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Maturity and Spawning in the Murrel, *Channa punctata* (Bloch, 1973) (Pisces, Teleostei, Channidae) from Guntur, Andhra Pradesh*

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In *Channa punctata* seven stages of maturity are recognised in females The minimum size at maturity is 120 mm in females. Gonado-somatic index in females is highest in July–August. Only one batch of mature ova is produced to be released in one spawning act. The spawning season extends from July to October. An analysis of the earlier studies on *Channa* spp. from India does not indicate any clear trend in regard to the spawning season in different areas from the south to the north of India.

Key Words: *C. punctata*, **Maturity, Spawning, Ovaries, Ova diameter**

Introduction

The determination of spawning season forms an essential part of biologic investigations of fishes. Such study in species which have a wide distribution, particularly in the north-south direction, help to reveal differences between stocks from different areas. A number of workers in India have referred to the breeding habits and spawning season in *C. punctata* and other Channids. A perusal of the literature on *C. punctata* reveals that except for the work at Aligarh of Qayyum and Qasim (1964) on maturity and spawning, the other studies are either based on limited material examined over short periods or are available only as abstracts or reports. Qayyum and Qasim (1964) concluded that it has only one breeding season from June to October in north India; they opined that it may have two breeding seasons in south India corresponding to the two monsoons.

This study deals with the maturity and spawning of *C. punctata* at Guntur (16.18 N, 80.29 E), which is located in the plains in the east coast of peninsular India.

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Materials and Methods

The study is based on 2,216 specimens: 1.005 females and 1,211 males ranging from 65 to 291 mm TL, collected from local markets at weekly intervals from May 1973 to April 1975. Observations on the development of the juveniles through adolescence into adults, and the determination of the spawning season on the basis of the maturity of the gonads, have been carried out mainly on the basis of examination of the ovaries, although simultaneously, the development of the testes also was followed. Efforts were made to collect eggs and larvae from the local ponds: a few post-larvae could be collected only on three occasions. The ova were measured under a compound microscope with the help of an ocular micrometer at a set magnification, each micrometer division (MD) representing 0.026 mm. In ovaries of stages III to V (maturing and mature) about 900 ova from each ovary were measured; in immature, early maturing and recovering spent ovaries (stages I, IIa and IIb) in which there is no great difference in the diameters of different ova, about 300 ova were measured. In the maturing and mature ovaries (stages III to V) all the ova in each subsample were measured, except the very small ova measuring less than 7 MD (0.18 mm), since they are present in all ovaries of different maturity stages. For convenience, the ova were divided into diameter-groups of three MD each (i.e. 1–3, 4–6, 7–9, and so on up to 49–51 MD) to determine the frequency distribution of ova of different sizes.

Gonado-somatic index (GSI) has been calculated only in females because the weight of testes is low. For this study the weights of ovaries in 681 specimens above 120 mm TL were taken and expressed as percentage of body weight, because it was evident that the majority of specimens below 120 mm were immature, though the minimum size of the female with mature ovaries is found to be 116 mm.

Maturity

Description of ovaries and ova

The paired ovaries of *C. punctata* are elongate sac-like structures lying parallel to the swim bladder, one on either side. They are united at three-fourths of their length (above the vent) to open out by a short oviduct (cystovarian type). Behind the vent they again extend as separate sacs for the remaining one-fourth of their length. The body cavity itself extends almost to the caudal peduncle.

Four groups of ova can be distinguished in adults:

(i) *Immature ova:* irregular shape, yolkless, white, transparent, nucleus clearly visible; diameter of ova 1 to 9 MD (0.026–0.234 mm) (this is the only group present in juveniles).

(ii) *Early maturing ova:* shape irregular, yolk deposition initiated, yellowish, translucent, nucleus visible, diameter of ova 6 to 18 MD (0.16–0.47 mm).

(iii) *Advanced maturing ova:* shape mostly spherical, globular yolk, opaque in the centre with faintly visible nucleus, periphery translucent, ova diameters 16 to 24 MD (0.42–0.62 mm).

(iv) *Mature ova:* spherical, yellow, opaque, diameter more than 24 MD (0.62 mm).

Stages of maturity

The following stages of maturity are recognised in females of *C. punctata* on the basis of macroscopic study of fresh ovaries and on the basis of measurement of ova diameters in preserved ovaries (figure 1). To express the size of the ovaries (in different stages of maturity) in relation to the body cavity, the vent is taken as the posterior limit for both ovaries and body cavity,

although the ovaries do extend for a short distance behind the vent and the body cavity extends almost to the caudal peduncle.

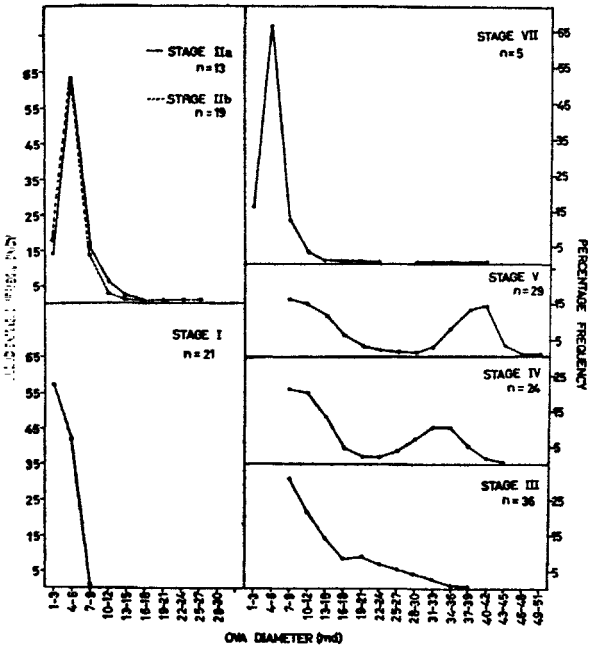

Figure 1 Frequency distribution of ova of different diameters in ovaries in different stages of maturity from data pooled from ovaries in each stage (*n*=number of ovaries)

Stage I (Juveniles): ovary thin, elongated, cylindrical, occupying less than half the length of body cavity, light pink, ova not visible to naked eye; under microscope: irregularly shaped, transparent, without yolk, nucleus clearly visible; ova belong to group '1'; ovary weight 0.03–0.15 g.

Stage IIa (maturing virgins): ovary thin, extending to slightly more than half the length of body cavity, light pink, ova not visible to naked eye; irregularly shaped; yolk deposition initiated in most ova, translucent, nucleus visible; ova in groups '1' and '2'; ovary weight 0.12 to 0.45 g.

Stage IIb (rematuring adults): ovary baggy, shrunken, extends to a little more than half the length of body cavity; reddish. A few opaque ova sometimes present, in addition to maturing ova of groups '2' and '3' and immature ova of group '1'; ovary weight 0.17–1.00 g.

Stage III (maturing adults): ovary golden yellow, slightly lobulated, ovarian blood vessels slightly visible, occupies about 3/4 of body cavity; ova visible to naked eye; most ova belong to groups '2' and '3' and a few to group '4'; ovary weight 0.30–3.50 g.

Stage IV (maturing adults): ovary light yellow (with light pinkish tinge), ovarian blood vessels prominent, ovary lobulated, occupies almost entire length of body cavity; ovarian wall thin; ova clearly visible to naked eye; opaque. A mode of group '4' ova in addition to few group '3' and large number of group '2' ova; ovary weight 0.50–5.68 g.

Stage V (mature adults): ovary light yellow, distended, occupying entire body cavity. Ova clearly visible to naked eye; group '4' ova dominant; ovary weight 1.20–17.00 g.

Stage VI (running ripe): not encountered in the catches.

Stage VII (spent): ovary blood-shot and baggy, sometimes with group '4' ova scattered in tissue and numerous immature (group '1') and early maturing ova (groups '2' and '3').

Males: The testes are generally not more than 10 mm length and right testis is smaller; they are of irregular shape. The weight and colour of the testes varies slightly with the season. However, the following stages of maturity can be recognised.

I. *Immature* (juveniles and spent): testes pinkish, translucent and very small
II. *Maturing:* testes flesh-coloured, slightly opaque; distended.
III. *Mature:* testes dull pink, opaque and distended.

Development of ova to maturity: The study is based on ova diameter measurements in 147 ovaries of specimens in different stages of maturity, ranging from 83 to 250 mm TL, collected from May 1973 to April 1975. The percentage frequency distributions of ova in ovaries of different stages of maturity are presented in figure 1. The figure presents pooled frequency distribution of ova of different diameters in a series of ovaries in each stage of maturity. Figure 2 shows the percentage frequency distribution of ova of different diameters in a few ovaries represntative of each of the stages from III to V.

In juveniles (stage I) the ova do not exceed 9 MD (0.23 mm); ova in 1–3 MD (0.026–0.078 mm) group occur in largest numbers. Individuals in stage II can be distinguished into:

(a) individuals becoming mature for the first time in life (adolescents—IIa) and

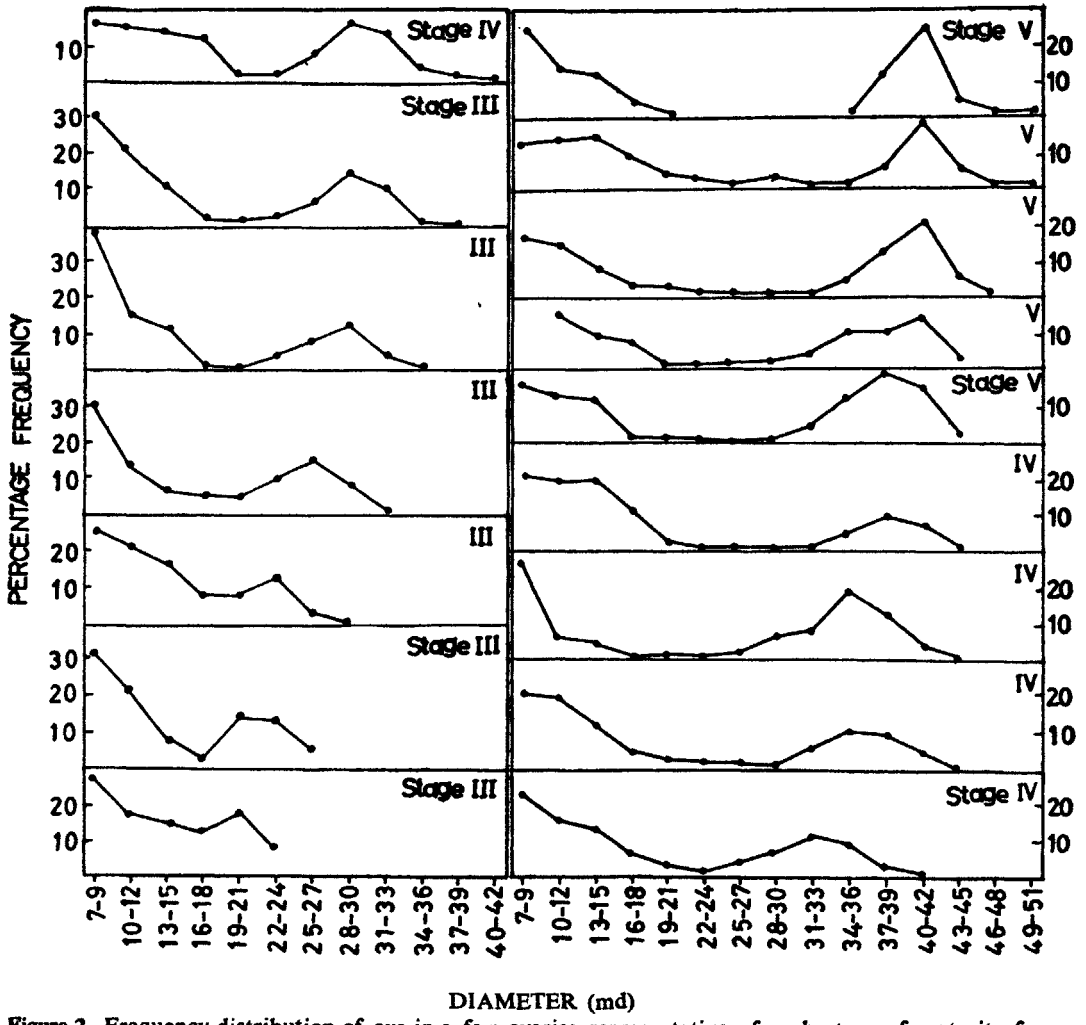

Figure 2 Frequency distribution of ova in a few ovaries representative of each stage of maturity from III to V, to show progress of maturation

(b) individuals which have spawned at least once before (rematuring adults–IIb), and which can be distinguished by the size and colour of ovaries.

In stage II the mode is at 4–6 MD group (0.10–0.16 mm). In adolescents (stage IIa), the maximum size of ova is 15 MD (0.39mm) and in most of the rematuring adults (stage IIb) also the maximum size of ova is 15MD; in a few the maximum size of ova is 18 MD (0.47 mm) while in a very few ovaries the maximum size of ova is 26 MD (0.68 mm). In ovaries in stages III–V, 7–9 MD (0.18–0.23 mm) group ova dominated all others. In stage III a group of opaque ova progressing towards maturity are separated from the much smaller translucent ova; besides the 7–9 MD group, a mode is seen at 19–21 MD (0.49–0.55 mm) group, though not so distinct. The maximum size of the ova in stage III is 32 MD (0.83 mm). In stage IV there is a distinct mode of maturing opaque ova at 31–36 MD (0.81–0.94 mm) group. Maximum size of the ova in stage IV is 44 MD (1.14 mm). In stage V the mode of mature ova has progressed to 40–42 MD (1.04–1.09 mm). The number of ova in this group is almost equal to the number of small immature ova. The largest recorded size of intra-ovarian eggs in stage V is 50 MD (1.30 mm).

As we follow the frequency polygons for stages I to V (figures 1 and 2) it would appear that along with the increase in the size of the ova from stages III to V, there is an increase in the percentage representation of the maturing ova, by small batches of eggs increasing in size continuously and contributing to the group of maturing eggs.

The ovaries of spent adults (stage VII) show a large number of small ova with mode at 4–6 MD (0.10–0.16 mm); only some of them show a few large opaque ova with a maximum size of 34 MD (0.88 mm); these ova are irregular in shape and most of them are dark. Probably they represent residual eggs which will be resorbed.

Length at first maturity

Length at first maturity in any species is determined on the basis of the smallest length group in which at least 50% of the individuals are mature during spawning season. The females in each length group were assigned to the corresponding stage of maturity (table 1). The table shows that all females measuring less than 90 mm had ovaries only in stage I, i.e., they are all juveniles. Females in the three length groups 90 mm, 100 mm and 110 mm are mostly in stage I; only a few of them are in stages II to IV. For the first time a mature female (stage V) is encountered in the 110 mm group. However, it is in the 120 mm group that we for the first time observe more than 50% females in stages III to VII during the spawning season. Moreover, during the spawning season, none of the ovaries of specimens measuring 130 mm and above are in stages I or II. We may therefore consider that at Guntur *C. punctata* attains first maturity at a length of 120 mm. It was not possible to determine the size at first maturity in males because there is hardly any difference between the testes of the older juveniles and of what are obviously spent adults measuring 150 mm and above.

Gonado-somatic index

The changes in GSI in different months are presented in figure 3. The figure shows that the general pattern of monthly variation in gonado-somatic index during the two years (1973–74 and 1974–75) is similar except that the highest value during 1973–74 is in August whereas during 1974–75 it is in July. This suggests that the period of peak spawning activity varies slightly from one year to another. The lowest values are obtained from November to February

Table 1 *Frequency distribution of females of different length groups in different stages of maturity during the spawning season (July–October) during the two years 1973–75 (pooled)*

Length group (mm)	*n*	Stages of maturation						
		I	IIa	IIb	III	IV	V	VII
60	4	4	—	—	—	—	—	—
70	13	13	—	—	—	—	—	—
80	22	22	—	—	—	—	—	—
90	24	21	—	—	1	2	—	—
100	38	31	2	—	2	3	—	—
110	25	17	2	—	3	2	1	—
120	22	3	1	—	1	5	3	9
130	25	—	—	—	1	6	5	13
140	20	—	—	1	1	5	5	8
150	17	—	—	—	—	4	6	7
160	10	—	—	1	—	4	3	2
170	19	—	—	–	2	4	11	2
180	12	—	—	—	1	8	3	—
190	6	—	—	—	—	—	6	—
200	8	—	—	—	—	3	5	—
210	4	—	—	—	—	1	3	—
220	2	—	—	—	—	—	2	—
230	1	—	—	—	—	—	1	—

n=no. of females; — = nil

when most of the rematuring adults have ovaries in stage IIb. The value gradually increases from March, when the ovaries begin to mature, to reach the maximum in July or August, when most of the adults are fully mature (stage V). In September there is a noticeable fall due to the presence of spent adults. The value for October 1973 is higher than that for the corresponding month of 1974 because of a few late spawners with ovaries in stage V. By October (1974) or November (1973) the spent (stage VII) and rematuring adults (stage IIb) cause the value to fall markedly.

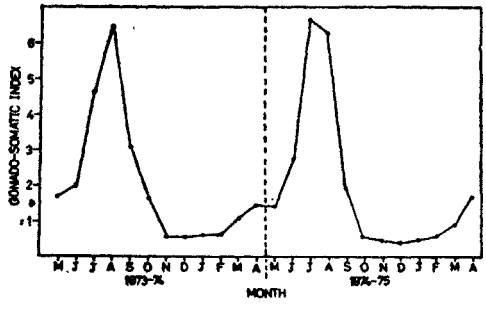

Figure 3 Gonado-somatic index in different months

Spawning

The ova-diameter frequency distribution of ovaries in different stages of maturity reveals that juveniles have a single stock of small transparent (yolkless) ova (stage I). In early maturing ovaries (stage II) some of the ova

increase in size and become translucent yellow (indicating initiation of deposition of yolk). As maturity progresses, the translucent ova increase in number and size (stage III). During stage IV, the maturing ova further increase in number and size to form a distinct mode that is separated from the stock of immature transparent and the early maturing translucent ova. The group of large ova further increases in number and size in stage V to form the spawning stock. Examination of a number of ovaries in different stages of maturity has shown that prior to the onset of the spawning season a continuous series of eggs from the stock of small transparent eggs gradually increase in size to contribute to the batch of eggs to be spawned in the ensuing spawning season. The progression of the modes indicates that only one batch of mature ova is produced to be released in one spawning act.

Qayyum and Qasim (1964) observed that at Aligarh the larger females spawn twice, whereas the females becoming mature for the first time presumably release only one batch of eggs. Belsare (1965) states that it spawns twice in each season in Saugar lake.

Similar differences in spawning behaviour have also been observed in *C. marulia* (Qasim & Qayyum 1962, Devaraj 1973) and in *Hilsa ilisha* (Pillay 1958, Swaroop 1959, Mathur 1964, Ramakrishnaiah 1972).

Spawning season

This is estimated on the basis of occurrence of adults in different stages of maturity in each month. The percentage frequency occurrence of ovaries in different months is presented in tables 2 and 3 for the years May 1973–April 1974 and May 1974–April 1975 respectively; in table 4 the percentage monthly occurrence of maturity stages from May 1973–April 1975, obtained by pooling the data of corresponding months in the two-year period are given. Table 2 shows that mature adults in stage V occur during June–October 1973, with greater numbers during July (27.3%) and August (20.9%)

Table 2 *Monthly percentage frequency distribution af ovaries in different stages af maturity during May 1973–April 1974*

Month	*n*	Stages of maturity							
		I	IIa	IIb	III	IV	V	VI	VII
May	20	5 0	25.0	30.0	30.0	10.0	—	—	—
June	30	10 0	13.3	—	50.0	23.3	3.3	—	—
July	33	9 1	—	—	21.2	42.4	27.3	—	—
Aug.	43	51.2	—	—	—	11.6	20.9	—	16.3
Sept.	54	63.0	2.0	—	—	3.7	7.5	—	24.0
Oct.	43	39.5	—	13.9	—	—	9.3	—	37.2
Nov.	56	33 9	—	66.1	—	—	—	—	—
Dec.	38	13.2	2.6	84.2	—	—	—	—	—
Jan.	41	24.4	7.3	68.3	—	—	—	—	—
Feb.	10	—	—	100.0	—	—	—	—	—
Mar.	64	14.1	14.1	56.2	12.5	3.1	—	—	—
Apr.	53	7.5	7.5	49.0	32.2	3.8	—	—	—

n=no. of ovaries

They (stage V) occur (table 3) from June to September 1974, but mostly during July and August (55.9% and 31.8% respectively). A composite picture of the occurrence of maturity stages in different months over the two-year period (table 4) shows that mature

Table 3 *Monthly percentage frequency distribution of ovaries in different stages of maturity during May 1974–April 1975*

Month	*n*	Stages of maturity							
		I	IIa	IIb	III	IV	V	VI	VII
May	51	7.8	25.5	25.5	37.3	3.9	—	—	—
June	67	13.4	6.0	1.5	35.8	37.3	6.0	—	—
July	43	—	2.3	—	11.6	27.9	55.9	—	2.3
Aug.	22	22.7	—	—	9.1	22.8	31.8	—	13.6
Sept.	79	56.9	3.8	2.6	—	3.8	7.6	—	25.3
Oct.	50	40.0	—	18.0	4.0	—	—	—	38.0
Nov.	23	8.7	—	91.3	—	—	—	—	—
Dec.	43	37.2	4.6	55.8	2.4	—	—	—	—
Jan.	35	34.3	—	65.7	—	—	—	—	—
Feb.	63	54.0	6.3	34.9	3.2	1.6	—	—	—
Mar.	22	31.8	13.6	54.5	—	—	—	—	—
Apr.	22	40.9	4.5	27.3	22.8	4.5	—	—	—

n=no. of ovaries

Table 4 *Monthly percentage frequency distribution of ovaries in different stages of maturity in the two years 1973–75 pooled*

Month	*n*	Stages of maturity							
		I	IIa	IIb	III	IV	V	VI	VII
Jan.	76	29.8	4.0	67.0	—	—	—	—	—
Feb.	73	46.5	5.7	43.8	2.8	1.4	—	—	—
Mar.	86	19.5	14.2	55.5	9.9	2.3	—	—	—
Apr.	75	17.3	6.7	42.7	29.3	4.0	—	—	—
May	71	7.0	25.3	26.8	35.2	5.6	—	—	—
June	97	12.5	8.5	1.3	39.5	32.5	5.5	—	—
July	76	4.0	1.3	—	16.0	34.0	43.5	—	1.3
Aug.	65	41.5	—	—	3.0	15.4	24.6	—	15.4
Sept.	133	59.5	3.0	1.5	—	3.8	7.7	—	25.0
Oct.	93	40.0	—	16.0	2.2	—	4.3	—	37.6
Nov.	79	26.6	—	73.4	—	—	—	—	—
Dec.	81	26.0	3.7	70.0	1.2	—	—	—	—

n=no. of ovaries

females (stage V) occur from June to October, and especially during July (43.5%) and August (25%).

One possible explanation for the absence of females (stage VI) in the running ripe condition in the catches is that the shock of capture causes the ripe females (assuming that at least some of them are captured) to shed the ova. During the spawning season, spent females were first recorded in August during 1973 and in July during 1974. Table 4 shows that they occur from July to October, their percentage representation increasing from August to October.

The gradual decrease in the percentage representation of mature females (stage V) from July to October reflects the spawning activity. Simultaneously, there is a gradual increase in the percentage representation of spent females during the same period; the largest number of spent females are seen in October.

The spawning period could also be confirmed by the collection of a few post-larvae in a pond at Guntur:

Date	*No.*	*Size(TL)*
28-8-1973	3	5 mm
11-9-1974	8	7–8 mm
12-10-1974	4	11 mm

Thus the data indicate that at Guntur, *C. punctata* spawns from July to October with peak activity during August and September. The seasonal cycle of gonadosomatic index also confirms that the spawning season extends from July to October.

Discussion

There are extensive observations on the spawning seasons of both marine and freshwater fishes of India. Very few of them are in-depth studies in the sense that the duration of the spawning season as estimated from examination of ovaries and intraovarian ova has not been confirmed by simultaneous examination of eggs and prolarvae in the environment. There are two reasons for this lacuna:

1. Correct identification of eggs and larvae is often difficult because plankton samples contain these stages of a few or more closely related species whose spawning seasons overlap. There are also technical problems in rearing eggs and larvae to a stage when they could be identified.
2. Right type of craft and gear are generally lacking for experimental capture of adults identifying and the early stages in life history.

Although these are problems unique to the tropical countries, the studies to date indicate that generally, the spawning seasons of tropical marine fishes are of relatively longer duration than those of most freshwater fishes. Qasim (1973), from a survey of the literature on the spawning seasons of Indian marine fishes, noted that many species appear to be continuous breeders and that prolonged spawning, lasting 7–9 months, was known in many species.

As regards Indian freshwater fishes, a perusal of the literature on their spawning seasons reveals that most species not only have relatively short spawning seasons but that most of them spawn after the onset of the south-west monsoon which begins in the extreme south-western part of India in late May and gradually progresses north. In most parts of India the monsoon begins about the middle of June and the rivers, lakes and ponds are in flood during July to September, which season coincides with the spawning season of most species.

There are a number of references to the spawning season of the common species of *Channa* from different localities (table 5) in India. An analysis of the earlier studies does not indicate any clear trend in regard to the spawning season in different areas

from the south to the north of India. The available data suggest that there is considerable variation both in regard to the length of the spawning season and the season when spawning takes place. A perusal of the literature indicates that many of the observations have been over relatively short periods or based on small samples. Although Qayyum and Qasim (1964) suggested that *C. punctata* may have two breeding seasons in south India (probably following Raj 1916), neither the other earlier records nor the present study indicate such a situation. Although Hosaini and Rahimullah (1946) state that it breeds throughout the year at Hyderabad, their statement is only in an

Table 5 *Spawning seasons of common Indian species of* Channa *in different areas as recorded by earlier workers* (The localities are arranged in a south to north sequence)

Species/Author	Locality	Spawning season	Remarks
1. *C. marulia* (Ham. Buch.)			
Devaraj (1973)	Bhavanisagar:		
	a. river & reservoir	May–July	
	b. swamp	Oct.–Dec.	
Parameswaran & Murugesan (1977)	Malnad (Karnataka)	Feb.–Nov.	
Khan (1924)	Punjab	Apr.–July	
Qasim & Qayyum (1962)	Northern India	monsoon and post-monsoon months	fractional spawner
2. *C. striata* (Bloch.)			
Raj (1916)	Madras	Jan.–Feb. and June–July	
Parameswaran & Murugesan (1977)	Malnad (Karnataka)	throughout the year	
Khan (1934)	Punjab	Apr.–June	
Qasim & Qayyum (1962)	Northern India	monsoon and post-monsoon months	fractional spawner
3. *C. punctata* (Bloch.)			
Raj (1916)	Madras	Jan.–Feb. and July–Aug.	
Jones (1946)	Madras	Aug.–Sept.	observed a number of broods during these two months
Parameswaran & Murugesan (1977)	Shimoga & Chickmagalur distts. in Karnataka	Apr.–Aug.	
Hosaini & Rahimullah (1946)	Hyderabad	throughout the year	
Khan (1934)	Punjab	Apr.–June	
Tandon (1963)	Punjab	July–Aug.	
Mookerjee (1945)	Bengal	June–Aug.	
Qayyum & Qasim (1964)	Aligarh	June–Oct.	fractional spawner

Abstract which does not give supporting data. The present study shows that as in the case of Indian carps (Hora 1945, Ahmed 1945, Qasim & Qayyum 1962), spawning of *C. punctata* is linked with monsoon floods, as in north India (Qasim & Qayyum 1962).

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