** This study was carried out to investigate the possible relationships of some morphometrics of gill rakers and intestine with size-related dietary variations in three sympatric freshwater fishes. A total of 245 specimens of yellowfin porgy, *Acanthopagrus latus*, redbelly tilapia, *Tilapia zilli* and greenback mullet, *Liza subviridis* (73, 90 and 82 specimens, respectively) were collected from Shatt Al-Arab River from Sep. 2010 to Aug. 2011. To facilitate the follow up of size-related variations, specimens of each fish species were divided into three representative size groups. Results of food analysis using the index of relative importance, IRI, indicated noticeable inter- and intra-specific variations in food habits between the examined species, where *A. latus* demonstrated evident carnivorous mode of feeding, *T. zilli* was herbivore and *L. subviridis* was mostly planktivore. Feeding mode was reflected obviously on gill arch length, gill raker number, length and width. *Liza subviridis* was characterized by more numerous (41-42), longer (3.38-5.83 mm) and thinner (0.09-0.14 mm) gill rakers, in comparison with other two species. Calculated gill raker gap and filtration area was varied also between species and size groups reflecting distinctive adaptive mechanisms for feeding modes. Filtration area was smaller in the planktivore *L. subviridis* (108.9-195.5), medium in the herbivorous *T. zilli* (151.7-267.5) and larger in the carnivore *A. latus* (174.4-331.2 mm<sup>2</sup>). Relative gut length, RGL, showed relatively opposite trend appearing larger in *T. zilli* (1.86-3.11), medium in *L. Subviridis* (1.89-2.51) and smaller in *A. latus* (0.9-1.06). All the studied morphometrics exhibited reasonable correlations with fish size denoting possible ontogenetic food shifts in these species.

### Introduction

Fishes vary widely in their food habits but can be categorized generally into plant eating herbivores, animal eating carnivores and mixed eating omnivores in between (5). These food preferences are reflected directly on the structural and functional characteristics of the entire digestive system, so every part, starting from the mouth, is modified and prepared to handle the consumed food items (15).

Gills play many vital roles in fish participating in respiration, feeding and osmoregulation (2, 14). Gill rakers (teeth-like structures on the inner side of gill arches) organize on opposition from both sides in a sieve-like apparatus aiding to prevent food loss through the opercular gap. This is recognized as the primary function of gill rakers (4, 15). Although gill raker number is well known taxonomic trait, it also reflects feeding mode in

fishes. Length and width of gill rakers, in addition to its number, could determine filtration capacity of fish which is related directly to the size of fish and food particles (25, 28).

Fish intestine is also differs in structure and length between various fish species, reflecting initially their food habits (1). Herbivores are known to have longer intestine than carnivores while omnivores stands in the middle deviating to one side or another according to the proportions of plant and animal food components (31). Intestine anatomy and length are well documented to change in many fish species with age, especially when accompanied by shifts in food preferences (1, 27, 31).

Study of gill raker morphometrics and intestinal length has obvious importance from the biological view of point. In addition, it has another important implication related to fish feed technology. Feed designers and manufacturers need such information in order to prepare suitable feeds for species intended to aquaculture (31, 36). Therefore, this study was carried out to investigate gill raker morphometrics and intestine length in relation to food habits in three sympatric species i.e. *Acanthopagrus latus*, *Tilapia zilli* and *Liza subviridis* that have prospects to aquaculture.

### Materials and methods

Samples of yellowfin porgy *Acanthopagrus latus*, redbelly tilapia *Tilapia zilli* and greenback mullet *Liza subviridis* (73, 69 and 71 specimens, respectively) were collected from Shatt Al-Arab River by seine net between September 2010 and August 2011. Fishes brought in iced containers to the laboratories of Department of Fisheries and Marine Resources, College of Agriculture, University of Basrah. Upon arriving, fish standard length and weight were measured, dissected, gills removed, fixed in 5% formalin and kept in refrigeration at about 4-5 C until further examination.

Intestine was removed, its length measured to the nearest mm, degree of fullness estimated and contents discharged carefully into a Petri dish. Different food items identified according to Hadi *et al.* (18) and Wehr and Sheath (36), sorted and estimated applying point method and frequency of occurrence (23). Index of relative importance (IRI) was calculated for each food item according to the formula of Stergiou (32):

$$IRI = C_w \times F$$

where  $C_w$  is the proportion of food item and  $F$  its frequency of occurrence.

Gill arches were separated and gill arch length (L) measured with aid of a flexible metal wire. Raker numbers (N) were counted on each arch under dissecting microscope. Using scaled ocular lens, length and base thickness (T) of 5 different representative gill rakers from each arch were measured to the nearest 0.01 mm and averages computed. Gill raker

gap (G, spacing between gill rakers) and filtration area (GF, water flowing space between gill rakers) were calculated according to Gibson's (16) equations:

$$G \text{ (in mm)} = L - (N - 1 \times T) / (N - 1)$$

$$F \text{ (in mm}^2\text{)} = (\sum L - L_{\max}) \times G$$

Where  $\sum L$  is the total length of all rakers on the arch or on all arches, and  $L_{\max}$  is the length of the longest raker on the arch.

Values of total filtration area or average gap were calculated for all arches from both sides and summed.

Relative intestine length (RIL) calculated according to Tengjaroenkul (36) as:

$$\text{RIL} = \text{Intestine length, mm.} / \text{Fish length, mm.}$$

Data analyzed statistically using SPSS statistical package V.19. One-way analysis of variance ANOVA and LSD test to compare means were performed, linear regression and correlation coefficients were calculated and their significance (at  $P < 0.05$ ) compared.

## Results and Discussion

Size classes of the three studied fish species i.e. *A. latus*, *T. zilli* and *L. subviridis* are presented in table 1. Fishes were divided depending on the predicted ontogenetic shifts in diet, size of maturity and length range available according to sample size in order to obtain meaningful explanations to their expected dietary modifications as suggested by Amundsen *et al.*(9).

**Table 1: Data of length, weight and size classes of the three studied species.**

Fish species	Size class	Length range, mm.	No. of fish	Average Length, mm	Average Weight, g
<i>A. Latus</i>	A1	<100	19	75.7±14.6	83.9±17.1
	A2	100-160	32	137.9±20.5	155.1±25.9
	A3	> 160	22	186.8±16.9	221.9±38.5
<i>T. Zilli</i>	T1	<110	21	91.9±9.9	55.96±8.9
	T2	110-140	36	127.7±9.6	81.89±10.8
	T3	> 140	33	167.1±11.2	109.36±10.6
<i>L. Subviridis</i>	L1	<110	18	87.1±12.3	21.14±11.2
	L2	110-140	35	129.3±9.3	48.78±14.1
	L3	> 140	29	171.2±9.4	69.36±9.9

As shown in table 2, the three studied species varied in their feeding habits with different degrees. Yellowfin porgy *A. latus* was strictly carnivore. Animal components in its diet comprised 92.2, 91.8 and 89.6% in size groups A1, A2 and A3, respectively, with no significant differences between the three size groups. However, notable differences in prey species could be seen from table 2. The smaller group A1 consumed more soft bodied preys like shrimp, zooplankton and annelids which decreased respectively in the other two size groups. In contrast, proportions of eggs, fishes, crabs and molluscs increased gradually with fish size. These results agreed well with previous studies on the feeding of this species (20, 33). Dietary shifts in carnivorous fish species relates normally to the development degree of digestive system. Prey capture tactics and manipulation of the ingested materials are upon the main reasons of these shifts in food habits (21, 22).

**Table 2: Food habits, calculated with Index of Relative Importance IRI, of three studied species divided according to size groups.**

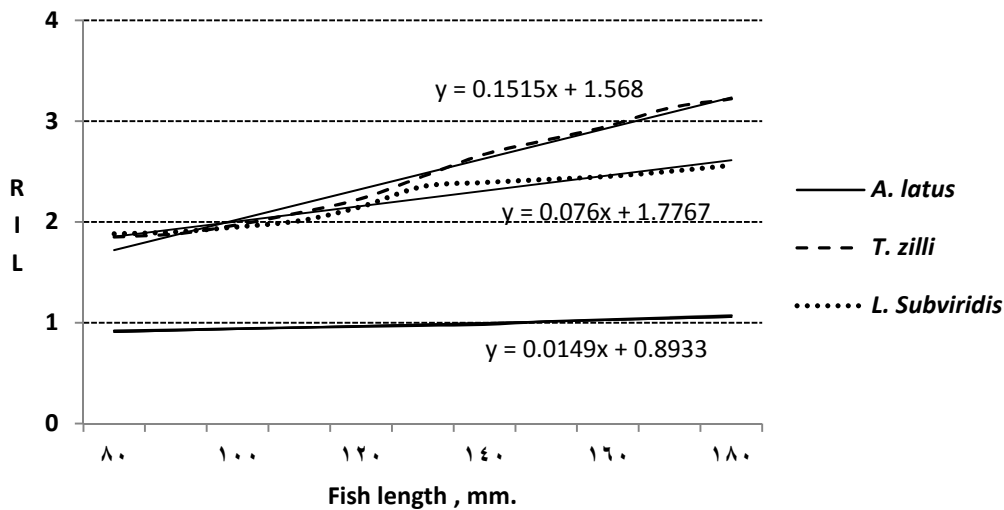
Fish species	<i>A. latus</i>			<i>Tilapia zilli</i>			<i>L. subviridis</i>		
	A1	A2	A3	T1	T2	T3	L1	L2	L3
Macrophytes	0.9	2.1	3.7	40.1	58.7	62.1	0.7	1.0	1.5
Phytoplankton	-	-	-	-	-	-	30.9	29.7	25.6
Algae	1.1	1.5	2.9	44.3	25.4	22.1	11.2	13.3	13.4
Diatoms	-	-	-	6.1	1.9	1.7	5.2	3.5	3.7
Detritus	-	-	-	0.9	1.2	1.4	44.1	46.2	46.9
Eggs	7.5	10.1	10.9	3.2	6.6	7.9	-	-	-
Fish	8.9	17.2	24.6	-	-	-	-	-	-
Shrimp	37.7	29.9	19.1	-	-	-	-	-	-
Crab	7.8	11.5	13.6	-	-	-	-	-	-
Zooplankton	9.5	1.7	1.1	3.4	2.9	2.8	0.5	1.2	3.7
Annelids	13.9	6.9	5.1	-	-	-	-	-	-
Molluscs	6.9	14.6	15.1	-	-	-	-	-	-
Inorganics	3.3	2.8	1.7	0.6	1.7	1.2	3.9	2.9	2.9
Miscellaneous	2.5	1.8	1.1	1.3	1.5	0.8	3.5	2.1	2.3

For size group limits, refer to table 1.

*Tilapia T. zilli* showed clear herbivorous feeding habits. Plant materials consisted 90.6% in size group T1 and decrease to 86.1 and 85.9% in size groups T2 and T3, respectively. Animal components which represented mainly by eggs and zooplankton, thought not important as plant materials, have an increased trend with fish size. It elevated from 6.6 in T1 group to 9.5 and 10.7 in T2 and T3 size groups, respectively. Most animal components in herbivore diets were ascribed to accident feeding. Eggs are found attached on higher plants or entrapped within algal masses which are the main components of plant components of *T. Zilli* (5, 6). This could be a potential explanation to the existence of some

animal components within feed items of such primary herbivore which have been recorded here and in previous studies (6, 22, 35).

Greenback mullet *L. Subviridis* showed mainly planktivorous feeding habits (Table 2). Phytoplankton, algae and diatoms consisted 47.3, 46.5 and 42.7% of total IRI value of food in size groups L1, L2 and L3, respectively. However, detritus was nearly of the same importance as phytoplankton where it consisted 44.1, 46.2 and 46.9% of total IRI of food in size groups L1, L2 and L3, respectively. Feeding on detritus and phytoplankton are two interchangeable aspects of filter feeding which is the prevailed mode of feeding in many mullet species (13). This agreed well with other studies on the same species and other related mullets (1, 8, 22).



**Figure 1. Relationship between fish length and relative intestine length RIL in *A. latus*, *T. zilli* and *L. subviridis*.**

Relative intestine length RIL in relation to fish length of the three studied species is depicted in figure 1. The RIL value changed slightly through the three size groups of *A. latus*. It increased by only 16.3% between lengths of 80-180 mm. Percentage increase was elevated to 36.17 and 74.05 in *L. subviridis* and *T. zilli*, respectively. Equations of linear regression of the three species are presented in figure 3 also. Despite of percentage increase in RIL, there were significant correlations between RIL and fish lengths in the three examined species ( $r = 0.981, 0.992$  and  $0.973$  for *A. latus*, *T. zilli* and *L. subviridis*, respectively). These values lie well within previous mentioned results for carnivorous, herbivorous and planktivorous fish species (1, 27, 31).

It is well documented that predatory fish have shorter intestines in comparison with herbivorous species (27, 29). Planktivorous fish occupy a rather middle position between

the other feeding modes in relation to RIL. This is one of the obvious adaptations to accommodate different feed components. Plant materials are slowly digested and absorbed so it requires longer intestine than animal preys (1). Carnivorous fishes contain a real stomachs or stomach-like structures which facilitate the digestion of animal feeds and decrease the time required for absorption of the digesta (31).

Table 3 demonstrate some morphometric features of gill arch and gill rakers in the studied size groups of the examined fish species *A. Latus*, *T. Zilli* and *L. Subviridis*. Gill arch length increased with size in the three studied species, although with various percentages; 197.99, 180.84 and 180.26% from the smaller to the larger size group of *A. Latus*, *T. Zilli* and *L. Subviridis*, respectively. Increasing size of gill arch and components e.i. gill rakers and filaments reflects its multiple contributions in many complicated processes like respiration, osmoregulation and feeding (3, 4, 7). However, growth rate of gill arch and its components can be an adaptive phenomenon although it lies mainly under genetic control (29, 30).

Gill raker numbers, from the other hand, are rather constant so it was considered as a taxonomic feature (10, 12). Numbers of gill rakers, as shown in table 3, were rather constant in the studied species e.i. 9-11, 11-12 and 41-42 in *A. Latus*, *T. Zilli* and *L. Subviridis*, respectively. However, some variation in gill raker numbers were recorded in various fish species and this limited variation was considered as acceptable by many authors (9, 16, 24, 26).

With the growth of gill arch and constant number of gill rakers, the latter showed notable growth in length and thickness (width). As mentioned by Goodrich *et al.* (17) and Liston (25), the rates of gill raker growth form the final structure of the branchial sieve which results from the interaction between gill rakers on both sides of fish. Gill raker length increased by 197, 156 and 173%, their thickness by 175, 174 and 156% in *A. Latus*, *T. Zilli* and *L. Subviridis*, respectively, with the latter significantly differed ( $p < 0.05$ ) from two other species (table 3). The same trends were recorded in similar and different fish species in relation to size and food habits (2, 28, 34).

**Table 3: Some morphometric features of gill arch and gill rakers in the studied size groups of *A. Latus*, *T. Zilli* and *L. Subviridis*.**

Fish species	Size class	GA L.	GR No.	GR L.	GR T.	G	FA
<i>A. Latus</i>	A1	44.7	9	1.01	0.56	5.028 <sup>a</sup>	174.389 <sup>a</sup>
	A2	73.8	9	1.32	0.77	8.455 <sup>b</sup>	289.871 <sup>b</sup>
	A3	88.5	10-11	1.99	0.98	8.853 <sup>b</sup>	331.230 <sup>c</sup>
<i>T. Zilli</i>	T1	38.1	12	1.27	0.19	3.274 <sup>a</sup>	151.730 <sup>a</sup>
	T2	56.6	12	1.55	0.29	4.855 <sup>ab</sup>	223.278 <sup>b</sup>
	T3	68.9	11-12	1.98	0.33	5.412 <sup>b</sup>	267.477 <sup>b</sup>

<i>L. Subviridis</i>	L1	30.9	41	3.38	0.09	0.683 <sup>a</sup>	108.931 <sup>a</sup>
	L2	42.6	41	4.93	0.11	0.955 <sup>ab</sup>	150.499 <sup>b</sup>
	L3	55.7	42	5.83	0.14	1.219 <sup>b</sup>	195.479 <sup>c</sup>

GA L., Gill Arch Length; GR No., Gill Raker Number; GR L., Gill Raker Length; GR T., Gill Raker Thickness; G, Gill Raker Gap; FA, Filtration Area. Values which marked by different litters, within the same column for each species, are significantly different ( $P \leq 0.05$ ).

Gill raker gap G showed different inter- and intra-specific degrees of development in the three studied species. It increased by 76.07, 65.3 and 78.47% in *A. Latus*, *T. Zilli* and *L. Subviridis*, respectively, with various significant and non significant differences between size groups within each species (Table 3). Filtration area FA took more prominent trend of ontogenetic variation. Significant differences were detected between size groups of the three studied species. As shown in table 3, FA increased gradually and significantly with fish size between 174.389- 331.230 in *A. latus*, 151.730- 267.477 in *T. zilli* and 108.931- 195.479 in *L. subviridis*. Values of FA reflect the size of entrapped food items between gill rakers so it is usually larger in carnivores (4, 28), smaller in herbivores and less in planktivores (11, 13). This agrees well with the results of the current study where the three studied species demonstrated distinct feeding habits (table 2).

In conclusion, the three studied fish species revealed clear ontogenetic development of gill raker sieve features which accompanied by size related variations in food habits. This phenomenon is note rare in fish. Several researches denoted rather similar results in marine and freshwater fish species (1, 2). The information which can be extracted from the results of the current study would have implications for prospected culture of these species. It can be very helpful in designing compositional and physical properties of intended natural or artificial feeds for the studied species. This could be one factor for success planning in future of aquaculture of these species.

## References

- 1- Abdullah, J.N. (2012). Relationship between food habit and alimentary tract and gill rakers morphology of mullet *Liza klunzingeri* from Shatt Al-Basrah canal. Basrah J. Agric. Sci., 25(2): 89-98.
- 2- Abdullatef, H.A. (2010). Length- weight relationship in the common carp *Cyprinus carpio* and yellowfin porgy *Acanthopagrus latus* with some functional criteria of respiratory system. Sci. J. Karbala, 8(1): 287- 291.
- 3- Abdullatef, H.A. and Al-Mhana, M.W.H. (2012). A comparative study of Length-weight relationship in Khashni *Liza abu* and Hemri *Barbus luteus* with some gill components. Sci. J. Karbala, 10(1): 46- 51.
- 4- Abuzinadah, O.A. (1995). Gill raker morphology in some Red Sea fish of different feeding preferences. J. KAU: Mar. Sci., 6: 193-122.

- 5- Adeyemi, S.O.; Bankole, N.O.; Adikwu, I.A. and Akombu, P.M. (2009). Food and feeding habits of some commercially important fish species in Gbedikere Lake, Bassa, Kogi State, Nigeria. *International Journal of Lakes and Rivers*, 2(1): 31-36.
- 6- Al-Lamy, J.H; Resen, A.K.; M.M. Taher and S.J. Muhammed (2012). Specialization and Diet Overlapped Between Two Alien Species (*Carrasius auratus* and *Tilapia zilli*) and Native Species (*Barbus luteus*) in East Hammar Marsh, Southern Iraq. *JKAU: Mar. Sci.*, 23(2): 25-37.
- 7- Almeida, A.P.G.; Behr, E.R. and Baldisserotto, B. (2013). Gill rakers in six teleost species: influence of feeding habit and body size. *Ciencia Rural*, Santa Maria, 43(12): 2208-2214.
- 8- Al-Shammary, A.C. (2010). Study of Occurrence and some of Biological aspects of *Liza subviridis* (Valencieunes, 1836) in Shatt Al-Basrah channel. *J. Basrah Res.*, B. 36(6): 143-156.
- 9- Amundsen, P.; Bohn, T. and Vaga, G.H. (2004). Gill raker morphology and feeding ecology of two sympatric morphs of European whitefish *Coregonus lavaretus*. *Ann. Zool. Fennici*, 41: 291-300.
- 10- Beveridge, M.C.M.; Briggs, M.R.P.; Northcott, M.E. and Ross, L.G. (1988). The occurrence, structure and development of microbranchiospines among the tilapias (Cichlidae: Tilapiini). *Canad. J. Zool.*, 66: 2564-2572.
- 11- Cheer, A.Y.; Ogami, Y. and Sanderson, S.L. (2001). Computational fluid dynamics in the oral cavity of ram suspension-feeding fishes. *J. Theor. Biol.*, 210: 463-474.
- 12- Delariva, R.L. and Agostinho, A.A. (2001). Relationship between morphology and diets of six Neotropical lorocariids. *J. Fish Biol.*, 58: 832-847.
- 13- Eiras-Stofella, D.R.; Charvet-Almeida, P.; Fanta, E. and Vianna, A.C.C.(2001). Surface ultrastructure of the gills of the mullets *Mugil curema*, *M. liza* and *M. platanus* (Mugilidae, Pisces). *J. Morphol.*, 247: 122–133.
- 14- Evans, D.H.; Piermarini, P.M. and Choe, K.P. (2005). The multifunctional fish gill: dominant site of gas exchange, osmoregulation, acid–base regulation, and excretion of nitrogenous waste. *Physiol. Rev.*, 85: 97–177.
- 15- Fugi, R.; Agostinho, A. A. and Hahn, N. S. (2001). Trophic morphology of five benthic-feeding fish species of a tropical floodplain. *Rev. Brasil. Biol.*, 61(1): 27-33.
- 16- Gibson, R.N. (1988). Development, morphometry and particle retention capability of the gill rakers in the herring *Clupea harengus* L. *J. Fish Biol.*, 32: 949-962.

- 17- Goodrich, J.S.; Sanderson, S.L.; Batjakas, I.E. and Kaufman, L.S. (2000). Branchial arches of suspension feeding *Oreochromis esculentus*: sieve or sticky filter. J. Fish Biol., 56: 858-875.
- 18- Hadi, R.A.M.; Al-Saboonchi, A.A. and Yousuf Haroon, A.K. (1984). Diatoms of the Shatt al-Arab River, Iraq. Nova Hedwigia, 39: 513-557.
- 19- Hjelm, J. and Johansson, F. (2003). Temporal variation in feeding morphology and size-structured population dynamics in fishes. Proc. Roy. Soc. London, Biol., 270: 1407-1412.
- 20- Hussain, N.A.; Mohamed, A.R.M.; Younis, K.H. and Mutlak, F.M. (2001). Biology of juveniles and immature *Acanthopagrus latus* in tidal pools of Khor Al-Zubair Lagoon, Iraq. Marina Mesopotamica, 16(1): 59-68.
- 21- Hussain, N.A.; Saoud, H.A. and Al-Shami, E.J. (2009). Specialization, competition and diet overlap of fish assemblages in the recently restored southern Iraqi marshes. Marsh Bulletin, 4(1): 21-35.
- 22- Hussain, N.A.; A.R.M. Mohamed; S.S. Al-Noor; B.W. Coad; F.M. Mutlak; I.M. Al-Sudani; A.J. Toman; Mojer, A.M and Abad, A. (2006). Species composition ecological indices, length frequencies and food habits of fish assemblages of the restored Southern Marshes. Annual report, Basrah University, Iraq, 114p.
- 23- Hynes, H.B.N. (1950). The food of freshwater sticklebacks (*Gasterosteus aculeatus*) and (*Pygosteus pungitius*) with a review of methods used in studies of food of fishes. J. Anim. Ecol., 19: 36-58.
- 24- Kumari, U.; Yashpal, M.; Mittal, S. and Mittal, A.K. (2009). Surface ultrastructure of gill arches and gill rakers in relation to feeding of an Indian major carp, *Cirrhinus mrigala*. Tissue and Cell, 41: 318–325.
- 25- Liston, J. (2005). The plasticity of gill raker characteristics in suspension feeders: Implications for Pachycormiformes. In: G. Arratia, H.-P. Schultze and M. V. H. Wilson (eds.) Mesozoic Fishes 5 – Global Diversity and Evolution: 121-143.
- 26- Mutlak, F.M. and Al-Faisal, A.J. (2009). A new record of two exotic cichlids fish *Oreochromis aureus* (Steindacher, 1864) and *Tilapia zilli* (Gervais, 1848) from south of the main outfall drain in Basrah city. Mesop. J. Mar. Sci., 24 (2): 160 – 170.
- 27- Peretti, D. and Andrian, I.F. (2008). Feeding and morphological analysis of the digestive tract of four species of fish (*Astyanax altiparanae*, *Parauchenipterus galeatus*, *Serrasalmus marginatus* and *Hoplias aff. malabaricus*) from the upper Paraná River floodplain, Brazil. Brazilian J. Biol., 68(3): 671-679.

- 28- Salman, N.A.; Al-Mahdawi, G.J. and Heba, H.M.A. (2005). Gill rakers morphometry and filtering mechanism in some marine teleosts from Red Sea coasts of Yemen. Egypt. J. Aquat. Res., 3(Special issue): 286-296.
- 29- Sanderson, S. L.; Mort, M. E. and Cech, J. J. (1998). Particle retention by non-suspension-feeding cyprinid fishes. Canad. J. Fish. Aquat. Sci. 55: 861-868.
- 30- Sanderson, S. L.; Cheer, A. Y.; Goodrich, J. S.; Graziano, J. D. and Callan W. T. (2001). Crossflow filtration in suspension-feeding fishes. Nature, 412: 439-441.
- 31- Shubar, A.J. and Al-Rudainy, A.J. (2012). Morphology of the digestive system in Gattan *Barbus xanthopterus* and grass carp *Ctenopharyngodon idella*. Proc. 11<sup>th</sup> Sci. Conf. Coll. Vet. Univ. Baghdad: 187-196.
- 32- Stergiou, K.I. (1988). Feeding habits of the Lessepsian migrant *Siganus luridus* in the eastern Mediterranean, its new environment. J. Fish Biol., 33: 531-543.
- 33- Taher, M.M. (2010). Specialization, trophic breadth and diet overlap of thirteen small marine fish species from Shatt Al-Basrah Canal, Southern Iraq. Marsh Bull., 5(2): 118-130.
- 34- Tanaka, H.; Aoki, I. and Ohshimo, S. (2006). Feeding habits and gill raker morphology of three planktivorous pelagic fish species off the coast of northern and western Kyushu in summer. J. Fish Biol., 68: 1041-1061.
- 35- Tengjaroenkul, B. (2000). Ontogenetic morphology and enzyme activities of the intestinal tract of the Nile tilapia *Oreochromis niloticus*. Ph.D. Dissertation. Virginia Polytechnic Institute and State University. U.S.A. 161p.
- 36- Wehr, J. D. and Sheath, R. G. (2003). Freshwater algae of North America, Ecology and classification. San Diego. Academic press. 918p.

## التغيرات الغذائية المرتبطة بالحجم وعلاقتها المظهرية في ثلاثة من أسماك المياه العذبة من شط العرب، البصرة، العراق

صلاح مهدي نجم\*، رجاء عبد علي المظفر و فرات قاسم جاسم

قسم الأسماك والثروة البحرية، كلية الزراعة، جامعة البصرة، البصرة، العراق

\*e-mail: salahm63@yahoo.com

**الخلاصة.** أجريت الدراسة الحالية لبحث العلاقات الممكنة بين القياسات المظهرية للأسنان الغلصمية والأمعاء والتغيرات المرتبطة بالحجم في التغذية في ثلاث أنواع متعايشة من أسماك المياه العذبة. جمع أجمالي 245 سمكة من الشانك *Acanthopagrus latus* والبلطي *Tilapia zilli* والبياح الأخضر *Liza subviridis* (73 و 90 و 82 سمكة من كل نوع ، على التوالي) من شط العرب بين أيلول 2010 وآب 2011. قسمت عينات كل نوع إلى ثلاث مجموعات حجم ممثلة لتسهيل متابعة التغيرات المرتبطة بالحجم. وأشارت نتائج تحليل الغذاء باستخدام دليل الأهمية النسبية IRI إلى وجود فروقات ملحوظة في عادات الغذاء ضمن الأنواع وفيما بينها حيث أظهرت أسماك الشانك نمطا مفترسا واضحا في التغذية. وكانت أسماك البلطي عاشبة فيما كانت أسماك البياح الأخضر متغذية على الهوائيم. وأنعكس نمط التغذية بوضوح على طول القوس الغلصمي وعدد الأسنان الغلصمية وطولها وعرضها. وتميزت أسماك البياح الأخضر بعدد أكبر (41-42) من الأسنان الغلصمية إضافة لطولها الأكبر (3.38-5.83 ملم) وعرضها الأقل (0.09-0.14) مقارنة بالأنواع الأخرين. وتفاوتت أيضا قيم الفسحة الغلصمية ومساحة الترشيح المحسوبة بين الأنواع ومجموعات الحجم انعكاسا للآليات التكوينية المميزة لأنماط التغذية. فقد كانت مساحة الترشيح أصغر (108.9-195.5 ملم<sup>2</sup>) في أسماك البياح الأخضر المتغذية على الهائمات، ومتوسطة (151.7-267.5 ملم<sup>2</sup>) في أسماك البلطي وأكبر (174.4-331.2 ملم<sup>2</sup>) في أسماك الشانك. وأظهر الطول النسبي للأمعاء اتجاها معاكسا حيث كان الأكبر (1.86-3.11) في أسماك البلطي ومتوسطا (1.89-2.51) في أسماك البياح الأخضر والأقل (0.9-1.06) في أسماك الشانك. وأظهرت كافة القياسات المظهرية المدروسة ارتباطات معقولة مع حجم الأسماك دالة على التحولات العمرية المحتملة في غذاء هذه الأنواع.