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RESEARCH ARTICLE

REPRODUCTIVE BIOLOGY OF STRIPED SNAKEHEAD*CHANNA STRIATA* INHABITING OF THE RIVER KRISHNA

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Abstract

The striped snakehead *Channa striata* is a highly commercial food fish and it has long been valued as an important fish but has become increasingly targeted, commercial fisheries due to demand for its nutrition. Currently, the fish population in the River Krishna undergoing a significant decline due to Natural, Anthropogenic stress, habitat destruction and unregulated fishing activities. To prevent this fish population decline, there is a need for comprehensive effort in the conservation and managing their reproduction. The objective of the present study was to investigate the reproductive biology of snakehead fish in the River Krishna. A total of 120 fishes were examined their reproductive stages are recorded. The findings revealed that the size of the fifty percent maturity at 30cm and gonads development started at 15cm. The peak spawning season was observed in month of August and followed by middle of the September, coinciding with monsoon season. The fish demonstrated a relatively high reproductive potential with fecundity ranging from 4,552 to 96,452 eggs depending upon the length. The study provides primary information on reproductive parameters of *C. striata* from the River Krishna which can be utilised for conservation and management of resources.

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Introduction:-

Knowledge on the reproductive biology of the commercially important species of fishesare prerequisite for the development of an effective fishery management strategy. Determination of the spawning season, spawning behaviour and of fecundity of a species an essential part of biological investigations (Krishna, 2008). Since the success or failure of the spawning in any particular season / year affects the recruitment to the population, these studies on a stock of fish are of paramount import in fisheries conservation and management (Krishna*et al.*, 2022a).Studies on the reproductive biology of a species are essential for estimating the reproductive potential of the population (Alam*et al.*, 2012). Determination of spawningseason, spawning behaviour, fecundity of a species is the essential part of biological investigations. Since the success or failure of the spawning in any particular year effects the requirement to the population, this study on a stock of fish are of paramount importance in fishery management (Krishna *et al.*, 2015). Such studies are necessary for estimating the population growth and of fluctuations in the abundance of different year-classes to suggest strategy for fishery management (Krishna *et al.*, 2022b). The *Channa striata* is a heterosexual, the females are visible bulging abdomen whereas the males by a narrow genital opening and papillae. Pillay and Rao (1962) formulated useful guidelines to determine different maturity stages on the basis

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of both internal and external appearance of gonads of both male and female Hilsa and to assess the period of spawning and size at fish maturity.

In some species, the weight of the gonads show considerable variation during different months of the year or season reflecting the stage of maturation in the seasonal spawning. These seasonal changes in gonad weight and the gonado-somatic index help in determining the spawning season(Nicolsky, 1963). During the preparatory phase, the gonads start undergoing maturation and show an increase in weight and size of the gonads and these attain the maximum weight just before in mature gonads spawning. During the spawning, the gametes are released and the gonads are emptied and reach the spent condition. These spent gonads after a period of recovery again start maturing with the onset of the preparatory phase. The cyclical changes in maturation are also reflected in changes in relative weight of the gonad. The value of the index becomes the maximum in fishes just prior to spawning and is minimum immediately after spawning.

Investigations on the reproductive biology of food fishes were primarily to understand the dynamics of the species characters. Earlier, some aspects of reproductive biology of different fishes were studied by Pillay (1954); Pillay and Rao, (1962); Alam and Pathak, (2010); Freitas*et al.,* (2011); Gray *et al.*,(2012); Islam *et al.,* (2013); Kumar *et al.,* (2014); Balkhandel and Kulakarni, (2015); Bhendarkar*et al.*,(2018); Jesaja*et al.*,(2018); Santana,(2019); Djumanto*et al.,* 2019; Jha*et al.,* (2019); Ghafouri*et al.,* (2019); Soeth*et al.,* (2019); Havimana*et al.*,(2020); Aye *et al.,* (2020); Purushottama*et al.*,(2020a, 2020b);Kumar *et al.*,(2021a); Alam*et al.*,(2022); Priyatha and Chitra, (2022), Rudyk-leuska*et al.*,(2022), Khan *et al.,* (2023) and Williams *et al.,* (2024).

Materials and Methods:-

Fish samples are collected from different stations in-between Amaravathi and Prakasam barrage of river Krishna from 2021-22, at regular fortnightly intervals. After measuring the total length and weight of each fish, the belly was cut open to note the sex and general appearance of the gonads. Weights of gonads were recorded and expressed as percentage of total body weight. These data were collected from females of all length groups with immature, maturing, mature, ripe and spent individuals. The spawning period is determined based on the stages of maturity of gonads. For the studies on the ova diameter of intra-ovarian ova, small pieces of ovarian tissues from right and left lobes of the gonads were taken. The ova are arranged in a straight line over the glass side and measured under microscope with a help of an ocular micrometer, at a fixed magnification. The ocular micro meter is calibrated with the help of the stage micrometer; one micrometer division (md) is equivalent to 0.025mm. The size of the smallest ova is 3md (0.075 mm). In the maturing ova and matured ovaries are larger than 3md, are measured, since the small size ova represent the general stock of oocytes is the germinal epithelium.

Gonado Somatic Index of individual fish was calculated using the following formula.

$$\text{Gonado Somatic Index (GSI)} = \frac{\text{Weight of the gonad}}{\text{Weight of the fish}} \text{X } 100$$

Fecundity:

Fecundity is estimated in the mature ovaries and these ovaries are weighted to nearest milligram in Monopan electrical balance, after the removal of excess of formalin. A small portion of ovary from the central region of the ovary was used for all estimations. The tissue piece is removed and weighted accurately to the nearest 10 mg, and the ova are separated from the adherent tissues and arranged over a slide and ova are counted these ova are expressed to spawned during the ensuring spawning season. Each ovary was taken out and excess of moisture was blotted out by using blotting paper. For the estimation of fecundity, mature and ripe ovaries of fish were used. For determining the number of ova in each ovary, 100 mg weighed portion from the anterior; middle and posterior regions of each right and left lobes of the ovaries were taken, on the pre-weighed Aluminium foil by using digital electronic balance. According to Hickling's (1940), the ova counting process is more time consuming.

Fecundity was calculated by using formula-

$$F = \frac{\textbf{NoofOvainthesamplexTotalweightoftheovary (g)}}{\textbf{Weightofthefish (g)}} \textbf{X100}$$

Results and Discussion:-

The reproductive organs of *C. striata* consists of bi-lobed gonads. The eggs were amber coloured, rounded and non-adhesive. During the present investigations the fecundity are varied from 4,552 to 96,452 eggs (for a fish with total length 15cm to 54cm). The number of eggs produced by a female is dependent on different factors such as size, age and environment (Krishna, 2008). During the present study, the fecundity were directly proportional to the weight of the fish and the fecundity increases progressively with ovary weight of the fishes. Roy *et al.,* (2014) recorded that fecundity was increases that fish size was increased.

Distribution of ova:

The ovaries in the adult fish containing ova of different size groups and in different stages of maturation, it has to be ascertained that the ova are distributed throughout the ovary. Ova from different regions in a mature ovary (Stage IV) were examined to determine whether there is my significant difference between the average diameters of ova in the anterior, middle and posterior regions of the ovary, and also between right and left ovaries, ova diameters of the different parts of the ovary and different stages of maturation was given (Fig.7).

Maturation:

The ovariesare elongated and bi-lobed. The lobes are unequal and right being longer than the left lobe. In mature individuals the ovary are light reddish in colour and occupies 75 percent of ventral cavity. Quasim (1973) reported a five stage of maturity scale to describe the maturation of ovaries of fish. In the present observation the ovary is classify into the following.

The following stages of maturity are recognized on the basis of the general appearance of gonads and intra-ovarian ova in females.

Stage I: Immature

Ovaries are little bit small, thin, and light reddish in color. Ova are not visible to see with the naked eye, less than 0.3 mm, and irregular in shape with transparent cytoplasm. Gonado-somatic index ranges between 0.14 and 0.56 mm.

Stage II: Maturing

Left and right ovaries are visible to the naked eye. Ovary elongated and cylindrical in shape and also light reddish in colour. Developing eggs are seen with the naked eye. Yolk deposition is initiated. Further, ovaries are large occupying more than one third of the body cavity. Ova are visible to the naked eye. The ova diameter ranges from 0.7 mm to 1.1 mm.

Stage III: Mature

Ovaries are very large occupying three-fourth of body cavity. Ova are large, round and opaque, packed with yolk and deep yellow in colour. The size of ova ranges from 1 mm to 1.5 mm and the ova are not shed even with a slight pressure on the abdomen.

Stage IV: Ripe

Ovaries are large, occupying nearly the whole body cavity. The ovary is light yellow in colour and eggs are shed even with a slight pressure on the abdomen. Genital opening is red and swollen. The diameter of the egg is increased to a maximum of 1.8 mm.

Stage V: Spent

Ovaries are flaccid, look like empty sacs, shrunken with some residual eggs. Blood-shoot in colour. Eventually, all the remaining eggs are absorbed and the ovary returns to maturing stage. The maximum diameter of ova in this phase is 1.2 mm.

Fig.1:-*Channastriata* - Female.

Fig.2:- Immature.

Fig.3:- Maturing.

Fig.4:- Mature.

Fig.5:- Ripe.

Fig.6:- Spent.

Length at first maturity:

Estimation of minimum length at first maturity helps in the determination of the length range of spawning stock of a population. The length at first maturity in any species is determined on the basis of the minimum length at which at least 50% individuals are mature during spawning is here considered as minimum size. In the present study, 50% maturity was observed at 30 cm length.

Spawning Season:

Percentage frequency occurrences of individuals with gonads in different stages of maturity during different months were determined to delineate the spawning season. The duration of spawning season can also be confirmed by the occurrence of eggs in the environment, but as it is not possible to do so, the spawning season is determined on the basis of occurrence of spent adults in the samples. The seasonal change in Gonado-somatic index also confirms the spawning season from late July to October in the population due to monsoon, the environment is suitable of spawning. Gonado-somaticindex(GSI)in*C.striata*showed significant variation ($p < 0.05$) in different months of the year. Higher GSIvalues were noted during August followed bySeptember. Afterwards, agradual decrease in GSI was observed in the months of November to January and reached its lowestvalue in March (Fig. 8). The mean egg diameter ranged ($p < 0.05$) from 0.14 to 1.2 mm with the highest eggdiameter observed in August and the least in March.

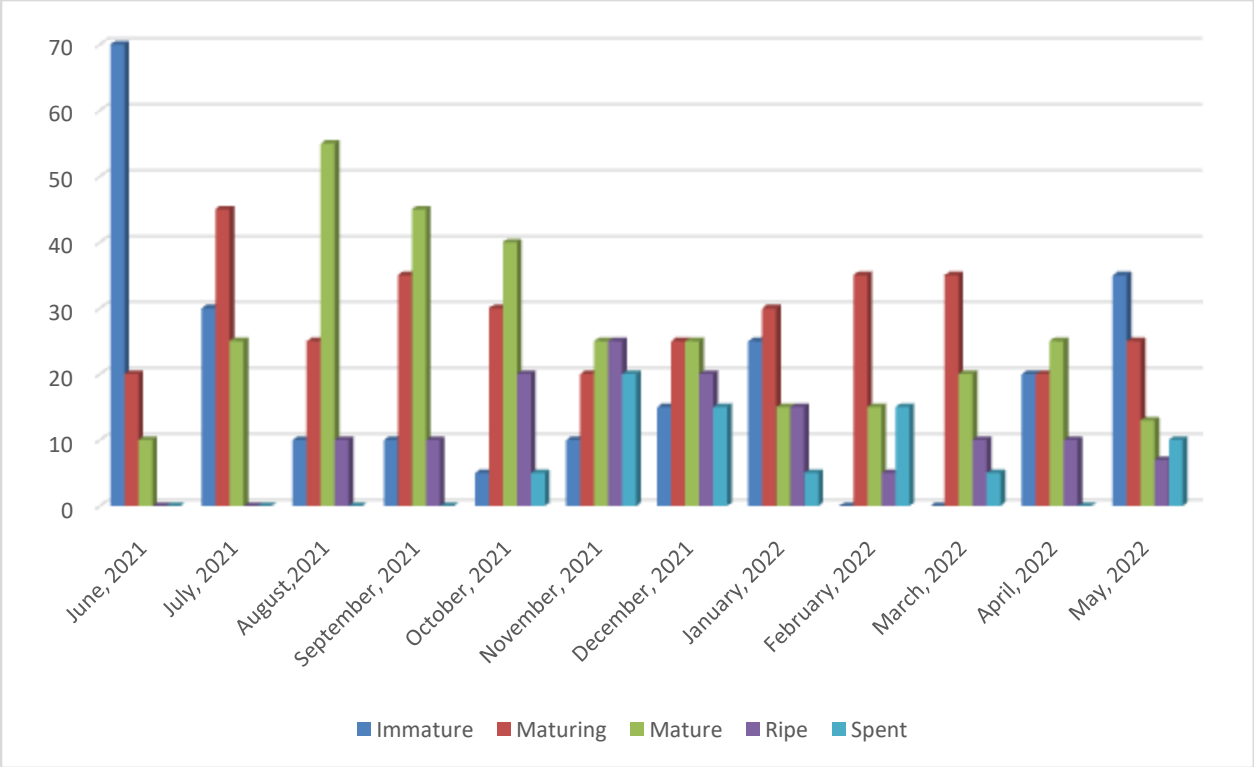

Fig.7:- Percentage of Maturation in different stages of Channa striatain different months.

The immature percentage recording through the year except February & March and fluctuate one month to another to reach maximum percentage 70% in month of June, 2021 and 30% in month of July, 2021. The maturing percentage was recorded highest (45%) in the month of July, 2021. The mature percentage recorded highest (55%) in the month of August. The ripe was highest recorded in the month of November and spent was also recorded highest in the month of November.

Length at first maturity:

Length at first maturity of a species is estimated on the basis of minimum length at which 50% of the individual become mature during spawning season. It helps in the determination of the length range of the spawning stock of a species, in the exploitation of populations. The method was employed by Clark (1934, 1998) in *Sardinellacacerulea*. Further, studied the *Mystus gulio* by Pantulu (1963); Sharma (1978) in M. cavasius; Madanmohan and Velayudhan (1986) in *Nemipterusdelagoae*. In the present study 120 females was recorded in various stages gonads of *C. striata*. Maturing and mature gonads were considered to spawn during the ensuring spawning season. The results represent the percentage of individuals with maturing and mature gonads in each centimetre length group in the sample. In the females measuring up to 15cm TL formed the immature group. In fishes larger than 15 cm TL the gonads stands undergoing maturation and fishes goes to 30cm TL and above goes to mature or running ripe gonads. From the present study observations, 50% of female's individuals are reaching maturation of the length of at 30 cm.

Gonado-somatic index is expressed by the weight of ovary as percentage of the body weight of fishes. This relationship is called Gonado-somatic index or coefficient of maturity (Kumar *et al.*, 2021a). In fishes, which are seasonal spawner's, the gonads undergo various changes during the different months of the year. After the spawning is completed, the spent fish a resting gonad for the further cycle. The resting gonad starts undergoing maturation and finally become mature or ripe during spawning season, when the gametes are released. These changes directly reflect in the changes weight of the gonads (Alam*et al.*, 2012). The values of the index low in immature fish and increasing slowly to the maximum in the ripe fish. Immediately after spawning the spent fish have lowest values recorded. Earlier studies of on gonads somatic index of some Indian fishes were studies by Natarajan and Jhingran (1961); David (1968); Bhatnagar (1972); Sharma (1978); Khan (1986), Bhendarkar*et al.*,(2018), Santana *et al.*,(2019) and Narejo and Jalabani, (2022) . In the present study is based on the gonad weight of fish (120 females). Average monthly value of the GSI during different months is given in (Fig.8). Duangjai*et al.*, (2020) stated that

oocyte maturation period of *Channa striata* was observed in April to August. Large number of gonadal development was in July. In the present study, The GSI was recorded highest in the month of August.

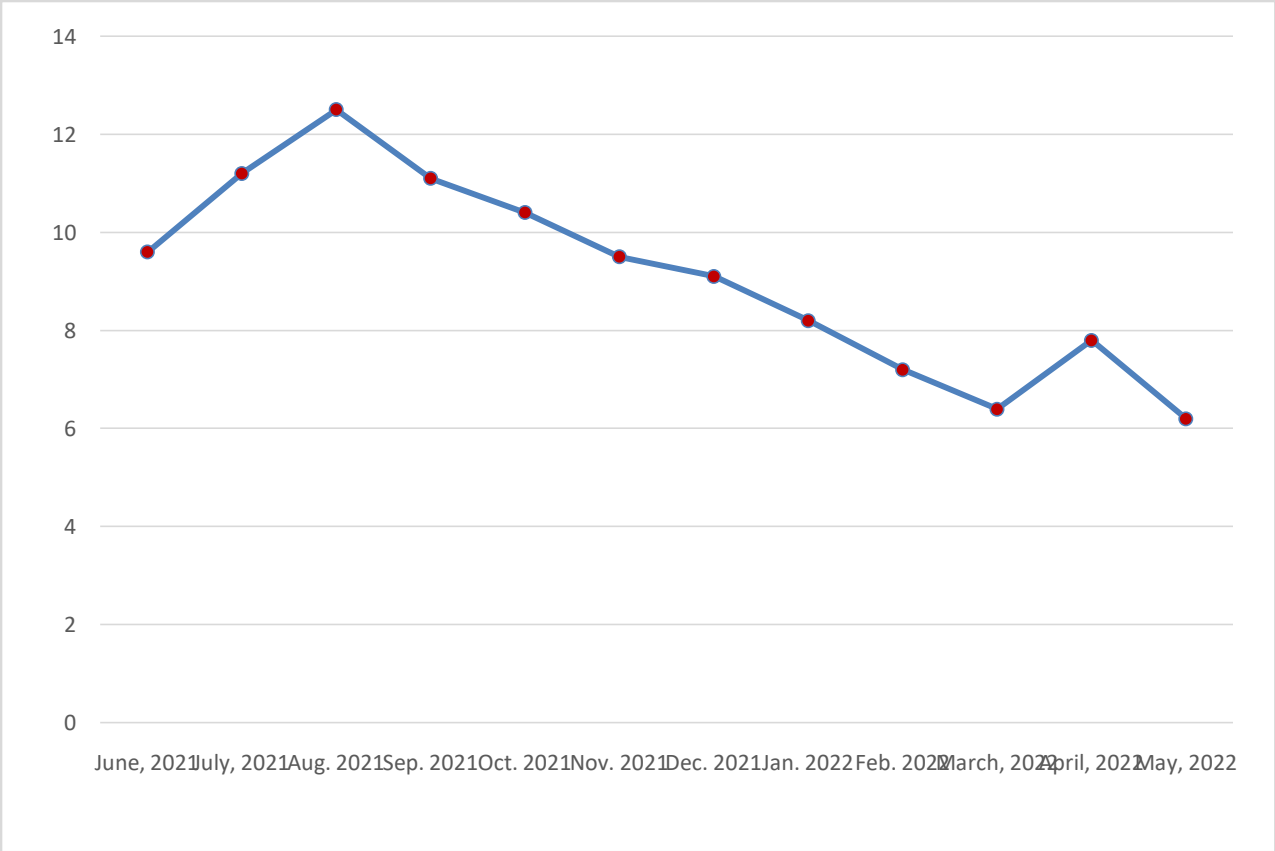

Fig.8:- Gonad somatic index (GSI) of females during the different months of 2021-2022 (No's: 10 per each month).

Spawning:

Fishes exhibit different type of spawning in different habitats (Qayyum and Qasim, 1962, 1964a and 1964b). The spawning behaviour of brackish water fishes has been studies by Moore (1974) from USA. In Indian concern the following authors are worked spawning in different type of fishes - Jocob and Krishnamurthi (1948); Pillay (1954); Sarojini (1957, 1958); Luther (1973); Kowtal (1967) and Gopalakrishnnan (1974); Swamykumar*et al.,* (2013) and Mokhtar*et al.*, (2015), Bhendarkar*et al.*, (2018), Santana *et al.*, (2019) and Narejo and Jalabani, (2022).

Spawning season:

Spawning season of *C. striata* in the present study was recorded on the basis of occurrence of different stages of maturity of each month. The ripe gonads which mainly encountered from September to February with greater number in the months of October to December coincided with high values of Gonado-somatic Index indicated the spawning of *C. striata* with peak in the month of August and extended middle of the September. Prasadam and Rangaswamy (1998) studied that brackish water fishes have prolonged spawning and Kowtal (1967) observed that in Indian waters the breeding of brackish water fishes take place during the post monsoon period. AnkurKashyap*et al.,* (2016) recorded that the maximum spawning observed during May to August in River Gomti of Lucknow Region. Khan *et al.*,(2023) reported that the peak gamete maturation during May to July in the Gangetic River system while, in the present study the peak spawning season in *C. striata* from Krishna River was recorded August and middle of the September. Seasonal change in the GSI was found to be high during spawning period and declined after spawning. Mature fishes were encountered between July and September.Gonado-somatic index and average of ova reached their maximum size during period of peak stages of spent individuals. Based on the evidence of the samples the spawning season of the fishes was July to September and peak spawning season was August and extended middle of the September.

Fecundity:

The numbers of eggs produced by the female in a spawning season has been determined by assessing proportional parts of the ovary either as volumes or weights and multiply in the factor of the proportion to obtain as estimate of the numbers. Estimation of fecundity in fishery management studies is useful toassess the population growth andestimating the number of eggs laid by fish of know length or weight in a population. To study the difference in fecundity between the stocks of fish (Kandler and Dutt, 1958). Fecundity studies in Indians fishes are studied by: Pillay (1958); Qayyum and Qasim (1964); David (1963), Sharma (1978); Sinha (1984); GopalRaje (1996), Rama Krishnaiah (1998); Rao *et al.,* (2005); Gupta, (2014) and Rao *et al.,* (2015), AnkurKashyap*et al.,* (2016), Santana , (2019), Soe*et al.,* (2022). Khan *et al.,* (2023) stated that the fecundity of *C. striata* ranges from 3,652 to 48,450 eggs in the Gangetic River System where as in the present study the fecundity in the Krishna River ranged from 4,552 to 96,452 eggs. Aliakbar*et al.,* (2024)recorded that the fecundity of *C. gachua* females from Kajou River of Makran basin ranges from 564 to 5,940 eggs. IsmatAra*et al.,* (2024) reported that the reproductive biology of the mullet, *Rhinomugilcorsula* in the Sitakunda coast of Bay of Bengal and fecundity varied from 31488 to 251880 eggs/fish.In the present study fishes of *C.striata* length recorded in between 15 to 54cm of total length and in weight range from 50g to 1.50kg. The fecundity of *C. striata* was ranged from 4,552 – 96,452 eggs depends up on the length.

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