

THE DIET AND FEEDING HABITS OF *LEUCISCUS VORAX* FISH IN THE MAIN OUTFALL DRAIN MIDDLE IRAQ

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ABSTRACT

A total of 58 *Leuciscus vorax* samples were collected from the Main Outfall Drain, inside the borders of the central Iraqi province of Al-Qadisiyah, throughout the extended period from the beginning of January to the end of December 2022. Several traditional fishing methods were adopted. The results indicated that the males ratio were 44.83% (26 individuals) of the total number, while the females were 55.17% (32 individuals), with the total gender ratio that was 1:1.23. Results indicated that the highest food activity was observed from August to November. The lowest was in February and December, at a level of 75. It was noted that the highest level of feed density was in October (14.71) and the lowest was in December (11). Fish ranked first in the overall importance of nutrients for *L. vorax* species during the study phases, with 52.97% for fish less than 20 cm long and 95.93% for individuals longer than 20 cm. The study concluded that *L. vorax* was predatory in its feeding behavior, with variations in food items consumed depending on the length of the fish.

Keywords: nutrition, *Leuciscus vorax*, the Third River.

الزیدی وباربسی

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نظم التغذية والسلوك الغذائي لأسماك *Leuciscus vorax* في المصب العام وسط العراق

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المستخلص:

تم جمع 58 عينة من اسماك *Leuciscus vorax* من منطقة المصب العام ضمن حدود محافظة القادسية وسط العراق. طوال المدة الممتدة من بداية كانون الثاني إلى نهاية كانون الأول 2022. وللحصول على العينات المختبرة تم اعتماد عدة طرائقاً للصيد التقليدي. أشارت النتائج إلى أن نسبة الذكور بلغت 44.83% (26 فرداً) من مجموع العدد الكلي الذي تم الحصول عليه. في حين كانت نسبة الإناث 55.17% (32 فرداً)، وكانت النسبة الكلية بين الجنسين 1:1.23 لصالح الاناث. بلغ أعلى نشاط للتغذية تمت ملاحظته اثناء المدة الممتدة من شهر اب إلى شهر تشرين الثاني. وكان أقلها في شهري كانون الاول وكانون الثاني، عند مستوى 75 فرداً. ولوحظ أن أعلى مستوى لكثافة التغذية كان في شهر تشرين الاول بمستوى بلغ 14.71، وأدنى مستوى كان في شهر كانون الأول مسجلاً قيمة قدرها 11. احتلت الأسماك المرتبة الأولى في مؤشر الأهمية النسبية للعناصر الغذائية اثناء مراحل الدراسة، إذ بلغت قيمة الأهمية النسبية لأسماك *L. vorax* التي يقل طولها عن 20 سم، 52.97% و 95.93% للأفراد ذات الأطوال الأكثر من 20 سم. خلصت الدراسة إلى أن سمكة *L. vorax* كانت مفترسة في سلوكها الغذائي، مع وجود اختلافات في المواد الغذائية المستهلكة تبعاً إلى أطوال تلك الأسماك.

الكلمات المفتاحية: التغذية، *Leuciscus vorax*، النهر الثالث.

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INTRODUCTION

Water bodies occupy large areas of Iraq, stretching from south to north, Iraq's internal waters cover an area of approximately 600-700 thousand hectares, of which natural lakes constitute an estimated 39%, dams and reservoirs 13.3%; as for rivers and their branches, they constitute 3.7%, and marshes constitute 44%. Besides, Iraq's southern border overlooks the Persian Gulf coast (7). Iraq is home to 53 native freshwater fish species and 20 exotic fish species (17). Local problems often cause damage at the level of biological organization, these problems include mismanaged fishing, overfishing, and the use of illegal fishing methods, and in addition, the construction of dams and reservoirs, along with other human activities, poses a significant threat to biodiversity and fish communities. These activities have affected inland waterways for many decades, leading to low water levels, slow water flow, and obstructing fish movement. Controlling the flow of river water leads to changes in the nature and depth of rivers and this alters the structure of fish communities and reduces their diversity (34, 7, 31). As a result, this instability causes a decrease in the fish population in communities (23,37). Researchers have conducted many studies on the growth of fish in different water bodies in Iraq (40, 8, 36, 10). Many of these studies have assessed the species of fish found in these areas, categorizing fish that are local, alien, and invasive to those environments. In the same way, many studies are about the quantity and quality of food in the guts of fish. Studying the feeding habits of coexisting species is important, since they show the potential to comprehend the suitable role that these fish play in the food chain. In addition, these studies also enable the identification of trophic overlap between fish species, a key factor in understanding the state of the fish community. Where fish populations often increase when food is available in sufficient quantities (6). *Leuciscus vorax* (*Aspius vorax*), is native freshwater fish species in Iraq, belonging to the family of Cyprinidae. It is also found in Syria and Iran (17). Many of the studies have focused on aspects of the key biology of *L. vorax* fish, due to the economic importance of this species. Besides, several

studies have looked at the relationship of height to the total weight of *L. vorax*. Oymak et al. (33) noted this species of fish while studying at Atatürk Dam on the Euphrates River, in Turkey. The greatest length for females resulted 86.3 cm at the age of nine years. As well, in a study conducted in the Shatt al-Basrah canal, Al-Dabical and Al-Daham (1) showed that the largest length of *L. vorax* was 104.11 cm. It is well known that the age groups of fish vary according to different characteristics of water bodies. Biro & Furesz (16) pointed out that the age of the fish reached 11 years in Lake Balaton. As for Epler et al. (21), they noticed that in the Lake Habbaniyah were six age groups, while in the Lake Tharthar there were seven age groups. They also found that this species reaches sexual maturity at the length of 47.2 cm in Habbaniyah Lake, whilst in Tharthar Lake it reaches maturity at 44.2 cm. Szyplula et al (41) confirmed that the largest length of this species of fish is 63.6 cm at seven years old in Tharthar Lake. As for Razzaza Lake, the greatest length found was 53 cm at the age of five years, while in Habbaniyah Lake, the biggest length found was 58.5 cm at the age of six years. The goal of this study was to clarify the food habits of *L. vorax* living in the Third River in central Iraq.

MATERIALS AND METHODS

The Main Outfall Drain (MOD) is also known as the Third River, it is a waterway situated between the Tigris and Euphrates rivers, that is technically used to drain agricultural activities from land on both sides of the river. The Third River, approximately 565 km long (3), flows from the city of Al-Shaklawiya, near the province of Baghdad (central Iraq), to the province of Basra in the south, passing through the provinces of Babylon, Al-Qadisiyah, and Dhi Qar. It is geographically divided into three sectors (northern, central, and southern). The most biologically vulnerable is the central part of the river, that is the part in which the study was carried out. The importance of this section of the river is because it is the only water source for the entire Hawr Ad Dalmaj Marsh (8). To conduct this study, two stations were selected in the middle section of this river, within Al-Qadisiyah province. Site 1 was located at 32°26'58.0" N, 45°06'17.3"E, which

represents the beginning of the river's entry into Al-Qadisiyah province. Site 2 was chosen at 32°11'12.5"N, 45°19'33.9"E. It is located in

front of the gate that supplies water to Hawr Ad Dalmaj Marsh (Figure 1)

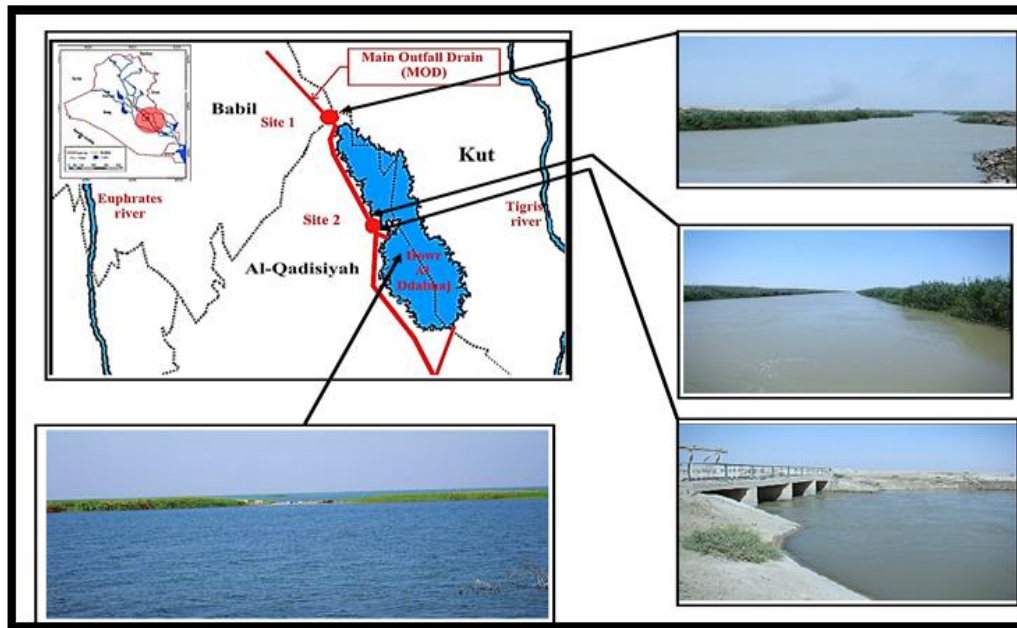


Figure 1. Map of the study area for Main Outfall Drain (MOD), with showed the two study sites (Site 1 and Site 2).

Throughout the study that ran from January 2022 to December 2022, fish were caught from both sites in the last third of each month. Several locally used fishing methods were relied upon, including net seine, and cast nets. Extracted fish samples were kept on crushed ice until they arrived at the laboratory. This is one of the best ways to keep the fish fresh. The total length and the rest of the studied morphological characteristics were measured, and the samples obtained were weighed. The data were then rounded to the nearest millimeter and milligram, according to the parameter considered. Sex ratios were calculated according to Krishnamurthy (27) by comparing the number of males and that of females captured during the study period.

$$X = M / F$$

Where: X = sex ratio; M = number of male fish; F = number of female fish

To analyze the components of food in the gut, a longitudinal incision was made in the side of the abdomen aligned with the spine. The intestines of *L. vorax* were then removed, excised and put in 5% formalin to preserve them until the tests were finished. Each stomach was assessed by giving it a fullness

score according to the point method (24). Its contents were then emptied recovering them into Petri dishes and classified using a microscope. Two methods were employed: the first method assigned points (P%) to each food item, while the second method assigned the frequency or occurrence (F%) of each food item. The value of the Index of Relative Importance (IRI) was evaluated according to Pinkas (35), and the Feeding Activity Rate (%) and Feeding Intensity Rate were estimated as described in Gordan (22). By visually observing the gonads, males and females were distinguished, since the male gonads (testicles) are white-colored, while the female gonads (ovaries) are granular and light yellow to orange in color (13).

RESULTS AND DISCUSSION

During the study period, a total of fifty-eight *L. vorax* fish were gathered from the two sites that were examined. There was a total of 35 individuals from the first station. Besides, 23 individuals from the second station. As shown in Figure 2, there was variation in the number of fish caught at the two stations during the study period.

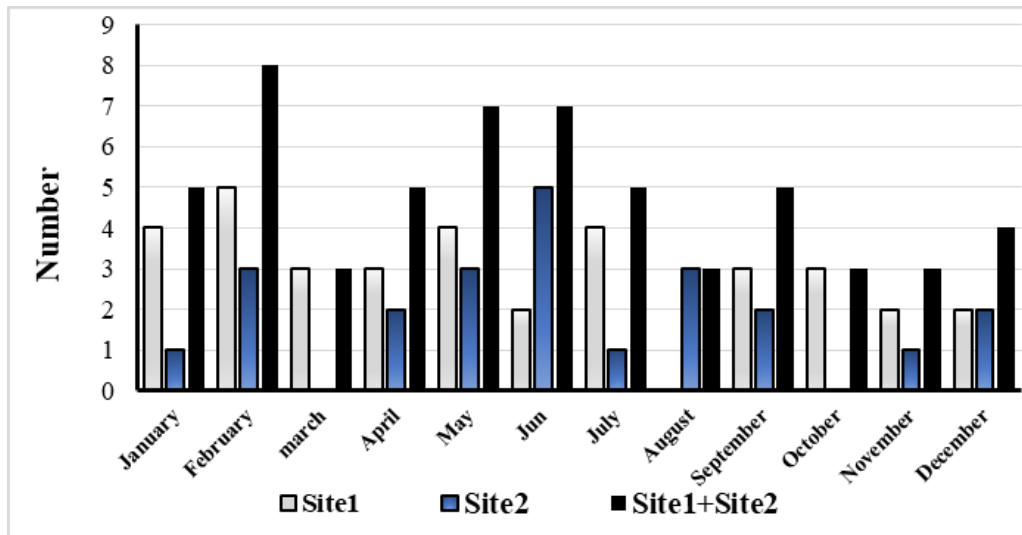


Figure 2. The number of monthly *L. vorax* fish caught in each station and the total number during the study period

The results showed that males account for 44.83% (26 individuals) of the total number and, consequently, females constitute 55.17% (32 individuals). With a total ratio between the two sexes of 1:1.23, as shown in Table (1).

There was a clear predominance of females during May with a value of 1:2.5, while the lowest value of this ratio was recorded in August, October, and November (1:0.5), as shows in Table (1).

Table 1. Number of males and females caught and sex ratio of *L. vorax*, from January-December 2022

Month	Number	Males		Female		Sex ratio	
		Number	%	Number	%	M:F	
January	5	2	40.00	3	60.00	1	1.5
February	8	3	37.50	5	62.50	1	1.67
march	3	1	33.33	2	66.67	1	2
April	5	2	40.00	3	60.00	1	1.5
May	7	2	28.57	5	71.43	1	2.5
Jun	7	3	42.86	4	57.14	1	1.33
July	5	2	40.00	3	60.00	1	1.5
August	3	2	66.67	1	33.33	1	0.5
September	5	2	40.00	3	60.00	1	1.5
October	3	2	66.67	1	33.33	1	0.5
November	3	2	66.67	1	33.33	1	0.5
December	4	3	75.00	1	25.00	1	0.33
summation	58	26	44.83	32	55.17	1	1.23

Sex ratio recorded during the current study period varied. Females were noticeably dominant and this was reflected in the total value of the sex ratio always in favor of females. Information on sex ratios forms a fundamental basis for understanding the relationship between individuals within the same species. It also indicates the reproductive capacity and status of fish communities (32, 9). The sex ratio can vary from the assumed 1:1 ratio from one species to another, alternatively this ratio can vary even for the

same species within the same fish community. It is recognized that this ratio can be affected by a series of determinants, such as the adaptation to society, the reproductive behavior, and the availability of food items, Besides environmental conditions (32, 4). The result achieved in this study may be due to potential bias in the fishing gear used. Behavior differences between sexes can increase the likelihood of one sex being captured sooner than the other (15, 28). The incidence of feeding activity, and feeding

intensity values of *L. vorax* species, were significantly different during the study period. The survey results showed that feeding activity was highest from August to November, as well as during the months of March, April, and June. The lowest value was recorded in February and December, which was 75.

Similarly, the feeding intensity of the studied stomachs varied significantly between the months. The highest level was recorded in October, and the lowest level was recorded in December, with values that reached 14.71 and 11, respectively (Table 2).

Table 2. Stomach content, Feeding Activity and Feeding Intensity of *L. vorax* caught and analysed during the study period

Month	Stomachs examined (n.)	Stomach containing food (n.)	Empty stomachs (n.)	Feeding activity	Feeding intensity
January	5	4	1	80	12.2
February	8	6	2	75	12.69
March	3	3	0	100	13.33
April	5	5	0	100	13.14
May	7	6	1	85.71	12.88
June	7	7	0	100	13.45
July	5	4	1	80	13.38
August	3	3	0	100	13.6
September	5	5	0	100	13.56
October	3	3	0	100	14.71
November	3	3	0	100	13.67
December	4	3	1	75	11

The main food components of the *L. vorax* diet include fish and algae and also aquatic insects, crustaceans, and molluscs. Fish, aquatic insects, and crustaceans had the highest Index of Relative Importance (IRI%). Fish ranked first in that index value, with a percentage of 52.97% for *L. vorax* which have lengths lesser than 20 cm, followed by aquatic insects (26.38%), then by crustaceans (19.47%), and then algae and molluscs (1.7% and 2.65%,

respectively), as shown in Table 3. As for *L. vorax* with a length more than 20 cm, an actual value of 95.93% for IRI was recorded. Significantly outperforming the rest of the nutrients recorded in the stomachs of these fish. While the Index of Relative Importance value for molluscs and crustaceans were similar, being 2.76% and 1.31%, respectively (Table 3).

Table 3. Points method values (P), frequency of occurrence (FO), and index of relative importance (IRI) for *L. vorax* fish during the study period

Food Item	Less than 20 cm			More than 20 cm		
	P	FO	IRI	P	FO	IRI
Algae	1.7	18.42	0.34	0	0	0
Plants and seeds	0	0	0	0	0	0
Diatoms	0	0	0	0	0	0
Organic crumbs	0	0	0	0	0	0
Aquatic insects	26.28	91.91	26.38	0	0	0
Crustaceans	19.47	92.71	19.55	4.1	27.87	1.31
Materials decomposing undiagnosed	0	0	0	0.13	0.82	0.001
Molluscs	2.65	26.32	0.75918	6.25	38.53	2.76
Fish	49.91	97.37	52.97	89.53	93.44	95.93

Results showed that the highest values recorded for feeding activity were during the months that tended to rise in temperature. So there seems to be a correlation between temperature and the intensity of feeding. Al-Kanani (4) concluded that there is a relationship between temperature and feeding

density in *Cyprinus carpio*, *Barbus xanthopterus*, and *Carasobarbus luteus*. Low feeding intensities during the winter may be attributed to the daily temperature, along with changes in food availability (42, 45, 46). Mohammed & Al-Khshali (30) also showed that food consumption increases with

increasing temperature until it reaches its ideal limit. Analysis of gut contents showed that *Leuciscus vorax* ate a limited range of food items, a result that reflects the limited availability of food items in the study area of MOD. Analysis of the stomach contents of *Leuciscus vorax* specimen whose length was less than 20 cm showed that the fish were eating limited foods of animal origin, such as fish, crustaceans, aquatic insects, and molluscs, with a very small percentage of foods of plant origin (algae), that did not exceed 0.34% in the Index of Relative Importance (Table 3). Thus, fish that fall within these length value can be considered carnivores. No food items of plant origins, such as aquatic plants and seeds, diatoms, and algae were recorded for fish with lengths that exceeded 20 cm. Instead, fish formed the main component of their diet, as indicated by the Index of Relative Importance, which recorded a value of 95.93%. Hence, the adult of *L. vorax* can be considered predatory. Das & Moitra (19) stated that the food item that is available for more than 75% of the food consumed is crucial for categorizing the eating habits of fish individuals. It seems that the expansion capacity of the oral cavity and the rapid prey-capture abilities of these fish have contributed significantly to the result observed in larger specimens of this species. Batty & Domenici (14) noted the position and size of the mouth in relation to the body often determines an individual's eating habits. The results obtained in this study are in line with those of previous research, suggesting that *L. vorax* juveniles showed a preference for the behavior of carnivores (39, 38, 12). The total percentage of total nutrients (except fish) in the diet of large species of *L. vorax* did not exceed 7%, a value that is close to the percentage obtained by Salman et al. (38) when studying the feeding of this species of fish in the AL- Hammar marsh. The findings state that there were no aquatic plants in the diet of large fish samples. This outcome contrasts with the conclusion reached by Wahab (43) when studied the nature of feeding this species in the Tuz Jay River, Iraq. He found that aquatic plants constitute 2.84% of the diet of *L. vorax*. These discrepancies may have due to the unavailability of these

nutrients in the study area (44, 2, 26). Fish feeding habits are mostly shaped by a wide variety of factors, including natural conditions, geographical location, water quality, and other factors (18, 20, 25, 5).

CONCLUSION

This study was carried out on the Third River, inside the borders of the central Iraqi province of Al-Qadisiyah. The results obtained showed the monthly changes in food selection and feeding habits of *L. vorax*. Fish less than 20 cm long were carnivores, while as for the fish that were more than 20 cm, they were considered predatory. In addition, the current study revealed that *L. vorax* species consumed more food in hot months, the peak feeding activity occurring in the period between August and November

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