ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 5, Issue, 03, pp.542-546, March, 2013

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

REPRODUCTIVE BIOLOGY OF *CHANNA PUNCTATUS* (BLOCH) FROM PADDY FIELD OF SIVASAGAR, ASSAM

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ARTICLE INFO

Article History:
Received 25th December, 2012
Received in revised form
26th January, 2013
Accepted 19th February, 2013
Published online 19th March, 2013

Key words:
Channa punctatus,
Maturity,
GSR,
Size at first maturity,
Ova diameter,
Fecundity, Assam

ABSTRACT

Generally *Channa punctatus* females are relatively smaller in size and have bulging abdomen while males possess, pin head like black dots on the ventral region of the body. The six different maturity stages have been recorded. The immature and maturing specimens were encountered from October-February, while developing, mature and gravid fish were recorded in February-March and spent fishes were recorded in between April and September. The gonadosomatic ratio (GSR) was increased gradually from February onwards reaching its maximum in April (10.81) and decline from June and July and thereafter it again increased in August (3.38) and September (4.57) and reached it minimum during November (1.34) and January (1.17). Size at first maturity (M_{50}) was observed for female and males at length group of 9.0-15.0 cm. The mean ova diameter of maturing was recorded was 0.34 (±0.03) mm; developing was 0.52 (± 0.16) mm; mature ova was 0.79 (±0.18) mm; gravid was 0.92 (±0.25) mm. Absolute fecundity was ranged from 2423 to 6466 and the number of eggs increases as the fishes gain in weight and length. Again, the relative fecundity varied from 104 to 216 and the value is found to be comparatively high in the younger size groups. The relationship of fecundity with total length, total weight and ovary weight has been calculated. *C. punctatus* are heterochronal breeder having two peak breeding season in April and September and it may be inferred that *C. punctatus* spawn twice in a year with double spawning peak. Spawning season was over by August and December onwards.

INTRODUCTION

The spotted snakehead, *Channa punctatus* (Bloch) belonging to the family Channidae, distributed throughout the South-East Asian countries and as far as north- eastern region of India is concerned, 9 species of *Channa* have been reported from this region (Musikasinthorn, 2000). It has been identified as a potential species for rearing in paddy fields, derelict and swampy water as it is a hardy and air-breathing fish. The fish breeds during south-west and north-east monsoons in flooded rivers and ponds and frequently found in flooded rice-fields of Assam. Of freshwater food fishes of N. E. India, they are amongst the easiest to transport due to their air-breathing abilities and hardness. In local markets, they are kept in large bins or tubs in large numbers in little water without aeration. Scanning of literature revealed a wide range of works on the biology of murrels. Reddy (1981) studied the length–weight relationship, condition factor and biometric indices of *Channa* species. The morphology of *Channa* species in the context of species confirmation is well reviewed in most of the taxonomic literature (Rao and Reddy, 1984 and Sarkar, 1996; Samad and Jafari, 1996; Vishwanath and Geetakumari, 2009). Different aspect of reproductive biology of *Channa* species was studied by Bhuiyan and Rahman (1984); Garg and Jain (1985); Chatterjee *et al*. (1991); Mishra (1991). Food and feeding behaviour of *Channa* were investigated by several authors (Reddy and Rao, 1993; Dutta, 1994; Bais *et al*., 1994; Ebanasar and Jayaprakas, 1995; Dasgupta, 2000; Prasad, 2002). Choudhury (2004) studied the reproductive biology and ecology of *C. barca* from Brahmaputra River. More recently, Saikia (2012) studied on the morphological differences in *Channa punctatus* from paddy field of Sivsagar and again, Saikia *et al*. (2012) investigated on the food and feeding habit of *C. punctatus* from paddy field of Sivasagar, Assam.

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Air-breathing forms like murrels definitely have certain advantages to cope up with rice-field environment and this is why they become potential candidate for rice cum fish culture. *Channa punctatus* (Bloch) has been gaining importance not only as a food fish but also as an aquarium fish for its body shape and behaviour. The fish is well known for its taste, high nutritive value and medicinal qualities and is recommended as a diet during convalescence (Haniffa *et al*., 2004). However, over the last 10 years, its population has undergone a steady decline due to overexploitation, loss of habitat, pollution as well as destructive fishing. According to CAMP report (1998), *Channa punctatus* was included in Lower Risk near threatened category (LR-nt) in India. Therefore, the present paper deals with the certain reproductive biology of *Channa punctatus* from the paddy field of Sivsagar district, Assam.

MATERIALS AND METHODS

The specimens of *C. punctatus* for biological studies were collected from paddy fields and wet lands of Sivasagar district of Upper Assam, India during 2009-2010. A total of 645 specimens were dissected for studying their general reproductive biology. Before dissecting out the gonads, the length and weight as well as colouration of individual specimen were recorded and the gonads, after recording their weight to nearest 0.01 gm in an electronic balance and also then morphological features, were preserved in 5% formalin for further studies.

Sexual dimorphism

The sexual dimorphism of target fish species was confirmed by using literature available of Talwar and Jhingran (1991).

Maturity cycle and maturity stages

Maturity cycle and maturity stages were determined following the key as outlined by Kesteven (1960) and Hopkins (1979). In order to study the condition of the gonads, the maturity index or gonado somatic ratio (GSR) was calculated according to the following formula (Vladykov, 1956), GSR = weight of gonad (g) x 100/ total body weight (g).

Size at first maturity and 50% maturity (M_{50})

The percentage of mature fish i.e. of stage IV to VI was examined for each length group of both sexes, and the 50% maturity or M_{50} has been determined as per Hodgkiss and Mann (1978).

Ova-diameter

Measurements of ova diameter were taken from formalin preserved ovary (anterior, middle and posterior part of individual ovary). Consequently random sub-samples were taken and subjected to ova-diameter measurement with the help of an ocular micrometer. The diameters of ova along whatever axes they lay parallel to the graduation of the micrometer, were measured to ensure random nature of the readings and unbiased values as suggested by Clark (1934).

Fecundity

Absolute fecundity was calculated as suggested by Grimes and Huntsmen (1980). It was obtained by using the following formula: $F = N \times G\ g^{-1}$. Where, F = fecundity, N= no. of eggs in sub sample, G= total weight (g) of ovary and g= weight (g) of the sub-sample. Similarly, relative fecundity was estimated by simply dividing absolute fecundity with total body weight (g). The relationship between fecundity and total length; between fecundity and body weight and between fecundity and ovary weight were calculated and log to log relationship in the form given below (Bagenal, 1978) has been followed: Log F = log a + b log X,

Where;

F = Fecundity,
X = variable factors like body length,
weight etc., and b are constants.

RESULTS AND DISCUSSION

Sexual dimorphism

Females are relatively smaller in size. The fully ripe females have bulging abdomen (Fig. 1) while males are cylindrical body shaped (Fig. 2). Males possess, pin head like black dots on the ventral region of the body and their urinogenital openings are elongated. Morphological difference during breeding season in *C. punctatus* shows that, belly remains protruded in females during breeding season and gravid male oozes out milt on pressing the abdomen. Males were generally brighter colouration in colour then females. Reddy (1979) recorded that the ventral and dorsal fin is shorter in *C. punctatus*, never reaching the vent in adult females whilst in male; they extend little beyond the vent.

Fig.1. Mature female

Fig. 2: Mature male

Maturity stages: The gonads are elongated organs lying in the body cavity and are held in position by the mesenteries. The six (6) different maturity stages were identified depending on their structure, abdominal cavity by gonads and the diameter of unspawned eggs (Table 1). It is observed that all stages of maturity occurred in most of the months of a year. The immature (stage-1) and maturing (stage II) specimens were encountered from October-February onwards, while developing (stage III), mature (stage IV) and gravid fish (stage V) were collected in February-March and spent fishes (stage VI) were recorded in between April and September. Some resting adult specimens were encountered throughout the year.

Table 1. Maturity cycle in *C. punctatus*

Stage	Maturity Stage	Characteristic features of gonads	
		Male	Female
I	Immature	Testis very thin, thread like attached to the kidney.	Ovaries thin, ribbon like, undetectable without aid, attached to the kidney
II	Maturing	Slight increase in volume and weight, creamy coloured	Ovaries become thicker, yellowish in colour, weight increases, eggs visible under microscope.
III	Developing	Marked increase in weight and volume covers almost half of the abdominal cavity.	Deep yellowish, diameter of ova increases.
IV	Mature	Testis enlarged, number of blood vessel increases.	Ovary occupies about two – third of the body cavity, eggs large and can be seen with naked eye, blood vessels distinct.
V	Gravid	Testis whitish, creamy, soft flabby.	Ovaries having loose walls, ripe and translucent eggs.
VI	Spent	Testis shrinking.	Ovaries flaccid, shows reduction in weight and volume.

Maturity index

The gonado-somatic ratio (GSR) or maturity index had been calculated for males and females separately and the data have been depicted in Table 2. In the present study, the GSR was found to increase progressively from February onwards reaching its maximum in April (10.81). A sudden decline of the value in June and July was observed and thereafter it again increased in August (3.38) and September (4.57) and reached it minimum during November (1.34) and January (1.17). In overall, the gonado-somatic ratio is found to be maximum (10.81) during April and minimum (1.17) during December.

Gonado-somatic ratio (GSR) was found to increase from immature stage (stage II) onwards, attained its maximum during the period of peak maturity (stage V) and dropped down abruptly thereafter when the fish reaches spent stage**.** Choudhury (2004) recorded maximum GSR value in July-August for *C. punctatus*. In the present study, the GSR was its maximum during May-June when the majority of the fishes were found to be matured. Observation in the GSR value indicated that the peak spawning season of *C. punctatus* seems to be in the pre-monsoon months (March-May). After that the GSR value

decreases readily indicating the culminating of the spawning season. The variation of GSR value in the same species may be due to differential climatic conditions, especially on the arrival of monsoon which delay or advanced the spawning time of fish species (Biswas, 1982).

Table 2. Average monthly maturity index (GSR) in *C. punctatus*

Month	Male	Female
Jan	0.1 (±0.04)	1.75 (±0.9)
Feb	0.22 (±0.01)	1.98 (±1.1)
Mar	0.25 (±0.02)	9.31 (±3.7)
Apr	0.35 (±0.01)	10.81 (±2.5)
May	0.27 (±0.03)	10.21 (±2.41)
Jun	0.08 (±0.01)	1.92 (±0.79)
Jul	0.06 (±0.02)	1.90 (±0.54)
Aug	0.13 (±0.03)	3.38 (±0.22)
Sept	0.15 (±0.02)	4.57 (±0.46)
Oct	0.23 (±0.02)	2.97 (±0.33)
Nov	0.14(±0.02)	1.34(±0.60)
Dec	0.09(±0.01)	1.17(±0.52)

Size at first maturity and M_{50}

Stages IV to V of the gonadal maturity stages had been considered as a mature gonad and this is presented (Table 3). The maturity stages for male (50.68%) and female (52.26%) was observed in length group 10.1-15cm. It has been observed that in both sex, 50% of the population of *C. punctatus* attains maturity at average length group of 12.5 cm (Fig. 3). Hence, this length groups may be considered as the length at which first maturity is attained. According to Mazzoni and Caramashi (1995), the size at first maturity has an important role in understanding life history of a species during its evolution. Reddy (1979) recorded size at first maturity 12.0 cm for *Channa punctatus*. The present findings was quite contrarily with the results of Choudhury (2004) recorded 50% maturity of *Channa barca* at 20.0-30.0 cm for female and 25.0-35.0 cm for male. Therefore, size at first maturity not only varies from species to species but also in the same species in different habitats.

Table 3. Percentage of maturity at various length groups of *C. punctatus*

Size Groups (cm)	Sex	Immature stage I	Maturing stage II and III	Mature stage IV and V
0 – 5.0	M	100.00	-	-
	F	100.00	-	-
5.1 – 10.0	M	79.94	15	5.06
	F	84.7	12.06	3.24
10.1 – 15.0	M	15.02	34.3	50.68
	F	18.06	29.68	52.26
15.1 – 20.0	M	-	-	100.00
	F	-	-	100.00
20.1 – 25.0	M	-	-	100.00
	F	-	-	100.00

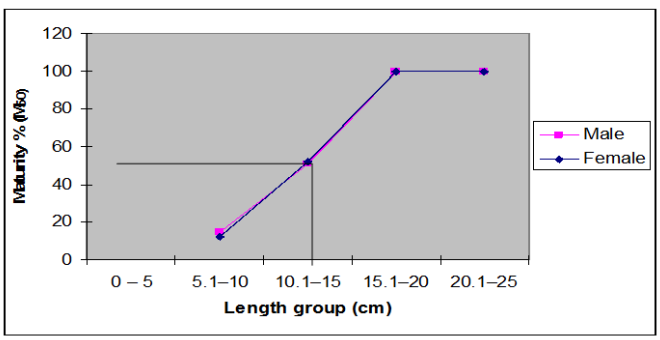

Fig. 3. Length at 50% maturity (M_{50}) in male and female

Ova-diameter

The mean ova diameter of maturing (stage II) was recorded as 0.34 (±0.03) mm and developing (Stage III) was found to be 0.52 (± 0.16) mm. The mean size of mature ova (stage-IV) is 0.79 (± 0.18) mm. The ripe ova (stage-V) was found to be 0.92 (± 0.25) mm (Table 4). It is observed that the ova diameter of *C. punctatus* gradually increased as the fish attain the gravid stage. In ripe fishes the average size was recorded between March and September. The gravid (stage V) specimens of *C. punctatus* contained single batch of mature ova in the ovary and after shedding the eggs the females again prepared itself for next spawning act. Again size of the ova varies from species to species generally low fecund fishes have relatively large size ova. Qasim and Qayyum (1962) divided the Indian fishes in to 3 categories on the basis of their ova size frequencies (a) species, which possess a single batch of maturing eggs in their ovaries and their spawning is adapted to an annual rhythm (b) fishes which have more than one group of maturing oocytes, the breeding season is long and stages of maturity at any given time show a considerable overlapping in the population (c) species which have oocytes of all sizes ranging from the small to large with no well marked batches since the cycle of maturation and spawning becomes a continuous process. Hence, *C. punctatus* can be grouped into the first category as the mature female contains a single batch of ova in the ovary.

Table 4. Maturity and ova diameter of *C. punctatus*

Stages	Degree of Maturity	Ova Diameter (mm)
I	Immature	----
II	Maturing	0.34 ± 0.03
III	Developing	0.52 ± 0.16
IV	Mature	0.79 ± 0.18
V	Gravid	0.92 ± 0.25
VI	Spent	-----

Fecundity

Absolute fecundity varies from individual to individual and it ranged from 2423.0 to 6466.0 (Table 5). In all the individuals the number of eggs increases as the fishes gain in weight and length. Again, the relative fecundity had been found to vary from 104.0 to 216.0 and the value is found to be comparatively high in the younger size groups. The relationship of fecundity with total length, total weight and ovary weight has been calculated and summarized as below.

Fecundity and Body weight Log F = 2.8967 + 0.5244 Log W (r = 0.79) Fecundity and Ovary weight Log F = 3.0884 + 0.8813 Log W (r = 0.98) Fecundity and Body length: Log F = 2.0852 + 1.3966 Log W (r = 0.73) Fecundity of *C. punctatus* was found to be highly variable in different size group. In fact, fecundity of fish is found to vary from species to species, even in members of the same species depending on age, length, weight and environmental conditions (Biswas *et al*., 1984). Ali (1999) found that absolute fecundity varied from 4326.0 to 9016.0 in *C. striatus* with relative fecundity from 10.5 to 36.3. Again, Choudhury (2004) reported that fecundity of *C. barca* fluctuated from 9853 to 13624 with relative fecundity ranging between 46.5 and 57.2. In the present study fecundity was found to increase with increase in ovary weight. However, the fecundity per-unit ovary weight gradually decreases in spite of the fact that weight of the ovary increased as the fishes grow in size and weight. Hence, the relation between fecundity and weight differs as breeding season approaches (Rath, 2000). It is important to note that the relative fecundity generally decreases as the fish grows. This may be due to increase in egg size with the presence of large fatty (Singh, 2011).

From the regression equations (b) it would appear that the fecundity has a linear relationship with body length, body weight and ovary weight with highly significant correlation coefficient (r). It was observed that the fecundity-body length relationship gives a better relationship as compared to fecundity-body weight and fecundity-ovary weight relationship in *Channa punctatus*. Similar relationships among body parameters and fecundity have also been reported by Joshi and Khanna (1980), Pathani (1981) and Singh (2011). Correlation coefficient (r) indicated a close relation between fecundity

and ovary weight than body weight, body length. Therefore, fecundity can be better expressed by body length than ovary weight and body length.

Table 5. Absolute and relative fecundity of *C. punctatus*

Total Length (cm)	Body Weight (gm)	Ovary Weight (gm)	Fecundity Absolute	Fecundity Relative
8.5	11.32	1.28	2423	214
9.9	12.38	1.30	2437	196
11.3	19.80	2.40	4266	215
12.2	20.71	2.52	4480	216
12.8	22.40	2.16	4050	180
13.1	26.55	3.35	4187	157
13.6	30.00	3.50	4375	145
14.0	32.00	3.65	4562	142
15.2	33.45	3.90	5850	174
16.7	61.71	4.85	6466	104

Spawning Season

The morphological changes in the gonads, progression of the size of the ova and above all, the rise and fall in GSR values are indicator of spawning season. The gonads start developing (Stage-III) from March-May. The ripe (stage-V) males and females are encountered during March-May and being peak in April. The spent (stage-VI) have been found from June-July, indicating that spawning was over. In overall, the gonado-somatic ratio is found to be maximum in April and minimum in December. Again, gonads have started developing during August to October and being peak during September. The spent stage was recorded from November onwards, indicating that spawning was over. *C. punctatus* contain single batch of mature ova and are heterochronal breeder having two peak breeding season. From the observed data it may be inferred that *C. punctatus* spawn twice in a year with double spawning peak.

It is well known that precise combination of environment factors are essential for maturation, ovulation and spawning of fishes. The ova diameter of *C. punctatus* indicated that there are six stages of maturity as also evident by morphological structure of gonad. Presence of single batch of mature ova during the spawning season and a prolonged breeding season indicate that *C. punctatus* is a heterochronal breeder. Absolute fecundity, as revealed from the present study indicates that the species is a low fecund. Parameswaran and Murugesan (1976) reported breeding season of *C. punctatus* and *C. striatus* from February to October-November and *C. orientalis* from May-August. The peak spawning season in all the species as inferred from the brood and seed abundance during June-July, coinciding with peak rainfall. Sriramlu (1979) also observed similar trend of spawning behaviour in *C. marulius* and *C. striatus*. The temperature gradually starts rising from March onwards and gonads too start to mature in both male and females. This is an indication that the species is an annual breeder.

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