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Reproductive biology of an endangered catfish, *Ompok bimaculatus* (Bloch, 1794) in the lotic waterbodies of Tripura, North-East India

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Abstract
The reproductive biological characteristics of *Ompok bimaculatus,* an endangered catfish of commercial importance were observed. 436 fish samples were collected from different lotic water bodies of Tripura between 2008 and 2011. Total weight of the sampled fish varied from 22 to 171.50 g and length varied from 16.50 to 33.0 cm. Dominance of female over male was observed in the species. The ratio of male to female was 1:1.65. Significant correlation was exist between fish length and weight in both males (R^2=0.943) and females (R^2=0.827). The regression parameter 'b' was close to 3.084 during summer, showing that fishes were growing isometrically in relation to length. However, value of 'b' during monsoon (b=2.851) and winter (b=2.192) were indicating allometric growth. The condition factor (K) in the females was found to be varied from 0.423 to 0.637 while, in males K value was ranged from 0.279 to 0.514. Monthly variation of maturity stages indicated the spawning period from May to August. Length at first maturity of female and male was 17.0 cm and 16.5 cm respectively. Maximum average Gonado-Somatic Index (GSI) values obtained for male and female were 2.195 and 15.582 respectively during spawning period and declined to minimum in October to January. The ova diameter was ranged from 0.827 to 1.358 mm. The fecundity was varied from 151-257 eggs/g body weight of fish which was highest during May to July. Linear relationship of fecundity with total length and body weight of the fish was found. The present findings divulge significant information on reproductive traits which can be further used for species restoration and captive breeding.

Keywords: *Ompok bimaculatus,* Fecundity, Gonado-Somatic Index, Length at first maturity.

1. Introduction
The fresh water fish fauna of India is a cluster of nearly 2500 species, comprising into three major families known as, *Cyprinidae*, *Siluridae* and *Channidae*, inhabiting in the inland ecosystems [1]. However, a great majority of fishes are yet to be analyzed well. Growth of the fish, the length and weight parameters, have positive influence on reproduction. Commonly the fecundity is more closely related to length than the somatic weight or ovary weight. Knowledge on reproductive traits like size at maturity, spawning, sex-ratio, ova diameter and fecundity are essential pre-requisites in any fishery management and conservation [2]. Since several ecological and physiological factors are largely dependent on size of fish individual rather than age. So, size-parameter is more biologically relevant than the age-parameter. Length and weight data are useful of fish sampling programs [3]. The use of biometric relationships necessitate in fisheries management and research in order to transform data collected in the field into indexes [4]. In a fish population, establishment of relationship between length and weight is essential for the calculation of production and biomass [5]. The condition factor (K) is an index reflecting interactions among biotic and abiotic factors in the physiological condition of the fishes. It shows the well being of the population during various life cycle stages [4]. The reproductive potential of a fish stock is determined by its fecundity. Studies on the reproductive biology of any fish are essential in evaluating the commercial potentialities of its stock, life history, cultural practice and actual management of small indigenous fishes [6]. Information about the reproductive season enables us to set seasonal closures around the reproductive season of the resources [7].
The catfish *Ompok bimaculatus* (Bloch, 1794), locally known as Pabda (butter catfish), is an indigenous freshwater small fish belonging to the family *Siluridae* of the order *Siluriformes* [8]. They are omnivorous feeding habit, mainly feed on insects. It is of high priced, delicious and nutritious and well preferred especially in the entire East and North East India and commonly

Found in natural water bodies; for example, rivers, lakes and floodplains etc. with an extensive geographical distribution in India, Bangladesh, Pakistan, Afghanistan, and Burma [9, 10]. The population has declined drastically as a result of several anthropogenic factors like indiscriminate fishing during the breeding season, wide use of pesticide and siltation in habitat [11, 12]. Owing to reduced abundance and restricted distribution, it has been listed as an endangered (EN) species as per IUCN criterion [13]. Lack of definite information on the biological aspects of this threatened fish species of the river system has hampered the planning and implementation of species specific conservation and management strategies [8]. The catfish *O. bimaculatus* was declared as the State Fish of Tripura, India [14]. Therefore, the aim of this study was to determine the reproductive biology like length-weight relationship, condition factor, sex-ratio, maturity stages, spawning season, Gonado-Somatic Index, size at first maturity, fecundity and egg size in a wild population of *O. bimaculatus* from different lotic habitats distributed in Tripura, North-East India.

2. Materials and Methods

2.1 Study areas

In Tripura, the total length of the river along with other basin is about 10,491.12 km. There are ten rivers found to be available in Tripura. Amongst them the three most important rivers are Gomati, Muhuri and Feni. The length of those three rivers is relatively greater and diversity of fish species is comparatively larger than the other river ecosystems of Tripura (Fig. 1 & Table 1).

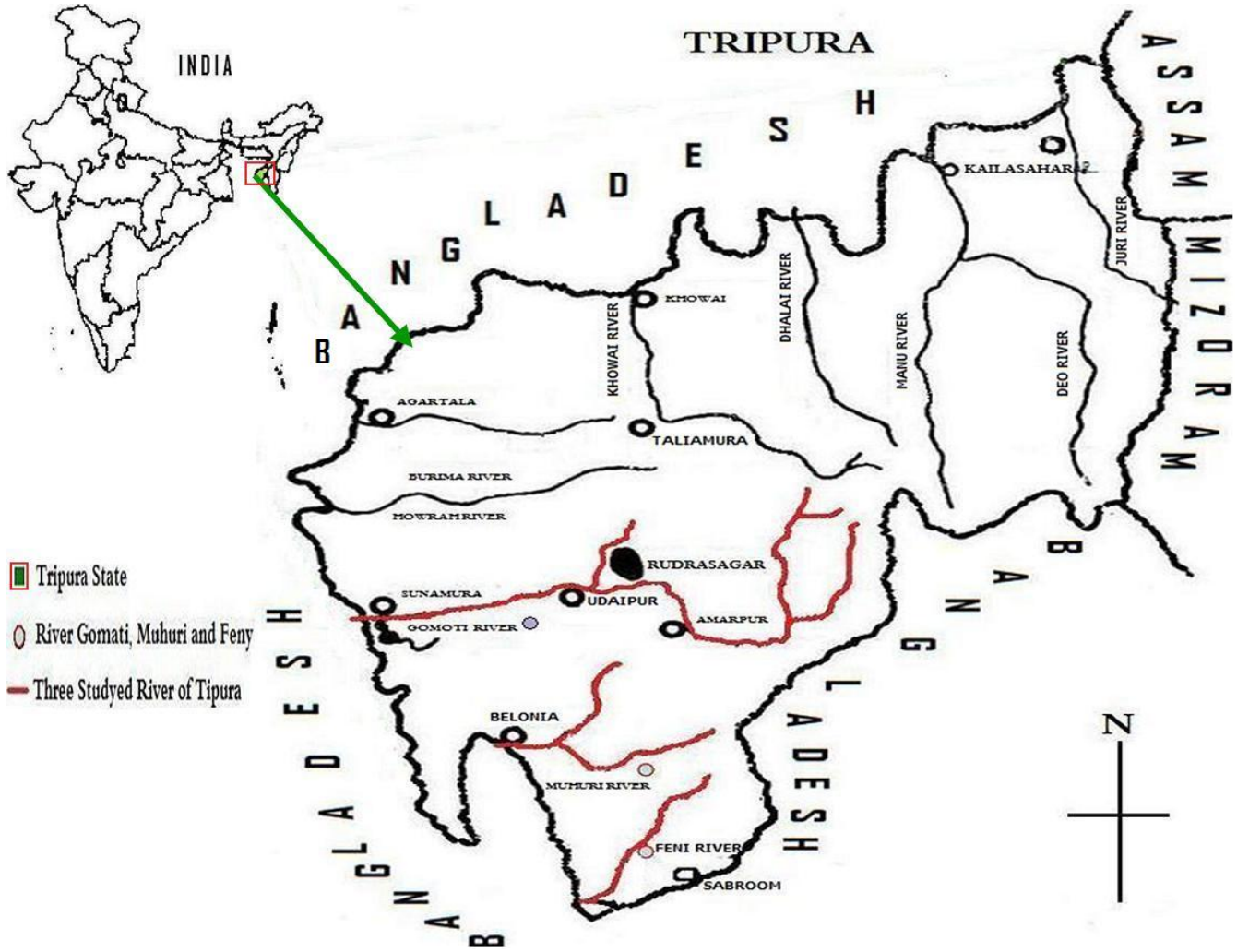

Fig 1: River Map of Tripura (Study Area)

Table 1: Detailed information about the rivers studied in Tripura, India

River	Origin & Flow	Location	Basin area (sq. km.)	% of the basin of total geographical area	Annual flow (in thousand m3)	% flow to total flow
Gomati	Longtharai and Atharamura range, Flow westward via Amarpur, Udaipur, Sonamura to Bangladesh.	$23^0$25'24.19"N, $91^0$45'14.71"E	2378	22.66	249399	31.45
Muhuri	Lushai hill (Deotamura range), Westward flow via Belonia to Bangladesh.	$23^0$11'10.93"N, $91^0$26'47.78"E	839	8.00	76247	9.63
Feni	Deotamura range, westward flow via Sabroom to Bangladesh.	$23^0$00'02.07"N, $91^0$43'51.11"E	555	5.28	50433	6.36

2.2 Physico-chemical Parameters
Physico-chemical characteristics of river water (fish habitat) like temperature, pH, free carbon-dioxide, dissolved oxygen, turbidity, water velocity, bicarbonate, phosphate and nitrate were estimated following APHA [15].

2.3 Biological Parameters
2.3.1 Length–Weight relationship and sex ratio
From February 2008 to January 2011, 436 samples of *O. bimaculatus* were collected from different sites representing different habitats in the river Gomati, Muhuri and Feni of Tripura. Various sizes of fishes were sampled by using gill net and bought to the laboratory. The sampled fish individuals were initially cleaned with double distilled water and then measured for total length with a digital caliper to the nearest 0.1 cm and body weight were determined to the nearest 0.1 g using electronic balance. Fish samples were identified according to Jayaram [10]. The length-weight relationship was estimated separately for males and females, using the linear form of the formula by Le Cren [16]: W = a x Lb (where, W = weight of the fish in g; L = length of the fish in mm and 'a' and 'b' are constants. The equation has been transformed into the following logarithmic form: Log W = log a + b log L and the values of 'a' and 'b' were determined empirically. The condition factor (K) was calculated from the relationship of Fulton [17]: K =100 × (W/L^3), where, W= body weight of the fish in g, and L = total length of fish in cm. The 95% confidence limits were determined in order to compare the variations among seasons. The sex ratio was estimated for each month from the proportion of females to males articulated as the percentage of the total sample. For this purpose the body colour and other morphological features were noticed under binocular microscope.

2.3.2 Maturity stage and spawning season
The maturity stages were ascertained on the basis of the degree of development of testes in males and ovaries in females. Cycle of gonadal maturation and breeding season has been studied by macroscopic and monthly examination of the different maturation stages of gonad; male and female gonads have then been grouped into different gonadal stages of development according to Nikolsky [18]. The percentage of mature individuals relative to immature and premature individuals was estimated for each age group and integrated to the logistic model Y= [1+ e(aX + b)]- 1, where Y is the proportion of individuals that were mature at age X, a and b are empirical parameters.

2.3.3 Length at first sexual maturity (L_{50})
Length at first maturity was estimated as the length at which a randomly chosen specimen had a 50% chance of being mature (with developed ova in their ovaries). Length at first maturity was worked out by plotting the percentages of matured fish individuals (=about 50% was female) against their length [19].

2.3.4 Gonado-Somatic Index (GSI %)
The gonads enlarge to mature as the fish grow. Till the maturity reaches the ripened stage, the relationship of growth of gonads with that of fish is directly proportionate. However, with spawning, as the ova are delivered and the gonad is spent, the weight of it is likely to decrease. Hence, the GSI steadily increases till the development of gonads into ripening. Then there is a notable decline with spawning. This index is calculated for both males and females separately and the monthly mean value was then plotted. Gonado-somatic index (GSI) was determined following the equation of Parameshwaran [20]: GSI = (Weight of gonad / Weight of fish) × 100.

2.3.5 Fecundity
Gravimetrically the fecundity of the fish was observed. During the study, the external connective tissues were removed carefully from the surface of the ovaries. With the help of blotting paper moisture of the ovaries was removed. Weight of the ovaries was recorded with fine electronic balance. Then 0.01 g of each ovary was taken out separately from anterior, middle and posterior regions of each ovarian lobe. The number of mature and immature eggs for each portion was sorted out and counted. The fecundity of the studied fish was observed adopting the methodology of Le Cren [16]: Fecundity= (number of eggs in the sample x weight of gonad) / weight of the sample. Relationship of fecundity with various body dimensions such as body length, body weight, ovary length and ovary weight were transferred into log transformed and least squares regression equation [21]: Log F = log a + b log X, Where, F = Clutch size (fecundity); X = Length/Weight; a = Regression constant, b = Regression coefficient.

2.3.6 Ova diameter
At different stages of the maturity the diameter of the ovum was measured with ocular micrometer under stereoscopic Olympus microscope along the longest axis of the ovum [22]. All data were analyzed using SPSS (version 16.0) for windows software program for statistical analysis. Data are presented as treatment means ± SD.

3. Results
The present study conducted to measure some significant biological parameters of *O. bimaculatus* which is found to occur in lotic ecosystems like Gomati, Muhuri and Feni rivers of Tripura. The depth of the lotic water bodies are varied from 3.5 m during peak summer to 6.7 m during monsoon period. Those freshwater river ecosystems possess certain physico-chemical characteristics as depicted in table 2.

Table 2: Physico-chemical characteristics of Gomati, Muhuri and Feni rivers of Tripura

Sl. No.	Parameter	Gomoti River	Muhuri River	Feni River
1	Water Temperature (^{0}C± SD)	29± 2.2	28± 3.7	29± 2.0
2	pH	7.5±0.92	7.14±0.84	7.6±0.55
3	Dissolved Oxygen (ppm ± SD)	6.0± 2.32	7.8± 2.16	6.5± 2.82
4	Free Carbon-dioxide (ppm ± SD)	1.3±0.12	1.7 ±0.84	1.5±0.12
5	Turbidity (cm ± SD)	2.5±1.1	2.8±1.2	2.6±1.2
6	Water Velocity (m/sec ± SD)	1.3-3.31 ±0.37	1.4-3.29 ±0.97	1.5-3.30 ±0.45
7	Bicarbonate (ppm ± SD)	125±27.10	107±12.10	130±10.16
8	Nitrate (ppm ± SD)	0.042 ± 0.001	0.063 ± 0.004	0.048 ± 0.002
9	Phosphate (ppm ± SD)	0.036 ± 0.002	0.048 ± 0.001	0.050 ± 0.004

Values are Mean ± Standard error.

3.1. Length –Weight relationship and Condition factor

Details of the seasonal variations in regression parameters, minimum and maximum total length range are presented in table 3 & 4. In the present study, value of b=3.084 for *O. bimaculatus* during summer, which is not significantly different than b=3.0, showing that fishes are growing isometrically in relation to length. Regression parameters were found to be highly significant. This indicates that the fishes retain the same shape and it grows isometrically. However, value of b during monsoon (b=2.851) and winter (b=2.192) is different from b=3.0 which is indicating allometric growth. A value less than b=3.0 shows that the fish becomes lighter for its length. Regression equation for male and female in relation to length-weight parameter is presented in Fig. 2 & 3. The value of correlation co-efficient or the value of 'r' for this fish species varies from 0.826-0.967. Generally, the value of 'r' lies between -1 to +1 and when the value is +1 or closer to +1 it indicates the correlation is very strong and positive. So, it indicates that there are very strong and positive correlations in length-weight data of this fish species and the correlations are highly significant. Linear relationship between age and length in *O. bimaculatus* of the studied fish individuals were found out (Fig. 4) and the regression may be expressed as: $y=1.3387x–1.9564$; (R^2 = 0.9918) whereas relationship between age and weight was asymptotic and the regression is expressed as: $y=6.1162x –36.528$; (R^2 = 0.782) (Fig. 5).

The condition factor (K) in the females is found to be varied from 0.423 to 0.637 while, in males K value is ranged from 0.279 to 0.514. A significant difference ($p<0.001$) in the condition factor (K) was noticed among seasons. Higher value of K was noticed in monsoon whereas low value of K was found during winter season.

Table 3: Length-Weight data of *O. bimaculatus* in the lotic waterbodies of Tripura

Sample size (n)	Total Length (cm)		Length Mean (cm)	Weight (g)		Weight
	Max.	Min.		Max.	Min.	Mean (g)
436	33	16.5	23.85	171.5	22	66.68

Table 4: Regression parameters of *O. bimaculatus* in the lotic waterbodies of Tripura

Seasons	'a' value	'b' value	Regression equation	'r' value	't ' test for 'b' value
Summer (February, March, April, May)	0.006	3.084	lnW= -5.0165+3.084*lnL	0.958	Calculated't' value is less than tabulated't' value. So, there is no significant difference of 'b' value.
Manson (June, July, August September)	0.097	2.851	lnW= -2.672+0.951*lnL	0.967	
Winter (October, November, December, January)	0.059	2.192	lnW= -2.819+2.192*lnL	0.826	

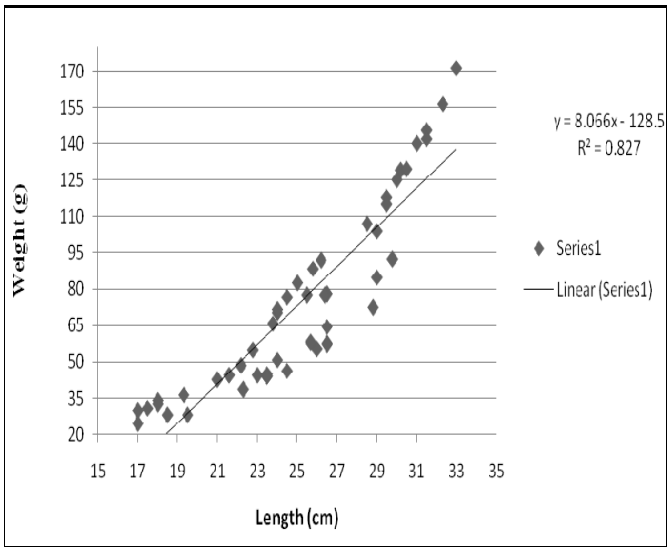

Fig 2: Regression curve showing length and weight relationship of *O. bimaculatus* (male)

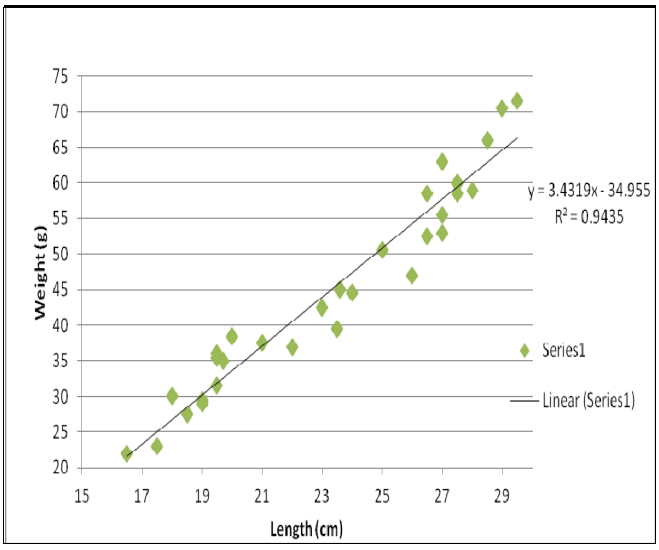

Fig 3: Regression curve showing length and weight relationship of *O. bimaculatus* (female).

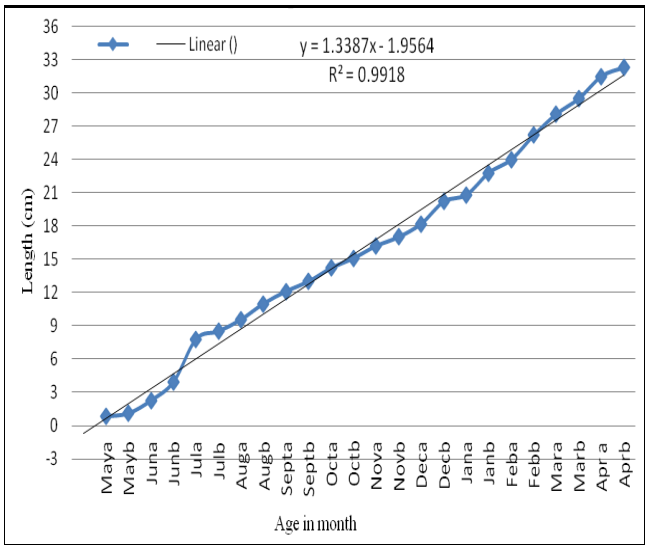

Fig 4: Regression curve showing **r**elationship between age and length in *O. bimaculatus*

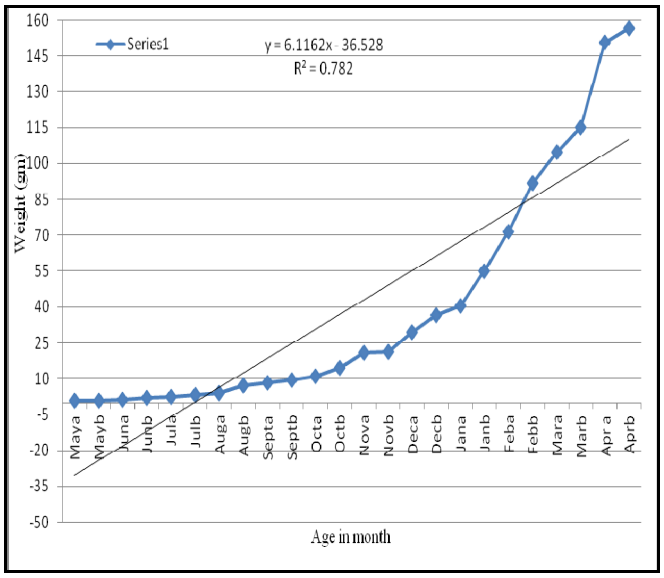

Fig 5: Regression curve showing relationship between age and weight in *O. bimaculatus*

3.2. Sex-ratio

Among the 436 specimens of *O. bimaculatus* studied, 147 and 93 have been observed to be female and male respectively. The overall sex ratio of males to females has been observed to be 1:1.65. The relative abundance of males and females for different length groups and various months were estimated by Chi-square for departure from hypothetical 1:1 ratio on null hypothesis [45]**.** Over the entire study showed significant (Chi-square, P<0.01) monthly variation from expected sex ration of 1:1 where females have shown dominance over males in all month except April, November and January (Table 3).

Table 5: Monthly variation of sex ratio of *O. bimaculatus* in lotic water bodies of Tripura.

Month	No of Male	No of Female	Total No	Sex Ratio	Chi-Square
February	6	15	21	1:2.5	17.24*
March	14	20	34	1:1.4	1.84
April	14	8	22	1:0.6	6.00*
May	10	20	30	1:2.0	6.45*
June	20	22	42	1:1.1	22.41*
July	23	38	61	1:1.6	13.33
August	17	39	56	1:2.9	8.64*
September	6	10	16	1:1.7	0.26
October	18	50	68	1:2.7	27.50*
November	6	4	10	1:0.7	4.14
December	22	50	72	1:2.3	5.41*
January	3	1	4	1:0.3	1.86
Overall	129	307	436	1:1.65	9.59

* Significant @ p=0.05

3.3. Determination of maturity stage

On the basis of microscopic and histological observation, four maturity stages of testes of *O. bimaculatus* have been noticed which are stated below: Stage I (Immature): Testes small in size, whitish in colour, very fine thread like in appearance; Stage II (Mature): Testes inflated in size and weight; colour is creamy whitish, Stage III (Ripe): The size and weight of testes are enlarged; yellowish white in colour. On putting slight pressure on abdomen, milt ooze out. Stage IV (Spent): The size and weight of testes are reduced with transparent appearance.

However, in the female, five maturity stages of ovary have been noticed as follows: Immature (Stage I): Ovaries colorless with thread like appearance. Ova are seen under microscope as irregular in shape but not visible to naked eyes, Maturing (Stage II): Ovaries are yellowish white in colour and ova are visible to naked eyes; Ova are spherical in shape, partly opaque with yolk development, Mature (Stage III): Ovaries light yellowish in colour and enlarged in size; ova are clearly visible to naked eyes, Ripe (Stage IV): Ovaries deep yellow in colour; with maximum size. Under microscope, ova are spherical in shape and opaque due to huge amount of yolk present, Spent (Stage V): Ovaries pale whitish in colour; almost thread like in appearance resembling the Stage I ovary.

3.4. Spawning Season

Stage I (Immature gonads) females have been noticed from December to March; highest percentage being noticed in

December while lowest percentage in March, Stage II (Maturing gonad) females have been found in Late January and available till April; highest percentage being observed in April and lowest percentage in February, Stage III (Mature gonad) females have been noticed from March to June; highest percentage being noticed in May and lowest percentage in March, Stage IV (Ripe) females have been noticed from May to September with highest percentage being noticed in June-July and lowest percentage in September, Stage V (Spent) females have been noticed in October and December; highest percentage being observed in December and lowest percentage in October. Males with Immature gonads (Stage I) have been noticed from January to March; highest percentage being noticed in February and lowest percentage in March. Matured gonad (Stage II) males first have been noticed in March and available till August; highest percentage being noticed in April and lowest percentage in August. Ripe gonad (Stage III) males have been noticed from April to September; highest percentage has been noticed in June-July while lowest percentage in September. Spent (Stage IV) males have been noticed from October to January; highest percentage being noticed in December and lowest percentage in January.

3.5. Length at first sexual maturity (L_{50})

The percentage distribution of mature ovaries and testes (Stage IV and above) in relation to length was found out. This depicted that the minimum length during sexual maturity was 16.3 cm in case of male and 17.0 cm in the female as well. Interestingly, all the females at the length of 17.0 cm were mature. In male, a length of less than 16.0 cm was immature condition. The largest immature male was 22.5 cm while the largest immature female was 24.3 cm. Length at first sexual maturity (L_{50}) varied with respect to sex where higher value was observed for females.

3.6. Gonado-Somatic Index (GSI %)

The GSI value of male and female was low during September to April. The GSI of both sexes increased monthly and attained its maximum level in June. The GSI of female was relatively greater than that of males. In the female there were very low GSI (%) as observed during January to March (4.723). Thus, it represented the occurrence of pre-spawning period during January to March. The GSI value increased gradually to reach at the greater value (15.582) in June (Spawning period), which was later on declined to minimum value (1.54). In male, there were very low GSI (%) as observed during January to March (0.421). Hence, it indicated that the pre-spawning period was developed during January to March. The GSI value enhanced gradually to a higher value of 2.195 in June (Spawning period) and then declined to minimum value of 0.392 in September. The data of the GSI of females and males are presented in Fig. 6 & 7.

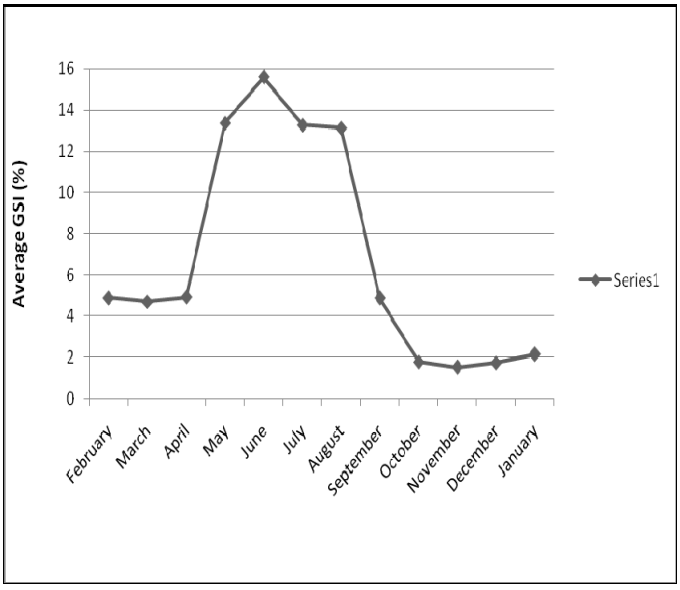

Fig 6: Monthly variation of Average GSI (%) of female *O. bimaculatus*

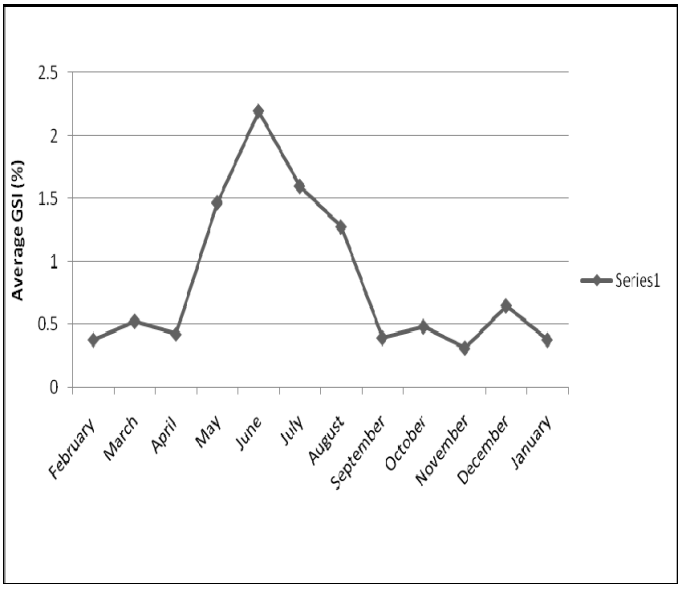

Fig 7: Monthly variation of Average GSI (%) of male *O. bimaculatus*

3.7. Fecundity

The absolute fecundity of the studied fish varied from 2190 to 41552 eggs/fish. However, the relative fecundity ranged from 151-257 eggs/g body weight of fish. The mean value of eggs per gram of ovary varied in month from a minimum of 168 in September to a maximum of 2465 in July. Fecundity was higher during May-July, which declined sharply during August-October and remained constant till January. Linear relationship of fecundity with total length and body weight of the studied fish individuals were found out (Fig. 8 & 9) and the regression may be expressed as: $y = 1237.x - 2670$; ($r^2 = 0.721$, $P<0.001$) and $y = 1394.x - 4388$; ($r^2 = 0.824$, $P<0.001$) respectively. So, fecundity was directly proportional to the length and weight of the studied fish species. Fecundity was also showing direct relationship with the weight of the ovary (Fig. 10). Monthly variation of average fecundity is being presented in Fig. 11.

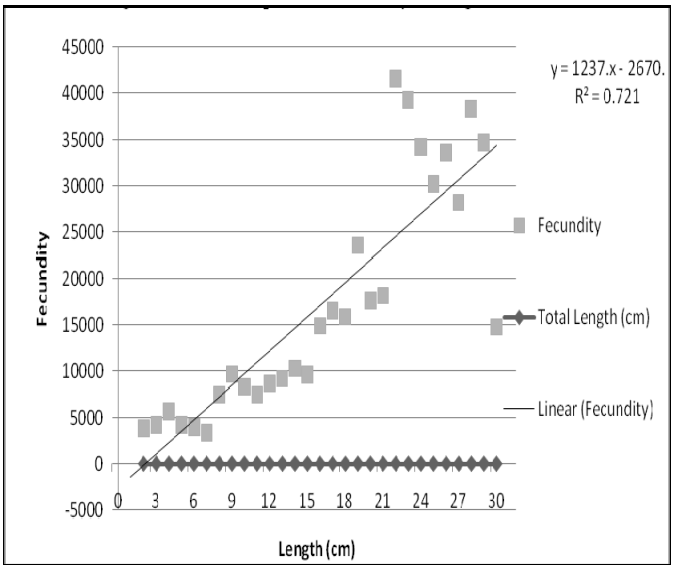

Fig 8: Regression curve showing **r**elationship between Fecundity and length of *O. bimaculatus*

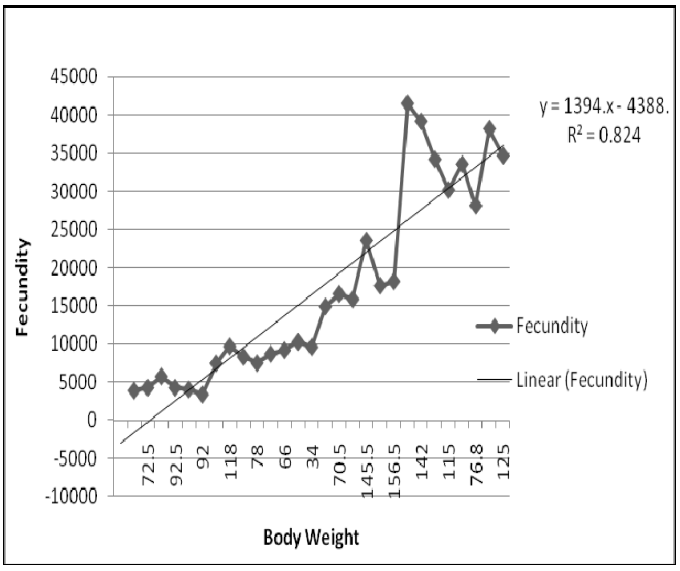

Fig 9: Regression curve showing relationship between Fecundity and weight of *O. bimaculatus*

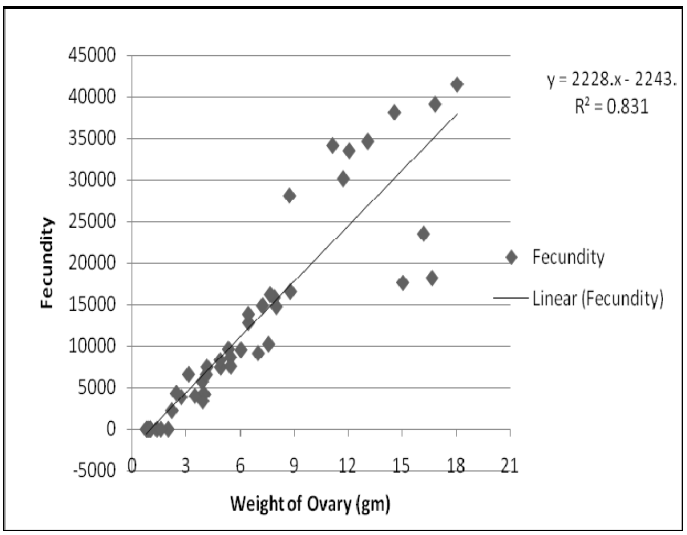

Fig 10: Regression curve showing relationship between Fecundity and Ovary weight of *O. bimaculatus*

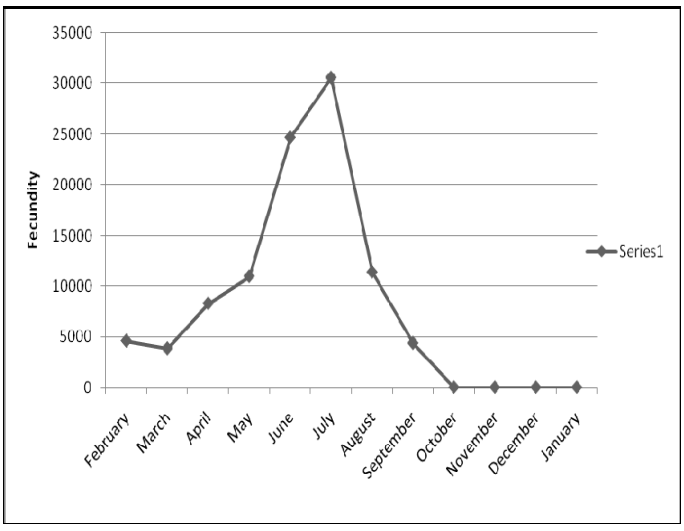

Fig 11: Monthly variation of Average Fecundity of *O. bimaculatus*

3.8. Ova diameter

The diameter of immature eggs ranged from 0.218 mm- 0.543 mm. While before spawning the diameter of the eggs varied from 0.548 - 0.806 mm. In mature eggs the diameter ranged from 0.856 mm- 1.358 mm. The frequency of occurrence of eggs at different diameter plotted against different months showed that immature eggs were found out during February–April and matures eggs in the month of May-July. Since August the development of mature eggs decreased quantitatively (Fig. 12).

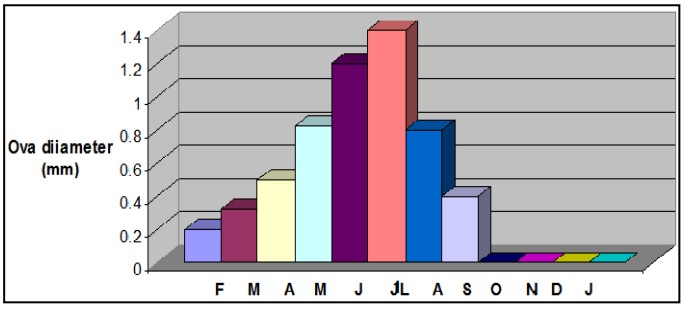

Fig 12: Monthly variations of diameter of ova in *O. bimaculatus*

4. Discussion

According to Hile [23], the value of 'b' usually remains constant at 3.0 for an ideal fish. However, Beverton and Holt [24] suggested the departure of the 'b' value from 3 is rare in adult fishes. The regression parameter 'b' value has been reported less than 3 for *Labeo calbasu* from Soni River and *Rasbora daniconius* from Karnataka [25, 26]. The 'b' values was 2.34 for *Crenicichla britskii*, 2.48 for *Trachydoras paraguayensis*, 2.40 for *Leporinus amblyrhynchus*, 2.78 for *Schizodon cl plantae*, 3.35 for *Loricaria spp.* [27]. The value of 'b' less than 3 in the present study on *O. bimaculatus* also indicates that the growth is not proportionate. However, in case of 'b' value, for the significance testing (t-test) with 7 degrees of freedom and at 0.05% significance level and found that the calculated 't' value is lesser than tabulated 't' value. So, there is no significant difference between the 'b' values of this fish and thus the result of this study is valid. Even though the change of 'b' values depends primarily on the shape and fatness of the species, various factors may be responsible for the differences in parameters of the length-weight relationships among seasons and years, such as temperature, salinity, food (quantity, quality and size), sex, time of year and stage of maturity [28]. The value of 'b' more than 3 during summer

season, pointing out that the sample size is large and they were in better condition [29]. The length weight relationship parameters are influenced by number of factors like season, habitat, sex, diet, gonad maturity, stomach fullness, and health [30].

The condition factor (K) of *O. bimaculatus* showed significant seasonal differentiations ($p<0.001$). The fluctuations in 'b' values from 3 during the monsoon and winter season revealed that the length weight relationship followed the cube law and might be influenced by the general condition of appetite and gonad contents. These factors are also responsible for the differences in condition factor (K). This may be due to variations in the state of maturity and availability of fish food organisms in the riverine ecosystem [31].

Dominance of the female species of *O. bimaculatus* over the male as observed in this study has similarly been observed in populations of other catfishes in lotic water bodies [32, 33]. Ham [34] ascribed this divergence to differential survival over other ecological conditions, whereas Fagade [35] elucidated the event as a mechanism for population regulation.

Males (16.5 cm) reach sexual maturity before females (17.0 cm). In order to understand the dynamics of the gonads and to assess reproductive mechanism of a species, information of the phases of gonadal development is virtually vital. In this species, the stage of maturity is noticed with the volume of gonad. Variations in the form of gonad were found to be noticed during filli-form appearance of the immature stage to the development of mature lobular stage during the maturation process. The maturation process stops with the formation of wrinkle-shaped gonad after completion of spawning. At that period the gonad looks like dull and lobule. Bruton [36] also observed similar findings on the reproductive cycle and gonad development stages in different fish species.

The breeding period of a fish species is found to be restricted to a definite duration [37]. Present observations also recorded that ovaries carry immature eggs during January-April and mature eggs during a period of May- July. This indicated that the studied fish species has a long spawning period, which extended from May to August. Damagala [38] opined that in trout fish all the eggs in an ovary mature at a time irrespective variations of length and weight. Similar observations were also noticed in the present studies. It is also noticed that the changes in GSI and egg diameter are characteristic features of fishes with cyclic and annual spawning season [39].

De Vlaming [40] considered Gonad Somatic Index (GSI) as indicator of the spawning period in teleosts. GSI (%) is found to be more appropriate in reproductive biology when associated with other indicators of the reproduction under macroscopic observations [41, 42]. Dmittincko [43] pointed out that the GSI for female was always higher than that for male probably due to greater weight of the ripe female gonad. The fluctuations of GSI value confirmed that *O. bimaculatus* began to spawn in June and continued till August with peak of GSI in June-July, characterizing a single annual spawning period and synchronic ovarian development corresponding to the warm season or associated with high water temperature [7, 41].

In the present studies, absolute fecundity varied from 2,190 to 41,552 eggs/fish which is relatively similar in comparison to the other catfishes. Gaigher [44] recorded 70,000 eggs for *C. gariepinus* in Hardap dam, south West Africa. Whereas, 6,50, 625 eggs were reported in *C. gariepinus* in Opa reservoir, Nigeria [32]. Fecundity of *Silurus triostegus* in Ataturk Dam Lake varied from 6,800 to 1,20,300 [45]. Variations in fecundity of fish species may be due to selectively different environmental factors such as water temperature, feeding, food abundance, species differentiation, nutritional resources etc. [21]. Peak season of fecundity of *O. bimaculatus* coincides with the onset of rain fall and flood water during May to August [46]. Harding [47] stated that most of the tropical fishes are adopted to breed on the rising flood conditions. Thus allowing the juveniles to take full advantage of the flooded banks for smooth feeding purpose and thus protected from predation. The choice of a particular season in fishes for breeding is influenced by various factors among these are changes in water quality characteristics, inter specific interactions and occurrence of suitable spawning sites [47]. Further, the present findings revealed a significant correlation ($r=0.831$) between fecundity and ovary weight.

The diameter of ova during peak season was ranged from 0.856 mm to 1.358 mm in the present observation. Similarly Nawar and Yoakin [48] noticed egg size in *C. auratus* ranged from 0.8 to 1.25 mm diameter. In fact, Douglas [49] also observed egg diameter ranged from 0.3 to 1.2 mm for *C. filamentosus* in Lake Kariba, South Africa.

5. Conclusions

According to the reproductive items, it can be concluded that the spawning season of *O. bimaculatus* extend from May to August. Length of first maturity of female *O. bimaculatus* is 17.0 cm and males 16.5 cm, respectively. Peak of GSI (%) in June/July, that is, single annual spawning is corresponding to the high rainfall and water temperature. Peak fecundity was observed during monsoon climate (June-July). Fecundity to a large extend depend on environmental conditions. Therefore, the results of present observations may be beneficial for species conservation and management strategies in the lotic ecosystem of Tripura and similar rivers and tributaries.

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7. References

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