Reproductive physiology and feeding biology of *Puntius sophore* of Tripura, India

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(Received: June 10, 2013; Revised received: October 15, 2013; Accepted: October 16, 2013)

**Abstract:** As a popular fish species *Puntius sophore* is well known in the market of Asia. It has considerable demand as ornamental fish also. An attractive phenotypic feature made this species beautiful. This species looks nice because of development of a beautiful undulating structure of the dorsal and caudal fins during slow swimming activity. The food search activity of the species looks very good-looking. Knowledge of some particular biological parameters such as reproductive physiology as well as feeding biology of this fish is important in aquaculture view point. For this purpose some particular parameters of reproductive physiology are being studied which have been development of gonads in relation to length and weight, gonado-somatic index, maturity stages related to age, fecundity and breeding periodicity as well. Amongst feeding biology parameters studied have been analysis of some digestive enzymes (such as pepsin and alpha-amylase) during fingerling and adult stage, growth and development in relation to age, RLG, assessment of condition factor (K) etc.

**Key words:** Sex ratio, Maturity stages, Gonado-somatic index, Pepsin, Alpha-amylase

**Introduction**

*Puntius sophore* is an economically important fish species. At various corners of Asia this species is considered as a popular fish species. This species is also popular being an ornamental fish species (Kottelat, 1993; Eschmeyer William, 1998). This species looks nice because of development of a beautiful undulating structure by the dorsal and caudal fins during slow swimming activity. The food search activity of the species looks very good-looking. Swimming behavior during various moments of food search and food collection made this species very much attractive. Escape movement of this fish species during predator avoidance is noticeable (Solomon et al., 2011). Probably for these reasons this species is so important as an ornamental fish for wide use in aquarium conditions. However, sufficient information on reproductive physiology as well as feeding biology of this fish are lacking. Therefore, this fish species is important in aquaculture view point. For this purpose some particular parameters of reproductive physiology are being studied which have been development of gonads in relation to length and weight, gonado-somatic index, maturity stages related to age, fecundity and breeding periodicity as well. Amongst feeding biology parameters studied have been analysis of some digestive enzymes (such as pepsin and alpha-amylase) during fingerling and adult stage, growth and development in relation to age, RLG, assessment of condition factor (K) etc. Under various freshwater ecosystems such as pond, wetland, lake etc. population of this fish species is decreased because of various anthropogenic reasons.


So, in conservation view point knowledge of reproductive physiology as well as feeding biology of this fish species is indeed important. Hence, the present paper communicates observation of some parameters of reproductive physiology as well as feeding biology.

**Site of Studies:** During present studies fish individuals of *Puntius sophore* in live have been sampled from the pond, lake and wetland ecosystems of Tripura (Lat 22°59’51.21”N, Long 91°43’26.98”E), a North-Eastern state of India. Geographically, the water bodies are located at 15.24 m above MSL. These water bodies are fresh water in nature with a depth of 7.76±2.34 m.

**Materials and methods**

During a period of March 2009 to February 2012 several fish individuals of *Puntius sophore* are being sampled from the wetland, pond as well as lake ecosystems. Sampling of the studied fish individuals in live is made during early morning period adopting traditional technologies (Jhingran, 2010). In the laboratory, some particular parameters of reproductive physiology are being studied which have been development of gonads in relation to length and weight, gonado-somatic index, maturity stages related to age, fecundity and breeding periodicity as well. Amongst feeding biology parameters studies are being done on analysis of digestive enzyme parameters such as pepsin and alpha-amylase during fingerling and adult stage, growth and development in relation to age, RLG, assessment of condition factor (K) adopting the methodology of Hepher (1988).

**Results**

Amongst the sampled fish individuals, the studied species sho-wed that the females have been numerically superior to that of males.

**Food and feeding habit of different developmental stages:**

This fish species occurs at surface layer of the freshwater ecosystem mostly in the lentic condition of the water. During fingerling stage *Puntius sophore* considers mostly pico-planktonic food of animal origin such as small sized rotifers, crustaceans and their parthenogenic eggs and fertilized resting eggs, and freshwater insects as well. At the adult stage, this fish species considers different sizes of zooplankton, different freshwater insects, and small prawn as well.

**Gut content analysis to assess the feeding aptitude/affinity:**

From the analysis point of view this fish species depicts availability of *Chlorella*, pico-planktonic biota, zooplanktonic biota, broken fish and prawn etc. in the gut.
Analysis of digestive enzymes in adult fish: _Puntius sophore_ during fingerling stage shows certain quantity of alpha-amylase (5.74±2.64 in activity unit /100g body weight) and pepsin (56.42±14.11 in activity unit /100g body weight) as well (table 1-2). During adult stage the quantity of both the alpha-amylase (8.87±2.11 in activity unit /100g body weight) and pepsin (106.9±10.86 in activity unit /100g body weight) have been relatively larger (Table 1). At this period pH of pepsin has been 3.27.

Growth and development in relation to age: Fertilized eggs look like pear-shaped and deep yellowish to faint orange coloured. The fertilized eggs hatch in about 72-96 hrs. The hatched larva looks transparent carrying a round shaped yolk material ventrally. Fry stage appears with the rudiments of dorsal, pectoral, anal and tail fins as well as development of mouth and paired eyes. During fingerling stage paired eyes, mouth and different fins are visible clearly. Development of different stages according to the age in days is presented in table - 2.

Relative gut length: Relative length of gut (RLG) shows that the value varies from 1.92- 2.12 in this species (table 3). Thus, it indicates that the studied species is omnivore.

Assessment of condition factor (K): In order to characterize the nature of physical stoutness of a particular species the condition factor (K) is found out with a formula (Fulton 1902, 1904) as follows:

\[
K = \frac{W}{L^3}
\]

[Where: ‘W’ is the weight of a fish individual (g) of a particular species; ‘L’ is the length (cm) of the said fish individual.]

The present work exhibits a higher value of condition factor (K) (table 7).

Sex Ratio: The sex ratio of 684 individuals of _Puntius sophore_ are being studied. Of these the total number of male as well as female have been 153 and 531 respectively. Therefore, the population studied so far showing that the ratio of male and female has been about 1.3.

Maturity stage related to age: The maturity stage of the females was determined based on the colour, shape, size and the microscopic observations of the ovary. The maturity stages of female species are as follows:

**Stage I – during immature condition:** Ovaries are transparent. Ovaries cover about ¼ area of the body cavity. In naked eye ova are not visible. At this stage the diameter of the ova ranging from 0.112 to 0.222 mm.

**Stage II – during immature condition:** Ovaries cover about ½ area of the body cavity. During this stage the ova looks transparent and a few (4-10 eggs) had started yolk formation. At this stage the diameter of the ova ranging from 0.3657-0.412 mm.

**Stage III – (stage at first maturity):** During this stage _Ovaries cover about ¾ area of the body cavity_. This stage contains a large number of mature ova, which are clearly visible in naked eye. At this stage the mature eggs are clearly separated from the matrix of immature eggs. The mature eggs are opaque, and spherical with yolk. The mature ova ranging from 0.934 - 1.06 mm.

**Stage IV – (at maturity):** During this stage the ovaries cover about ¾ area of the body cavity and extending laterally. They appear to be granular with deep yellowish color. The mature ova ranging from 1.1-1.18 mm.

**Stage V – (at maturity):** Ovaries cover most part of the body cavity and extending laterally. Eggs with large yolk containing ova. Egg diameter ranging from 1.07-1.21 mm. The ovaries contain close implication of blood vessels.

**Stage VI – (at maturity):** The ovaries cover the entire available body cavity. Ova are off-white. In _Puntius ticto_ (Hamilton, 1822) the diameter of ova ranging from 1.22-1.28 mm. While in _Puntius sophore_ (Hamilton, 1822) it is 1.08-1.12 mm. The abdomen of the species at this stage is much spherical. As a result, the ovary found to be inripe and so, this stage is specific for spawning.

**Stage VII – (at maturity):** In _Puntius sophore_ the ovary during this stage consists of a number of small eggs (0.544-0.667 mm) and only a few large eggs (1.031-1.092 mm).

** Gonado-somatic index:** To get a clear idea regarding the maturity stages and periodicity of spawning, the gonado-somatic index as well as weight of gonad is found out as a percent of body weight. The gonado-somatic index = 166.72 for females and 66.47 for males.

During late April to early July there is a gradual enhancement of gonadal weight showing the abundance of ovaries at Stage-V and VI. In case of female the maximum weight of gonad is seen during June and for males maximum weight of gonad is seen during May. During late June there is a sharp decline in gonadal weight (of both female and male) indicating the spawning of the first batch of eggs. However, during late August to early of October the gonadal weight appears to be increased depicting increase of maximum weight of gonad for the second time. During late-October there is a sharp decline in the weight of the gonad (in both female and male) showing spawning for the second time.

**Length at first maturity:** In _Puntius sophore_ during mature condition the females are being noticed first at the length of 80 mm. Therefore, the size at first maturity in _Puntius sophore_ is 77 mm.

**Table-1:** Digestive enzymes (Alpha-amylase and Pepsin) activities (in activity unit /100 g body weight) in _Puntius sophore_ during fingerling and adult stage.

<table>
<thead>
<tr>
<th>No of observation</th>
<th>At fingerling stage</th>
<th>At adult stage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alpha-amylase</td>
<td>Pepsin</td>
</tr>
<tr>
<td>1</td>
<td>3.47</td>
<td>42.83</td>
</tr>
<tr>
<td>2</td>
<td>3.56</td>
<td>43.67</td>
</tr>
<tr>
<td>3</td>
<td>3.74</td>
<td>43.98</td>
</tr>
<tr>
<td>4</td>
<td>4.63</td>
<td>44.56</td>
</tr>
<tr>
<td>5</td>
<td>5.23</td>
<td>44.62</td>
</tr>
<tr>
<td>6</td>
<td>5.64</td>
<td>45.12</td>
</tr>
<tr>
<td>7</td>
<td>5.72</td>
<td>46.14</td>
</tr>
<tr>
<td>8</td>
<td>5.81</td>
<td>47.89</td>
</tr>
<tr>
<td>9</td>
<td>5.84</td>
<td>47.91</td>
</tr>
<tr>
<td>10</td>
<td>5.90</td>
<td>48.34</td>
</tr>
<tr>
<td>11</td>
<td>5.91</td>
<td>49.88</td>
</tr>
<tr>
<td>12</td>
<td>5.95</td>
<td>54.64</td>
</tr>
<tr>
<td>13</td>
<td>5.96</td>
<td>56.21</td>
</tr>
<tr>
<td>14</td>
<td>5.98</td>
<td>57.86</td>
</tr>
<tr>
<td>15</td>
<td>6.01</td>
<td>58.38</td>
</tr>
<tr>
<td>16</td>
<td>-</td>
<td>62.64</td>
</tr>
<tr>
<td>17</td>
<td>-</td>
<td>64.34</td>
</tr>
<tr>
<td>18</td>
<td>-</td>
<td>64.88</td>
</tr>
<tr>
<td>19</td>
<td>-</td>
<td>66.12</td>
</tr>
<tr>
<td>20</td>
<td>-</td>
<td>67.72</td>
</tr>
</tbody>
</table>
When a fish...

Table 2: Studies on Growth and development in relation to age in Puntius sophore

<table>
<thead>
<tr>
<th>Stage</th>
<th>Size (mm)</th>
<th>Age (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hatching of Fertilized eggs</td>
<td>1.06</td>
<td>1 - 1.19</td>
</tr>
<tr>
<td>Hatching</td>
<td>3.43 - 4.0</td>
<td>2 - 3</td>
</tr>
<tr>
<td>Spawn</td>
<td>5.87</td>
<td>4 - 6</td>
</tr>
<tr>
<td>Fry</td>
<td>7.89</td>
<td>6 - 10</td>
</tr>
<tr>
<td>Fingerling</td>
<td>11.79 - 14.1</td>
<td>14 - 16</td>
</tr>
<tr>
<td>Adult</td>
<td>77.82 - 116.72</td>
<td>52 - 57</td>
</tr>
</tbody>
</table>

Fecundity: In this species during a length of 08.00-11.8 cm the weight varies from 20.0-60.0 g where the length of ovary ranges from 2.2 cm to 3.8 cm with a weight of 3.0-5.2 g. The results of the total length of this fish species, total weight, ovary weight and fecundity of Stage-VI ovaries of some female samples has been presented in Table 4.

The relationship between fecundity (F) and fish length (L) can be expressed as:

\[
\log F = 2.4823 \log L - 4.3005
\]

Correlation coefficient (r) = 0.346

The relationship between fecundity (F) and fish weight (W) and fecundity and ovary weight (Ow) can be expressed as:

\[
F = 0.1517W + 10.2011
\]

Correlation coefficient (r) = 0.3858

\[
F = 2.3732
\]

Discussion

Fish population in natural aquatic ecosystem is usually dominated by females. In many fish species the female individuals are physiologically more active than those of males. As a result, they can tolerate various adverse conditions of water. For this reason the female fish individuals of many fish species are quantitatively greater in ecosystem despite various stressed conditions prevailing in the water bodies (Shepherd and Bromage 1988, Banik 2010a,b, 2011a,b, 2013). Present studies also reveal quantitative dominance of female in the population. Some workers pointed out that (Jhingran 2010, Banik and Saha 2011) Puntius during fingerling and adult stages prefer food biota of animal origin. Gut content analysis also shows presence of different kinds of pico-plankton, zooplanktonic organisms, broken fish and some small prawn species etc. in the gut of Puntius sophore.

Some workers (Hpher 1988, Banik and Bhattacharjee 2011, 2012) opined that in fish digestive enzyme activity may vary from species to species and it is related to physiological performance and ambient climatic conditions of the ecosystem of a fish species. Hpher (1988) further stated that the concentration of digestive enzyme varies in relation to age of a fish species also. The present study also depicts variation in the concentration of alpha-amylase and pepsin during different stages of the life cycle of Puntius sophore. Growth and development of different stages of fish can be studied in excellent way since the embryo in fish is transparent and develops quickly. In relation to its age its development is well defined and so, different stages of its life cycle can be distinctly studied (Gilbert 2013). Here also a distinct development is noticed with reference to hatching of fertilized eggs, and formation of hatching, spawn, fry, fingerling and adult stages.

Hpher (1988) and Malla (2013) noticed that the overall intestinal length, which is relative to the length of the body of the fish, varies among species and it might be correlated to the feeding habit of a fish species. The data of RLG of the presently studied fish species showing omnivorous feeding habit.

Banik and Saha (2011, 2012) pointed out that a fish individual depicts stoutness when phenotypically shows approximately round and relatively thicker shaped. However, during undernourished or ill-condition of a fish individual it has a condition factor of less than 1. Usually, a healthy fish has a K-value of greater than 1. Some researchers (Banik and Bhattacharjee 2011, 2012) pointed that some particular fish species showing shorter, stout and smaller cranium. Those fish species have relatively higher condition factor than the species with slender and streamlined morphology. When a fish individual attains sexual maturation, condition factor (K) usually exhibits a higher value. The present result also noticed similar observation. Banik et al. (2011) and Malla (2013) studied different maturity stages of Ompok bimaculatus and found that during immature condition of the fish individual (Stage I) the ovaries were transparent covering some particular areas of the body cavity. At stage II of the immature condition, the ovaries cover about half of the body cavity area and at that stage also the ova seems to be transparent with a few egg started development of yolk area. During stage-III which was found to be a stage at first maturity showing that ovaries cover some more area of the body cavity and have had a greater quantity of mature ova and...
the mature eggs were separated from the matrix of immature eggs. The mature eggs were opaque and spherical with yolk. At maturity condition of stage-IV the ovaries covered most areas of the body cavity and appeared to be granular with deep yellowish color. During maturity period of stage-V, a large area of the body cavity was covered by ovaries. The eggs at this stage found to be with greater quantity of yolk. During maturity period of stage-VI the ovaries covered the whole part of the body cavity. The ova at this stage seems to be off-white. At stage VII of maturity condition the ova was seen in shrinking form so that it covered only about half of the body cavity area. Similar results have also been noticed in the present investigation.

Pillay (2000) pointed out that for knowledge of the maturity stages and periodicity of spawning of the fish species, the information of gonado-somatic index and weight of gonad is important. Jhingran (2010) opined that at some stage during late April to early July there is a gradual development of gonad viewing the abundance of ovaries at Stage-V and VI. In case of female the greatest weight of gonad will be found during the month of June. In case of male fish greatest weight of gonad will be noticed in May. At late June there will be sharp decline in gonad weight of both female and male, which probably shows the spawning of the first lot of eggs. During late July to early August the gonad weight seems to be enlarged showing swell of gonad for the second time. The present observations also noticed similar findings where gonado-somatic index is 166.72 in females and 66.47 in males and during mature condition the female has been observed first at the length of 80 mm. Hence, it may be concluded that the size at first maturity in Puntius sophore is 77 mm. Several workers (Pillay 2000, Jhingran 2010) highlighted the impact of the values of fecundity in aquaculture view point. They (Pillay 2000, Jhingran 2010) further pointed out that a higher fecundity is a result of relatively greater fish production. In present study population genetics and captive breeding of Ompok bimaculatus through efficient nutritional supplementation. In: 1st Tripura Science Congress 2010 (Banik 2010).


Banik, S.: Reproductive physiology and feeding biology of Puntius sophore