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Variations in occurrence, abundance and diet of hilsa, *Tenualosa ilisha* larvae in the north of Shatt Al-Arab River, Basrah, Iraq

A. R. M. Mohamed, S. M. Ahmed., M. T. Al- Okailee*
Department of Fisheries and Marine Recourses, College of Agriculture, University of Basrah, Iraq
*Marine Science Centre, University of Basrah, Basrah, Iraq

Abstract. The larvae of hilsa, *Tenualosa ilisha* were surveyed from the northern part of Shatt Al-Arab River during January 2008 to June 2009. A total of 631 hilsa larvae (5.0-18.0 mm) were collected comprising 8.57% of the total fishes larvae collected. All hilsa larvae were collected during March-September with peak of abundant was in August. The lowest abundance of hilsa larvae was 80 larvae/10m² in March 2008 and the highest abundance was 2215 larvae/10m² in August. Water temperature ranged from 11.6 to 31.4 ^{o}C, salinity varied from 1.9 ‰ to 3.1 ‰ and water transparency ranged from 33 cm to 104 cm. The overall diet of hilsa larvae consisted mainly of adult and larvae copepod (55.7 %), cladocera (27.3 %) and organic detritus (17.0 %). According to Castello plot, the larvae of *T. ilisha* were a generalist feeder. The results indicated that the northern part of the Shatt Al-Arab River is a spawning and nursery ground for larvae of this species.

Key words: Hilsa shad, larvae, abundance, Shatt Al-Arab, Iraq.

Introduction

The Indian shad, *Tenualosa ilisha,* belongs to the family Clupeidae (herring family). The scientific name of the species, *Hilsa ilisha* has been revised recently to *Tenualosa ilisha* (16), but the popular name "hilsa" has been used for more than a century. The hilsa shad (*Tenualosa ilisha*), locally known as 'sbour' in Iraq and the region is an important migratory species in the Indo-West Pacific region, belongs to the subfamily Alosinae of the family Clupeidae. Its geographical distribution extends from the Arabian Gulf, along the coast of Pakistan, India, Bangladesh, and Burma to South Vietnam (33). The normal habitat of hilsa is the lower regions of the estuaries and the foreshore areas. During the breeding season they ascend the rivers and after spawning return to the original habitat where they remain until the next breeding season (44).

Survey of the published literature on the river shad, *Tanualosa ilisha* has been carried out by several authors (21; 29; 3; 22; 4; 11).

The hilsa shad fishery is by far the largest single species fishery in Iraq, ascending from the marine waters of the Arabian Gulf to the upper reaches of the Shatt Al-Arab River and Khor Al-Zubair to reproduction during the period March to August, coincided with the spring flooding of the Tigris and Euphrates Rivers (22). Recently, (2) reviewed the total hilsa landings from Iraqi waters for the period 1965 to 2007 and found that the highest landing was about 12 thousand tons in the year 2002, constituted 52% of the total commercial marine fish landings. However, he stated that the hilsa contributed 48% of the total fish landings during 1965-1974, which was the highest, compared to the period of 1990-2002 (28%) and the period of 2003-2007 (12%). During 2008, 4,645 tones of *T. ilisha* were landed in the Khuzestan Province, Iran (20)

Although, the biology, stock assessment and fisheries of sbour in Iraqi waters have been described (26; 25; 27; 23; 22; 8; 5; 40; 42), little was known about the larvae of hilsa in Iraqi waters. However, due to the biological importance of the Shatt Al-Arab River as spawning and nursery ground for this species, its reproductive biology thoroughly discussed by (8). (6) stated that the northern part of Shatt Al-Arab was a spawning, nursery and feeding ground for larvae of fresh water and marine fishes. (41) on the other hand, studied the occurrence, abundance, growth and food habits of hilsa juveniles in restored East Hammar marsh.

Therefore, the aim of the present study is to investigate the monthly variation in the occurrence, abundance and food habits of hilsa, *T. ilisha* larvae in the upper reaches of the Shatt Al-Arab River.

Materials and Methods

The Shatt Al-Arab River is formed by the confluence of the Tigris and Euphrates rivers at Qurna, flows southeastern direction to open in the Arabian Gulf. The total length of the Shatt al-Arab River is about 200 km; the width varies from 400 to 1500 m and its depth from 7.5 to 12.5 m. The water level is affected by the high and low tides of the Gulf. Hundreds outlets in the form of small rivers and canals are found on both sides of Shatt Al-Arab.

Five sampling stations were chosen to fish larvae survey from the north part of Shatt Al-Arab River (Fig. 1). Station 1 is situated in the Garmat Ali River, opposite to the Basrah University, the depth and width of the river are 10m and 238m, respectively. Station 2 is situated near Al-Najibia Power Station, the depth and width of the river are 12m and 280m, respectively. Station 3 is situated at the confluence of Garmat Ali River with Shatt Al-Arab River, the average depth of the river is 2m. Station 4 is situated near the Al-Sindibad Island, the depth and width of the river are 5m and 500m, respectively. Station 5 is situated at the mouth of Al-Jebasi river, the depth of this station is 5m. All sampling stations were characterized by growing of aquatic plants, such as, *Phragmites australis, Typha domingensis*, *Ceratophyllum demersum*, *Vallisneria spiralis* and *Potamogeton* spp. *Potamogeton* spp., but station 3 is denser vegetation.

Ichthyoplankton samples were collected from the five stations monthly during October to January and twice monthly during February to September for the period from January 2008 to June 2009, during daytime and at low tide. Sampling was conducted using two types of conical nets, length of each one 1.25m and equipped with a flow-meter. The first type has opening diameter 30 and 50cm with mesh sizes 100-300µ and the second type 30cm with mesh sizes 100-300µ. Oblique tows were conducted at a speed of 0.5 m/s for approximately 10 minutes from near the bottom to the surface (48). Samples were preserved in 10% formalin. At each station, a quadrate size 50 x 50cm was used to collect the plants and placed in a plastic bag and transported to the laboratory. Surface water temperature was measured by simple thermometer, and salinity by instrument of YASI 556MPS. Secchi disk was used for water transparency measurement.

In the laboratory, identification of Hilsa larvae from other species was done using dissecting microscope (35) and the total length of each specimen was measured. The

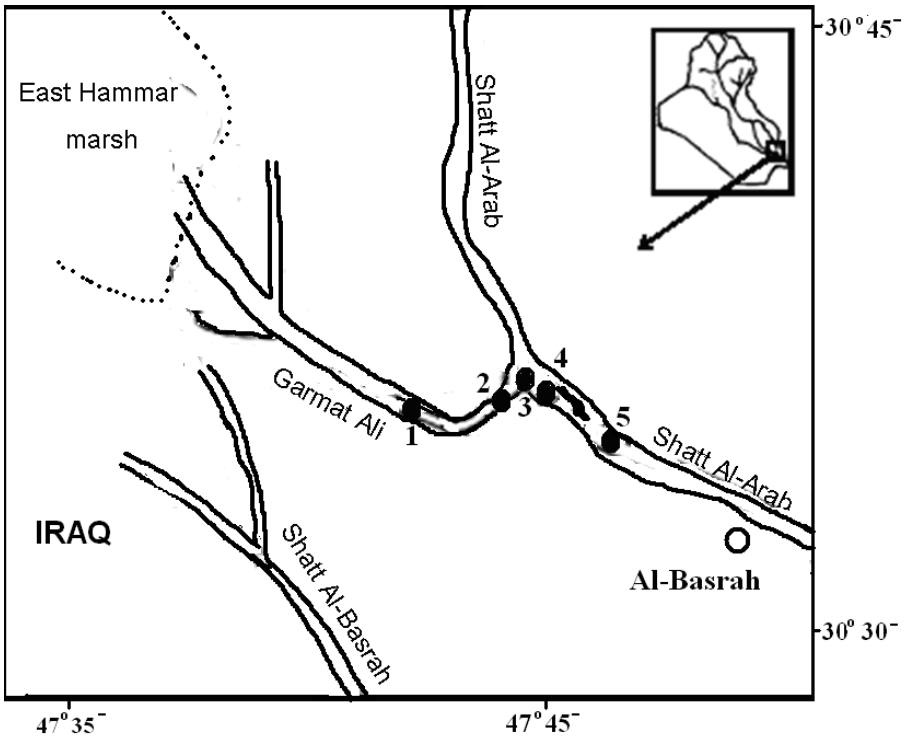

Fig. 1. Map showing sampling stations in the study region

specimen was then cut open and the entire digestive tract was removed, and allotted points for fullness according to (49). The gut contents were identified under dissecting microscope consulting (15) and (19). Feeding activity and feeding intensity for each monthly sample were calculated after (14) and (18) respectively. Two analytical methods were used to analyze stomach contents, i.e. points and frequency of occurrence (26). To assess the importance of various food items, an index of relative importance (IRI) designated by (50) was used as follows:

$$IRI\ \% = P\ \% \times O\ \%$$

where, P % is percentage of total points for each food item and O % is percentage of occurrence for each food item.

To determine feeding strategy and the importance of food items, Costello graphical method (12) was used. This method combine percentage of food item occurrence (O%) and the percentage of weighted point of the food item (O%).

The correlation coefficients between different environmental parameters and number of fish larvae were calculated ($n= 18$, $p\leq 0.05$), the correlation coefficient is significant at $r \geq 0.505$. All statistical computations were made using SPSS software (version 11, 2001) statistical package.

Results

Occurrence and Abundance

In total, 360 samples were taken by plankton nets and from aquatic plants resulting in the capture of 7360 fish larvae from the study region. Six hundreds and thirty one larvae of hilsa that were identified are all *T. ilisha***,** comprised 8.57% of the total fishes larvae collected. The length of hilsa larvae ranged from 5 to 18 mm.

The numbers and abundance of larvae taken by nets and from plants for all stations during the study period are given in Figures 2 and 3. Most of hilsa larvae

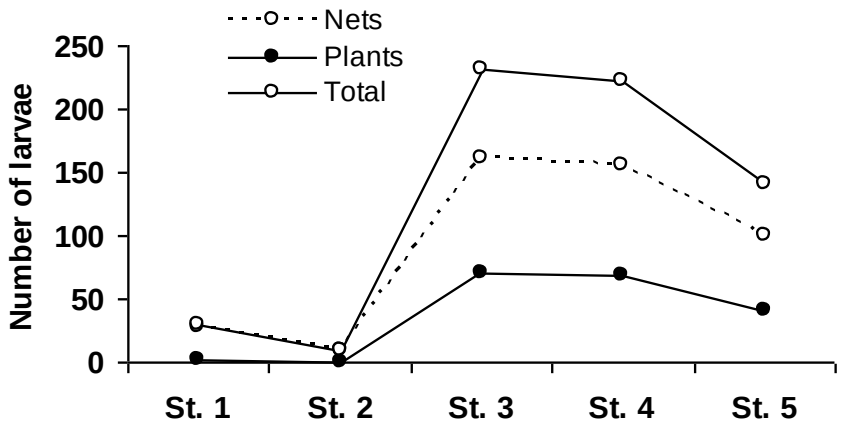

Fig. 2. Numbers of larvae taken by nets and from plants for all stations

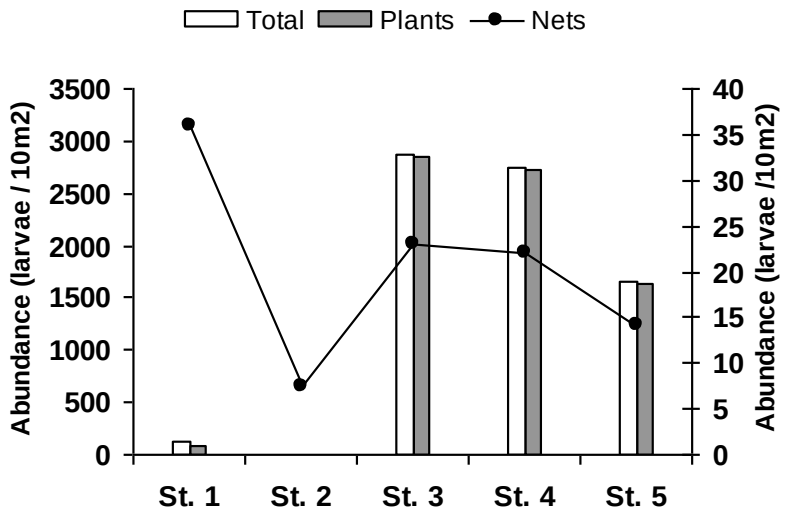

Fig. 3. Abundance of larvae collected by nets and from plants for all stations

were collected by nets. The highest number of hilsa larvae (232) was collected from station 3 and the lowest number (nine) was from station 2, in which collected by nets only (Fig. 2). The highest abundance of hilsa larvae was 2863 larvae/10m² in station 3 (Fig. 3). The overall number and abundance of hilsa larvae in the study region were 634 larvae and 7388 larvae/10m², respectively.

Monthly variations in the number and abundance of hilsa larvae during the study period are presented in Figures 4 and 5. Hilsa larvae were found in the study region during seven months of the year, from March to September. The peak of occurrence was during August for both from the plants or by nets. Number of larvae ranged from 4 larvae in March 2008 to 159 larvae in August. The lowest abundance of hilsa larvae was 80 larvae/10m² in March 2008 and the highest abundance was 2215 larvae/10m² in August .

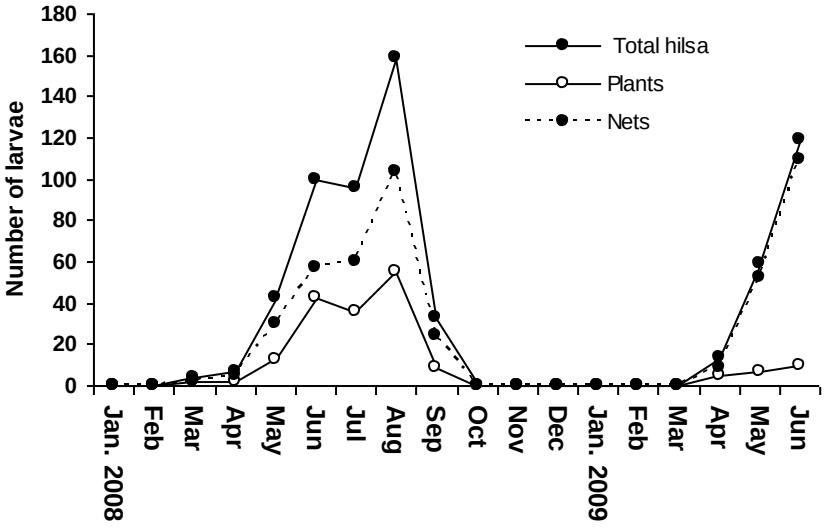

Fig. 4 . Monthly variation in number of hilsa larvae collected by nets and from plants

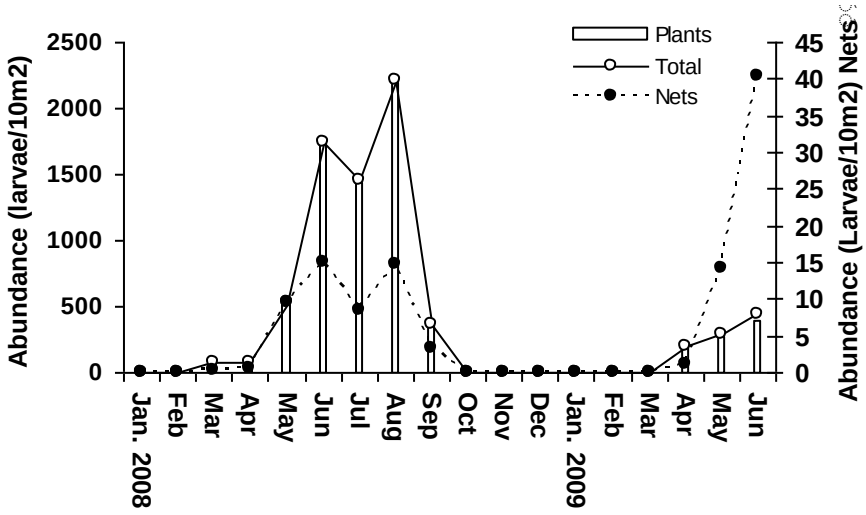

Fig. 5. Monthly variation in abundance of hilsa larvae collected by nets and from plants

Monthly changes in mean values of water temperature, salinity and transparency in the study region are illustrated in Figure 6. Water temperature ranged from 11.6 ^{o}C in January 2008 to 31.4 ^{o}C in August 2008. Salinity changed from 1.9 ‰ in December 2008 to 3.1 ‰ in August 2008, while water transparency ranged from 33 cm in July 2008 to 104 cm in January 2008. Water temperature and salinity showed significant positive correlations (0.713 and 0.661, $p \leq 0.05$) with the number of *T. ilisha* larvae,

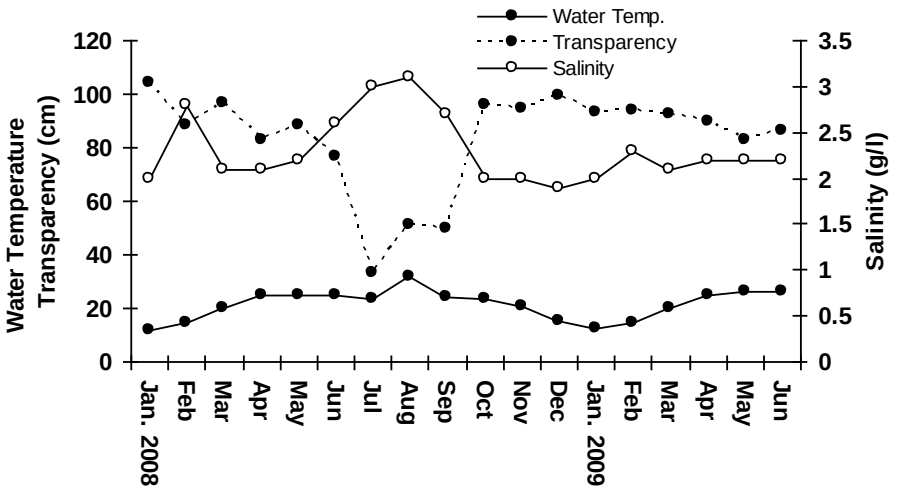

Fig. 6. Monthly variations in the water temperature, salinity and transparency

respectively, while transparency exhibited significant negative correlation with the number of larvae (-0.671, $p \leq 0.05$).

Food composition

A total of 631 larvae of *T. ilisha* stomachs were used for diet analysis, 480 of them were feeding larvae and 151 with yolk sac.

Monthly changes in mean feeding intensities of larvae *T. ilisha* are given in Figure 7. The lowest mean intensity value (16.7 point/fish) was encountered in June 2009, while individuals collected in July and September exhibited peak mean intensity (20 point/ fish). Larvae were active in feeding and never cease feeding and the feeding activity was 100% through out the year.

Figure (8) provides information on monthly variations in index of relative importance (IRI) of various food categories of larvae *T. ilisha*. It is evident that adult copepods occupied the first position in order of relative importance in larvae diet at most months. Their peaks constitution were encountered in July and September (IRI= 50%). Cladocera, *Daphnia* spp. came second in diet relative importance, forming their highest constitution (30.8%) in April 2008. The overall diet of larvae *T. ilisha* (Fig. 8) according to the IRI consisted mainly of adult copepod (38.1 %), cladocera (27.3 %), larvae copepods (17.6 %) and organic detritus (17.0 %).

According to Castello plot, the larvae of *T. ilisha* were a generalist feeder (Fig. 9).

Discussion

It has been known for a long time that the river shad *T. ilisha* lives in the sea for most of its life and migrates to rivers for spawning. After egg laying and hatching of larvae, these fishes go back to marine habitats for further growth. (44) mentioned that the hilsa shad migrate a distance of at least 1200 km up some river systems on the Indian subcontinent for spawning, whereas, a distances of 50–100 km are more typical in Bangladesh (46). In Iraq, (4) stated that hilsa were seen in the river Tigris at Baghdad in 1955, while (1) said that hilsa may reach up to Qalaat Salah on the Tigris River and to Al-Fahod on the Euphrates River about 150-180 km north of Basrah. At

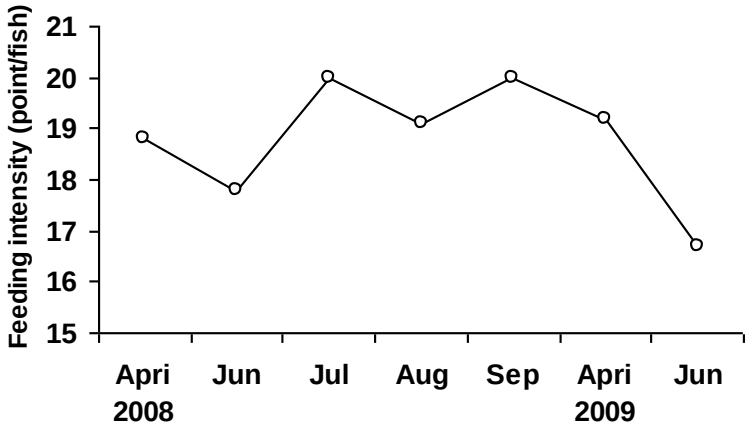

Fig. 7. Monthly variations in feeding intensity in diet of hilsa larvae

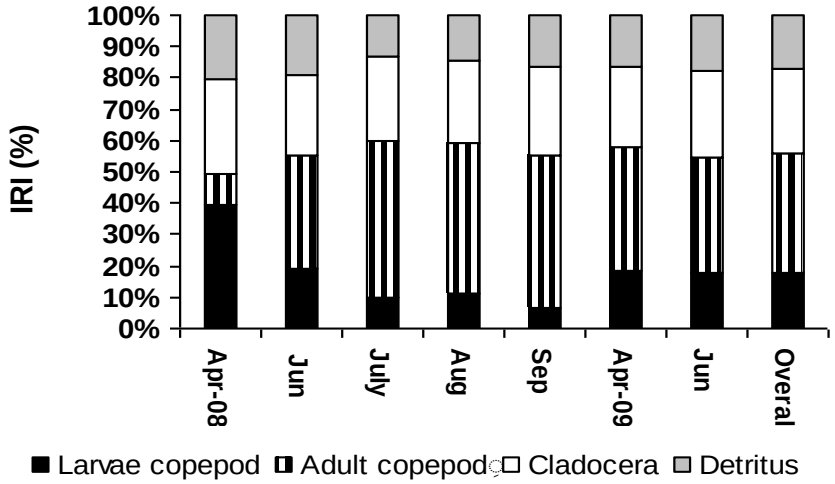

Fig. 8. Monthly variations in diet composition (IRI) of hilsa larvae

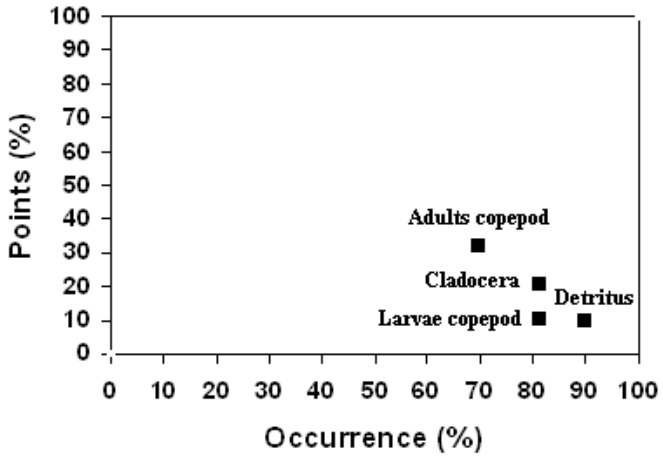

Fig. 9 . Diet and feeding strategy of hilsa larvae

present, upstream migrations of hilsa to northern rivers and tributaries may be affected due to low water levels. (42) pointed out that hilsa constituted only 1.2 and 0.1% of the artisanal fisheries in the junction of Tigris and Euphrates rivers (Qurna), respectively during 2005. Water levels in the lower parts of Iraq were reduced since 1990s due to large dams and reservoirs constructed on the Euphrates and Tigris by Turkey, Iran, Syria, and Iraq and effectively eliminated the flood pulses that sustained wetland ecosystems in the lower Tigris-Euphrates basin (43). Prior to the end of the twentieth century the discharge rate of the Tigris ranged from 3000 $m^3.sec^{-1}$ to less than 500 $m^3.sec^{-1}$, while that of the Euphrates ranged from 2000 $m^3.sec^{-1}$ to less than 250 $m^3.sec^{-1}$ (45).

In the present study, hilsa larvae were collected from all stations in the study region, but the highest number and abundance were found in the shallower and denser vegetation station, which is situated at the confluence of Garmat Ali River with Shatt Al-Arab River. (17) stated that the hilsa larvae prefer marginal waters in the regions where the total depth does not exceed approximately 1.3 m, some collections made beyond this depth; to about 2.0 m. (9) observed the bathymetric distribution of *Tenualosa* larvae in the middle state of the River Ganga near Allahabad, India and found that the larvae were more commonly available in surface and subsurface depths ranging from approximately 10 to 50 cm. Possibly the high current in such zones affects their distribution of the larvae. (8) pointed out that the hilsa larvae distributed along the banks of the Shatt Al-Arab River within the area extended from 30 to 120km from the estuary. These banks are characterized by slow currents due to the thick growth of aquatic plants. (6) collected hilsa larvae from the south of the present study region. Young of hilsa were also collected from shallow banks in the northern part of the Shatt Al-Arab (24).

The length of hilsa larvae collected in the present study ranged from 5.0 to 18.0 mm. According to (31) the early hilsa larvae of 4.5 to 5.0 mm in length would be about 4-5 days old. Using the availability of this group as the index of spawning it may be inferred that the breeding of hilsa started towards the beginning of March and continued till late in April with the maximum peak towards the middle of March and another minor peak towards the middle of April in India. The presence of hilsa larvae in the region indicates that the study area is one of the spawning grounds for this species. (8) collected hilsa spawners and larvae from the same area.

Hilsa larvae were found in the study region from March to September and the peak of abundance was during August, no hilsa larvae were found from October to February. The appearance of larvae hilsa (8.7-17.2 mm) in the Shatt Al-Arab River in June to October 1997 was reported by (8). At the same time, (41) stated that the juveniles of hilsa (3.0-14.0 cm) captured in the East Hammar marsh, north of the present study area in large swarms, constituted 10.4% of the total fish catch during July-November 2008, and then disappeared from the marsh during December-February. Historically, the locations of major hilsa fishing grounds in Iraq were extended from the Shatt Al-Arab estuary (Al-Fao) to the upper stretches (Garmat Ali), and the fishing season is a very popular time started in early March, sometimes continuing through the end of August, mainly by drift gill nets (30). (39) studied the movement pattern of hilsa through otolith microchemistry, hilsa were collected from marine, estuarine, and freshwater habitats were born in all main rivers in Bangladesh, to assess the extent of movement of fish within the Ganges River system and adjacent coastal waters and they found that most hilsa returned to fresh water after they reached sexual maturity, but not necessarily to their natal region.

Our results showed positive correlations between number of hilsa larvae and both water temperature and salinity, while have negative correlation with transparency. It is appeared that water temperature has effect on the occurrence of hilsa in the Shatt Al-Arab River. The highest abundance of hilsa larvae was corresponding with the highest water temperature during August. The hilas larvae disappeared from the study region during cold months. The absence of hilas larvae from Shatt Al-Arab River during cold months was also recorded by (8). Again, (41) showed the disappearance of juveniles of hilsa from the east Hammer marsh during the winter months and they concluded that hilsa may be moved back to marine habit to complete their growth. The subject of the downstream migration of juvenile American shad has been done by many authors in North America and they suggested that the timing of the emigration of juveniles from the rivers, like that of the spring spawning migration of the adults, is closely linked to changes in water temperature and occurs sequentially, when water temperature falls below 15.5°C (10; 34). (37) noted that the final emigration of juvenile shad from the Connecticut River was associated with the high river flows and low temperatures of the late autumn.

Hilsa shad is anadromous in nature. It is capable of withstanding a wide range of salinity and traveling great distances up-stream. The disordinary increasing in salinity level of Shatt Al-Arab river during the year of 2008 was correlated with the declined in water discharge from Tigris, Euphrates and Karun Rivers during this year.

There was a negative correlation between number of hilsa larvae and the Secchi disk transparency of water in the present study. (28) stated that the offspring of hilsa live in the rivers and streams for about 6-7 months and at the onset of monsoon, especially when the clear water of the rivers and streams began to get turbid, they migrate to the sea for maturation. (32) mentioned that the index of visibility has a great effect on the process of hatching of the eggs of hilsa, when the value of the Secchi disc is 20 cm or less, the water will not be conducive for hatching in river pools and nursery ponds. Also, (36) found that in a confined freshwater body, the water will be suitable for hatching when the index of visibility reaches 14 and 67 cm in the pool, and was 27 cm in nursery ponds.

The result of analyzing stomach contents of larvae hilsa in present study revealed that the feeding activity and feeding intensity were high and were generalized feeders, consumed larvae and adult copepod, cladocera (*Daphnia*), and organic detritus.

Very few studies have been performed regarding food and feeding habits of larvae and juveniles hilsa. (47) studied the food of hilsa in the size range 50 to 150 mm from Chilka Lake, India, consisted of organic detritus (48.56%), copepods (25.82%), algae (10.32%), molluscan larvae (7.85%), mysids (5.34%) and diatoms (2.10%). (41) found that the food of hilsa juveniles (3.0-14.0 cm) in east Hammar marsh was consisted of filamentous algae (40%), diatoms (34%), organic detritus (8%), copepoda (7%), cladocera (5%), rotifera (4%), and ostracoda (2%).

(7) found that the main food of adult hilsa in Ashar Canal, Shatt al-Arab River was zooplankton (mainly copepods – *Cyclops*) and phytoplankton such as dinoflagellates and diatoms. It was also found that the average volume of food in each stomach is more in small fishes than in large ones.

(13) stated that the gill rakers in adult hilsa were fully developed with minute papillae form an efficient filtering mechanism for sieving minute food organisms, while imperfectly developed gill rakers without papillae in fish (below 50 mm) fail to develop such efficient filtering device. They concluded that the stomach content analysis of fry, juvenile and adult hilsa revealed that copepods were the most important food items consumed by the fish of all sizes at all times of the year. The only basic difference was

that the fry and juvenile hilsa mainly fed on copepods, while the adult hilsa showed a considerable amount of organic matter along with the copepods and minute organisms like diatoms, rotifers, green algae and protozoans were present.

It could be concluded from the occurrence and abundance of hilsa larvae during March-September that the study area is one of a spawning and nursery grounds for hilsa in the Shatt Al-Arab River, and the larvae hilsa were mainly subsisted on zooplankton.

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تغيرات بتواجد ووفرة وغذاء يرقات اسماك الصبور *Tenualosa ilisha* في الجزء الشمالي لنهر شط العرب، البصرة، العراق

عبدالرزاق محمود محمد، سمية محمد أحمد، منى طه العكيلي*

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

*مركز علوم البحار، جامعة البصرة، العراق

الخلاصة. أجري مسح ليرقات اسماك الصبور *Tenualosa ilisha* من الجزء الشمالي لشط العرب خلال الفترة من كانون الثاني 2008 إلى حزيران 2009. جمعت 631 يرقة صبور (5.0–18.0 ملم) والتي شكلت 8.57% من المجموع الكلي ليرقات أنواع الأسماك. جمعت جميع يرقات الصبور خلال آذار–أيلول وكانت قمة وفرتها في آب. كانت أدنى كثافة لليرقات 80 يرقة/10م² خلال آذار 2008 وأعلى كثافة 2215 يرقة/10م² خلال آب. تراوحت درجة حرارة المياه بين 11.6 إلى 31.4°م والملوحة بين 1.9 إلى 3.1‰ والنفاذية بين 33 إلى 104سم. بين تحليل محتويات القناة الهضمية أن يرقات الصبور غير متخصصة في تغذيتها وتكون غذائها من يرقات وبالغات مجذافية الأرجل (55.7%)، براغيث الماء (27.3%) و فتات عضوي (17.0%). بينت الدراسة أهمية الجزء الشمالي من شط العرب ونهر كرمة علي كمنطقة تكاثر وحضانة لهذا النوع من الأسماك.