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Full Length Research Paper

Aspects of the reproductive biology of African pike characin/fish, *Hepsetus odoe* (Bloch, 1974) in an artificial lake, Nigeria

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Abstract

Aspects of the reproductive biology of *Hepsetus odoe* (Block, 1974) were studied in Ado Ekiti Reservoir, Nigeria from August 2014 to February 2015 in order to estimate its reproductive biology. Gonad maturation was determined macroscopically and microscopically, fecundity by gravimetric method and gonadosomatic indices calculated. Sex ratio of the species was 1.1:1.0 (male: female) which, indicates lack of difference in the longetivity of the sexes. Mean fecundity was 2,598±1,077 for fish mean length 24.10±2.42cm. Egg diameter has mean value of 1.74±0.2mm from ripe/matured stage. Size at maturity for the females was 22.37cm and for males 22.46cm. Maturity occurred in both males and females within the first year (1^+) of life in the reservoir. The mean value of Gonadosomatic index (GSI) in female 1.3±1.6% was higher than in males with mean value of 0.6±0.6%. Highest number of ripe fish and mean value of GSI were recorded in both males and females during the two spawning peaks observed, September to October (raining season) and January to February (dry season).There was significant correlation between weight of females with fecundity (r=0.8) and Gonadosomatic index (0.78) (p<0.05)

Key Words: Sex ratio, maturity age, egg diameter, gonad maturation stages, spawning peaks, reservoir.

Introduction

Nigeria is blessed with numerous freshwater bodies including vast networks of rivers, streams, seasonally flooded plains as well as natural and manmade reservoirs, which form habitat for fish (Bolorunduro, 2003). The contributions of fish to human nutrition and health are well documented with fish constituting almost half of the total number of vertebrates in the world (Kar and Sen, 2007). According to Olaosebikan and Raji (2013), Nigeria fresh water is the richest in West Africa with 316 fish species inventoried. A large number of these species are better known to the rural population due to the importance they attach to them as a vital and affordable source of nutrition (Kareem *et. al.,* 2015)

Studies on fecundity and other reproductive features are essential from the viewpoint of production, stock management and assessment in any water body. Development and exploitation of aquatic resources in African countries is limited. This can be attributed to dearth of information on the biology of seasonally breeding species of fish and shell fish endemic to Africa (Oben *et. al.,* 2000). Knowledge of the reproductive biology is needed in establishing the production potential of fish species and consequently their exploitation and management rationale. The Gonadosomatic index (GSI) is particularly helpful in identifying days and seasons of spawning, as the ovaries of gravid females swiftly increase in size just prior to spawning. If it is possible to collect reasonable numbers of gonads each month from adults (e.g. 30-50 individuals) over a year, one can usually determine the spawning season for the fish. Fishes with low egg diameters have been reported by some authors. These include; *Schilbe mystus* (Ayoade, 2004), *C. gariepinus* (Abayomi and Arawomo, 1996), *E. lacerta* (Ugwumba, 1991), *H. bebe* (Adebisi, 1987; Oben *et al.,* 2000), *E. vittata* and *Pellonula afzeliusi* (Ekpo, 1982).

Hepsetus odoe is an economically important fish in Nigerian freshwaters and particularly in Ado Ekiti Reservoir where it forms one of the major commercial catch. It is a culturable fish species. Studies on the aspects of biology of the species have been carried out by Idowu (2007) in the reservoir. Oso *et. al.,* (2011) reported fecundity, condition factor and gonadosomatic index of the species. Other aspects of the reproductive biology such as age at maturity, egg diameter, spawning peaks were not investigated. Since the biology of fish is known to vary with habitat and over time, the aim of the present study was to estimate some aspects of the reproductive biology of *H. odoe* in Ado Ekiti Reservoir. The objectives of this were to estimate: the sex ratio,

age at maturity, egg diameter, gonadosomatic index and gonad maturation stages of *Hepsetus odoe.* Results obtained will enable rational management and sustainable exploitation of this commercially important species in the reservoir.

Materials and Methods

Study Area

Ado-Ekiti Reservoir was constructed by damming River Ireje in Ado -Ekiti, Ekiti State, Nigeria in 1958. The Reservoir is a major source of water supply for domestic uses and also supports artisanal fisheries. The Reservoir lies between latitude 7^0 35´– 7^0 36´ North and Longitude 5^0 12´–5^0 13´ East at an altitude of about 440m above sea level. The Topography of the reservoir is undulating and surrounded by highlands. Ado -Ekiti lies within the tropical rainforest zone of South -Western Nigeria and experiences a distinct dry season (from November to March) and rainy season (from April to October).

The adjourning vegetation is dominated by: Elephant grass *(Pennisetum purpureum*), Giant star grass (*Cynodon plectostachyum*), Rhodes grass *(Chloris guyanan*a) and Siam weed (*Eupatorium dorantum*). The ichthyofauna consists of the tilapias, *Tilapia zillii*, *Sarotherodon galileaus*, *Sarotherodon melanotheron* and *Oreochromis niloticus;* catfishes, *Chrysichtys nigrodigitatus*, *Clarias gariepinus,* and *Hetero-brancchus bidorsalis*; *H. odoe* as well as the barb, *Barbus* sp.

Collection of fish samples

Weekly samples of *H. odoe* were obtained from the landing centre of fishermen from Ado Ekiti Reservoir from August 2014 to February 2015. The fish samples were captured by fishermen using gill set net of 3cm mesh size. The nets were set overnight by the licensed fishermen operating in the reservoir and harvested the following morning between the hours of 6.00 am to 7.30 am. Fish samples (dead) obtained were immediately preserved in 10% neutral formalin prior to laboratory analysis.

Sex ratio

Sex of each specimen collected was determined by examination of the gonads after dissection and the ratio of male to female calculated using chi square test

Fecundity

Fecundity in this study was taken as the number of ripening eggs in a female prior to the next spawning season (Bagenal, 1978). Ripe ovaries were used for the estimation. The Nikolsky (1963) method of gonad classification served as a guide in picking only the ripe ovaries for fecundity estimation. The ovaries were preserved in Gilson's fluid (Composition of Gilson's fluid: 100ml of 60% alcohol, 880 ml of Distilled water, 15 ml of 80% nitric acid, 18ml of Glacial acetic acid, 20g of Mercuric chloride, (Ricker, 1968). The specimen bottles containing the preserved eggs were labelled to show date of collection, standard length, and total length, weight of fish and weight of ovary.

The gravimetric method which involves sub sampling by weight was used in fecundity estimation. This method has been reviewed by Bagenal (1978). Preserved eggs were washed with ordinary water to drain excess preservative and were left on filter paper for about 5 – 10 minutes after removing any ovarian tissue left. The eggs were then weighed on a Santorious sensitive metler balance and five subsamples of the egg were weighed and number of eggs in the subsamples counted. By proportion the total numbers of eggs in the ovary were calculated. This method of estimating fecundity is accurate to about 1% (Simpson, 1959).

The linearity of the fecundity – length and fecundity – weight relationships was determined using the equation:

$$\text{Log } Y = a + b \text{ Log } X$$

where;

Y = fecundity estímate,
X = length (cm) or weight (gm) depending on the relationship
'a' and 'b' are constants.
Correlation coefficient (r) was determined from regression analysis

Egg diameter

The egg diameter was measured using an ocular micrometer in a binocular microscope. A stage micrometer was used to calibrate the microscope. For each ovary, the egg diameter of about fifty randomly selected eggs were measured and the mean taken as the average egg diameter. Egg diameter was measured in millimetre (mm).

Size at maturity

The size at maturity is taken as the minimum length at which 50% of the males and females were found with matured gonads.

Gonadosomatic index (GSI)

The monthly gonadosomatic indices of the gonads were calculated using the formula of Dadzie and Wangila (1980) from the weekly samples obtained.

$$GSI = \frac{\text{Gonad weight}}{\text{Fish weight}} \times \frac{100}{1}$$

The linearity of the gonadosomatic index – weight relationship was determined using the equation
$\text{Log } Y = a + b \log X$

Where;

Y = gonadosomatic index,
X = weight of fish (g)

a and b are regression constants.

Stages of gonad maturation

Gonad maturity stages were assessed and classified according to a modified classification of Hilge (1977) as follow: Stage I – Immature, II – Developing, III – Mature, IV – Ripe and running and V – Spent

Results

Sex ratio

Out of 685 specimens examined 354 were males and 331 were females giving a sex ratio of 1.1:1.0 (male: female). There was no significant difference (P>0.05) in the sex ratio.

Fecundity

Fecundity ranged from 1,372 to 4,853 with mean of 2,598 ± 1,077 eggs for a fish of 20.4 – 28.2cm (Mean = 22. 4 ± 1.2 cm) standard length and 75-308g (mean = 168.70 ± 78.10g) weight. Logarithmic transformation of fecundity length and fecundity weight relationships is illustrated in Figures 1 and 2. These were represented by the following regression equations.

Log F = 1.82 + 0.72 Log W (r = 0.83).
Log F = -0.85 + 3.06 Log L (r = 0.74)

Where

W = weight of fish (g),
L = standard length of fish (cm),
F = fecundity

The correlation between fecundity and weight as well as length was high (r = 0.8 and r = 0.7) and significant.

Egg diameter

Egg diameter ranged between 1.40 – 2.07 mm with mean of 1.74 ± 0.2mm from ripe/matured stage.

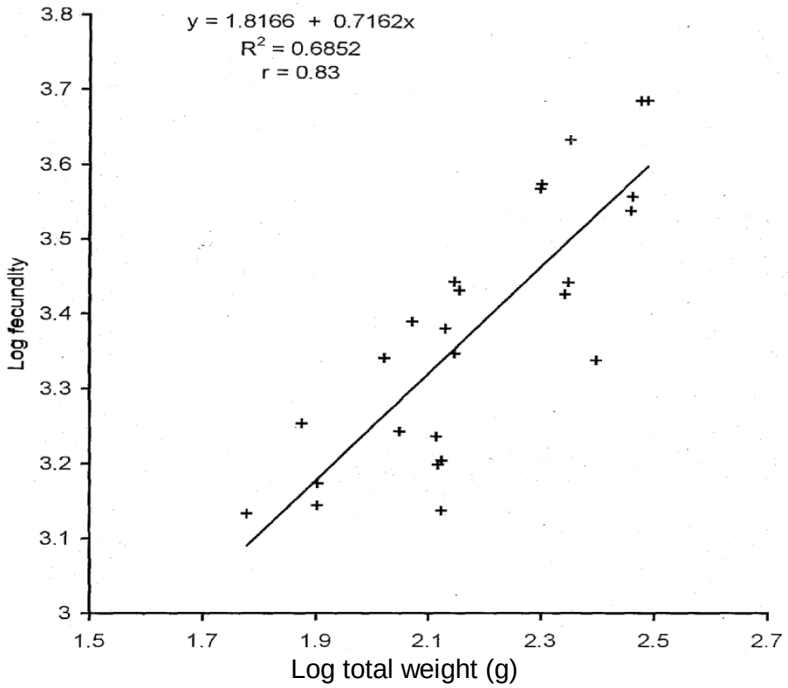

Fig. 1: Log fecundity - Log total weight relationship of *Hepsetus odoe* in Ado-Ekiti Reservoir

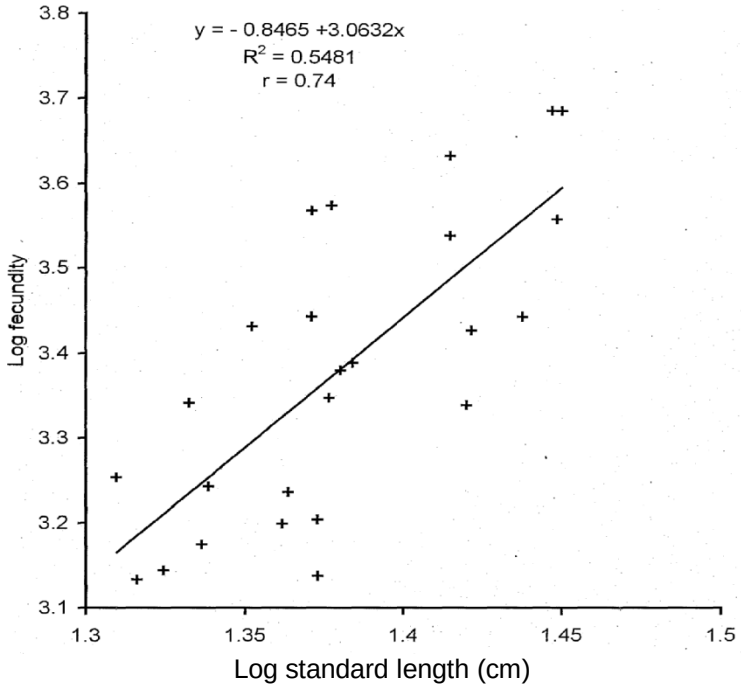

Fig. 2: Log fecundity - Log length relationship of *Hepsetus odoe* in Ado-Ekiti Reservoir

Size at maturity

The size at maturity for the female *H. odoe* was 22.4cm and 22.5cm for males. The minimum length at which 50% of the females and males had matured gonad in the reservoir was 21.4± 0.7cm and 22.3± 0.5cm (standard length) respectively. Maturity occurred in both males and females within the first year (1^+) of life in the reservoir.

Gonadosomatic index

Monthly variation of gonadosomatic index and weight for both male and female *Hepsetus odoe* was illustrated in tables 1a and 1b. Gonadosomatic index (GSI) was higher in females 0.6 - 1.8% with mean value of 1.3 ± 1.6% than in males 0.4 - 1.1% with mean value of 0.6 ± 0.6%. Figure 3 illustrates monthly variation in GSI. The lowest mean GSI values were recorded in December for both males and females, 0.4 ± 0.3 and 0.6 ± 7.4 respectively; while the highest values of 0.9 ± 0.2% and 1.8 ± 1.7% were recorded in February for both males and females respectively. High values were also recorded in September and October for males and females, 0.8 ± 1.1% and 1.5± 2.9% respectively. GSI was highest when mean weight was highest in both male and female fish.

Logarithmic transformation of gonadosomatic index-weight relationships of male and female are illustrated in figures 4 and 5 respectively. These can be represented by the following regression equations:

Males: Log W = 0.17 + 0.01 Log L (r = 0.18)
Females: Log W = -0.97 + 0.02 Log L (r = 0.78)
Where
W = weight (g)
L = standard length
r = correlation coefficient
Unlike the males correlation coefficient values of females (r = 0.78) were significant (P<0.05).

Table 1a: Gonadosomatic index (GSI) and weight of male *Hepsetus odoe* in Ado-Ekiti Reservoir

Month / Year	Fish weight	Gonadosomatic index (GSI)
August, 2014	151.39±34.60	0.57 ± 0.30
September	100.91±88.00	0.75 ± 1.14
October	123.36 ± 50.9	0.52 ± 0.48
November	95.35 ± 18.40	0.39 ± 0.27
December	86.49 ± 4.60	0.35 ± 0.30
January, 2015	152.68 ± 55.90	0.89 ± 0.21
February	152.83 ± 56.12	0.89 ± 0.21
Mean	126.54 ± 55.49	0.63 ± 0.55

Table 1b: Gonadosomatic index (GSI) and weight of female *Hepsetus odoe* in Ado-Ekiti Reservoir

Month / Year	Fish weight	Gonadosomatic index (GSI)
August, 2014	86.61± 80.10	0. 72 ± 0.78
September	170.48 ± 72.70	1.48 ± 2.87
October	106.36 ± 47.86	1. 27 ± 0.71
November	85.30 ± 60	0.61 ± 0.53
December	104.82 ± 27.46	0.56 ± 0.007
January, 2015	158.96 ± 69.72	1.80 ± 1.73

February	159.14 ± 69.63	1.81 ± 1.72
Mean	133.74 ± 73.26	1.33 ± 1.62

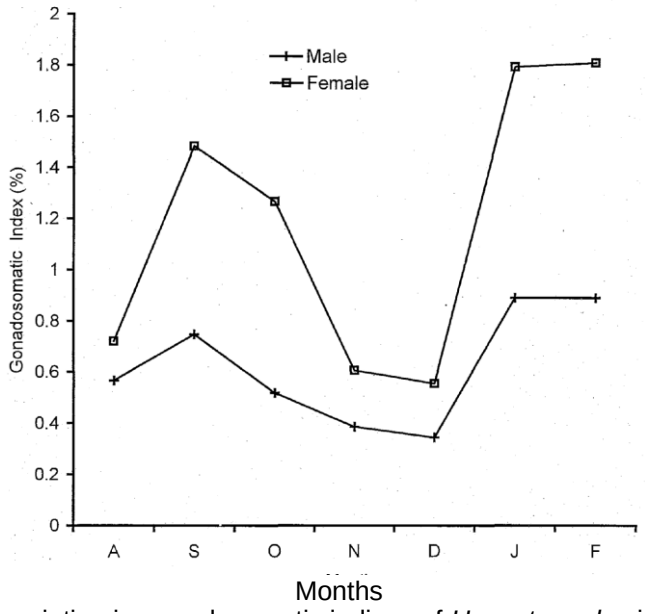

Figure 3: Monthly variation in gonadosomatic indices of *Hepsetus odoe* in Ado-Ekiti Reservoir

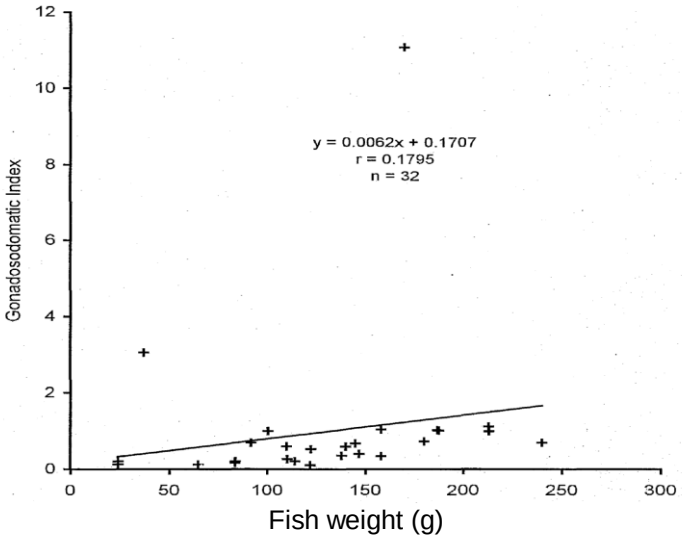

Figure 4: Linearity of gonadosomatic index - weight relationship of male *Hepsetus odoe*

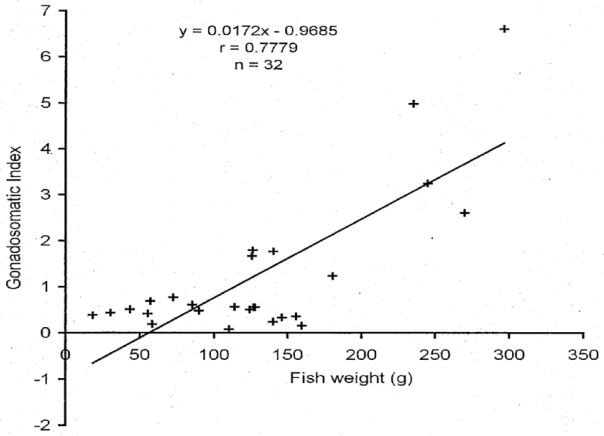

Figure 5: Linearity of gonadosomatic Index - weight relationship of female *Hepsetus odoe*

Stages of gonad maturation

The gonads were in pairs. All the gonad maturity stages were encountered. These stages were immature, developing, mature (ripening), ripe and running, and spent. The description of gonadal stages was as follows:

Stage1 (**Immature)** – ovaries appeared like pairs of translucent pale white strips and weighed less than 0.5% of fish weight. Eggs were not visible, thus microscopic observations were needed to ascertain sex. The testes in this stage appeared as a pair of white filaments.

S**tageII (Immature and developing**) – Eggs in this stage though minute were visible to naked eye. Ovaries here tended creamy in colour and weighed more than 0.5% fish weight. The testes in this stage were still white but increased in size with lobes.

S**tageIII** (**Ripening)** – ovaries were swollen and the lobes were lost. The colour tended yellow and gonad weighed 1-5% of fish weight. The testes appeared like those in stage II but were larger and softer. The lobes became more prominent.

StageIV (**Ripe running stage) –** ovaries in this maturation stage were fully swollen with anterior bulges and central depression giving a pear like appearance. The ovary wall ruptured and eggs tended reddish due to vascularisation. Ovaries were no longer in strips but occupied more than three quarters (75-80%) of the abdominal cavity and rendered alimentary canal and gut almost inconspicuous. Eggs were mostly translucent yellowish and scattered easily on contact. Eggs easily extruded from vent when pressure was applied to the flanks. The ripe testes were swollen and multilobed. The colour was creamy white. Blood vessels gave pinkish shades in some areas. When pressure was applied on the flanks, milty drops extruded from the genital pore.

StageV (**Spent**) – ovaries in this stage were brownish towards the vent region. They appeared flaccid, eggs still extruded on forced pressure at the flanks. Testes in this stage were flabby and pinkish tending brown. Milt still extruded on forced pressure at the flanks.

Table 2a & b show the monthly variations in gonad maturity stages observed in *H. odoe* during the period of investigation. The females had highest ripe eggs (stage IV) in September and January. Stage V (spent stage was recorded only in October 2014.

Table 2a: Monthly Occurrence (by number) of the gonad maturity stages of female *Hepsetus odoe* in Ado-Ekiti Reservoir

Month/year	**Gonad maturity stages**				
	I	**II**	**III**	**IV**	**V**
August, 2014	3	15	9	-	-
September	3	12	-	13	-
October	12	45	6	9	3
November	-	15	3	3	-
December	-	3	3	-	-
January,2015	-	24	12	15	-
February	-	6	9	6	-

Table 2b: Monthly Occurrence (by number) of the gonad maturity stages of male *Hepsetus odoe* in Ado-Ekiti Reservoir

Month/year	**Gonad maturity stages**				
	I	**II**	**III**	**IV**	**V**
August, 2014	3	12	9	-	-
September	15	6	3	-	-
October	24	21	15	6	-
November	9	3	9	3	-
December	6	-	3	-	-
January,2015	-	3	3	6	-
February	3	3	6	6	-

Discussion

The sex ratio observed in this study did not differ significantly from the expected 1:1 ratio. According to Nikolsky (1969), a 1:1 sex ratio represents lack of difference in the longetivity of the sexes. Oso *et.al.* (2011) observed different sex ratio of female to male (2:1) *H. odoe* in the same reservoir between September and December; this could be due to the fact that the biology and ecology of fish may vary with time. The report of Kareem *et. al.,* (2015) on the sex ratio of *H. odoe* from Eleyele Reservoir was also contrary to those of the present study in Ado Ekiti Reservoir. The author reported that the overall sex ratio of sampled *H. odoe* showed a preponderance of females over males and significantly differs. According to Fagade *et. al*. (1984) and King (1991) the wide disparities in sex ratio could be adjudged as a mechanism for population regulation. Balogun (1980) also reported similar skewed sex ratio of 1:3 for *H. odoe* in Epe Lagoon, Nigeria.

The low fecundity recorded in *H. odoe* in this study when compared with other fish species with high fecundities is probably related to the differences in breeding behaviour. As a rule, the fecundity of a fish is inversely related to the degree of parental care it exhibits (Nikolsky, 1963; Adebisi, 1987). The low fecundity of *H. odoe* could therefore be a confirmation of the existence of some degree of parental care. Ekpo (1982) reported low fecundity (1,545 – 3, 953 standard length 20.5 – 21.5 cm) for *H. odoe* in Lekki Lagoon. Merron *et al*. (1990) made similar observation in the species in Okavango Delta in Botswana. The authors recorded fecundity of 2,630 for *H. odoe*. Some fish species have been reported to have high fecundity. Elliot (1986) obtained 20, 168 – 33, 601 for *Schilbe mystus* of total length 21.6cm and 28.3cm respectively. Abayomi and Arawomo (1996) reported 15,667 – 650,626 for *C. gariepinus*. The authors further reported that this can be attributed to the spawning behaviour of fish to lay more eggs to account for the losses to predators and adverse external factors.

Fecundity of *H. odoe* increased with fish size. Kareem *et. al.* (2015) in Eleyele Reservoir, Ibadan and Merron *et.al.* (1990) in River Sokoto made similar observation on *H.odoe*. This has also been reported by several workers for other fish species (Adebisi, 1987; Ezenwaji, 1992; Olurin, 1994; Oben, 1995; Oben *et al.*, 2000; and Ayoade, 2009, Oso *et. al.* 2011 and Oso *et. al.* 2013,).

The eggs of *H. odoe* in this study were relatively large and their sizes were higher than 1.36mm of the same species in Lekki Lagoon reported by Ekpo (1982). This could be as a result of differences in habitat which may reflect the amount of food available and consumed. The egg size of fish varies from one species to another and are affected by various factors such as the degree of parental care (Fryer and Iles, 1972; Fletcher and Wooton, 1995), mode of spawning Adebisi, 1987), length of interspawning interval (Townsend and Wooton, 1984) amount of food consumed (Springate *et. al*., 1985; Fletcher and Wooton, 1995) and habitat (Elliot 1986; Ayoade, 2004). Generally, fish species with low egg diameter are usually very fecund while species with large egg diameter are less fecund and may show some degree of parental care (Ekpo, 1982; Adebisi, 1987; Oben *et al*., 2000).

Fish species with large egg diameters include, mouth brooding *Tilapia* species such as *S. galileaus*, *T. aurea,* (Dadzie, 1970). Other fish with large egg diameters include *X. nigri, Pollimyrus adspersus* and *Petrocephalus sanvagii* (Ekpo, 1982). The egg diameters of species that are closely related to *H. odoe* have also been reported to be large. These fish species include *A. longipinnis* and *A. chaperi* (Ekpo, 1982).

The females of *H. odoe* mature at a slightly smaller size than male in Ado-Ekiti Reservoir. According to Olatunde (1977), sexual maturity can be assessed by either consideration of size or age of fish. In cases where maturity is size-dependent, fish maturity depends on age; this is influenced by the growth rate of the fish (Imevbore, 1970). Thus a fish with faster growth will mature at a bigger size than a fish with slow growth rate. Thus, the difference in size at sexual maturity in male and female *H. odoe* may be attributed to differences in growth rate between them. Aim (1959) reported that within species, the mean age and size at which maturity is reached varied between populations and environmental conditions. The size at which a fish matures depends on a number of factors which include asymptotic length and its life span (De Silva, 1973) or shortage of food supply and intensive predation (Fryer and Iles, 1972, Ricker, 1975).

Females were slightly heavier than males in this study. Similar observation was made by Kareem *et.al.* (2015). This could be due to additional weight gain in ovaries of females especially during the breeding season. All the five maturation stages occurred every month throughout the study period except the spent stage (stage V) which occurred only in October and ripe and running stage (Stage IV) which was absent only in December. This indicates that *H. odoe* bred throughout the year (multiple spawner). Abundance of ripe fish was more in October and January, although it was abundant in all other months. This shows that *H. odoe* bred both during the rainy and dry seasons with the peak breeding in these periods of peak abundance of ripe fish. Variations in gonadosomatic indices (GSI) of female fish confirmed that the peak breeding was in September to October (rainy season) and January to February (dry season). The spent stage (stage V) encountered in October further confirms that spawning occurred in September.

Conclusion

Hepsetus odoe is a a multiple spawner in Ado Ekiti Reservoir, it bred both during the rainy and dry seasons with the peak breeding in these periods of peak abundance of ripe fish and highest gonadosomatic index, September to October (rainy season) and January to February (dry season). Knowledge of the fecundity of *H. odoe* can be utilized to ascertain the time and number of recruitments and population dynamics. Knowledge obtained from this study will enable rational management and sustainable exploitation of this commercially important species in the reservoir.

References

Adebisi AA (1987). The Relationships between the fecundities, gonadosomatic indices and egg sizes of some fishes of Ogun River Nigeria *Archives of hydrobiology* 3.I: 151 – 156.

Aim G (1959). Connection between maturity, size and age in fishes. *Rep. Inst. Fresh Wat. Res.* (Drottningholm) pp 405-145.

Ayoade AA (2004). The Bionomics of *Schilbe mystus* (Linne, 1766) in Asejire and Oyan Lakes, Southwestern Nigeria. Ph.D. Thesis, University of Ibadan 275p.

Ayoade AA (2009). Aspects of the reproductive biology of the African Butter catfish *Schilbe mystus (*Teleostei: Schilbeidae*)* in an artificial lake in South western Nigeria. The Zoologist 7: 130-140.

Abayomi OS and Arawomo GAO (1996). Sex ratio and fecundity of *C. gariepinus* in Opa reservoir, Ile-Ife, Nigeria. *Proceedings of the Annual Conference of Fisheries Society of Nigeria* (FISON) 1996. 122-130pp.

Balogun K (1980). The biological survey of fishes in Epe lagoon. University of Lagos, Lagos

Bolorunduro PI (2003). Post harvest loss assessment and adopting of disseminated technologies and artisanal fisheries of north western Nigeria. University of Ibadan, Nigeria.

Bagenal TB (1978). *Methods for Assessment of fish production in freshwaters.* (Ed. Bagenal) pp. 219 – 255 Blackwell Scientific Publications.

Dadzie S (1970). Laboratory experiment on the fecundity and frequency of spawning in *Tilapia aurea Bamidgeh 22*: 14 – 18

Dadzie S and Wangila BCC (1980). Reproductive biology, length – weight relationship and relative condition of pond raised *Tilapia zilli* (Gervais). *Journal of Fish. Biology 17*: 243 – 253.

De Silva SS (1973). Aspects of the reproductive biology of the sprat, *Sprattus sprattus* in inshore waters of the West Coast of Scotland. *Journal of Fish. Biology. 5*: 698-705.

Ekpo AEA (1982). Length weight relationship, food habits and fecundity of non – Cichid fishes in Lekki Lagoon, Nigeria. M. Sc. Thesis, University of Lagos.

Elliot OO (1986). Some aspects of the biology of the fishes of Asejire Lake. Ph.D. Thesis, University of Ibadan, Nigeria 301 PP.

Ezenwaji HMG (1992). The reproductive biology of four African catfishes (Osteichthyes: Clariidae) in Anambra River Basin, Nigeria. *Hydrobiologia* 242: 155-164.

Fagade SO, Adebisi AA, Atanda AN (1984). The breeding cycle of *Sarotherodon galilaeus in* IITA Lake Ibadan, Nigeria. *Arch. Hydrobiol. 100:* 493-500

King RP (1991). Some aspects of the reproductive strategy of *Ilisha africana* (Bloch, 1795) (Teleostei: Clupeidae) in Qua Iboe River estuary, Nigeria. *Cybium 15:*239-257.

Fagbenro O, Adedire O, Fateru O, Owolabi I, Ogunlana O, et al. (2005). Digestive enzyme assays in the gut of *Oreochromisniloticus* LINNAEUS 1757, *Parachanna (Channa) obscura* GUNTHER 1861 and *Gymnarchusniloticus* CUVIER 1829. *Animal Research International 2*: 292-29

Fletcher DA and Wooton RJ (1995). A hierarchical response to differences in ration size in the reproductive performance of female three-spined stickebacks. *Journal of fish Biology 46. 4:* 657-668.

Fryer G and Iles TD (1972). *The Cichlid fishes of the great Lake of Africa* – Their Biology and Evolution. Edinburgh Oliver and Boyd. 641.

Hilge V (1977). On the determination of the stages of gonadal ripeness in female bony fishes. *Meeresforsch 25:* 149–155.

Idowu EO (2007). Aspect of the biology of *Hepsetus odoe* in Ado Reservoir Nigeria Ph.D. Thesis,

University of Ibadan, 198 pp

Imevbore AMA (1970). Some Preliminary Observations on theratio and fecundity of the fish in the River Niger. Kaiji Lake Studies I (Ecology), Ed. S.A. Visser Published for NISER by the Ibadan University Press.

Kar D,Sen N (2007). Fish diversity of Mizoram, Tripura and Barak drainage.*Zoos' Print Journal22*: 2599-2607.

Kareem OK, Ajani EK, Orisasona O, Olanrewaju AN (2015.) The Sex Ratio, Gonadosomatic Index, Diet Composition and Fecundity of African Pike, *Hepsetus odoe* (Bloch, 1794) in Eleyele Lake, Nigeria. J Fisheries Livest Prod 3:139.

Merron GS, Holden KK and Bruton MN (1990). The reproductive biology and early development of the African pike, *Hepsetus odoe,* in the Okavango Delta, Botswana, *Environmental Biology of Fishes 28:* 215 – 235.

Nikolsky GV (1963). *The ecology of fishes.* Academic press London, and New York. 352 pp.

Nikolsky GV (1969). Fish Population Dynamics. Oliver and Boyd, Edinburgh. PP. 323.

Oben PM (1995). Age, growth and reproductive biology of some mormyrid species (Pisces: Mormyridae) in the Lekki Lagoon, Nigeria. Ph.D. Thesis, University of Ibadan, Nigeria.

Oben PM, Ugwumba OA and Oben BO (2000). Aspects of the reproductive biology of the Mormyrid, *Hyperopisus bebe* (Lacepede) in the Lekki Lagoon, Nigeria. *Nigerian Journal of Science 34:* 305-316.

Olaosebikan BD, Raji A(2013). Field Guide to Nigerian Freshwater Fishes (Revised Edition).National Institute of Freshwater Fisheries Research (NIFFR), New Bussa, Nigeria.

Olatunde AA (1977). The distribution, abundance and trends in the establishment of the family Schilbeidae (Osteichthyes: Silarifomes) in Lake Kainji, Nigeria. *Hydrobiologia 56:* 69-80.

Olurin KB (1994). The Ecology of feeding, reproduction and growth of the fishes in Oyan Lake. Ph.D. Thesis. University of Ibadan, 209pp.

Oso JA, Idowu EO, Fagbuaro O, Olaniran TS, Ayorinde BE (2011). Fecundity, Condition Factor and Gonado-Somatic Index of *Hepsetus odoe* (African Pike) in a Tropical Reservoir, Southwest Nigeria. World Journal of Fish and Marine Sciences 3: 112-116.

Oso JA, Ogunleye OA, Idowu EO, and Majolagbe FA(2013).Gonado-somatic Idex, Sex ratio and Fecundity of Tilapia zilli in a Tropical Reservoir, South West Nigeria. Jourl of Biol 01 pp 42-45

Ricker WE (1968). *Methods of Assessment of Fish Production in Freshwaters* Blackwell Scientific Publications Oxford 313.

Ricker WE (1975). Computation and interpretation of biological statistics of fish populations. *Bullettin of fish Research.Board.Canada 191:* 382pp

Simpson AC (1959). Method used for separating and counting eggs in fecundity studies on herring (*Clupea harengus*) *Occassional Paper. Ido-Pacific Fish Cun*. 59/12.
Springate JRC, Bromage NR and Cumarantunga, PRT (1985). The effects of different ration on fecundity and egg quality in the rainbow trout (*Salmo gairdneri*). In: *Nutrition and feeding in fish* (Cowey, C.B., Mackie, A.M. and Bell, J.G. Eds) London Academic Press. 371-393.
Townsend TJ and Wooton RJ (1984). Effect of food supply on the reproduction of the convict cichlids *Cichlosoma nigrofasciatumJournal of Fish Biology* 29: 91-104.
Ugwumba OA (1991). Aspects of the reproductive biology of the Ten – pounder *Elops larcerta* (Val.) in Lekki Lagoon, Lagos Lagoon and off the Lagos Coast, Nigeria. Nigeria Journal of Science.