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Diet and trophic status of three cyprinids fish in the Shatt Al-Arab River, Iraq

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Abstract: *Diet composition and feeding relationships of three cyprinid species, C. luteus, C. carpio and C. auratus from the Shatt Al-Arab River, Iraq, were assessed during 2016-2017. Fish were collected by gill nets, cast net and electro-fishing. The index of relative importance (IRI%) of food item was determined by combined the frequency of occurrence and points methods. There were monthly variations in feeding activity and intensity of all species, which decreased in the colder months. All species were omnivorous and C. carpio was a low specialized feeder, while C. auratus and C. luteus were generalized feeders. The diet of C. luteus primarily comprised algae (24.3%), aquatic insects (23.0%), macrophytes (21.6%), detritus (10.9%), diatoms (9.9%) and snails (8.0%). the diet of C. carpio was comprised of aquatic insects (37.8%), followed by macrophytes (19.0%), snails (17.2%), detritus (9.8%) and fish (7.1%). C. auratus fed on aquatic insects (28.9%), followed by macrophytes (26.2%), algae (12.8%), detritus (12.4%), zooplankton (6.0%), diatoms (5.8%) and snails (5.5%). The diet of the C. auratus was more close to that of C. luteus (S%= 0.75) compared to C. carpio (S%= 0.50). It means that these fish species are in competition for food items in the Shatt Al-Arab River. The diet of the C. auratus was more similar to that of C. luteus (S%= 0.75) compared to C. carpio (S%= 0.50). It means that these species are in competition for food in the Shatt Al-Arab River.*
Key words: *Cyprinids fish, food habit, omnivorous, Shatt Al-Arab River, Iraq*

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I. Introduction

The family Cyprinidae is one of the most important families of fish with 376 genera and some 3,148 valid species (Eschmeyer and Fong, 2018), distributed throughout the world in almost every type of waters; small streams, rivers, lakes and pools in North America, Eurasia and Africa (Coad, 2010). It is the most important and dominant family of fish in the freshwater systems of Iraq, ca. 72% of native fish (Coad, 2010).

The cyprinid fish *Carasobarbus luteus* (Heckel, 1843), which is called himri in Iraq, is endemic and widely distributed in the rivers Tigris and Euphrates and adjacent drainage basins (Coad, 2010). This fish is considered one of the most important species for artisanal fisheries and is consumed domestically as fresh fish. FAO/UN (1966) reported that the total landing of *C. luteus* was five tons, constituted 43.6% from the total fish landings at seven main wholesale markets in Iraq during 1965. Mohamed *et al.* (2008) mentioned that the *C. luteus* represented 8.6% of the total fish landing in the artisanal fishery of Swab river which is part from Al- Huwazah marsh, Iraq during 2005. Hussian *et al.* (1989) stated that *C. luteus* occupied the second most abundant species in the Shatt Al-Arab River during 1982-1983, comprised 4.3% of the total fish catch.

The common carp (*Cyprinus carpio* Linnaeus, 1758) are native to temperate portions of Europe and Asia. It has been widely introduced to other parts of the world; North America, southern Africa, New Zealand, Australia and Asia (Woynarovich and Horvath, 1980; Kottelat and Freyhof, 2007). Carp is a non-native species in Iraq and was first brought in 1955 from Indonesia and Netherland to cultivated in fish ponds in Baghdad, later in 1960 this species was introduced into Tharthar, Habbaniya and Hammar lakes (Al-Hamed, 1966). Since that this species become one of the most widely distributed fish species in various water bodies of Iraq (Coad, 2010). Al-Hassan *et al.* (1989) reported the presence of *C. carpio* in the Shatt Al-Arab River.

The silver crucian carp *Carassius auratus* (Linnaeus, 1758), a cyprinid native to Eastern Asia, is an example of a non-indigenous fish species that has successfully established populations throughout Europe, North and South America, New Zealand and Australia (Lorenzoni *et al*., 2010). Al-Nasiri and Shamsul Hoda (1976) listed the freshwater fish species of Iraq and referred to the presence of *C. auratus*, this species is now well established in the Shatt Al-Arab River and dominated the fish assemblage in the river, constituting 20.8, 23.7 and 13.24% of the total catch during 2010, 2012 and 2016, respectively (Mohamed *et al*., 2012, 2015; Mohamed and Abood, 2017).

Knowledge on the food, feeding habits and trophic interrelationships of fish is essential to understand the life history of fish including growth, behavior, reproduction, migration and other vital activities of fish, and also help to understand the predicted changes on ecosystem due to natural or anthropogenic interventions (Priyadharsini *et al.,* 2012; Sajeevan and Kurup, 2013).

Studies on the food habit of *C. luteus, C. carpio* and *C. auratus* have been made by many workers at different water bodies of Iraq; about *C. luteus* (Barak and Mohamed, 1982; Al-Rudainy, 1989; Saud, 2004; Hussain *et al.*, 2008; Lazem, 2009; Maktoof , 2013; Wahab, 2013; Mohamed, 2014; Abdullah, 2015; Mohamed *et al*., 2015), about *C. carpio* (Saud, 2004; Al-Shamma'a *et al.*, 2006; Hussain *et al.*, 2009; Mohamed and Hussain, 2012; Nasir and Farnar, 2014) and about *C. auratus* (Saud, 2004; Hussain *et al.*, 2008; Al-Shamma'a *et al.*, 2009; Lazem, 2009; Mohamed and Hussain, 2012; Wahab, 2013; Mohamed *et al*., 2015).

During the last years, the Shatt Al-Arab River has been suffered from the deterioration of the water quality due to series of anthropogenic activities such as agricultural runoff wastes and untreated wastewater, invasion of fish species and seawater intrusion as a result of drastically reduced in water quantity and quality related to the decline in rates of the flow from the Tigris, Euphrates and Karun Rivers (Al-Tawash *et al.,* 2013; Brandimarte *et al.*, 2015; Yaseen *et al*., 2016). Therefore, the present work is designed to described the diet and trophic status of *C. luteus, C. carpio* and *C. auratus* in the Shatt Al-Arab River under this circumstance.

II. Materials and Methods

The study was conducted in the Shatt Al-Arab River, in the southern of Iraq. The river forms from the confluence of the Tigris and Euphrates rivers at Al-Qurna town northern Basra Governorate, and flows to southeastern direction towards the Arabian Gulf (Fig. 1). It is about 204 km, and varies in width from 250 m at Al-Qurna to more than 1,500 m at the estuary. The River is affected by the tidal current of the Gulf. Field samplings were carried out monthly from the three sites on the river during November 2015- October 2016. Site 1 (upstream) is located near Al-Dair Bridge, site 2 (midstream) is sited in Abu Al-Khasib district and site 3 (downstream) is located north Al-Fao town (Fig. 1).

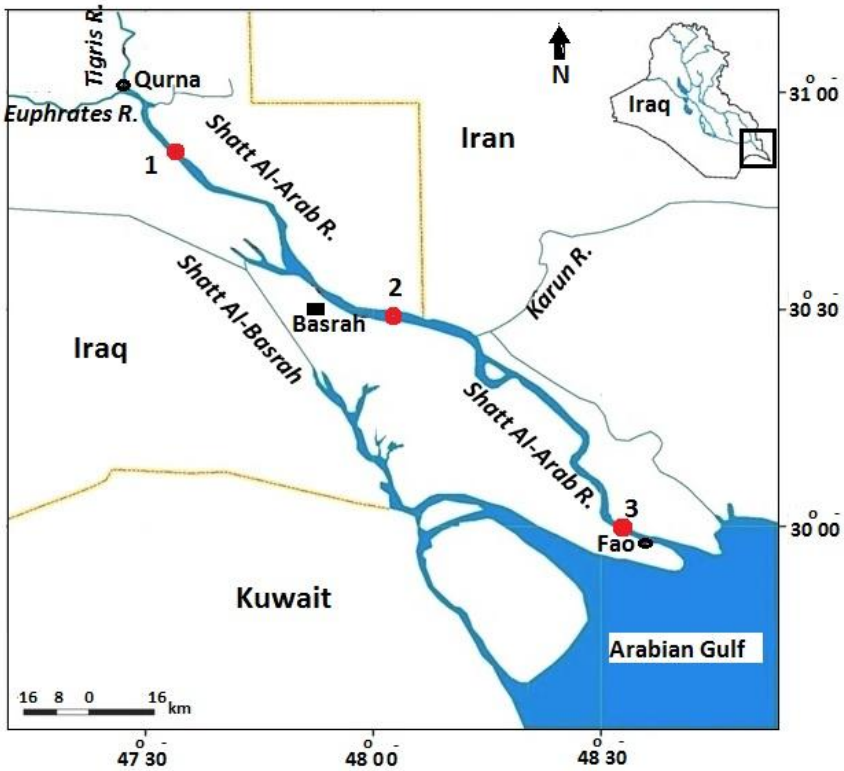

Fig. 1. Map of Shatt Al-Arab River with locations of study sites.

Fish were collected from each site by gill nets (200-500 m length with 15- 35 mm mesh size), cast net (9 m diameter with 15x15 mm mesh size) and electro-fishing by generator engine (provides 300-400V and 10A). Fish were classified to species following Coad (2010). After capture, the fish were preserved in crashed ice prior to dissection in the laboratory. Some relevant ecological factors were determined in situ namely, water temperatures and salinity.

Fish were measured for total length (TL, mm) and weight (W, g), then dissected ventrally to extract the digestive tract and adopted the first third of the intestine to study their food contents. The fullness index was estimated on a 0-20 points scale (Hynes, 1950). Thus 0, 5, 10, 15 and 20 points were allotted to: empty, ¼ full, ½ full, ¾ full and fully stomach, respectively. Diet contents were examined under stereoscopic and optical microscopes, and the food items were identified to the lowest possible taxonomic level. Diet contents were identified according to Edmondson (1959) and Hadi *et al.*, (1984). Feeding intensity and feeding activity for each monthly sample were calculated after Dipper *et al*., (1977) and Gordon (1977), respectively. The feeding index was determined after Sarkar and Deepak (2009). The vacuity index was calculated as the number of empty stomachs divided by the number of stomachs analyzed (Maia *et al*., 2006).

The presence of each food item was presented by a percentage by weighted points (P%), calculated from the sum of points given for each food item divided by the total number of points. Estimation of the occurrence of the different food organisms in each specimen was presented by the percentage occurrence (O%) calculated from the number of guts which contain the organism in question out of the total number of fish examined (Hyslop, 1980). The importance of food item was determined by combined the two methods to calculate the index of relative importance (IRI%) of Stergion (1988) as follows:

$$IRI= O\% \times P\% \quad \text{and} \quad IRI \%= IRI / \Sigma IRI * 100$$

The trophic niche breadth for each species was calculated according to the formula proposed by Levins (1968):

$$B= 1/\Sigma P_i{}^{\wedge 2}$$

where, B is Levins index of niche breadth and P_i is proportion of food group (i) in the diet. To standardize niche breadth on a scale from 0 to 1, the modification suggested by (Krebs, 1989) was adopted as follows:

$$B_A = (B-1)/ (n-1)$$

where, B_A is Levins standardized niche breadth, B is Levins index of niche breadth and n is number of food groups for each species. This index was used to test the feeding specialization of each species. The highly specialized feeders species fall within the range of 0.0-0.25, while the low specialized feeders between 0.26-0.49 and non-specialized (generalized) feeders are within the range of 0.50-1.0.

The similarity and the dietary overlap among diets of fish in Shatt Al-Arab River also were evaluated using cluster analyses for food items that represented more than 10% relative importance were considered major items in the diet of each species and according to the method described by Blackith and Reyment (1971). Clustering was performed according to Jaccard similarity index using SPSS software (ver. 22) statistical package.

III. Results

Feeding activity and feeding intensity

A total of 1171 individuals from the three species in the Shatt Al-Arab River were examined: *C. luteus* (TL= 95-220 mm, n= 256), *C. auratus* (TL= 50-223 mm, n= 576) and *C. carpio* (TL= 38-685 mm, n= 339). Figure (2) illustrates monthly variations in the feeding activity of *C. luteus*, *C. auratus* and *C. carpio* in the river. It is clear that these species were active in feeding round the year and never cease feeding, but variations in feeding activity were notable. The feeding activity of *C. luteus* ranged from 81.5% in September to 100% in April, *C. auratus* fluctuated from 83.7% in March to 98.2% in June and *C. carpio* varied from 77.5% in February to 100% in December, March to May.

Monthly changes in the feeding intensity of *C. luteus*, *C. auratus* and *C. carpio* in the river are given in Figure (2). The feeding intensity of *C. luteus* ranged from 81.5% in September to 100% in April, *C. auratus* fluctuated from 83.7% in March to 98.2% in June and *C. carpio* varied from 77.5% in February to 100% in December, March to May. However, the feeding intensity of *C. luteus* ranged from 9.3 point/fish in November to 15.7 point/fish in June, *C. auratus* varied from 8.1 point/fish in December to 15.0 point/fish in July and *C. carpio* changed from 12.5 point/fish in December to 17.5 point/fish in July.

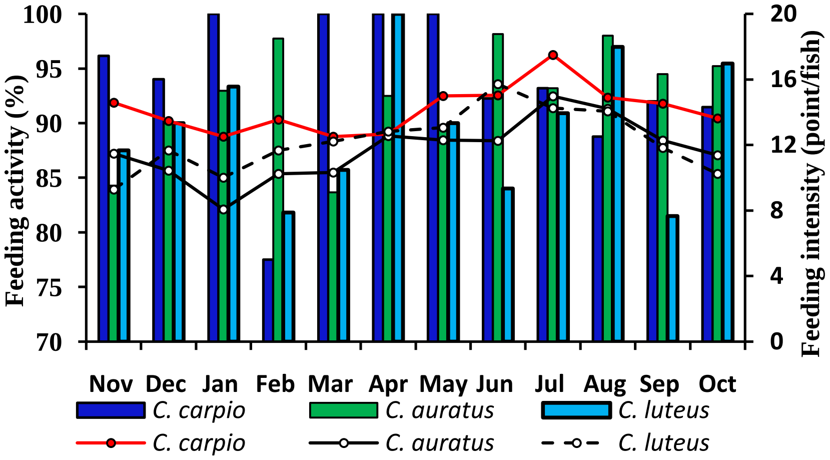

Fig. 2. Monthly variations in feeding intensity and activity of the studied species

Feeding and vacuity indices

Figure (3) shows monthly variations in the feeding and vacuity indices of *C. luteus*, *C. auratus* and *C. carpio* in the river. The feeding index of *C. luteus* varied from 46.4% in November to 78.6% in June, *C. auratus* changed from 40.4% in January to 74.9% in July, and *C. carpio* ranged from 62.5% in January and March to 87.5% in July. The overall values were 61.2%, 58.5% and 70.8% for *C. luteus*, *C. auratus* and *C. carpio*, respectively. While, the vacuity index of *C. luteus* fluctuated from 0% in April to 18.5% in September, *C. auratus* varied from 1.9% in June to 16.4% in March, and *C. carpio* changed from 0% in January, March, April and May to 22.5% in February (Fig. 3). The overall values of vacuity index for the three species were 10.2%, 7.5% and 6.2%, respectively.

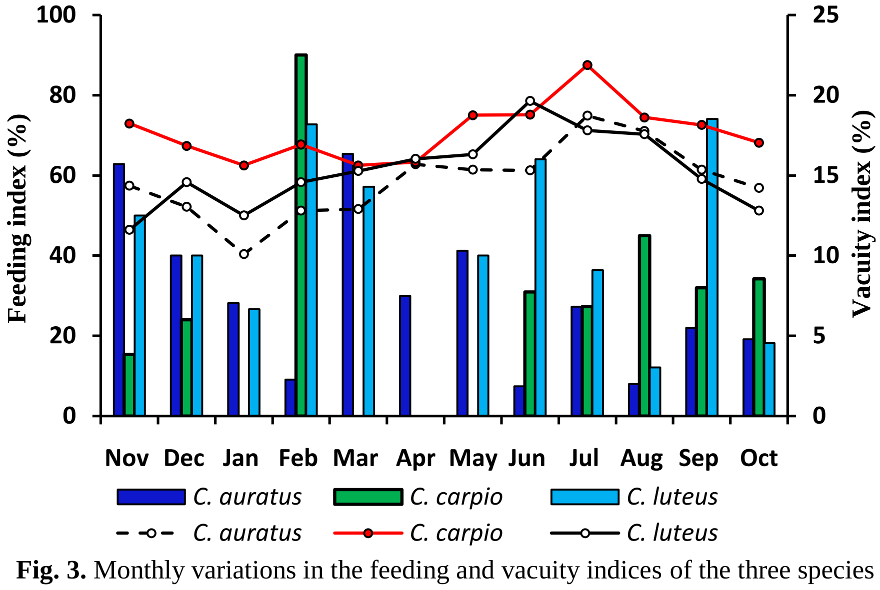

Fig. 3. Monthly variations in the feeding and vacuity indices of the three species

Seasonal variation in diet composition

The monthly data of the food components of each species were pooled to describe the seasonal variations in the food habits of the fish species. Seasonal changes in indices of relative importance (IRI) of various ingested food items which represented more than 5% relative importance were considered to be major items in the diet of each species are shown in Figure 4. Algae came first position in order of relative importance in diet of *C. luteus*, and varied from 12.5% in autumn to 34.9% in summer. Aquatic insects occupied the second position and ranged from 17.4% in summer to 33.4% in spring. Macrophytes were occupying the third position and ranged from 12.5% in spring to 33.4% in autumn. The contribution of detritus in the diet fluctuated from 9.7% in spring to 13.4% in autumn. Diatoms occupied the fifth position in diet of *C. luteus* and ranged between 0.8% in summer and 23.1% in winter. The contribution of snails in the diet fluctuated from 0.5% in winter to 14.7% in autumn. The overall diet composition of *C. luteus* was comprised of algae (24.3%), aquatic insects (23.0%), macrophytes (21.6%), detritus (10.9%), diatoms (9.9%) and snails (8.0%).

Aquatic insects occupied the first position in order of relative importance in diet of *C. auratus*, and the percentage contribution ranged between 16.2% in winter and 42.5% in spring (Fig. 4). Macrophytes were occupying the second position and ranged from 17.0% in spring to 34.2% in autumn. Algae came third and fluctuated from 7.9% in summer to 19.3% in winter. The proportion of detritus in the diet varied from 9.8% in summer to 16.8% in winter. Zooplankton occupied the fifth position in dietary importance and varied from 0.2% in summer to 11.4% in spring. Diatoms and snails made up their highest contributions in winter (12.1%) and summer (15.4%), respectively. In general, *C. auratus* fed on aquatic insects (28.9%), followed by macrophytes (26.2%), algae (12.8%), detritus (12.4%), zooplankton (6.0%), diatoms (5.8%) and snails (5.5%).

The percentage contribution of aquatic insects in diet of *C. carpio* ranged between 27.7% in winter and 49.4% in summer (Fig. 4). Macrophytes occupied the second position and ranged from 9.8% in spring to 29.3% in autumn. Snails came third and varied from 9.8% in winter to 23.6% in spring. The contribution of detritus in the diet fluctuated from 8.4% in spring to 11.3% in autumn. Fish as food item in the diet of *C. carpio* ranged from 1.3% in summer to 18.4% in winter. Generally, the diet of *C. carpio* was comprised of aquatic insects (37.8%), followed by macrophytes (19.0%), snails (17.2%), detritus (9.8%) and fish (7.1%).

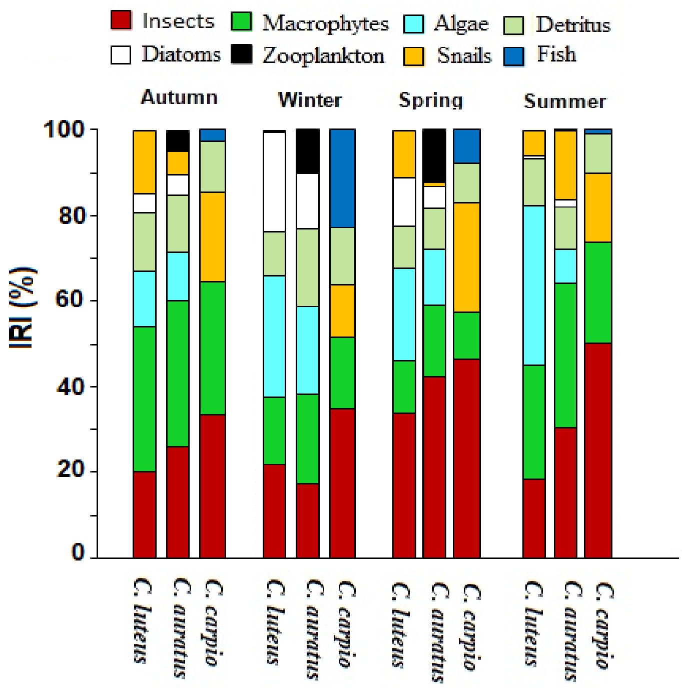

Fig. 4. Seasonal changes in the relative importance index (IRI%) of food items of the three species

Feeding selectivity and specialization

Table 1 shows the percentages of the feeding selectivity index for the different food items of *C. luteus*, *C. auratus* and *C. carpio* in the Shatt Al-Arab. Aquatic insects recorded the highest value of the index (33.4%) with the maximum value (45.4%) for *C. auratus*, followed by macrophytes (21.5%) with the highest value (51.8%) for *C. auratus*. Snails ranked third with 13.5% and the maximum value (50.4%) for *C. carpio*. Algae came fourth with 10.3% with the highest value (48.8%) for *C. auratus*. Detritus ranked fifth by 9.3% and the maximum value (54.3%) for *C. auratus*. The diatoms ranked sixth with 3.9%, followed by zooplanktons (3.4%), fish (2.8%), fish eggs (1.5%) and shrimps (0.5%).

Table 1. Feeding selectivity index for the different food items of the three species

	Insects	Macro-phytes	Snails	Algae	Detritus	Diatoms	Zoopl-ankton	Fish	Fish eggs	Shrimps
Species	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**	**%**
C. luteus	15.7	18.6	17.6	42.7	18.9	38.3	4.2	23.5	8.8	-
C.	45.4	51.8	32	48.8	54.3	56.8	86.7	14.3	85.1	-
C. carpio	38.8	29.6	50.4	8.5	26.8	4.9	9.1	62.2	6	100
Mean	33.4	21.5	13.5	10.3	9.3	3.9	3.4	2.8	1.5	0.5

The feeding selectivity index according to the nature source of the food components for *C. luteus*, *C. auratus* and *C. carpio* in the Shatt al-Arab included animal origin (73.0%), plant origin (18.4%) and detritus (8.6%). The values of the index for animal food items were 63.0% for *C. luteus,* 70.9% for *C. auratus* and 85.2% for *C. carpio*, whereas, for plant food items were 8.3% for *C. carpio*, 18.8% for *C. auratus* and 28.1% for *C. luteus*. The feeding selectivity index for detritus was 6.5% for *C. Carpio*, 8.9% for *C. luteus* and 10.3% for *C. auratus*.

The results of feeding specialization for the three species showed that the index of Levins standardized niche breadth for *C. carpio* was low (B_i = 0.380), which indicates that this species is a low specialist feeder, while *C. luteus* and *C. auratus* were considered non-specialized feeders (B_i = 0.543 and 0.523, respectively).

Food similarity

Similarity dendrogram among fish species based on their diet is presented in Figure 5. Two main groups could be distinguished, group I with a similarity level (0.75) was comprised of *C. auratus* and *C. luteus*. This group is characterized by a high intake of insects, macrophytes, algae and detritus. Group II with a similarity level (0.50) was included *C. carpio*, which fed mainly on insects, macrophytes, snails, detritus and fish.

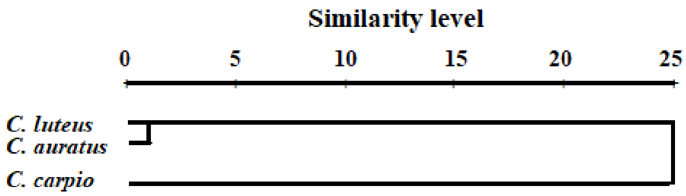

Fig. 5. Similarity dendrogram among some fish species based on their diet

IV. Discussion

This study has demonstrated that *C. luteus, C. auratus* and *C. carpio* are continuous feeders and never cease feeding all the year round, despite notable monthly fluctuations in feeding activities and intensities. Higher values in feeding intensity and feeding activity, recorded in warm periods of the year were coincided with rise in ambient water temperature. Water temperature is one of the most important environmental variables affecting the distribution and abundance of different species of fish, and the feeding activity and food consumption are affected by temperature due to lower temperature than ideal limits (Chorbley, 2011) . This finding agreed with the previous dietary studies on these species, such as Rybczyk (2006) and Al-Shamma'a (2011) on *C. auratus*; Maktoof (2013) on *C. luteus*; Hussein *et al.* (2000) and Shukla and Patel (2013) on *C. carpio*.

Based on dietary composition results, *C. luteus*, *C. auratus* and *C. carpio* can be considered as omnivores, but *C. carpio* was a low specialized feeder, while *C. luteus* and *C. auratus* were a dietary generalized feeders. Hussain *et al.* (2009) found that *C. auratus* individuals were low specialization feeders in East Hammar and Huwayza marshes and generalized feeders in Suq Al-Shuyaok marsh, whereas *C. luteus* individuals were low specialized feeders in Huwayza and Suq Al-Shuyaok marshes and generalized feeders in East Hammar marsh, while *C. carpio* is generalized feeder in the three marshes. Mohamed *et al.* (2015) stated that *C. auratus* and *C. luteus* individuals were generalized feeders in East Hammar marsh.

The results exhibited that the *C. luteus* in the present study was omnivorous, and tend to has 55.8% plant components compared with 33.4% for the animal components. This finding is in agreement with the findings of several studies. Al-Rudainy (1989) found that *C. luteus* fed on macrophytes (21.9), algae (20.0%), molluscs (14.2%), crustaceans (13.5%), aquatic insect (13.1%) in Hammar marsh. Abdullah (2015) stated that *C. luteus* consumed algae (34.4%), macrophytes (30.9), crustaceans (10.5%), zooplankton (6.6%) and aquatic insects (6.4%) in Shatt Al-Arab River. Mohamed *et al*. (2015) stated that macrophytes (22.3), algae (19.8%), crustaceans (15.9%), aquatic insects (13.8%), snails (12.8%) and diatoms (7.3%) were apparent in the gut of *C. luteus* in East Hamma marsh. Moreover, the studies of Pazira and Vatandost (2008) and Baboli *et al*. (2013) concluded that *C. luteus* were omnivorous fish in the Dalaki and Helle Rivers, India and in Karkheh River, Iran respectively, and consumed a wide range of food items of plant, animal and detritus origins.

In contrast, several authors have been reported that *C. luteus* was herbivores species in different Iraqi waters. Barak and Mohamed (1982) stated that *C. luteus* consumed mainly macrophytes (63.8%) and algae (12.6%) in Qarmat Ali marsh. Saud (2004) found that *C. luteus* fed on macrophytes (62.1%) and algae (34.7%) in the Qarmat Ali River. Hussain *et al.* (2008) mentioned that *C. luteus* fed on algae (48.1%), macrophytes (32.2%) and aquatic insect (8.3%) in the southern marshes of Iraq. Lazem (2009) stated that *C. luteus* consumed algae (63.6%), aquatic insect (16.1%), diatoms (13.2%) and macrophytes (6.4%) in Qarmat Ali River. Maktoof (2013) stated that macrophytes (70.7%), algae (14.2%) and detritus (6.1%) were apparent in the gut of

C. luteus in Main Outfall Drain, Al-Nassiriya, Iraq. Wahab (2013) stated that *C. luteus* fed mainly on algae (55.0%), macrophytes (25.6%) and detritus (6.1%) in Tigris River. Mohamed (2014) found that *C. luteus* consumed algae (46.6%), diatoms (22.1%), zooplankton (10.6%) and macrophytes (10.5%) in Huwazah marsh.

Most previous studies have concluded that the *C. auratus* was omnivorous and consumed a wide range of food items of plant and animal origins. Saud (2004) found that *C. auratus* has been considered as omnivores fish in the Qarmat Ali River, fed on algae (42.4%), macrophytes (24.3), aquatic insect (16.3%) and detritus (15.5%). Al-Shamma'a *et al.* (2009) stated that *C. auratus* consumed detritus (48.0%), algae (10.6%), macrophytes (10.4%), and zooplankton (10.1%) in Euphrates River, Iraq. Moreover, Hussain *et al.* (2008) mentioned that *C. auratus* fed on algae (46.6%), macrophytes (17.9), detritus (17.8%), aquatic insect (12.3%) and crustacean (3.8%) in the southern marshes of Iraq. Mohamed *et al*. (2015) stated that algae (19.7%), crustacean (18.0%), macrophytes (16.3%), zooplankton (13.8%), aquatic insect (13.3%), snails (10.4%) and diatoms (7.6%) were apparent in the gut of *C. auratus* in East Hamma marsh, Iraq. Wahab (2013) reported that *C. auratus* in Tigris River, Iraq fed on detritus (39.1%), macrophytes (27.8), algae (9.8%), crustacean (5.4%) and aquatic insect (13.3%).

Other studies indicated that *C. auratus* was herbivorous species, Lazem (2009) found that *C. auratus* fed on algae (53.9%), followed by macrophytes (20.9%), detritus (13.1%) and diatoms (6.1%) in the Qarmat Ali River. Also, Al-Noor (2010) mentioned that this species consumed mainly diatoms (60.0%), followed by algae (25.0%) and zooplankton (15.0%) in East Hammar marsh. Mohamed and Hussain (2012) found that the diet of *C. auratus* in East Hammar marsh consisted of algae (46.0%) and diatoms (25.5%). Moreover, Rybczyk (2006) found that the highest contributions of the food items of *C. auratus* in Polish waters were those of ostracods (13.31%) and cladocera (*Bosmina*, 10.9%, *Leptodora*, 10.3% and *Daphnia*, 10.2%).

The present study revealed that the *C. carpio* was omnivorous in its diet, fed mainly on aquatic insects, macrophytes (macrophytes) and snails. The omnivorous feeding habit for *C. carpio* has been noticed in many Iraqi waters. Saud (2004) found that *C. carpio* fed mainly on snails (65.1%) and detritus (27.8%) in the Qarmat Ali River. Al-Shamma'a *et al.* (2006) mentioned that the diet of this species in the Haditha Dam was consisted of macrophytes (25.7%), detritus (24.3%), molluscs (21.3%) and aquatic insects (14.0%). Hussain *et al*. (2009) stated that *C. carpio* fed mostly on crustacean (34.4%), detritus (30.0%) and snails (25.8%) in southern marshes. Mohamed and Hussain (2012) reported that the species in East Hammar marsh fed on algae (25.5%), snails (18.2%), zooplankton (12.7%) and diatoms (12.7%). Nasir and Farnar (2014) found that *C. carpio* fed mainly on algae (26.6%), followed by zooplankton (20.1%) and crustaceans (10.2%) in the Shatt Al-Arab River.

C. carpio was found to be omnivorous in its feeding habits elsewhere, consumed a wide range of food items of plant and animal origins (Saikia and Das, 2008; Ali *et al.,* 2010; Dadebo *et al*., 2015). Saikia and Das (2008) reported that the gut contents of *C. carpio* in Indian lakes largely contain algae, zooplankton (Cladocera, Copepoda, Rotifera), benthic organisms (Diptera mainly Chironomidae larvae), detritus and mud. Ali *et al.* (2010) shown that the food items of *C. carpio* consist of zooplankton, phytoplankton and benthic organisms were apparent in the gut of *C. carpio* from Hirfanli Dam, Turkey. Dadebo *et al*. (2015) reported that the most important food items in the gut of *C. carpio* from Lake Koka, Ethiopia were detritus, insects, macrophytes, algae and diatoms and zooplankton. However, some previous studies indicated that *C. carpio* was carnivorous species, the most important prey types for the species were molluscs and crustaceans in the Hammar marsh (Al-Kanaani, 1989; Al-Rudauny, 1989), and in the Shatt Al-Arab River (Hussain *et al*., 1992).

It is well known that the feeding and trophic relationships of fish change with availability of food, locality and spatial distribution within the habitat (Bagenal, 1978; Mohamed and Hussain, 2012). Also, it is a widely accepted generalization that stream fish are mostly opportunistic in their feeding habits because of the highly variable nature of habitat and resources (Johnson and Arunachalam, 2012).

Analysis of food similarity between the three species showed that there was a high similarity between species, especially between *C. auratus* and *C. luteus*, which fed mostly on insects, macrophytes, algae and detritus. The diet of the *C. luteus* was more close to that of *C. auratus* compared to *C. carpio*. When comparing the overall feeding patterns of the three species, *C. carpio* is characterized by a high intake of food items of animal origin than the other. It means that these species are in competition for food in the Shatt Al-Arab River. This finding agreed with the previous dietary studies on these species in various Iraqi waters (Saud, 2004; Wahab, 2013; Lazem, 2009; Abdullah, 2015; Mohamed *et al*., 2015).

Established populations of exotic fish can alter energy flow through a system either by filling vacant ecological niches or competing with native fish as well as having considerable impacts on conservation and restoration of native biodiversity (Scott et al. 2003).

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