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Reproductive Biology of Hilsa Shad *Tenualosa ilisha* (Teleostei: Clupeidae) During Spawning Migration in the Shatt Al Arab River and Southern Al Hammar Marsh, Basra, Iraq

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ABSTRACT

Aspects of the reproductive biology of Hilsa shad, *Tenualosa ilisha* from Shatt al Arab river and Southern Al Hammar Marsh during spawning migration have been investigated from the period of April 2013 to March 2014. A total of 1456 specimens were collected using gillnets and landings. The size range of the specimens collected throughout the migration season was 50-460 mm in Total Length (TL). Males were dominant in the smaller lengths, while females did in the larger lengths. The monthly variation in mean length for both sexes showed two distinct peaks, the first was during February-March and the second during September-November. The overall sex ratio showed that females were dominating (1:1.7). The sex ratio varied both spatially and seasonally. Monthly variations in Gonad Somatic Index (GSI) and Dobriyal index indicated that Hilsa shad had a long spawning season with two distinct peaks in April and November. Macroscopic observations of gonads showed six maturity stages. The spatial occurrence of maturity stages suggested that Hilsa shad spawn in all the stations of Shatt al Arab river. The size at 50% maturity was 210 mm for females and 170 for males. The absolute fecundity ranged from 223750-1477780 eggs for fishes with total length range of 200-450 mm and mean weight range of 246.3-891.7 g. The relative fecundity for the same length and weight group ranged from 900.5-1657.1 egg/g. The relationship between absolute fecundity (A_F) and total length was $A_F = 0.007\times TL^{3.129}$ ($R^2 = 0.97$, n = 62) and that between A_F and body weight (B_w) was, $A_F = 190\times B_{w1.327}$ ($R^2 = 0.95$, n = 62).

Key words: *Tenualosa ilisha*, sex ratio, gonad somatic index, maturity stages, Dobriyal index, fecundity

INTRODUCTION

The Hilsa shad, *Tenualosa ilisha* (Hamilton, 1822) is an anadromous clupeid that migrates from the Arabian Gulf towards freshwater rivers for spawning. In Iraq, it migrates in the Shatt al Arab river and surrounding marshes up to 100 km. It is a widely distributed species in Asia and the Middle East (Pillay and Rao, 1963) and has recently been described in Malaysia (Arai and Amalian, 2014). A dramatic decline in annual catch of Hilsa shad in Iraq has been observed, mainly because of the decrease in water availability due to the construction of dams, which has affected its spawning, feeding and migration (Roomian and Jamili, 2011). Additionally, there was a steady decline in Hilsa shad from Iraqi marine catches. Reductions of the total catch from 52.9% during the years 1991-1994 (Ali *et al*., 1998) to 30.7% during 2000-2006 (Al-Dubakel, 2011) and to 18.9% over the 2007-2011 (Mohamed and Qasim, 2014a) have been reported. Many recent studies on the biology and reproduction of Hilsa shad in Bangladesh have been conducted (Haldar and Amin, 2005; Rahman and Cowx, 2006; Mazid *et al*., 2007; Amin *et al*., 2008). Hossain *et al*. (2014) discovered the spawning grounds of Hilsa shad in the coastal waters of Bangladesh by using the GIS and other techniques. In Pakistan, the aspects of biology and fisheries of *Tenualosa ilisha* have also been reported (Narejo *et al*., 2008; Panhwar *et al*., 2011). A notable work on the population statistics emphasizing the need of preventing undersize catch during its upstream migration was done by Panhwar and Liu (2013). In bay of Bengal, Milton (2010) and Dutta *et al*. (2012) documented the population structure, mortality rate, exploitation rate and management of Hilsa shad. Other researchers described the important biological parameters and stock of this species in the inland and marine waters of Iran (Marammazi, 1995; Marammazi *et al*., 1998; Hashemi *et al*., 2010; Roomian and Jamili, 2011; Roomiani *et al*., 2014). Likewise many studies have been done on this species in the Iraqi waters (Hussain *et al.,* 1991, 1997; Al-Noor, 1998; Mohamed *et al*., 2008, 2009). Mutlak (2012) described the population of Hilsa in Al Hammar Marsh and Mohamed and Qasim (2014b, c) reported its stock and reproductive biology in the Iraqi marine waters. Hence, this study describing the reproductive biology of Hilsa shad in the Shatt al Arab River and Southern al Hammar Marsh to shed light on and effects of environmental changes in the region on the biology of Hilsa shad.

MATERIALS AND METHODS

In total, 1,456 specimens (428 males, 534 females and 494 unidentified small individuals) of *T. ilisha* were collected from the Shatt al Arab River between April, 2013 and March, 2014. The study area included all the Shatt al Arab river and the Southern part of Al Hammar Marsh in Basra Governorate, Southern Iraq. Five stations were chosen, starting from the city of Al-FAW in the estuary section of the river to the northern-most station in the Al Hammar Marsh. The stations of Abu al-Khasib, Sebba and Tigris-Marsh were intermediary. The Tigris-Marsh station was at the junction of the Shatt Al and Garmat Ali rivers, which flow from the Al Hammar Marsh (Fig. 1).

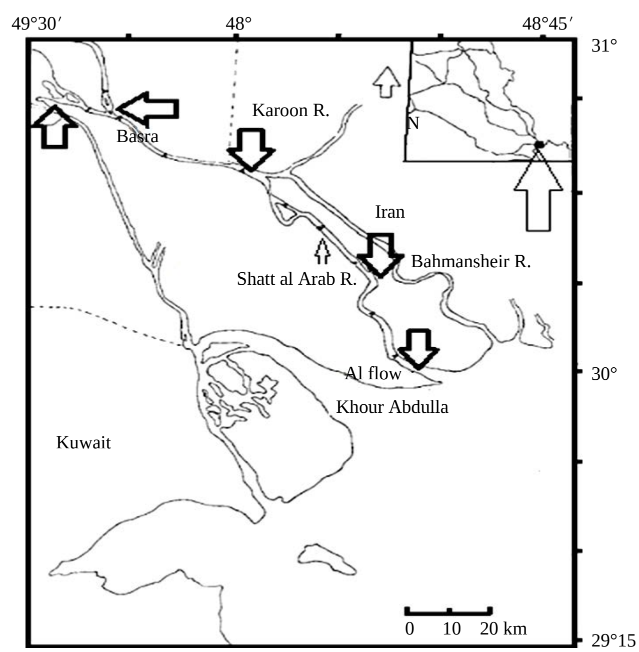

Fig. 1: Study area of *Tenualosa ilisha* (Arrows indicate the sampling stations)

Specimens were collected using gillnets. To control the selectivity, fish samples were collected using panels with different mesh size (67×67, 57×57, 48×48, 42×42, 33×33 and 30×30 mm). Port samples were also taken as supplement samples with different size group of fishes. A beach seine with mesh sizes of 20×20, 18×18 and 16×16 mm was used to collect juveniles in Marsh habitats. Total Length (TL) was recorded to the nearest 1.0 mm. Gonad weight was taken to the nearest 0.001 g and body weight to the nearest 0.1 g.

To determine the spawning season four indices were used (Zhang *et al.,* 2009) i.e., monthly changes in gonad somatic Index, seasonal progression of gonads, Dobriyal index and Fulton's condition factor. Gonad Somatic Index (GSI) or coefficient of maturity value was determined for each month and region according to the following formula:

$$\text{GSI (\%)} = \frac{\text{Gonad weight (g)}}{\text{Body weight (g)}} \times 100$$

Macroscopic determination of gonad maturity stages and seasonal progression of gonads (maturity stages) was recorded by gross physical (morphological) examination of testes and ovary. Based on macroscopic characteristics maturation stages were determined according to the degree of opacity of the gonads, consistency and vascularization, oocytes or sperm visibility and overall coloration of the gonads (Kesteven, 1960; Macer, 1974; Lagler, 1978; White *et al.*, 1998; Shinkafi *et al*., 2011; Nath, 2013). Dobriyal Index (DI) was calculated following the method of Dobriyal *et al.* (1999), which was equal to the average cube root of gonad weight (Wg), i.e., $\text{DI} = \sqrt[3]{\text{Wg}}$ The Fulton's condition factor K was calculated monthly by the formula:

$$K = 10^5 \times W / L^3$$

were, W is body weight in grams, L is total length in millimeters (Biswas, 1993; Froese, 2006). A Chi-square test was used to estimate sex ratio the deviation from the expected 1:1 ratio (Sokal and Rohlf, 1995). The length at 50% maturity was estimated to further shed light on the reproductive biology of sampled species (Bagenal, 1978; Hodgkiss and Man, 1978). For fecundity estimation ovaries with running maturity stages were preserved in modified gilson fluid (Simpson, 1951) which help in hardening the eggs and break down the ovarian tissues (Bagenal, 1978). Gravimetric sampling was used to estimate the fecundity. After being liberated from the ovarian tissues, the eggs were thoroughly washed and spread on blotting paper in order to dry in air. The total number of eggs was then weighed and random samples of about 500 eggs were counted out and weighed. The total number of eggs in the ovaries is then obtained from the equation:

$$F = n\ G/g$$

where, F is fecundity, n is number of eggs in the subsample, G is total weight of the ovaries and g is weight of the subsample in the same units (Holden and Raitt, 1974). The Absolute Fecundity (AF) was calculated as the total number of mature ovum in the running ovary, while the Relative fecundity (R_F) was calculated as A_F/body weight.

RESULTS

Size structure: The size and weight of the specimens of *T. ilisha* collected throughout the migration season in the study area (Table 1) ranged from 50-460 mm TL and 0.97-1253 g

Table 1: Length and weight ranges and averages of female and male *Tenualosa ilisha*

		Females					Males			
		TL (mm)		Weight (g)			TL (mm)		Weight (g)	
Months	No.	Range	Average (±SD)	Range	Average (±SD)	No.	Range	Average (±SD)	Range	Average (±SD)
Jan.	0	0	0	0	0	0	0	0	0	0
Feb.	30	220-440	293.7 (±100)	185-1253	267.7 (±99)	8	170-280	280.2 (±57.9)	35-200	179.5 (±137.2)
Mar.	25	200-400	288.7 (±103)	179-988	237.1 (±105)	17	165-350	208.2 (±60.6)	32-329	189.5 (±160.2)
Apr.	80	120-445	247.7 (±110)	16-928	253.1 (±113)	143	92-400	248.2 (±79.6)	8.1-690.9	199.5 (±157.2)
May	84	110-435	180.3 (±75.8)	11-1071	107.1 (±77.3)	168	50-370	212 (±87.2)	13.7-576	148.6 (±120)
Jun.	60	200-460	283.9 (±79.2)	26-1190	309.4 (±105.2)	122	80-300	192.1 (±57.6)	5.2-302.8	89.7 (±75.5)
Jul.	74	90-400	195.1 (±89)	7.0-780.4	170 (±159)	31	70-320	219.3 (±57.1)	3.5-581	134 (±125)
Aug.	64	160-370	257.3 (±29.1)	39-330.6	182.4 (±54.3)	11	160-310	253 (±45.1)	31.5-311	173.6 (±86.4)
Sep.	48	220-410	281.4 (±25.2)	92.7-819.2	256.5 (±80.7)	10	190-300	260 (±52.1)	65-252.8	144.3 (±81.2)
Oct.	20	255-310	294.5 (±16.9)	186-399	263 (±64.2)	15	275-325	295 (±13.6)	199-332	260 (±38.5)
Nov.	20	270-350	287.7 (±20)	200-405	277.7 (±50)	19	280-309	279 (±11.6)	245-274	270 (±30.5)
Dec.	0	0	0	0	0	0	0	0	0	0

TL: Total length

Table 2: Sex ratio differences according to length group and months for *Tenualosa ilisha*

	Length					
Months	<100	100-200	200-300	300-400	400-500	Mean
Jan.	0	0	0	0	0	0
Feb.	0	0	5.7:1	1.5:1	All females	1:3.7
Mar.	0	0	6.7:1	1:1.8	All females	1:1
Apr.	0	All males	9.6:1	4:1	1:19	1.8:1
May	All males	All male	1.8:1	2.2:1	All females	2:1
Jun.	All males	All males	1.9:1	2.2:1	All females	2:1
Jul.	2:1	1.6:1	1:3	1:3.7	All females	1:2.3
Aug	0	0	1:8	1:3.4	0	1:5
Sep.	0	All males	1:3.1	1:4	All females	1:4
Oct.	0	0	1:1	1:1.8	0	1:1.3
Nov.	0	0	1.4:1	1:1	1:14	1:1
Dec.	0	0	0	0	0	0
Mean	8:1	15:1	1:1	1:1.2	1:18	1:1.7

(Table 1). Males were smaller in length and weight than females. Total length of females ranged from 90-460 mm, with an average of 261.03 (±64.5 SD) mm and a body weight range of 7.0-1253 g, with an average of 231.79 (±103 SD)g. Males had a total length range of 50-400 mm, with mean of 244 (±56.5 SD) mm and a body weight range of 3.5-690 g with an average of 178.87(±67.6 SD)g. The biggest weight of females and males was observed in June. The highest mean total length was observed in October. The monthly variation in mean length for both sexes combined showed two distinct peaks. The first was recorded during February-March and the second was recorded during September-November. However, a big decline in mean length was observed during May and July.

Sex ratio: The overall sex ratio of all the specimens was favoring females, 1:1.7 (Table 2). Based on a Chi-squared test sex ratios were not significantly deviated from 1:1. The males were significantly more abundant than females in April, May and June. Females were more abundant during February, July, August and September. In March, October and November the sex ratio was not significantly different from 1:1 (1.1, 1.13 and 1.1, respectively). The sex ratio also varied according to fish length. In the length groups >100 and 100-200 mm, males predominated, whereas females predominated in the length groups 300-400 and 400-500 mm. In the intermediate length group (200-300 mm), the sex ratio was not different from 1:1. The spatial changes in sex ratio have showed that males have outnumbered females in the Marshes (3.8:1) and the Tigris-Marshes interface (7.7:1) (Fig. 2). However, females have outnumbered males in the estuary (0.6:1) and the Shatt al Arab (0.8:1), with no significant difference from the 1:1 sex ratio.

Gonad Somatic Index (GSI) and Dobriyal index: The maximum values of GSI were observed in April (9.5±2.4) for females and in February (2.5±1.4) for males (Fig. 3). Two distinct peaks were observed for both sexes. The first peak was during March-June and the second was in August-October. This result suggested that the spawning season was prolonged from March to November, with distinct spawning peaks at the beginning and the end of the spawning migration. Spatially, GSI of females has decreased gradually from the estuary to the marshes (Fig. 4). Mean Dobriyal index was 1.28 and 2.34 for males and females respectively. Seasonal variation in Dobriyal

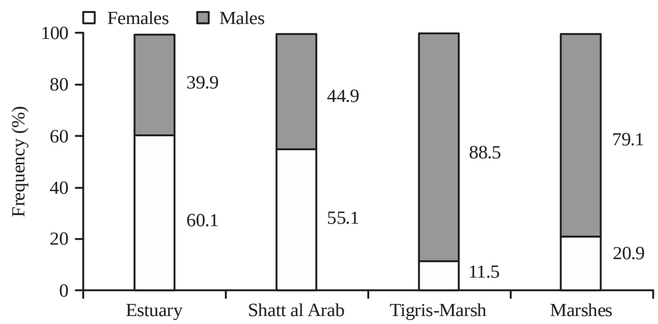

Fig. 2: Spatial percentage composition of male and female (frequency %) of *Tenualosa ilisha*

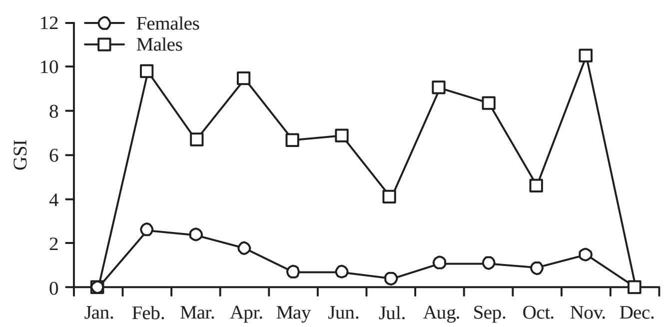

Fig. 3: Monthly variations of the average GSI for females, males and immature *Tenualosa ilisha*

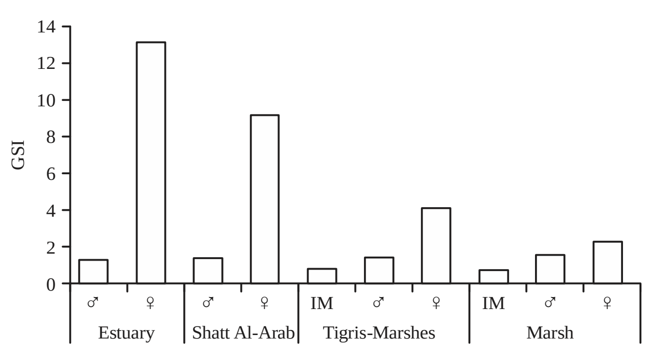

Fig. 4: Spatial variations of the average GSI for females, males and immature *Tenualosa ilisha*

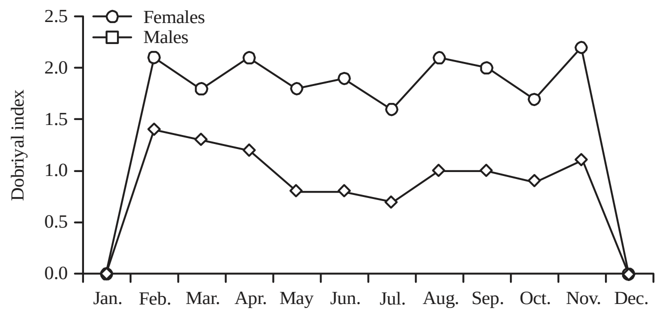

Fig. 5: Seasonal variations in the average Dobriyal index for females and males *T. ilisha*

Table 3: Macroscopic and description of gonad maturation stages of *T. ilisha* females and males

Stage	Sex	Brief description of gonad
Stage1: Immature	F	Ovary cord like, waxy translucent, ova invisible to the necked eye, thick membrane. Found during all the study months. GSI range 0.7-2.1, Mean 1.3±0.5
	M	Testes thread-like, elongated, translucent to grey in color. Laid in the corner, about half length of body cavity. GSI range 0.06-0.7, Mean 0.65±0.06
Stage II: Maturing	F	Pale yellow, more than tree quarter of body cavity, with visible opaque ova, granular appearance, lobular. Found during all the study months except November. GSI range 3.2-16.9, Mean 9.3±4.3
	M	Testes darker than former stage, appearing pale reddish white. Wider and less translucent, about half to three quarters the length of the body cavity, with visible vascularization. GSI range 0.35-2.3, Mean 1.7±1.4
Stage III: Running	F	Yellow to orange yellow, large occupies all the body cavity, lobular with translucent yellow tiny ova, delicate ovary membrane. Ova flow out with gentle pressure. Some ova out the genital opening, found in February-November. GSI range 7.5-18.2, Mean 12.9±3.2
	M	Swollen Creamy white with homogeneous texture, more than three quarters the length of the body cavity, Sperms flow out with gentle pressure. GSI range 2.1-3.2, Mean 2.6±0.5
Stage IV: Partial spent	F	Flaccid, bloody brown with some tiny opaque yellow residual ova. Found during May-November. GSI range 5.6-7.4, Mean 6.5±0.9
	M	Not turgid flaccid, not homogeneous texture, sperms still flow out with pressure. Not similar coloration with some bloody areas. GSI range 0.2-1.3 mean 0.65±0.2
Stage V: Spent	F	Flaccid empty sac, reddish bloody with many tiny opaque yellow residual ova, found during May-Nov. GSI range 2-4, Mean 3±0.9
	M	Bloody white, flaccid, not bright coloration, long slender and delicate. GSI range 0.1-0.5, Mean of 0.2±0.09
Stage VI: Resting (recovery)	F	Fleshy color, semi translucent, not turgid and not firm texture. GSI range 3-10.5, Mean 9.2±0.8 Found during may-November
	M	Greyish white, about one third body cavity length, nearly flaccid, homogenized coloration. GSI range 0.6-1.3, Mean 1.0±0.27

F: female, M: Male

index was observed (Fig. 5) and these seasonal variations were coincided with the seasonal variations in GSI which showed prolonged spawning season with two distinct peaks.

Macroscopic examination of gonads: Six maturity stages were identified using macroscopic examination. To simplify the implementation of management measure the virgin and the developing virgin were pooled as immature stage, while the ripe, developing and graved stages were pooled as maturing stage (Table 3). Temporal variation in gametogenic patterns for males and females has showed that the developed condition of gonads (maturing) was found in every month except for November. The highest percentage of maturing gonads was observed in April and the lowest was in May (Fig. 6). Based on macroscopic features, fishes with gonads with running or partially spent and spent stages were considered as spawning individuals and could be used to determine the spawning season. Figure 6 shows the monthly occurrence of gonads with spawning

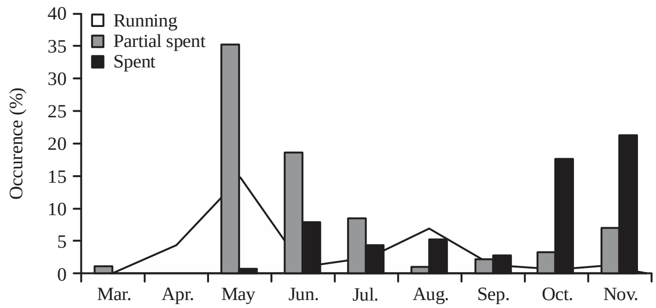

Fig. 6: Temporal variations in the occurrence of spawning maturity stages of *Tenualosa ilisha*

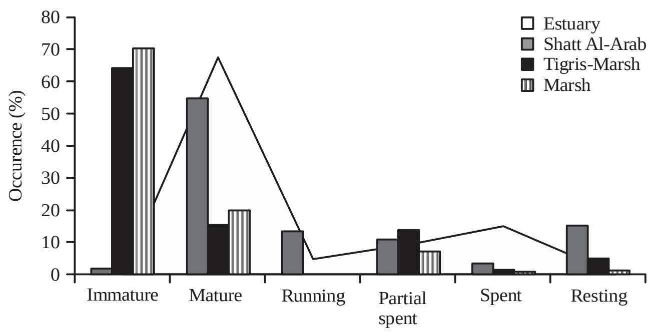

Fig. 7: Spatial variations in the occurrence of spawning maturity stages of *Tenualosa ilisha*

stages only. Running stages were recorded from April to November, with the highest percentage in May. Fishes in partially spent stages were found from May to November. The occurrence of fish in the spent stage seemed to increase gradually from May to November. Therefore, Hilsa shad in the Shatt al Arab seemed to spawn during March to November. Al Hammar Marsh and the Tigris-Marsh area were dominated by fishes with the immature stage, 70.4 and 64.4%, respectively (Fig. 7). The fish in spawning stages including running, partially spent and spent stages were found in the entire study region. The estuary had a high percent of spent individuals 15.4 and 4.9% running individuals. In the Shatt al Arab 13.5% of the fishes were in the running stage. No running stages were observed in the Marshes and Tigris-Marsh areas. The Marshes and Tigris-Marsh areas contained fishes in the partially spent stage with occurrence of 7.3 and 13.8% and with occurrences of 1.0 and 1.4%, in the spent stage.

Length at first maturity: The smallest mature Hilsa shad female was found in the marshes in July, with 180 mm total length, Age II+, spent maturity stage and GSI= 0.9. While the smallest mature male was found in Abo Al Khaseeb station in the middle of Shatt al Arab River in July with total length of 129 mm, Age I+, with partial spent maturity stage and GSI = 0.025. The Lm_{50} was 210 mm for females and 170 mm for males.

Fecundity: The fecundity was estimated from 223750-1477780 based on females with 200-450 mm TL and 246.3-891.7 g (Table 4). The relative fecundity for the same length and weight group was 900.5-1657.1 egg/g. The relationship between absolute fecundity, Total Length (TL) and body weight (Wt) were:

Table 4: Absolute and relative fecundity of *Tenualosa ilisha* females and males

Total length group (mm)	No.	Mean TL (mm) (±Sd)	Mean body weight (g) (±Sd)	Mean GSI (±Sd)	Mean absolute fecundity (egg) (±Sd)	Mean relative fecundity (egg/g) (±Sd)
200-250	19	238.3 (±2.9)	246.3 (±89.9)	11.3 (±6.7)	223750.6 (±20231.6)	900.5 (±68.8)
250-300	17	277.9 (±11.9)	235.8 (±31.1)	10.8 (±2.8)	311489.3 (±27845.2)	1320.9 (±77.9)
300-350	11	317.5 (±14.0)	322.9 (±44.3)	12.8 (±2.4)	573907.0 (±30241.6)	1477.0 (±89.6)
350-400	15	390.0 (±8.9)	522.4 (±210)	13.1 (±5.0)	851582.8 (±35799.9)	1630.1 (±54.9)
400-450	10	430.0 (±13.3)	891.7 (±89.7)	10.8 (±3.5)	1477780.5 (±112457.3)	1657.1 (±90.1)

TL: Total length, GSI: Gonad somatic index

$$\text{Absolute fecundity} = 0.007\times\text{TL}^{3.128}\ (R^2 = 0.97, n = 62)$$

$$\text{Absolute fecundity} = 190.57\times\text{Wt}^{1.327}\ (R^2= 0.95, n=62)$$

DISCUSSION

The results of this study has showed obvious seasonality per size group, suggesting two distinct peaks. The first peak was recorded during February-March and the second was recorded during September-November, indicating that fishes with different sizes have not occured in the same area year-around. The observerd temporal pattern of size structure was probably due to the spawning migration of the species (Mutlak, 2012; Mohamed and Qasim, 2014b; Hussain *et al*., 1991). Along the study period, males were slightly smaller than females except in June. Vicentini and Araujo (2003) stated that one highly likely factor to be investigated and that can cause differentiation between sexes is fish growth. It was found that males were predominant in the smaller lengths and females in the larger lengths. The adaptive significance of such sexual differences may be the cause to maximize egg-production biomass and minimize intarspecific competition (Clarke, 1983). In contrast with Roomian and Jamili (2011), no marked decline was observed in the mean length and weight for males and females during the months of August and September. The sizes of shad observed in other studies were lager, which suggests higher fishing pressure on Hilsa shad in this study (Mohamed and Qasim, 2014a). Hilsa shad population sex ratio in the Shatt al Arab has showed some deviation from equilibrium and favored females. Dominance of females coincides with many studies in Iraq like Hussain *et al.* (1991) and Mohamed and Qasim (2014b), in Iran like Roomiani *et al.* (2014) and in Kuwait like Al-Baz and Grove (1995). Contradictory views have been expressed by previous investigations in Shatt al Arab (Hussain *et al*., 1994; Al-Noor, 1998; Mutlak, 2012). Several other reasons suggested for the unequal sex ratios in other studies, including differences in mortality, growth and longevity (Vicentini and Araujo, 2003; Zhang *et al.,* 2009). Sex ratio varies temporally and spatially (Arocha and Barrios, 2009). Sex ratios were dependent on fish size. Females were highly predominant in larger lengths while males were dominant in smaller sizes. This finding coincides with Al-Noor (1998) conducted in the same study area. Zhu *et al.* (2008) noted that change in sex ratio according to body length is an important parameter and might directly relate to growth rate or natural and fishing mortalities. Sex ratios have differed along different months and that could be attributed to the spawning activity.

The temporal and spatial variation in Gonad Somatic Index (GSI) or coefficient of maturity and Dobriyal index could be used to determine the spawning season and the spawning ground. The results of this study suggest that the spawning season in the Shatt al Arab River has extended from March to November with two distinct peaks. The first peak was recorded at the beginning of the spawning migration period while the second was recorded at the end of it. Dobriyal index is the cube root of the average gonad weight in grams that is used as a measure of reproductive capacity, determination of spawning season, sexual maturity and frequency of spawning (Dobriyal *et al.*, 1999). Unlike the gonadosomatic index, Dobriyal index does not involve body weight which is dependent on feeding intensity, food availability and environmental and physiological stress. The seasonal variation in Dobriyal index also indicated the prolonged spawning season with two peaks at the beginning and the end of the migration season. The spawning season observed in this study was longer than many previous studies. Al-Noor (1998) founded that the spawning season of *T. ilisha* in Shatt al Arab was extended from March to October and Al-Uqaili (2011) has observed larvae from March to September in the northern part of the Shatt al Arab River. In Iran, Roomiani *et al.* (2014) suggest that the spawning season of *T. ilisha* in the Khuzestan Provenance rivers occurred from May to August. Unpublished data from the Kuwait Institute for Scientific Research on *T. ilisha* in the Shatt al Arab River showed that this species spawns during May-August with a peak in May-June (Al-Baz and Grove, 1995). Mutlak (2012) founded that the spawning season was from April-September. Hussain *et al.* (1991, 1994) founded that Hilsa shad in the Shatt al Arab spawn in the period from June to August. Al-Hassan (1999) noted a long spawning season with two peaks for spawning, the first was during March-May and the second was from July to August. These differences in the spawning period of Hilsa shad populations may be due to changes in the environmental factors caused by climate change. Climate change has had a clear impact on the annual timing of life-history events of animals and plants (Bradley *et al*., 1999; Walther *et al*., 2002), such as selective pressures on the date of spawning (Crozier *et al*., 2008) and variations in reproductive characteristics (Barange and Perry, 2009).

Spatial variation of maturity stages showed that the spawning were found in all the regions suggests that Hilsa shad spawn along the migration route from the estuary to the Marshes as well as mid Shatt al Arab (Abu Al Khaseeb). The marshes and Tigris-marshes regions were dominated by individuals in the immature stage, which mean that it was a nursery area.

The smallest mature Hilsa shad and Lm_{50} for both sexes were smaller than those reported in previous studies. In the Shatt al Arab, Hussain *et al.* (1991) found that the smallest mature female was 239 mm and the smallest mature male was 225 mm. Hussain *et al.* (1994) found a range of 250-250 mm for males and average size of 330mm for females. Al-Noor (1998) found an average size of 250 mm for males and 378 mm for females. Amin *et al.* (2005) found that Hilsa shad mature at one or two years old, ranging 34-25 cm for males and 28-30 cm for females. Mutlak (2012) found that the L_m for Hilsa shad in Al-Hammar was 25.6 and 24.2 cm for females and males, respectively. Islam *et al.* (1989) pointed out that in Bangladesh waters; males appear to attain their first maturity at size range of 260-290 mm, while females do not attain their first maturity before a size range of 310-330 mm. In the Iraqi marine waters; the first sexual maturity for females was at a length of 220 and 200 mm for males (Mohamed and Qasim, 2014c). Milton (2010) found that Hilsa shad grew fast and reached sexual maturity within 6-12 months, with life span up to 2-4 years. The results herein showed that Hilsa shad was matured younger than that in previous years. The change in size at first maturity could be attributed to hydrological and ecological changes. Climate change was found to affect the age of sexual maturity of Atlantic salmon and Atlantic cod, where warmer conditions lead to earlier maturity (Brander, 1994; Jonsson and Jonsson, 2004). Fecundity in this study was higher than that found in previous studies (Al-Noor, 1998; Jabir and Faris, 1989; Hussain *et al.,* 1991). This could be an indicator of stress which is attributed to environmental conditions that change due to water shortage (Al-Maliky, 2012). However, other factors such as the impact of the increase of fishing cannot be ruled out as it might cause density dependent effects such as early maturity, fast growth and more eggs production.

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