CHAPTER ONE

INTRODUCTION:

There is great need for fish farming to be encouraged. This is because fish as a source of animal protein is of high quality – easily digestible and of positive health results. Fish has a high content of polyunsaturated (omega III) fatty acids which are important in lowering: blood cholesterol level and high blood pressure, the risk of age related muscular degeneration and vision impairment, the risk of sudden death from heart attacks, rheumatoid arthritis, and the risk of bowel cancer and insulin resistance in skeletal muscles (Amien-Gheme, 2007). These facts have generated a high demand potential for fish and its products. According to Federal Department of Fisheries statistical survey, out of a total of 615, 507 metric tonnes (0.616m mt) of domestic production of fish in Nigeria in 2007, 81.9% is from artisanal fisheries, 13.8% from aquaculture while 4.3% is from industrial fishing. The survey showed that the total fish demand is estimated at 2.66 million mt occasioning a yawning gap between demand and domestic production. There has been therefore, the tendency towards massive importation of fish into the country in a bid to bridge the gap. This situation has created a trade imbalance contributing to depletion of foreign exchange reserve. It is not in the best interest of the country. For example in 2007, 0.74 million mt of fish valued at US$594.4 million was imported and 0.005 million mt valued at US$38.3 million exported according to Federal Department of Fisheries statistical survey (fisheries statistics of Nigeria, 2007) . The survey also showed that there was a decline in production from artisanal and industrial fishing due to over fishing in the waters while there was a steady increase in aquaculture production. The portention of this situation is that the potential for bridging the wide gap between total fish production and demand lies in aquaculture. Therefore any effort or research geared towards development of aquaculture should be considered important and encouraged.

Aquaculture has advanced considerably to the level of intensive and extensive rearing of fish in flow-through and recirculatory systems. This notwithstanding, there abound numerous local farmers that are desirous to embark on fish farming even at subsistence level in their homesteads. Such farmers cannot afford the hi-tec facilities, and are bound to benefit from this research work which focuses on the traditional homestead fish farming. Often fish farming is integrated with livestock, i.e. savings for feed, labour etc or gains to livestock or crops by introducing fish (Ahmed and Bimbao, 2001). Pond preparation involves amongst other things organic and in-organic fertilization (Omole et al, 2006).

Fish farmers are usually confronted with the problem of choice of fertilizer (organic) for treatment of their pond water before stocking of fingerlings. There is abundance of cattle dung (excreta), poultry droppings, and pig excreta in our locality. These materials are potential fertilizers/manures for water treatment in fish culture. This project sets to verify the usefulness of each of these fertilizers to the growth of stocked fingerlings of *Heterobranchus longifilis* and thus determine which one is most effective.

The life of fish is dependent on the water medium in which it lives. Therefore any factor that affects the quality of the water will equally affect the life of the fish. The environmental factor is about the closest in determining the survival of fish, the effective utilization of nutrients and the general performance of culture species. The environmental factors affecting the development and practice of aquaculture include the parameters of water quality such as temperature, dissolved oxygen, turbidity, pH, alkalinity, nitrate-nitrogen, and phosphate-phosphorous (Aguigwo, 1998).

Temperature affects a lot of vital activities in the aquatic system particularly plankton and fish life (Balarin and Hatton, 1979). Because fish are poikilothermic (temperature fluctuations synchronise with that of environment), temperature has a remarkable influence on the principal and vital activities of the fish notably respiration, growth, and reproduction. Temperature of water also influences the solubility of oxygen in water, and therefore the dissolved oxygen status in the environment determines the amount of energy available to fish for metabolic processes (Boyd, 1979). Turbidity restricts light penetration and limits photosynthesis in the pond and is usually given as a measure of secchi disk visibility – the greater the turbidity of water, the smaller the secchi disk visibility. In ponds, turbidity, and colour may result from colloidal clay particles entering with run-offs, colloidal organic matter originating from the decay of vegetation or from abundance of plankton (Nwadukwe and Onuoha, 1987).

The choice of *H. longifilis* fingerlings in this study is well focused. This is because *H. longifilis* is one of those catfishes that can grow to a very large size under culture. It can attain the weight of over 3kg. Therefore any positive discovery made on factors that affect its growth potential will be of immense benefit to the fish farming industry. It's use as a culture species as a matter of necessity should continue to be promoted. This is because of the that it is locally available, readily be multiplied either through artificial or natural inducement, hardy and tolerant to low oxygen concentration in the pond due to its efficient air breathing organs, omnivorous and can survive on a wide variety of food materials, protein is palatable and like other fishes, low in cholesterol content and contains the essential amino acids, which the human body cannot synthesize, and attains large size, harvested fish has a good market price.

AIMS AND OBJECTIVES

The aims and objectives of this study are to:

i. Verify the effect of organic manure/fertilizers – poultry dropping, cattle dung, and pig excreta on the growth performance of fingerlings of *Heterobranchus longifilis* in three concrete fish ponds alongside a control.

ii. Determine the effect of the organic fertilizers on physico-chemical parameters of pond water.

iii. Verify the relative effects of the organic fertilizers on generation of natural food (plankton) in the pond water.

iv. Ascertain the effect of the organic fertilization on the growth of the fingerligs of ***H. longifilis,*** and

v. Ascertain which of the different organic fertilizers that has good biogenic importance in fish farming.

CHAPTER TWO

REVIEW OF LITERATURE

Many researchers have worked on the variations of fishpond water parameters occasioned by the changes in the environment and how these variations affected the life of the cultured fish. Boyd (1979) showed that pH range of 6.5 – 9.0 is desirable for fish production while pH of 11 is alkaline death point and pH 4 is the acid death point. Between pH 4 and 5 no reproduction takes place while between pH 4 and 6.5 only slow growth can be achieved. Alkaline or neutral water seems more productive than acid water (Hickling 1962). Swingle (1957) pointed out that water with pH ranging from 6.5 to 9.0 before daybreak is most suitable for culture. Khan *et al* (1983) related increase in alkalinity with increase in photosynthesis. Huet (1972) recommended pH range of 7-8 as being the best for fish. Aguigwo (1998) showed that the dissolved oxygen is necessary for metabolic activities of aerobic aquatic organisms and that dissolved oxygen decreases with increase in temperature, plankton densities, and extreme oxygen decrease causes asphyxiation. Ellis (1937) reported that 5ppm of dissolved oxygen (DO) is the upper limit at which asphyxiation takes place. Swingle (1969) stated that pond fish would die if exposed for long periods to less than 0.3 mg/litre DO, and that 1.0 mg/litre DO was the minimum concentration necessary to support fish at rest for long periods and concentrations below 5.0 mg/litre were undesirable in fish ponds.

Kemdirim and Ejike (1993) stated that nitrates and phosphates are known to be very important in phytoplankton growth, abundance and productivity in water bodies. Round (1969) described the structure of some of these phytoplankton especially the algae. Boyd (1979) showed that phosphorous is the key metabolic nutrient and that the supply of this element often regulates the production of natural waters. Nwuba and Onuoha (2006) stated that the elements needed by fish are: carbon, hydrogen, oxygen, nitrogen, phosphorous, potassium, sulphur, calcium, iron and magnesium, and that they also need trace elements such as copper and zinc which are required in small amounts. All these elements play important role in the metabolism of both animal and plankton alike which in turn constitute source of food for fish in the pond. Vines and Rees (1968) listed the specific functions of these elements.

Hickling (1962) in a research to determine the effects of the three major components of fertilizer on fish yield showed that phosphorous has an overriding importance followed by nitrogen and then potassium. Although there may be some disadvantages associated with the use of organic fertilizers for treatment of pond water, it is hoped that the advantages outweigh the disadvantages. Okoronkwo (2001) stated that with the increasing use of human and animal waste in agriculture, the risk of spreading infectious agents such as pathogenic helminthic eggs is likely to be in the increase. Erondu (1987) reported that the disadvantage of organic manure lies in the fact that they deplete dissolved oxygen during decomposition and offend aesthetic value of the pond and are liable to transmit parasitic diseases. Occasionally in fertilized pond excessive growth of algae may result not necessarily as a result of over-fertilisation and they form dense scums on the surface of water and such growths have been primary causes of fish kills in ponds (Onuoha, 1987). Talking about the advantages: Schroeder (1978) reported that organic manure add detritus to the pond and thus stimulate the heterotrophic food chains producing more bacteria and zooplankton. Darnell (1968) stated that organic manure encourages the formation of detritus which constitute all types of organic materials in various stages of decomposition. Further breakdown of detritus yields colloids of aggregate of large and small particles. The large molecules include proteins, carbohydrates, lipids, etc. The small molecules exist as dissolved biochromes, vitamins, amino acids, sugars, nitrites and nitrates. Davy and Chouinard (1981) reported that organic manures are good sources of moina and cyclops. These are good sources of food for fish. The application of organic manure has to be with caution so as not to over fertilise. Mgbenka (1988) reported that excessive application of animal wastes in ponds can lead to sudden rise in production of toxic substances like ammonia (NH_3) and hydrogen sulphide (H_2S) and methane (CH_4). The fish *Heterobranchus longifilis* used in this work may be classified thus:

Kingdom – Animalia

Phylum - Chordata

Subphylum - Vertebrata

Class - Osteichthytes

Subclass - Actinopterygii (ray fined fish)

Order - Siluriformes (catfish)

Family - Clariidae

Genus - Heterobranchus

Species- *Heterobranchus longifilis*_(Valenciennes, 1840)

CHAPTER THREE

3.0 MATERIALS AND METHODS

In this study the fingerlings of *Heterobanchus longifilis* were subjected to different organic fertilizers (poultry droppings, cattle dung, and pig excreta) treatments. The effects of the different organic fertilizers on the water quality parameters and growth rate of fish in different ponds were monitored. For proper assessment a control containing no fertilizer was set up alongside the other treatments.

3.1 STUDY SITE

The project site was Nnamdi Azikwe University Zoology Department Fish farm/ponds. Four concrete ponds each measuring 3.08m x 2.27m x 0.9m (LxWxD) were used for the project (Plate 1a).

3.2 FLOODING AND WATER TREATMENT

The ponds were flooded, by water supplied by commercial water tanker up to 70cm mark in each pond. Equal dry weights (6kg) of different sources of organic fertilizer/manure namely poultry, cattle and pig were measured using psalter weighing balance, put in a plastic porous bag and immersed in the labeled ponds (Plate 1b):- Pond I: poultry droppings (PoM); Pond II: cattle dung (CaM); Pond III: Pig excreta (PiM); Pond IV was the control (C) containing no fertilizer/manure. Porous bags were used so that solution of organic manure containing nutrients should sift out from the bag and diffuse freely into the water. The suspended bags of manure were removed after seven days, and two weeks allowed for the pond to stabilise before stocking.

Plate 1a: Photograph showing the site of the project

Plate 1b: Photograph showing the flooded and treated ponds

3.3 PROCUREMENT, STOCKING, AND FEEDING

i. Procurement

The fingerlings aged six weeks were procured from Willie Dimaka fish hatchery at Agulu in Anaocha Local government area of Anambra State (about 20 km from UNIZIK). The four ponds were stocked three weeks after with fingerlings of *Heterobranchus longifilis* (Fig 1). The average weight of fingerlings at stocking was 3 g. Average standard length (SL) was 4.7 cm and average total length (TL) was 5.6 cm. These measurements were determined through random sampling of 30 fingerlings from the population of all the procured fingerlings using scoop net, ruler, and psalter weighing balance (Table 1).

ii. Stocking Density

The stocking density of 7 fish/m^3 was determined from the number of fish stocked in each pond: 30, and the dimensions of each pond: 3.08m (length) x 2.27m (width) x 0.70m (depth of water).

iii. Feeding and Ration Level

The feed was compounded from soyabean meal and crayfish at 40% crude protein level using Pearson square, and fed at 1.5% body weight of fish/daily. The weekly daily ration for each pond was 9.50g calculating from the total weight of fish of 90 g in each pond at stocking. The weekly daily ration per pond of 9.50 g was consistently fed for 14 weeks, then doubled and fed up to 18th week. The weekly ration was again doubled and fed up to 23rd week. It was then increased by 6 g and fed up to 27th week, then increased by 5 g and fed up to 31st week (Appendix III).

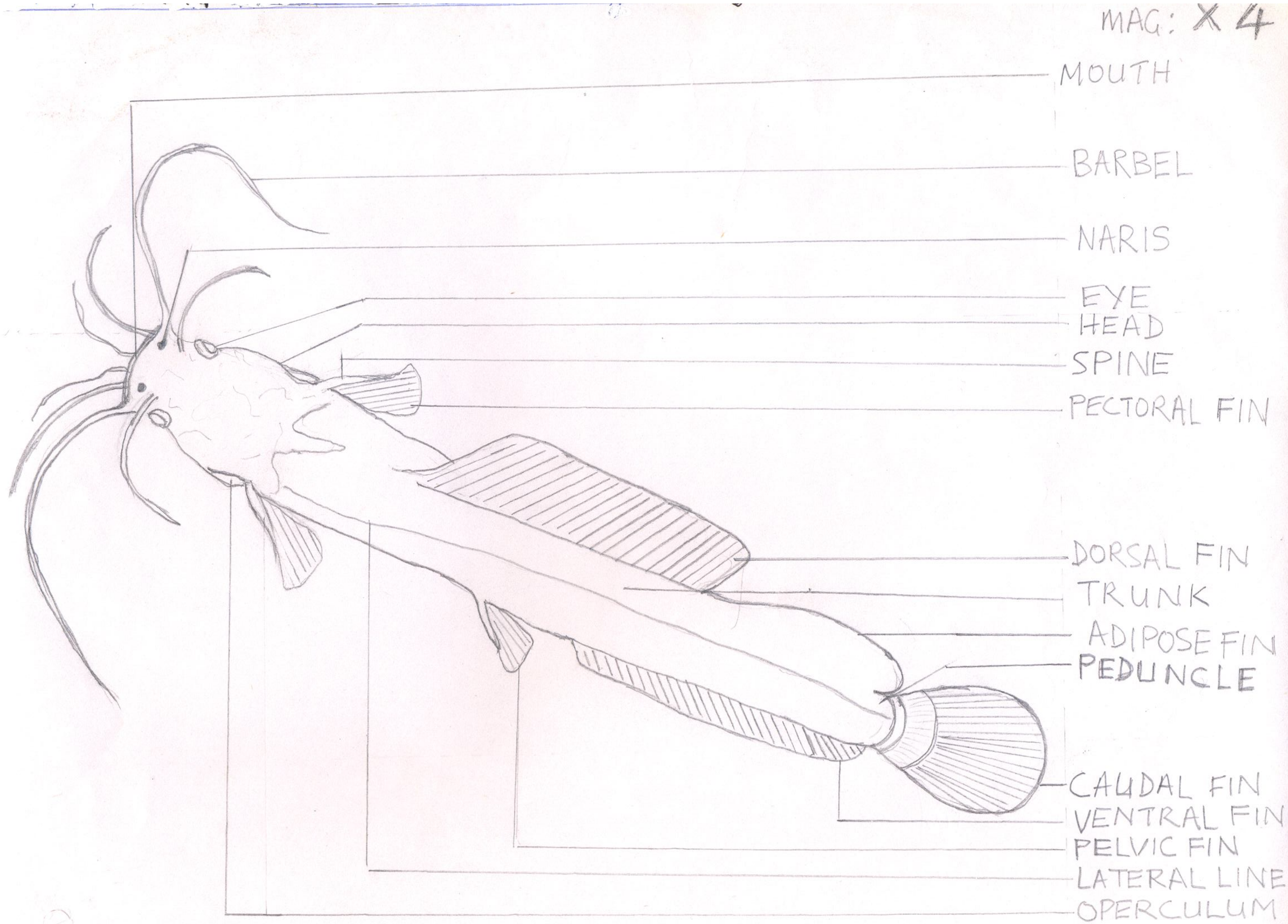

FIG I: Diagram of **Heterobranchus longifilis** fingerling showing its external features

TABLE I: MEASUREMENT OF FINGERLINGS OF *Heterobranchus longifilis* SAMPLES BEFORE STOCKING

S/N	SL (CM)	TL (CM)
1	6.7	8.0
2	6.0	7.1
3	5.0	5.9
4	4.5	5.4
5	4.2	5.0
6	4.1	4.9
7	6.5	7.6
8	6.7	7.9
9	5.9	7.0
10	5.5	6.4
11	6.7	8.0
12	4.4	5.6
13	3.9	4.6
14	4.3	5.2
15	6.0	7.0
16	3.6	4.3
17	3.8	4.4
18	3.9	4.6
19	4.2	5.0
20	3.5	4.1
21	3.7	4.3
22	3.7	4.3
23	5.8	6.9
24	3.5	4.1
25	4.2	5.0
26	4.4	5.6
27	5.0	5.9
28	3.5	4.1
29	4.2	5.0
30	3.9	4.6
Total	141.3	167.8
MEAN	4.7	5.6

LEGEND:
SL = Standard Length
TL = Total Length

3.4 SAMPLING

i. Length and weight measurements

The fingerlings were sampled randomly once every month using scoop net. From each pond ten fingerlings were sampled out, weighed using a Psalter weighing balance. The standard and total length of the fingerlings were measured using a ruler. For the months of June and July individual weights of the fingerlings were not recorded because they were not sensitive enough on the weighing balance, rather the sample was weighed and the obtained weight was divided by the number in the sample to obtain the mean.

ii. **Plankton**

The plankton were sampled to determine their distribution in each pond. Plankton net (70µm mesh size) was used and density estimated by counting the number of different plankton in equal drops of pond water on the microscope slide.

iii. **Macrofauna**

The presence of amphibians and insects was monitored by direct visual observation and counted.

3.5 DETERMINATION OF WATER QUALITY

i. **Weekly visual observations**

Weekly visual observations of the pond water in each pond was made to note the changes in colour of water due to different treatments.

ii. **Temperature, transparency, and pH (acidity/alkalinity)**

Weekly measurements were made of (a) temperature, using centigrade thermometer suspended with thread and immersed in water (b) transparency using secchi disk suspended with a calibrated rope. The disk was continuously lowered into the pond water until the white-black pattern of the secchi disk vanished from sight. The depth at that point was read off on the rope to become the transparency (c) pH using the colorimetric pH paper which was dipped into the pond, brought out and matched against standard pH colours.

iii. **Dissolved oxygen (DO)**

The dissolved oxygen in each pond was determined using the Winkler's sodium thiosulphate method (Zoo. 615 tutorials). After titration the equation $N_1V_1 = N_2 \; V_2$ was used to calculate the concentration of the oxygen in the water sample. N_1 is the normality of sodium thiosulphate; V_1 is volume of sodium thiosulphate titre; N_2 is the concentration of oxygen in the water sample; V_2 is the volume of water sample.

$$N_2 = \frac{N_1 \; V_1}{V_2}$$

Multiply by equivalent weight of 0_2 = 8

Multiply by 1000 to get the concentration in mg/litre.

ie $$N_2 = \left[\frac{\text{Vol. of titre} \times N}{\text{Vol. of sample}} \times 8 \times 1000 \right] \text{mg/litre}$$

Where N is the normality of sodium thiosulphate solution.

3.6 DETERMINATION OF PERCENTAGE OF SOME CHEMICAL ELEMENTS IN THE ORGANIC MANURES

The three different organic manures were analysed using Buck Scientific Atomic Abssorption Spectrophotometer 200-A at the Service Training Centre, University of Nigeria, Nsukka, to determine the percentage of some important elements namely phosphorous, potassium, calcium, magnesium and sodium. Nitrogen was determined using Kjeldahl N – method.

3.7 DETERMINATION OF TOTAL BIOMASS/NATURAL PRODUCTIVITY OF THE PONDS

The ponds were drained, and fish in each pond harvested, counted and weighed to determine the total biomass of fish in each pond. To estimate the natural production of each pond, we may then work back from the total fish crop according to Hickling, 1962. Food Conversion Rate (ratio) (FCR) is food supplied divided by the weight of fish gained i.e.

$$FCR = \frac{F}{(Wt-Wo)}$$

where F = wt of feed

Wo = initial wt of fish

Wt = live wt of fish at harvest

In each pond the total weight gain is supported by the supplementary feed and the natural production. If the FCR of the supplementary feed is known and the quantity supplied to each pond determined, then the gain in weight due to supplementary feed is calculated from the above equation. The difference between this and the total weight gain in each pond becomes the natural productivity of the pond. The feed used in this project was compounded from soyabean and crayfish at 40% crude protein level. According to Hickling, 1962 the standard crude conversion rate of soyabean is 3-5, and that of prawns and shrimps 4-6. The amount of this supplementary feed that will be converted into fish protein in each pond may then be calculated making use of the average conservative figures of the crude conversion rates of the feed ingredients thus: (3+4) ÷2 = 3.5. Since the amount of feed used in each pond is 756 g, and by the definition of food conversion rate the gain in weight to be produced by this quantity of feed is Fw in the equation:

$$\frac{756}{Fw} = 3.5$$

Therefore $Fw = \frac{756}{3.5} = 216$ g

3.8 EQUIPMENT AND CHEMICALS USED

Plates 2a and 2b are assemblage of equipment and chemicals used in carrying out the research work.

3.9 STATISTICAL ANALYSIS

The experiment is a simple randomized one. The statistical analysis was carried out using analysis of variance (ANOVA). It is a statistical tool used in comparing equality of more than two ‘treatment’ means. If there are only two means to be compared for equality, we use the t-test (Montgomery, 1976).

TABLE 2 MONTHLY MEAN WEIGHT ± STANDARD DEVIATION

MONTH	**MEAN WEIGHT OF FISH (g)**			
	PI	PII	PIII	PIV
AUGUST	13.95 ± 6.6	18.09 ± 19.6	12.05 ± 3.81	14.39 ± 4.87
SEPTEMBER	20.03 ± 6.62	25.80 ± 28.87	15.56 ± 7.15	19.30 ± 5.34
OCTOBER	24.0 ± 6.45	43.29 ± 50.49	22. 30 ± 5.79	23.90 ± 2.77
DECEMBER	46.20 ± 20.35	100.0 ± 49.73	30.60 ± 12.87	32.00 ± 12.33

TABLE 3 MONTHLY MEAN LENGTH ± STANDARD DEVIATION

MONTH	**MEAN TOTAL LENGTH OF FISH (cm)**			
	PI	PII	PIII	PIV
JUNE	10.30 ± 1.27	10.14 ± 1.90	9.16 ± 0.91	9.40 ± 0.77
JULY	10.74 ± 2.40	11.19 ± 3.95	10.50 ± 1.38	10.20 ±1.09
AUGUST	11.25 ± 2.26	11.96 ± 4.01	10.77 ±1.13	11.43 ± 1.04
SEPTEMBER	12.67 ± 0.70	13.47 ± 5.26	11.86 ± 1.72	12.77 ± 1.0
OCTOBER	12.21 ± 1.19	14.94 ± 1.61	12.50 ± 1.15	13.26 ± 0.87

One way analysis of variance (ANOVA) (Appendix H) tables were generated from the growth (weight) measurements data (Appendix D) and Table 2) for the three treated ponds and control for four months (August-October and December when final harvest was made) using the Statistical Package for Social Studies (SPSS). ANOVA tables (Appendix I) were not generated for the months of June and July due to lack of individual records of weight of the sample fingerlings. ANOVA tables were also generated from the length measurements data (Appendix E and Table 3) for the ponds for five months (June – October).

The hypothesis made are null hypothesis Ho, and alternative hypothesis H_1.

Ho: the treatment effects are equal ($t_1 = t_2 = t_3 = t_4$)

H_1: Not all treatment effects are equal ($t_i \neq t_j$)

$(i = {}_{1....4})$

$(j = {}_{1....4})$

$(i \neq j)$

$\propto = 0.05$ where $\propto$ is the percentage left to chance elements in the research or the significance level, was used.

For each pond the p-value from the ANOVA table was compared with $\propto = 0.05$ (p-value is the value at which the parameter starts being significant): a higher p-value ($p>0.05$) means that treatment effect is not significant and Ho would be accepted, and rejected otherwise (i.e. $p \leq 0.05$).

Post Hoc analysis (Appendix F) was carried out to determine which mean differed significantly from others using Scheffe's multiple comparism test and range test.

Scheffe's test was considered appropriate. It is used when the experiment is not designed (not completely randomised) and equal variance assumed. Range tests identify homogenous subsets of means that are not different from each other. Pairwise multiple comparisms test the difference between each pair of means and yield a matrix where asterisks indicate significantly different group means at an alpha level of 0.05 (Harry and Steven, 2002).

2a

Photograph showing the equipment and chemicals used.

2b

Photograph showing the nets and basins used.

CHAPTER FOUR

RESULTS

FLOODING AND WATER TREATMENT

4.1 After the flooding of the ponds and subsequent treatment with the three different organic manures, visual observations were made to know the effect on the colour of the water, formation of scum and occurrence of macro zooplankton. Similar observations were made in the control pond (Table 4).

TABLE 4: VISUAL OBSERVATIONS OF THE PONDS' CONTENTS

WK	PoM/PI	CaM/PII	PiM/PIII	C/PIV
1	Dark brown Colour No. Scum A lot of mosquito larvae. Few water beetles Rotten odour	Dark brown colour film of greenish scum Lot of mosquito larvae Few water beetles Rotten odour	Light brown colour Dispersed and subme-rged light green scum Few mosquito larvae Few water beetles Rotten odour	Clear water down to pond bottom. Few mosquito larvae Chironomid larvae nest on the pond bottom Rotten odour absent
2	Very dark green Difficult to see any organism	Dark brown tadpoles seen Lot of mosquito larvae Leeches seen	Dark green Mosquito larvae present Leeches seen	Very light green Small sized dragon fly nymphs seen. Pond floor visible
3	Light green colour No scum	Dark green in colour Floor slippery	Light green colour with scum at the surface Floor slippery	Light green colour with scum at the surface
4	Light green colour No scum	Dark green with scum covering up to ¼ of water surface	Scum over the entire surface with clear water underneath	Very light green with scum covering half of the surface
5	Dark green colour No scum	Brownish green No scum	Greenish colour Submerged algal scum	Light green sub-merged algal scum Few scum afloat
6	Yellowish green colour No scum	Brownish green Very scanty scum	Lush green No scum	Light brown scum covers about $^{1}/_{3}$ of surface

7	Lush green colour No scum	Brown colour No scum	Brownish green No scum	Light brownish green No scum
8	Green colour No scum	Brown colour No scum	Brownish green No scum	Light brownish green No scum
9	Green colour No scum	Brownish colour No scum	Brownish green colour	Light brown scum covers 40% of surface
10	Leafy green colour No scum	Dark brown colour No scum	Greenish brown colour No scum	Light green with diffuse particulate scum
11	Green colour No scum	Yellowish brown colour No scum	Brownish green colour No scum	Light green colour diffuse scum
12	Leafy green colour No scum	Grayish green colour No scum	Yellowish green colour No scum	Light green colour diffuse scum
13	Leafy green colour No scum	Greyish green colour No scum	Yellowish green colour No scum	Light green colour Diffuse scum
14	Brownish green colour No scum	Yellowish green colour Scanty scum	Yellowish green colour No scum	Thick scum at the surface with clear water underneath
15	Dark brownish green colour No scum	Brownish green colour No scum	Brownish green colour No scum	Clear water under thick scum.

Legend:
PoM = PI = Poultry Manure
CaM = PII = Cattle Manure
PiM = PIII = Pig Manure
C = PIV = Control

4.2 TRANSPARENCY, PH AND TEMPERATURE READINGS

Readings were taken for transparency, pH and temperature in the four ponds at the intervals of one week for fifteen times (Appendix A).

The mean periodic variation in transparency, pH and temperature were computed (Appendix B and table 5). The mean periodic variation of each of these three parameter's in the four ponds are presented in bar charts (fig2,3 & 4)

TABLE 5: MEAN VALUES OF TRANSPARENCY, pH AND TEMPERATURE VARIATIONS

	PI	**PII**	**PIII**	**PIV**
TRANSPARENCY (cm)	25.4±9.02	33.5±6.22	36.4±6.78	45.9±4.92
pH	8.2±0.67	7.7±0.60	7.6±0.53	6.4±0.51
TEMPERATURE (^{o}c)	28.4±1.70	27.4±1.62	28.3±1.50	28.1±1.37

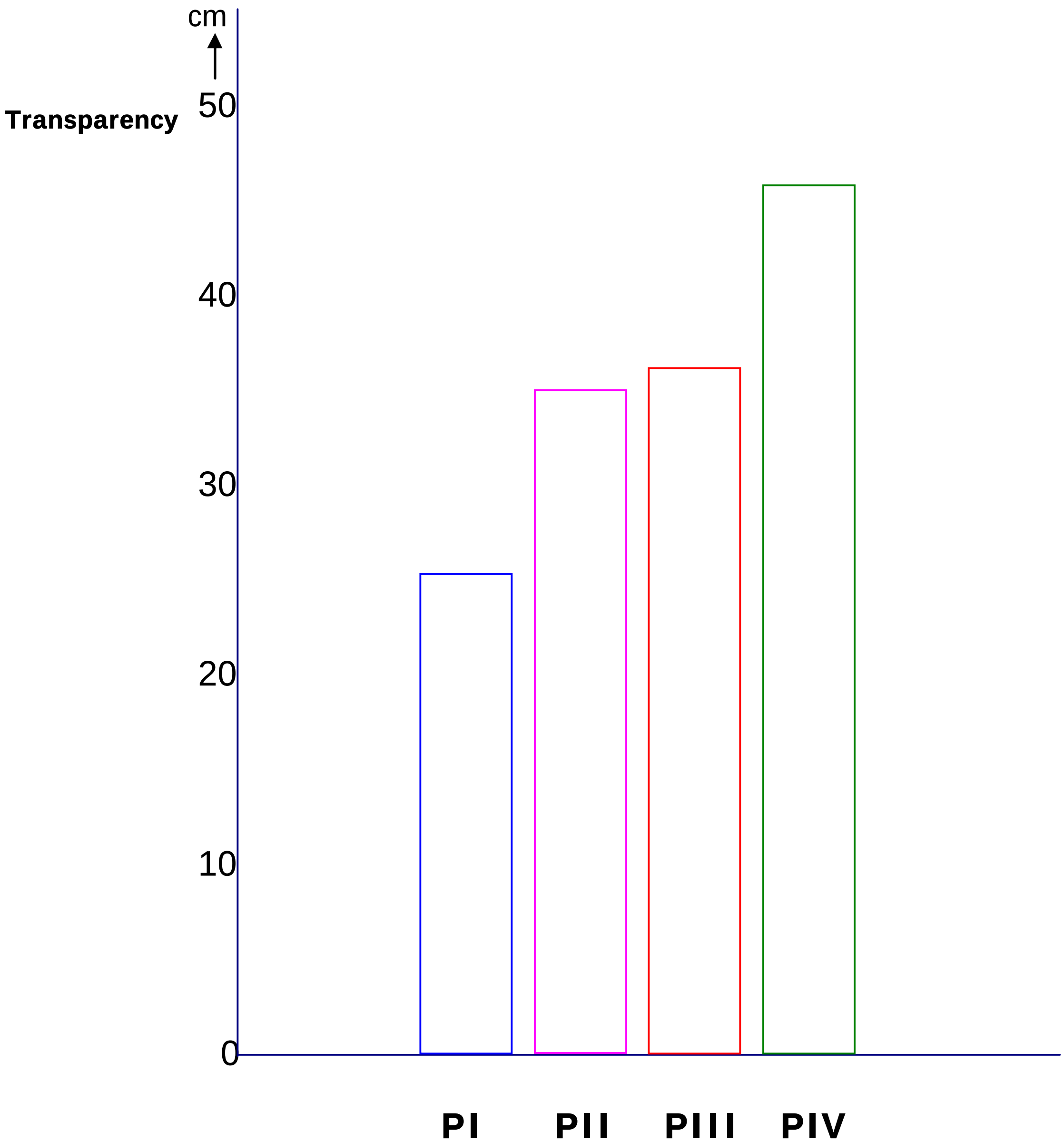

FIG 2: MEAN VALUES OF VARIATION IN TRANSPARENCY

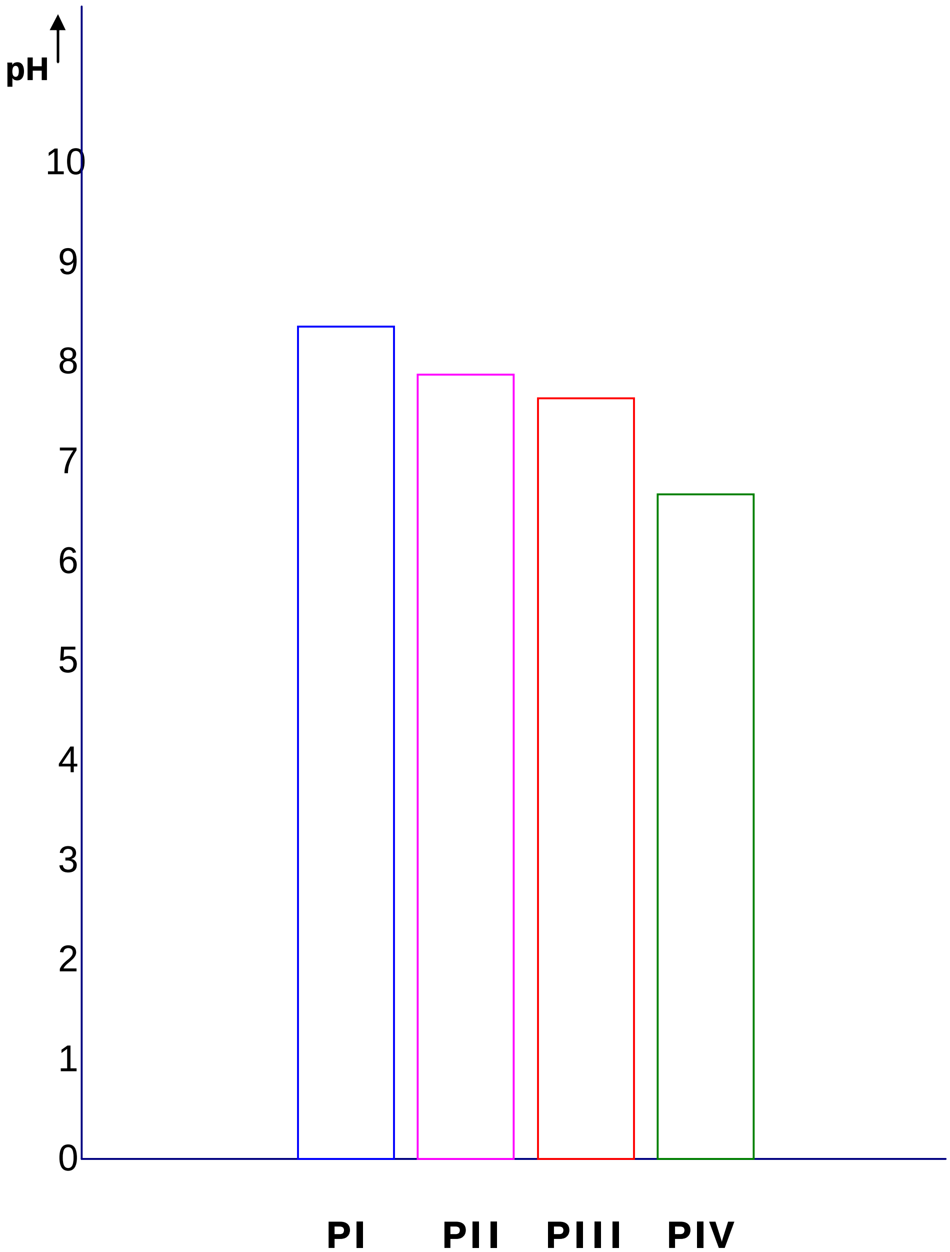

FIG 3: THE MEAN VALUES OF pH VARIATION

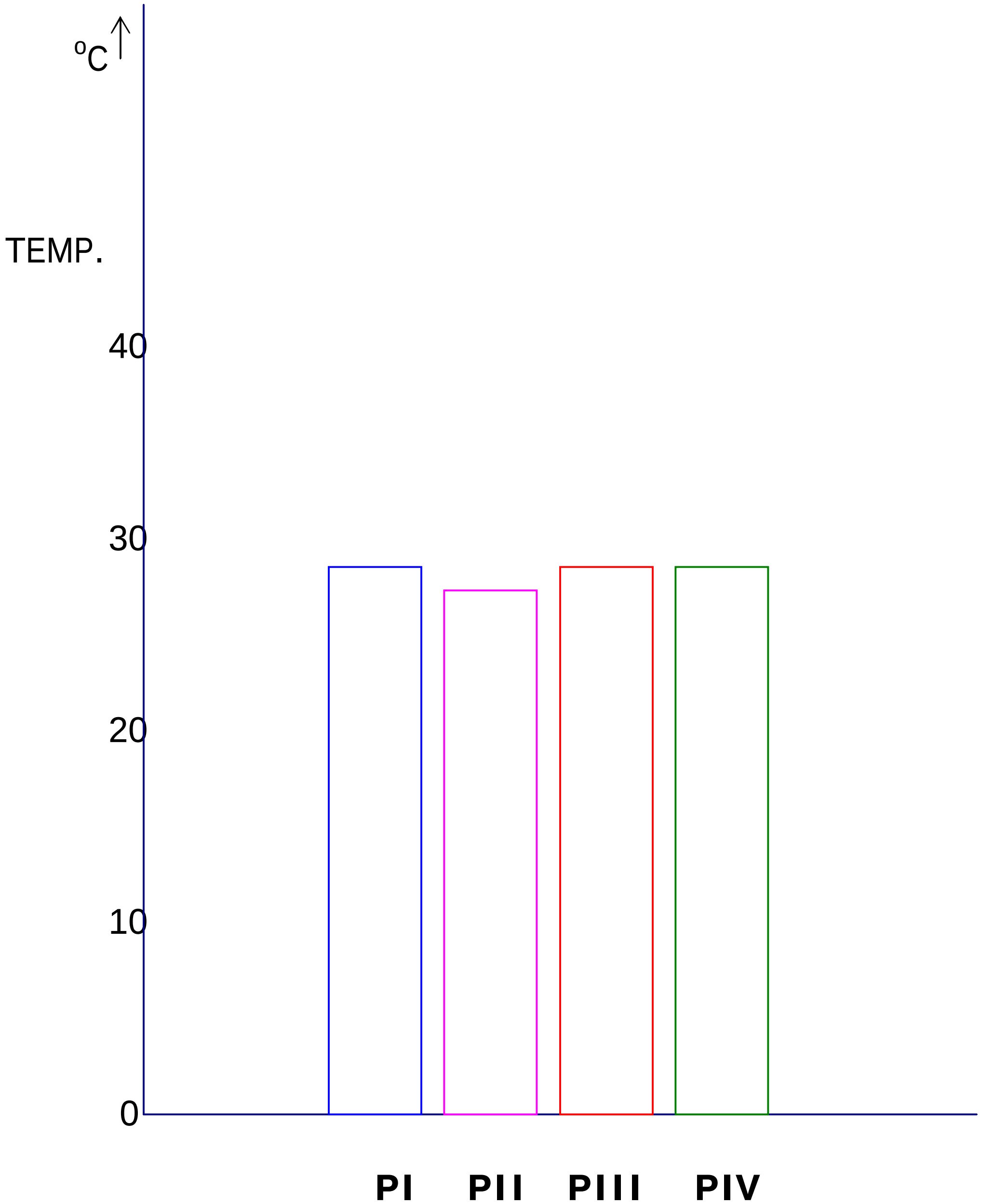

FIG 4: THE MEAN VALUES OF TEMPERATURE VARIATION

3. MONTHLY GROWTH MEASUREMENTS OF STOCKED FISH

Monthly measurements of total length, standard length, and average weight of fish in each pond were done for five months (Appendix G) and the monthly mean total length and mean weight of fish in each pond were determined for five months (Table 6). Using this, graphs of mean total length against time and mean weight of fish against time were plotted for each pond (Figs 5 &6).

TABLE 6: MONTHLY MEAN VALUES OF TOTAL LENGTH AND WEIGHT OF FISH SAMPLES IN EACH POND

PERIOD IN MONTHS	PI		PII		PIII		PIV	
	MEAN TOTAL LENGTH (TL) CM	MEAN Weight (g)	MEAN TOTAL LENGTH (TL) CM	MEAN Weight (g)	MEAN TOTAL LENGTH (TL) CM	MEAN Weight (g)	MEAN TOTAL LENGTH (TL) CM	MEAN Weight (g)
1st	10.30	7.50	10.14	7.50	9.16	6.25	9.40	6.25
2nd	10.74	12.50	11.19	15.0	10.50	10.0	10.20	10.0
3rd	11.25	13.95	11.96	18.09	10.77	12.05	11.43	14 .39
4th	12.67	20.03	13.47	25.80	11.86	15.56	12.77	19.30
5th	13.21	24.0	14.94	43.29	12.50	22.30	13.26	23.90

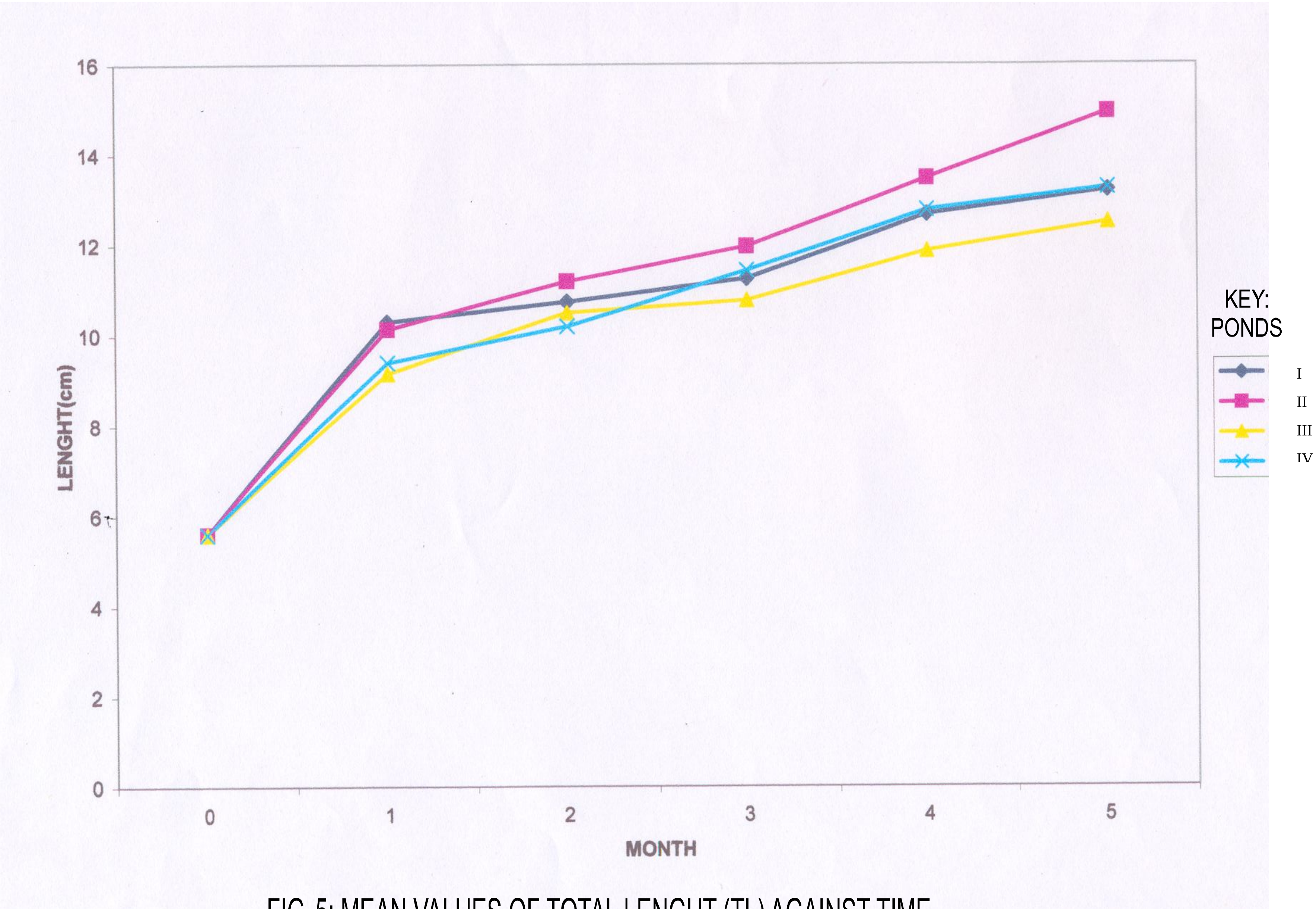

FIG. 5: MEAN VALUES OF TOTAL LENGHT (TL) AGAINST TIME

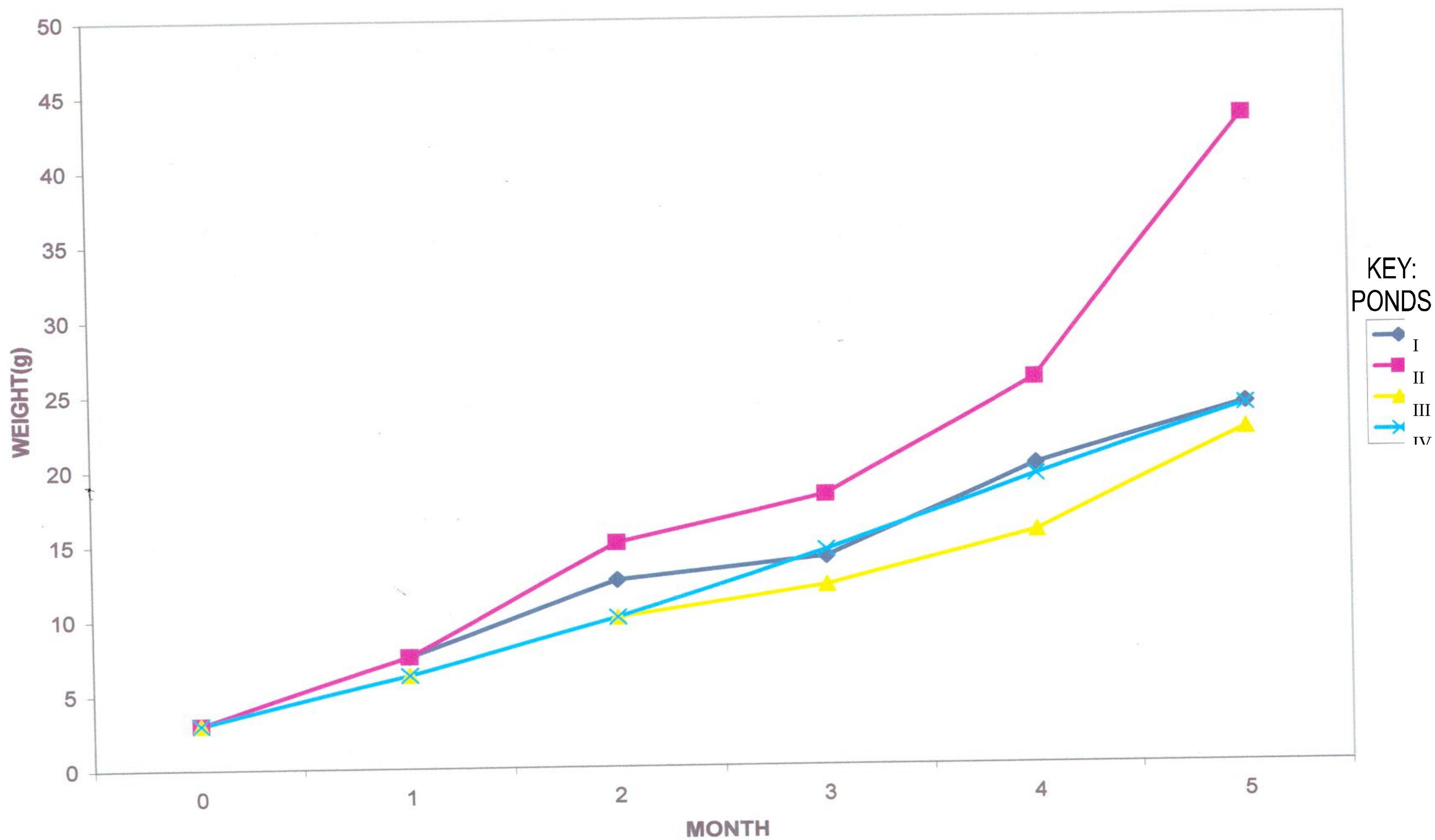

FIG. 6: MEAN VALUES OF WEIGHT OF FISH AGAINST TIME

4. **SUPPLEMENTARY FEED CONSUMPTION**

Equal amount of supplementary feed was used in each pond and the total quantity used for the period calculated as in (Table 7)

TABLE 7: ESTIMATED SUPPLEMENTARY FEED RATION

PI	PII	PIII	PIV	TOTAL
756g	756g	756g	756g	3024g (3.024kg)

5. DETERMINATION OF DISSOLVED OXYGEN IN THE POND WATER

Using Winklers sodium thiosulphate method the oxygen concentrations in the ponds were obtained (Tables 8 and 9) at room temperature.

TABLE 8: READINGS FOR DETERMINATION OF DISSOLVED OXYGEN (DO) IN THE PONDS

PONDS	Upper reading	Lower reading	End point
I	2.30	2.60	0.30ml
II	2.60	2.95	0.35ml
III	3.00	3.35	0.35ml
IV	3.35	3.75	0.40ml

TABLE 9: DISSOLVED OXYGEN (DO) IN THE FOUR PONDS

	PI	PII	PIII	PIV
DO	9.6mg/l	10.8mg/l	10.8mg/l	12.8mg/l

6. DETERMINATION OF PERCENTAGE CHEMICAL ELEMENTS IN THE ORGANIC MANURES

TABLE 10: PERCENTAGE DISTRIBUTION OF SOME IMPORTANT ELEMENTS IN THE ORGANIC MANURES

ELEMENTS / ORGANIC MANURE	P %	K %	Ca %	Mg %	Na %	N %
PoM	2.3	6.5	12.8	6.4	14.8	3.6
CaM	2.5	3.2	3.6	4.8	9.4	3.3
PiM	3.6	6.8	10.6	3.2	18.9	2.8

Key: PoM = Poultry manure
CaM = Cattle manure
PiM = Pig manure

7. PLANKTON ANALYSIS

Diagrammatic representations of various types of plankton in the four ponds from the month of May to July as observed under the microscope and macrofauna observed directly were as in (Figs7a and 7b). The planktons were identified and their relative distribution in the four ponds in each of the three months shown (Tables 11-13).

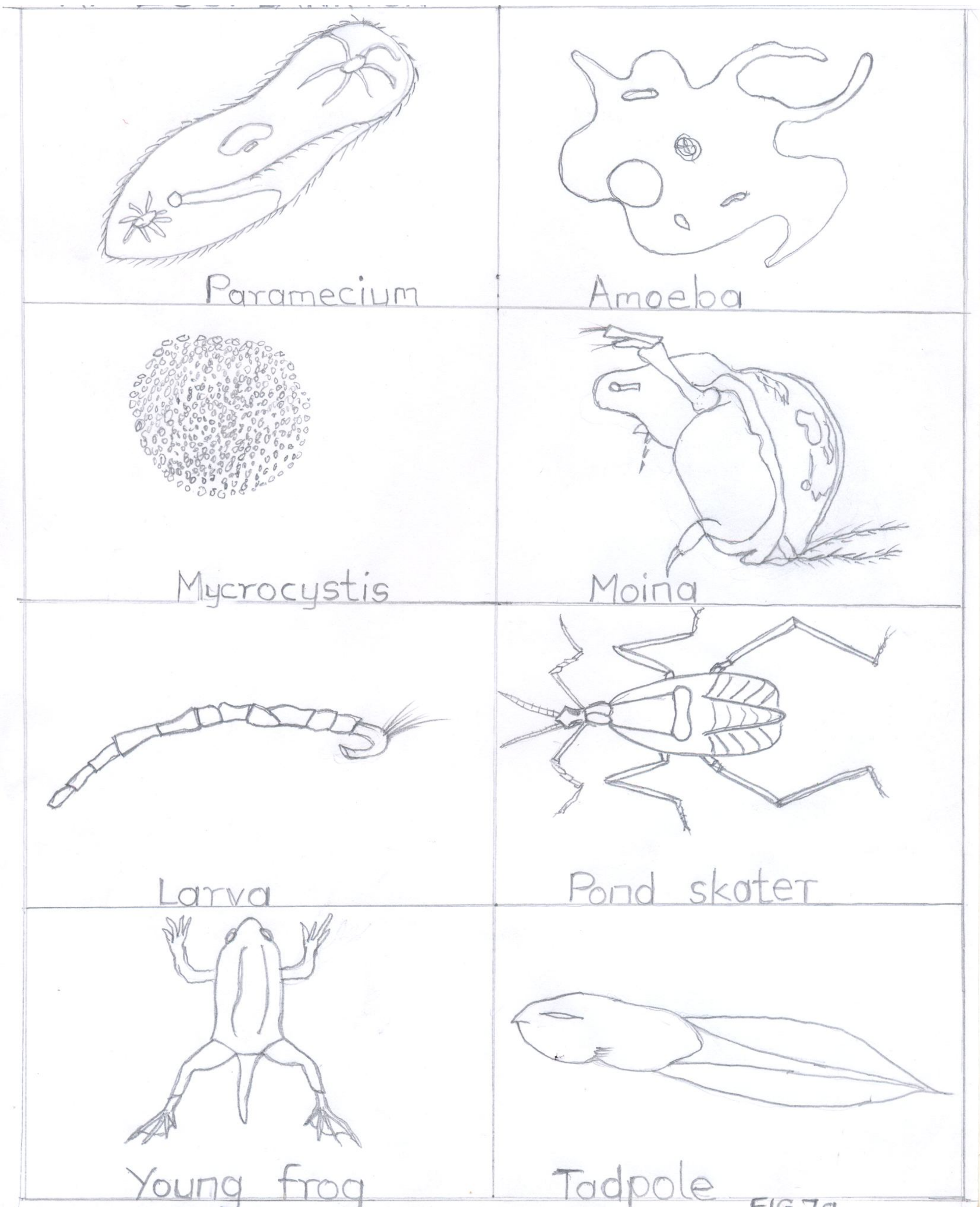

FIG 7a : **OBSERVED ZOOPLANKTON AND MACROFAUNA IN THE FOUR PONDS (FROM MAY TO JULY)**

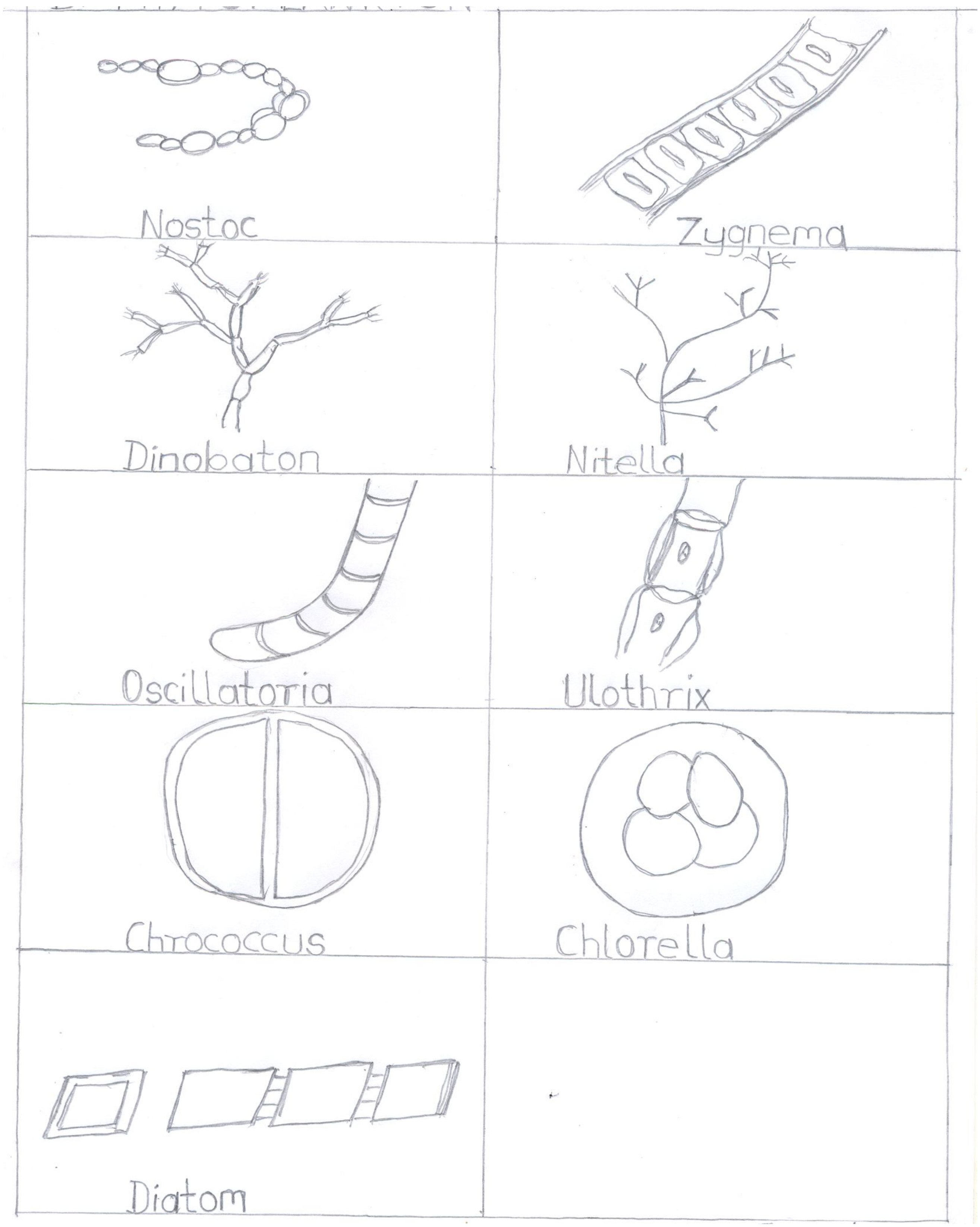

FIG. 7b : **OBSERVED PHYTOPLANKTONS IN THE FOUR PONDS (FROM MAY TO JULY)**

TABLE 11: RELATIVE DISTRIBUTION OF PLANKTONS FOR THE MONTH OF MAY

S/N	MONTH / MAY	POND I	POND II	POND III	POND IV
	Zooplankton				
1	Paramecium	++	++++	++++	+
2	Amoeba	++	+++	+++	+++
3	Mycrocystis				
4	Moina	++++	++++	++++	+++
5	Larva		+		
6	Pond skater	++++	++++	++++	++++
7	Young frogs				
8	Tadpole	+	+		
	Phytoplankton				
1	Nostoc	+	++++	++	+
2	Zygnema			+	
3	Dinobaton	+			
4	Nitella	+			
5	Oscillatoria				
6	Ulothrix				+
7	chrococcus		++		
8	Chlorella				
9	Diatom	++	++++	+++	++++

LEGEND :
+ → 1 no.
++ → 2 nos.
+++ → 3 nos.
++++ → Many (>4)

TABLE 12: RELATIVE DISTRIBUTION OF PLANKTONS FOR THE MONTH OF JUNE

S/N	MONTH / JUNE	POND I	POND II	POND III	POND IV
	Zooplankton				
1	Paramecium	+++	++++	++	++
2	Amoeba	+++	++++	+++	
3	Mycrocystis	+		+	
4	Moina	++++	++++	+++	+++
5	Larva	+	+		
6	Pond skater	+++	++++	++++	++++
7	Young frogs	++			
8	Tadpole				
	Phytoplankton				
1	Nostoc		+++	++	+
2	Zygnema				
3	Dinobaton			+	
4	Nitella	+			
5	Oscillatoria				
6	Ulothrix				+
7	chrococcus				
8	Chlorella				
9	Diatom	++++	+++	++	++++

LEGEND : + ⟶ 1 no.
++ ⟶ 2 nos.
+++ ⟶ 3 nos.
++++ ⟶ Many (>4)

TABLE 13: RELATIVE DISTRIBUTION OF PLANKTONS FOR THE MONTH OF JULY

S/N	MONTH / JULY	POND I	POND II	POND III	POND IV
	Zooplankton				
1	Paramecium	++++	+++	++	+
2	Amoeba	++	++++		
3	Mycrocystis			+	
4	Moina	++++	++++	++++	+++
5	Larva			+	
6	Pond skater	++	++++	++++	++++
7	Young frogs				
8	Tadpole				
	Phytoplankton				
1	Nostoc		++	++	+
2	Zygnema			+	
3	Dinobaton			+	
4	Nitella	++			
5	Oscillatoria	++			
6	Ulothrix				++
7	chrococcus		++		+
8	Chlorella				+
9	Diatom	++++	+++		++++

LEGEND :
+ → 1 no.
++ → 2 nos.
+++ → 3 nos.
++++ → Many (>4)

8. THE FINAL BIOMASS OF FISH IN THE PONDS

The fish in all the ponds were harvested, measured individually and collectively for each pond (Table 14 and summarized to number and weight harvested in each pond (Table 15) and represented in a bar chart (Fig 8).

Table 14: TOTAL FISH HARVEST

PI		PII		PIII		PIV	
S/N	**WT OF FISH (g)**	**S/N**	**WT OF FISH (g)**	**S/N**	**WT OF FISH (g)**	**S/N**	**WT OF FISH (g)**
1	20.0	1	150.0	1	20.0	1	30.0
2	90.0	2	85.0	2	21.0	2	15.0
3	25.5	3	200.0	3	40.0	3	50.0
4	30.0	4	100.5	4	14.0	4	35.0
5	43.0	5	70.0	5	30.0	5	18.0
6	16.0	6	30.0	6	50.0	6	20.0
7	75.0	7	100.0	7	16.0	7	55.0
8	60.0	8	64.5	8	18.0	8	25.0
9	40.0			9	45.0	9	45.0
10	55.0			10	47.0	10	37.0
11	45.0			11	36.0	11	40.0
12	50.0					12	14.0
13	50.5						
TOTAL	**600.0**		**800.0**		**337.0**		**384.0**
	46.20		**100.00**		**30.60**		**32.00**

TABLE 15: SUMMARY OF HARVEST

PONDS	INITIAL TOTAL WEIGHT (g)	NO. OF FISH HARVESTED	TOTAL WEIGHT AT HARVEST (g)	TOTAL WEIGHT GAIN (g)	WEIGHT GAIN DUE TO SUPPLEMENTARY FEED (g)	NATURAL PRODUCTIVITY (g)
I	90	13	600	510	216	294
II	90	8	800	710	216	494
III	90	11	337	247	216	31
IV	90	12	384	294	216	78

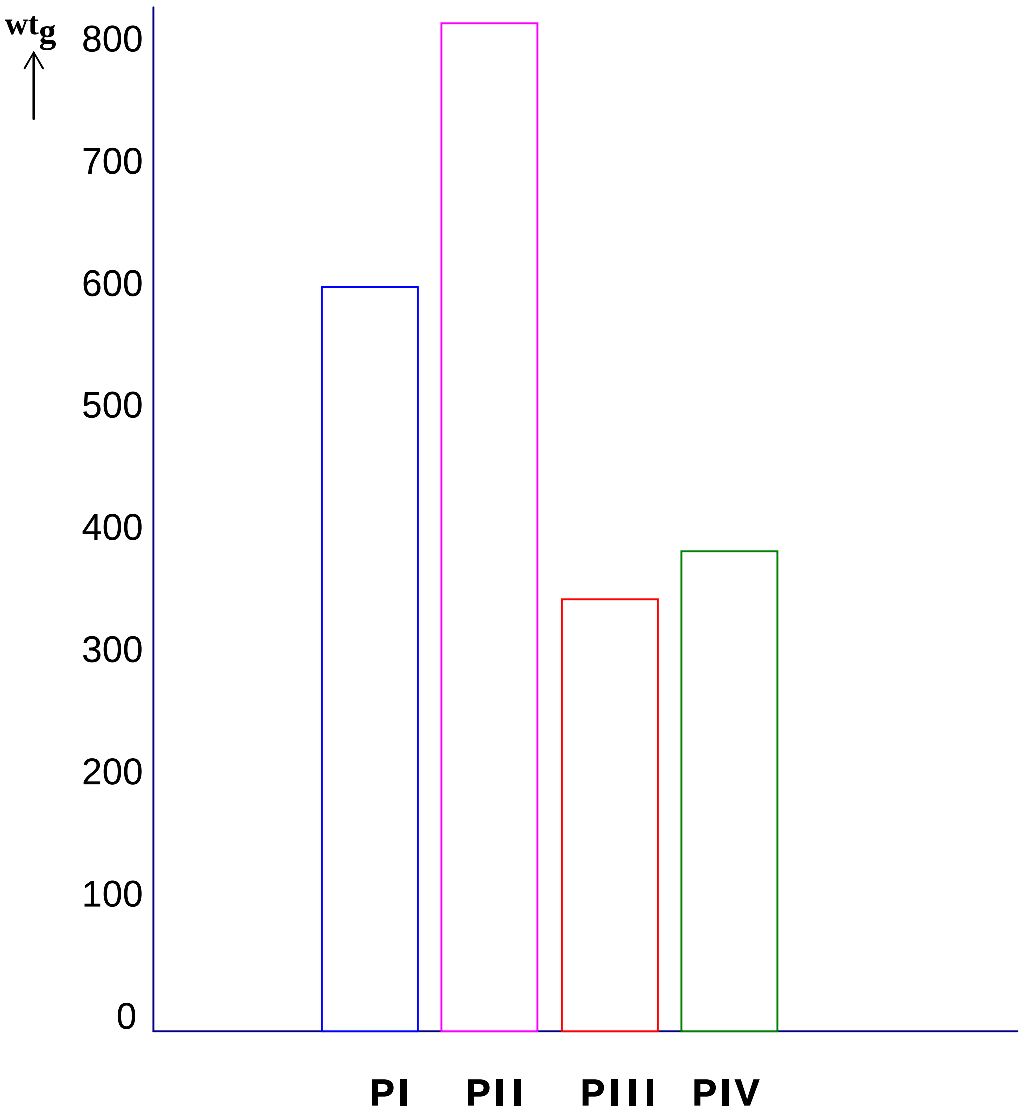

FIG 8: RELATIVE WEIGHTS OF FISH SPECIMENS HARVESTED FROM THE FOUR PONDS.

9. STATISTICAL ANALYSIS

TABLE 16: ANALYSIS OF VARIANCE (ANOVA) SUMMARY

Month	P-value		∝	Decision	Conclusion
	Length	Weight			
June	0.184	-	0.05	Accept Ho	Treatment effect not significant
July	0.804	-	0.05	Accept Ho	"
August	0.776	0.843	0.05	Accept Ho	"
September	0.707	0.725	0.05	Accept Ho	"
October	0.449	0.427	0.05	Accept Ho	"
December	-	0.000	0.05	Reject Ho	Treatment effect significant

CHAPTER FIVE

DISCUSSION

The results of the research showed that the treatment of pond water with different organic manures brought about different effects on the pond water. The fish ponds as water bodies were influenced by various physico-chemical parameters. The interplay of these parameters greatly influenced water quality characteristics and by extension the productivity of such ecosystem thus agreeing with Ufodike *et al* (2001). Table (4) showed that the chemical compositions of the manures were not the same as they affected the ponds' water differently. The water in pond IV (the control) which contained no manure remained clear down to pond bottom for sometime before changing to light green colour. This may be due to some chemical components entering the pond through atmospheric dust and rainfall, even wastes from the fish. It was observed that algal scum occurred largely at the surface of the control pond with clear or light green water underneath especially during the afternoons. This phenomenon also occurred to a little extent in pond III (pig excreta). This may be explained by the fact that during the day when photosynthesis occurs the clusters of algae trap bubbles of oxygen which bring about buoyancy effect and the algae float at the surface. In the evening/night as the oxygen depletes with usage the scum sinks to the pond bottom. All these were experienced in this study.

The measurement of transparency, pH and temperature (Appendix A & B, Table 5, and figs 2-4) showed that on the average pond I (poultry manure) registered the highest temperature, the highest pH and the lowest transparency while pond IV (control) registered the highest transparency and lowest pH. Pond II (cattle manure) registered the lowest temperature. This may be explained by the fact that poultry manure releases some nutrients into the water which favour the generation of thick plankton population especially phytoplankton more than in other manures and therefore greatly reduces the transparency due to abundance of plankton. This experience in this study agrees with Nwadukwe *et al* (1987). While in the control without manure, algae was only slightly formed and this accounted for highest figure for transparency. The highest mean value of pH recorded by pond I (poultry manure) may be explained by the fact that measurement occurred mostly during the day when photosynthesis was taking place. The high concentration of phytoplankton which utilized carbon dioxide more than in any other pond with higher tendency towards alkalinity as opined by Nwadukwe *et al* 1987 was observed in this study. The highest mean temperature may be due to metabolic activities of zooplankton, which might be in higher concentrations than other ponds. The mean temperature and mean pH values for these ponds were within the normal range (6.5-9) for aquaculture except pond IV with mean pH of 6.4, thus agreeing with Boyd 1979.

Monthly growth measurements showed that the fish in pond II (cattle manure) had the highest growth rate followed by that of pond I (poultry manure), pond IV (control), and then pond III (pig manure)

(Appendix G and Table 6). These facts are illustrated in the graphs of growth rate (Figs 5 and 6). Equal amount of supplementary feed was fed to each pond (Table 7, Appendix C). Therefore any growth differential could be due to biogenic status of each pond at interplay with the ambient physico-chemical parameters occasioned by the respective organic manures as opined by Ufodike *et al* (2001). The relative oxygen concentration at laboratory room temperature (Tables 8-9) showed that pond IV (control with no manure) had the highest oxygen concentration of 12.8mg/l followed by pond II (cattle manure) and pond III (pig manure) both 10.8mg/l, and then pond I (poultry manure) with 9.6mg/l. The highest oxygen concentration in pond IV may be due to the fact that it contained less zooplankton and less organic matter and therefore less need for utilization of oxygen. The analysis of the different organic manures showed that the most important components of a fertilizer – N.P.K (Hickling; 1962), are contained in the three different manures (Table 10). Phosphorous is more important component of a fertilizer than any other element followed by nitrogen and then potassium. This is because phosphorous is the main component of the energy molecules of adenosine triphosphate (ATP). The organic manures also contained trace elements like Ca, Mg and Na which are important metabolites (Table 10). The organic manures contained different percentages of these elements and this might have accounted for the difference in the biotic and abiotic conditions of the ponds' water and this was reflected in the visual observations made. It should be noted that pig excreta contained highest percentage of phosphorous, followed by cattle excreta and the poultry excreta. Poultry excreta contained the highest percentage of nitrogen while pig excreta contained the highest percentage of potassium. (Table 10)

The various plankton (phytoplankton, zooplankton/macrofauna) observed in the samples from the ponds are as represented in Figs 7a and 7b. The relative distributions of the plankton in the ponds month by month are shown in tables 11-13. It showed that *Paramecium sp.,* Moina, pondskaters, diatom are in great abundance in the ponds throughout the period more than any other planktons followed by *Amoeba sp.* Pond II contained the highest concentration of these planktons followed by pond I, pond III and the pond IV (control) in that order. These planktons constituted the natural food of the fish in the ponds. The control pond, although did not contain any organic manure, still performed as if organic manure was added. The implication of this seems to be that if a pond is flooded and allowed to age, it will naturally become biogenic, i.e. natural treatment. This may be due to airborne dust particles that contain some spores or dry vegetative parts of some planktons, and also contamination by birds, reptiles and amphibians as they seek to drink or breed in water, and through supplementary feed as well as wastes from the fish crop. This situation also applies to the other ponds. This is a lesson that one can even do without the addition of any organic manure hoping that nature will do that, albeit slowly. However, for quick response in biogenic development of the pond water, organic manure should be used to treat the water.

Tables 14 and 15 show that out of a total 30 nos. fingerlings stocked in each pond, far less numbers were recovered viz- pond I (poultry excreta) 13 fingerlings; pond II (cattle excreta) 8 fingerlings; pond III (pig excreta) 11 fingerlings; and pond IV (control) 12 fingerlings. Pond II yielded the greatest total weight of 800 g followed by pond I 600 g; pond IV 348 g; and the pond III 337 g. The low number of fish harvested from each pond may be due to intra cannibalism or natural death due to adverse physico-chemical changes that might have occurred and other unforeseen circumstances. Pond II yielded greatest weight of fish. Fig 8 showed the yield per pond at a glance.

From table 15 it is also noted that natural productivity was highest in pond II (cattle manure) followed by pond I (poultry manure), pond IV (control) and then pond III (pig manure). Although poultry manure and pig manure have relatively higher percentage distributions of some agriculturally important elements and minerals than cattle manure, it may be that the percentage distribution in the cattle manure especially N, P, K favoured optimum generation of plankton in pond II. The highest DO in pond IV (control) with some natural treatment perhaps leveraged its productivity over that of pond III (pig manure).

Statistical analysis showed that there was no significant effect of the treatments on the experiment for the first five months. This was evident from the one way analysis of variance (ANOVA) tables (Appendix H and I) as generated using the Statistical Package for Social Sciences (SPSS).

From the five ANOVA tables obtained in the first five months (June –October): $p>0.05$ for all cases, and accordingly all the Ho accepted (Table 16). However, from the graph of mean weight of fish in the four ponds against time (Fig 6) it was apparent that while the effect of treatments agreed with the observations in the ANOVA tables, the graph of pond II which was treated with cattle manure, after the first months, clearly indicated that the effect of the treatment was already showing signs of long run significant performance as evident from the outstanding slope of the graph. Tendency towards this fact was equally evident from the outstanding slope of pond II in the graph of mean total length against time (Fig 5). The ANOVA result for the first five month was probably not sensitive enough to capture that effect at that point.

The sixth ANOVA table (Appendix F and H) obtained at the final harvest from the four ponds showed that $p<0.05$ for pond II and therefore treatment effect significant, and thus Ho rejected (Table 16).

Scheffe's Post Hoc (multiple) comparism tests (Appendix F) showed that pond II (CaM) when compared with pond I (PoM), pond III (PiM), and pond IV using orthogonal contrasts showed that treatment effect was significantly higher while other pairs of comparison between ponds I, II and III did not show significant treatment effect (Appendix F). The implication of this may be that the significance in treatment effect was due to pond II which was treated with cattle manure.

CONCLUSION

The three different organic manures – poultry droppings; cattle dung; and pig excreta have been subjected to investigation and their effects on some physico-chemical parameters and biogenic capacity of pond water verified. Some findings were made as follows:

1. Failure to treat pond water with organic manure cannot prevent generation of plankton in the pond, i.e. natural treatment.

2. Treatment of pond water with organic manure brought about quicker generation of plankton.

3. The physico-chemical parameters of pond water varied in relation to the type of organic manure used to treat the pond water.

4. Dissolved oxygen content of pond water in the control pond was higher than the values obtained in the treated ponds.

5. Transparency attained highest value in the control pond.

6. Treatment of pond water with organic manure increased the pH of pond water with highest value in that treated with poultry droppings.

7. Temperature variations in the ponds were minimal

8. The natural production generated by cattle dung yielded the highest fish crop followed by poultry droppings and pig excreta, respectively.

9. Significance in treatment effect may be due to pond II which contained cattle manure.

Therefore, if organic manure must be used to improve the biogenic productivity of the pond water before stocking of fingerlings, the best option may be cattle manure.

These findings may be of immense assistance to local fish farmers who are yet unaware of the importance of organic manure/fertilizer and the best in the treatment of their pond water.

Recommendation:

There is room for further studies with other species of fish, and different environments.

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APPENDIX A

TABLE 17: TRANSPARENCY, pH, AND TEMPERATURE READINGS.

WK	PONDS / PARAMETER	I	II	III	IV
WK1	Transparency in cm	43	29	44	53
	pH	7	8	8	6
	Temperature ^{o}c	30	29	30	30
WK 2	Transparency in cm	42	24	43	52
	pH	7	8	7	6
	Temperature ^{o}c	30	28	29	29
Wk 3	Transparency in cm	40	23	41	50
	pH	7	6	7	8
	Temperature ^{o}c	30	29	29	30
WK 4	Transparency in cm	29	35	38	39
	pH	8.5	8	8.5	6.5
	Temperature ^{o}c	30	30	29	30
WK 5	Transparency in cm	28	35	38	44
	pH	8	8	7.5	6
	Temperature ^{o}c	28	28	28	28
WK 6	Transparency in cm	27	45	38	48
	pH	8	8	8.5	6.5
	Temperature ^{o}c	27	27	28	27.5
WK 7	Transparency in cm	20	39	30	40
	pH	8.5	8	7.5	7
	Temperature ^{o}c	27	27	26.5	28
	Transparency in cm	18	45	35	45

WK 8	pH	9.0	6.5	6.5	6.0
	Temperature ^{o}c	27	27	27	27
WK 9	Transparency in cm	18	40	30	40
	pH	8.5	7.5	7.5	6
	Temperature ^{o}c	27	27	27	27
WK 10	Transparency in cm	17	37	36	53
	pH	8.5	8.5	7.5	6
	Temperature ^{o}c	30	29	29	29
WK 11	Transparency in cm	18	36	39	44
	pH	9.0	7.5	8	6.5
	Temperature ^{o}c	27	27.3	27.5	27.2
WK 12	Transparency in cm	17	34	37	42
	pH	9	8.5	8	6.5
	Temperature ^{o}c	26	26	26	26
WK 13	Transparency in cm	18	34	29	46
	pH	8.5	7.5	8	6
	Temperature ^{o}c	27	27	27	27
WK 14	Transparency in cm	23	33	33	45
	pH	8	7	7.5	6.5
	Temperature ^{o}c	32	32	32	30.4
WK 15	Transparency in cm	23	34	35	48
	pH	8	8	7.5	6.5
	Temperature ^{o}c	28	28	29	27

APPENDIX B

TABLE 18: WEEKLY VARIATIONS IN TRANSPARENCY, pH AND TEMPERATURE IN POND I.

WEEK	TRANSPARENCY in cm	pH	TEMPERATURE °C
1	43	7	30
2	42	7	30
3	40	7	30
4	29	8.5	30
5	28	8	28
6	27	8	27
7	20	8.5	27
8	18	9	27
9	18	8.5	27
10	17	8.5	30
11	18	9.0	27
12	17	9.0	26
13	18	8.5	27
14	23	8	32
15	23	8	28
MEAN	**25.4±9.02**	**8.2±0.67**	**28.4±1.70**

TABLE 19: WEEKLY VARIATIONS IN TRANSPARENCY, pH and TEMPERATURE IN POND II

WEEK	TRANSPARENCY in cm	pH	TEMPERATURE °C
1	29	8	29
2	24	8	28
3	23	6	29
4	35	8	30
5	35	8	28
6	45	8	27
7	39	8	27
8	45	6.5	27
9	40	7.5	27
10	37	8.5	29
11	36	7.5	27.3
12	34	8.5	26
13	34	7.5	27
14	33	7	32
15	34	8	28
MEAN	**33.5±6.22**	**7.7±0.60**	**27.4±1.62**

TABLE 20: WEEKLY VARIATIONS IN TRANSPARENCY, pH AND TEMPERATURE IN POND III

WEEK	TRANSPARENCY in cm	pH	TEMPERATURE °C
1	44	8	30
2	43	7	29
3	41	7	29
4	38	8.5	29
5	38	7.5	28
6	38	8.5	28
7	30	7.5	26.5
8	35	6.5	27
9	30	7.5	27
10	36	7.5	29
11	39	8	27.5
12	37	8	26
13	29	8	27
14	33	7.5	32
15	35	7.5	29
MEAN	**36.4±6.78**	**7.6±0.53**	**28.3±1.50**

TABLE 21: WEEKLY VARIATIONS IN TRANSPARENCY, pH AND TEMPERATURE IN POND IV

WEEK	TRANSPARENCY in cm	pH	TEMPERATURE
1	53	6	30
2	52	6	29
3	50	8	30
4	39 ++	6.5	30
5	44++	6	28
6	48	6.5	27.5
7	40	7	28
8	45	6	27
9	40	6	27
10	53	6	29
11	44	6.5	27.2
12	42	6.5	26
13	46	6	27
14	45	6.5	30.4
15	48	6.5	27^{o}C
MEAN	**45.9±4.92**	**6.4±0.51**	**28.1±1.37**

APPENDIX C:

WEEKLY RATIONS

WK	MONTH	PoM/PI (g)	CaM/PII (g)	PiM/PIII (g)	C/PIV (g)	TOTAL (g)
1	8th May – 14th May	9.50	9.50	9.50	9.50	38.00
2	15th May – 24TH May	9.50	9.50	9.50	9.50	38.00
3	22nd May – 28th May	9.50	9.50	9.50	9.50	38.00
4	29th May – 4th June	9.50	9.50	9.50	9.50	38.00
5	5th June – 11th June	9.50	9.50	9.50	9.50	38.00
6	12th June – 18th June	9.50	9.50	9.50	9.50	38.00
7	19th June – 25th June	9.50	9.50	9.50	9.50	38.00
8	26th June – 2nd July	9.50	9.50	9.50	9.50	38.00
9	3rd July – 9th July	9.50	9.50	9.50	9.50	38.00
10	10th July - 16th July	9.50	9.50	9.50	9.50	38.00
11	17th July – 23rd July	9.50	9.50	9.50	9.50	38.00
12	24th July – 30th July	9.50	9.50	9.50	9.50	38.00
13	31st July – 6th Aug.	9.50	9.50	9.50	9.50	38.00
14	7th Aug – 13th Aug	9.50	9.50	9.50	9.50	38.00
15	14th Aug – 20th Aug	19.00	19.00	19.00	19.00	76.00
16	21st Aug – 27th Aug	1900	19.00	19.00	19.00	76.00
17	28th Aug – 3rd Sept	19.00	19.00	19.00	19.00	76.00
18	4th Sept – 10th Sept.	19.00	19.00	19.00	19.00	76.00
19	11th Sept – 17th Sept.	38.00	38.00	38.00	38.00	152.00
20	18th Sept – 24th Sept.	38.00	38.00	38.00	38.00	152.00
21	25th Sept – 1st Oct	38.00	38.00	38.00	38.00	152.00
22	2nd Oct – 8th Oct	38.00	38.00	38.00	38.00	152.00
23	9th Oct – 15th Oct	38.00	38.00	38.00	38.00	152.00
24	16th Oct – 22nd Oct	44.00	44.00	44.00	44.00	176.00
25	23rd Oct – 29th Oct	44.00	44.00	44.00	44.00	176.00
26	30th Oct – 5th Nov	44.00	44.00	44.00	44.00	176.00
27	6th Nov – 12th Nov	44.00	44.00	44.00	44.00	176.00
28	13th Nov – 19th Nov	49.00	49.00	49.00	49.00	196.00
29	20th Nov – 26th Nov	49.00	49.00	49.00	49.00	196.00
30	27th Nov – 3rd Dec	49.00	49.00	49.00	49.00	196.00
31	4th Dec – 10th Dec	49.00	49.00	49.00	49.00	196.00
		756.00	756.00	756.00	756.00	3024.00

APPENDIX D

MONTHLY GROWTH (WEIGHT) MEASUREMENTS FOR DETERMINATION OF ANALYSIS OF VARIANCE

1ST MONTH: JUNE 2006

S/N	PoM (g)	CaM (g)	PiM (g)	C (g)
1 2 3 4 5 6 7 8 9 10	75.0	75.0	62.5	62.5
	7.50	7.50	6.25	6.25

2ND MONTH: JULY 2006

S/N	PoM (g)	CaM (g)	PiM (g)	C (g)
1 2 3 4 5 6 7 8 9 10	125.0	150.0	100.0	100.0
	12.50	15	10	10

3RD MONTH: AUGUST 2006

S/N	PoM (g)	CaM (g)	PiM (g)	C (g)
1	15.0	27.0	8.0	18.0
2	15.0	9.0	9.0	9.5
3	5.0	9.4	10.0	18.0
4	8.0	9.5	16.0	20.0
5	6.0	10.0	13.6	10.0
6	28.5	75.0	20.0	20.0
7	18.0	14.5	16.0	9.5
8	20.0	8.0	9.0	9.4
9	14.5	9.5	10.0	20.0
10	9.5	9.0	9.5	9.5
	13.95	18.09	12.05	14.39

4TH MONTH: SEPTEMBER 2006

S/N	PoM (g)	CaM (g)	PiM (g)	C (g)
1	15.0	6.0	26.0	18.0
2	26.0	6.0	9.5	25.0
3	25.0	16.0	26.0	10.0
4	20.0	10.0	26.0	27.0
5	18.0	10.0	9.3	16.0
6	9.3	100.0	16.0	25.0
7	20.0	60.0	14.0	14.0
8	25.0	20.0	10.0	24.0
9	23.0	12.0	9.8	18.0
10	19.0	18.0	9.0	16.0
	20.03	25.80	15.56	19.30

5TH MONTH: OCTOBER 2006

S/N	PoM (g)	CaM (g)	PiM (g)	C (g)
1	25.0	75.0	24.0	25.0
2	24.0	187.0	24.0	24.0
3	25.0	10.4	14.0	30.0
4	37.5	23.0	25.0	23.0
5	24.0	25.0	23.0	25.0
6	23.0	24.0	24.0	26.0
7	10.5	18.5	14.0	23.0
8	18.0	22.5	35.0	23.0
9	26.0	23.0	20.0	20.0
10	27.0	24.5	20.0	20.0
	24.0	43.29	22.30	23.9

6TH MONTH: DECEMBER 2006

S/N	PoM (g)	CaM (g)	PiM (g)	C (g)
1	20.0	150.0	20.0	30.0
2	90.0	85.0	21.0	15.0
3	25.5	200.0	40.0	50.0
4	30.0	100.0	14.0	35.0
5	43.0	70.0	30.0	18.0
6	16.0	30.0	50.0	20.0
7	75.0	100.0	16.0	55.0
8	60.0	64.0	18.0	25.0
9	40.0	-	45.0	45.0
10	55.0	-	47.0	37.0
11	45.0	-	36.0	40.0
12	50.0	-	-	14.0
13	50.0	-	-	-
	46.2	100.0	30.6	32.0

APPENDIX E

MONTHLY GROWTH (LENGTH) MEASUREMENTS FOR DETERMINATION OF ANALYSIS OF VARIANCE

1ST MONTH: JUNE 2006

S/N	PoM (cm)	CaM (cm)	PiM (cm)	C (cm)
1	11.50	15.40	7.50	11.00
2	10.30	11.00	9.00	9.40
3	9.50	10.50	9.10	9.40
4	10.50	9.60	10.30	9.10
5	9.20	9.00	9.80	9.10
6	8.00	9.50	8.10	10.50
7	9.50	9.30	10.50	9.00
8	12.10	9.00	8.50	9.60
9	12.20	9.50	9.00	9.20
10	10.50	8.60	9.80	8.10
	10.33	10.14	9.16	9.40

2ND MONTH: JULY 2006

S/N	PoM (cm)	CaM (cm)	PiM (cm)	C (cm)
1	11.60	14.20	10.50	11.90
2	11.70	9.00	10.70	9.90
3	8.10.	9.50	8.10.	10.30
4	7.10	10.50	12.40	10.10
5	12.80	10.00	11.00	9.80
6	7.80	8.90	11.40	9.70
7	9.50	9.60	9.00	12.30
8	11.80	8.60	12.60	8.70
9	12.00	11.20	9.50	9.80
10	15.00	20.40	10.60	8.90
	10.74	11.19	10.50	10.20

3RD MONTH: AUGUST 2006

S/N	PoM (cm)	CaM (cm)	PiM (cm)	C (cm)
1	12.00	14.90	9.00	12.50
2	12.00	9.60	9.50	10.50
3	7.90	10.00	11.00	12.60
4	9.00	10.60	12.00	12.80
5	8.50	11.00	11.60	10.70
6	16.00	23.00	12.20	12.20
7	12.50	11.80	12.00	10.50
8	12.20	9.00	9.50	10.00
9	11.90	10.20	10.90	12.20
10	10.50	9.50	10.00	10.30
	11.25	11.96	10.77	11.43

4TH MONTH: SEPTEMBER 2006

S/N	PoM (cm)	CaM (cm)	PiM (cm)	C (cm)
1	12.00	8.50	14.50	12.50
2	14.00	8.50	10.50	13.50
3	13.60	12.00	14.20	11.20
4	12.90	11.00	13.90	15.10
5	12.60	11.00	9.80	12.30
6	9.80	26.00	12.20	13.40
7	12.70	21.00	12.00	12.00
8	13.60	12.80	11.00	13.00
9	13.00	11.40	10.90	12.50
10	12.70	12.50	9.60	12.20
	12.69	13.47	11.86	12.77

5TH MONTH: OCTOBER 2006

S/N	PoM (cm)	CaM (cm)	PiM (cm)	C (cm)
1	11.70	21.10	14.10	14.20
2	13.00	28.00	13.90	12.70
3	13.40	11.00	10.50	14.90
4	14.20	12.00	13.60	12.00
5	14.00	13.50	12.10	13.70
6	13.00	14.00	12.70	14.30
7	11.00	12.50	11.00	13.10
8	12.50	11.90	13.20	13.00
9	14.30	12.00	12.00	12.50
10	13.00	13.40	11.90	12.20
	13.21	14.94	12.50	13.26

APPENDIX F:

APPENDIX F:

APPENDIX G: MONTHLY GROWTH MEASUREMENTS OF FISH SAMPLES FOR JUNE – OCTOBER

1. JUNE 2006

S/N	PoM/PI			CaM/PII			PiM/PIII			C/PIV		
	Cm SL	Cm TL	Wt of all sampled fish	Cm SL	Cm TL	Wt of all sampled fish	Cm SL	Cm TL	Wt of all sampled fish	Cm SL	Cm TL	Wt of all sampled fish
1	9.5	11.5		13.3	15.4		6.5	7.5		9.8	11	
2	8.7	10.3		9.2	11		7.7	9.0		8.2	9.4	
3	8	9.5	75g	9	10.5	75g	8	9.1	62.5g	8.2	9.4	62.5g
4	9	10.5		8.2	9.6		8.9	10.3		7.8	9.1	
5	7.8	9.2		7.6	9		8.3	9.8		7.8	9.1	
6	6.7	8.0		8.1	9.5		6.9	8.1		9.0	10.5	
7	7.9	9.5		7.8	9.3		9.2	10.5		7.8	9	
8	10.2	12.1		7.6	9		7.5	8.5		8.4	9.6	
9	10.6	12.2		8.1	9.5		8.0	9.0		7.9	9.2	
10	9	10.5		7.3	8.6		8.2	9.8		7.0	8.1	
Mean	**8.74**	**10.33**	**7.5g**	**8.62**	**10.14**	**7.5g**	**7.92**	**9.16**	**6.25g**	**8.1**	**9.4**	**6.25g**

2. JULY 2006

S/N	PoM/PI			CaM/PII			PiM/PIII			C/PIV		
	Cm SL	Cm TL	Wt of all sampled fish	Cm SL	Cm TL	Wt of all sampled fish	Cm SL	Cm TL	Wt of all sampled fish	Cm SL	Cm TL	Wt of all sampled fish
1	10.0	11.6		13.0	14.2		9.1	10.5		10.5	11.9	
2	10.1	11.7		7.9	9.0		9.4	10.7		8.5	9.9	
3	7.0	8.1	125g	8.4	9.5	150g	7.1	8.1	100g	8.9	10.3	100g
4	6.0	7.1		9.5	10.5		10.9	12.4		8.8	10.1	
5	11.0	12.8		8.7	10.0		9.5	11.0		8.4	9.8	
6	6.5	7.8		7.7	8.9		9.8	11.4		8.3	9.7	
7	8.2	9.5		8.4	9.6		7.7	9.0		10.5	12.3	
8	10.6	11.8		7.5	8.6		10.8	12.6		7.6	8.7	
9	10.5	12.0		9.5	11.2		8.2	9.5		8.4	9.8	
10	12.8	15.0		17.9	20.4		9.0	10.6		7.4	8.9	
Mean	**9.37**	**10.74**	**12.5g**	**9.85**	**11.19**	**15g**	**9.15**	**10.5**	**10g**	**8.8**	**10.2**	**10g**

3. AUGUST 2006

S/N	PoM/PI			CaM/PII			PiM/PIII			C/PIV		
	Cm SL	Cm TL	g wt	Cm SL	Cm TL	g wt	Cm SL	Cm TL	g wt	Cm SL	Cm TL	g wt
1	10.2	12	15.0	12.9	14.9	27.0	7.9	9.0	8.0	10.7	12.5	18.0
2	10.2	12	15.0	8.3	9.6	9.0	8.3	9.5	9.0	9.3	10.5	9.5
3	6.7	7.9	5.0	8.7	10	9.4	9.5	11.0	10.0	11.0	12.6	18.0
4	7.8	9.0	8.0	9.4	10.6	9.5	10.3	12.0	16.0	11.2	12.8	20.0
5	7.4	8.5	6.0	9.5	11	10.0	10.5	11.6	13.0	9.5	10.7	10.0
6	13.5	16.0	28.5	18.2	23	75.0	10.8	12.2	20.0	10.6	12.2	20.0
7	10.7.	12.5	18.0	10.7	11.8	14.5	10.5	12.0	16.0	9.3	10.5	9.5
8	10.6	12.2	20.0	7.7	9.0	8.0	8.2	9.5	9.0	8.8	10.0	9.4
9	10.6	11.9	14.5	8.8	10.2	9.5	9.5	10.9	10.0	10.6	12.2	20.0
10	9.2	10.5	9.5	8.3	9.5	9.0	8.7	10.0	9.5	9.2	10.3	9.5
Total	96.9	112.5	139.5	102.5	119.6	180.9	94.2	107.7	120.5	100.2	114.3	143.9
Mean	**9.67**	**11.25**	**13.95**	**10.25**	**11.96**	**18.09**	**9.42**	**10.77**	**12.05**	**10.02**	**11.43**	**14.39**

4. SEPTEMBER 2006

S/N	PoM/PI			CaM/PII			PiM/PIII			C/PIV		
	Cm SL	Cm TL	g wt	Cm SL	Cm TL	g wt	Cm SL	Cm TL	g wt	Cm SL	Cm TL	g wt
1	10.5	12.0	15.	7.2	8.5	6.0	12.7	14.5	26.0	10.5	12.5	18.0
2	11.6	14.0	26	7.2	8.5	6.0	8.9	10.5	9.5	11.5	13.5	25.0
3	11.5	13.6	25	10.1	12.0	16.0	11.9	14.2	26.0	9.6	11.2	10.0
4	11.0	12.9	20	9.8	11.0	10.0	11.8	13.9	26.0	12.9	15.1	27.0
5	10.5	12.6	18	9.8	11.0	10.0	8.1	9.8	9.3	10.5	12.3	16.0
6	8.2	9.8	9.3	23	26.0	100.0	10.5	12.2	16.0	11.6	13.4	25.0
7	11.0	12.7	20	17.5	21.0	60.0	10.0	12.0	14.0	10.2	12.0	14.0
8	11.5	13.6	25	11	12.8	20.0	9.3	11.0	10.0	11.2	13.0	24.0
9	11.3	13.0	23	10.3	11.4	12.0	9.2	10.9	9.8	10.5	12.5	18.0
10	11.2	12.7	19	10.5	12.5	18.0	8.2	9.6	9.0	10.1	12.2	16.0
Total	108.3	126.9	200.3	116.4	134.7	258.0	100.6	118.6	155.6	108.6	127.7	193.0
Mean	**10.83**	**12.69**	**20.03**	**11.64**	**13.47**	**25.80**	**10.06**	**11.86**	**15.56**	**10.86**	**12.77**	**19.30**

5. OCTOBER 2006

S/N	PoM/PI			CaM/PII			PiM/PIII			C/PIV		
	Cm SL	Cm TL	G wt	Cm SL	Cm TL	g wt	Cm SL	Cm TL	g wt	Cm SL	Cm TL	g wt
1	10.5	11.7	25.0	18.4	21.1	75.0	12.1	14.1	24.0	12.3	14.2	25.0
2	11.2	13.0	24.0	24.4	28.0	187.0	12.2	13.9	24.0	10.8	12.7	24.0
3	12.0	13.4	25.0	9.5	11.0	10.4	9.0	10.5	14.0	12.8	14.9	30.0
4	12.2	14.2	37.5	10.1	12.0	23.0	11.5	13.6	25.0	10.2	12.0	23.0
5	12.1	14.0	24.0	11.5	13.5	25.0	10.6	12.1	23.0	11.7	13.7	25.0
6	11.2	13.0	23.0	12.2	14.0	24.0	10.8	12.7	24.0	12.5	14.3	26.0
7	9.7	11.0	10.5	10.6	12.5	18.5	9.4	11.0	14.0	11.2	13.1	23.0
8	10.5	12.5	18.0	10.4	11.9	22.5	11.2	13.2	35.0	11.3	13.0	23.0
9	12.5	14.3	26.0	10.2	12.0	23.0	10.2	12.0	20.0	10.8	12.5	20.0
10	13.0	15.0	27.0	11.6	13.4	24.5	10.3	11.9	20.0	10.5	12.2	20.0
Total	114.9	132.1	240.0	128.9	149.4	432.9	107.3	125.0	223.0	114.1	132.6	239.0
Mean	**11.49**	**13.21**	**24.0**	**12.89**	**14.94**	**43.29**	**10.73**	**12.50**	**22.30**	**11.41**	**13.26**	**23.9**

APPENDIX H: ONE WAY ANALYSIS OF VARIANCE (ANOVA) TABLES AS GENERATED BY 'SPSS' FROM FISH WEIGHT (FW) MEASUREMENTS

a. FW, August

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	188.755	4	47.189	.349	.843
Within Groups	4735.096	35	135.288		
Total	4923.851	39			

b. FW, September

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	551.687	4	137.922	.515	.725
Within Groups	9374.309	35	267.837		
Total	9925.996	39			

c. FW, October

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2989.735	4	747.434	.988	.427
Within Groups	26484.725	35	756.708		
Total	29474.460	39			

d. FW, December

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	28062.921	3	9354.307	12.848	.000
Within Groups	29122.238	40	728.056		
Total	57185.159	43			

APPENDIX I: ONE WAY ANALYSIS OF VARIANCE (ANOVA) TABLES AS GENERATED BY 'SPSS' FROM LENGTH MEASUREMENTS (LM)

a. LM, June

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	9.315	3	3.105	1.704	.184
Within Groups	65.613	36	1.823		
Total	74.928	39			

b. LM, July

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.641	3	1.880	.330	.804
Within Groups	205.033	36	5.695		
Total	210.674	39			

c. LM, August

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7.249	3	2.416	.369	.776
Within Groups	235.571	36	6.544		
Total	242.820	39			

d. LM, September

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	13.035	3	4.345	.467	.707
Within Groups	335.255	36	9.313		
Total	348.290	39			

e. LM, October

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	700.003	3	233.334	.904	.449
Within Groups	9291.897	36	258.108		
Total	9991.900	39			