AFRREV STECH
An International Journal of Science and Technology
Bahir Dar, Ethiopia

Vol.1 (3) August-December, 2012:231-252

ISSN 2225-8612 (Print) ISSN 2227-5444 (Online)

Prevalence of Henneguya Chrysichthys and Its Infection Effect on Chrysichthys Nigrodigitatus Fecundity

Abraham, J.T and Akpan, P.A
Department of Biological Sciences
Cross River University of Technology, Calabar
P.M.B. 1123 Calabar, Cross River State, Nigeria

Abstract

Four Hundred (400) samples of Chrysichthys nigrodigitatus were examined for Henneguya chrysichthys using methods described for gill examination, egg separation and histopathology. Monthly prevalence ranged from 5(14.7%) to 17(51.5%). Highest monthly parasite intensity (5 parasites /kg) was recorded in the month of June and July while highest mean condition factor (0.9900 kg/cm^3) was observed in the month of July. 88 (22.0%) and 47 (11.8%) prevalence were recorded for wet and dry seasons respectively. More females (17.3 %) hand infection than males (16.5 %). Infection was highest in 41-50cm, 61cm-70cm and 61cm-70cm in the low moderate and high infection categories. Eighty (20.0%) of 238 (59.5 %) females examined were gravid. 57 (14.3%) of gravid females examined were infected. Absolute

fecundity range of 3,865 eggs to 28,675 eggs and 3,601 eggs to 24,699 eggs and relative fecundity of 366 and 251 were recorded for uninfected and infected fish respectively. Oocyte diameter varied between 1.0mm and 3.6mm and 0.3mm and 1.8mm for uninfected and infected gravid females. Histological examination revealed distorted connective tissue elements, flaccid oocytes with some oocytes without nucleus in the ovarian tissue of infected gravid females. F=2.813 L $^{2.3}$ and F=2.761 L$^{2.1}$ were obtained for fecundity length relationship for uninfected and infected gravid female Chrysichthys. The results are discussed.

Key words: Prevalence, Histopathology Fecundity, Gravid, Oocytes.

Introduction

Henneguya chrysichthys is a flagellated protozoa that is parasitic in *Chrysichthy nigrodigitatus.* Many forms of protozoa infecting fish have been reported by Ama - Abasi and Obiekezie (2002) and Klinger and Francis-Floyd. (2002). They include *Icthyophthirus multifis, Chilodonella sp*, *Trichodina sp* and *Apiosoma sp*. Others are *Hexamita sp, Icthyobodo sp Cryptobia sp and others.*

Many protozoa parasitic in fish are considered to be commensals, However, pathogenic protozoa such as *Trichodina sp* are known to cause mortality in both wild and cultured fish species. For instance, a heavy infection of *Trichodina sp* has been reported to cause mortality in Sphareroides (Obiekezie, 1983). Mortality due to protozoa infection arises as a result of severe alteration of morphology and physiology of fish. For instance, *Hexamita sp* was reported by Obiekezie (1983) to cause malnutrition and emaciation, *Chilodonella sp* is responsible for respiratory and osmoregulatory imbalance, *Myxobolus cerebralis* in brain of fish leads to whirling disease. Usually the host brain cells at the point of invasion of *Myxobolus cerebralis,* undergoes enormous hypertrophy forming xenoma which sometimes are several millimeters in diameter.

The silver catfish, *Chrischthys nigrodigitatus* (lacepede) is a major and common catch alongside *Ethmalosa fimbriata*, *Pseudotolithus elongatus* and *Cynoglossus senegalensis* caught along the Cross River Estuary. These fish species are highly demanded in many states in Nigeria. The fishery of Cross River Estuary depends to a large extent on *Chrysichthys nigrodigitatus.* It is known to be the most dominant fish in trawl catches accounting for a considerable frequency of occurrence in both artisanal and trawl fishery of Cross River Estuary (Enin, 2007). Because of the high food fish value of *Chrysichthys nigrodigitatus* (Ezenwa, 1988 and Obiekezie and Enyenihi, 1978), investigation into the

possibility of culturing the fish to meet with demand has been concluded (Ezenwa, 1982 and Ekanem, 1992) and some fish farmers in the southern part of Nigeria, especially Calabar, have embaked on trial culture. A knowledge of fecundity of the fish and biological factors which influence its fecundity will boost its production.

Chrysichthys nigrodigitatus commonly known in local parlance as "Inagha" spawns in fresh water environment and migrates to Cross River Estuary all the year round (Moses; 1979, and Ezenwa; 1978). Peak spawning months cover the months of May to July. Evidence for the spawning of the fish in Cross River (fresh water) has been the constant presence of post larva and the presence of female with ripe running eggs (Ezenwa, 1978). The spawned population later migrate downstream to constitute the estuarine population. Therefore, Cross River Estuary cohorts are usually marked by juveniles, matured and prespawned individuals;

Fecundity, the number of viable oocytes in the ovarian tissue of a fish is an important parameter in stock size estimation and stock discrimination (Holden and Raitt; 1974, and Ekanem, 2000). The use of fecundity as criteria for estimation of population parameters and maintenance of fishery industry cannot be overemphasized. Leone (1967) successful separated three population of surf smelt, *Hypomesus pretiosus* based on the knowledge of the fecundity and egg size. Relationship between fecundity and morphometric parameters of fish has been demonstrated by Jones (1974) and Ekanem (2000). In their reports fecundity was proportional to the body weight and to the length of fish. Environment factors such as water quality, temperature, and location within niches can influence fecundity. Rounsefell (1957) reported environmental factors to cause location related differences in fecundity of the same species of salmon. Pitt (1964) and Nagasaki (1958) reported similar observations in *Hyppoglossoides platessoides* and *Clupea pallasi* respectively. Ezenwa *et al., (*1986) showed that egg size, fecundity and condition factor varied with individual *Chrysichthys nigrodigitatus* and that location can influence egg size. Population of *Chrysichthys nigrodigitatus* in Warri River were reported to produce larger eggs and had higher fecundity than those from other locations.

Obiekezie and Enyenihi (1986) reported *Henneguya chrysichthys* in the African estuarine cat fish *Chrysichthys nigrodigitatus*. Only the cyst of *Henneguya* was isolated from the proximal ends of filamental rays of the fish. The bony materials of the rays and central cartilage were destroyed. Also, cross section of the infected gills displayed perforation of filamental rays. No host reaction was

reported. Cyst growth was described as synchronic following observation of matured cyst with young plasmodia. As many as 14 large cysts occurred along a single filament (Obiekeze and Enyenhi 1988). Casal *et al;* (2002) isolated a two symmetrical end ellipsoidal matured spores of *Henneguya friderici* from the gill filament, gut, kidney and liver of a fresh water teleost *Leporinus friderici* from river Amazon. 30% prevalence (9 out of 30) of the parasite in the fish was reported. Spores development was described as asynchronic.

Earlier reports of *Henneguya chrysichthys* in *Chrysichthys nigrodigitatus* from Cross River Estuary make no mention of the effects of the parasite on fecundity of the fish. The objectives of this work are; to observe the prevalence of *Henneguya chrysichthys* and its effects on the fercundity (reproductive capacity) of *Chrysichthys nigrodigitatus*.

Materials and methods

Study Area

Cross River Estuary takes its rise from Cameroon Mountains and flows west ward into Nigeria, then Southward into Atlantic Ocean at the gulf of Guinea. It occupies an area of 54,000km^2 with 39000km of the area in Nigeria (Ama-Abasi and Holzlohner 2002 and Akpan and Ofem, 1993). The Estuary is located approximately between latitude 4° and 3°N and Longitude 7° 30 and 10°E in the South East of Nigeria (Figure 1).

Collection of sample

Four Hundred (400) wild captive *Chrysichthys nigrodigitatus* were bought from local fishers and fish traders along the bank of Cross River Estuary. Sample points included; Nsidung beach, Esuk utan and Ibaka. Fishing gears used by fishers were hooks, seines and set nets. Collection of samples lasted from February, 2010 to January, 2011.

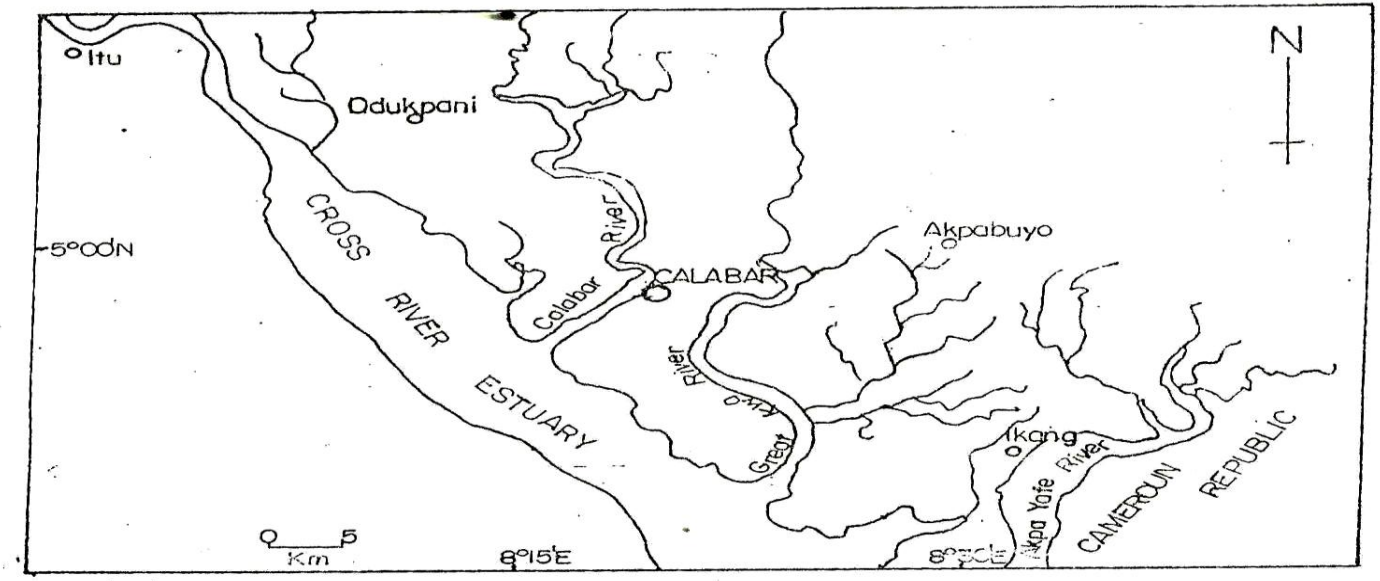


FIG. 1: Map of study area showing Cross River Estuary and it's Tributries.

Morphometric

Fish length (L) was measured to the nearest 0.1cm using a measuring board. While fish weight and ovarian tissue weight was taken to the nearest 0.5g using triple beam balance. Length and weight measurement were used to determine condition factor (C.F), fecundity-length and fecundity-weight relationships.

Condition Factor

Condition Factor was calculated using the formula

$$C.F = 100W/L^3$$

Where W = Fish weight

L = Fish Length

Examination of gills for parasite

Each fish was placed on a dissecting board. The opercula cavity was cut open with the aid of a pair of forceps and scissors. The gills were first examined using hand lens. Gills were removed into Petri dish. Gills arches with parasites were then scrapped into Petri dish containing 4% formalin. Sediments were filtered out and smeared on micro slide and examined under microscope.

Separation of eggs in Ovarian Tissue

After measurement, ovaries were carefully excised from the body cavity of each fish and immersed in Gilson fluid (Simpson, 1951) and Ekanem, 2000) for 5 days. This helps to harden the eggs, breaks the ovarion tissue and helps in liberating the eggs.

Estimation of Fecundity (F)

Absolute fecundity was taken as the total number of eggs in the ovarion tissue of a fish prior to spawning (Bagenal, 1978). After separation, eggs were washed several times to remove excess preservative. The eggs were placed on filter paper to remove excess water before being weighed using the Mettler P1210 chemical balance. Eggs in 1-gram sub-sample were counted. Counting was done for five similar sub-samples and the mean estimated and taken as the number of eggs per gram of weight. Fecundity was taken as the number of eggs in all sub-samples from ovarian tissues of a particular fish. Relative fecundity (RF) was obtained as the mean number of eggs per unit's length (cm) or the mean number of eggs per unit weight (g) of fish (Ekanem, 2000). Scatter diagrams of fecundity by fish

length and scatter diagram of fecundity by fish weight was drawn. A regression line was fitted on each scatter diagram by the least square method (Draper and Smith, 1966). Relationship between fecundity and fish length (cm) and fecundity and fish weight (W) were established for uninfected and infected gravid female fish. The relationship was of the form

$$F = aL^b$$

and $$F = aW^b$$

Where a, and b are intercepts and slope respectively.

F = fecundity

W = Whole body weight of fish

L = Total length of fish

Egg diameter was determined by measuring the diameter of 300 randomly selected eggs from gravid female using calibrated eyepiece micrometer. Weighted mean of all means of fish egg diameter was taken as the diameter of egg.

Histopathology

Exercise gills and ovarian tissue were fixed in Bouins fluid for 7 days. Fixed samples were treated independently as follows.

Fixed samples were washed in water to remove excess fixative and dehydrated in ascending grades of absolute ethanol (30, 50, 70, 90 and 100%) for two hours in each changed grade of ethanol. Dehydrated samples were cleared in an equal mixture of chloroform and xylene (1:1) and then in two changes of xylene. Cleared samples were impregnated and attached to a rectangular wooden block. Thin sections were cut using rotary microtome. Cut sections were picked on albumenized slides, slant to drain water, stained with Harris haematoxylin and mounted in Canada balsam for examination with light microscope. Histological changes observed when stained tissue from infected gravid fish (Test) was compared with stained tissue from uninfected fish (control) were recorded.

Categorization of infection

Infection of *Chrysichthys nigrodigitatus* by *Henneguya chrysichthys* was categorized based on international standard. Low infection (1-5 parasites/kg),

moderate infection (6 – 9 parasite/kg) and high infection (10 and above parasite/kg)

Gonadosomatic index (G.S.I.)

This was estimated by the relationship

G.S.I = OW/W where

OW = Ovarian tissue weight

W = Whole body weight of fish.

Results

Henneguya chrysichthys was observed as an oval cyst somewhat white in colour and visible to the naked eye on the filamental rays of the fish gills. (Plate:1) Photomicrograph revealed the cyst as circular block placed at interval from each other. Surface of the filament directly in contact with the cyst appeared eroded. There was total loss of epithelial cell layer of the gill filament where the cyst occurred. Infected fish appeared weak and emaciated

One hundred and thirty five (33.8%) of the 400 *Chrysichthys* examined were infected by *Henneguya chrysichthys.* Monthly prevalence record ranged from 5(14.7%) to 17(51.5%) in the months of January and June respectively (Table 1) Seasonal prevalence was in favour of wet season months with (22.0%) against 11.8% recorded in dry season months (Figure 2). More females (17.3%) had infection than males (16.5%). Table 2 shows prevalence of *Henneguya in Chrysichthys* by length classes in low, moderate and high infection categories.

Highest means monthly parasite intensity (5 parasites /kg) was observed in the months of July and August (when the study area experienced rain almost every day) while mean condition factors observed appeared to show no marked difference from 09820 recorded in the month of June which had highest prevalence of the parasite (Table 1).

Plate 1: Gill of *Chrysichthys nigrodigitatus* infected by *Henneguya chrysichthys*

Arrows point to cysts of *Henneguya chrysichthys* on gill filaments of *Chrysichthys nigrodigitatus*

Table 1: Monthly prevalence, intensity and condition factor of *Henneguya chrysicthys* in *Chrysicthys nigrodigitatus*

Month	No of Fish examined	No. (% Prev) of Fish Infected	Mean (x) Monthly Intensity (Parasites/kg)	Mean (x) Condition factor (Kg/cm3)
FEBRUARY	33	9.(27.3	3	0.9010
MARCH	33	9(27.3)	3	0.9030
APRIL	34	10(29.4)	4	0.900
MAY	33	15(45.5)	4	0.9021
JUNE	33	17(51.5)	4	0.9820
JULY	34	17(50.0%)	5	0.9900
AUGUST	33	15(45.5%)	5	0.9801
SEPTEMBER	33	14(42.2%)	3	0.9020
OCTOBER	34	10(29.4%)	3	0.9301
NOVEMBER	33	8(24.2)	3	0.9860
DECEMBER	33	6(18.1)	2	0.7010
JANUARY	34	5(14.7)	2	0.7080
∑	400	135(33.8)	X = 41/12 =3.4	

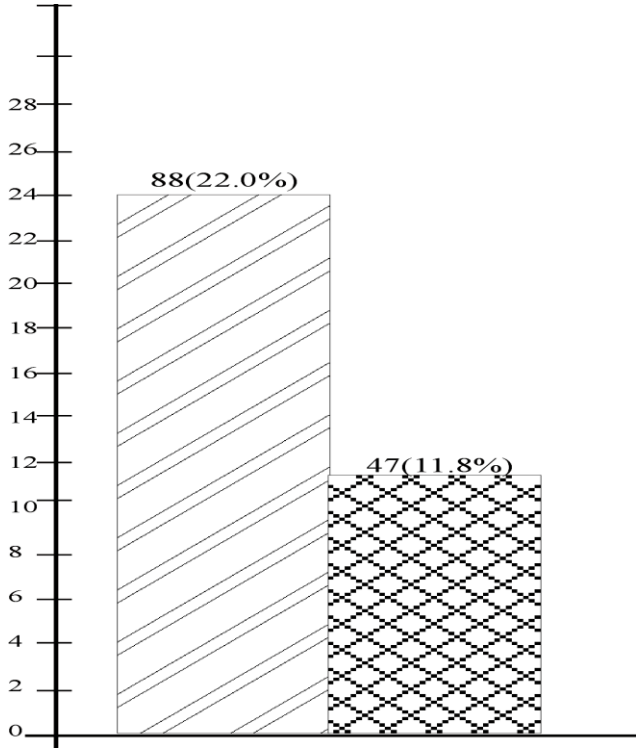


Figure 2: Seasonal prevalence of *Henneguya chrysththys* in *Chrysichthys nigrodigitatus* from Cross River Estuary.

Wet Season

Dry Season

Table 2: Prevalence and intensity of *Henneguya* sp by different length class of *Chrysichthys nigrodigitatus* at low, moderate and high infection.

Length Class (cm)	No of fish examined			No. (% .) of fish infected.									Mean Intensity(per/kg)		
				Low infection			Moderate infection			High infection.					
	M	F	Total	M	F	Total	M	F	Total	M	F	Total	Low infection	Moderate infection	High infection
11-20	40	70	110	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0.(0.0)	0(0.0)	0(0.0)	0(0.0)	-	-	-
21-30	31	52	83	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0.(0.0)	0(0.0)	0(0.0)	0(0.0)	-	-	-
31-40	36	44	80	4(11.1)	0(0.0)	4(5.0)	9(25.0)	2(4.5)	11 (13.8)	0(0.0)	0(0.0)	0(0.0)	4	7	-
41-50	18	22	40	6(33.3)	2(9.1)	8(20.0)	7(38.9)	10(45.5	17(24.5)	2(11.1)	0(0.0)	2(5.0)	4	6	10
51-60	15	18	33	3(20.0)	2(11.1)	5(15.2)	10(40.0	11(61.1)	21(63.5)	0(0.0)	6(33.3)	6(18.2)	3	6	10
61-70	10	15	25	1(10.0)	3(20.0)	4(16.0)	9(90.0)	13(86.7)	22(88.0)	1(10.0)	6(40.0)	7(28.0)	2	7	13
71-80	7	8	15	3(42.9)	1(12.5)	4(16.7)	6(85.7)	5(62.5)	11(75.3)	1(14.3)	2(25.0)	3(20.0)	2	8	14
81-90	5	9	14	2(40.0)	0(0.0)	2(14.3)	2(40.0)	4(44.4)	6(42.9)	0(0.0)	2(22.3)	2(14.3)	3	7	13
∑	162	238	400	19(11.7	8(3.4)	27(6.8)	43(26.5)	45(18.9	88(22.0)	4(2.5)	16(6.7)	20(5.0)	X=3	X=7.	X=12.

Summary of females examined was:

- No of females examined - - - - 238
- No of females infected by *Henneguya* - - 69
- No of infected gravid females - - 57
- No. of infected ungravid females (69-57) - 11
- No of examined gravid females - - 80
- No of examined gravid females not infected (80-57) 23

Eighty (20.0%) of the 238(59.5%) females examined were gravid. 57(14.3%) of the 80 gravid females examined were among the 69(17.3%) infected females. Summary of morphometric and fecundity estimate for infected and uninfected gravid females are shown on table 3.

Absolute fecundity of uninfected gravid females ranged from 3,865 eggs recorded for fish 35cm and weight 685.2g to 28,675 eggs recorded for fish 76cm and weight 2483.39. These gave a fecundity range of 110.4 eggs/cm and 5.6 eggs/g to 377.3 eggs/cm and 11.6 eggs/g respectively. Fecundity-length and fecundity-weight of gravid uninfected females *Chrysichthys* were found to be

$$F = 2.813\ L^{2.3} \quad \text{and}$$

$$F = 10.714\ W^{1.7}$$

Table 3: Summary of Morphometric and fecundity estimate for gravid infected and gravid uninfected females in all categories of *Henneguya chrysichthys* infection in *Chrysichthys nigrodigitatus*.

Morphometric and Fecundity Parameters / Categories of Infection	Sample Size (n)		Mean Total Length (cm)		Mean Weight (g)		Mean Condition Factor (cf)		Mean Ovarian weight		Mean egg (No./cm) (RF)		Mean G.S.I (g)	
	IN	UN	IN	UN	IN	UN	IN	UN	IN	UN	IN	UN	IN	UN
Low Infection	31	12	59.3	60.1	167.5	18.89	0.8023	0.87172	172	243	346	3.88	0.112	0.129
Moderate Infection	19	8	60.3	60.5	1690	17.28	0.7708	0.7803	261	278	351	353	0.154	0.164
High Infection	7	3	70.0	70.5	1800	1998	0.5248	0.5702	280	292	355	359	0.155	0.146
∑	57	23												

Oocyte diameter of uninfected gravid females varied between 1.0mm and 3.6mm. It was observed that egg size did not depend on fish length. Some smaller fish had eggs with greater diameter than some longer fish for instance a fish 38cm had eggs of 2.6mm diameter while another fish of length 63cm had eggs of 2.2mm diameter. However, the size (cm) of the ovarian tissue was directly proportional to fish length. The longer the fish, the longer, bigger and heavier was the ovarian tissue.

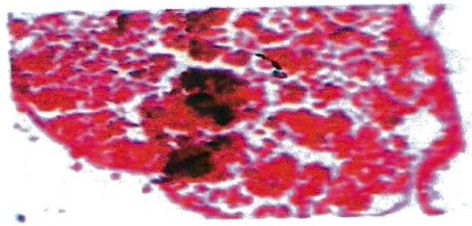
Absolute fecundity of infected gravid females ranged from 3,601 eggs recorded in fish 42cm and weight 658.5g to 24699 eggs recorded in fish 76cm and weight 1946.0g. These give a mean fecundity range of 85.7 eggs/cm and 54.7 eggs/g to 366.7 eggs/cm and 13.9 eggs/g respectively. Oocyte diameter of the infected gravid females range from 0.3mm to 1.8mm. Fecundity-length relationship and fecundity weight relationship for infected fish were found to be

$$F = 2.761 \quad L^{2.1}$$

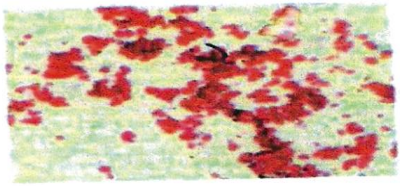
$$F = 10.135 \ W^{0.5}$$

Comparison of absolute fecundity of the uninfected gravid fish with absolute fecundity infected gravid fish using t-test showed significant difference at $P \leq 0.05$.

Histological Section of Ovarian tissues of infected gravid female *Chrysichtys* showed distorted connective tissues element and flaccid oocytes with some oocytes without nucleus within the tissue (Plate 2).



Control 1



Test 1

Plate 2: Histopathology of Oocytes of female *Chrysichthys nigrodigitatus* infected by *Henneguya* sp.

Control 1: Histological section of ovarian tissue of uninfected female *Chrysichthys nigrodigitatus*

Test 1: Histological Section of Ovarian tissue of infected female *Chrysichthys* showing distorted connective tissue elements and flaccid oocytes

Discussion

The occurrence of *Henneguya chrysichthys* in *Chrysichthys nigrodigitatus* agress with the reports of Obiekezie (1983) and casal *et al;* (2002) that *Henneguya* infects catfish. However, the stage and location of the myxosporean parasite reported differ in some aspects. While only the cyst of *Henneguya* was isolated at the proximal and distal ends of the filamental rays of the fish gills during these studies, Casal *et al;* (2002) isolated the adult

stage of the parasite from organs of the host catfish (*Leporinus friderici*) especially from those organs that are located along the gut and from Kidney.

The overall prevalence, 135 (33.8%) observed during this studies is high and the mean monthly parasites per kilogram fish observed are above the international standard of 1 parasite per kilogram (Klinger and Francis-Floyd, 2002) for marketable fish. Highest monthly parasite prevalence (51.55% and 50.00%) and intensity (5 parameter/kg) corresponds with wet season months (June and July). During wet season, estuarine salinity becomes considerable reduced due to rain water run-off into the estuary. This encourages parasites survival which in turn increases their possibility of infecting the host. As salinity increases towards marine concentration, the population of parasites decreases (Paulin and Morand, 2005) and the possibility of infecting the host is reduced. Thus, relatively lower prevalence and intensity were recorded during dry season months. The phenomenon of seasonal dynamics of fish parasites helps in determining the population biology of host-parasite system (Kennedy, 1977) and increase parasite population during wet season months corresponding with low salinity and increase pollutants (Asuquo, 1989) makes fish parasite especially macro-parasite biomakers for pollutants in aquatic environment, as was earlier reported by schludermann *et al*; (2003). Because of the relative higher prevalence and intensity of parasites during wet season months, the relationship between *Chrysichthys nigrodigitatus* and the various parasites that can infect the fish within Cross River Estuary ecosystem can better be studied during raining season.

Estimated mean relative fecundity of uninfected (RF = 366) and infected gravid females (RF = 251) of *Chrysichthys nigrodigitatus* differed significantly at P.= 0.05. The highest fecundity estimate for uninfected gravid females (28,676 eggs) was found to be high than 28,086 eggs reported by Ekanem (2000) for Cross River population and 2,884 eggs reported by Fagade and Adebisi (1979) for Lake Adejire as the highest fecundity estimated for *Chrysichthys nigrodigitatus.* It is difficult to declay the Cross River Estuary population as superior to Cross River (fresh water) population in terms of fecundity because both population have been reported to undergo anadromous and catadromous migration respectively at one time of the year or the other (Ezenwa *et al;* 1986). However, Cross River Estuary and Cross River population are superior to lake Adejire population in terms of fecundity.

Great disparity was observed between the fecundity of *Chrysichthys nigrodigitatus* obtained from the Cross River Estuary and the fecundity of the same species obtained from Badagry Lagoon and Imo River. A fish 45cm was found to have fecundity of 14,966 eggs during this research, while 12,602 eggs and 11,316 were recorded for fish of the same length at Badagry lagoon and Imo River respectively (Ezenwa, *et al* 1986 and Ekanem 2000)

Fecundity – length and fecundity- weight relationship obtained for uninfected gravid female *Chrysichthys* agrees with existing literature but those of infected gravid females differed from existing literature. The exponential b-value, (2.3) linking fecundity with total length of uninfected gravid female *Chrysichthys* agrees with the value obtained by Ekanem (2000) and falls with the range 2.3 – 5.3 reported by Bagenal (1978) for varieties of species of *Chrysichthys*. The b-value (2.1) obtained for infected gravid female *Chrysichthys* differs from that reported for uninfected *Chrysichthys* in this work and does not fall within the range presented by Bagenal (1978) for varieties of *Chrysichthys* species. It suggest that growth of the infected fish in terms of length proceeded in a pattern that is not as proportional to fecundity as was reported by Ekanem (2000) for uninfected fish. This is further shown by the fact that the number of egg/cm of uninfected fish was always greater than that of infected fish.

The range 1.0m m to 3.6mm obtained for oocyte diameter of uninfected gravid female in this studies does not differ significantly from 0.65 – 3.45 reported by Ekanem (2000) and a mean of 3.54mm reported by Imevbore (1970) for gravid females *Chrysichthys* from Cross river and Niger River respectively. However, the maximum 3.6mm differs significantly from the maximum oocyte size reported for *Chrysichthys nigrodigitatus* and *Chrysichthys walkeri* respectively by Ikusemiju (1976). Occytes observed in ovarian tissue of infected gravid females were flaccid. Connective tissue elements were distorted and the normal arrangement of oocytes in the ovarian tissue was lost. 1.8mm maximum oocyte diameter recorded for the infected fish is relatively smaller than that recorded for uninfected fish, though it falls within the range given by Ekanem (2000) for *Chrysichthys.*

The presence of the cyst of *Henneguya* in gills of *Chrysichthys* resulted in lost of epithehial cells evident by erosion of gills at the point where the cysts occupied. Erosion of gills surface definitely affected exchange of metabolites across the gill surface. The fish probably suffered low oxygen uptake, accumulation of excess salts, less food intake and loss of blood cells. Earlier

examination of infected fish blood revealed low erythrocyte count and changes in erythrocyte sedimentary rate when infected fish blood was compared with uninfected fish blood (Abraham and Akpan, 2011). Also, because of in sufficient exchange of metabolites at the gill chamber, food oxidation, absorption and assimilation may have proceeded at low rate insufficient for effective growth. Growth became retarded not only of the somaitic cells but also of reproductive cells (oocytes). Thus the relationship between fish weight and ovarian tissue weight (Gonadosomatic index) was found to vary and the mean of the differences between the G.S.I. recorded for infected and uninfected fish was significant at $p< 0.05$.

The work of Rounsefell (1957) which reported environment factors to cause location related differences in fecundity of same species of Salmon and the fact that there are regional differences in fecundity of *Chrysichthys nigrodigitatus* as reported by Ezenwa *et al* (1986) may account for disparity in fecundity but loss of nucleus in some cells and alteration in normal orientation of oocyte in ovarian tissue of uninfected gravid female *Chrysichthys* as shown in the histopathology section of ovarian tissue of infected gravid female (test) and uninfected gravid female (control) of *Chrysichthys nigrodigitatus*.

The presence of *Hennaguya chrysichthys in Chrysichthys nigrodigitatus* caused emaciation of the fish and reduced reproduction potential evident by poor oocyte development, lost of oocyte nucleus, flaccid oocytes and abnormal orientation of oocyte in ovarian tissues of infected fish. *Henneguya* is a protozoa and most protozoan infections can be controlled by maintaining good water quality, high quality food supply and enough spacing. Commercial fish farmers especially those currently culturing *Chrysichthys can* maintain cultures free from *Henneguya* infection by upholding the controlled measures listed above. Routine check and isolation of infected fish can prevent spread of parasite infection among cultured fish. Control of parasitic infection in fish cultured is an important function of increase productivity.

References

Abraham, J. T, and Akpan, P. A. (2011), Prevalence of *Henneguya chrysichthys* (Flagellated protozoa-cyst) and Haematological changes due to the infection in *Chrysichtlys nigrodigitatus*. *African Research Review 5 (4)* 124-134.

Akpan, E. R and Offem, J. O.(1993): Seasonal Variations in Water Quality of the Cross River. Nigeria *Revenue de Hydrobiogic Tropicale, 26(2).* 95-102

Ama- Abasi D.E and holzlohner, S. (2002). Length frequency distribution of *Ethmalosa fimbriata* (Bowdich) in Cross River Estuary and Adjacent Coastal Waters. *Global Journal of Pure and Applied Sciences, 10* ***(3)***. 379-383.

Ama- Abasi D.E and Obiekezie, A.I (2002): *Trichodina* (Emberg ciliphora petrichida) infection of clariid catfishes cultures in Nigeria. *African Journal of Fisher and Agriculture*, ***3***, 1-19.

Asuquo, F. E. (1989): Water Quality of Cross River, Nigeria. Tropical Ecology, 30(1). 31-40

Bagenal, T. B. (1978): Aspects of Fish Fecundity. In S.D. Gerting (Ed.), Ecology of Freshwater Fish Production. Oxford: Blachwell, 15-101.

Casal, G., Maros, E.and Azeuedo, C. (2002). Light and Election Microscopic Study of the Myxosporean *Henneguya, frideric n sp* from the Amazonnian teleostean fish, *Leporinus frederici, parasitology,* 126,313-319.

Draper, N. and Smith, H (1966). Applied Regression Analysis. John Willey and Sons, Inc., New York. 407 p.

Ekanem, S. B. (1992): Studies on the Freshwater pond Culture Chrysichthys nigrodigitatus (lacepede). University of calabar, calabar, Nigeria. *Ph. D.thesis*. p. 249

Ekanem, S. B. (2000): Some Reproductive Aspects of Chrysichthys nigrodigitatus (lacepede) from Cross river, Nigeria. ***Naga, The*** *ICLARM Quarterly, 23 (2****)***. 24-27

Enin, U. I. (2007): Personal communication

Ezenwa B. I. O. (1982) Production of Catfish, *Chrysichthys nigrodigitatus* in Brackish water pond in Nigeria using groundnut cakes as supplement feed. *Aquaculture, 27*. 77 - 208

Ezenwa, B.I.O Ikusemiju and C. I. O Olaniyan. (1986): Comparative Studies of the Catfish, *Chrysichthys nigrodigitatus* (lacepede) in Three isolated Geographical areas in Nigeria for Breeding purposes, p.

258-262. in E.A. Huisman (ed.) Aquaculture research in the African region. Wageningenm The Netherlands.

Ezenwa, B.I.O. (1978): Studies on the Distribution, Age and Growth of the Catfish, Chrysichthys nigrodigitatus in Brackish water ponds in Nigeria using Groundnut cakes as Supplements feed. *Agriculture, 27*. 177-208.

Fagade S. O. and A. A. Adebisi (1979) on the fecundity of Chrysichthys nigrodigitatus (Lacepede) of A sejore dam, Oyo State Nigeria. Nigeria. *Nigerian Journal of Natural Sciences, 1*.127-131

Holden, M. J. and Raitt, D. F. S.(1974): Manual of Fisheries Science .patt 2-methods of Resource Investigation and their Application. *FAO fish. Tech. Pap. 115 Rev. 1*:1-21.

Ikusemiju, K. (1976): Distribution, reproduction and growth of the Catfish, *Chrysichthys walkeri* (Gunther) in the Lekki Lagoon, Nigeria. *Journal of Fish Biology, 8.* 453 – 458

Immerbore, A. M. A. (1970) Some preliminary observation on the sex ratio and fecundity of fish in the River Niger. In S. A. visser (ed.) Kainji, a Nigerian man-made Lake 1. Ecology University Press, Ibadan, Nigeria.

Kennedy, C. R. (1977): The Regulation of fish parasites. In J. C. Holmes, R. P. Hobbs and T. S. leong (eds) regulation of Parasite populations London Academy Press. 63 – 189.

Klinger, R.& Francis-Floyd, R. (2002). Fish parasitological. Florida. University of Florida. 1 - 30

Leone, C.C. (1967). Fecundity of Surd smelt in the state of Washington. University of Washington, Seattle. *M.S. Thesis.*

Moses, B.S. (1979). The Cross River: its Ecology and fisheries. *Proc. Int. cont. on Kainji lake and River Basin Dev. In Africa. KLRI* 355-371.

Nagasaki, F. (1958). The fecundity of pacific herring, clupea pallasi, in British Columbia Coastal waters**.** *Fish Res. Bd. Can. 15*:313-330

Obiekezie, A. I. & U.K., Enyenihi. (1988). *Henneguya Chrysichthys* Nov. (protozoa: Myxozoa) from the gills of estuarine catfish *Chrysichthys*

nigrodigitutus (lacepede) (pisces: Bagridae) in ***Nigeria.*** *J. Afr Zool. 102*:33-42

Obiekezie, A. I. & Enyenihi, U.K. (1986). Protozoa: Myxozoa. Parasites of the African estuarine catfish**,** *Chrysichthys nigrodigitutus* **(**lacepede) pisces: Bagridae. *Review of African Zoology*, I, 10-17.

Obiekezie, A. I. (1983). Systematic account of fish parasites in the Cross River estuary and the South East Coast of Nigeria. ***Unpublished*** *PhD thesis*, University of Calabar. Nigeria.

Pitt, T. K.(1964). Fecundity of American plaice, hippoglossoides Platessoides (F) from Grand Bank and Newfoundland areas. *J. fish. Res. Bd. Can. 21*:507-512.

Polin, R and Morand S. (2005) Diversity of Parasites. Lecture series. Otogo. University of Otogo Press.

Rounsefell, Y. A. (1957). Fecundity of north American Salmonidae. U.S. fish. Wildl. Bull. 57:451-486.

Schludermann, C. Konecny, R. Laimgruber S. Lewis J. W. Schmer, F. Chovanec A. and Sure B. (2003) Fish macroparasite as Indicators of eavy Metals Pollution in River sites in Australia. *Parasitology 126*

Simpson, A. C. (1951). The fecundity of plaice. *U.K. Min. Agric. Fish. Food Invest, Ser. 217*:3-27

