Maturation and Reproductive Biology of Reba Carp *Cirrhinus Reba* (Hamilton) in Lower Anicut Reservoir, Tamil Nadu, India

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Abstract

Examine the reproductive biology of *Cirrhinus reba* at Lower Anicut reservoir and analyses of gonads assessed by ovarian cycles. Sex ratio, size at first maturity, GSI, macroscopic appearance ovary, fecundity, oocyte diameter and histological examination suggested as a result of spawning season. Males were 59.4% and females 40.6% suggested the ratio significantly deviated from expected 1:1. Size at 50% maturity estimated from logistic model curve 132 mm in males and 148 mm for females. GSI was represented increasing the development of gonads in both sexes until it was ripe and spent. During spawning, increasing the length and weight of gonads from immature to ripe, maximum values of GSI for both sexes (3.43%-3.49% to 4.09%- 6.01%) were obtained during April to August with peak in July. Size-frequency distribution of ova diameter were clearly indicate maximum values of diameter enclosed during July to corresponding microscopic stages of gonads. Five stages of oocyte development were determined through histological examination can be divided immature, maturing, matured, ripe and spent. Total length, weight, gonad length and weight were significantly related to fecundity. Stocks of *C. reba* were enclosing females spawn once a year during spawning season. Following, the implications for management and controlled feral carp stocks were discussed in detail.

Keywords *C. Reba* sex ratio; Size at first maturity; GSI; Fecundity; ova diameter; Macroscopic; microscopic examination of gonads

Introduction

Investigating the reproductive biology of commercially downtrodden fishery can provide some useful information on reproductive uniqueness to expand sound biological assumption for unambiguous stock assessment and management purposes [1]. Beginning the management standpoint is very essential for fish resources and stock that uneven nature and it defined remain more or less unwavering whole time distribution [2]. Following, the reproductive stock assessments should be made for each stock (sexes) separately. Several taxonomical assessments of the stock variables of fish species, along with studies that the species genetic and migratory characteristics to provide the information are used to define the stock structure of such species [3]. Generally, there is only sparse information on reproductive-related characteristics of the species and even fewer data were available for developing more timely estimates of these characters for current stock and reproductive assessment. To date, reproductive variables (e.g. sex ratio and maturity) pertaining to the population used to assessments based research were conducted over three decades ago. Besides, both scientific and management consensus have recommended that all nations strive to limit further increases in fishing effort [4].

Determination of reproductive maturity and development of fecundity is rudimentary in fishery biology. Owing, the importance of these parameters is full of life in fish populations [5] and commonly estimate for economic significance of species. As well, the most suitable way to determine the reproductive cycle in female fishes to observe the seasonal and developmental changes in gonads [6-8]. Subsequently, the maturation cycle has been described by morphological changes of gonads undergo to attain full growth and ripeness. However, methods to identifying spawning seasons of fishes are reviewed who recommended that the histological studies while expensive, time consuming, most reliable yield and to focusing a clear objectives on spawning cycles [9]. Like, the histological examination is well thought-out essential to detecting the details within the maturation cycles in females [9,10]. In current years, there has been an ever-increasing interest for culture aspects in Reba carp *Cirrhinus reba* both commercial and angling species in India and adjacent Asian countries. Although there is much anecdotal evidence of the moribund stocks and there has been no obvious and complete meticulous investigation on biology and reproductive stock structure. Resembling, *C. reba* is one of the most popular food fish and it's widely distributed in India, Bangladesh, Pakistan, Nepal, Burma and Thailand [11,12]. Yet, the wild population of this species on the way out due to heavily harvested. To date, no qualitative and quantitative unique stocks are available in this riverine system. However, the catches of this species have turned down in recent years due to increase its range of fishing mortality etc. [13]. For that reason, the feasible management seems to be very necessary of this species. Hitherto, the biological research information is most vital one to meet the diminishing state of the *C. reba*. Besides, being important noted studies on fisheries biology can expressed in reproductive survey have largely favoured to collection of all information on the wild captured fishes [14].

Furthermore, the reproductive biology i.e. length at first maturity, sex ratio, GSI, fecundity and spawning are among the important aspects of reproductive biology of fishes. To explain the variations in the level of populations as well as make efforts to increase the amount
of harvest and recruitment stocks are great value in management of fishery and also very essential part of aquaculture practices. Because, the low down reproductive rate and direct relationship between stock structures of the fish populations are very extremely susceptible [15]. Consequently, the populations could be depleted under high fishing mortality on mature fish or by any substantial fishing on immature age. These results are implied that the population is going to vulnerable intense fishing activities in the sampling (reservoir) region. The reproductive information which is vital one for stock assessment and fishery management of this species is still unknown. Some of them authors were reported that observations on the spawning of C. reba in Cauvery and Bhavani waters were estimated fecundity of this species from India [16-18]. Presently, there is a little and incomplete information was available in reproductive biological status of C. reba in different waters. However, no specify and completely published evidences on reproductive biology and histological background in this sampling region. As an outcome of the information on reproductive history through comparison with previous studies and also the foremost occurrence of some temporal changes in these traits are detailed discussed. On the other hand, the deficient in the earlier period of research information (GSI, fecundity, reproductive cycle, growth and mortality) are uncertainty resource and fishing pressures at highly risk and it possibility to sustainable exploitation. Besides, the results obtained in this study, this is my part of doctoral research work. Finally, the main objective of this study was providing the first and complete reproductive information of C. reba in Cauvery (Kollidam) waters. Collectively, the results presented here are intended to provide fishery biologists more timely information and ultimately make stronger stock assessment efforts.

Materials and Methods

Study site

Biological data was collected from a branch of Cauvery, specifically Kollidam (Coleroon) river, Lower Anicut was selected for the present study (Figure 1) which is located 11°08’03”N latitude and 79°27’05”E longitude. The Kollidam river flows from west to east forming located in northern boundary of this block flanking at Tamil Nadu. The present fishery occupies a prominent one and totally 395 (225 males and 170 females) individuals of C. reba were collected.

Sample collection

Specimens were kept chilled in ice box immediately after capture and brought to the laboratory for further examinations. Total length (TL) were obtained using a measuring board and recorded to nearest mm while the total weight (TW) was measured [19] using an electronic balance (DIGI’ Arts maximum=500 g to d=0.05 g) and recorded nearest to g. Specimens were identified morphologically using scientific literature relevant to the group with original descriptions [20]. Further, species identification using tissue samples (i.e., caudal fin) were collected and stored in sterile eppendorf tubes containing absolute ethanol, sealed with parafilm kept at room temperature for DNA analysis [21]. After that, sex was determined by gross examinations of the stomachs. At the same time juveniles, males and females were differentiated and data were recorded after dissecting out the gonad. Specimens were preserved in 5% formalin for future examinations. Damaged specimens were rejected.

Reproduction

Specimens were eviscerated in order to determine sex and collect the gonads for further analysis. After examination of the gonads, fishes were classified in different sexes, length and shape of the gonads and colours are also recorded. Sex ratio of C. reba were studied using Chi-square test (χ²), following the equation [22] assuming that the ratio of both sexes in the population. Gonado Somatic Index (GSI) was calculated [23] whereas, the GSI was expressed as GSI = (GW/TW) × 102 while, GW- gonad weight and TW- total weight. Following, the relation between length and maturity in each size class was demonstrated on a logistic diagram to estimating the total lengths at 50% (Lm50) maturity. The proportion of mature fish gonads were observed by following the description [24]. The size at first maturity was determined by one of the author [25] and also directly compared to plotting the percentage of mature fish against their length. The size at which 50% of the females were matured (with developed ova in ovary) was considered as the size at first maturity. Subsequently, the gonads were cleaned, weighed and preserved in 10% neutral buffered formalin. The fecundity was estimated by counting the number of mature ova (opaque and larger in size) from known weights of sub samples collected from the anterior, posterior and middle portions of the ovaries and calculating the total number of mature ova [26].

Where,
The relationships between fecundity with total length, total weight, gonad length and gonad weight were obtained by plotting as a scatter-plot by linear regressions. To determine the spawning season and breeding periodicity, the ova diameter progression was recorded (an ocular micrometre was used for measurement of diameter) with plotting the mean percentage frequency of ova of diameter in mature ovaries, against different months [27]. Small and transparent ova were considered as immature, medium sized and less transparent were considered as maturing and the large opaque ova were considered mature or ripe. The histological analysis was performed in order to analyse and assess the reproductive characteristics of this species. Determine the individual stage of sexual maturation and annual reproductive cycle of fishes, because it provides more consistent than visual inspection of the reproductive organs [28].

### Results

Monthly variations of sex ratio were referred as 395 specimens whereas 225 males and 170 females. The percentage of males ranged from 48.0% (July 2011) to 66.0% (October 2010) and 33.4% (August 2010) to 51.7% (July 2011) in females while, the minimum and maximum sex ratio was ranged from 1:0.50 and 1:1.06 (P>0.05*) whereas, the overall sex ratio was examined 1:0.69 (P>0.01**). To conclude, the percentage of males was 59.4% and females 40.6%. Generally, the sex ratio was approximately 1:1. However, the present study suggested that the ratio were highly significant and deviated from the expected 1:1 ratio (Table 1).

<table>
<thead>
<tr>
<th>Months</th>
<th>Male</th>
<th>Female</th>
<th>Total samples</th>
<th>% of Male</th>
<th>% of Female</th>
<th>Ratio M:F</th>
<th>Chi square</th>
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</thead>
<tbody>
<tr>
<td>Apr-11</td>
<td>20</td>
<td>17</td>
<td>37</td>
<td>60</td>
<td>40</td>
<td>01:00.7</td>
<td>1.2**</td>
</tr>
<tr>
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<td>18</td>
<td>15</td>
<td>33</td>
<td>60</td>
<td>40</td>
<td>01:00.7</td>
<td>1.2**</td>
</tr>
<tr>
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<td>19</td>
<td>15</td>
<td>34</td>
<td>58.6</td>
<td>41.4</td>
<td>01:00.7</td>
<td>0.5*</td>
</tr>
<tr>
<td>July</td>
<td>19</td>
<td>15</td>
<td>34</td>
<td>48.3</td>
<td>51.7</td>
<td>01:01.1</td>
<td>0.125*</td>
</tr>
<tr>
<td>August</td>
<td>19</td>
<td>14</td>
<td>33</td>
<td>63.3</td>
<td>36.7</td>
<td>01:00.6</td>
<td>2.1**</td>
</tr>
<tr>
<td>September</td>
<td>18</td>
<td>12</td>
<td>29</td>
<td>60.7</td>
<td>39.3</td>
<td>01:00.6</td>
<td>1.3**</td>
</tr>
<tr>
<td>October</td>
<td>20</td>
<td>10</td>
<td>30</td>
<td>66.6</td>
<td>33.4</td>
<td>01:00.5</td>
<td>3.3**</td>
</tr>
<tr>
<td>November</td>
<td>18</td>
<td>13</td>
<td>31</td>
<td>62</td>
<td>38</td>
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<td>1.2**</td>
</tr>
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<td>14</td>
<td>33</td>
<td>57.5</td>
<td>42.5</td>
<td>01:00.7</td>
<td>0.47*</td>
</tr>
<tr>
<td>Jan-12</td>
<td>18</td>
<td>16</td>
<td>34</td>
<td>60</td>
<td>40</td>
<td>01:00.7</td>
<td>1.2**</td>
</tr>
<tr>
<td>February</td>
<td>19</td>
<td>16</td>
<td>35</td>
<td>61.2</td>
<td>38.8</td>
<td>01:00.6</td>
<td>1.125*</td>
</tr>
<tr>
<td>March</td>
<td>18</td>
<td>13</td>
<td>31</td>
<td>62</td>
<td>38</td>
<td>01:00.6</td>
<td>1.2**</td>
</tr>
<tr>
<td>Total</td>
<td>225</td>
<td>170</td>
<td>395</td>
<td>59.4</td>
<td>40.6</td>
<td>01:00.7</td>
<td>25.94**</td>
</tr>
</tbody>
</table>

Significant at P>0.05* and P>0.01**

Table 1: Monthly variations of sex ratio of C. reba.

The size at first maturity was studied based on the various size groups of individuals. The logistic curves describing that the relationships between proportions of maturity in each length interval were estimated for both sexes. The LM 50% sexual maturity was observed in both sexes while, large and white testes and brownish ovaries were defined as mature and also increased the GSI values of gonads. The proportions of 50% maturity were estimated and attain 132 mm in males and 148 mm in females were found (Figure 2a and 2b).

In males, (testes) stage-I immature were recorded low during August (10%) and gradually increased with peak in October (80%). Stage-II maturing during October (16%) were gradually increased with attained high level during December (45%) and gradually decreased during January (36%) to March (21%). Stage-III mature fishes were recorded from December (26%) onwards with peak during March (87%). The stage-IV ripe gonads were noticed high during April (80%), June and July (100%). Finally, the spent or resting stage-V were observed between August (60%) to September (30%).
The gonado somatic index (GSI) was represented as increasing the progressive development of gonads in both sexes until gonads were ripe and index was high during spawning and low for the period of spent. Increasing weight from immature to ripe gonad condition (GSI) was illustrated in Figure 3. The maximum values of GSI for both sexes were obtained during April to August with peak in July. Following, the monthly changes of reproductive activity in male C. reba are shown in Figure 4a. Gonads were categorized into five developmental stages based on the observations of the nature and their abundance.

A total of 63 ovaries with distinct modes of size-frequency distribution of oocytes were used to estimate fecundity. The fecundity was estimated ranging from 91321 to 337389 (TL-from 137 mm and TW 61.2 g to 235 mm and 157.5 g) and also the average was referred as (Mean ± SD) 256420.8 ± 67659.47. Further, the relative fecundity was estimated against to total length and total weight of the body, total length and total weight of gonads were shown in Figure 5a and 5d and Table 2.
Variables | Log values of Fecundity | 'b' value of Fecundity | $r$ | $r^2$ | $P$
--- | --- | --- | --- | --- | ---
Total Length-Fecundity | $\log F = 1.156 + 1.981 \log TL$ | 14.322 | 0.726 | 0.684 | $<0.05$
Total Weight-Fecundity | $\log F = 3.322 + 1.143 \log TW$ | 2098.94 | 0.785 | 0.625 | $<0.05$
Gonad Length-Fecundity | $\log F = 2.963 + 1.315 \log GL$ | 918.34 | 0.760 | 0.652 | $<0.05$
Gonad Weight-Fecundity | $\log F = 3.352 + 1.032 \log GW$ | 2249.06 | 0.792 | 0.638 | $<0.05$

b—Slope; $r$—Correlation co-efficient; $r^2$—Regression co-efficient; $P$—Probability

Table 2: Regression models of different variables for fecundity of C. reba.

On the basis of monthly variation, distinct groups of ova were observed during ripe condition in Figure 6. The size-frequency distribution of ova shows that diameter were clearly indicate that equally distribution of the gonads, with maximum values of ova diameter ($1.693 \pm 0.087$) covered during July to corresponding the shown in microscopic stages of gonads.

Figure 6: Monthly variations of ova diameter (μm) of C. reba

The reproductive cycles were noticed as five stages viz., stage-I (Immature), stage-II (Maturing), stage-III (Mature), stage-IV (Ripe) and stage-V (Spent) in both sexes. The gonads were segregated i.e., anterior, middle and posterior parts showed for histological variations in different maturity stages were covered in Figures 8 and 9. Firstly, all the parts of testes showed similar stages of development in a particular stage. Immature and resting phase (Figure 8a) were covered the numerous spermatogonia and small seminiferous lobules was observed. Spermatogonia were large containing central nucleus with distinct nucleolus.

Following the slow mitotic activity was occurring in maturing phase and spermatogonia were started dividing and transformed into sperm mother cells (Figure 8b). Intense spermatogenesis was treated during latter part of developing phase. Spermatogonia decreased and numerous primary and secondary spermatocytes were visible. The primary spermatocytes were smaller than spermatogonia whereas the secondary spermatocytes, were smaller than primary with clump chromatin material (Figure 8c). In pre-spawning phase, blood capillaries became conspicuous; the seminiferous lobules were larger in size and full of sperm. Spermatogonia were few and all stages of spermatogenesis can be seen in various lobules (Figure 8d). In spawning phase, the semiferous lobules became empty for the reason that of release of sperms (Figure 8e). During spent, the empty and collapsing seminiferous lobules were observed which contain residual or unexpelled sperm.
In spent phase, the ovary showed atretic and discharged follicles of reproductive output. Besides, the faster growth rate leads sex ratio. In the present species, sex ratio in favour of males during the predominately because they tend to mature earlier than females. Some atretic follicles were also observed in this stage. In spawning number of ova and ripe eggs were observed in the ovary (Figure 9e).

Phase, ripe ova come out by rupturing of follicular epithelium (Figure 9d). In pre-spawning the hydration process continues awaiting ovulation, when breeding the mature ova increase size with accumulation of yolk. The ova maximum attained the micro-divisions (μm). Gonad / genital aperture often inflamed.

Table 3: Macroscopic gonad descriptions of *C. reba*.

<table>
<thead>
<tr>
<th>Development stages</th>
<th>Category</th>
<th>Testes</th>
<th>Ovary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage-I</td>
<td>Immature</td>
<td>Testes very small, thread-like, elongated, whitish in colour, not easy separate from viscera, small opaque and lack of milt in the transverse section.</td>
<td>Ovaries are ribbon-like, fleshy white-colour, occupy one-half of body cavity and oocytes are not visible.</td>
</tr>
<tr>
<td>Stage-II</td>
<td>Maturing</td>
<td>It is larger than immature testes, white with shining colour and slightly produces dilute milt when squeezed.</td>
<td>Ovaries light brownish colour and occupy to some extent of the body cavity. Mass of small invisible eggs to naked eye.</td>
</tr>
<tr>
<td>Stage-III</td>
<td>Mature</td>
<td>Testes large, ivory whitish colour, vascularization heavy in back of them and externally dorsal blood vessels are present. Males are easily identified by reddish genital opening and oozing of milt with slight pressure is applied on abdomen.</td>
<td>Ovaries long, dark-brownish and fill almost whole of the body cavity. Ova big, brown or light greenish colour while, when seen under the microscope.</td>
</tr>
<tr>
<td>Stage-IV</td>
<td>Ripe</td>
<td>Testes are firm with elongated, bulged, creamy white colour with free-flowing milt. It occupies 20-80% length of body cavity. Sometimes testes were white with blood spot nature.</td>
<td>Brownish ovary, large and fill entire body cavity. Eggs pass out slight pressure applied on abdomen. In breeding the mature ova increase size with accumulation of yolk. The ova maximum attained the micro-divisions (μm). Gonad / genital aperture often inflamed.</td>
</tr>
<tr>
<td>Stage-V</td>
<td>Spent</td>
<td>Testes are grey (dull white) with bloody, faccid, loosely and rubbery as the regress to resting.</td>
<td>The ovary light pinkish, flaccid, blood-spot. A water-like fluid passing out on pressing. The larger ova completely discharged or sometimes with black spots. Some residual oocytes visible, ovary wall thickened and wrinkled.</td>
</tr>
</tbody>
</table>

**Discussion**

The results point out that the *C. reba* undergoes a specific seasonal fluctuation and its gonadal conditions. At the outset, sex ratios can have an idealistic impact when predicting the species population point of reproductive output. Besides, the faster growth rate leads increasingly to less loss from predation and this might influence the sex ratio. In the present species, sex ratio in favour of males during the spawning has been reported and also no sexual dimorphism was occurred. The reasons probably may be ecologically or genetically or both [29]. Males are usually predominating in the young fish, because they mature earlier but live less [30]. In the younger groups, the males predominate because they tend to mature earlier than females. Following, the females are suspected to leave the spawning grounds more rapidly than male counterparts [31]. In natural environment the optimum sex ratio is 1:1 but it may be far from this in particular age and size group.

Besides, an increasing sex ratio with body size has been documented, it possibly due to differences in mortality rates between sexes. Whereas, the growth differences were documented between sexes, sexual dimorphism and migration may also use influential factors [32]. However this study revealed that, seasonal variation of the population occurs only in the catch. The presence of more female individuals during most of the months may be due to the vulnerability of females. So far, the variability may perhaps due to factual differences in the composition of local populations or it may be an artifact of sampling strategies rooted by season covered or gear biases [33]. Though the differential habitat occupy by sex has been earlier observed in tropical fishes [34] with the possible reason of this species may also accord. Following, the males are compared to females during peak period of spawning and such predominance could be due to migration of females to relatively deeper waters, therefore being less vulnerable during spawning or behavioural differences between two sexes. On the other hand, males live in shallow areas from where they are easily caught. Some earlier authors were incomplete reported about these aspects like, sex ratio in same species in different waters at various time were strongly accordance in the present work [16,17,32,35-37].

The size at first maturity was observed the males are attained at 50% sexual maturity was smaller than females. LM 50% is an important trait of life history necessary for successful fishery management, thus fundamental establishment means that avoid exploitation of young individuals and consequential reduction of spawning stock. Besides, most of the males reach maturity smaller and younger than females which explains the greater duration of life, the females mature later. However, observed relationship between first sexual maturities temperature based in every region. Hence, younger ages and smaller sizes at maturity are observed in warm waters, whereas in cooler waters both age and size at maturity are higher [38]. Subsequently, the
Logistic curve has been successfully used to estimate the size at 50% maturity for suggested that stock density, food, water and temperature may influence the growth of fish and further affecting the age at 50% mature [39]. The present study provides the information on size at first maturity of _C. reba_ which is reported for the first instance in this sampling region.

The gonad somatic index is predominantly helpful to identifying gonadal maturity and spawning season of any fish species. As expected, a clear relationship was apparent between GSI and summer than winter.

The maturity of _C. reba_ which is reported for the first instance in this sampling region.

**Figure 7** a) Morphological structure of testes of _C. reba_; b) Morphological structure of ovary of _C. reba_.

The gonado somatic index is predominantly helpful to identifying gonadal maturity and spawning season of any fish species. As expected, a clear relationship was apparent between GSI and reproductive stage in both sexes. However, it was observed that the species spawned once in a year with single spawning peak during July confirmed by GSI and ovarian cycle. Moreover, in this study females are larger than males with the ratio (male: female) increased based on the growth. Here, the changes of GSI and histological analysis of gonads, the ovary and testis were mature during April-August and regressed during September-December with peak in July [37]. The gonads were enclosed in different stages of seasonal maturation were also observed in this study. The present findings were supported some earlier authors in same species [40,36,41] to predictably the _C. reba_ is an annual breeder with a single spawning period restricted to south-west monsoons extending from May to July in Assam and Bangladesh. One of the author's was reported that the species were spawned from June to August with a peak in June [32].

Authors were reported that the spawning period of _Cirrhinus mrigala_ from June to August with a peak in July [42]. The mature ripe ovaries in females and also increase the values of GSI. In contrast, GSI values of testes showed that the mature stages are covered in the season of summer with increase in temperature and also raise the spermatic activity whereas, the primary and secondary spermatocytes and spermatids were filled in the lumen of lobules. On the similar, the season of summer also comprises the preparation of pre-spawning phase. Hence, the GSI level of gonads was higher in summer than winter.

**Figure 8** Microscopic stages of testes development in male _C. reba_; a) Stage-I: Tunica albuginea very thin covered externally with the help of mesothelium. Spermatogonia (SGA) indicated yellow colour arrow in immature testis; b) Stage-II: Arrangement of primary spermatocytes (PSC); c) Stage-III: Secondary spermatocytes (SSC-yellow colour arrow) of testicular cells in mature testis containing a prominent central lumen (CL-pink colour arrow) and peripheral sperm sinuses (SS-white colour arrow); d) Stage-IV: Spreading pattern of spermatozoa (SZ- yellow colour arrow) in a ripe/running ripe testis; spermatids (ST- pink colour arrow) and sertoli cells (SC-white colour arrow) also present; e) Stage-V: Residual spermatozoa (RSZ-yellow colour arrow) and large central lumen (pink colour arrow) is clearly shown. Scale bars =100 μm.

Besides, the seasonal factors of GSI might a greatly influence in the maturation of ovary by resulting the successive changes of the gonads and body weights [43]. On the other hand, declining GSI it gives clear indication for affected metabolism which in turn affects the reproductive potential due to some stressors [44]. From the final observation it is evident that the _C. reba_ has only one breeding season of short duration running from April to August, with a peak in July. Similar observations have been made [16,17,40] from Cauvery, Bhavani River, Muzaffarnagar (UP) India and Bangladesh waters.

Gonad maturation during spawning low food availability in most of the fishes throughout to utilize somatic energy reserves, particularly rich protein content to need for reproductive growth [45]. This suggested that the fishes may store the energy required for spawning in the liver or viscera. It is likely that required energy for spawning might be derived from their diet instead of energy reserves [46]. In the tropical cyprinids, spawning seasons were associated with seasonal rains, flooding of rivers or monsoons and also alike in temperate cyprinids. One of the author's was [47] reported that the water temperature reaches to critical values during spring and final maturation stages of oocyte development are completed in carp may spawn, providing the appropriate spawning stimuli are require. Further, the photoperiod is also considered an important ultimate factor regulating the timing of spawning, recruitment, spawning success, survival of the larvae, growth of juveniles, water level and quality, nutrients, temperature, breeding substrate and vegetation are also which may to determine the spawning success in cyprinids [47].
The ovarian or testis developmental stages documented through macroscopic examination were easier than other methods while, the large samples could be regularly examined. However, this technique may guide to erroneous categorization in reproductive analysis of fishes [52]. Further, the variation of GSI has been used for number species as a measurement of reproductive maturity. In this context, the author [53] was recommended that GSI is not precise indicator of gonadal activity. Hitherto, the spawning period to determine by four methods namely, macroscopic appearance of ovary, GSI, oocyte frequency distribution and histological examination was in good conformity [38], which suggested that the present research work of the spawning period (April to August) was reasonably assessed.

Subsequently, the gonad development and reproductive strategy have been described in many teleost fishes in a great endeavour to understand the time of course and energetic consequences of reproductive effort [54]. From the development of oocytes and microscopical histological examination, the present work was concluded that the C. reba belongs to synchronous type of oocyte development [54-56]. One of the author's [45] was reported the reproductive biology of carp around the world shows them to be a very adaptable species. This may be explained by a short lifespan during oocytes development, prior to spawning. As well, the present histological examination of the ovary was assessed by GSI and also validated through microscopical stages. Besides, the present study evidenced that the GSI, histological analyses, hydrating oocytes, new and old POF (Post Ovulatory Follicles) were suggests that the spawning season of C.reba was enclosed 1-5 (April-August) months and single spawning with peak during July. In this context, there are no more work were attempted in worldwide the same oocyte development, macroscopic and microscopic examination of the present species so far. However, this study was compared with other freshwater carp. Authors are [45] quoted that the spawning season of carp Cyprinus carpio can last 7 months to 9 months with peak during September. The only notable extremes being the season beginning one month earlier (August) and closing a month later (April). As a result, the spawning season does differ noticeably in duration across all sites. Further, the spawning might happen at some sites like autumn and even occurred in winter at one site. So, spawning season of carp populations in other temperate regions of the world is typically shorter 2 months to 4 months are differed. It can be concluded that the present work was confirmed by microscopically documented maturity stages with spawning period during summer (April-August) and peak in July. So far, no more studies have been conducted in complete aspects of reproductive biology of the present species while, it could not compared with the similar works. Furthermore, it might be evaluating the different observations were strongly accordance with the present work carried out. It is reasonably to think that the impact of C. reba fishery management is very low, since there are no one author could not attempt the complete biological aspect is still unknown. In this connection, the species abundance goes to decline in this sampling area [13] together at this time the reproductive capacity was low mean that the C. reba population should be closely disproportionately. Accordingly the proper monitoring of its reproductive possible and fishery management of its exploitation to conserve the sufficient reproductive potential must be addressed for future viewpoint work to reach sustainable development.
Conclusion

Based on conclude, the knowledge of reproductive biology of C. reba may also helpful in formulating regulations that can ensure their survival in our water ecosystems. One of the interesting realistic output of this study, the differences of sex ratio and size at maturity of both sexes, this species could be rapidly and accurately predicted using an 'easy-to-get' parameter. Following, the parameter could be a very useful biological indicator to evaluate the particular species with match up to others for forthcoming living. On the other hand, the general idea could be used as the life-history traits to indices of population feasibility. Hitherto, the pattern of GSI was concluded that the C. reba has an active short reproductive period. As a result, their reproduction in this reservoir shows slight differences from other reports, which might be reflected to diverse environmental conditions. Yet, the estimation of fecundity and total number of oocytes is often used. Further, this can be leading as shown from frequency distribution of the oocytes of C. reba while, proportion of the oocytes will mature and therefore it do contribute to reproduction process. To end with, a comprehensive foremost histological study were compared to other carps that should lead to a better understanding of these teleosts. So far, the major finding has been observed that the C. reba population was going to turn down at this catchment area. In the face of, this may not be possible for the reason and inability breeds most of them artificially.

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