# STIMUIATION OF ALGAE GROWTH AND ITS USE WITH SUPPLEMENTARY FEEDS ON THE GROWTH 0F OREOCHROMIS NILOTICUS

BY

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# DEDICATION

To my Late Uncles,

Mr. Philip N. Fonge

Mr. Isaac Fonge

and

my Auntie, Mama Lucia A. Fonge

Finally to my Affectionate Parents:

Mr. Lucas A. Fonge

and

Mrs. Agnes A. Fonge

## DECLARATION

I hereby declare that this thesis is my own work and has not been presented in any form for another qualification at any other university or institution. Information derived from the published or unpublished works of others have been duly acknowledged.

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## CERTIFICATION

This thesis, entitled "Stimulation of Algae Growth and Its Use with Supplementary Feeds on the Growth of *Oreochromis niloticus* by FONGE, Beatrice Ambo meets the regulation governing the award of the degree of Master of Science in Fisheries and Hydrobiology of Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

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## ABSTRACT

The effects of stimulated algae growth using organic and/or inorganic fertilizers and supplementary feeds on the growth of Oreochromis niloticus were studied over a period of seven weeks.

The growth rates and types of algae population that developed in the media were recorded. Growth media characteristics measured included temperature, hydrogen ion concentration (pH), electrical conductivity, dissolved oxygen (DO), biochemical oxygen demand (BOD), nitrate-nitrogen ($NO_3$-N), phosphate-phosphorus ($PO_4$-P), and potassium ($K^+$). The fish were observed for variation in weight gain or loss, length gain or loss, condition factor, food conversion efficiency, protein efficiency ratio, and mortality rates.

About fifty (50) algae taxa belonging to the chlorophyta, euglenophyta, bacillariophyta, cyanophyta and pyrrophyta were recorded. Growth rates were faster in NPK fertilized water and reached a peak after two weeks. In the chicken droppings-stimulated water, growth rate was slow in the first and second weeks, but increased rapidly, reaching its peak in the fifth week. Chicken droppings produced the highest algae growth with the highest amount of taxa population. Pyrrophyta was not recorded in NPK fertilized water. The physico-chemical parameters showed no significant differences within the treatments, but no significant differences were observed between treatments in conductivity

dissolved oxygen and phosphate-phosphorus. When supplementary feeds and fish were added to the tanks, no significant differences in temperature and biochemical oxygen demand were observed between treatments.

There was no correlation between the mean weight and the mean standard length gained by the fish in the different treatments. Treatment B (chicken droppings, lake water and corn bran) had the highest mean standard length gain, while treatment D (chicken droppings, groundnut cake, corn bran at 30% protein level) had the lowest mean standard length gain. Treatment H (NPK, groundnut cake and corn bran at 30% protein level) had the highest weight gain, while treatment D had the lowest.

It was concluded that chicken droppings produced higher algal growth with more algae taxa than NPK fertilizer, resulting in an increase in the mean standard lengh gained with a decrease in the mean weight gained. But when chicken droppings was combined with other food supplements (groundnuts cake and/or corn bran), there was a decrease in mean standard length gained due to oxygen depletion. During feeding, Oreochromis niloticus selects microcystis sp, Cruciyema sp and Cosmarium sp better than Trachelomonas sp and Euglena sp as their food.

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# CHAPTER ONE

## INTRODUCTION

The growth of organisms under healthy conditions is related to the quality and quantity of food fed to them. Fish live and obtain all nourishment from water bodies. But not all water bodies have the same productive potentials and not all food materials are produced in situ in the water bodies. Some are introduced from sources outside the water body. The major fish food produced in situ in water bodies are the plankton, periphyton and other aquatic vegetation. These could be divided into the primary, secondary and tertiary producers. The primary producers in the open water are the phytoplankton (the algae) and the secondary are the zoo-plankton, which feed on the algae. The zooplankton may also include some insect larvae or crustaceans. The zooplankton may be secondary or tertiary producers. The periphyton is algae that are attached to submerged surfaces, e.g. diatoms, the chlorophyta, and cyanophyta, while planktons are floating food material, e.g. chlorophyta and cyanophyta (Round, 1980; Denny, et al, 1978). The phytoplankton, periphyton and emergent aquatic plants are the primary producers and together with the zoo-plankton and zoobenthos constitute the autochthonous fish food in the aquatic habitats.

Another important source of fish food are the bottom sediments. This is inhabited by worms or invertebrates that burrow into the soft mud or live on the surface of the soft mud, wich is rich in life, dead and decaying food

materials, which make the sediment conducive for aquatic life including fish.

Other sources of fish food in the aquatic habitats are obtained in the catchment areas. They may contain decayed or decaying remains of plants and animals washed from the catchment areas. These are the allochthonous materials which may constitute another important source of fish food in the habitat. All these food sources enhance natural productivity in water bodies and thus promote aquatic life and growth.

Fish, one of the most important aquatic animals needed by man, obtains its food from the aquatic environment. But fish productivity can be increased by supplementing the natural food. These feeds are added depending on the feeding habit of the fish, the species and age of fish cultured. Fish are adapted to a wide variety of food, some feed exclusively on vegetable matter, others on animal matter. Fish species fed with vegetable materials obtain low protein nutrients, although they grow well. They, therefore, require low protein intake for healthy growth. Such species are called herbivorous fishes. Examples of herbivorous fishes are Tilapia zilli and Ctenopharyngodon idellus. Their major digestive enzymes are the carbohydrases (Olatunde , 1977). Others feed exclusively on animal matter. These are carnivorous fishes. This type of fish take more protein than herbivorous fish species and their major digestive enzymes are the proteinases (Robert, 1978).

Examples of carnivorous fish are Hydrocynus brevis, Lates niloticus and Heterotis niloticus. Other fishes feed on both plant and animal matter. They are ominivorous. Examples are Oreochromis niloticus, Oreochromis aureus and Clarias gariepinus.

There are fish species which feed on floating food material. They are planktophagus. Examples of these planktophagus fish include Sarotherodon galileaus and Sarotherdon hornmorum. Others feed on attached materials. Example is Anathonemus senegalensis. While Sarotherodon variabilis feed on bottom materials and are called detritus and bottom feeders.

Culturing of fish in Africa started in Egypt and this dates as far back as 2,500 BC (Bardach, et al, 1972). In the central part of Africa, Bardach et al (1972) and Huet (1972) reported that fish culture only started in 1920 in Kenya, where it was initiated by the Europeans, who probably for reasons of familiarity concentrated on exotic species. Some of the exotic fish species brought and cultured are still being cultivated in Africa, e.g. Protopterus dolli. The youngs of this feed on worms, insect larvae and small crustaceans; while their adults feed on other fishes and snails. The food is from the pond water where cassava tubers and leaves, and brewery wastes were introduced as food.

Other species cultured were Heterotis niloticus in Cameroon, Congo, Gabon and Nigeria (Bardach et al, 1972).

These feed mostly on zooplanktons and can also consume large food items like pellated food, macroplants and small fish.

Citharinus species cultured in Niger and Congo are indigenous species but little is known about their feeding habits, although they accept dry foods like rice bran, and cassava tubers (Bardach, et al, 1972).

Some other fish species like Barbus sp, Labeo sp are ominivorous. Most Clarias spp cultured in Africa are canivorous except Clarias anquillaris which is ominivorous. Of all the fish species cultured in Africa, the cichlids have been the most successful (Bardarch, op cit), with Tilapia spp being the most cultured and most successful in the genus. Their success is based on their adaptability to enclosed system and also their feeding habits which ranges from planktophagus in Sarotherdon quinensis to ominivorous in Tilapia niloticus (Oreochromis niloticus) (Bardarch, op cit).

With increasing knowledge of aquaculture in the world and coupled with the reduction in animal protein, Africans have started increasing effort towards production and consumption of fish protein, which is considered as the cheapest source of protein. And the fish Oreochromis niloticus has been found to be the most successful and widely cultured due to its diversified feeding habits, resistant to poor water quality, diseases, and being able to grow well in an enclosed environment (Otubusin and Amaechi, 1987).

In the light of these, this research was designed to search for other supplementary feeds that O. niloticus could feed on in aquaria; and particularly to look at the different types of algae stimulated by the two fertilizers, i.e. chicken droppings (organic) and NPK (inorganic fertilizer). It was also aimed at studying the feeding habit and the relative abundance of algae presence in the different media.

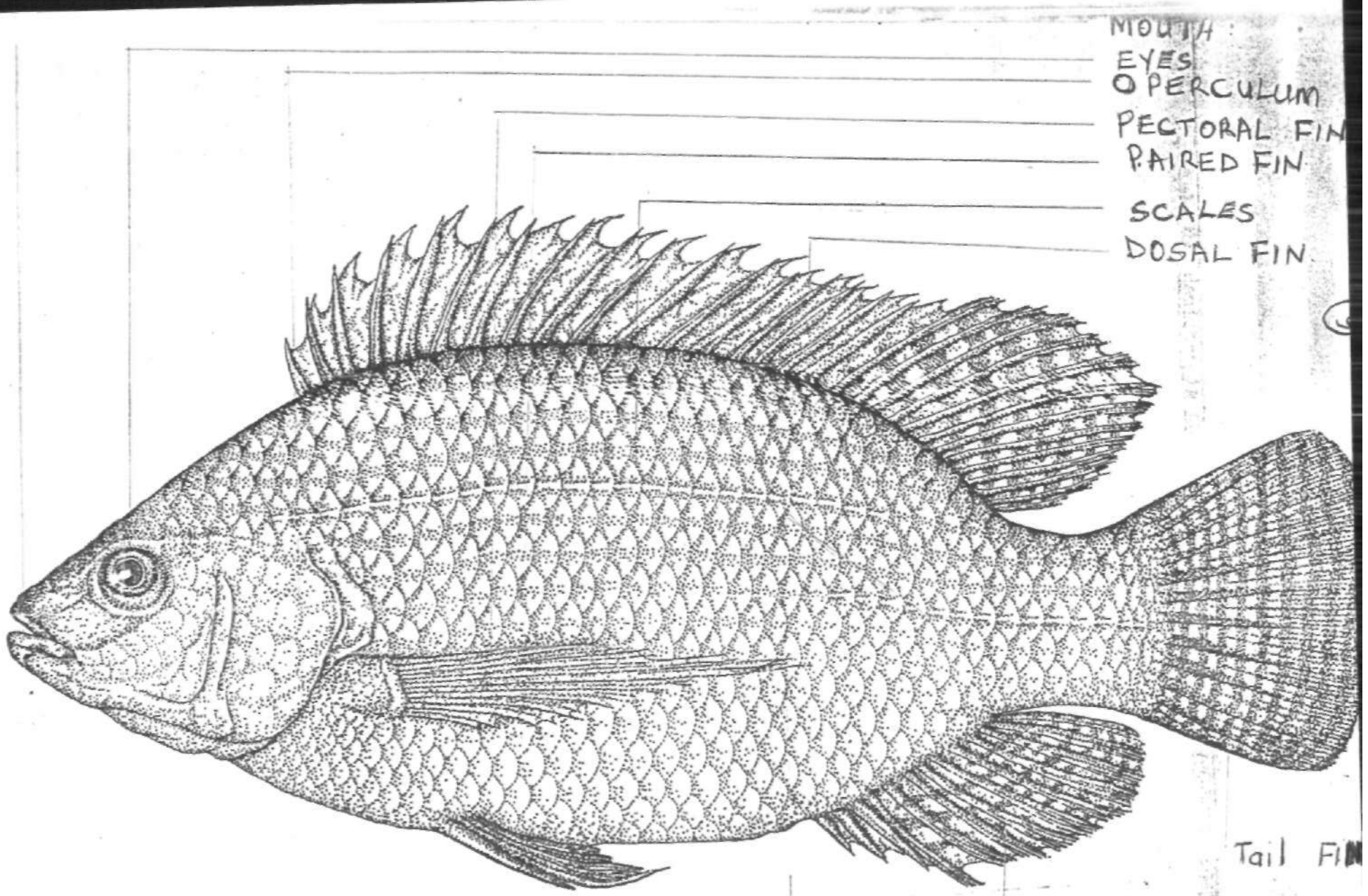



Fig 1 Oreochromis niloticus

Adapted after, Lewis (1974)

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Dietary Requirements of Fish

Like land animals, fish require protein, carbohydrates, fats, minerals and vitamins in a well balanced diet for growth, reproduction and normal physiological function of the body (Bardarch, et al, 1972).

### 2.1.1 Protein

Some fish have a high protein requirement for growth and other physiological maintenance than other vertebrates (Ayinla and Faturoti, 1990). According to Cruz and Laudancia (1977) protein requirement of fish depends on the size and age of the fish, the type of fish species, its feeding habit and the temperature of the water in which they are growing. For example, Oreochromis niloticus fry weighing about 2g requires about 40% crude protein for growth (Jauncey, 1982). Juvenile fish weighing about 7.5 g need about 34% (Writee and Stickney, 1981), while their adults need about 20% (Jackson, et al, 1982). For Clarias gariepinus the protein requirements are different. The dietary protein requirement for Clarias fingerlings is 31-34% while their adults need about 40% (Ayinla and Akande, 1988).

Fish require high protein for growth and they obtain this from the aquatic fauna and flora which sometimes may not completely meet the requirement of commercially fast growing

fish. Fish in culture obtain additional protein from supplementary feeds introduced by the aquaculturist. Usually the supplementary feed is formulated to give the full protein complement and may explain why fish in culture grow faster than those in the wild.

In aquaculture, the protein requirements of the different fish species has to be satisfied. The quality of protein in any diet is principally based on the amount of essential amino acids present. There are about twenty naturally available amino acids, but only ten are essential for fish growth. According to Ayinla (1991) and NRC (1983), ten essential amino acids required by local fish species for growth are as shown in Table 1.

TABLE 1: TEN ESSENTIAL AMINO ACIDS NEEDED BY SOME LOCAL FISH SPECIES FOR GROWTH

| AMINO ACID | CYPRINUS CARPIO 1% | OREOCHROMIS NILOTICUS 2% | CLARIAS FRY 3% | GARIEPINUS FINGER-LINGS 3% | GARIEPINUS JUVE-INILE |
|---|---|---|---|---|---|
| Histidine | 2.1 | 1.7 | 2.8 | 2.8 | 3.9 |
| Isolencine | 2.3 | 3.1 | 4.7 | 4.7 | 5.3 |
| Leucine | 3.4 | 3.4 | 9.2 | 9.2 | 12.3 |
| Lysine | 5.7 | 5.1 | 7.3 | 7.3 | 8.6 |
| Methionine & Cystine | 3.1 | 3.2 | | | |
| Phenylalanine & tyrosine | 6.5 | 5.7 | 3.5 | 3.5 | 3.8 |
| Threonine | 3.9 | 3.6 | 4.8 | 4.8 | 4.9 |
| Tryptophan | 0.8 | 1.0 | - | - | - |
| Valine | 3.6 | 2.8 | 3.5 | 3.5 | 3.5 |

SOURCE: Ayinla (1991) and NRC (1983).

### 2.1.2 Energy Food Sources

According to FAO (1978), Ivlev (1939) was the first to work on fish bioenergetics. He carried out both the laboratory and field observations aimed at obtaining an energy budget for carp population. According to him, energy budget can be divided into: (1) consumed or ingested energy and (2) assimilated energy.

Consumed or ingested energy comprises of energy in faeces and urine and that used for heat production for tissue growth, fat storage, eggs and sperm production, and embryo

maintenance. Assimilation energy is defined by the IBP News (1969) as the sum of production and respiration, or according to the IBP Handbook No. 3, Ricker (1968) described it as the food absorbed less the excreta.

Fish obtain this energy from carbohydrates, lipids and sometimes protein foods if the first two are defficient. In the absence of biochemical problems, carbohydrates are at the helm of fish metabolism because of the necessity for energy supply for most physiological processes. According to Phillip (1969), fish has low carbohydrate requirement compared to other animals. However, this food component makes the chief and irreplaceable energy sources. Phillip et al (1966) indicated that in brook trout the carbohydrates are utilized as an energy source, although this specie is relatively non-efficient metabolizer of a high level carbohydrate diet. Phillips et al (1966) reported that the level of assimilable carbohydrates in the diet of brook trout (Salvelinus fontinatis) should be limited to 12% carbohydrates, otherwise its liver will be overloaded with glycogen deposits and this situation may lead to death. Buchler and Halver (1961) reported that chinook salmon (Oncorhynchus tshawytscha) is tolerant to about 48% dietary carbohydrates with no pathological symptoms. An excess or defficiency in useful carbohydrate also affect the growth rate of fish, although it may not have any effect on the fish health. Although carbohydrate levels do not affect fish health, carbohydrates are most readily combusted during metabolic processes for

energy supply which is vital in increased protein and lipids utilization for body growth (Lovell, 1987; FAO, 1978).

Carbohydrate sources for feed formulation include corn which contains about 40% carbohydrates, groundnut cake about 36.3%, coconut about 34%, etc. (Ayinla, 1991). Because carboydrate foods are relatively cheaper to supply than protein food, nutritionists have given more priority to meet protein requirements, from which carbohydrate supplies will be derived. For instance, feeds for most species made with commonly available ingredients are not likely to be extremely low or high in energy, when the protein requirements are met. According to Lovell (1987), a 32% protein catfish feed containing soybean 50%, grain 10% and animal by-product 8%, plus vitamin and mineral supplement 2% contain approximately 2.8 kal of digestible energy per gram.

### 2.1.3 Lipids

Lipids are used as energy giving foods. In addition, they have other nutritional functions; they provide a vehicle for absorption of other fat-soluble nutrients such as sterols and vitamins. They play a role in the structure of cell and sub-cellular membrane. They are components of hormones and precursors for prostaglandins synthesis. Some lipid components such as sterols and certain fatty acids must be provided in the diet and thus are essential nutrients for fish.

Some warm-water fishes, such as channel catfish (Ictalurus punctatus), do not appear to be as sensitive to fatty acid deficiency as cold water fish species. Study by Stickney and Andrews (1972) showed no specific fatty acid requirement for channel catfish which seem to have similar nutrient requirement with our local catfish (i.e. C. gariepinus). However, he did find that high diet concentration of 18:2 n-6 fatty acid reduced growth. Later work, however, has shown that menhaden oil (high in n-3 fatty acid) produced higher growth rate in channel catfish than beef fat (no n-3 fatty acid). Contrarily, Tilapia zilli requires n-6 and not n-3 fatty acid. It is difficult to determine fish requirements for fatty acids because the metabolic requirement is very small and fatty acid stored in the body or even carried over from the egg yolk can influence performance of the experimental fish. Lovell (1987) reported that not much work has been done in determining the essentiality of fatty acids in cultivable fish species in Nigeria due to the fact that attentions are focused on the protein requirement which has higher cost implications in feed production. According to Lovell (1987), most fish species respond to lipids in the diet. How much of this response is caused by supplying essential fatty acid and how much is due to a readily available energy source is difficult to discern.

## 2.2 Algae as Fish Food

Some species of algae are known to have high nutrient values. Investigations from various countries have revealed that the nutritional content of the algae varied greatly with the substrates used for the culture and the species of algae (Kott and Wachs, 1964; Nicholas, 1986). In general, under normal conditions, the organic content of algae on a dry weight basis is estimated to be 40-60% protein, 10-20% carbohydrates, 5-15% lipids, 5-10% ash, and 5-10% crude fibre (NAS, 1983). Algae are known to contain some especially riboflavin, biotin and thiamine, certain minerals and most amino acids which are vital for both man and other animals (Palmer, 1980). Algae compared favourably with other conventional feeds, both nutritionally and economically; the protein content can be as high as 70% if grown in some synthetic materials (Palmer, 1980).

One advantage of algae over land plants as feed is that there is no waste in the form of fibrous or woody or other inedible part (Palmer, 1980). However, the cell wall is very rigid and difficult to digest, especially by monogastric animals (Round, 1980; Popma, 1982). Recently, various types of algae are being cultivated for fish food, human consumption and for treating waste water. Some species which are being cultivated for food on a large scale include chlorella and spirulina (Round, 1980). According to Dada (1989), Chlorella sp contains the following nutritional values: crude protein 50-57%, carbohydrates 19-21%, lipids 5%

and crude fibre 4-8%. It also contains essential minerals like calcium, iron, zinc and with all the ten essential amino acids needed by fish. Other algae used as fish food include Scenedesmus, Closterium, Chlamydomonas, and Rhizonlaria.

Palmer (1980); Round (1980); NAS (1982 and 1983); Sandbank and Hepher (1978); Ufodike and Ekokotu, (1986) reported that sewage-grown algae can be used as partial replacement for other conventional feeds (soybeans, corn, groundnut cake, and fish meal).

However, there are certain constraints associated with algal as fish feed. According to Nas (1982), human pathogens have been found in fish intestine and can pose health hazards if eaten raw or partially cooked from fish fed with waste grown algae. Others include the presence of toxicants (pesticides, antibiotics and hormones) in the substrate used for cultivating algae (NAS, 1982). Algae such as Microcystis, Gonyaulax and Gymodium produce toxins which are lethal to some aquatic animals, especially fishes (Swingle, 1968; Round, 1980).

Denny, Bowker and Bailey (1978) observed that the indigenous tilapias of Lake Victoria consume algae either in suspension, e.g. Sarotherodon escaulentus or from bottom deposits as in the case of S. variabilis. In their study on T. nilotica (Oreochromis niloticus), the predominant commercial fish of Lake George, Uganda, Planktonic algae were shown to be the primary food for these species. Bowker and

Denny (1979) also demonstrated that periphyton communities of Nyumba Ya Mungu reservoir, Tanzania contribute much to the food chain and production of herbivorous fish.

Dada (1989) reported that fish fed in diet with 30% algae plus fish meal grow better than those with fish meal diet only. While fish fed with 30% algae grow faster than those fed with soya bean diet.

### 2.2.1 Increased algal growth

Algae are grouped into phytobenthos (bottom dwelling), periphyton (attached algae) and the plankton (floating algae). They are primary producers in aquatic environment, thus manufacturing their own food with the help of sunlight, chlorophyll, organic and inorganic nutrients and dissolved carbon dioxide from the environment. The algae are the main stay of aquatic food chain as the primary fixers of energy. Other aquatic organisms (the consumers) depend on them either directly or indirectly.

Primary consumers feed directly on the producers. Secondary consumers feed on the primary consumers, while the tertiary consumers may feed on both the primary and secondary consumers. Examples of primary consumers are zooplankton, planktophagus fishes, crustaceans, rotifers, etc. Secondary consumers include canivorous fish and sometimes human beings, while the tertiary consumers include carnivorous fishes like Lates niloticus and Hydrocynus brevis. Kirk and Howell

(1972), and Kinne (1977) reported that the well being of fish depends on the availability and abundance of zooplankton. Zooplankton depends on the abundance and quality of the algae present.

Fish growth can be increased by increasing the growth of algae (APHA, 1985). The stimulation of algae can be obtained by increasing both the nitrogen and phosphorus content of the water body. This can be done by using organic and inorganic fertilizers.

Organic fertilizer include both animal and plant wastes. Examples of these include chicken droppings, decaying vegetation and cow dung. On decay or mineralization, they provide nitrogen and phosphorus. Chicken droppings, for example, provide 7.2 mg/l and 7.35 mg/l of nitrate ($NO_3$) and phosphate ($PO_4$) respectively (Ovie and Adeniji, 1990). These organic fertilizer can be applied to ponds either by sac or fermentation method.

The inorganic fertilizers commonly used are NPK (nitrogen, phosphorous and potassium) and superphosphate. NPK contains potassium nitrate and potassium phosphate giving the ratios of the said elements as 15:15:15, superphosphate is potassium phosphate and it is deficient in nitrogen, where it is used. The nitrogen necessary for growth is obtained from the atmosphere through fixation by blue-green algae present in water. In aquatic habitat, it has been found that phosphorus is usually the most limiting factor to the growth

of algae (APHA, 1985). Inorganic fertilizer can be applied either by broadcasting or by sac method (Ovie and Adeniji, op cit). The introduction of fertilizer may result in eutrophication leading to nuisance growth of algae, oxygen depletion, changes in physical and chemical conditions of water which may cause fish death (Huet, 1972). Proper monitoring of the aquatic environment before and after application of fertilizer is, therefore, very necessary.

## 2.3 Water Quality

The productivity of a given body of water is determined by its physical, chemical and biological properties. The environmental properties of water need to be conducive for fish to grow and reproduce well.

The physical properties of water include temperature, turbidity, water transparency, etc., while the chemical properties include pH, Carbondioxide content, Oxygen (dissolved oxygen), Nitrogen, Phosphorus, Biochemical Oxygen Demand (BOD), etc. (Lind, 1979). Fish need this environment at its optimum for proper growth, survival and reproduction (Lind, op cit). Any change (i.e. either a rise or a fall) from optimum will affect the existence of fish; therefore, they should be properly monitored.

### 2.3.1 Temperature

Temperature is the most easily and commonly observed environmental parameter of water (Taivo and Murray, 1981). It affects the dominance and distribution of phytoplankton in water. Cairo (1956) showed that phytoplankton dominance varies with temperature; between 20°C and 25°C diatoms predominate, green algae predominate at between 30°C and 35°C and above 35°C blue-green algae are dominant.

Changes in temperature also lead to stratification in the water column especially in deep lakes. Stratification divides the water column into epilimnion (warm upper layer), hypolimnion (the lower cooler layer) and the thermocline (the middle layer) which separates the two layers. The hypolimnion is often associated with low primary productivity and consequently, low dissolved oxygen (Wetzel, 1983). Hawkes (1975) reported that fish and other aquatic organisms tend to migrate from the hypolimnion to the epilimnion where water condition and food availability are suitable (Ridney and Steel, 1975).

### 2.3.2 Oxygen (dissolved oxygen)

Dissolved gases such as oxygen are essential for the metabolism of all aquatic organisms. Ellis (1937) and Brinley (1944) have shown that a minimum of 4.0 mg/l of oxygen is required to maintain a well rounded population and below this concentration massive death of organisms due to

suffocation may occur except for some few tolerant ones. The amount of oxygen in water is increased by primary productivity and by wind action which aerate the surface of the water.

Seasonal changes of dissolved oxygen has been found to be positively correlated with the density of phytoplankton (DAS, 1961). Low turbidity, diurnal fluctuations, water temperature, free carbondioxide and total alkalinity affect primary productivity which results to a reduction in the amount of dissolved oxygen presence in water (Khan et al, 1983). Insufficient amount of oxygen in a water body results in anaerobic decomposition with the release of growth nutrients such as nitrogen and phosphorus used by algal for increased growth.

The United States Environmental Protective Agency (USEPA) (1977) noted that dissolved oxygen concentration is not only an important water quality criterion in supporting a well-balanced aquatic fauna and flora communities.

### 2.3.3 Hydrogen ion concentration (pH)

Hydrogen ion concentration (pH) is significant in studies of primary productivity. Very alkaline waters are generally unproductive but pH values between 6.5 and 7.5 are most favourable for productivity (Lind, 1979). Huet (1972) reported that fish grow well when the pH of the water is neutral or when it is slightly alkaline, that is pH values

between 6 and 9. But at high pH, organic matter decomposition is very high resulting in increased carbondioxide production (Talling and Rzoska, 1967). High pH also facilitates phosphate removal from water environments (Boltermen, 1975). This element is important in primary productivity. A decrease in pH results in a decrease in species diversity (Godfrey, 1980).

## 2.4 Nutrient Requirement of Algae

Literature review dealing with aspects of algal nutrient requirements (Pitcairn and Hawkes, 1973; Smith, 1982; Lovstad, 1983; Wurtsbaugh, et al, 1985; Nicholas, 1986) reveals that for algal optimal or near optimal growth rates, some organic nutrient and inorganic mineral are essential. These nutrients are commonly refered to as growth-promoting substances.

Studies reveal that the following inorganic elements are required by one or more algal species: NPK, Mg, Ca, S, Fe, Cu, Mn, Zn, Mo, Na, Co, V, Si, Cl, B, and I. Of these, N, P, Mg, Fe, Cu, Mn, Zn and Mo are regarded as the most essentials of all algae and are not replaceable (Lewin, 1974; Smith, 1982; Nicholas, 1986). On the other hand, S, K, and Ca may be replaced to some extent. The macronutrient elements required for optimal growth include N, P, K, S, Ca, and Mg, whereas some elements are essential to all algae in small quantity (micronutrients). Such elements include Fe, Mn, Cu,

Zn, Si, Na, V and I. Cobalt is known to be required as vitamin $B_{12}$ by algal flagellates (Hutner et al, 1949) or in the inorganic form by certain blue-green algae (Nicholas, 1986). Scenedesmus sp require vanadium for growth (Nicholas, 1986); boron and silicon have been demonstrated to be essential for diatoms (Anderson, 1983 and Wurtsbaugh et al, 1985).

### 2.4.1 Nitrogen (N) and phosphorus (P)

Nitrogen and phosphorus are important nutrients needed for growth and maintenance of aquatic organisms (Vollenveider, 1976). Nitrogen is obtained basically from the atmosphere or from the environment (catchment area) in the form of organic and/or inorganic fertilizers. In aquatic environment, free nitrogen is fixed by blue-green algae into useful nitrogen for growth. The aquatic microphytes use nitrogen for growth thus depleting its amount in the water. On death and decay, the nitrogen is released back in the environment (Lind, 1979).

Nitrogen affects the growth of primary producers in aquatic habitats. According to larsson et al (1985), increased nitrogen results in an increase in primary productivity. Beadle (1974) reported that undetectable quantities of nitrate and phosphate in lakes are commonly associated with a very high rate of algal growth.

It can only be introduced either as organic or inorganic fertilizer (Lind, 1979; Vollenveider, 1976). Very low or even undetectable quantities of phosphates in lakes are commonly associated with a very high rate of algal growth as in Lake George in Uganda (Talling and Talling, 1968; Beadle, 1974). Woodson and Gore (1968) reported that phosphorus usually occurs in very small amounts and this may result in a deficiency in plants, and thus, a restriction in phytoplankton growth. It has also been shown that phytoplankton may store large quantities of phosphorus so that growth can continue long after the water has been depleted of phosphorus. A decrease in phosphorus in an aquatic environment could be attributed to algal abundance (Prowse and Talling, 1958; Talling, 1967).

Einsele (1944) found that phosphate added to water disappeared in a few days, having been taken up by algae. Woodson and Gore (1968) mentioned that inorganic nitrogen and phosphorus are usually low, but that there may be other factors influencing the availability of phosphate in the inorganic form. These other factors may include the presence of iron chelators that help to chelate ferric oxide, thus the removal of the ferric oxide could make phosphates more available in water and iron available for nitrogen fixation.

Nitrogen and phosphorus have, therefore, been established as limiting factors for the growth of algae (Biggar and Corey, 1969). The dissolved salt of these elements in water are important for both algae and fish growth (Lind, 1979; APHA, 1980).

### 2.4.2 Cations

Much work has been done to ascertain the effects of these ions on plant growth and the distribution of phytoplankton. The occurrence or absence of one of the cations will affect growth (Worthington and Ricardo, 1936). The effects of any one of these nutrients can hardly be isolated from another, for they are very interdependent (Woodson and Gore, 1968). Potassium and sodium have been widely studied. Talling and Talling (1965) estimated potassium and sodium by flame photometer and found that the concentration of these two ions increased with an increase in conductivity and total ionic concentration.

Potassium was always present in smaller amount than sodium, but the ratio of the two ions does not show any considerable variation. They did not, however, study the importance of these ions on the algae. Most studies seem to indicate the significance of potassium in algal development without studying the specific role this element plays in their life (Woodson and Gore, 1968). Nicholas (1986) believed that potassium serve as activator of enzymes in plant metabolism. Steward (1974) and Nicholas (1986) also reported that remarkable depressions of the photosynthesis rate observed in Nostoc and Chlorella was as a result of a deficiency in potassium, while other cations like magnessium and calcium are very important in algae growth. Magnessium is a constituent of chlorophyll, and therefore a definite requirement for pigmented algae and also essential for the

formation of catalase. Magnessium deficiency interrupts all division in Chlorella sp resulting in abnormally large cells (Stewart, 1974). While calcium, like some macronutrients of algae, are very essential but the quantity required vary greatly between species. Cell division of certain algae, for example Conium, tend to be affected by calcium concentration (Round, 1980). Calcium ions are known to stimulate sheath formation in Oscillatoria limosa (Foerster, 1964) and promote flagella agglutination in Chlamydomonas sp (Wiese and Jones, 1963). Stewart (1974) demonstrated that the thickness of the covering of the cell of a number of species of blue-green algae is both calcium and magnessium-dependent.

## 2.5 Objective

Some scientists have worked on the stimulation of specific algae using either organic or inorganic fertilizers or using two different organic fertilizers to produce algae in large amount; and used as fish food and for waste treatment. However no work has been done on the effect of organic (chicken droppings) and inorganic (NPK) fertilizers on algae growth in aquaria tanks with the intention to decrease the high competition that exists between man and other organisms for the smaller protein supply.

Therefore, this research was designed to determine:

(a) the composition and relative abundance of algae stimulated by chicken droppings and/or NPK fertilizer,

(b) the different algae digested by Oreochromis niloticus.

(c) the various growth response in Oreochromis niloticus in the stimulated algae water with the addition of some local food supplements.

(d) the physico-chemical changes that occur in the tanks, their effect on algae and fish growth, and

(e) finally, the rate of mortality in Oreochromis niloticus during the experimental period.

# CHAPTER THREE

# MATERIALS AND METHODS

## 3.1 Algae Growth Stimulation

Algae growth in aquaria tanks were stimulated using chicken droppings as organic fertilizer and NPK (nitrogen, phosphorus, potassium) as an inorganic fertilizer. The chicken droppings were obtained from NAPRI chicken farm and sterilized in an autoclave at 121°C for 15 minutes. The NPK was obtained from the open market.

Water already seeded with algae was obtained from Kubanni Lake (University Lake) and 28 litres dispensed into 20, 32 litre tanks standing on a raised platform in the open (Plate 7). The following treatments were carried out.

1. 10 grams of sterilized chicken droppings were introduced into eight of the tanks;
2. 5 grams NPK were dissolved in eight of the tanks;
3. 5 grams and 2 1/2 grams of chicken droppings and NPK respectively were introuced into two tanks, while two tanks were left untreated as the control.

The algae that developed in the tanks were monitored weekly for seven weeks using cell density and identification of the algae taxa that developed in the three fertilised treatments. Algae taxa identification was either from fresh samples or from samples preserved using Lugol's solution. Where necessary, fresh samples were concentrated by

Fig 2

The Erected Tanks used

the Experiment.



## 3.2 The Effect of Algal Growth and Food Supplement on the Growth of *Oreochromis niloticus* (fish)

Ten fish fingerlings collected from Maigana fish farm were acclimatized for one week after which they were introduced into 10 sets of replicately treated aquarium tanks. Before introducing the fish in the tanks, the algae were allowed to develop for two weeks, then the different food supplements were added with the fish forming ten sets of replicated treatments, namely:

A. Lake water and chicken droppings

B. Lake water, chicken droppings and corn bran

C. Lake water, chicken droppings and groundnut cake

D. Lake water, chicken droppings, groundnut cake and corn bran at 30% protein level

E. Lake water and NPK fertilizer

F. Lake water, NPK and corn bran

G. Lake water, NPK and groundnut cake

H. Lake water, NPK, groundnut cake and corn bran at 30% protein level

I. Lake water, NPK and chicken droppings

J. Lake water (untreated) control.

The standard length and weight of the fish was taken once a week for seven weeks. Comparison was made between the treatments; this was based on the mean body weight and mean standard length gained.

### 3.2.1 Body weight

The initial mean body weight of each set of fish introduced into the tanks was measured to the nearest gram using an electrical balance model P1 200 N. By the end of each week, the mean weight gained by the fish in the various tanks were calculated.

### 3.2.2 Standard length

The mean standard length of each set of ten fingerlings in each of the treatments were measured by the end of each week using a measuring board. The mean standard length gained per week per treatment for the seven weeks was calculated.

## 3.3 Feeding Habit and Food Selection

After seven weeks two fish from each of the treatments (where the fertilizers were introduced) were removed, washed and dissected. The gut was removed and sectioned into fore, mid and hind guts. The gut contents were scrapped onto a glass slide and observed under the microscope. The different algae taxa were identified in the different cultured media and sketches were made. Note was taken of the different cell structure of algae, that is, whole cells, partly digested, or completely digested, found in the gut of Oreochromis niloticus.

## 3.4 Culture Parameters

For proper fish growth and survival, the condition of the culture medium were monitored and analysed same hour, each week for seven weeks.

The water quality parameters monitored were:

1. Temperature
2. Dissolved oxygen (DO)
3. Biochemical oxygen demand (BOD)
4. pH
5. Conductivity
6. Nitrate-nitrogen ($NO_3N$)
7. Phosphate-phosporus ($PO_4$-P)
8. Potassium

This experiment was done in two phases:

a. Culturing of algae in NPK, chicken droppings and control water;
b. Culturing algae and the addition of local food supplements.

### 3.4.1 Temperature

Both shade and water temperatures were measured with alcohol in bulb thermometer calibrated at intervals of $1^{o}C$ with a maximum temperature reading of $40^{o}C$. Shade temperature was taken by holding the thermometer above the water for about five minutes until it stabilized. Water temperature was determined by lowering the thermometer into

the water in an inclined position for about five minutes to allow for equilibrium before recording.

### 3.4.2 Dissolved oxygen (DO)

This was determined by the modified winkler azide method (Lind, 1979; APHA, 1985).

Duplicate water samples in 250 ml brown ground-glass stoppered bottles were fixed on the site using 2 ml manganous sulphate as catalyst followed by 2 ml alkaline-iodine azide solution. This treatment fixes the dissolved free oxygen. In the laboratory, 2 ml concentrated sulphuric acid ($H_2SO_4$) was added. This dissolved the precipitate complex formed between the azide and dissolved oxygen releasing molecular iodine equivalent to the dissolved oxygen. This solution is yellow or brownish depending on the amount of iodine. 100 ml of this solution was titrated with 0.0125 N sodium thiosulphate until it turned pale yellow and 1 ml of starch solution added turning the solution to blue colour. The titration was continued until the blue colour disappeared. The volume of the 0.0125 N sodium thiosulphate titrant used is equivalent to the dissolved oxygen present in the original sample (Lind, 1979). The total dissolved oxygen mg/l was calculated using the formula:-

$$\text{Dissolved oxygen (mg/l)} = \frac{V(D) \times N(D) \times 8 \times 1000}{\text{Volume of Sample-2}}$$

D = sodium thiosulphate ($Na_2S_2O_3$)

N = normality of $Na_2S_2O_3$)

V = volume of thiosulphate (0.0125 N) used in the titration.

### 3.4.3 Biochemical oxygen demand (BOD)

Water samples in the different treatments were incubated at room temperature for five days in the dark before titrations for oxygen using modified winkler-azide method (Lind, 1979 and APHA, 1980).

(BOD mg $l^{-1}$) = Dissolved oxygen on day I - dissolved oxygen on day 5.

### 3.4.5 pH

Sub-surface water samples were collected from the tanks using plastic bottles and taken to the laboratory for pH determination. A pH meter pye unican model 292 pH was used and the temperature compensated at 25°C. The pH meter was standardised with buffer solution at pH 4.0; pH 7.0; pH 9.0 using pH tablets (GURR), before the readings were taken.

### 3.4.6 Electrical conductivity

Sub-surface water were collected from the tanks and conductivity measured using a conductivity bridge (electrolytic conductivity measuring set model MC-1, Mark V) with the temperature compensated at 25°C with a cell constant of K = 0.1 was pre-rinsed and filled with the test water before the readings were taken. The readings were expressed in micro-ohm/cm (umhos/cm).

### 3.4.7 Nitrate-nitrogen ($NO_3$-N)

The estimation of this was carried out in Soil Science Department.

The phenoldisulphonic acid method was used as described by Mackereth (1963). 100 ml of water samples were evaporated to dryness followed by the addition of 2 ml phenoldisphonic acid to the residue. This was left for 10 minutes. 15 ml of distilled water was added followed by 5 ml strong ammonia solution. The resultant yellow mixture was stirred and allowed to cool. The absorbance was measured at 410 nm wave length with a spectrophotometer model 5101, using distilled water as the blank. The $NO_3$-N concentration was read from the calibration curve.

### 3.4.8 Phosphate-phosphorus ($PO_4$-P)

The estimation of this was carried out in Soil Science Department. This was determined by using the Deniges method (Mackereth, 1963; Lind, 1979; APHA, 1980).

1 ml of Deniges reagent and five drops of stannous Chloride were added to 100 ml water samples. Absorbance at 690 nm wave length was measured with a spectrophotometer model 5101 using distilled water as the blank. The $PO_4$-P concentration of water sample was read from a calibration curve.

### 3.4-9 Potassium ($K^+$)

The estimation of this was carried out in Boil Science Department. Potassi Uffl w»s estimated using the flame photo-met»rftnclre&u11srecorcl»d-

:

### 3.5 Survival Rate

Mu c h p)'" e c a u t i on s a *a* p o s s i b 1 e w a s take n t o a v O i d stress on the experimental •fish. The tanks were observed daily for dead fish which were *rwmovwd* immediately. The percentage mortality per treatment was calculated and comparisons between treatments made.

### 3.6 Statistical Analysis

The results obtained for all the parameter *arB* shown *in* Tables 6„ 7 and S. Those msuits were subjected to statistical analysis using analysis of variance (ANOVA).

The analysis was done according to Walpole (1992) and the results for the various parameters were tabulated as shown in Tables 10, lt and 12.

Test: ")'b tes t i f t he obsE rved va 1 ue i s si gn 1 f i can $1_9$ t he calculated value should be less than the observed value- In the case of this research« the values were calculated as fol1ows-

During algal culturing, the F-calculated was:

| Source | Df | F-value |
|---|---|---|
| Replications | 6 | 3.7 |
| Treatments | 2 | 5.1 |
| Error | 12 | |

During algal culturing, addition food supplements and fish, the F-calculated was:

| Source | Df | F-value |
|---|---|---|
| Replication | 6 | 2.67 |
| Treatmenta | 9 | 2.38 |
| Error | 54 | |

The calculated F-values were 3.7 and 5.1 during algal culturing and 2.69 and 2.38 when supplementary feeds were added to the culture.

The observed value is rejected if less than the calculated value. Conversely, it is accepted or significant if more than the calculated (table) value.

In the calculation for F-value, the following formula was used:

$$\text{Correction factor (CF)} = \frac{(x)^2}{tr}$$

where

t = number of observation 10

r = number of replication 7

$x^2$ = squares of grand total (GT)

Total sum of squares $SS_{total} = (x)^2 - CF$

Treatment sum of squares $SS_{(treatment)} = A^2 + B^2 + C^2$

... $J^2 - CF$.

A, B, C, D are the treatments.

Sum of squares of error = $SS_{total} - SS_{rep} + SS_{trt}$

DF = (t-1) or (r-1), degree of freedom for treatment or for replication.

Mean squares of treatment:

$$M_S = \frac{SS_{treat}}{DF\ treatment}$$

Mean squares of replication:

$$M_S = \frac{SS_{rep}}{DF\ of\ replication}$$

Mean error = $Ms_{error} = SS_{err/df\ error}$

$Df_{error} = t(r-1)$

F-value or F-ratio = $Ms_{treat/mserror}$.

The ANOVA used was a one-way analysis of variance or completely randomised design (CRD).

In testing the significant level of the F-values the confidence limit taken was $P < 0.05$ at 95% confidence level. The various F-values for the different parameters are shown in Tables 6b, 7 and 8 of Appendix.

In order to know the best treatments and to recommend the best treatment with the best fish growth, the least significant difference (LSD) was calculated.

$$LSD = Erdf_{0.05} \frac{2EMS}{R}$$

as shown in Table and Table

Erdf = error degree of freedom

Ems = error mean square

R = replication

Length-weight relationship.

Regression line equation is $W = aL^b$

W = weight

L = length

a = constant

b = exponent

Equation of the line = $\log_W = \log_a + b \log L$ or $y = ax + c$.

The regression coefficient $b = \dfrac{xy - \frac{x \; y}{n}}{\left(x^2 - \frac{(x)^2}{n}\right)\left(x^2 - \frac{(x)^2}{n}\right)}$

$$a = \frac{xy + x \; y}{\frac{n}{x^2 - \frac{(x)^2}{n}}}$$

## Calculations

The condition factor, K is given by:-

$$K = \frac{100\ w}{L^b}$$

w = weight

L = standard length

b = regression coefficients.

$$\text{The Protein Efficiency Ratio} = \frac{\text{unit weight gained}}{\text{unit protein fed}}$$

# CHAPTER FOUR

# RESULTS

## 4.1 Algae Taxa and Algae Growth Rate in Chicken Droppings and NPK Stimulated Water

About 50 algal taxa were identified in 40 genera from Kubanni lake and from water collected from Kubanni lake treated with chicken droppings (organic fertilizer) and NPK (inorganic fertilizer). The treated water showed different algal growth rate and enhanced different types of taxa.

In the control tanks, the following taxa were identified: Chlorophyta was found to be the most dominant division with Scenedesmus dimorphus and Cosmarium sp as the most dominant species. Englenophyta was the next division with Euglena sp being the most dominant. Cyanophyta and Bacillariophyta were sub-dominant division, while Pyrrophyta was the least represented with Peridinum cinctum as the only species (Table 2).

In the NPK stimulated water, chlorophyta was the most dominant division with Scenedesmus dimorphus and Scenedesmus quadrilus as the most dominant species. Euglenophyta was the next with Euglena sp as the most dominant, while cyanophyta and bacillariophyta were poorly represented (Table 2).

In the chicken droppings stimulated water, chlorophyta and euglenophyta were the most dominant division. Cyanophyta

and bacillariophyta were sub-dominant and pyrrophyta was poorly represented with Peridinum cinctum as the only species (Table 2).

In the NPK and chicken droppings stimulated water, Scenedesmus dimorphus (chlorophyta) was the most dominant species. Euglena sp and Phacus sp (Euglenophyta) were sub-dominant, while Peridinium cinctum (Pyrrophyta) was poorly represented.

Comparing all the four treatments, chicken droppings was more productive. It contains not only phytoplankton but zooplanktons as well. The zooplanktons were crustaeceans and insects. Crustaeceans was found mostly in chicken droppings stimulated water and the control. While insects were poorly represented in NPK stimulated water.

Descriptions, sketches and photographs of the different taxa found in the control, water stimulated with NPK and chicken droppings are shown in Plates 1, 2, 3, 4 and 5 respectively. The distribution of taxa in the different treatments is given in Table 2.

TABLE 2: ALGAE TAXA AND THEIR DIFFERENT DIVISION FOUND IN NPK AND CHICKEN DROPPINGS STIMULATED WATERS

| DIVISION | GENUS/SPECIES | CTRL. | NPK | CHICKEN DROPPINGS | NPK AND CH. DR. |
|---|---|---|---|---|---|
| Euglenophyta | Euglena minuta | - | | | |
| Chlorophyta | Pandorina morum | - | | | |
| Cyanophyta | Microcystis aeruginosa | - | - | - | - |
| Chlorophyta | Cosmarium sp. | - | | | - |
| Cyanophyta | Merismospidia tennissima | - | - | | - |
| Cyanophyta | Anabaena spiracides | - | - | | |
| Cyanophyta | Oscillaria nigra | - | - | | |
| Chlorophyta | Crucigenia irregularia | - | | | - |
| Euglenophyta | Trachelomonas volvocina | | | | - |
| Euglenophyta | Tracehlomonas sp. | | - | | - |
| Unidentified | | - | | - | - |
| Unidentified | | - | | - | - |
| Euglenophyta | Phacus sp. | | | | |
| Euglenophyta | Phacus sp. | | | - | |
| Chlorophyta | Scenedesmus obliqnus | | | | |
| Chlorophyta | Haematococcus lacustris | | | | |
| Chlorophyta | Tetradon minimum | | | | |
| Chlorophyta | Scenedesmus dimorphus | | | | |
| Chlorophyta | Clusterium sp. | | | | |
| Chlorophyta | Scenedesmus longus | | | | |
| Euglenophyta | Phacus sp. | | | | |
| Chlorophyta | Gleocystis planctonica | | | | |
| Chlorophyta | Phytoconis sp. | | | | |

TABLE 2 cont'd

| DIVISION | GENUS/SPECIES | CTRL | NPK | CHICKEN DROPPINGS | NPK AND CH. DR. |
|---|---|---|---|---|---|
| Euglenophyta | Eualena sp. | | | | |
| Pyrrophyta | Peridinum cinctum | | | | |
| Diatoms | Frushula spp. | | | | |
| Unidentified | - | | | | |
| Chlorophyta | Ulothrix sp. | | | | |
| Chlorophyta | Coelastrum microporum | | | | |
| Chlorophyta | Sphaeroplea sp. | | | | |
| Chlorophyta | Scenedesmus gradrilus | | | | |
| Chlorophyta | Cosmarium contradum | | | | |
| Diatoms | Navicula sp. | | | | |
| Diatoms | Pinnularia sp. | | | | |
| Diatoms | Unidentified | | | | |
| Chlorophyta | Oedogonium sp. | | | | |
| Chlorophyta | Scenedesmus sp. | | - | | |
| Chlorophyta | Cosmarium sp. | | - | | |
| Euglenophyta | Euglena sp. | | - | | |
| Cyanophyta | Microcystic sp. | | - | - | |
| Chlorophyta | Chlorococcus dispersons | | - | - | |
| Euglenophyta | Trachelomonas hispidia | | - | | |
| Euglenophyta | Trachelomonas sp. | | - | - | |
| Diatoms | Cymbella sp. | | - | - | |

TABLE 3: RELATIVE ABUNDANCE OF ALGAE TAXA IN THE DIFFERENT TREATMENTS WITHIN SIX WEEKS

| SPECIES | LAKE WATER (UNTREATED) CONTROL | | | | | | NPK TREATED WATER | | | | | | CHICKEN DROPPINGS TREATED WATER | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WEEKS | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 |
| Euglena sp | 0.9 | 2.6 | 2.6 | 3 | 3 | 4 | 5.9 | 6.9 | 0.1 | 5.9 | 0.5 | 3 | 2.4 | 6.9 | 6.9 | 7.8 | 16.3 | 4.8 |
| Pandorina morus | 0.5 | 1 | 1 | 2 | 1 | 2 | 2.6 | 2.6 | - | 0.26 | 0.25 | 0.1 | 0.25 | 0.25 | 2.6 | 2.6 | 0.4 | - |
| Microcystis sp | - | 0.1 | - | 2 | 1 | 3 | 0.1 | 0.1 | - | 0.1 | 2 | 0.1 | 0.1 | 0.25 | 0.37 | 2 | 2 | 0.1 |
| Cosmarium sp | 0.38 | 0.38 | - | 2 | 2 | 1 | 0.38 | 1 | - | 0.8 | 2 | 1.2 | 0.38 | 1.25 | 1.25 | 4.9 | 3.9 | 0.8 |
| Merismopedia tenuissima | 0.1 | - | - | - | 0.1 | 0.1 | 0.1 | - | - | - | - | - | - | - | - | - | - | - |
| Anabaena spiroides | 0.25 | 0.5 | 0.5 | 1 | 0.5 | 0.5 | 0.1 | 0.63 | - | - | - | - | - | 0.1 | 1.25 | 3.6 | 0.1 | - |
| Oscillatoria nigra | 0.5 | - | - | - | 0.8 | - | 0.38 | 0.6 | - | - | - | - | 1 | 0.25 | 2.6 | 4 | 3 | 0.1 |
| Crucigenia irregularis | 0.3 | - | - | - | 0.25 | - | - | - | - | 0.1 | - | - | - | 0.1 | 2.6 | 2.6 | 0.1 | 0.1 |
| Trachelomonas sp | 0.1 | 0.1 | - | 0.1 | 0.1 | - | 13.6 | 0.1 | 0.1 | - | - | 0.1 | 0.5 | 0.1 | 2.6 | 2.6 | 0.2 | 0.1 |
| Phacus sp | 0.25 | 0.38 | 2.6 | 2.6 | 3.2 | 3.0 | 13.5 | 14.1 | 6.9 | 2 | 0.8 | 0.9 | 1.9 | 4.7 | 6.9 | 7 | 5.8 | 9.0 |
| Scenedesmus sp | 5.7 | 6.9 | 7 | 6 | 5 | 4 | - | 16.5 | 7.2 | 4 | 30.5 | 17.3 | 8 | 8.1 | 9.2 | 10 | 8.2 | 6.0 |
| Haematococcus sp | 0.1 | 0.26 | - | 0.1 | 0.1 | 0.1 | 1.75 | - | - | - | - | - | 1.1 | 1.1 | - | - | - | - |
| Tetradon minimus | 0.1 | - | - | 0.1 | 0.1 | - | - | - | - | 0.1 | 0.1 | - | 1.5 | 1.1 | - | - | 0.1 | 0.1 |
| Peridinium cinctum | 0.1 | - | - | 0.1 | 0.1 | 0.1 | 0.1 | - | - | - | - | - | 0.1 | 0.1 | 0.26 | 0.1 | 0.2 | 0.1 |
| Frashila sp | 0.1 | 0.25 | - | - | 0.1 | 0.1 | - | - | - | 0.1 | - | 0.1 | 0.1 | 0.1 | - | - | 0.25 | 0.4 |
| Ulothris sp | 0.1 | 0.1 | - | 0.1 | 0.25 | 0.2 | 5.5 | - | - | 0.1 | - | - | 0.1 | 0.25 | - | - | 2.6 | 0.1 |
| Sphacroplea sp | 2.8 | - | - | 0.1 | 0.1 | 0.1 | 0.1 | 0.38 | 0.26 | 0.1 | - | 0.1 | - | - | - | - | - | - |
| Naricula sp | 0.1 | 0.1 | - | - | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | - | 0.1 | - | 0.1 | 0.1 | 0.1 | 6.2 | 0.4 |
| Pinnularia sp | 0.1 | 0.26 | 0.26 | 1 | 1 | 0.1 | 0.63 | 0.26 | 0.26 | 0.1 | - | 0.1 | 0.5 | 0.39 | 1 | 1 | 3.2 | 0.1 |
| Oedogonium sp | 2.1 | 2.0 | 2.26 | 3.0 | 1.1 | 2 | - | 2 | 1 | 0.1 | 0.1 | 0.1 | 0.88 | 0.1 | 1 | 0.1 | 5.9 | 0.1 |
| cymbella sp | 0.3 | 0.3 | 1 | 1.1 | 2 | 0.1 | - | - | - | 0.1 | - | - | 0.3 | 0.1 | 1 | 0.1 | 3.2 | 0.1 |
| Chlorococcus dispersus | 0.1 | - | - | - | 6.1 | 0.1 | - | - | - | - | - | - | - | 0.1 | 1 | 0.1 | 8.1 | 0.1 |
| Coelastrum microporum | 0.2 | 0.13 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Closterium setaceum | 0.1 | - | - | 0.1 | 0.1 | 0.1 | - | - | 0.1 | - | 0.1 | 0.1 | - | - | 0.1 | 0.1 | 0.1 | - |
| Gloecystis plactonica | 0.1 | 0.1 | - | - | 0.1 | 0.1 | - | 0.1 | - | 0.1 | - | - | 0.1 | - | - | - | - | - |
| Phytoconis | 0.1 | - | 0.1 | - | 0.1 | 0.1 | 0.1 | 0.25 | 0.1 | - | - | | - | - | 0.1 | 0.1 | 0.1 | 0.1 |

**TABLE 4: RELATIVE ABUNDANCE OF ALGAE DIVISION FOUND IN LAKE WATER**

| SPECIES | WEEKS | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| Euglenophyta | 8.1% | 19.9% | 30.0% | 23.4% | 30.3% | 33.5% |
| Chlorophyta | 81.9% | 69.9% | 59.8% | 55.3% | 47.7% | 47.4% |
| Cyanophyta | 5.5% | 39.0% | 2.8% | 12.3% | 11.3% | 16.9% |
| Bacillariophyta | 3.9% | 5.9% | 7.3% | 8.6% | 15.0% | 2.0% |
| Pyrrophyta | 0.6% | - | - | 0.4% | 0.5% | 0.1% |

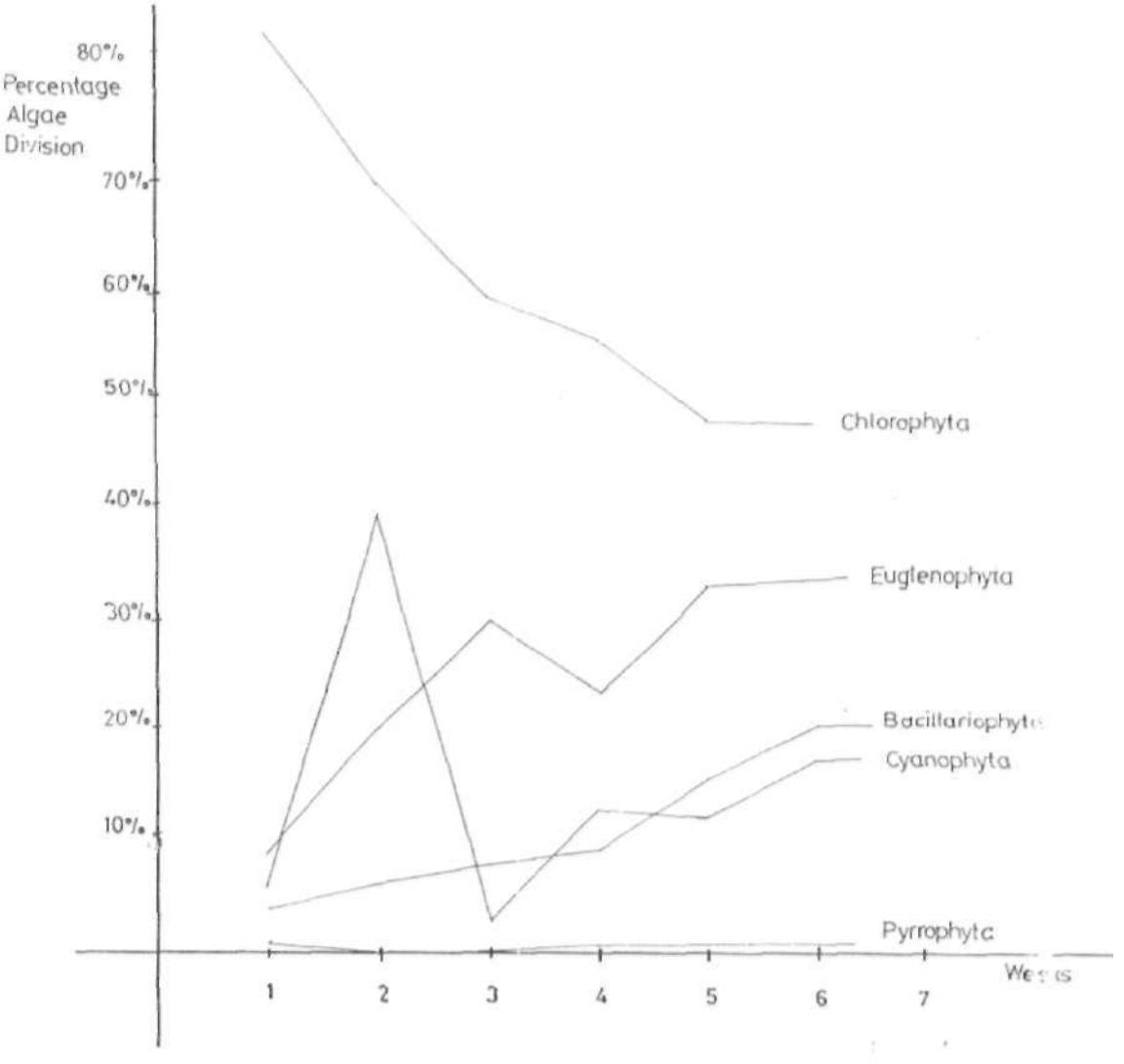
**TABLE 5: RELATIVE ABUNDANCE OF ALGAE DIVISION FOUND IN NPK STIMULATED WATER**

| SPECIES | WEEKS | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| Euglenophyta | 43.9% | 46.3% | 44.1% | 56.6% | 3.6% | 17.2% |
| Chlorophyta | 54.0% | 50.2% | 53.7% | 40.5% | 85.4% | 81.1% |
| Cyanophyta | 1.5% | 2.9% | - | 0.7% | 5.5% | 0.4% |
| Bacillariophyta | 0.6% | 0.7% | 2.2% | 2.2% | - | 1.3% |

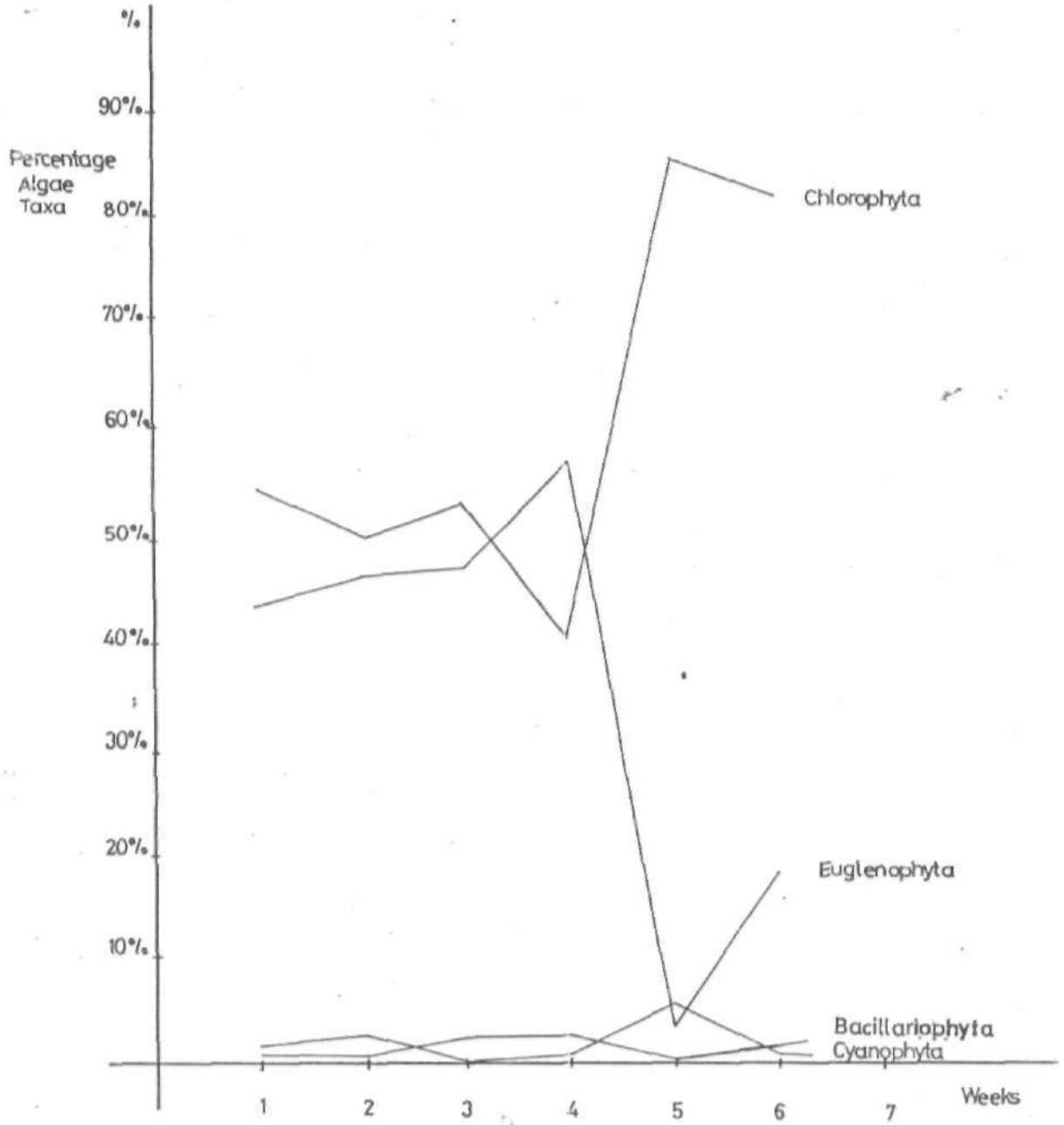
**TABLE 6: PERCENTAGE RELATIVE ABUNDANCE OF ALGAE DIVISION FOUND IN CHICKEN DROPPINGS STIMULATED LAKE WATER**

| SPECIES | WEEKS | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| Euglenophyta | 24.9% | 46.2% | 40.2% | 35.7% | 38.3% | 61.8% |
| Chlorophyta | 64.1% | 44.1% | 44.4% | 42.2% | 37.2% | 32.4% |
| Cyanophyta | 3.1% | 2.4% | 10.3% | 19.7% | 7.9% | 0.8% |
| Bacillariophyta | 3.0% | 2.4% | 4.8% | 2.8% | 19.9% | 4.4% |
| Pyrrophyta | 0.5% | 0.4% | 0.6% | 0.2% | 0.2% | 0.4% |

FIG 3 RELATIVE ABUNDANCE OF ALGAE DIVISION FOUND IN LAKE WATER



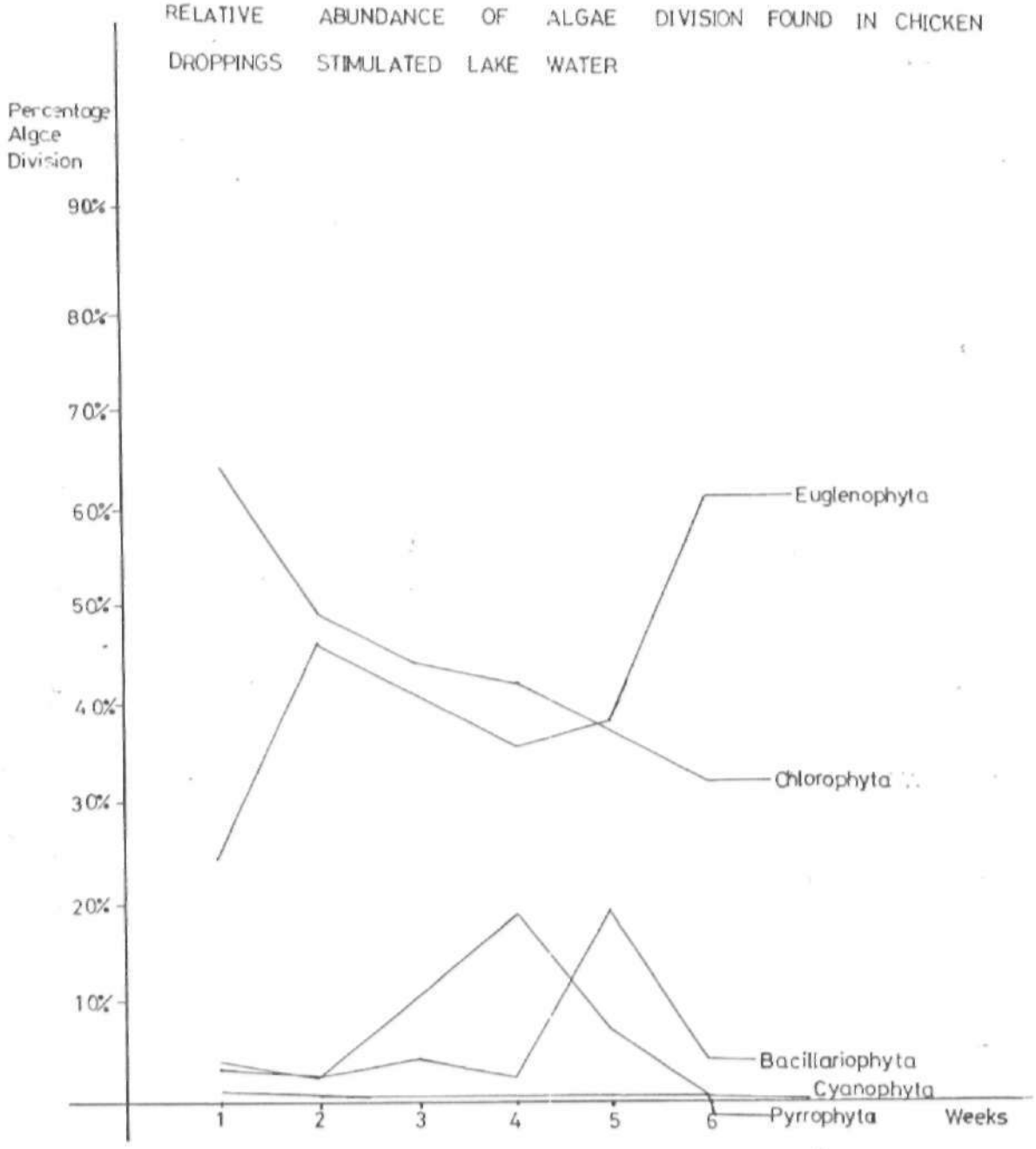
F1G 4 RELATIVE ABUNDANCE OF ALGAE DIVISION FOUND IN N.P.K.




4

FIG 5

RELATIVE ABUNDANCE OF ALGAE DIVISION FOUND IN CHICKEN DROPPINGS STIMULATED LAKE WATER



The relative abundance of algal taxa found in the different treatments are shown in Table 2. The percentage relative abundance of the various division in the different treatments are given in Tables 4, 5 and 6, Figs. 3, 4, and 5.

Table 3 shows that increase of algae growth in NPK stimulated water had its maximum growth in Week 2 and the least growth in Weeks 3 and 4. In chicken droppings stimulated water, the highest growth was observed in Week 5 and lowest in Week 2.

## 4.2 Physico-chemical Parameters

Table 4 shows the physico-chemical parameters measured from the algae stimulated water using NPK and chicken droppings as fertilizers. Table 5 shows the physico-chemical parameters measured from the algae stimulated water, additional local food supplements.

### 4.2.1 Temperature $^{o}C$

The temperature values obtained from shade and experimental tanks in algae stimulated water are shown in Tables 4a and 5a.

The average shade temperature was 29.6$^{o}C$. The highest water temperature (27.7$^{o}C$) was obtained in chicken droppings stimulated water. The lowest was found in the control 25.8$^{o}C$. There was a significant difference in temperature in algae stimulated water in the different fertilized treatments (F-value = 14.3).

TABLE 4: THE PHYSICO-CHEMICAL PARAMETERS OBSERVED WITHIN SEVEN WEEKS IN UNTREATED LAKE WATER (CONTROL), NPK (INORGANIC FERTILIZER) AND CHICKEN DROPPINGS (ORGANIC) FERTILIZER DURING ALGAE CULTURING AND FISH CULTURING

4a: Temperature (in $^{o}C$) observed within 7 weeks during Algae cultivation in the different fertilized media

| TIME IN WEEKS | NPK FERTILIZER | CHICKEN DROPPINGS | CONTROL (UNTREATED WATER) | SHADE TEMP. | $\bar{X}$ | $\Sigma X$ |
|---|---|---|---|---|---|---|
| Temperature (in $^{o}C$) | | | | | | |
| 01 | 29 | 30 | 29 | 32 | 30 | 120 |
| 02 | 28 | 29 | 29 | 31 | 29.3 | 117 |
| 03 | 27 | 28 | 20 | 29 | 27.5 | 110 |
| 04 | 21 | 23 | 21 | 26 | 22.8 | 91 |
| 05 | 26 | 26 | 22 | 27 | 25.3 | 101 |
| 06 | 27 | 29 | 27 | 30 | 28.3 | 113 |
| 07 | 28 | 29 | 27 | 32 | 29 | 116 |
| $\bar{X}$ | 26.7 | 27.7 | 25.8 | 9.0 | | |
| $\Sigma X$ | 185 | 194 | 181 | 207 | | |

ANOVA for Temperature in weeks for the different fertilized media

Temperature

| Source | Df | SS | MS | F |
|---|---|---|---|---|
| Replication weeks (W-1) | 6 | 2 | 0.3 | 0.08 |
| Treatment (t-1) | 3 | 159 | 53 | 14.3 |
| Error (w-1)(t-1) | 18 | 66 | 3.7 | |
| Total | 27 | | | |

TABLE 5a: TEMPERATURE IN WEEKS PER TREATMENT

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | $\bar{X}$ |
|---|---|---|---|---|---|---|---|---|
| A | 31 | 27 | 25 | 25 | 26 | 30 | 26 | 27.1 |
| B | 28 | 27 | 25 | 25 | 26 | 28 | 25 | 26.3 |
| C | 29 | 29 | 24 | 24 | 27 | 27 | 26 | 26.9 |
| D | 27 | 29 | 25 | 24 | 26 | 29 | 24 | 26.3 |
| E | 29 | 28 | 26 | 24 | 22 | 22 | 25 | 26.9 |
| F | 29 | 29 | 25 | 26 | 28 | 29 | 26 | 27.4 |
| G | 28 | 28 | 25 | 27 | 26 | 30 | 27 | 27.4 |
| H | 28 | 29 | 25 | 27 | 28 | 30 | 28 | 27.9 |
| I | 27 | 29 | 25 | 25 | 28 | 28 | 27 | 27 |
| J | 27 | 27 | 25 | 26 | 27 | 29 | 27 | 26.9 |
| ST | 32 | 30 | 28 | 30 | 30 | 32 | 29 | 30 |
| $\bar{X}$ | 28.4 | 28.2 | 25 | 25.2 | 26.9 | 28.9 | 26.1 | |
| $\Sigma X$ | 284 | 282 | 250 | 252 | 269 | 289 | 261 | |

ST = Shade Temperature

ANOVA FOR TEMPERATURE IN WEEKS PER TREATMENT

| Source | Df | SS | M.S | F |
|---|---|---|---|---|
| Replication (Weeks) (w-1) | 6 | 150.57 | 25.095 | 31.8 |
| Treatments (t-1) | 9 | 15.73 | 1.748 | 2.22 |
| Error (w-1)(t-1) | 54 | 42.57 | 0.788 | |
| Total | 69 | | | |

Within the fertilized treatments, Week 2 had the highest (29.3°C) and Week 4 had the lowest (22.8°C). There was no significant difference in temperature (F-value = 0.08). In algae stimulated water and food supplement, the average shade temperature was 30°C.

The highest water temperature was obtained in treatment H (27.9°C) and the lowest (26.3°C) in treatment B. There were no significant differences in temperature between treatments (F-value = 2.2).

Within treatments, the highest water temperature (28.9°C) was obtained in the sixth week. While the lowest temperature (25°C) was in the third week. There was a significant difference in temperature within the different treatments (F-value = 31.8).

### 4.2.2 Hydrogen ion concentration (pH)

In algae stimulated water, the highest pH (8.6) was obtained in chicken droppings water, the lowest was obtained in NPK stimulated water (pH = 8.2) (see Table 4). There was significant difference in pH in algae stimulated treatments (F-value = 19).

Within the treatments, the highest was observed in Week 4 (9.3) and the lowest was observed in Week 1 (8.0). There was no significant difference in pH within the different fertilized treatments (F-value = 0.09).

b: pH observed within 7 weeks during Algae cultivation in the different fertilized media

| TIME IN WEEKS | NPK FERT-ILIZER | CHICKEN DROPPINGS | CONTROL (UN-TREATED WATER) | $\bar{X}$ | $\Sigma X$ |
|---|---|---|---|---|---|
| 01 | 9.0 | 7.0 | 8.2 | 8.1 | 24.2 |
| 02 | 8.0 | 8.3 | 7.9 | 8.1 | 24.2 |
| 03 | 7.9 | 8.3 | 8.7 | 8.3 | 24.9 |
| 04 | 8.3 | 8.8 | 8.7 | 8.6 | 28.8 |
| 05 | 8.0 | 9.9 | 8.3 | 8.7 | 26.2 |
| 06 | 7.9 | 9.1 | 8.0 | 8.3 | 25 |
| 07 | 8.1 | 8.7 | 7.6 | 8.2 | 24.4 |
| $\bar{x}$ | 8.2 | 8.6 | 8.2 | | |
| $\Sigma X$ | 57.2 | 60.1 | 57.4 | | |

ANOVA for pH in weeks for the different fertilized media

| | Df | SS | MS | F |
|---|---|---|---|---|
| Replication | 6 | 0.79 | 0.13 | 0.09 |
| Treatment | 2 | 55.9 | 27.95 | 19 |
| Error | 12 | 17.61 | 1.47 | |
| Total | 20 | | | |

TABLE 5b: pH IN WEEKS PER TREATMENT

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | $\bar{X}$ | $\Sigma X$ |
|---|---|---|---|---|---|---|---|---|---|
| A | 8.3 | 8.3 | 9.1 | 9.9 | 9.1 | 8.8 | 9.7 | 9.0 | 63.2 |
| B | 8.0 | 8.3 | 8.0 | 8.7 | 8.4 | 8.0 | 8.4 | 8.3 | 57.8 |
| C | 8.0 | 8.1 | 8.1 | 8.5 | 8.2 | 8.3 | 7.8 | 8.2 | 57.1 |
| D | 7.9 | 7.9 | 8.1 | 7.8 | 7.6 | 7.3 | 7.6 | 7.7 | 54.2 |
| E | 7.9 | 8.3 | 8.3 | 7.9 | 7.2 | 8.1 | 8.2 | 8.0 | 55.9 |
| F | 7.9 | 8.3 | 7.4 | 7.9 | 7.2 | 7.3 | 7.9 | 7.7 | 53.1 |
| G | 7.9 | 8.4 | 8.2 | 8.5 | 8.3 | 8.0 | 7.8 | 8.1 | 57.1 |
| H | 7.9 | 8.3 | 7.2 | 7.9 | 7.5 | 7.0 | 8.6 | 7.8 | 54.4 |
| I | 7.9 | 8.6 | 8.2 | 8.4 | 8.2 | 8.1 | 8.3 | 8.2 | 57.7 |
| J | 7.9 | 8.7 | 8.3 | 8.4 | 8.1 | 8.1 | 8.5 | 8.3 | 58 |
| $\bar{X}$ | 8.0 | 8.3 | 8.1 | 8.4 | 8.0 | 7.9 | 8.3 | | |
| $\Sigma X$ | 79.6 | 83.2 | 80.9 | 83.9 | 80.0 | 79.0 | 82.7 | | |

ANOVA FOR pH IN WEEKS PER TREATMENT

| Source | Df | SS | M.S | F |
|---|---|---|---|---|
| Replication (Weeks) (w-1) | 6 | 2.23 | 0.37 | 3.12 |
| Treatment (t-1) | 9 | 9.42 | 1.05 | 8.75 |
| Error (w-1)(t-1) | 54 | 6.23 | 0.12 | |
| Total | 69 | | | |

In algae and food supplemented waters, within treatments Week 4 had the highest pH value (8.4) while Week 6 had the lowest (7.9). There was a significant difference in pH within the different treatments (F-value = 3.12) (see Table 3b).

Between treatments, treatment A had the highest pH (pH 9) and treatment D had the lowest pH values (pH = 7.7). There was a significant difference in pH between treatments (F-value = 8.75).

### 4.2.3 Conductivity, $K_2O$

The conductivity values obtained from the algae stimulated water are shown in Table 4c.

The highest conductivity value ($2.3 \times 10^{-2}$ microhoms) was found in chicken droppings stimulated water during algae culturing. The lowest value ($1.6 \times 10^{-2}$ microhoms) was observed in the control. There was a significant difference in conductivity between treatments during algae culturing (F-value = 4.1).

Within treatments during algae culturing, the highest value ($2.6 \times 10^{-2}$ microhoms) was observed in Week 2 and the lowest ($0.7 \times 10^{-2}$ microhoms) in Week 5. There was no significant difference in conductivity within treatments during algae culturing.

The conductivity values were not constant between and within treatments but their means were fairly constant

7c: Conductivity ($K_{20}$) x $10^{-2}$ Microhms) observed within 7 weeks during Algae cultivation in the *different fertilized media*

| TIME IN WEEKS | NPK FERT-ILIZER | CHICKEN DROPPINGS | CONTROL (UN-TREATED WATER) | $\bar{X}$ | $\Sigma X$ |
|---|---|---|---|---|---|
| 01 | 1.0 | 1.8 | 1.8 | 1.5 | 4.6 |
| 02 | 3.5 | 3.1 | 1.8 | 2.8 | 8.4 |
| 03 | 2.9 | 1.1 | 3.5 | 2.5 | 7.5 |
| 04 | 1.4 | 2.6 | 1.0 | 1.7 | 5.0 |
| 05 | 0.4 | 1.5 | 0.2 | 0.7 | 2.1 |
| 06 | 2.2 | 2.4 | 2.1 | 2.3 | 6.7 |
| 07 | 2.2 | 3.5 | 1.0 | 2.3 | 6.7 |
| $\bar{x}$ | 1.9 | 2.3 | 1.6 | | |
| $\Sigma X$ | 13.6 | 16 | 11.6 | | |

ANOVA for conductivity ($K_{20}$) x $10^{-2}$ Microhms in weeks for the different fertilized media

| | Df | SS | MS | F |
|---|---|---|---|---|
| Replication week | 6 | 1.1 | 0.18 | 0.16 |
| Treatment | 2 | 8.9 | 4.5 | 4.1 |
| Error | 12 | 13.5 | 1.1 | |
| Total | 20 | | | |

TABLE 8c: CONDUCTIVITY ($K_{20}$) IN WEEKS PER TREATMENT ($1 \times 10^{-2}$) MICROHMS)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | $\bar{X}$ | $\Sigma X$ |
|---|---|---|---|---|---|---|---|---|---|
| A | 1.8 | 3.1 | 1.2 | 2.6 | 1.4 | 0.8 | 2.7 | 1.8 | 13.3 |
| B | 1.5 | 3.2 | 1.2 | 2.7 | 1.4 | 0.8 | 3.0 | 2 | 14 |
| C | 1.6 | 3.3 | 1.2 | 2.0 | 1.9 | 3.3 | 3.1 | 2.3 | 16.4 |
| D | 1.6 | 3.6 | 3.4 | 1.3 | 1.6 | 5.7 | 3.6 | 3.0 | 20.8 |
| E | 1.6 | 4.1 | 3.4 | 1.3 | 1.4 | 4.5 | 3.5 | 2.8 | 19.8 |
| F | 1.5 | 5.3 | 3.1 | 1.9 | 1.6 | 4.6 | 3.7 | 3 | 21.9 |
| G | 1.6 | 2.5 | 1.2 | 2.5 | 1.5 | 3.4 | 3.2 | 2.3 | 15.9 |
| H | 1.7 | 8.0 | 2.2 | 1.4 | 2.1 | 4.0 | 3.7 | 3.3 | 23.1 |
| I | 1.7 | 3.5 | 3.5 | 1.9 | 2.1 | 4.0 | 3.6 | 2.9 | 20.3 |
| J | 1.8 | 3.6 | 3.5 | 1.9 | 2.1 | 3.7 | 3.5 | 2.9 | 20.1 |
| $\bar{X}$ | 1.64 | 4.0 | 2.4 | 1.9 | 1.7 | 3.5 | 3.4 | | |
| $\Sigma X$ | 16.4 | 40.2 | 24.1 | 19.5 | 17.3 | 34.5 | 33.6 | | |

ANOVA FOR CONDUCTIVITY IN WEEKS PER TREATMENT

| Source | Df | SS | MS | F |
|---|---|---|---|---|
| Replication (w-1) | 6 | 54.35 | 9.06 | 60.4 |
| Treatments (t-1) | 9 | 14.84 | 1.65 | 11 |
| Error (w-1)(t-1) | 54 | 8.32 | 0.15 | |
| Total | 69 | | | |

ranging from 1.8-3.4 and 1.64-4 microhoms respectively in algae culture and food supplement media (see Table 8c).

Between treatments, treatment D had the highest conductivity value ($4 \times 10^{-2}$ microhoms) and treatment A had the lowest ($1.8 \times 10^{-2}$ microhoms). There was significant difference in conductivity between treatments (F-value = 11).

Within treatments, Week 2 had the highest conductivity ($4 \times 10^{-2}$ microhoms) and Week 1 had the lowest ($1.64 \times 10^{-2}$ microhoms). There was a significant difference in conductivity within the treatments (F-value = 60).

### 4.2.4 Dissolved oxygen (DO)

Tables 7d and 8d show the amount of dissolved oxygen present in the water during algae culturing and also during algae culturing and food supplements.

In the algae culture waters, NPK stimulated water had the highest dissolved oxygen (5.1 mg/l) while chicken droppings (4.5 mg/l) had the lowest. There was no significant difference in dissolved oxygen (F-value = 3.3).

Within treatments Week 2 had the highest value (5.6 mg/l) and Week 5 had the lowest (3.8 mg/l). There was no significant difference in dissolved oxygen within treatments during algae culturing (F-value = 0.8).

4
7d: Dissolved oxygen (DO) mg/l observed within 7 weeks during Algae cultivation in the different fertilized media

| TIME IN WEEKS | NPK FERT-ILIZER | CHICKEN DROPPINGS | CONTROL (UN-TREATED WATER) | $\bar{X}$ | $\Sigma X$ |
|---|---|---|---|---|---|
| 01 | 5.3 | 4.3 | 6.3 | 5.3 | 15.9 |
| 02 | 5.6 | 5.3 | 6.0 | 5.6 | 16.9 |
| 03 | 4.7 | 5.2 | 5.8 | 5.2 | 15.7 |
| 04 | 4.6 | 5.0 | 3.7 | 4.4 | 13.3 |
| 05 | 4.5 | 2.3 | 4.2 | 3.7 | 11 |
| 06 | 6.0 | 4.7 | 2.0 | 4.2 | 12.7 |
| 07 | 5.2 | 4.5 | 4.0 | 4.7 | 14.2 |
| $\bar{x}$ | 5.1 | 4.5 | 4.6 | | |
| $\Sigma X$ | 35.8 | 31.8 | 32 | | |

ANOVA for DO mg/l in weeks for the different fertilized media

| | Df | SS | MS | F |
|---|---|---|---|---|
| Replication week | 6 | 0.54 | 0.09 | 0.07 |
| Treatment | 2 | 8.61 | 4.3 | 3.3 |
| Error | 12 | 15.25 | 1.3 | |
| Total | 20 | | | |

TABLE 8d: DISSOLVED OXYGEN CONTENT (DO) IN WEEKS PER TREATMENT (mg/l)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | $\bar{X}$ | $\Sigma X$ |
|---|---|---|---|---|---|---|---|---|---|
| A | 7.8 | 3.8 | 3.7 | 2.4 | 7.8 | 7.8 | 7.6 | 5.8 | 40.9 |
| B | 7.2 | 5.2 | 4.6 | 6.5 | 7.1 | 7.5 | 7.5 | 6.5 | 45.5 |
| C | 7.1 | 7.1 | 3.7 | 5.1 | 7.1 | 6.4 | 7.0 | 6.2 | 43.5 |
| D | 5.5 | 6.4 | 4.0 | 4.2 | 6.8 | 5.2 | 6.9 | 5.6 | 39.0 |
| E | 6.9 | 5.0 | 4.5 | 8.5 | 6.4 | 4.8 | 6.8 | 6.1 | 42.9 |
| F | 7.1 | 7.0 | 11.3 | 15.2 | 7.5 | 8.2 | 7.4 | 7.1 | 63.7 |
| G | 7.3 | 9.0 | 9 | 11 | 7.6 | 8.4 | 7.2 | 8.4 | 59.5 |
| H | 6.5 | 7.3 | 8.4 | 9.4 | 7.6 | 6.2 | 7.0 | 7.5 | 52.4 |
| I | 7.7 | 5.6 | 7.2 | 8 | 6.7 | 4.8 | 6.8 | 6.7 | 46.8 |
| J | 6.1 | 7.6 | 5.6 | 6.9 | 7.0 | 6.2 | 6.8 | 6.5 | 46.2 |
| $\bar{X}$ | 6.9 | 6.4 | 6.2 | 7.7 | 7.2 | 6.6 | 7.1 | | |
| $\Sigma X$ | 69.2 | 64 | 62 | 77.2 | 71.6 | 65.5 | 70.9 | | |

ANOVA FOR DISSOLVED OXYGEN (DO) IN WEEKS PER TREATMENT

| Source | Df | SS | MS | F |
|---|---|---|---|---|
| Replication (weeks) (w-1) | 6 | 16.29 | 2.72 | 4.85 |
| Treatment (t-1) | 9 | 83.81 | 9.31 | 16.63 |
| Error (w-1)(t-1) | 54 | 30.31 | 0.51 | |
| Total | 69 | | | |

In algae culturing and food supplements, treatment G had the highest DO value (8.4 mg/l) and treatment D had the lowest (5.6 mg/l). There was significant difference in dissolved oxygen between treatments (F - value = 16.63).

Within treatments, Week 4 had the highest dissolved oxygen value (7.7 mg/l) and Week 2 had the lowest (6.2 mg/l). There was a significant difference in dissolved oxygen (DO) within treatments (F-value = 4.85).

### 4.2.5 Biochemical oxygen demand (BOD)

BOD is the consumption of oxygen by the organic matter contained in water. The amount of oxygen consumed in the algae culturing medium is shown in Table 4e. The BOD values varied between 1.0-2.4 mg/l with the lowest in the control water 2.4 mg/l and the highest in chicken droppings stimulated water (1.6 mg/l). There was no significant difference in BOD (F-value = 3.3).

In algae culturing, within treatments Week 1 (3.1 mg/l) had the lowest and Week 5 (1.4 mg/l) had the highest. There was no significant difference in BOD (F-value = 0.16).

In algal culturing and food supplements treatment I had the lowest value (2.5 mg/l) and treatment C had the highest (1.1 mg/l). There was no significant difference in BOD between treatments (F-value = 1.35).

4

7e: Biochemical oxygen demand (BOD) mg/l observed within 7 weeks during Algae cultivation in the different fertilized media

| TIME IN WEEKS | NPK FERT-ILIZER | CHICKEN DROPPINGS | CONTROL (UN-TREATED WATER) | $\bar{X}$ | $\Sigma X$ |
|---|---|---|---|---|---|
| 01 | 3.2 | 3.0 | 2.5 | 2.9 | 8.2 |
| 02 | 2.0 | 1.0 | 1.5 | 1.5 | 4.5 |
| 03 | 1.2 | 0.7 | 1.7 | 1.2 | 3.6 |
| 04 | 2.0 | 2.0 | 1.0 | 1.7 | 5 |
| 05 | 2.0 | 1.0 | 1.2 | 1.4 | 4.2 |
| 06 | 2.9 | 1.0 | 1.4 | 1.8 | 5.3 |
| 07 | 3.0 | 2.5 | 2.0 | 2.5 | 7.5 |
| $\bar{x}$ | 2.3 | 1.6 | 1.6 | | |
| $\Sigma X$ | 16.3 | 11.2 | 11.3 | | |

ANOVA for BOD mg/l in weeks for the different fertilized media

| | Df | SS | MS | F |
|---|---|---|---|---|
| Replication week | 6 | 2.43 | 0.405 | 1.9 |
| Treatment | 2 | 6.9 | 3.45 | 16.4 |
| Error | 12 | 2.5 | 0.21 | |
| Total | 20 | | | |

TABLE 5e: BIOCHEMICAL OXYGEN DEMAND (BOD) IN WEEKS PER TREATMENT (mg/l)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | $\bar{X}$ | $\Sigma X$ |
|---|---|---|---|---|---|---|---|---|---|
| A | 4.2 | 0.9 | 1.4 | 0.6 | 3.1 | 2.0 | 0.5 | 1.8 | 12.7 |
| B | 3.6 | 0.3 | 1.1 | 1.6 | 1.8 | 0.7 | - | 1.3 | 9.1 |
| C | 3.5 | 0.7 | 1.4 | 0.5 | 0.7 | 0.5 | 0.1 | 1.1 | 7.4 |
| D | 4.0 | 0.3 | 1.3 | 1.7 | 0.4 | 0.7 | - | 1.2 | 8.4 |
| E | 1.2 | 0.8 | 1.4 | 2.0 | 1.6 | 3.5 | - | 1.6 | 11.5 |
| F | 5.3 | 1.1 | 3.5 | 1.9 | 2.0 | 2.5 | 0.9 | 2.5 | 17.2 |
| G | 5.3 | 1.4 | 1.4 | 1.3 | 1.4 | 1.5 | 0.5 | 1.8 | 12.8 |
| H | 2.4 | 1.1 | 0.6 | 2.4 | 0.7 | 2.1 | 0.6 | 1.4 | 9.9 |
| I | 6 | 1.0 | 2.4 | 3.0 | 1.5 | 2.8 | - | 2.2 | 16.7 |
| J | 1 | 5.9 | 1.8 | 3.7 | 0.4 | 0.7 | 0.8 | 2.1 | 14.3 |
| $\bar{X}$ | 3.7 | 1.3 | 1.6 | 1.9 | 1.4 | 1.7 | 0.4 | | |
| $\Sigma X$ | 36.5 | 13.5 | 16.3 | 18.7 | 13.6 | 17 | 4.4 | | |

ANOVA FOR BOD IN WEEKS PER TREATMENT

| Source | Df | SS | MS | F |
|---|---|---|---|---|
| Replication (w-1) | 6 | 57.22 | 9.5 | 7.88 |
| Treatment (t-1) | 9 | 14.68 | 1.63 | 1.35 |
| Error (w-1)(t-1) | 54 | 65.09 | 1.21 | |
| Total | 69 | | | |

Within the treatments Week 1 had the lowest BOD value (3.7 mg/l) while Week 7 had the highest (0.4 mg/l). There was a significant difference in BOD within treatment (F-value = 7.88) (Table 8e).

### 4.2.6 Nitrate-nitrogen ($NO_3$-N)

Tables 7f and 8f show the different concentrations of nitrate-nitrogen ($NO_3$-N) between and within the difference treatments.

In algae culture medium, NPK stimulated water had the highest $NO_3$-N concentration (3.6 mg/l) while the lowest (2.4 mg/l) was observed in the control. There was significant difference in $NO_3$-N in algae culture medium (F-value = 23.4).

Within treatments, Week 7 had the highest (4.7 mg/l) and Week 1 had the lowest (0.09 mg/l).

In algae culture medium and food supplements, treatment I had the highest $NO_3$-N value (9.3 mg/l) and treatment J had the lowest (2.5 mg/l). There was significant difference in the concentration of nitrate-nitrogen between the different treatments (F-value = 18.13).

Within treatments, Week 2 had the highest $NO_{3p}$-N value (5.1 mg/l) and Week 1 had the lowest. There was significant difference in $NO_3$-N concentration within treatments (F-value = 24.93).

4
7f: Nitrate-nitrogen concentration ($NO_3$-N) mg/l observed within 7 weeks during Algae cultivation in the different fertilized media

| TIME IN WEEKS | NPK FERT-ILIZER | CHICKEN DROPPINGS | CONTROL (UN-TREATED WATER) | $\bar{X}$ | $\Sigma X$ |
|---|---|---|---|---|---|
| 01 | 0.03 | 0.03 | 0.03 | 0.03 | 0.09 |
| 02 | 3.5 | 2.8 | 2.6 | 2.97 | 8.9 |
| 03 | 3.4 | 4.2 | 3.4 | 3.7 | 11 |
| 04 | 1.1 | 5.6 | 2.1 | 2.9 | 8.8 |
| 05 | 2.4 | 2.7 | 1.6 | 2.2 | 6.7 |
| 06 | 4.6 | 4.0 | 3.4 | 4.0 | 12 |
| 07 | 4.2 | 5.8 | 4.0 | 4.7 | 14 |
| $\bar{X}$ | 2.7 | 3.59 | 2.4 | | |
| $\Sigma X$ | 19.23 | 25.13 | 17.13 | | |

ANOVA for $NO_3$-N mg/l in weeks for the different fertilized media

| | Df | SS | MS | F |
|---|---|---|---|---|
| Replication | 6 | 4.96 | 0.82 | 0.95 |
| Treatment | 2 | 40.8 | 20.4 | 23.4 |
| Error | 12 | 10.39 | 0.87 | |
| Total | 20 | | | |

TABLE 8f: NITRATE-NITROGEN ($NO_3$-N) IN WEEKS PER TREATMENT WITHIN SEVEN SEEKS (mg/l)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | $\bar{X}$ | $\Sigma X$ |
|---|---|---|---|---|---|---|---|---|---|
| A | 0.01 | 2.8 | 4.0 | 5.6 | 2.8 | 4.8 | 5.8 | 3.7 | 25.8 |
| B | 0.01 | 2.2 | 2.2 | 3.4 | 2.8 | 5.8 | 6.2 | 3.2 | 22.6 |
| C | 0.001 | 3.4 | 1.7 | 7.3 | 2.2 | 4.9 | 5.2 | 3.5 | 24.7 |
| D | 0.001 | 3.3 | 2.0 | 2.2 | 1.6 | 3.6 | 4.8 | 2.5 | 17.5 |
| E | 0.002 | 3.4 | 3.4 | 1.1 | 2.2 | 4.2 | 4.8 | 2.7 | 19.1 |
| F | 0.00 | 8.9 | 3.4 | 1.1 | 1.7 | 4.4 | 4.7 | 3.7 | 25.9 |
| G | 0.001 | 4.5 | 5.0 | 3.9 | 1.7 | 4.9 | 5.7 | 3.7 | 25.7 |
| H | 0.00 | 5.3 | 5.6 | 2.2 | 1.7 | 5.9 | 7.2 | 3.9 | 27.9 |
| I | 0.00 | 14.6 | 16.2 | 6.6 | 12.2 | 7.2 | 8.0 | 9.3 | 64.8 |
| J | 0.003 | 2.6 | 3.4 | 2.2 | 1.7 | 3.4 | 4.5 | 2.5 | 17.8 |
| $\bar{X}$ | 0.003 | 5.1 | 4.69 | 3.56 | 3.06 | 4.9 | 5.7 | | |
| $\Sigma X$ | 0.03 | 51.0 | 46.9 | 35.6 | 30.6 | 49.1 | 56.9 | | |

ANOVA FOR NITRATE-NITROGEN ($NO_3$-N) IN WEEK PER TREATMENT

| Source | Df | SS | MS | F |
|---|---|---|---|---|
| Replications (w-1) | 6 | 222.9 | 37.15 | 24.93 |
| Treatments (t-1) | 9 | 243.17 | 27.02 | 18.13 |
| Error (w-1)(t-1) | 54 | 80.24 | 1.49 | |
| Total | 69 | | | |

### 4.2.7 Phosphate-phosphorus ($PO_4$-P)

Tables 7g and 8g show the different concentrations of $PO_4$-P between and within treatments in algae culture medium and algae culture medium and food supplements.

In algae culture medium, NPK stimulated water had the highest $PO_4$-P value (6.1 mg/l) and the lowest value (4.7 mg/l) in the control. There was no significant difference between the different treatments in algae culture (F-value = 3.9).

In algae culturing and food supplements, treatment I had the highest $PO_4$-P value (6.6 mg/l) and treatment B had the lowest (4.4 mg/l). There was significant difference in $PO_4$-P concentration between treatments (F-value = 14.70).

Within treatments Week 1 had the highest (5.8 mg/l) and Week 4 had the lowest (4.6 mg/l). There was a significant difference in $PO_4$-P concentration within the different treatments (F-value = 5.63).

### 4.2.8 Potassium ($K^+$)

Tables 7h and 8h show potassium ion concentration in algae stimulated water and within and between treatments containing different food supplements.

In algae stimulated water, the highest value was observed in NPK stimulated water (56.5 mg/l) and the lowest (41.7 mg/l) in the control. There was significant difference between treatments (F-value = 50.8) during algae culturing.

4
7g: Phosphate-phosphorus ($PO_4$-P) mg/l observed within 7 weeks during Algae cultivation in the different fertilized media

| TIME IN WEEKS | NPK FERTILIZER | CHICKEN DROPPINGS | CONTROL (UNTREATED WATER) | $\bar{X}$ | $\Sigma X$ |
|---|---|---|---|---|---|
| 01 | 7.5 | 5.3 | 5.0 | 5.9 | 17.8 |
| 02 | 7.1 | 5.0 | 4.5 | 5.5 | 16.6 |
| 03 | 3.2 | 4.0 | 4.8 | 4.0 | 12.0 |
| 04 | 6.5 | 3.3 | 5.2 | 5.0 | 15.0 |
| 05 | 6.3 | 5.8 | 4.4 | 5.5 | 16.5 |
| 06 | 6.7 | 6.1 | 4.3 | 5.7 | 17.1 |
| 07 | 5.2 | 5.3 | 4.5 | 5.0 | 15 |
| $\bar{X}$ | 6.1 | 5.0 | 4.7 | | |
| $\Sigma X$ | 42.5 | 34.8 | 32.7 | | |

ANOVA for $PO_4$-P mg/l in weeks for the different fertilized media

| | Df | SS | MS | F |
|---|---|---|---|---|
| Replication | 6 | 7.6 | 1.3 | 1.3 |
| Treatments | 2 | 7.5 | 3.8 | 3.9 |
| Error | 12 | 11.8 | 0.98 | |
| Total | 20 | | | |

TABLE 8g: PHOSPHATE-PHOSPHORUS IN WEEK PER TREATMENT (mg/l)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | $\bar{X}$ | $\Sigma X$ |
|---|---|---|---|---|---|---|---|---|---|
| A | 5.3 | 5.0 | 4.6 | 3.3 | 5.8 | 6.0 | 5.3 | 5.0 | 35.3 |
| B | 5.5 | 3.5 | 4.1 | 3.2 | 5.2 | 5.5 | 3.9 | 4.4 | 30.9 |
| C | 5.5 | 4.6 | 4.8 | 4.2 | 5.0 | 5.1 | 4.9 | 4.9 | 34.1 |
| D | 4.6 | 4.2 | 4.1 | 4.3 | 4.0 | 4.3 | 6.0 | 4.5 | 31.5 |
| E | 7.5 | 7.1 | 7.2 | 6.5 | 6.7 | 6.8 | 5.2 | 6.7 | 47 |
| F | 7.5 | 6.9 | 7.0 | 7.0 | 7.5 | 7.5 | 6.0 | 7.0 | 49.2 |
| G | 4.2 | 4.0 | 4.2 | 4.0 | 6.2 | 6.2 | 5.9 | 4.9 | 34.7 |
| H | 4.5 | 4.2 | 4.1 | 4.3 | 4.5 | 4.6 | 4.0 | 4.3 | 30.2 |
| I | 8.6 | 7.5 | 6.9 | 5.3 | 6.1 | 6.2 | 5.6 | 6.6 | 46.2 |
| J | 5.0 | 4.3 | 5.2 | 4.1 | 4.5 | 4.6 | 4.1 | 4.5 | 31.8 |
| $\bar{X}$ | 5.8 | 5.1 | 4.8 | 4.6 | 5.6 | 5.7 | 5.1 | | |
| $\Sigma X$ | 58.2 | 51.3 | 52.2 | 46.2 | 55.3 | 56.8 | 50.9 | | |

ANOVA OF PHOSPHATE-PHOSPHORUS IN WEEKS PER TREATMENT

| Source | Df | SS | MS | F |
|---|---|---|---|---|
| Replications (w-1) | 6 | 10.14 | 1.69 | 5.63 |
| Treatments (t-1) | 9 | 70.14 | 7.79 | 14.70 |
| Error (w-1)(t-1) | 54 | 28.47 | 0.53 | |
| Total | 69 | | | |

4
7h: Potassium Ion ($K^+$) mg/l observed within 7 weeks during Algae cultivation in the different fertilized media

| TIME IN WEEKS | NPK FERT-ILIZER | CHICKEN DROPPINGS | CONTROL (UN-TREATED WATER) | $\bar{X}$ | $\Sigma X$ |
|---|---|---|---|---|---|
| 01 | 6.1 | 6.5 | 6.1 | 6.25 | 18.7 |
| 02 | 19.0 | 12.0 | 18.2 | 16.4 | 49.2 |
| 03 | 37.1 | 38.1 | 36.1 | 27.1 | 111.3 |
| 04 | 60.8 | 60.0 | 61.2 | 60.7 | 182.0 |
| 05 | 81.0 | 73.0 | 59.0 | 71.0 | 213.0 |
| 06 | 91.2 | 100.0 | 59.3 | 83.5 | 250.5 |
| 07 | 100.1 | 56.2 | 52.6 | 69.6 | 208.9 |
| $\bar{X}$ | 56.5 | 49.2 | 41.7 | | |
| $\Sigma X$ | 395.3 | 345.8 | 292.2 | | |

ANOVA for $K^+$ mg/l in weeks for the different fertilized media

| | Df | SS | MS | F |
|---|---|---|---|---|
| Replication | 6 | 730.1 | 121.7 | 0.78 |
| Treatments | 2 | 15807.35 | 7903.7 | 50.8 |
| Error | 12 | 1866.1 | 155.5 | |
| Total | 20 | | | |

TABLE 8h: POTASSIUM IN WEEKS PER TREATMENT (mg/l)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | $\bar{X}$ | $\Sigma X$ |
|---|---|---|---|---|---|---|---|---|---|
| A | 6.5 | 13.0 | 38.1 | 63.0 | 74 | 108 | 59.4 | 51.7 | 362.0 |
| B | 6.7 | 13.5 | 39.0 | 64.0 | 69 | 54 | 54.0 | 42.9 | 300.2 |
| C | 6.2 | 12.9 | 36.1 | 62.8 | 54 | 48.6 | 64.8 | 49.7 | 285.4 |
| D | 6.0 | 13.5 | 36.0 | 63.2 | 53 | 43.2 | 54.0 | 38.4 | 268.9 |
| E | 6.3 | 19.1 | 36.6 | 64.8 | 81 | 91.8 | 102.6 | 57.5 | 402.2 |
| F | 6.2 | 18.4 | 37.1 | 62.4 | 7.9 | 81.0 | 86.4 | 52.9 | 370.5 |
| G | 6.0 | 24.0 | 39.2 | 62.1 | 63 | 59.4 | 124.2 | 53.8 | 376.9 |
| H | 6.3 | 20.1 | 29.3 | 62.1 | 61 | 43.2 | 64.8 | 32.4 | 280.8 |
| I | 6.5 | 14.4 | 39.2 | 59.4 | 67 | 97.2 | 91.8 | 53.6 | 375.5 |
| J | 6.1 | 18.9 | 37.2 | 62.1 | 59 | 59.4 | 57.6 | 42.9 | 300.4 |
| $\bar{X}$ | 6.3 | 16.8 | 36.8 | 62.5 | 66 | 68.6 | 75.96 | | |
| $\Sigma X$ | 62.8 | 167.6 | 367.8 | 624.9 | 660 | 685.8 | 759.6 | | |

ANOVA FOR POTASSIUM IN WEEKS PER TREATMENT

| Source | Df | SS | MS | F |
|---|---|---|---|---|
| Replication (w-1) | 6 | 45787.5 | 7631.3 | 46.50 |
| Treatment (t-1) | 9 | 2601.5 | 289.1 | 1.76 |
| Error (w-1)(t-1) | 54 | 8863.6 | 164.1 | |
| Total | 69 | | | |

Within treatments, Week 6 had the highest (83.5 mg/l) and Week 2 had the lowest (16.4). There was no significant difference within treatments (F-value = 0.8) during algae culturing.

In algae stimulated water and food supplements, treatment E had the highest potassium ion concentration (53.8 mg/l) and treatment H had the lowest (32.4 mg/l). There was no significant difference in potassium ion concentration between treatments (F-value = 1.76).

Within treatments, Week 7 had the highest potassium ion concentration and Week 1 had the lowest. There was significant difference in $K^+$ concentration within treatments (F-value = 46.5).

## 4.3 Growth Rate of Oreochromis niloticus During the Experimental Period

### 4.3.1 Standard length

Fig. 6 shows both the mean standard length gain and mean weight gain. In treatment B, the highest standard length (0.53 cm) was gained and treatments D had the lowest (0.26 cm) (Table 9a). There were no significant differences in standard length gain of the fish between the treatments (F-value = 1).

The highest standard length gain (0.89 cm) was obtained in the seventh week and the lowest (0.15 cm) was in the sixth

TABLE 9: MEAN STANDARD LENGTH OF FISH GAINED PER TREATMENT WITHIN SEVEN WEEKS ($cm^3$)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | $\bar{X}$ | $\Sigma X$ |
|---|---|---|---|---|---|---|---|---|---|
| A | 0.91 | 0.87 | 0.30 | 0.39 | 0.00 | 0.04 | 1.16 | 0.52 | 3.67 |
| B | 1.45 | 0.03 | 0.32 | 0.47 | 0.35 | 0.00 | 1.11 | 0.53 | 3.73 |
| C | 0.9 | 0.06 | 0.28 | 0.19 | 0.23 | 0.01 | 0.84 | 0.39 | 2.51 |
| D | 0.32 | 0.12 | 0.03 | 0.42 | 0.16 | 0.17 | 0.61 | 0.26 | 1.83 |
| E | 0.54 | 0.77 | 0.13 | 0.02 | 0.3 | 0.15 | 0.96 | 0.41 | 2.87 |
| F | 0.24 | 0.27 | 0.12 | 0.07 | 0.47 | 0.30 | 0.73 | 0.31 | 2.2 |
| G | 0.27 | 0.46 | 0.39 | 0.24 | 0.35 | 0.34 | 0.97 | 0.43 | 3.02 |
| H | 0.39 | 0.18 | 0.31 | 0.47 | 0.35 | 0.14 | 0.88 | 0.39 | 2.72 |
| I | 0.55 | 0.42 | 0.12 | 0.20 | 0.32 | 0.18 | 0.87 | 0.38 | 2.66 |
| J | 0.16 | 0.76 | 0.10 | 0.20 | 0.15 | 0.2 | 0.79 | 0.34 | 2.36 |
| $\bar{X}$ | 0.57 | 0.39 | 0.21 | 0.27 | 0.27 | 0.15 | 0.89 | | |
| $\Sigma X$ | 5.73 | 3.94 | 2.1 | 2.67 | 2.68 | 1.53 | 8.92 | | |

ANOVA FOR MEAN STANDARD LENGTH GAINED IN WEEKS PER TREATMENT

| Source | Df | SS | MS | F |
|---|---|---|---|---|
| Replication (w-1) | 6 | 4.0 | 0.69 | 13.8 |
| Treatment (t-1) | 9 | 0.47 | 0.05 | 1 |
| Error (w-1)(t-1) | 54 | 2.74 | 0.05 | |
| Total | 69 | | | |

TABLE 10: LEAST SIGNIFICANT DIFFERENCE (LSD) FOR STANDARD LENGTH OF OREOCHROMIS NILOTICUS WITHIN 7 WEEKS

| TREATMENTS | RANKING THE DATA | LSD |
|---|---|---|
| B | 0.53 | 0.29 |
| A | 0.52 | 0.28 |
| G | 0.43 | 0.19 |
| E | 0.41 | 0.17 |
| C | 0.39 | 0.15 |
| H | 0.39 | 0.15 |
| I | 0.38 | 0.14 |
| J | 0.34 | 0.1 |
| F | 0.31 | 0.07 |
| D | 0.21 | 0.02 |

week* There were mignifiCttflt t!i.fferences in standard Length gain by fifth within treatment nt time progreeeed (F.....value • 13.4).

From the least ©ignifleant difference (LSD) calculated as shown *in* '(able iu« it was found **that** treatmentA *B,* A,, *&f* *Ef* *Cf* H„ 1„ J and F had no Significant difference between them. Howerj, there was a significant difference between thein and treatment D.

### 4,3.2 Weight gain

Treatments G and H had the highest weight gain (0.7? g) while treatment B had the lowest (0„.l.i *g)* weight.gain (Table S *irt)*. There were no significant differences in weight gain between treatments (F.....value *• 2.47).

Within treatments„ Week 6 had the highest weight gain (0.82 g) and Week 3 had the highest (•••<). 38 g) weight loss. There were significant differences ±*n* weight gain within the different treatments (F-value •• 11.2).

Looking at the LSD treatment, H and G had no significant difference between the *iv* means but there was a mar1•ed signi.fiCantdi.fferencebetwecnthemandtreatmentsI„C,D, E> A, F„ J, and B (level of test) (Tablefed).

## 4-4 Length—Weight Relationship

A graph of corresponding standard lengths and weight yams of Oreorhr OJ&4J niloM.ru":. and a regression line was

TABLE 8: MEAN WEIGHT OF FISH GAINED PER TREATMENT WITHIN SEVEN WEEKS (gm)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | $\bar{X}$ | $\Sigma X$ |
|---|---|---|---|---|---|---|---|---|---|
| A | 0.62 | 0.1 | -0.23 | 0.32 | 0.6 | 0.3 | 0.38 | 0.31 | 2.19 |
| B | 0.25 | 0.32 | -1.6 | 0.17 | 0.30 | 1.1 | 0.68 | 0.11 | 1.22 |
| C | 0.53 | 0.56 | -0.23 | 0.11 | 0.40 | 0.34 | 0.53 | 0.40 | 2.81 |
| D | 0.19 | 1.05 | -0.49 | 0.42 | 0.44 | 0.33 | 0.72 | 0.38 | 2.66 |
| E | 0.4 | 1.02 | -0.23 | 0.36 | 0.38 | 0.33 | 0.69 | 0.36 | 2.95 |
| F | 0.43 | 0.55 | -0.64 | 0.69 | 0.22 | 0.20 | 0.54 | 0.28 | 1.99 |
| G | 0.99 | 0.65 | -0.19 | 0.11 | 0.03 | 2.39 | 1.4 | 0.77 | 5.38 |
| H | 0.42 | 0.15 | 0.62 | 0.42 | 0.64 | 1.86 | 1.3 | 0.77 | 5.41 |
| I | 0.16 | 0.57 | -0.18 | 0.43 | 0.63 | 0.75 | 0.36 | 0.47 | 2.71 |
| J | 0.26 | 0.28 | -0.71 | 0.27 | 0.56 | 0.57 | 0.74 | 0.28 | 1.97 |
| $\bar{X}$ | 0.44 | 0.53 | -0.38 | 0.33 | 0.42 | 0.82 | 0.73 | | |
| $\Sigma X$ | 4.36 | 5.26 | -3.8 | 3.3 | 4.2 | 8.2 | 7.3 | | |

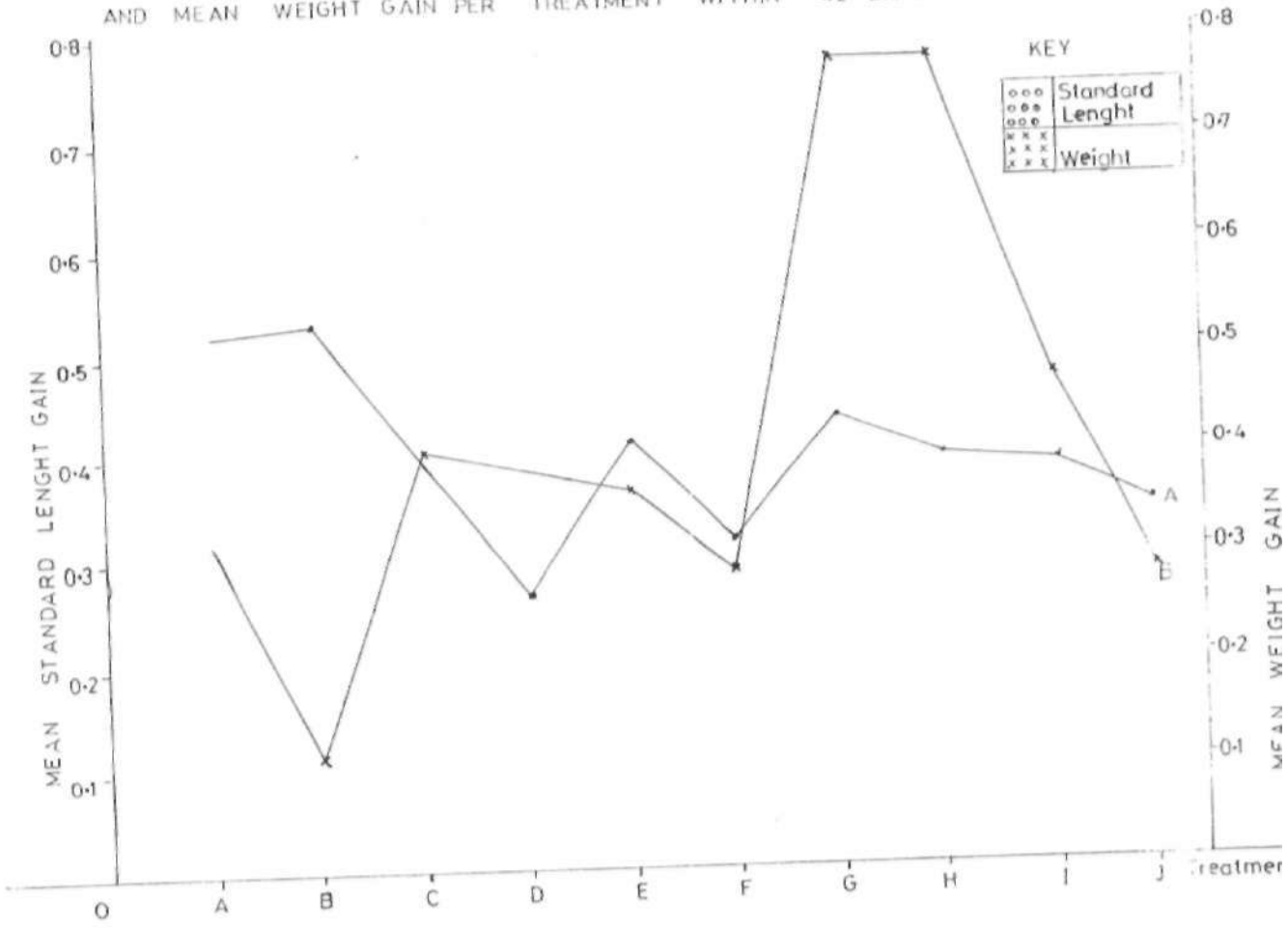
ANOVA FOR MEAN WEIGHT GAINED IN WEEKS PER TREATMENT

| Source | Df | SS | MS | F |
|---|---|---|---|---|
| Replication (w-1) | 6 | 10.07 | 1.68 | 11.2 |
| Treatment (t-1) | 9 | 3.37 | 0.37 | 2.47 |
| Error (w-1)(t-1) | 54 | 8.17 | 0.15 | |
| Total | 69 | | | |

TABLE 9: LEAST SIGNIFICANT DIFFERENCE (LSD) FOR WEIGHT GAINED OF OREOCHROMIS NILOTICUS WITHIN 7 WEEKS

| TREATMENTS | RANKING THE DATA | LSD |
|---|---|---|
| H | 0.77 | 0.36 |
| G | 0.77 | 0.36 |
| I | 0.47 | 0.06 |
| C | 0.40 | -0.1 |
| D | 0.38 | -0.03 |
| E | 0.36 | -0.05 |
| A | 0.31 | -0.1 |
| F | 0.28 | -0.13 |
| J | 0.28 | -0.13 |
| B | 0.11 | -0.30 |

FIG 6 THE MEAN STANDARD LENGHT GAIN PER TREATMENT WITHIN 7 WEEKS AND MEAN WEIGHT GAIN PER TREATMENT WITHIN 42 DAYS



drawn. There was correlation between the weight and standard length gain as shown in Figs. 6 and 7.

The regression coefficient had a negative value (-0.1348) with 0.4 as the T-ratio. The regression line is given by Y = 0.42 - 0.54 x calculated using the formula as presented in Appendix 1.

### 4.5 Condition Factor (K)

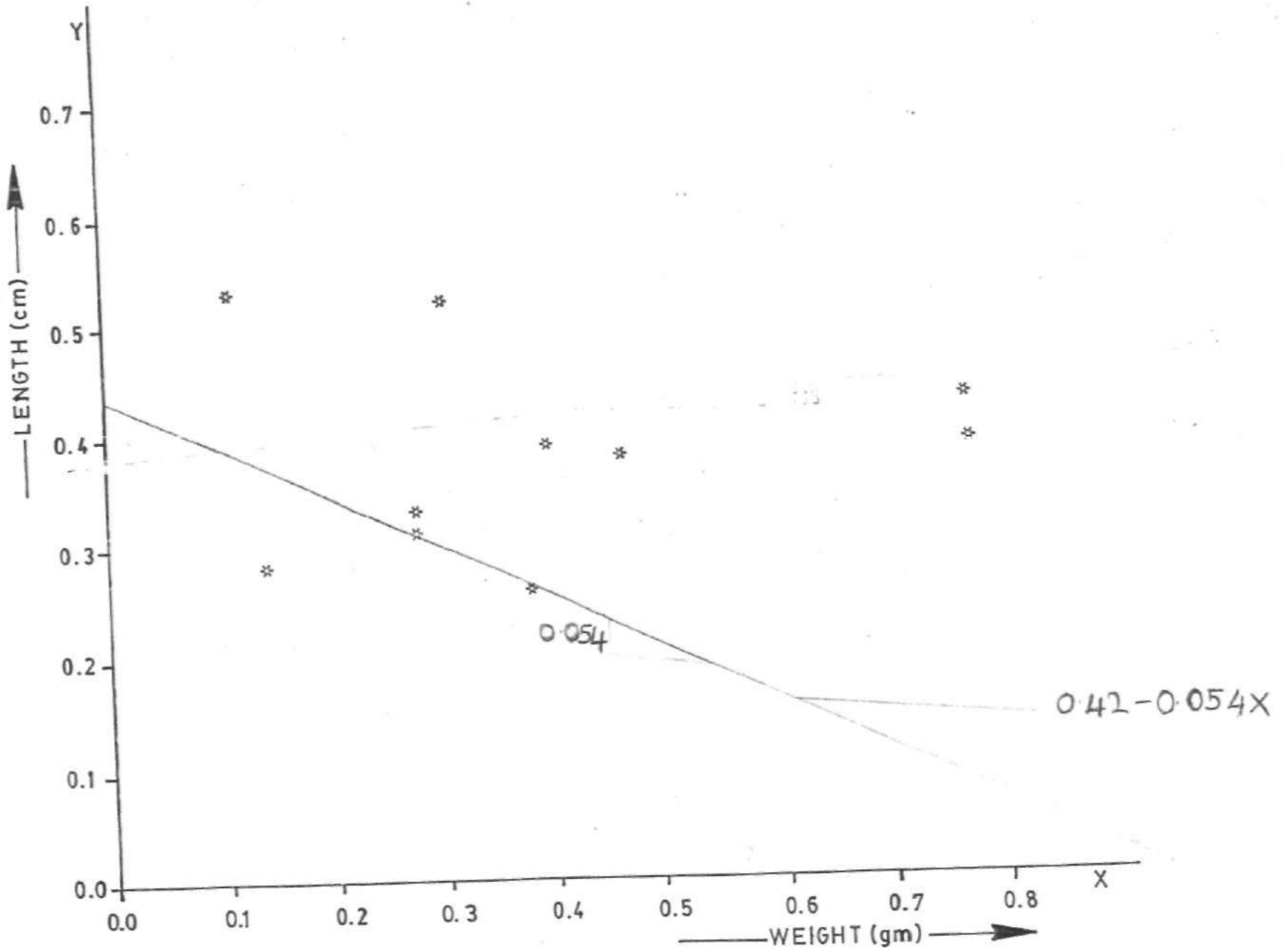
Table 10 shows the condition factor of Oreochromis niloticus for the different treatments. It was observed that the condition factors K, were high for all the treatments with the highest in treatment G (68.14) and the least in treatment B (10.09).

### 4.6 Protein Efficiency Ratio (PER)

Crude protein analysis showed that groundnut cake had 41% protein; corn bran had 9.2%, while algae in the treatment with NPK and chicken droppings had 6.9% and 7.2% protein respectively.

PER values (Table 11) were highest with treatment E had the highest value (0.52) while treatments B, C and D had the lowest (0.01).

Fig. 7: LENGTH-WEIGHT RELATIONSHIP PER TREATMENT FOR 7 WEEKS.



E 10: CONDITION FACTOR OF OREOCHROMIS NILOTICUS IN THE DIFFERENT TREATMENTS

| TREATMENT | MEAN CONDITION FACTOR |
|---|---|
| A | 28.18 |
| B | 10.09 |
| C | 35.09 |
| D | 31.40 |
| E | 31.86 |
| F | 23.73 |
| G | 68.14 |
| H | 67.14 |
| I | 10.87 |
| J | 24.14 |

TABLE 14: PROTEIN EFFICIENCY RATIO OF OREOCHROMIS NILOTICUS IN THE DIFFERENT TREATMENTS

| TREATMENT | WEIGHT GAIN | PROTEIN EFFICIENCY RATIO |
|---|---|---|
| A | 0.31 | 0.04 |
| B | 0.11 | 0.01 |
| C | 0.40 | 0.01 |
| D | 0.70 | 0.01 |
| E | 0.50 | 0.05 |
| F | 0.20 | 0.03 |
| G | 0.[illegible] | 0.0[illegible] |
| H | 0.72 | 0.0[illegible] |
| I | 0.47 | 0.01 |
| J | 0.30 | 0.07 |

**The different types of algae nb** ei /ed **in the fore and hind guts of fish collected from** NPI . **chicken dropping stimulated water and** control water - **<n in Table 16.**

**In NPI', stimulated water- it wa- observed that In tha fore—aut. CoEmarium con' um. Mici 5tis so. Cruciaema irreuular: (-unlena SO.** Pinnul i i **D. I enptiesmus dimorohus. Gloecvstis so. 1** *o* **and Trachelomonas Ivocina** wei nmd **as shown** in Plat» **1 • In the hind gut. the followina soecies** were Found: Euali n< D. **Gloecvstis so, Trachelomonas** v< Lna and **• D.**

---

In chid en droppings stimulated r, the **fore-out of the fish contained Scenedesmus Ion** IU **' hvtoconis SDp Phacus so. Cru'** i lia Lrr_paular La. Cvmb so, **Navii** *UIM* **so and Frustula so as shown** in Plate 5a. **In the hind gut. Peridinium so.** Phacus **so.** h achelomon hi[1] oidia, and **Lualena** I[1] **SD were observed as shown in Plate ⅓i**

**In NPK and chicken** dropoing **' ilized wat»r$_f$ the following algae species** were **found** in **the fore gut of the fish: Cosmarii n** Lis S D . Pij D, ! hacus ft£., **Cruciaenia irreoularia.** Eual i^ s_p. nus **dimorohus.** · **Scenedesmus lonaus.** Phvto ndpr^i **inorum.** 1 1 **Trachelomonas volvocina and - In H™** 1. **hind nut.** Euplena sp$_T$ 1 M nonas **volvocina[1]. Cruciaenia .irreoularia and Trachelomoi hisoidia were found:.**

In control water, the fore gut of the fish contained Cosmerium contractum, Microcystis sp, Euglena sp, Scenedesmus dimorphis, Phacus sp and Trachelomonas hispidia as shown in Plate 4. In the hind gut, Euglena sp, Trachelomonas hispidia and Phacus sp were observed.

4.3 Mortality Rate of Clarias gariepinus Fingerlings

Table 17 shows the percentage mortality during the observed period in the different treatments. It was found that treatment E had the highest survival rate (90%) while treatment I had the rate (50%).

'.E 16: ALGAE TAXA FOUND IN BOTH THE FORE AND HIND GUT OF FISH IN THE DIFFERENT FERTILIZED TREATMENTS

| /ISION | GENUS/SPECIES | CTRL | NPK | CD | NPK/CD |
|---|---|---|---|---|---|
| lorophyta | Cosmarium sp | | | | |
| lorphyta | Cosmarium sp | | | | |
| anophyta | Microcystis sp | | | | |
| atom | Pinnularia sp | | | | |
| lenophyta | Phacus sp | | | | |
| orophyta | Crucigenia irregularia | | | | |
| enophyta | Euglena sp | | | | |
| lenophyta | Trachelomonas volvocina | | | | |
| lorphyta | Scenedesmus dimorphus | | | | |
| lorophyta | Gloecystis sp | | | | |
| lorophyta | Sphaeoplea sp | | | | |
| lorophyta | Scenedesmus longus | | | | |
| orophyta | Phytoconis sp | | | | |
| atoms | Cymbella sp | | | | |
| lorophyta | Pandorina morum | | | | |
| atom | Frustula sp | | | | |
| atom | Navicula | | | | |
| rophyta | Peridimium sp | | | | |
| glenophyta | Trachelomonas hispidia | | | | |

RL = Control CD = Chicken droppings

PLATE I: PHOTOGRAPH OF SOME ALGAE FOUND IN THE DIFFERENT FERTILIZED TREATMENTS

1.
2. Scenedesmus Dimorphus
3. Phytoconis Sp
4. Pandorina morum
5. Oscillatoria nigra
6. Phytoconis Sp
7. Scenedesmus Quadrilus
8. Microcystis Sp
9. Cymbella Sp
10. Unidentified sp
11. Spirulina sp
12. Ulothrix sp
13. Cosmarium sp
14. Navicula sp
15. Zooplankton
16. Oscillatoria sp
17. Euglena sp
18. Unidentified zooplankton
19. Beatle
20. Peridinium sp

Plate 1

Photographs of some algae taxa
in all the treatments

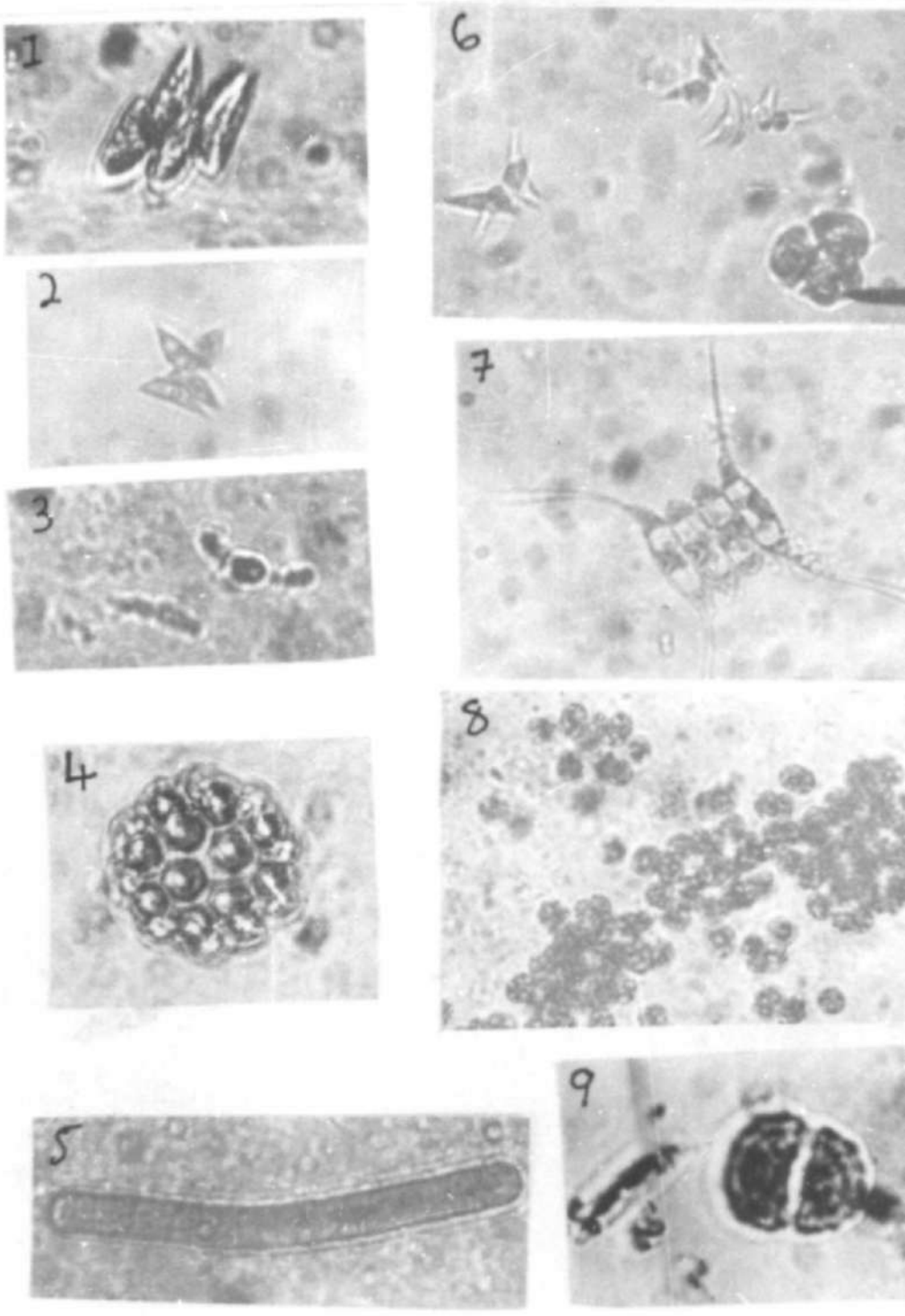
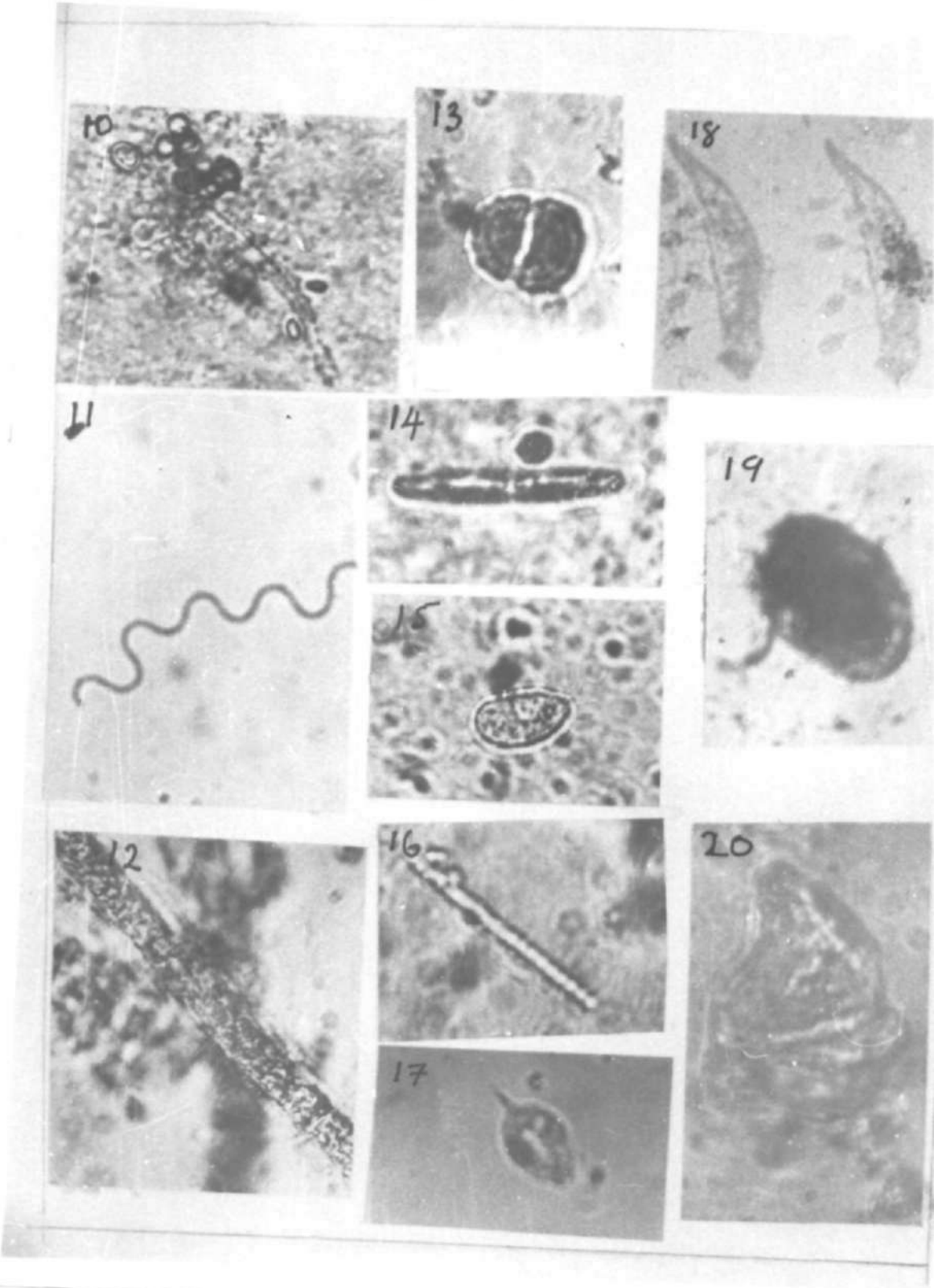


Plate 1 Cont.



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TABLE 1: MORTALITY RATE OBTAINED IN THE DIFFERENT TREATMENTS WITHIN THE EXPERIMENTED PERIOD (7 WEEKS)

| TREATMENTS | NUMBER OF FISH | PERCENTAGE MORTALITY |
|---|---|---|
| A | 20 | 80 |
| B | 20 | 65 |
| C | 20 | 70 |
| D | 20 | 75 |
| E | 20 | 90 |
| F | 20 | 70 |
| G | 20 | 75 |
| H | 20 | 80 |
| I | 20 | 50 |
| J | 20 | 70 |

# CHAPTER FIVE

## DISCUSSION

Experiments have shown that photosynthesis is accelerated when fertilizers either in organic or inorganic form are added to promote growth (Pitcarn and Hawkes, 1973; Wartsbaugh et al, 1985; Nicholas, 1986).

Chicken droppings (organic fertilizer) and NPK (inorganic fertilizer) are known to be rich in nutrients vital for algal growth. Chicken droppings are considered richer in nutrients. The feeds are formulated to provide all the growth nutrients required by chicken. It is partially digested by chicken and, therefore, is rich in both organic and inorganic compounds considered suitable as a fertilizer (Delmendo, 1980). NPK (nitrogen, phosphorus, potassium) fertilizer contains only inorganic nutrients.

In this work, it was found that the two fertilizers stimulated differently the growth of different algae taxa from the lake water. The rates of growth of the algae in the two culture media also varied.

In the control experiments (untreated lake water), the major algae taxa found were chlorophyta, euglenophyta, bacillariophyta, cyanophyta and pyrrophyta. The chlorophyta were the dominant division, with Cosmarium sp and Scenedesmus sp being co-dominant.

In NPK-stimulated water, the major algae stimulated were chlorophyta, euglenophyta, bacillariophyta and cyanophyta. In this, too, the chlorophyta dominated by scenedesmus sp were the most represented.

In chicken droppings stimulated water, chlorophyta and euglenophyta were dominant with Euglena sp and Cosmarium sp being the most represented. Phacus and Trachelomonas sp were also prominent in tanks fertilized with chicken droppings. This is in agreement with the works of Delmendo (1980).

Algae grew at different rates in the different treatments. In the untreated water (control), there was no sharp increase in algal growth during the experiment. In these tanks, the algal depended only on the nutrients found in the water.

In NPK stimulated water, algae sprouted quicker (see Table 4) with maximum density in the second week. This is thought to be due to the readily available growth nutrients (nitrogen and phosphorus) in the NPK fertilizer coinciding with the increased $NO_3$ and $PO_4$ values in Week 2. Smith (1982) stressed the special position occupied by nitrogen among all the nutrients involved in algal growth. He also said that during photosynthesis in the chloroplast, not only carbohydrate but also amino acids, protein and other substrates were being synthesised. As a result, apart from water and carbon dioxide, simple compounds of other elements, especially nitrogen, are very vital. Therefore, with the

readily available nitrogen in NPK, algal growth was boosted. This growth continued till the fourth and fifth weeks, when a decline in population was obtained. This was because the nutrients needed for growth by the algae were being exhausted.

During the first two weeks, diatoms and chlorophyta were more dominant in chicken droppings stimulated water (see Table 3) but the algae population was low. In the third and fourth weeks, maximum growth was observed. This could be attributed to mineralization of the organic matter in the droppings, thus releasing nitrogen and phosphorus (major growth nutrients). The major taxa then grew as stated above.

By the end of the experiment, chicken droppings produced greater taxa diversity than NPK stimulated water. This could be attributed to the presence of both organic and inorganic nutrients in chicken droppings. According to Delmendo (1980), chicken droppings have high organic matter (particularly, urea and uric acid) and is a richer substrate with both inorganic and organic nutrients for algae cultivation.

## 5.1 Physico-chemical Parameters

The variation in the physico-chemical parameters between treatments in this experiment is attributable to the types of fertilizers introduced (organic based or inorganic), the

types of algae stimulated into growth and growth rates of the different algae stimulated.

Chicken droppings stimulated water registered the highest temperature, pH and conductivity values. In NPK stimulated water, the pH was the lowest while temperature and conductivity was higher than the control tanks.

The increase in temperature, pH and conductivity values in chicken dropping stimulated water could be attributed to the decaying activities of the chicken droppings. This fermentation of organic matter increased the temperatures in the tanks. Also, during fermentation carbon dioxide is released resulting in a decrease in pH. However, with the removal of $CO_2$ by algae, the $p^H$ increases. The increase conductivity in chicken droppings can also be attributed to the large amount of algae growth presence. Low pH in NPK stimulated water could be attributed to low algae growth and high carbon dioxide present in the NPK stimulated water. The variations in temperature in the tanks was a response to temperal variations in ambients weather conditions.

Changes in culture medium were experienced after the addition of food supplements. While most treatments showed no significant differences between them, treatment D (chicken droppings, groundnut cake and corn, a mixture with 30% protein) showed low pH and high conductivity. The low pH was as a result of decaying organic matter and the high

conductivity resulted from mineralization of the organic matter. Treatment A (chicken dropping) which did not have any food supplements maintained a high pH as a result of high algae productivity after mineralization of the organic matter present. This treatment also had the lowest conductivity compared with other treatments with feed supplements. It is believed that this was due to absence of other sources of dissolved nutrients and the incorporations of existing nutrients into algae biomass.

Oxygen was the only dissolved gas measured. This was because of its importance in the biology of water. Its presence is necessary for animal life (Woodson and Gore, 1965), and its absence leads to anaerobic bacteria respiration in the bottom sediments which may release tied up nutrients for algae growth. Oxygen content of lake water, usually reflects the rate of photosynthetic activity and reflects algal abundance (Olaniyan, 1969).

In this research, high dissolved oxygen was observed in NPK stimulated water and the lowest in chicken droppings. This could be attributed to the decaying activities of the chicken wastes which resulted in oxygen depletion (Imerbore, 1979). This low oxygen in chicken droppings stimulated water, correspond with high BOD, which means high de-oxygenation. The increased de-oxygenation was due to an aerobic oxidation of organic matter by bacteria. NPK stimulated water registered high dissolved oxygen because there was less decaying activities. The fertilizer

stimulated algae growth resulting in high dissolved oxygen registered.

After the addition of supplementary feeds, treatment G (NPK, groundnut cake) had the highest amount of dissolved oxygen. Treatment D (chicken droppings, groundnut cake and corn bran at 30% protein level) had the lowest dissolved oxygen and biochemical oxygen demand. This increase in treatment G was attributed to high algae growth as a result of addition of organic matter (groundnut cake) which increased photosynthesis. While the decrease in treatment D is because of increasing demand for oxygen for the decaying process of the large organic matter present. This agrees with the finding of Imerbore (1979) and Obiola (1984) who observed that high organic matter decay result in high de-oxygenation by bacteria and less oxygenation by algae.

NPK had the highest nitrate-nitrogen ($NO_3$-N), phosphate-phosphorus ($PO_4$-P) and potassium ($K^+$) compared with chicken droppings and the control (untreated) water. This could be attributed to the low algal growth rates with NPK compared with chicken droppings. This low algal growth rate resulted in a reduction in the amounts of the minerals taken up by the algae.

Meanwhile, the addition of this fertilizer in the lake water gave an additional supply of these ions to the water. Comin et al (1983) observed that the peak of nitrate concentration seem to be related to import from agricultural land (organic and inorganic fertilizers) into the ponds.

With the addition of supplementary feeds, it was found that treatment I (NPK and chicken droppings) had the highest $NO_3$-N and $PO_4$-P). Treatment D had the lowest $NO_3$-N while treatment B had the lowest $PO_4$-P. The increase in $NO_3$-N and $PO_4$-P in treatment I could be attributed to additional $NO_3$ and $PO_4$ introduced by the two fertilizers combined with its relatively low algae production. The decrease in treatment D ($NO_3$-N) and treatment B ($PO_4$-P) can be attributed to high algae growth observed in the chicken dropping stimulated water, which turn to reduce these compounds. According to Drake and Heaney (1987) and Balarabe (1989), phosphorus decreases with increase in algae bloom.

For potassium ($K^+$) treatment E (NPK and lake water) had the highest and treatment H (NPK, corn bran and groundnut cake at 30% protein level) had the lowest. The increase $K^+$ in treatment E was as a result of the introduction of the ion by the NPK fertilizer and also the low algae growth rates. While the decrease in treatment H was attributed to high algae growth which was more because of the additional organic base of the food supplements, thus increasing algae growth.

## 5.2 Growth Rate of *Oreochromis niloticus* During the Observation Period

The best fish weight gained was produced from treatments G (NPK and groundnut cake) and H (NPK corn bran and groundnut cake at 30% protein level). This could be attributed to the high protein food diet added to the already maximum algae

population. Huet (1972) and Meyer et al (1973) observed that feed containing 30% protein produced good growth in Oreochromis niloticus. This is in agreement with the present findings. Low fish weight gain was obtained in treatment D (chicken droppings, groundnut cake and corn bran). In this tank, it was observed that dissolved oxygen values were low. Low dissolved oxygen values will produce oxygen stress on the fish leading to reduced metabolic activities and, therefore, low weight gain.

In the third week, the fish lost some weight and this was at a period when there was dissolved oxygen depression. It is probable that this dissolved oxygen depression created a stress on the fish, as a result of the stress created by oxygen depletion, the fish probably stopped consuming the supplied feed. As a result, sustainance of metabolic activities was maintained by food reserves in the body, thus leading to weight loss.

### 5.2.1 Standard length

The increase in standard length gain in treatment B (chicken droppings and corn bran) and Week 7 could be attributed to algal growth. The increased algae growth in these tanks could be attributed to additional carbon content from the chicken droppings and corn bran added. This increased algal growth, contributed to increased food availability and increase in dissolved oxygen, produced by algae. The decrease in the mean standard length gained in

treatment D (chicken droppings, groundnut cake and corn bran at 30% protein level) could be attributed to the quantity of food fed to the fish. Secondly, not all the food fed to the fish were eaten by them. The unconsumed food decayed, resulting to oxygen depletion. If the amount of decayed material is high, oxygen depletion will be very high resulting in fish stress and finally a decrease in weight. However, both minimum weight and length gain were from this tank which also had the least dissolved oxygen. It would appear that the greatest suppressant of growth as shown by both growth indices (length and weight gain) is dissolved oxygen concentration.

There was no correlation between standard length and weight gained. This could be due to the fact that standard length is not directly related to the quality and quantity of food fed. But with weight, the quantity and quality of food fed had a change in the fish. Changes in the physico-chemical parameters might also affect weight. Huet (1972) and Taivo and Murray (1982) reported that a change in the physico-chemical parameters affect the growth rate of fish. The condition factors (K) in treatment B was the highest; meaning the relative well being of fish in this tanks was good (with the highest weight gained).

## 5.3 Protein Efficiency Ratio (PER)

The high PER value in treatment C (NPK stimulated algae) and low values in treatments D and C does not coincide with the amount of protein fed to the fish. However, the PER found in B is a reflection of the low protein food (corn bran 9.8% protein and algae present 7.2%) fed to the fish, than the 41% protein found in groundnut cake.

## 5.4 Feeding Habit/Food Selection

Trachelomonas sp, Euglena sp and Microcystis sp were found in both fore and hind gut collected from the different treatments. This meant that they were not selected as food by the fish. According to Ayaa (personal communication), Trachelomonas sp are resistant to heat treatment probably because of their theca. This probably made them unselectable by the enzymes of the fish as their food.

## 5.5 Survival Rates

More fish were lost in the waters treated with chicken droppings. This could have been due to low DO resulting from decomposition of organic matter which tend to reduce the amount of oxygen supply to the fish. The accumulation of

supplementary feed in the tanks could have led to oxidative decomposition of the organic matter by bacteria leading to oxygen depletion and hence fish kills. Ovie and Adeniji (1990) reported that water containing chicken droppings will cause oxygen depletion if not properly monitored.

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# CHAPTER SIX

## CONCLUSION AND RECOMMENDATION

In algae cultivation, using chicken droppings (organic based) and NPK (inorganic based) as fish food, the chicken droppings provided more alage growth than the inorganic fertilizer (NPK) and also more algae taxa. Therefore, to provide fish with their natural food supply, chicken droppings is a better fertilizer than inorganic (NPK) fertilizer. The medium, however, must be closely monitored for oxygen depletion because the decay of organic matter leads to increased BOD and $O_2$ depletion. If rapid growth of fish is required, supplementary feeding will be necessary. NPK (inorganic fertilizer) in this case will be a preferred source of algae growth nutrients. For instance, in this experiment, when NPK fertilizer was combined with groundnut cake and corn bran at 30% protein level, it gave better fish growth compared to chicken droppings with groundnut cake and corn bran at 30% protein level. The chicken droppings stimulated water showed oxygen depletion and high conductivity resulting in stress and high mortality in the fish.

Trachelomonas sp and Euglena sp were found to be poorly selected in the gut of Oreochromis niloticus. This algae were more pronounced in chicken droppings. If these become the major algae in fish culture, it is likely that the fish may not grow well.

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## PLATES

### EUGLENA MINUTA  PLATE 2 FIG. 1  PLATE 3 FIG. 17

L = 35

B = 12.3

Pear shaped cell with one terminal flagellum. Cell body capable of changing shape, Eye spot present. Conspicuous nucleus especially while changing direction.

### PANDORNIA MORUM  PLATE 2 FIG 2  PLATE 4 FIG 12

L = 68.0

B = 51.0

D = 2 - 27 - 4.53

Eight cells with colony orate shape envelope in a Gelatinous matrix.

Cell members range between 24-50 applose. They are free floating flagellated cells.

### MICROCYSTIS AERUGINOSA  PLATE 2 FIG 3, PLATE 4 FIG 4

L = 70

W = 20

The cells are usually numerous. Groups in 3 or 4 scattered in a gelatinous envelope.

COSMARIUM SP. PLATE 2 FIG 4, PLATE 3 FIG 1

L = 24.5

W = 17.5

It has an indented body wall which turns to divide the cell into two equal parts. The walls are round at each end.

MERIMOPEDIA TENNISSIMA PLATE 2 FIG 5

L = 18

D of cells = 2

A plate-like colony of globose cells compactly arranged in rows.

It has a homogenous nucilage; colony quadragular.

The cells are grouped in 4 and they are 32 in number.

ANABAENA SPIROIDES PLATE 2 FIG 6, PLATE 4 FIG 7

L = 14

W = 7

Terminal cells are rounded about 14 long and 7 wide in the filament. It contained limited granules.

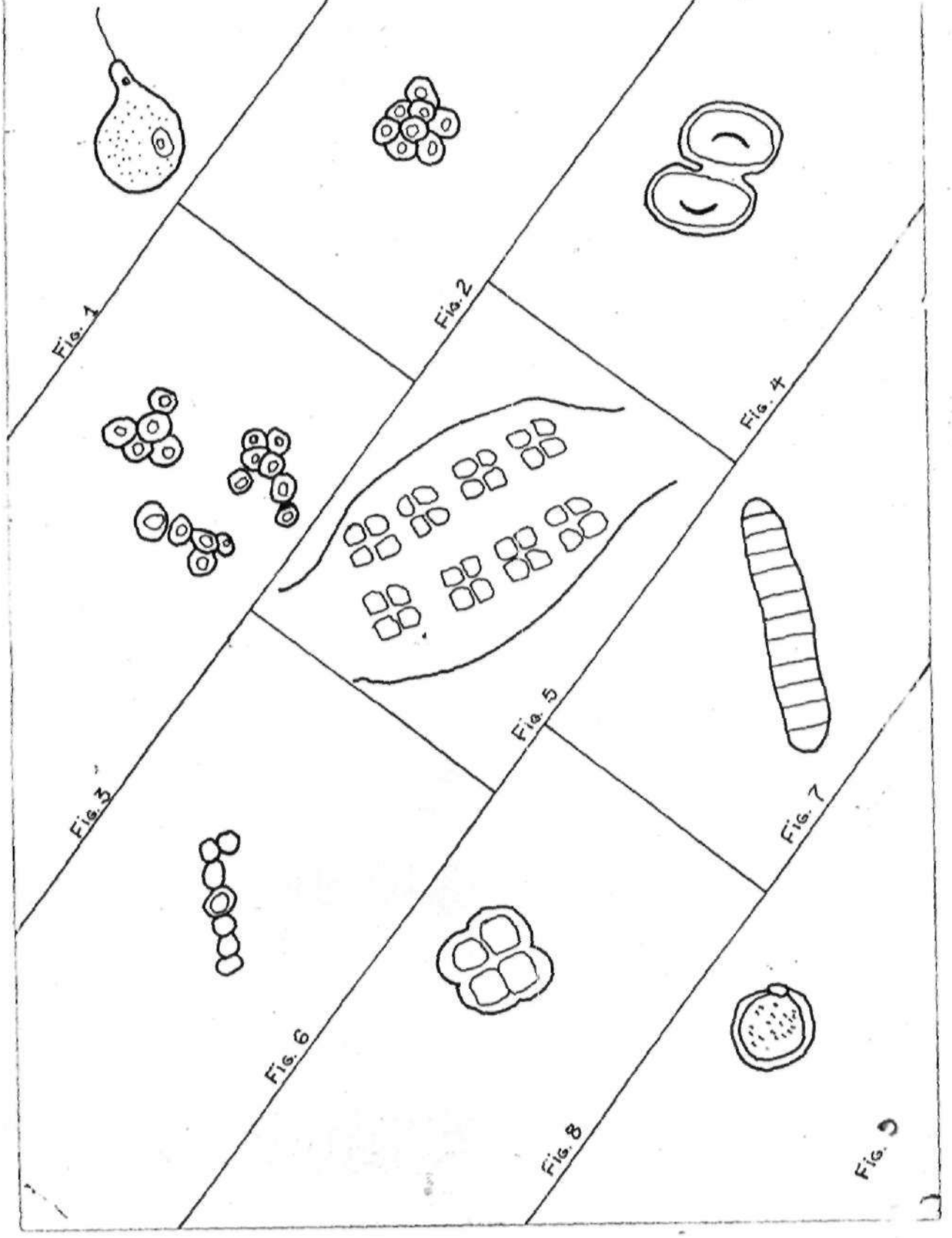
OSCILLATORIA NIGRA PLATE 2 FIG 7, PLATE 4 FIG 1

L = 6.81

B = 2.29

PLATE 2

# Algae Taxa Found in Lake water.



It is a filamentous algae and has a slightly tapering apex and curved.

CRUCIGENIA IRREGULARIS PLATE 1 FIG 8, PLATE 3 FIG 7, PL 4 FIG 3

L = 24.5

W = 12.3

D = 6.8

Is in tetrad from the body wall divided into four equal parts.

PLATE 1 FIG 9, PLATE 3 FIG 6, PLATE 4 FIG 13

TRACHELOMONAS VOLVOCINA

(Var [Drezepolki, compressa 1925, p 224])
(In Procott, 1964)

Cell chromatophore is quite distinct in clumps with a projection at the based so that the cell is more distinct.

PLATE 1 FIG 10

TRACHELOMONAS SP

L = 27.5

W = 16.45

It has a flagellum aperture; outer wall smooth.

PLATE 1 FIG 11

UNIDENTIFIED

L = 24

W = 2

PLATE 2 FIG 12

UNIDENTIFIED

L = 24.5

W = 14

It has spines surrounding the cell wall.

PLATE 2 FIG 13, PLATE 4 FIG 16

PHACUS SP

L = 31.5

W = 24.5

It has a curve tail. With a smooth densed chromatophore.

PLATE 2 FIG 14, PLATE 4 FIG 15

PHACUS SP

L = 65.88

W = 40.80

It has a curve tail with a smooth densed chromatophore. It has two nuclei; present almost at the centre of the cell.

PLATE 2 FIG 15, PLATE 3 FIG 4

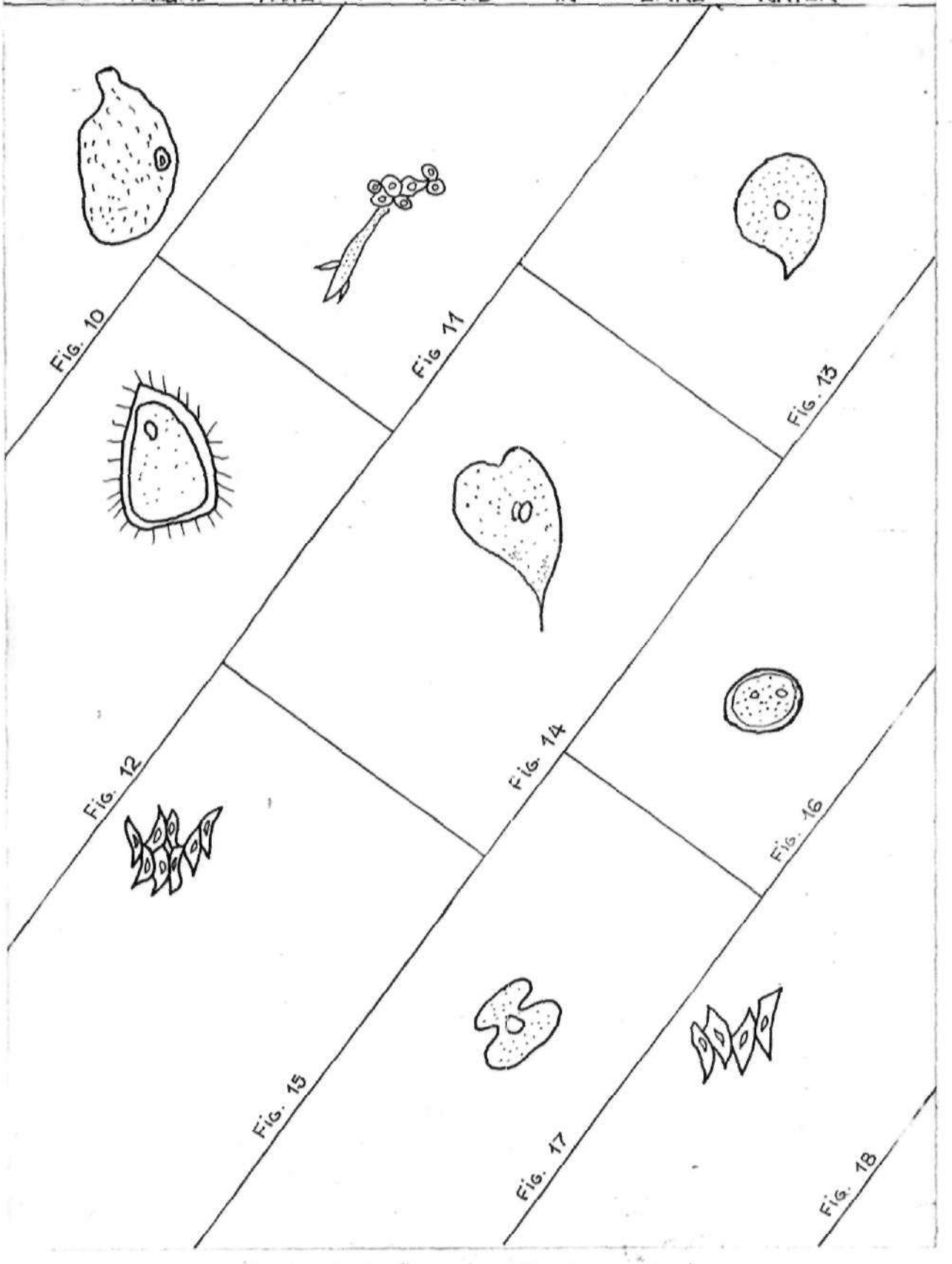
SCENEDESMUS OBLIQUUS

L = 15

W = 6.1

PLATE 2

ALGAE TAXA FOUND IN LAKE WATER



It contains eight cells in a single flat series. It does not contain spines.

PLATE 2 FIG 16

HAEMATOCOCCUS LACUSTRIS

L = 14

W = 7

It is ovoid in shape. Chloroplast is apparently cup-shaped.

PLATE 2 FIG 17

TETRAEDON MINIMUM

D = 17.5

The cells are smaller; tetragonal in shape. Their angles are rounded and without spines. Contains chromatophore.

PLATE 2 FIG 18, PLATE 4 FIG 22

SCENEDESUMS DIMORPHUS

L = 24.5

W = 21

Diameter of outer cells = 9

It has a colony of four pusiform cells arranged in a single series. The inner cells have straight sharp apices.

PLATE 2 FIG 19

CLUSTERIUM SP

L = 87.5

D = 35

The chloroplast is a lobed plate extending almost the entire length of the cell.s

The cells are long with needle-like tapering to a sharp point at both ends.

PLATE 2 FIG 20

SCENEDESMUS LONGUS

L = 28

D 10.5

It is a colony composed of eight cylinder cells arrayed in a single series. The outer cells contain long, curved spines at each pole. The cells contain one long spines at one pool only.

PLATE 2 FIG 21, PLATE 3 FIG 11

PHACUS SP

L = 49

W = 28

PLATE 2 FIG 22, PLATE 3 FIG 5

GLOEOCYSTIS PLANCTONICA

L = 20

W = 14

Group of four cells spherically united in a free-floating gelatinous colonies.

PLATE 2 FIG 23, PLATE 3 FIG 3

PHYTOCONIS SP

L = 17.5

W 14

PLATE 2 FIG 24, PLATE 3 FIG 9

EUGLENA SP

L = 17.5

B = 20.43

PLATE 2 FIG 25, PLATE 4 FIG 8

PERIDINIUM CINCTUM

L = 18

W = 7.35

PLATE 2 FIG 26, PLATE 3 FIG 24

FURSTULIA SP

L = 47

W = 14

PLATE 2 FIG 27

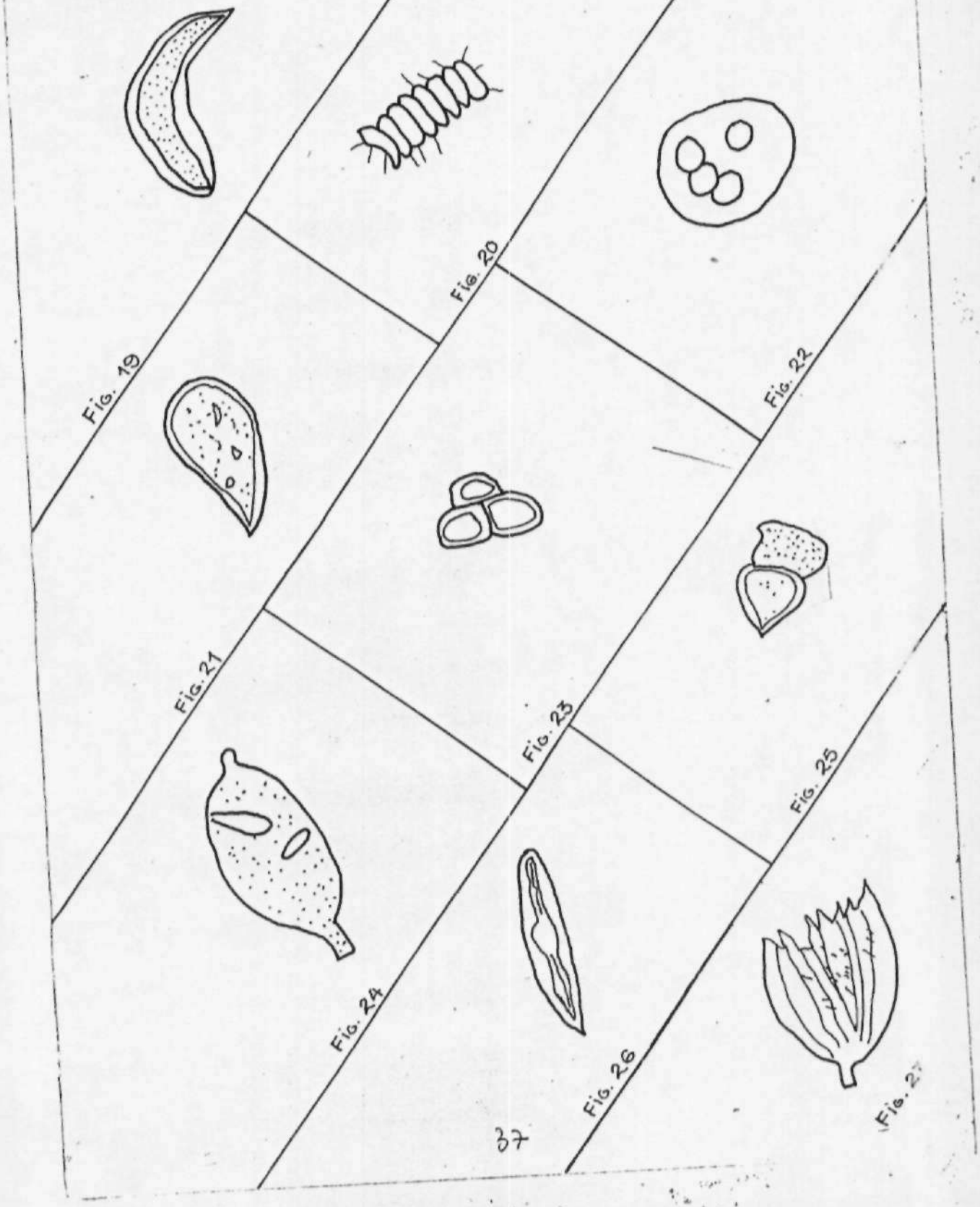
UNIDENTIFIED

L = 168

D = 73.5

PLATE 2

ALGAE TAXA FOUND IN LAKE WATER.




37

PLATE 1 FIG 28, PLATE 4 FIG 10

ULOTHRIX SP

L = 17.5

W = 14

PLATE 1 FIG 29, PLATE 3 FIG 10

COELASTRUM MICROPORUM

L = 20

B = 17.5

Coenobium spherical cells. Each cell adjoined to neighbouring cells. They are about 32 cells in number.

PLATE 1 FIG 30, PLATE 3 FIG 16

SPHAEROPLEA SP

L = 70

D = 7

Free floating with long cylindrical multincleate units. It has thickened cross walls. Chloroplasts numerous orate.

PLATE 1 FIG 31, PLATE 4 FIG 19

SCENEDESMUS QUADRILUS (Var longispins M. Smith)

L = 26.25

L of spine = 14

D of cells = 14

Cell contains spines at the external cells.

PLATE 2 FIG 32

COSMARIUM CONTRADUM

L = 14

W = 10.5

D = 7

It has an indented body wall which tends to divide the cell into two equal parts. The chromatophore is scattered. The cells are round at each end.

PLATE 2 FIG 33

NARICULA SP

L = 28

D = 10

PLATE 2 FIG 34, PLATE 4 FIG 23

NAVICULA SP

L = 28

D = 10.5

PLATE 2 FIG 35, PLATE 3 FIG 8, PLATE 4 LFIG 11

PHACUS SP

L = 17.5

W = 10.5

It has a curve apex and a densed chromatophore present.

PLATE 2

ALGAE TAXA FOUND IN THE LAKE WATER.

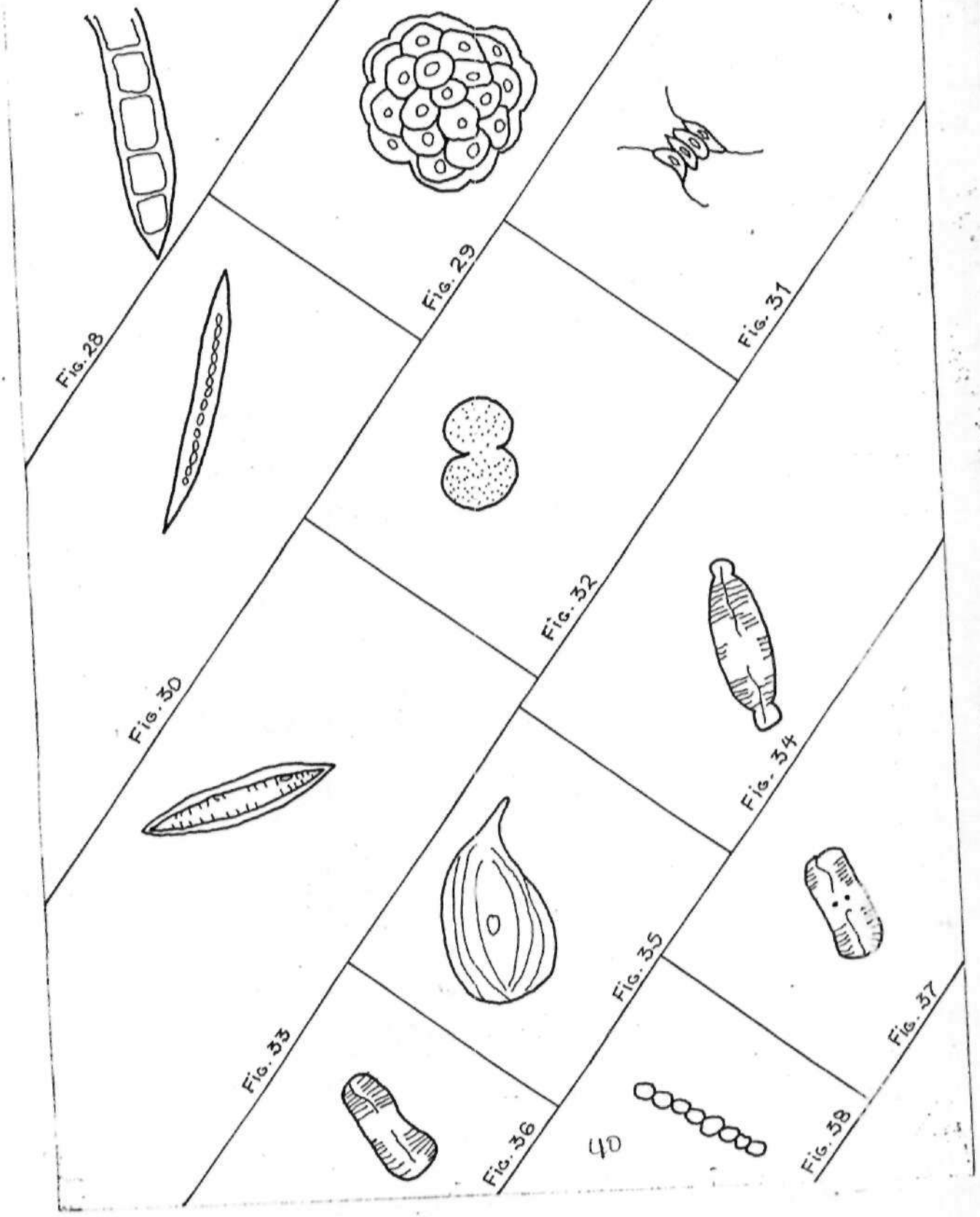


PLATE 2 FIG 36, PLATE 3 FIG 15

PINNULARIA SP

L = 35

W = 10.5

It contains two pyremoid at the centre of the cell.

PLATE 2 FIG 38

OEDOGONIUM SP

L = 31.5

W = 3.5

PLATE 3 FIG 2

SCENEDESMUS SP

L = 20

W = 14

Two fusiform subacute cells. Medium cells slightly curved.

PLATE 3 FIG 12

COSMARIUM SP

L = 14

W = 10.5

It has an idented body wall which tends to divide the cell into two equal parts. It has a double cell wall.

PLATE 3

ALGAE TAXA STIMULATED by N. P. K.

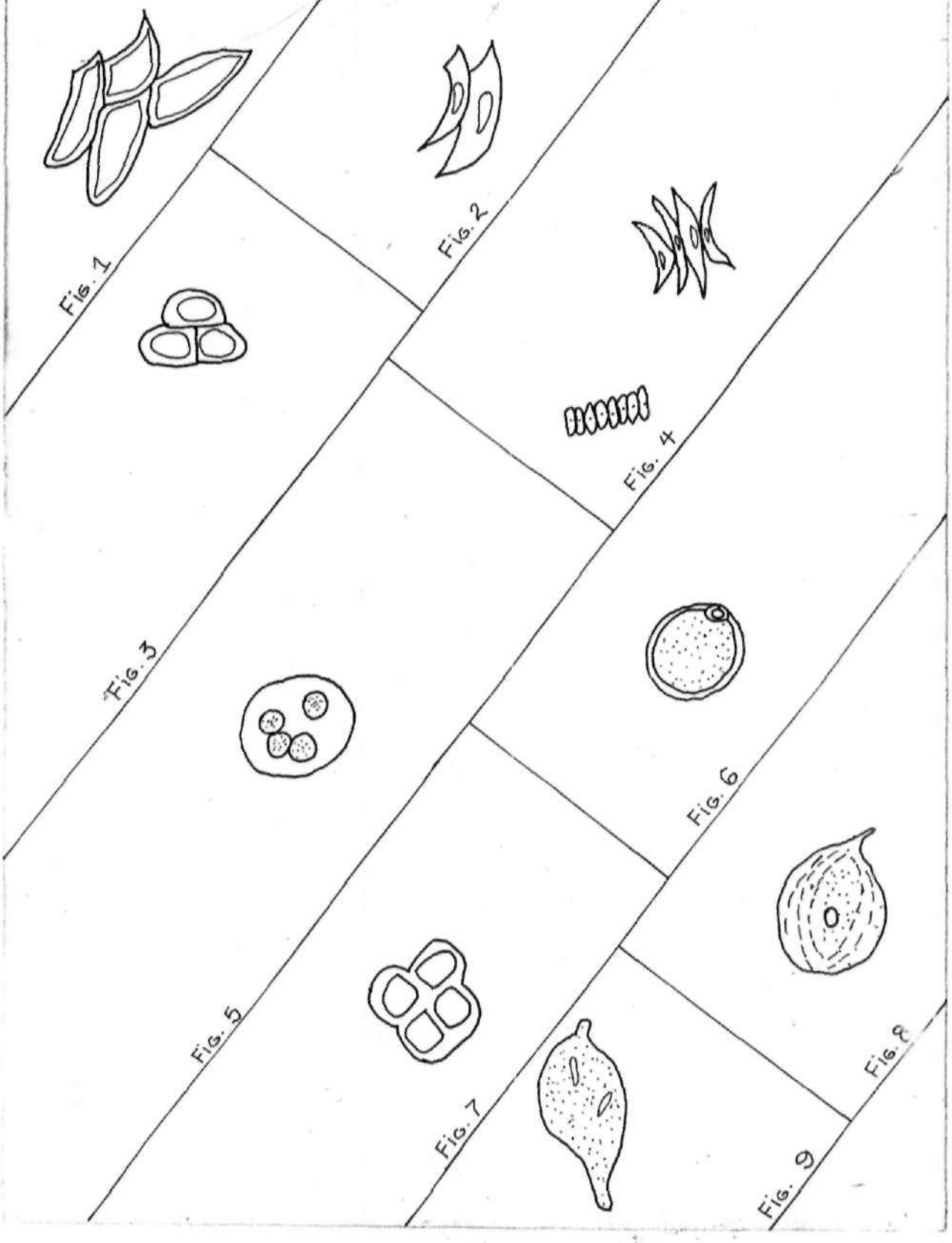


PLATE 3 FIG 13

COSMARIUM SP

L = 24.5

W = 17.5

The chromatophore has been divided into two equal parts like two cells joined together by a gelatiouns matrix.

PLATE 3 FIG 14

MICROCYSTIS SP

L = 70

W = 59.5

Numerous spherical cells closely and irregularly arranged within copron mucilage. Free floating cells.

PLATE 3 FIG 18

CLUSTERIUM SETACEUM

L = 70

W = 6.0

PLATE 4 FIG 5

MICROCYSTIS AERUGINOSA

L = 241.5

B = 220.5

PLATE 4 FIG 6

CHLOROCOCCUS DISPERSUS

L = 24.5

W = 17.5

PLATE 3

ALGAE TAXA stimulated by N. P. K.

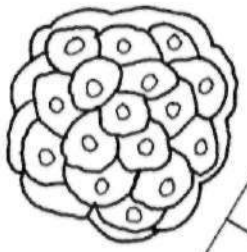


Fig. 10



Fig. 11

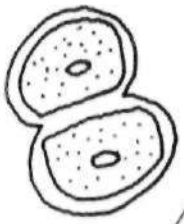


Fig. 13

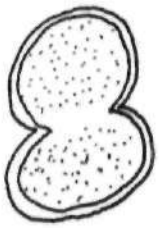


Fig. 12

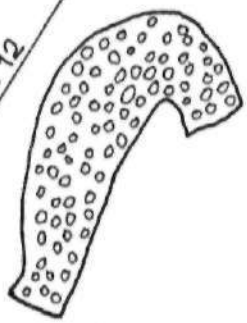


Fig. 14



Fig. 15



Fig. 16



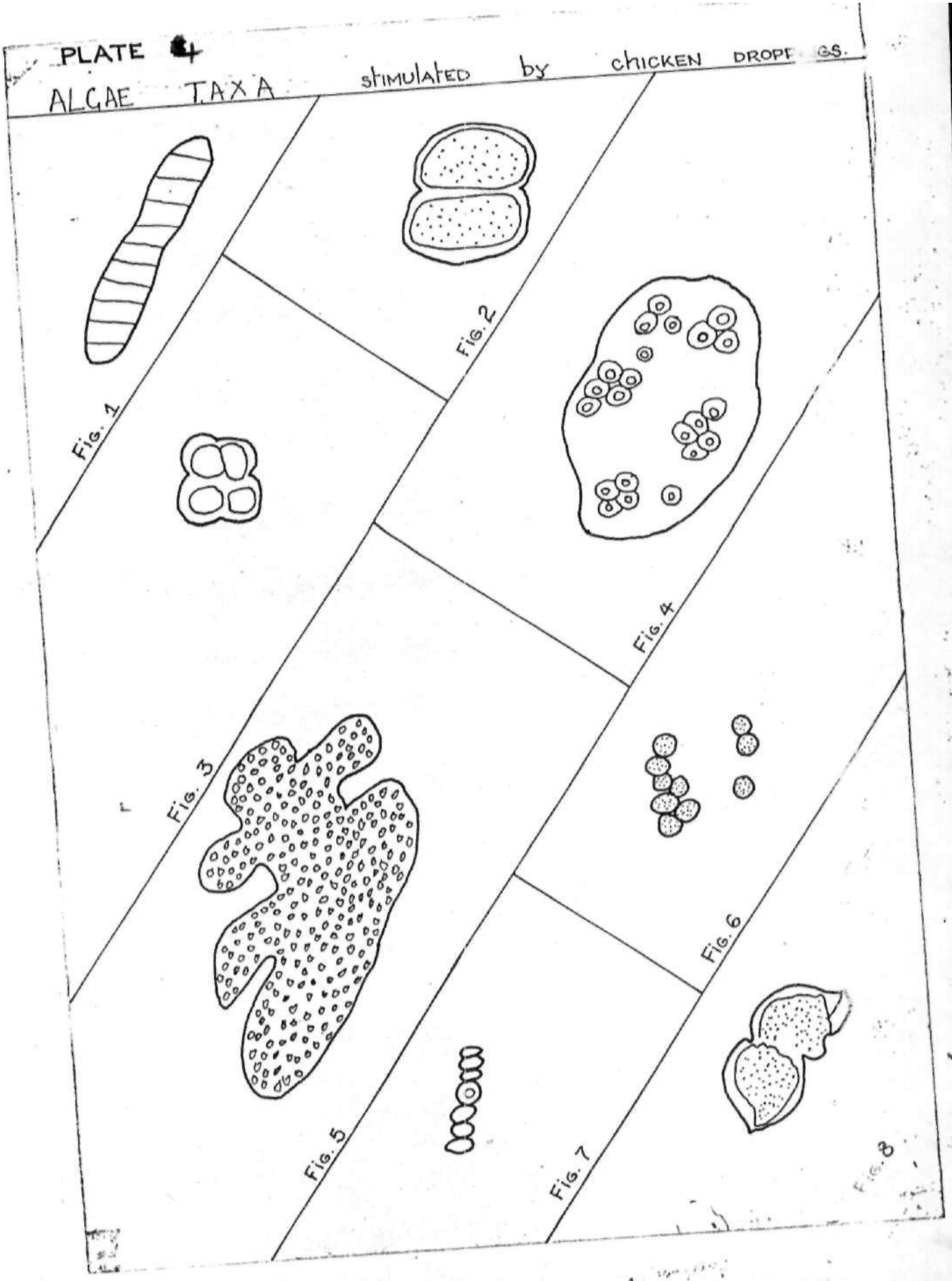
Fig. 18



Fig. 17

PLATE 4

ALGAE TAXA stimulated by chicken droppings.



Free floating, orate irregular shaped colony of 16 spherical cells. Cells are about 2.5-5.5 in diameter.

PLATE 4 FIG 9

TRACHELOMONAS HISPIDIA

L = 22.5 (including the flagellum aperture)

W = 14

Outer wall smooth, flagellum aperture with three lobes.

PLATE 4 FIG 14

EUGLENA SP

L = 35

W = 28

PLATE 4 FIG 15

EUGLENA SP

L = 164.5

W = 70

Has no flagellum. The body wall is densed with chromatophore

PLATE 4 FIG 18

PHACUS SP

L = 248.5

W = 91

It has a lobe like curve apex and a densed chromatophore.

PLATE 4

ALGAE TAXA stimulated by CHICKEN DROPPINGS.

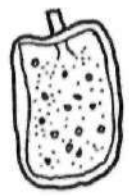


Fig. 9

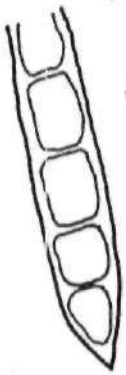


Fig. 10



Fig. 11

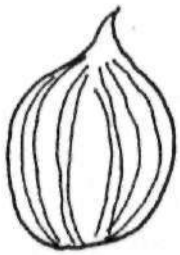


Fig. 12

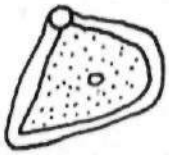


Fig. 13



Fig. 14

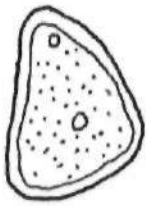


Fig. 15

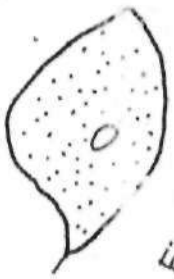


Fig. 16

PLATE 4 FIG 25

CYMBELLA SP

L = 59.5

W = 17.5

PLATE 34

ALGAE TAXA STIMULATED BY CHICKEN DROPPINGS.

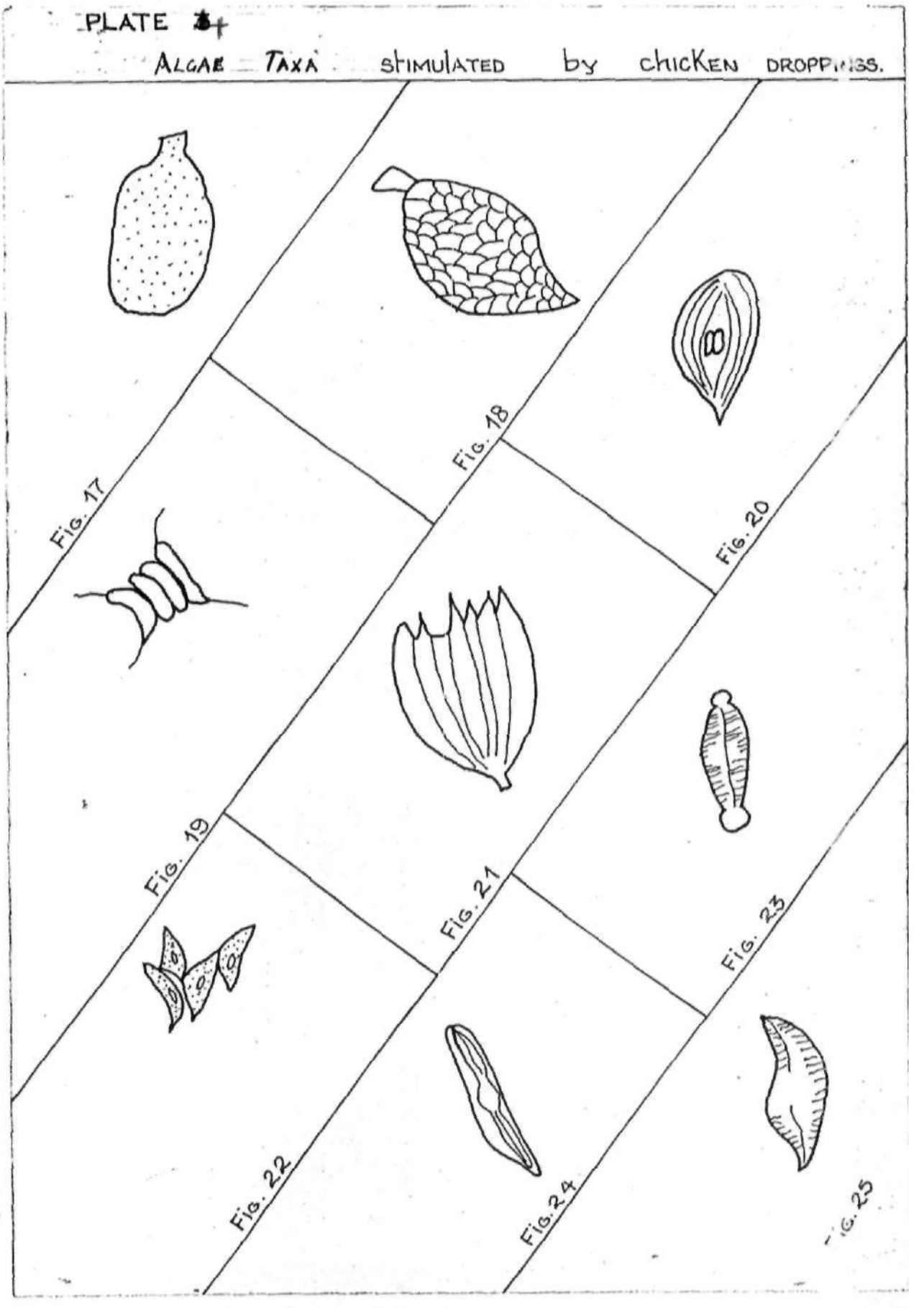


PLATE 5

ALGAE TAXA found in N.P.K and Chicken droppings stimulated water

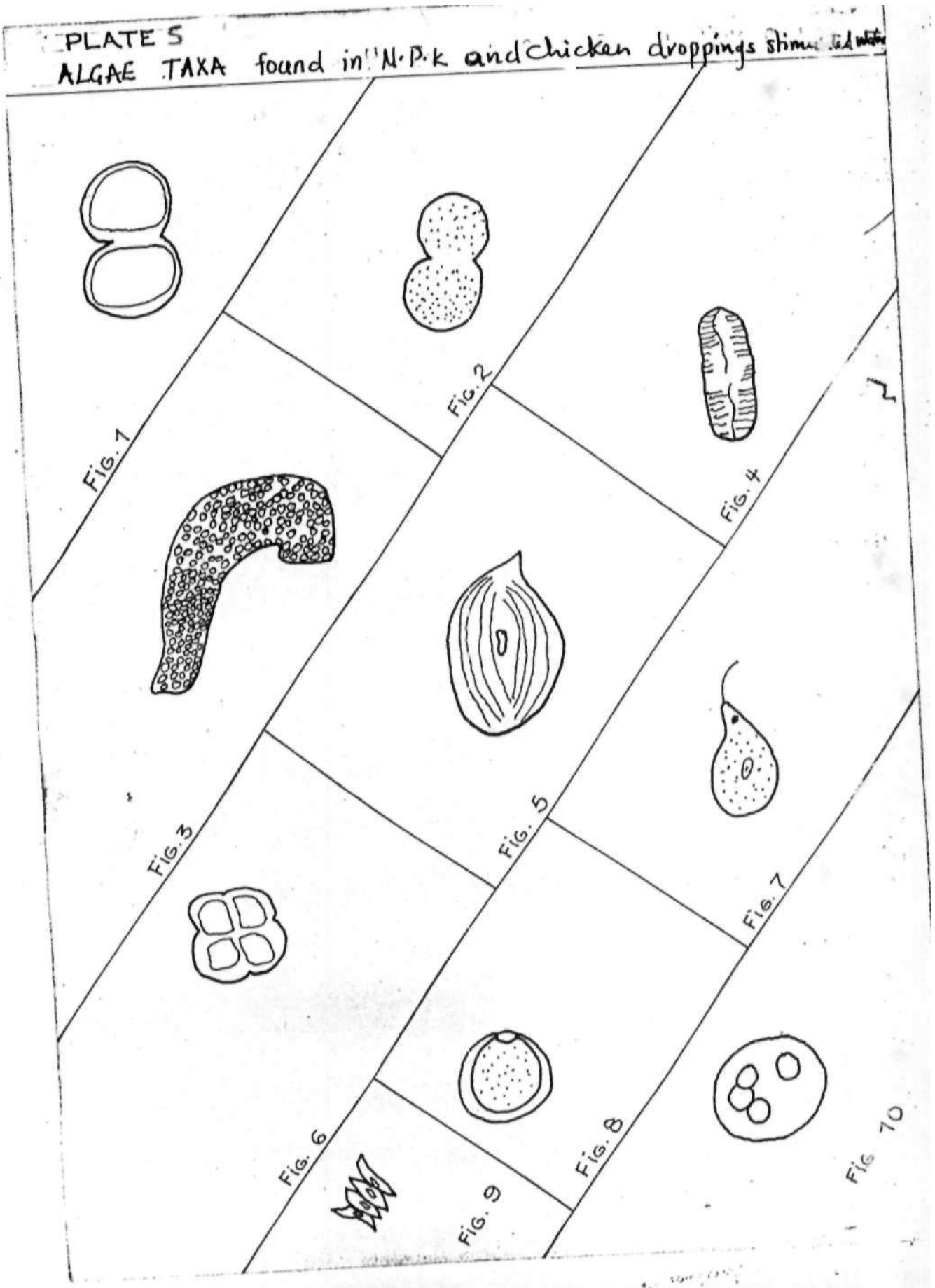


PLATE 5

ALGAE TAXA - FOUND IN N·P·K and CHICKEN DROPPINGS stimulated WATER

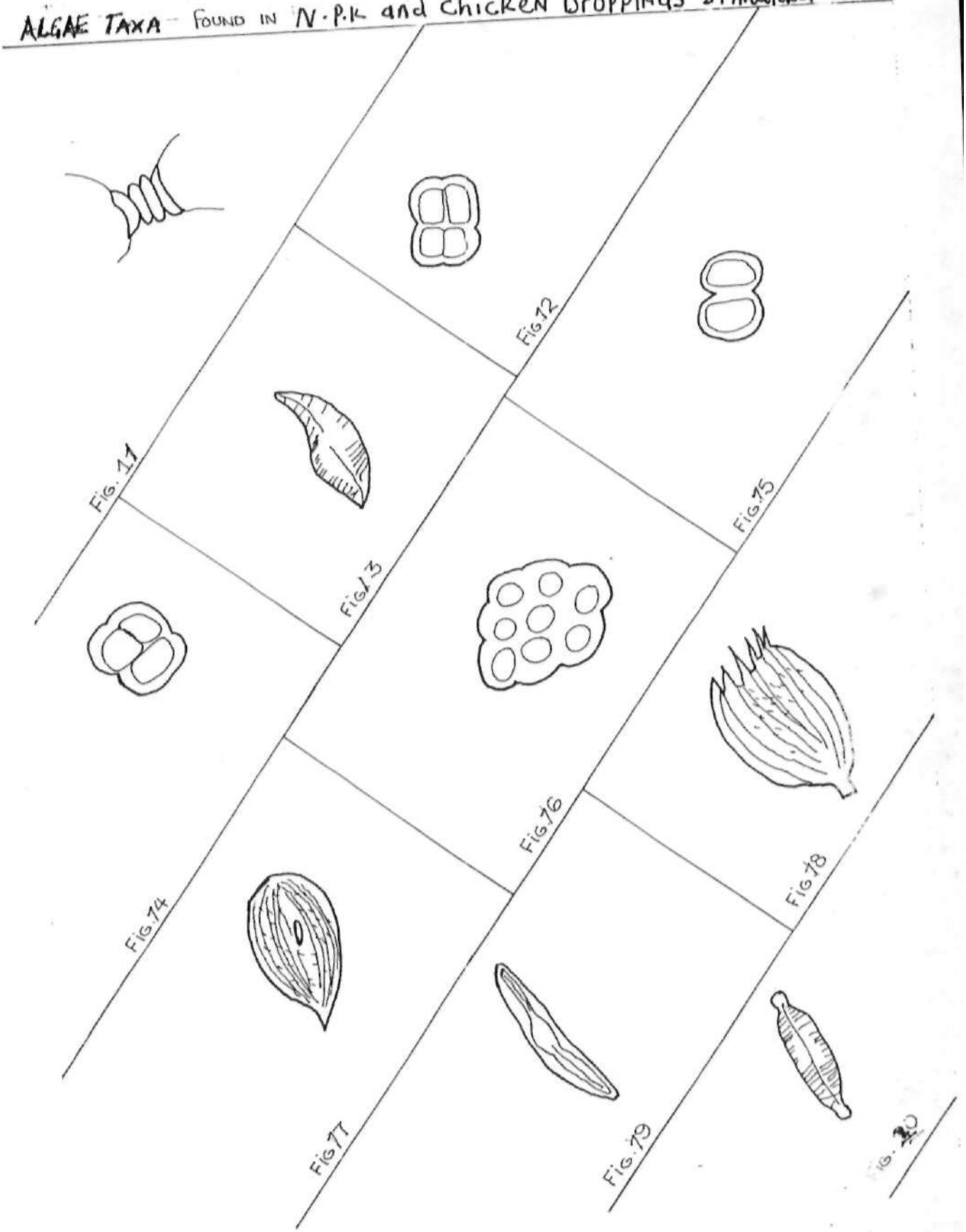


PLATE 5

ALGAE TAXA FOUND IN N.P.K and chicken droppings stimul. d Water

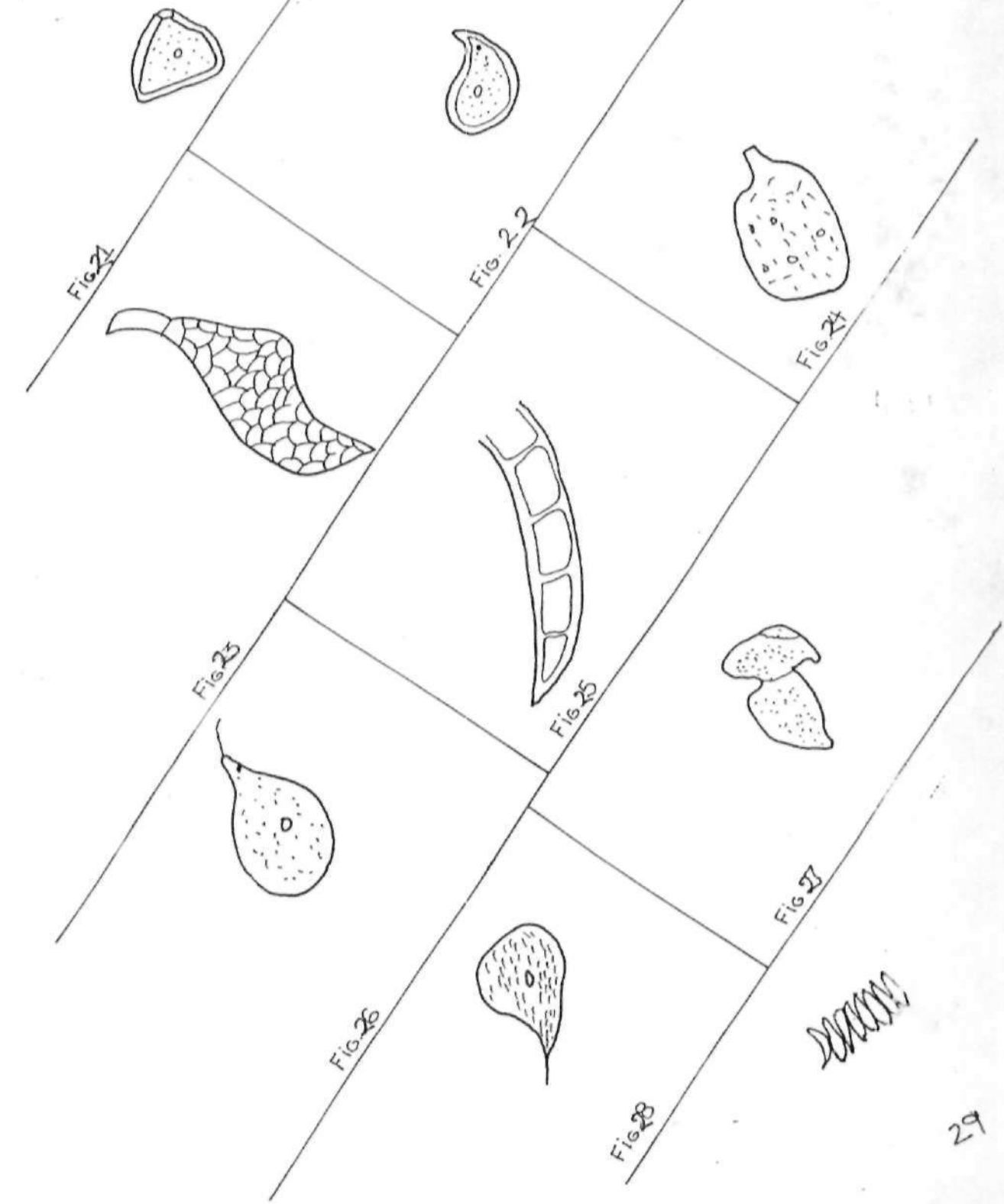
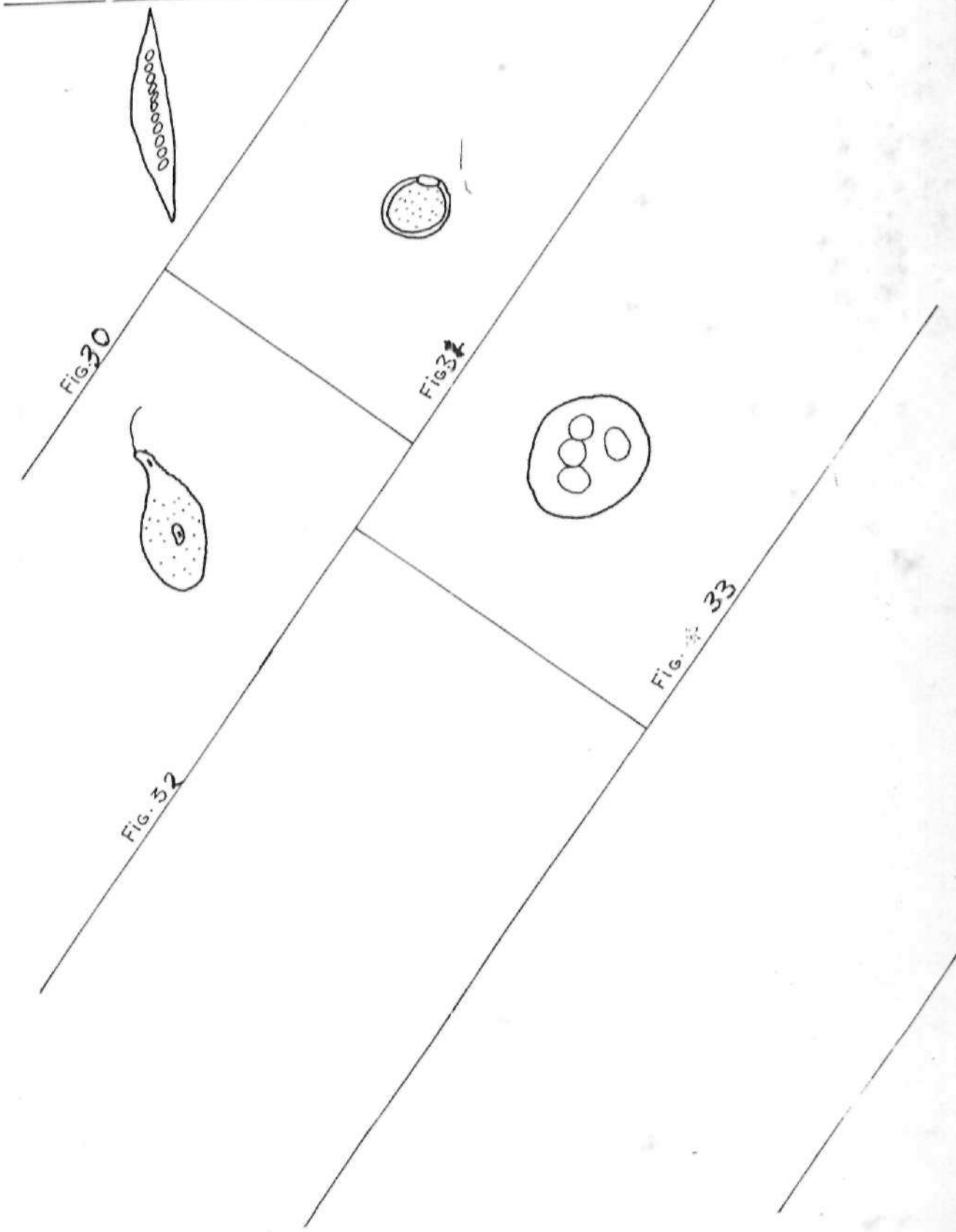


PLATE 5

ALGAE TAXA found IN N.P.K and chicken droppings stimulated water



APPENDIX 1: LENGTH-WEIGHT RELATIONSHIP OF *OREOCHROMIS NILOTICUS* IN DIFFERENT TREATMENTS WITHIN 7 WKS

| TREATMENT | X | Y | XY |
|---|---|---|---|
| A | 0.31 | 0.52 | 0.1612 |
| B | 0.11 | 0.53 | 0.0583 |
| C | 0.40 | 0.39 | 0.156 |
| D | 0.38 | 0.26 | 0.0988 |
| E | 0.36 | 0.41 | 0.1476 |
| F | 0.28 | 0.31 | 0.0868 |
| G | 0.77 | 0.43 | 0.3311 |
| H | 0.77 | 0.39 | 0.3003 |
| I | 0.47 | 0.38 | 0.1786 |
| J | 0.28 | 0.34 | 0.0952 |
| $\Sigma X$ | 4.13 | 3.96 | $\Sigma XY = 1.6139$ |
| $\Sigma X^2$ | 2.1057 | 1.6322 | |
| $(\Sigma X)^2$ | 17.0569 | 15.6816 | |
| $\bar{X}$ | 0.413 | 0.396 | |

$$r = \frac{\Sigma XY - \frac{\Sigma X \Sigma Y}{n}}{\sqrt{\left(\Sigma X^2 - \frac{(\Sigma X)^2}{n}\right)\left(\Sigma Y^2 - \frac{(\Sigma Y)^2}{n}\right)}}$$

$$M = \frac{\Sigma XY - \frac{\Sigma X \ \Sigma Y}{n}}{\Sigma X^2 - \frac{(\Sigma X)^2}{n}}$$

$$t = r \frac{(n-1)}{1 - r^2}$$

$$\frac{1.6139 - \frac{4.13 \times 3.96}{10}}{\sqrt{\frac{(2.1057 - 1.70569)(1.632 - 1.56816)}{0.4001 \qquad 0.06404}}}$$

$$\frac{-0.02158}{\sqrt{0.02561664}} \qquad \frac{-0.02158}{\sqrt{0.160051992}}$$

$$R = -0.13483$$

$$M = \frac{\Sigma XY - \frac{\Sigma X \Sigma Y}{n}}{\Sigma X^2 - \frac{(\Sigma X)^2}{n}}$$

$$M = \frac{-0.02158}{0.4001} = -0.054$$

$df = n-2$

$df = 8$

$Y = mx + c$

$Y = -0.054x + c$

$Y = Y + b(x - x)$

when $x = 0$

$Y = 0.396 + (-0.054)(X - 0.413)$

$Y = 0.396 + (-0.054)(0 - 0.413)$

$Y = 0.396 + (0.054)(0.413)$

$Y = 0.396 + 0.02$

$Y = 0.42$

$Y = -0.054x + 0.42$

$Y = 0.42 - 0.054x$

$$t = 0.135 \frac{(10 - 1)}{1 - 0.135^2}$$

$t = 0.135 \quad 9.167 \quad t = 0.41$