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Reproductive Ecology of Mola (*Amblypharyngodon mola*)

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ABSTRACT

*Reproductive cycle of mola (*Amblypharyngodon mola*) in a pond and in a beel along with some aspects of their physico-chemical parameters, morphometry etc. were carried out at Rajshahi. The highest (81.08%) average monthly percentage of ovigenous female Mola in pond was in September and lowest (20%) in November, whereas the highest (87.30%) and the lowest (28.57%) values in beel were found in May and in November respectively. Both the Gonado Somatic Index (GSI) and Gonadal Langth Index (GLI) of Mola showed two distinct peaks, one in May and another in September where GSI values were 19.51% and 22.48% and GLI values were 36.31% and 36.19% respectively. Similar peaks were found in the beel where GSI values were 20.98% and 18.72% and GLI values were 41.77% and 40.58% respectively. The lowest mean fecundity of Mola in pond was 1023±625 and the highest was 6806±125 in size groups of 5.0-5.5cm and 8.1-8.5cm respectively. Ova diameter of Mola in pond showed two distinct peaks one in May and another in September where Ova diameter values were 30 μm and 29 μm respectively. Similar peaks were found in beel where OD values were 28 μm and 27 μm respectively. Above result shows that Mola (*A. mola*) breeds twice a year with one peak in May and another in September in both pond and beel. Some ecological parameters were also observed in the study areas.*

Key words: Reproductive, ecology, fish, *Amblypharyngodon mola*.

INTRODUCTION

Reproductive Ecology of any fish is essential for assessing commercial potentialities of its stock, life history, culture practice and actual management of its fishery (Lagler, 1956). Reproductive potential of a population is one of the basic exigencies to designate the individuals of that population in respect to their gonadal conditions. In order to make success in fish culture, it is important to assess the yearly breeding cycle of culturable fishes. Spawning of fish occurs during a particular phase of the reproductive cycle. Some of them breed once annually while others at regular intervals throughout the year. Knowledge of gonadal development and the spawning season of a species allow subsequent studies on spawning frequency of its population, which is important for its management. A thorough understanding of the early development of a fish species is also considered an important step for the fish calturists. Very little works has been done in such direction in this country. Few works deserve worth mentioning *viz.,* Afroze and Hossain (1990), Hossain *et al*. (1991), Nargis and Hossain (1992) and Parween *et al.* (1993).

Survey of available literature reveal that works on the fecundity of different fishes have been done in this country by many researchers like Miah and Dewan (1984), Afroze end Hossain

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(1990)., Faruq *et al.* (1996), Kabir *et al.* (1998), Wahab *et al*. 2003, Kohinoor (2000), Kohinoor *et al.* (2003), Mazid and Kohinoor (2003). In view of economic importance and food value of this fish it is very important to collect the information of Reproductive Ecology of *A. mola* for better scientific management and conservation of this important fish species. Keeping this in mind the present study has been undertaken.

MATERIALS AND METHODS

Durations and study area

The experiment was undertaken in one pond (closed water) and in one beel (open water) at Rajshahi. The pond is located at the Govt. Fish seed Multiplication Farm (FSMF) of Directorate of Fisheries, Matshya Bhaban, Rajshahi. The beel Chandi, a natural depression was situated at Mohonpur upazila of Rajshahi district.

Preparation of pond

Pond was dried out and embankment was repaired. The lime was applied and fertilized with cowdung, urea and T.S.P. Then it was filled-up with water from deep tube well.

Stocking of fish and feeding

The stocking of brood fish of Mola was done in August to September @ 100 per decimal. Agricultural bi-products such as rice-bran or wheet-bran (50%) and mustard oilcake (50%) were used as supplementary feed at the rate of 3% of body weight, twice a day. The pond was also fertilized with cowdung at the rate of 4 kg/decimal at 15 days interval.

Water sample collection and water analysis

On the spot, water quality parameters were recorded between 8.30 and 9.30 am at monthly interval from experimental pond (FSMF pond) and Chandi beel. The water quality parameters (NH_4, NH_3, CO_2, NaCl, Cl, DO and $CaCo_3$) were determined by using Spectrophotometer (HACH DR 2000) and Fish Farming Test Kit Box (HACH, FF-1A, USA).

Fish sample collection

33 specimens of *A. mola* were randomly undertaken for further investigation at monthly interval both from the pond and the beel. Morphometric study was done of individual fishes. Then the ovary of each fish was taken out very carefully and preserved in 10% buffered formalin in labelled vials for subsequent study.

Morphometric study

All the measurements were taken with the help of mm scale attached against the wooden board. The weight (in grams) of the fishes was taken by fine electric balance. Before weighing, the specimen was washed with water and left exposed to air and the excess of moisture was dried off with the help of a blotting paper for taking accurate weight.

Length of the ovary was taken with the help of a fine point divider by using an mm scale. General feature and structure as well as month wise size shape and color of gonads of the experimental fish were studied during sample collection and preservation.

Methods for determining the reproductive cycle of *A. mola*

Data were collected for gravid females for calculation of percentage of the gravid females against time following Farmer (1974). The Gonado Somatic Index (GSI), Gonado Length Index (GLI) and fecundity were calculated according to the formula given by Lagler (1956). The weight of a spent gonad were measured with the help of an electric balance Model no. (FX-300) Dissected ovaries were stained with alcoholic eosin solution and after fixation and mounted in Canada balsam following the routine procedures of deparaffinization and dehydration.

A total of 109 matured fish were examined from the pond and 125 from the beel.

Ova diameter (OD)

Ova diameter was measured according to Dan (1977).

RESULTS AND DISCUSSION

Chemical parameters of water

pH

The maximum and minimum pH in pond were 8.0 in May and 7.0 in December, respectively while in beel it was recorded as 8.0 in May and 7.0 in January.

DO

The highest DO (7.5 mg/l) was recorded in December and the lowest DO (3.9 mg/l) was recorded in July in pond. In case of beel the highest (10 mg/l) was recorded in December and the lowest (5 mg/l) was recorded in July.

In the rainy season, particularly from May to July the water temperature was relatively high and rainfall was also high. Physico-chemical parameters of water in pond and beel are shown in Table 1.

Table 1. Water quality parameters of the experimental pond and beel for two years

Months	Chemical Parameters (Mg/L) in pond										Chemical Parameters (Mg/L) in beel									
	Total alkalinity	NH_4	NH_3	CO_2	NaCl	Cl	DO	Total hardness ($CaCo_3$)	NO_2	pH	Total alkalinity	NH_4	NH_3	CO_2	NaCl	Cl	DO	Total hardness ($CaCo_3$)	NO_2	pH
January	225.10	1.30	-	14	100	55	4	152.60	0	7.2	239.40	0.6	0.003	20	100	60	6	205.2	0	7.0
February	155.00	0.30	0.033	13	100	60	5	155.20	0	7.5	222.30	0.2	0.015	19	100	60	8	153.9	6.6	7.5
March	220.20	0.20	0.002	15	50	56	5	153.90	0	7.5	171.00	0	-	20	100	60	8	119.7	-	7.6
April	255.10	1.23	-	20	100	60	5	255.10	0.16	7.9	256.50	0	0	20	150	90	6	171	0	7.9
May	183.20	1.01	0.125	21	100	60	7	183.00	0	8.0	273.60	0.2	0.017	25	100	60	8	153.9	0	8.0
June	1.80	0.50	0.003	19	100	60	7	175.00	0	7.6	239.40	0.3	-	21	100	60	6	171	3.6	7.5
July	188.60	0.23	0.016	20	50	55	3.9	165.00	0	7.5	222.30	0.4	-	22	100	60	5	205.2	3.6	7.5
August	1.66	0.33	0.004	21	100	60	4	190.10	0.35	7.6	205.20	0.4	0.04	12	50	30	6	153.9	0.03	7.6
September	1.23	1.22	2.228	14	100	30	7	189.30	0.45	7.6	222.30	0.5	0.04	19	50	30	9	223.3	0	8.0
October	239.40	0.00	0	17	50	-	7	188.10	0.03	7.5	222.30	0	0	15	50	30	7	171	0	7.5
November	205.20	0.20	0	10	100	60	7	171.00	0	7.2	188.10	0.2	-	19	100	60	9	153.9	0	7.6
December	205.20	0.20	-	14	100	60	7.5	153.90	0	7.0	239.4	0.4	0.018	15	100	60	10	188.1	0.33	7.5

Present work reveals that dissolved oxygen decreased in July but high dissolved oxygen content was recorded during the month of December. This finding is less similar to that of Kohinoor *et al.* (2003).

Lagler (1956) believed that spawning results from a combination of changes especially those involving temperature, pH, oxygen and dissolved chemicals. The gonads of the adult females usually contain many large eggs and remain in this condition for many days or weeks. Then on the appearance of the bright day, a number of females will spawn at nearly same time. Moreover, light also have some effect on ovulation of fishes.

Behavior

In the present work, it was observed that *A. mola* tends to avoid the source of light. Every living animal wants to save themselves from engulfment of the predators. This escaping behaviour is also common to *A. mola*. Manning (1972) reported that *T. nalalensis, T. mossambiona* and other cichlid fish showed escaping behavior.

Morphometry

The smallest specimen of mola was measured 0.5 cm in total length and the largest was 9.0 cm. These were collected in the month of January and August respectively. The largest size specimens were available from July to August. The medium sizes were observed from February to June. The juvenile and immature fishes were also found during December and January.

Good catches were obtained from August to January. The smallest and the largest females were 4.3 cm and 8.9 cm in their length, respectively, having weight of 0.5 g and 5.6 g respectively. In the month of June in both the year it was found that the first size group ranging from 0.1-0.9 cm was representative whereas the size groups of 5.0-5.9 cm and 8.0-8.9 cm formed only 10%, which were the lowest and 6.0-6.9 cm and 7.0-7.9 cm size groups formed 40%, which was the highest. In July of both the years these two size groups formed 70% and 30%, respectively.

Sex-determination

Male and female fishes could be clearly distinguished only in the breeding season. In the early stages, it was very difficult to separate them from each other. For breeding purposes, it was necessary to separate male and female rapidly and accurately through some external characters.

Males and females were different in color. The males were comparatively brighter than the females. The color of females was light and they were large in size. In case of mature female the abdomen was soft and swollen, pelvic fins were smooth and caudal fin was deeply forked. During the spawning season their distended abdomen easily recognized mature females.

Sex-ratio

In the studied population, the ratio of males and females was approximately 1:1.71. Identification of sex was based on the secondary sexual characters and the maturation of ova and testes of females and males, respectively. Separation of sex was much easier for adult fishes. There were well-marked external differences between the two sexes. Monthly analysis of sex ratio indicated that male and female fishes did not occur in constant proportion of the fishing grounds but might very considerably from month to month (Table 2).

Table 2. Average month wise sex ratio of *A. mola* in pond and beel for two years

Months	Pond				Beel			
	Male (%)	Female (%)	Ratio		Male (%)	Female (%)	Ratio	
January	46.67	53.33	1	1.14	50.00	50.00	1	1.1
February	48.15	51.85	1	1.07	40.91	59.09	1	1.44
March	48.89	51.11	1	1.04	35.00	65.01	1	1.83
April	20.63	79.37	1	3.84	24.24	75.76	1	3.13
May	20.00	80.00	1	4.00	15.15	84.85	1	4.60
June	21.67	78.33	1	3.61	16.67	83.33	1	4.99
July	31.82	68.18	1	2.14	16.67	83.33	1	4.99
August	33.85	66.15	1	1.95	22.73	77.27	1	3.39
September	25.00	75.00	1	3.00	16.13	83.87	1	5.19
October	37.21	62.79	1	1.69	40.00	60.00	1	1.50
November	56.14	43.86	1	0.78	47.50	52.50	1	1.10
December	60.38	39.62	1	0.66	52.27	47.73	1	0.91

In pond condition, except November and December the females were predominant in the population and highest percentage of females (80%) was observed in the month of May. The percentage of females started to decrease up to August. Then again started to increase and another pick was observed in September (75%). After that started to decrease from October and the lowest percentage was observed in December (39.62%). In case of beel similar trend was found. The highest (52.27%) percentage of male was recorded in December and lowest (15.15%) in May. Simultaneously, the highest (84.85%) percentage of female was recorded in May and the lowest (47.73%) in December.

Separation of sex of *A. mola* was much easier for adult fishes. There were marked external differences between the two sexes. Huq (1977) reported that the area of genital pore was observed to be quite helpful for identification of sexes in catfishes of Bangladesh.

Maturation and breeding seasons

Maturation

Maturity was studied by physical and histological features of testes and ovaries and ova-diameters frequency method for male and female mola. For physical features of gonads, length and weight of

the gonads were compared with the body length and weight, color and other noticeable features were also compared with each other. Present study observed that the fishes were matured at the length of 5, 6, 7 and 8-cm. However, it was observed that the fish gained first maturation within 4 to 5 months although all of them did not breed.

It was found that the fish was quite mature at the age of fourth and fifth months. According to some scientists, commencement of full maturity seems to depend on age, size and also on temperature (Lagler 1956).

Male attained maturity earlier than female. Similar investigation made by Kohinoor *et al.* (2003) supports the existence of this pattern in *A. mola*. The workers in this field had classified the maturity stages of various fishes according to various features *viz.*, general appearance, color, shape and size, position of the gonads, ova diameter, etc.

In the present study, five stages of oocyte maturation were identified such as: (a) immature, (b) maturing, (c) mature, (d) ripe and (e) spent stage.

Size of first maturity

As only mature mola fish entered the area of the pond to spawn, the size of males and females in the samples gave information on the size at which mola fish attained sexual maturity first. The smallest mature male mola collected was 4.8 cm in total length and 1.90 g in weight and the female was 5.5 cm in total length and 2.2 g in weight as the growth rate of females was more than that of males.

Reproductive organs

The reproductive organs of mola fish consisted of bilobed gonads. Both testes and ovary were asymmetrical in respect to size, length and weight. Gonads of different stages of maturity differed in shape, size and color etc in different seasons.

Female reproductive system of A. mola

Paired ovaries are situated above the alimentary canal and below the kidney. The length of the ovaries varies with the size of the fish. The two lobes of each ovary were elongated and they were connected along their dorsal surface by their mesentery from which they were suspended in the abdominal cavity. The two ducts extending from the posterior ends of ovary united to form a common oviduct leading to form a common oviduct leading to the urogenital pore.

In an immature female, the ovaries appeared as compact thread-like whitish structure and extended anteriorly up to the cardiac stomach and posteriorly up to the urogenital pore.

In mature female, the ovary was more massive and extended anteriorly behind the cardiac stomach posteriorly up to the urogenital pore. The ripe ovary might be extended up to the back of the esophagus and posteriorly up to the end of urogenital pore. In ripe stage the ovary covered three fourth of the abdominal cavity. A membranous capsule enclosed each ovary, which was continuous of its side with the wall of the oviduct.

A. mola had bilobed ovary of which the right lobe is always bigger than the left one at the ripe stage. On ventral side each lobe of the ovary was attached with a well-developed distinct fatty layer. While recording the weight of the ovary these fatty layer was carefully separated from the ovary and discarded.

Male reproductive system

The testes of *A. mola* were creamy white, elongated, and paired structures. It had two divisions the right and the left lobes and was equal in size. They were attached to the body wall by mesenteries. During the spawning season, the testes became whitish in color and flesh. The shape of testes became much larger at this time than a normal one. The weight of a fully mature male gonad was 0.3 g.

During the months of May to August, the male used to shed white milt and after spawning season it became lighter in weight. This stage was also known as spent stage. The spent male gonad appeared as a very thin and thread-like structure. There was no trace of the whitish substance any more. The weight of a typical spent mola gonad varied from 0.1 to 0.5 g.

Description of maturation stages

The maturation cycle of gonads was followed during present investigation by defining the following five stages of maturation. A description of maturity stages is given below:

Stage I (Immature), Stage II (Maturing), Stage III (Mature), Stage IV (Ripe) and Stage V (Spent).

Stage I (Immature)

The testes were small and occupied about one sixth of the body cavity. The ovaries of *A. mola* appeared as small thread-like and nearly whitish in color. Ova were not visible in naked eye. Under microscope they were irregular in shape and transparent with a nucleus. Average diameter was less than 0.042 mm.

Stage II (Maturing)

The testes during this stage gradually increased in size and weight and occupied from one fifth to one third of the body cavity. Maturing ova of *A. mola* were spherical and partly opaque due to commencement of yolk formation. Ovaries occupied about half of the space of the body cavity. Color of the ovaries remained white or whitish yellow. Before going to the mature stage it turned yellow in color, diameter was less than 0.140 mm.

Stage III (Mature)

The tastes became fully mature and occupied the whole body cavity. Ovaries enlarged to their maximum size and became highly distended. The ovaries occupied three forth or most of the space in the body cavity. Ovaries in majority of cases were spherical and in some slightly oval and transparent at the periphery. These were yellow and reddish yellow in color. The ova showed a general increases in size and diameter was less than 0.336 mm.

Stage IV (Ripe)

A. mola started to spawn during this stage. This size and the weight of the testes became considerably reduced. The colors of the testes were whitish yellow. At this stage the ovary became deep yellow and reddish yellow in color. These were fully ripe, enlarged and occupied much of the body cavity. Majority of the ova were spherical and a few were oval in shape. The whole cytoplasmic region was full of yolk formation. At this stage, the ova gained the full size and were liberated from the ovary to the outside via oviducts. The diameter of ova was less than 0.574 mm.

Stage V (Spent)

During this stage the size and the weight of the testes became considerably reduced. In *A. mola* this stage included ovaries which was partially in spent and fully spent condition. Color was mainly pale whitish. The fully spent ovary had bloodshot in fresh condition and appeared as empty bag. The model size of ova at this stage corresponded with the stage II. In some cases it was observed that the ovary was found to contain both ripe as well as degenerating oocytes.

Distribution and patterns of eggs in a spent ovary

Spent ovary became regressed and irregular in shape. Spent fish could be distinguished from immature fish by the pigmented covering of the ovary, which was transparent in immature fish. Only the right ovary was taken and dissected carefully to show the distribution of the eggs. It was found that immature eggs were white, smaller and numerous; and arranged in definite rows. The egg diameter ranged from 0.024 to 0.568 mm. Most of the eggs had lost their spherical shape, became irregular and very soft. At this stage the eggs were delicate and impossible to count.

Percentages of ovigenous female

Average monthly percentage of ovigenous female Mola in the pond was the highest (81.08%) in September and lowest (20%) in November. In case of beel, the highest (87.30%) percentage was found in May and the lowest (28.57%) were found in November. In both pond and beel two peaks were observed in May and in September. Percentages of ovigenous female of Mola in a pond and in a beel are presented in Table 3.

Table 3. Average monthly percentage of ovigenous female of *A. mola* in pond and beel for two years

Months	Pond		Beel	
	No. of gravid female	Percentage (%)	No. of gravid female	Percentage (%)
January	0	0	0	0
February	0	0	0	0
March	7	30.43	11	47.83
April	19	52.78	30	42.86
May	40	80.00	55	87.30
June	23	48.94	28	46.67
July	30	58.82	32	49.23
August	22	57.89	30	53.57
September	30	81.08	26	81.25
October	13	48.15	12	40.00
November	5	20.00	6	28.57
December	0	0	0	0

Gonado-Somatic Index (GSI) and Gonadal length index (GLI)

The GSI and GLI are the indicators of the status of gonadal development and maturity of individuals of mola was calculated for female during the whole year. In the pond both GSI and GLI showed two distinct peaks one in May and another in September. GSI values were 19.51% and 22.48% and GLI values were 36.31% and 36.19%, respectively. Similar peaks were found in the beel where GSI values were 20.98% and 18.72% and GLI values were 41.77% and 40.58%, respectively. Average GLI in pond was 25.96%, which is lower than that of beel fish (31.16%). On the other hand, average GSI was higher (13.92%) in pond fish sample than that of beel (10.69%).

In certain months of the year the mature females carried mature and ripe ovaries, which increased the value of GSI and GLI. Such higher values of GSI and GLI were observed during the months of May to September. Such type of variation in GSI and GLI only occurred in mature as reproductively active fish.

Average length of the fish, body weight, length of the gonad, weight of the gonad, percentage of gonadal length index (GLI) and percentage of gonado-somatic index (GSI) of Mola in a pond and in a beel are presented in Table 4. Observation on GSI and GLI during different months of the year indicates that the female Mola remained mature in the months from May to September.

Table 4. Gonadal length index (GLI) and Gonado-somatic index (GSI) of *A. mola* in ponds and beels for two years

Months	Pond		Beel	
	GLI	GSI	GLI	GSI
January	11.55	4.00	21.34	1.80
February	15.21	11.79	22.54	2.40
March	22.72	13.92	26.57	7.30
April	27.61	16.86	33.92	11.68
May	36.31	19.51	41.77	20.98
June	34.01	18.03	40.95	14.28
July	30.77	13.69	37.01	16.69
August	29.06	12.93	25.00	14.49
September	36.19	22.48	40.58	18.72
October	32.41	14.85	36.92	9.93
November	22.91	10.97	24.09	6.29
December	12.80	8.01	22.24	3.74

Afroze and Hossain (1990) observed that the GSI values of Mola were maximum in August and minimum in November. They stated that the GSI values of male and female Mola began to increase from January with a peak in March followed by a steep fall in April. Again the index values began to rise and there was a second peak in June and a third peak in September. Peaks of the GSI index values in March, June and September might be due to the completion of maturity and subsequent steep fall in the index values clearly indicated alternatively the spawning and spent condition of fish.

Fecundity

For fecundity study, Mola samples were divided into seven size groups from 5.0 cm up to 8.5 cm at 0.5 cm interval.

In the pond the lowest mean gonadal weight was 112.56±155.00 mg in the size group of 5.0–5.5 cm and the highest was 799.52±11.23 mg in the size group of 8.1-8.5 cm. The lowest fecundity was 1023±625 and the highest was 6,806±125 in the size groups ranging from 5.0-5.5cm and 8.1-8.5 cm respectively (Table 5). In the beel, the lowest mean gonadal weight was 115.60+159.00 mg in size group of 5.0-5.5 cm and the highest was 805.25+15.29 mg in the size group of 8.1-8.5 cm. The lowest fecundity was found 1220+550 and the highest was found 6923+425 in the size group 5.0-5.5 cm and 8.1-8.5 cm, respectively (Table 5).

The number of eggs produced by a female depended on various factors like size, age, condition and types of samples (Lagler, 1956). Generally, it has been found that the number of eggs increased with the size of fish. Wotton (1973) suggested that variation in fecundity was primarily a reflection of variation in the size of fish at maturity.

Table 5. Fecundity of *A. mola* in pond

Group Size in length (cm)	Pond	Beel
5.0-5.5	1,023±625	1,220±550
5.6-6.0	1,935±597	1,950±595
6.1-6.5	2,665±816	2,775±725
6.6-7.0	3,039±1145	3,240±725
7.1-7.5	4,089±1856	4,335±515
7.6-8.0	4,113±1810	4,445±650
8.1-8.5	6,806±125	6,923±425

Mookherjee and Basu (1946) reported that a single female of Mola laid 500 eggs in West Bengal. Dewan and Doha (1979) observed that the fecundity of Mola ranged from 1,021 to 13,815 in Bangladesh. Parveen (1984) stated that the average fecundity of Mola was 3,601. Misra and Jain (1985) showed that the fecundity of Mola ranged from 1,210 to 16,072. In another study, Afroze and Hossain (1990) stated that the fecundity of Mola varied from 400 to 8,550. Mustafa (1991) studied the fecundity and breeding season of Mola and observed that the mean fecundity was 738.

Ova diameter (OD)

The ova with maximum diameters were found in May and September in both pond and beel of both years. In the month of January the average diameter of avarian aggs was minimum (84 μm) in pond.

Then it showed increasing trend from February to April and one peak was observed in May in both pond and beel (30 μm and 48 μm) then a drop was observed in June and it remained approximately same up to August. Then another peak was observed in September in both pond and beel (29 μm for pond and 48 μm for beel). After that it showed decreasing trend from October to December in both pond and beel.

The month-wise range of the diameter of the eggs was not so affected by the seasonal variation but mean value was influenced by the seasonal factors.

The reason behind this was the frequent occurrence of mature and ripe ova in certain months. Maturing or immature ova in the ovary were more frequent in the other months. This was obvious that mature and ripe ova were found in the ovary of mature female once in May and again in September of the year in both pond and beel and this was the period of highest reproductive activity in *A mola*. From the above observations it appears clearly that the fish might spawn twice in a year once in May and again in September.

There is great variation in the frequency of the reproductive cycle as well as the time or times of the year that occurs in various fish (Orr, 1967). Majority of the fishes exhibit a marked seasonal cycle in egg production.

The ova with maximum diameter were found in the months of May and September of the same year. In the month of January, the average diameter of ovarian eggs was less than that of December but from February the diameter of ova began to increase gradually. Thus it might be concluded that mature and ripe ova were commonly found in the ovary of mature female between April and October and this was the period of highest reproductive activity of *A. mola*.

GSI, GLI, Fecundity, OD of monthly ovary samples supported the existence of two spawning seasons of Mola (one in May and the other in September). These results are supported by the findings of Mustafa (1991) who observed and noted the existence of two spawning seasons on the basis of ova diameter and GSI.

Reproductive cycle and breeding season

Out of several methods in vogue to assess the reproductive cycle, some of them were used in the present study of *A. mola*. By all methods it became clear that rainy season is the most intensive breeding season in this specimen.

CONCLUSION

The above results showed that during the month from April to October the ovaries were matured and ripe in condition. Higher percentage of gravid females, maximum GLI & GSI, OD and fecundity values suggested that the reproductive cycle of Mola is from April to October with two peaks, one in May and other in September *i.e.,* it breeds twice in a year in both closed and open water environment.

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