SEXUAL MATURITY, FECUNDITY AND EGG SIZE OF WILD AND CULTURED SAMPLES OF *BAGRUS* *bayad* *macropterus*

By

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ABSTRACT

Twenty four matured samples of *Bagr us bayad macropterus* from the wild and under captivity, size ranging from 412.69–3300.00g total body weight, were analysed for sexual maturity, fecundity and egg size. The average fecundity obtained were 53,352.59 and 21,028.32 eggs for the wild and cultured fish respectively. Positive relationship was observed between fecundity, body size and gonad weight. Fecundity increased as body size increased. A more positive and linear relationship was observed between fecundity and gonad weight than fecundity and total body weight.

Egg diameter, length and weights were determined from the egg samples. The mean size range of eggs for cultured fish were 0.74–1.05mm diameter; 1.01–1.20mm length and 0.25–0.40mg egg weight. Wild samples had mean size range of 0.68–1.09mm diameter, 0.85–1.38mm length and egg mean weight range of 0.15–0.40mg. Sexual maturity is dependent on size (1kg and above). The egg diameter, egg length and weight bears no relationship with each other. Gonad development study indicated that gonad development was faster under captivity than in wild.

Keywords: *Bagr us bayad macropterus*, fecundity, Maturity, Egg size.

INTRODUCTION

*Bagr us bayad macropterus* (Fig. 1 & Plate 1) is one of the species of the family Bagridae identified from Nigerian Freshwaters especially in Rivers Kaduna, Niger, Benue and Lake Chad (Visser, 1970; Reed et al., 1967; Holden and Reed, 1972).

The species have reputable growth size reaching 90cm in length and about 7kg in weight. Males grow bigger than females under natural conditions (Reed et al., 1967; Visser, 1970; Holden and Reed 1972; Lewis, 1974; Olaosebikan and Raji, 1998). *Bagr us bayad macropterus* has high commercial value in Nigerian freshwater fish markets and have wide spread consumer acceptance.

Lagler et al. (1977), defined fecundity as the total number of eggs produced by an individual female fish, usually in one breeding season. Mc Fadden et al., (In: Bagenal, 1966), defined fecundity as “weight of eggs produced by a female”. Fecundity is influenced by a number of factors such as age, size of fish, species, condition of the fish and environmental factors such as availability of food, water quality, temperature, season and reproductive behaviour of species, such as parental care system (Lagier et al., 1977). Thus, fecundity may be related to care accorded to eggs. Species without parental care, have high fecundity producing large number of eggs.

According to Wootton (1992), the volume of eggs a fish can produce depends upon the space available in the body cavity to accommodate the eggs before spawn-
Fecundity of 3.34±0.11 eggs per gram total body weight. They observed that fecundity increased as the fish length increased. They observed low correlation between fecundity and standard length (r = 0.370, P = 0.001) and between fecundity and body weight, (r = 0.367, P=0.0010) and between fecundity and gonad weight, (r = 0.299, P = 0.001). Ugumba and Ugumba (1988) obtained fecundity range of 14,000-56,000 eggs for, *C. gariepinus* at size range of 320g–600g total body weight. Douglas (1979) obtained fecundity range of 4,069–71,935 egg in size range of 30-70cm total length of, *C. gariepinus* in Rhodesia. Egg size can be expressed in many ways. A single diameter or two are mostly used. The longest diameter is equal to egg length while the diameter perpendicular to this is egg width (Kato and Kamler, 1983). Other measures of egg size include egg volume, wet weight and dry weight (Bagenal, 1971). From bioenergetic point of view, the best measure of egg size is the caloric equivalent of an egg i.e energy content per egg (J egg⁻¹) (Wootton, 1992). This indicates the amount of energy available to a developing embryo.

Fish eggs vary in shape. Majority of teleost have spherical eggs, some are ellipsoidal while some are rod-shaped (Kamler, 1992).

The objectives of this study was to:

- study the maturity stage, fecundity and egg size of, *B. b. macropterus*; and
- to determine the relationship between fecundity and body size, fecundity and gonad weight, egg size and fecundity, egg length and diameter, egg length and egg weight, egg diameter and egg weight of, *B. b. macropterus*.

**MATERIALS AND METHODS**

Twelve (12) fresh samples of, *B. b. macropterus* size ranging from 550gms-3.30kg total body weight (TBW) and 35.50cm standard length (SL) were purchased from fishermen at Shiroro Lake. They were transported in ice cold box to the Fisheries Department Laboratory, F.U.T, Minna and preserved in a Deep freezer. They were later analyzed for fecundity, gonad maturity stage, and egg size for wild samples.

Another twelve (12) fresh samples, size ranging from 412.69kg – 2.22kg total body weight (TBW) and 31.00 – 58.00cm standard length (SL) were taken from samples maintained under captivity in outdoor earthen pond in FUT, Minna during culture experiment of the species. These samples were analysed for fecundity, gonad maturity stage and egg size for cultured samples.

After thawing and mopping out water, the total body weight (TBW), total length(TL) and standard length (SL) of the fish were recorded. Weight was determined using a top loading meter balance, model PM 2000 which measured to the nearest milligram (mg). Large samples were weighed using manual to loading balance (SALTER Model 180). Lengths were measured using meter rule placed on a Laboratory bench. Mature ovaries with visible eggs were analysed for fecundity, egg size and egg weight. Gonad maturity stages were determined and classified according to the method of Bruton (1979) and Lamai (1993) as outlined below.

From the study of wild populations of, *Clarias gariepinus*, Bruton (1979), classified the gonadal maturation stages in fish into eight developmental stages.

**Stage 1: Immature virgin stage:** At this stage, minute gonads are seen close to the vertebral column. Testes and ovaries are transparent, elongate threads or empty bags.

**Stage 2: Developing virgin stage:** Sexual products have not begun to develop. Gonads are small; testes are elongated transparent bags. Ovaries are transparent and translucent red. Eggs are only visible when squashed and examined under magnifying glass or microscope low power. Fish are about 100g wet weight.

**Stage 3: Developing stage:** Testes are changing from transparent to pale rose colour. Ovaries are reddish brown, becoming oval in shape. Eggs are visible to the naked eye as white granules, developing into yellow spheres.

**Stage 4: Maturing stage:** Testes are enlarged and white. Ovaries are enlarged, opaque and orange. Eggs are about 1 mm in diameter.

**Stage 5: Maturity stage:** Testes are swollen, white, or sometimes slightly pink with grey proximal edging. Testes and ovaries are approximately equal in size, but one of a pair ay be longer than the other. Sexual products are mature and at maximum weight, although eggs are not readily released by light manual pressure on the belly. Eggs are round, opaque yellow and present as discrete bodies. The ovary wall is transparent. At this stage fish could be between 200-500g and may remain at this stage for sometime.

**Stage 6: Ripe stage:** Fish at this stage are on a spawning run. Ovaries distend the body cavity. Sexual products (eggs) are extruded easily on application of light manual pressure on the belly. The testes are ripe and turgid at this time. This stage ends with a collapse of gonadal sacs.

**Stage 7: Spent stage:** Sexual products have been discharged and the remaining eggs reabsorbed. Testes are deflate grey-white sacs. The genital aperture is inflamed and red.

**Stage 8: Recovering spent:** Gonads are very small, they appear as small transparent or white sacs under the vertebral column: eggs are invisible to the naked eye.

Total weights of ovaries were determined, then
sub-samples of 0.5gm were taken. Number of eggs in the sub-sample were counted under low magnification using stereo dissecting microscope according to the methods of Imevbore (1970), Bagenal (1978), and Peters (1983). Sub-samples from ovaries with large visible eggs were counted on a petri dish placed on dark background. The total egg number was estimated using the formula of Bagenal (1978).

\[
\text{Fecundity} = \frac{\text{Total weight of ovary} \times \text{number of eggs in sub-sample}}{\text{Weight of sub-sample}}
\]

The percentage fecundity of individual fish in relation to the body weight were calculated using the formula:

\[
\% \text{ Fecundity} = \frac{\text{Total body weight} \times 100}{\text{Weight of sub-sample}}
\]

Total number of eggs (fecundity)

After determining the fecundity, the ovaries and eggs were preserved in formosaline solution according to the method of Mahoney (1971), for further histological studies. Ovaries and eggs preserved in formosaline solution remained fresh but hydrated. They also maintained their normal size, shape and colour. (Peters 1983). The difference in weight between fresh and formosaline preserved ovaries and eggs were very slight and negligible, and egg size and weight were determined from the preserved samples following the method of Mahoney (1971); Douglas (1979), and Peters (1983). Formosaline was prepared by the formula of Mahoney (1971). Viz:

\[
100\text{ml Formosaline} = 10\text{ml} 40\% \text{ formalin} + 0.9 \text{ gm NaCl} + 90 \text{ ml distilled water}
\]

Eggs were stripped out from the ovary and separated from tissues under stereo microscope so that only eggs without the attached tissues were measured. According to Wootton (1979); Coburn (1986), and Kamler (1992), a single diameter is commonly used for egg size, usually the shorter diameter taken as the width, while the longest diameter is taken as the length of the egg. Egg diameter (the width) was used for egg size in this study following the method of Imevbore (1970); Douglas (1979); Wootton (1992) and Kamler (1992).

The egg length and diameter were measured with calibrated ocular and stage micrometer mounted on a binocular light microscope at x100 magnification.

Egg weight according to Peters (1983), is weight of egg from which the adhering water has been removed. Wet egg tends to have shiny surface, which becomes dull when water is removed. This method was adopted in this study and egg weight was determined using mettler analytical balance, model AE 100 which measures to the nearest one thousand of a milligram. The measurements were converted to milligram by multiplying by 1000.

A total of 96 eggs of different sizes, four from each fish sample, were measured and the mean value for each fish was determined. Relationship between body weight, body length and fecundity, gonad weight and fecundity, gonad weight and body weight, egg length and egg diameter, egg diameter and egg weight for both wild and cultured sample was determined by correlation and regression analysis, using Computer Cricket graph package.

RESULTS

*B. b macropterus* attainment of the productive and maturity stage is determined by body size usually, 1 kg and above. The smallest mature female with gonads at developing stage (stage 1) encountered in this study was 250g TBW and 27.50cm SL. The eggs were not visible to the naked eyes so it was not included in fecundity count. The smallest female with maturing gonad (stage IV) in this study was 1.25 kg TBW 45.00cm SL (Table 2). The smallest developing male encountered with gonad in stage III was 1.45kg. TBW and 45.50cm SL. Gonad maturity stages for each sample are indicated in tables 1 and 2.

*B. b ayad macropterus* has high fecundity and produce numerous small sized eggs. Fecundity was observed to be related to body size, maturity stage and size of ovary. Large sized fish with mature gonad had large number of matured visible eggs. Small sized fish with small ovaries had numerous small eggs, some of which were observed to be still in follicular stage. Follicular eggs (i.e eggs still surrounded by follicle cells) still in the primordial germ cells were not included in the egg count in this study.

Tables 1 and 2 shows total body weight, standard length, fecundity, percentage fecundity, gonad weight and maturity stages of the cultured and wild samples respectively. The mean fecundity of the cultured and wild samples were 21028.32 and 53352.59 respectively. Figures 2, 3, 4, 5, 6, 7, 8 and 9 shows the relationships between standard length, total body weight, gonad weight and fecundity of cultured and wild samples of, *B. b macropterus*. All indicate high and linear relationship and fecundity increase as body size increased. The relationship between standard length/fecundity (Fig. 2) and total body weight/fecundity (Fig. 4) of cultured samples show slightly loose relationships, $r^2$ value 0.71 for standard length/fecundity and 0.84 for total body weight/fecundity. A better relationship was observed between gonad weight and fecundity in all cases, $r^2$ values 1.00 and 0.99, (Figs 6 and 7). Eggs of, *B. b macropterus* are non-buoyant, non-sticky and oval in shape (Plate 2). They are yellowish brown in colour when matured. Eggs of various sizes were encountered in the ovary. Large matured eggs were located towards the middle of the ovary. The mean size range of eggs for cultured sample was 0.74 – 1.05mm diameter, 1.01 – 1.20mm egg length and 0.25 – 0.40mg egg weight. The grand mean was 1.15± 0.09mm egg length, 0.34 ± 0.04 mg egg weight and 0.94 ± 0.10mm egg diameter. The wild samples had size range

TABLE 1

<table>
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<tr>
<th>Sample Type</th>
<th>Body Length (cm)</th>
<th>Body Weight (kg)</th>
<th>Fecundity (mean ± SD)</th>
<th>Gonad Weight (g)</th>
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<td>45 – 60</td>
<td>2 - 3</td>
<td>21,000 ± 500</td>
<td>1,400 ± 200</td>
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<td>Wild</td>
<td>35 – 55</td>
<td>1.5 – 2.5</td>
<td>35,000 ± 1,000</td>
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TABLE 2

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<th>Body Weight (kg)</th>
<th>Fecundity (mean ± SD)</th>
<th>Gonad Weight (g)</th>
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<td>1.5 – 2.5</td>
<td>35,000 ± 1,000</td>
<td>2,000 ± 300</td>
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of 0.85 – 1.38 mm egg length, 0.15 – 0.40 mm egg weight and 0.68 – 1.09 mm diameter. The grand mean egg sizes for the wild sample was 1.12 ± 0.14 mm egg length, 0.29 ± 0.08 mg egg weight and 0.94 ± 0.12 mm egg diameter. Table 3 shows the mean values of egg weight, length and diameter of a few wild and cultured samples.

Figures 10 and 11 shows the relationships between mean egg length and mean egg weight of the wild and cultured samples. It was observed here that egg length bears no relationship with egg weight, r² value was 0.01 for wild samples and 0.20 for cultured samples. Figures 12 and 13 shows relationships between mean egg length and mean egg diameter of the wild and cultured samples. It was observed here that there is just a slight relationship r² values 0.15 for the wild and 0.37 for cultured samples. Figures 14 and 15 shows relationship between mean egg weight and mean egg diameter of the wild and cultured samples. No relationship was observed between egg weight and egg diameter, r² values were both 0.00.

DISCUSSION

Study of reproductive cycles and gonad development stages in fish have been documented by many workers, Kesteven (1960); Nikolsky (1963b); Lehri (1967); Douglas (1979); Bruton (1979) Bruton (1979) and Lamai (1993), classified gonad maturation cycle in, C. gariepinus into eight developmental stages as outlined above. Their description of each stage is applicable to the species under consideration, except the fish size specification in stage V. B. b. macropterus species do not reach reproductive stage until they are about 1 kg and above in total body weight.

Examination of growth marks on the vertebra of the female with matured eggs indicated that the fish was in its 3rd year of growth. Imevbore (1970), in his study of sex ratio and fecundity of fishes in river Niger encountered smallest mature B. b macropterus female at 26.50 cm SL and male at 41.50 cm SL. He also observed that in many species the length at which males mature was smaller than that of females except in Alestes baremose, Labeo combie and Bagrus bayad. In these species, the smallest mature males were larger than the smallest mature females.

Larger fish had higher fecundity. An average size B. b macropterus of 1.25 kg from the wild had 43,467.60 eggs while a fairly large fish of 3.30 kg had 92,124.92 eggs. This agrees with the observations of Lagler et al. (1977), and Wootton (1992) that fecundity of fish increases as body size increases. Wootton (1992) further observed that the volume of eggs a fish can produce depend upon the space available in the body cavity to accommodate eggs before spawning. Many works on fecundity of other species indicates similar phenomenon. Lamai (1993) observe fecundity of 51,183 eggs for C. gariepinus at an average size of 0.7 kg. Abayomi and Arowomo (1996) obtained fecundity range of 15,667 – 550,625 eggs from C. gariepinus at size range of 39.50 – 82.50 cm total length. Ugumba and Ugumba (1988) obtained fecundity range of 14,000 – 56,000 eggs for C. gariepinus at size range of 320-600 gm total body weight. Gudkov (1994) obtained fecundity of 510 – 2,278 eggs for Teranet char, Salvalinus teranetz at size range of 27 – 44 cm total length. Mekeyeva (1984) obtained fecundity range of 400 – 500 eggs per cm² for Silver carp at size range of 60 – 65 cm total length.

Although fecundity increased as body size increased, low relationship was observed between fecundity and standard length (r² = 0.71). Better relationship was found between fecundity and gonad weight, (r² = 1.00). similar observation was made by Douglas (1979) on C. gariepinus and C. lazera, and Peters (1983) on Tilapias (Cichlidae).

Size range of eggs for this species compared well with that of, C. gariepinus, C. lazera and C. macrocephalus. Nawar and Youkin (1962), found egg size range of 0.90 – 1.25 mm diameter in C. lazera. Douglas (1979), encountered size range of 0.3 – 1.2 mm diameter for C. gariepinus eggs in lake Kariba, S. Africa. Sidthmunka (1972), encountered egg size range of 1.3 – 1.6 mm diameter for C. macrocephalus in Thailand.

Except for the slight relationship between the egg diameter and egg length, no relationship was observed between egg length and weight, egg length and diameter, and egg diameter and weight, as similarly observed by Peters (1983) on Cichlidae eggs.

CONCLUSION

B. b macropterus is a commercially important freshwater species in Nigeria. They have high growth rate and are well distributed in Rivers Kaduna, Niger, Benue and Lake Chad. The species have high fecundity ranging from 9,189.60 – 92,124.92 eggs at size range of 550.00g – 3.30 kg total body weight (TBW) and 35.50 cm – 65.00 cm standard length (SL). They produce numerous small size eggs ranging from 0.68 – 1.05 mm egg diameter. They reach reproductive stage at large body size, from 1 kg and above.
Table 2: Fecundity, gonad weight, maturity stage and some morphometric measurements of cultured samples of *Bagrus bayad macropterus*.

<table>
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<tr>
<th></th>
<th>Total body weight (TBW) (g)</th>
<th>Standard Length (SL) (cm)</th>
<th>Gonad weight (g)</th>
<th>Fecundity</th>
<th>Percentage Fecundity (%)</th>
<th>Maturity stage*</th>
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<td>1</td>
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Y. X. 26010.00 g 640231.12
0 2167.50
SD 939.51

*Bruton (1979)*

Table 3: Mean Length weight and diameter of eggs from wild and cultured *B. b macropterus* sample

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<td>1.02</td>
<td></td>
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</tbody>
</table>

ΣX 13.49 3.43 11.27 ΣX 13.78 4.07 11.23
Grand 0 1.12 0.29 0.94 Grand 01.15 0.34 0.94
SD 0.14 0.08 0.12 SD 0.09 0.04 0.10
Fig. 1: Diagram of the external features of *Bagrus bayad macropterus*.

Plate 1. External view of *Bagrus bayad macropterus* (Daget).

Plate 2. *Bagrus bayad macropterus* egg showing the oval shape structure (9Mg x 150).
Fig. 2: Relationship between the standard length and fecundity of cultured samples of *Bagrus boyad macropterus*.

Fig. 3: Relationship between the standard length and fecundity of wild samples of *Bagrus boyad macropterus*.
Fig 4: Relationship between the total body weight and fecundity of cultured samples of
Eugenia baya macroptera

Fig 5: Relationship between the total body weight and fecundity of wild samples of
Eugenia baya macroptera
Fig. 6: Relationship between gonad weight and fecundity of cultured samples of *Bagrus bayad macropterus*.

Fig. 7: Relationship between gonad weight and fecundity of wild samples of *Bagrus bayad macropterus*.
Fig. 8: Relationship between gonad weight and total body weight of cultured samples of *Bagrus bayad macropterus*

\[ y = -3.42 + 0.01x \quad r^2 = 0.87 \]

Fig. 9: Relationship between gonad weight and total body weight of wild samples of *Bagrus bayad macropterus*

\[ y = -2.23 + 0.02x \quad r^2 = 0.90 \]
Fig 10: Relationship between mean egg length and weight of wild samples of *Bagrus bayad macropterus*

\[ y = 0.21 + 0.08x \quad r^2 = 0.01 \]

Fig 11: Relationship between mean egg length and weight of cultured samples of *Bagrus bayad macropterus*

\[ y = 0.57 - 0.20x \quad r^2 = 0.20 \]
Fig. 12: Relationship between mean egg length and diameter of wild samples of *Bagrus hayad macropterus*

Fig. 13: Relationship between mean egg length and diameter of cultured samples of *Bagrus hayad macropterus*
Fig. 14: Relationship between mean egg weight and diameter of wild samples of *Bagrus bayad macropterus*

Fig. 15: Relationship between mean egg weight and diameter of cultured samples of *Bagrus bayad macropterus*
REFERENCES


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