Isolation And Identification Of Species Of Phytoplankton In Efugo Fish Farm In Kuje Area Council Of Fct Abuja.

Solomon, R, J. And Uchai, O, D.

Department Of Biological Sciences, Faculty Of Science, University Of Abuja, Nigeria.
johnsol2004@yahoo.com

Abstract: The phytoplankton identification and species composition in fish ponds in Efugo farms in Kuje Area council in FCT Abuja were studied for a period of 2 months (June – July 2015). A total of twenty-eight genera belonging to five taxonomic groups were recorded from the fish ponds. The phytoplankton species composition was surpassed by *Chryophyta* with 9 species consisting of 28.6%. This was followed by *Cyanophyta* (6 species) consisting of 21.4%, *Euglenophyta* with 3 species consisting of 10.7% and *Pyrrophyta* consisting of 7.2%. The highest in abundance is *Cyanophyta* consisting of 39.6%, 38.4% and 29.6% for earthen pond, concrete pond and shaded concrete pond respectively while the highest in the number of species is the genus *Chrysophyta*. The low nature of species of phytoplankton and abundance observed in this study must have being caused due to the frequent or regular changing of the water.

[Solomon, R, J. And Uchai, O, D. **Isolation And Identification Of Species Of Phytoplankton In Efugo Fish Farm In Kuje Area Council Of Fct Abuja.** *Researcher* 2017;9(5):1-12]. ISSN 1553-9865 (print); ISSN 2163-8950 (online). http://www.sciencepub.net/researcher. 1. doi:10.7537/marsrsj090517.01.

Key words: Phytoplankton, *Chryophyta* and Efugo farms.

Introduction.

Phytoplankton (singular-phytoplankter) is very small (microscopic) free floating plants that drift with water currents. They exist in both freshwater and marine environments (Microsoft Corporation, 2009; Lindsey and Scott, 2010; Encyclopædia Britannica, 2012). Like terrestrial plants, they use carbon dioxide, release oxygen and convert minerals to the form that animals can use. They are responsible for 50 percent of all photosynthetic activity on Earth. They can be divided into two divisions which include: phototrophic bacteria (which are made up of purple sulphur bacteria and green sulphur bacteria) and algae (which are made up of *euglenophyta*, *chrysophyta*, *phaecophyta*, *rhodophyta*, *pyrrophyta* and *cyanophyta*) (Edmondson, 1959). Their composition and abundance is highly dependent on the availability of sunlight, carbon dioxide and nutrients such as nitrate, phosphate and silicate etc. These factors influence their density and distribution throughout the water column. Phytoplankton is very important because they form the base with which the aquatic ecosystem is culminating (Reynolds, 1984). They are a source of food to almost all aquatic life either directly or indirectly.

Phytoplanktons are drifting plants that inhabit the pelagic zones of oceans, seas, or bodies of fresh water. They provide a crucial source of food to zooplanktons, to larger aquatic organisms such a crustacean (Thurman, 2007). Phytoplankton typically flows with water currents. They are the autotrophic component of the plankton community and a key factor to oceans, seas, and fresh water basins ecosystem. Most phytoplanktons are too small to be individually seen with the unaided eye. However when present in high enough numbers; some varieties may be noticeable as a green discoloration of the water, this due to the presence of chlorophyll within the cells and in some species also due to the presence of accessory pigment such as phycobili proteins. Their horizontal position is determined by the surrounding currents. This is in contrast to nekton organisms such as squid fish and marine mammal that can swim against water current flow and control their position (Emiliani, 1991). The local abundance varies horizontally, vertically and seasonally, the primary cause is the variability of light. Phytoplankton is photosynthesizing microscopic organisms that inhabit the upper sub-lit layer of almost all oceans and bodies of fresh water. They are the agents for primary production, the creation of organic compounds from carbon dioxide dissolved in water, a process that sustains the aquatic food web, (Ghosal *et al.,* 2011). Phytoplankton obtain energy through the process of photosynthesis and must as well live in a well-lit surface layer known as the Euphotic zone of an ocean, sea, lake and fresh water. Phytoplankton accounts to half of all photosynthetic activity on earth (NASA, 2005). There are about 5,000 known species of phytoplankton (Hallegraeff, (2003), Andewrson *et al*., (2003). In terms of numbers the most important group of phytoplankton include the diatoms, cyanobacteria and dinoflagellages, although many other groups of algae are represented. Phytoplankton are a key food item in both aquaculture and mariculture, both utilize phytoplankton as food for the animals being farmed. In aquaculture phytoplankton must be obtained and introduced directly. The plankton can either be collected from a body of water or cultured, (McVey *et al*., 1993).

Statement of problem.

Phytoplankton is microscopic plants that live in water. These small plants are very important to the ocean/river and to the whole planet. They are the base of the food chain. Many small fish and whales eat them. The bigger fish eat the little fish, the food chain continues and at some point in time we come into it when we eat the fish so the phytoplankton becomes our energy too. Phytoplankton concentrations in surface waters were estimated to have decreased by about 40% since 1950, (Boyce *et al.,* 2010). A depletion of this phytoplankton which is the primary source of energy or the base of the food chain will affect other organism. Also carbon dioxide is essential for phytoplankton survival, which means the more phytoplankton there are, the more carbon dioxide will be sucked out of the air. When there is less carbon dioxide in the atmosphere, the temperature is going to be lower. When there is a smaller population there is more carbon dioxide in the air. This leads to higher temperature leading to global warming. Also the effects of anthropogenic activities which cause pollution of water also affect the availability of phytoplankton, (*Natures News*, 2010).

Justification.

In the wake of skyrocketing global prices of fish fertilizer and fish feeds, the water pollution associated with use of fertilizer and the contribution of fertilizer to climate change, there is a need to search for alternative sources of fish nutrients. Phytoplankton is one such alternative being used as supplement to fish feed or fertilizer to ascertain the effective growth and yield fish. Culturing of Phytoplankton can be promoted as a possible supplement to fish feeds and be promoted among fish farmers.

Biology of phytoplankton.

There are two major groups of phytoplankton:

(1) Non-motile, fast-growing diatoms; and

(2) Motile flagellates and dinoflagellates, which can migrate vertically in the water column in response to light.

The diatoms are further divided into two groups based on cell shape:

(1) Pennate diatoms, which evolved first during the Late Cretaceous, are long and flat; and

(2) Centric diatoms, which evolved later than the pennates, are shaped like pillboxes and may have elaborate arrays of spines projecting from their cell walls.

Phytoplankton varies widely in physical and chemical requirements for population growth. Diatoms and dinoflagellates also differ significantly with respect to motility, cell-wall composition and ornamentation, and nutritional and reproductive strategies, (Arrigo, 2005).

Diatoms have cell walls, called frustules, made of silica (the same material in glass and opal). In contrast, dinoflagellates can have a rigid cell wall, called a theca, made of cellulose plates, or they can have a non-rigid cell membrane (no theca). These two forms of dinoflagellate structures gave rise to the terms “armoured” and “un-armoured” (or “naked”) dinoflagellates, (Cavalier-Smith, 1991). Diatoms and dinoflagellates can be highly ornamented, which aids in species identification. Cell surface designs on some diatoms may help focus light on chloroplasts, allowing survival at greater depths where light intensity is very low, (Stoecker, 1999). Long spines, cell shape, and the formation of chains and colonies make diatoms more difficult for predators to grasp or bite and also assist in flotation. Some dinoflagellates form chains, whereas others have protuberances that look like wings, crowns, or horns, for similar reasons.

Both groups commonly reproduce by simple cell division. Some species of diatoms and dinoflagellates are known to produce resting stages. Resting spores in diatoms, and cysts in dinoflagellates, allow species to survive in unfavourable conditions. Some diatoms form specialized sexual-reproductive structures called auxospores that look like greatly enlarged versions of normal vegetative cells. Dinoflagellates have motile sexual phases that may become cysts or normal vegetative cells, depending on prevailing conditions, (Pfiester *et al.,*1987).

Although all species of dinoflagellates and diatoms share certain basic requirements for growth (light, carbon dioxide, nutrients, trace elements, habitable temperature and salinity), they can differ considerably in their optimal requirements for these factors. Nutritionally, diatoms rely solely on photosynthesis as a source of energy; they cannot survive if they are transported below the photic zone. Dinoflagellates, in contrast, have several survival strategies, ranging from photosynthesis to predation and parasitism, (Schnepf *et al.,* 1992). Some dinoflagellate species have feeding veils that are extruded around such food items as diatoms. Both groups are able to absorb nutrients and vitamins into the cell and have distinct preferences for the forms of some of those nutrients. In addition, chelating agents (compounds that attract trace metal ions), such as those derived from humic material, have been shown to be beneficial for phytoplankton growth. Not surprisingly, then, red tides in different parts of the world commonly have been associated with rainfall-related land, river runoff and ponds. Silica is a limiting factor for diatom growth, whereas nitrogen and phosphorus can be limiting factors for dinoflagellate growth, (Klausmeier *et al.,* 2004).

Transport of phytoplankton.

The name "phytoplankton" consists of two Greek words meaning "plant" (phyto) and "wanderer" (plankton). All species of phytoplankton are at the mercy of oceanic currents for transport to areas that are suitable for their survival and growth. Thus, physical processes can play a significant role in determining the composition and distribution of phytoplankton species, and they are an important factor in the development of blooms. Areas of strong mixing and movement discourage the concentration of cells or may physically disrupt an existing bloom. Calm seas and stable water masses (rivers and ponds) are conducive to the concentration of cells. In addition to delivering colder, nutrient-rich waters from depth, coastal upwelling physically concentrates phytoplankton near the surface. This concentration of cells in the upper photic zone, together with increased nutrients, may provide a competitive edge for the faster-growing diatoms during upwelling events. Conversely, a period of relaxation following upwelling can result in stratified water mass consisting of a layer of calm, warmer surface water and a deeper layer of colder, nutrient-rich water. These conditions favour the development of dinoflagellate blooms, called "red tides," because these types of phytoplankton can actively swim to the surface to photosynthesize during the day and migrate to deeper areas at night to absorb nutrients, (Faust *et al*.,2002). Relaxation events can also be associated with down welling, where warmer offshore waters are adverted near shore, pushing coastal surface waters down along the sea floor to deeper areas. Researchers in other parts of the world have shown that dinoflagellates are commonly associated with these warm-water front's that are adverted near shore.

Blooms, Red Tides, and Toxicity.

Phytoplankton blooms in general, and toxic blooms in particular, have been increasing in frequency and distribution worldwide since the 1980's. Although the seasons of this apparent increase is unclear, several have been suggested:

1. Increased nutrients input to coastal oceans from human activities,
2. Large scale climatic changes (climatic changes, global warming),
3. Transport of toxigenic species in ship ballast water,
4. Increased use of coastal resources for shell fish harvesting and aquaculture, and
5. Increased surveillance by government health agencies and researchers.

The common used term 'red tide' is quite misleading because phytoplankton blooms are frequently other colours (brown, green, even yellow) and are not a tidal phenomenon. Although diatoms are more numerous than dinoflagellates in terms of number of species, the dinoflagellates are associated with worldwide occurrences of red tides. A unique characteristic of some red tides is the phenomenon of bioluminescence, (Hastings, 1996). Light produced by some species of dinoflagellates (*Noctuluca scintillans, Lingulodinium polyedra*) can actually illuminate the waves and surface of the ocean under bloom conditions, (Haddock *et al.,*2009).

Some species of phytoplankton can have harmful effects on organisms at different tropic levels. Blooms of otherwise harmless species result in massive fish kills by depleting dissolved oxygen or by clogging the gills of fish. Phytoplankton species that pose the greatest risk to marine and fresh water life and to the humans who harvest various organisms within it, are those that produce bio-toxins. These natural toxins are concentrated in different species at different tropic levels. Bivalve shellfish (mussels, clams, oysters) and fishes which consume phytoplankton concentrate marine/fresh water bio-toxin, increasing the danger to the next consumers (larger fish, sea bed, aquatic mammals, humans).

Ecology of phytoplankton.

Phytoplankton is photosynthesizing microscopic organisms that inhabit the upper sunlit layer of almost all oceans and bodies of fresh water. There are agents of primary production, the creation of organic compounds from carbon dioxide dissolved in the water, a process that sustains the aquatic food web (Ghosal *et al*., 2011). Phytoplankton obtain energy through the process of photosynthesis and must therefore live in well-lit surface layer (termed the euphotic zone) of an ocean, sea, lake, river or other body of water. Phytoplankton account for half of all photosynthetic activities on earth, (NASA, 2009). Their cumulative energy fixation in carbon compounds is the bases for vast majority of oceanic and also many fresh water food webs (chemosynthesis is a notable exception). The effects of anthropogenic warming on the global population of phytoplankton are an area of active research. Changes in the vertical stratification of water column, the rate of temperature – dependent biological reactions, and the atmospheric supply of nutrients are expected to have important effect on future phytoplankton productivity (Henson *et al*., 2010, Stauncher *et al*., 2010). Additionally, changes in the mortality of phytoplankton due to rates of zooplankton grazing may be significant. As a side note on of the more remarkable food chain in the ocean- remarkable because of small number of links- is that of phytoplankton- feeding krill (a crustacean similar to a tiny shrimp) feeding baleen whales.

Phytoplankton is also crucially dependent on minerals. These are primary macronutrients such as nitrate, phosphate or silicic acid, whose availability is governed by the balance between the so called biological pump and upwelling of deep nutrient- rich waters. However across large regions of the world's oceans such as southern oceans, phytoplanktons are also limited by the lack of micronutrient iron. This has led to some scientist advocating iron fertilization as a means to counteract the accumulation of human-produced carbon dioxide in the atmosphere (Richtel, 2007). Large-scale experiments have added iron (usually as salt such as iron sulphate) to the oceans to promote phytoplankton growth and draw atmospheric carbon dioxide into the water bodies. However controversy about manipulating the ecosystem and the efficiency of iron fertilization has slowed such experiments. Phytoplankton depends on other substances to survive as well. In particular, vitamin B is crucial. Areas in the ocean have been identified as having a major lack of vitamin B, and correspondingly, phytoplankton. While most phytoplankton species are obligate photo-autotrophs, there are some that are mixotrophic and other, non-pigmented species that are actually heterotrophic (the latter are often viewed a zooplankton). Of these the best known is dinoflagellate genera such as *Noctiluca* and *Dinophysis,* which obtain organic carbon by ingesting other organisms or detrital material.

The term phytoplankton encompasses all photoautotrophic microorganisms in aquatic food webs. Phytoplankton serves as the base of aquatic food web, providing an essential ecological function for all aquatic life. However, unlike terrestrial communities, where most autotrophs are plants, phytoplankton are a diverse group, incorporating protistan eukaryotes and both eubacterial and archaebacterial prokaryotes (Hallegraeff, 2003). In terms of numbers, the most important groups of phytoplankton include the diatoms, cyanobacteria and dinoflagellates, although many other groups of algae are represented. One group, the coccolithophorids, is responsible in part for the release of significant amounts of dimethyl sulphide into the atmosphere.

Environmental controversy.

A 2010 study published in *Nature* reported that marine phytoplankton have declined substantially in the world's oceans over the past century. Phytoplankton concentrations in surface waters are estimated to have decreased by about 40 percent since 1950 alone, at a rate of 1 percent per year, possibly in response to ocean warming, (Boyce *et al*., 2010). The study generated debate among scientist and led to several communications and criticisms also published in *Nature*, (Rykaczewski *et al*., 2011). Studies have shown that both chlorophyll and primary production had declined. The airborne fraction of carbon dioxide from human emissions, the percentage neither sequestered by photosynthetic life on land and sea nor absorbed in the ocean abiotically, has been almost constant over the past century, and that suggests a moderate upper limit on how much a component of the carbon cycle as large as phytoplankton may have declined, if such declined in recent decades, (Knorr, 2009).

Aquaculture.

Phytoplankton are a key food item in both aquaculture and mariculture. Both utilize phytoplankton as food for the animals being farmed. In mariculture, the phytoplankton is naturally occurring and is introduced into enclosures with the normal circulation of seawater. In aquaculture, phytoplankton must be obtained and introduced directly. The plankton can either be collected from a body of water or cultured, though the former is seldom used. Phytoplankton is used as a food stock for the production of rotifers (Mcvey *et al*., 1993), which are in turn used to feed other organisms. Phytoplankton is also used to feed many varieties of molluscs, including pearl oysters and giant clams.

The production of phytoplankton under artificial conditions is itself a form of aquaculture. Phytoplankton is cultured for a variety of purposes, including food stock for other aqua cultured organisms, a nutritional supplement for captive invertebrates in aquaria. Culture sizes ranges from small-scale laboratory cultures of less than 1L to several tonnes of thousands of litres for commercial aquaculture. Regardless of the size of the culture, certain conditions must be provided for efficient growth of plankton. The majority of cultured planktons are marine, and sea water of a specific gravity of 1.010 to 1.026 may be used as a culture medium. This water must be sterilized usually by either high temperatures in an autoclave or by exposure to ultra-violet radiation, to prevent biological contamination of the culture. Various fertilizers are added to the culture medium to facilitate growth of plankton. A culture must to aerate or agitated in some way to keep plankton suspended, as well as to provide dissolved carbon dioxide for photosynthesis. In addition to constant aeration, most cultures are manually mixed or stirred on a regular basis. Light must be provided for the growth of phytoplankton. The colour temperature of illumination should be approximately 6,500K, but values from 4,000K to upwards of 20,000K have been used successfully. The duration of light exposure should be approximately 16 hours daily; this is the most efficient artificial day length, (Mcvey *et al*., 1993).

Growth strategy of phytoplankton.

In the early twentieth century, Alfred C. Redfield found the similarity of the phytoplankton's elemental composition to the major dissolved nutrients in the deep ocean, (Redfield, 1934). Redfield proposed that the ratio of nitrogen to phosphorus (16:1) in the ocean was controlled by phytoplankton's requirements which subsequently release nitrogen and phosphorus as they are re-mineralised. This so called "Redfield ratio" in describing stoichiometry of phytoplankton and sea water has become a fundamental principle to understand the marine ecology, biogeochemistry and phytoplankton evolution, (Arrigo, 2005). However, Redfield ratio is not a universal value and it may diverge due to the changes in exogenous nutrient delivery and microbial metabolisms in the ocean, such as nitrogen fixation, de-nitrification, and anammox.

The dynamic stoichiometry shown in unicellular algae reflects their capability to stock pile nutrients in internal pool, shift between enzymes with various nutrient requirements and after osmolyte composition, (Sterner *et al.,* 2002). Different cellular components have their own unique stoichiometry characteristics, for instance, resource (light or nutrients) acquisition machinery such as proteins and chlorophyll contain high concentrations of nitrogen but low in phosphorus. Meanwhile, growth machinery such as ribosomal RNA contains high nitrogen and phosphorus concentration.

Based on allocation of resources, phytoplankton is classified into three different growth strategies, namely survivalist, bloomer and generalist, (Klausmeier *et al.,* 2004). Survivalist phytoplankton has high ratio of N:P (>30) and contains numerous resource acquisition machinery to sustain growth under scarce resources. Bloomer phytoplankton has low N: P ratio (<10), contains high proportion of growth machinery and adapted to exponential growth. Generalist phytoplankton has similar N:P to Redfield ratio and contain relatively equal resource acquisition and growth machinery.

Phytoplankton are the base of virtually all food webs in the ocean/river and lakes. If you like they can be compared to the vegetation on land, and just like land based plants the phytoplankton need light and nutrient to grow. Unlike most terrestrial vegetation, the phytoplanktons are not plants but rather algae and some groups of bacteria that are able to photosynthesize. Sea weeds are also algae (macro algae) whereas the phytoplankton are micro algae due to the fact that they are mostly single cells and can only be seen with the aid of a microscope. The analogy with terrestrial plants falls a bit down a bit since, although phytoplankton need water, naturally they are surrounded by the stuff it is hardly in short supply. Also, the nutrients they need for growth are contained in the water bathing the cells and so the whole basis of nutrient uptake and gas exchange is based on diffusion gradients between inside of the cell and concentrations of surrounding water.

Naturally there has been much written on the phytoplankton and how they grow, (Fogg, 1991). The key limitation factors of growth, light, nutrients and wind driven movements of surface waters play in controlling phytoplankton dynamics. It is important to bear in mind that the phytoplankton cannot swim against the movement of water masses, and so the physics (light penetration, temperature, density, boundary layer effects with other water masses) of the system, be it an ocean, lake, farm yard pond really does determine the ability of algal populations to grow, (Williams *et al.,* 2002, Falkowski *et al.,* 2007, Kaiser *et al.,* 2011).

Materials And Methods.

Description of the area.

Efugo Farms is located between GSS and Army check point, opposite LEA, Kuje, FCT Abuja. It is situated at latitude $9^0$32N and longitude $50^0$10E with a land mass 11 hectares, Kuje Area Council is about 40km south-west of Abuja and is one of the six area councils of the federal capital territory Abuja. Abuja is located at the centre of the country with a land area of 8,000 square kilometres. Its vegetation combines the savannah grassland type of the north and middle belt with the tropical rain forest type of the south of Nigeria. The overall effect of this is that Abuja has rich soil for agricultural cultivation and enjoys an equable climate that is neither too hot (35^0 C) nor too cold (22^0 C) all year round (Dan-kishiya and Chiaha, 2010). There are two main seasons in F.C.T. These are the dry and wet seasons. The wet season, begins toward the end of March and ends towards the end of October. University of Abuja Main Campus as an academic environment, it is majorly occupied by students, staffs, subsistence Fulani farmers and business men and women found in the mini market.

The samples were collected from the fish ponds in Efugo farms in Kuje Area council, FCT Abuja through June and July, 2015. The analysis was carried out in the biology laboratory of University of Abuja.

Collection and preservation of samples.

Sampling was carried out once a week for four weeks and in the morning before 8am. The evaluation of phytoplankton at these three ponds (earthen pond, concrete pond and concrete shaded pond) was determined by counting and identifying them using standard identification keys. A pour through method was used to collect the samples. A 10 litre graduated bucket was used to collect the water at 20cm below the water surface, poured into a 55 Nano metre plankton net and repeated 10 times to make a total of 100 litres of water filtered. The samples were collected weekly for four weeks between June and July 2015. Collected plankton was poured into a plankton bottle fixed with 70% ethanol solution, cocked and labelled properly for further laboratory analysis. The sample was kept in the plankton bottle for three days. This was to allow the plankton to settle and the supernatant was then decanted.

Analysis of phytoplankton.

In the laboratory, each sample was fixed with 70% ethanol solution was concentrated to 10mls to enable analysis using the drop count method described by Onyema *et al.,* 2007). A dropping pipette was used to place 1 drop at ten different times for each sample after adjusting to 10mls was studied at different magnification using a light microscope.

Identification of phytoplankton species.

Phytoplankton species were identified and sorted into different taxonomical groups with the aid of appropriate identification manuals, (Jeje *et al.,*1986).

Determination of species composition and statistical analysis.

Each species was grouped into their respective taxa in a tabular form. Pie chart was used to show the percentage composition of each taxon of phytoplankton. MS EXCEL statistical package was used for the analysis.

Results.

Table 1: Species composition of phytoplankton's in earthen pond of Efugo farm (June-July 2015).

Phytoplankton Group	Genus/Species	Abundance	Phytoplankton group abundance	Percentage (%)
Chrysophyta	*Fragillaria sp*	8	78	31.2%
	Nitzchia sp	25		
	Navicula sp	12		
	Ophiocytium sp	6		
	Cyclotella sp	7		
	Tabellaria sp	6		
	Oscillatoria sp	8		
	Synedra sp	4		
	Pinnularia sp	2		
Chlorophyta	*Ankistrodesmus*	15	58	23.2%
	Closterium sp	9		
	Penium sp	5		
	Spirotaenia sp	4		
	Zygnema sp	10		
	Tetraspora sp	5		
	Spyrogyra sp	4		
	Protococcus sp	6		
Cyanophyta	*Phormidium sp*	7	99	39.6%
	Anabaena sp	10		
	Aphanocapsa sp	28		
	Merismopedia sp	9		
	Polycystis sp	15		
	Coelosphaerium	30		
Euglenophyta	*Phacus pyrum*	4	9	3.6%
	Euglena sp	5		
Pyrrophyta	*Peridinium sp*	4	6	2.4%
	Chilomonas sp	2		
Total		**250**	**250**	**100**

The collection of the samples of plankton from the different ponds (earthen pond, concrete pond and shaded concrete pond) for four weeks yielded good results from the samples analysed. The results interpreted are shown in tables and charts below. A total number of 5 genera of phytoplankton were found in two ponds, the earthen and concrete pond but only four were identified in the shaded concrete pond. The species composition of phytoplankton from the earthen pond for the four weeks shows the various species identified in the pond and their numbers. The genus *Chryophyta* was found to have the highest number of species (9 species) with the specie *Nitzchia sp* having the highest in the number of occurrence and the specie *Pinnularia sp* having the lowest number in specie abundance. The second, genus *Chlorophyta* with 8 species were also identified (*Ankistrodesmus fractus, Closterium sp, Penium sp, Spirotaenia sp, Zygnema sp, Tetraspora sp, Spyrogyra sp and Protococcus sp*), having 23.2% of the total percentage of the whole species identified. The specie *Ankistrodesmus fractus* has the highest number of specie (15). The genus *Cyanophyta* has the highest number of species which add up to 99. Six phytoplankton species were identified and with the highest percentage of 39.6%. The specie *coelosphaerium sp* was the most abundant specie in the earthen pond with a total number of 30 species. The genus *Euglenophyta* and genus *Pyrrophyta* both contain the least number of identified species from the sample collected from the earthen pond. *Phacus pyrum* and *Euglena sp* are the two species of *Euglenophyta* found in the earthen pond from the samples collected during the four weeks making 2.4% of the total numbers of identified species in the sample collected from the earthen pond.

The sample from the concrete pond gave rise to the identification and isolation of 22 species of phytoplankton grouped into 5 different genera. There is a significant reduction in the numbers of individual species of the different phylum compared to the earthen pond due to the regular changing of the water in the concrete pond. The genus *Chryophyta* has the highest number of identified species, with a total of 35.2% from the total percentage of all the numbers of phytoplankton's identified in the concrete pond for the four weeks. The species *Nitzchia sp* and *Navicula sp* has a number species identified to be 17 and 12 respectively while the specie with the lowest number of species identified is *Ophiocytium sp* with 2 species. The genus *chlorophyta* has 5 species identified, with a total number of 23 species. The species are *Ankistrodesmus fractus*, *closterium sp*, *Zygnema sp, Spyrogyra sp, protococcus sp*, accounting 18.4% of the total number of phytoplankton identified from the sample taking during the four weeks of the study. The genus *cyanophyta* in the concrete pond also has the highest in total of the species isolated and identified from the sample amounting to the total of 48 and a percentage of 38.4% of the total number of species identified from the whole sample during the four weeks. The genus *Euglenophyta* has only 2 species identified, *Phacus pyrum* and *Euglena sp* are 2 and 1 respectively while the genus *Pyrrophyta* also have 2 species identified, *Peridinium sp* and *Chilomonas sp* with 4 and 5 in numbers respectively.

Table 2: Species composition of phytoplanktons in concrete pond of Efugo farm

Phytoplankton Group	Genus/Species	Abundance	Phytoplankton group abundance	Percentage (%)
Chrysophyta	*Fragillaria sp* *Nitzchia sp* *Navicula sp* *Ophiocytium sp* *Cyclotella sp* *Tabellaria sp* *Oscillatoria sp*	4 17 12 2 3 3 3	44	35.2%
Chlorophyta	*Ankistrodesmus fractus* *Closterium sp* *Zygnema sp* *Spyrogyra spp* *Protococcus sp*	8 5 5 2 3	23	18.4%
Cyanophyta	*Phormidium sp* *Anabaena sp* *Aphanocapsa sp* *Merismopedia sp* *Polycystis sp* *Coelosphaerium sp*	3 4 15 5 8 13	48	38.4%
Euglenophyta	*Phacus pyrum* *Euglena sp*	2 1	3	2.4%
Pyrrophyta	*Peridinium sp* *Chilomonas sp*	4 3	7	5.6%
Total		**125**	**125**	**100**

Lastly the shaded concrete pond has the least in the number of species identified and also the least in abundance due to the unavailability of sunlight and also due to the frequent changing of the water. In the shaded concrete pond only four genera of phytoplankton were identified compared to the earthen pond and concrete pond where 5 genera were identified. The four genera are *Chrysophyta, Chlorophyta, Cyanophyta* and *Euglenophyta* with the exception of the genus *Pyrrophyta*. The shaded condition of the pond is responsible for the reduced phytoplankton abundance. Phytoplankton needs sunlight for photosynthesis. The genus *Chrysophyta* has 5 species, members of these 5 species amounting to 44 in number resulting to 35.2% of the total number of species present in the shaded concrete pond samples analysed during the four weeks.

Table 3: Species composition of phytoplanktons in shaded concrete pond of Efugo farm

Phytoplankton Group	Genus/Species	Abundance	Phytoplankton group abundance	Percentage (%)
Chrysophyta	*Fragillaria sp* *Nitzchia sp* *Navicula sp* *Cyclotella sp* *Chlorogibba sp*	2 5 2 1 1	11	20.4%
Chlorophyta	*Ankistrodesmus fractus* *Closterium sp* *Zygnema sp* *Protococcus sp*	4 2 3 3	12	22.2%
Cyanophyta	*Anabaena sp* *Polycystis sp* *Coelosphaerium sp*	3 5 8	16	29.6%
Euglenophyta	*Menoidium sp* *Euglena sp*	2 4	8	14.8%
Total		**43**	**43**	**100**

The total number of species in each taxonomic group of phytoplankton samples was put into a table which shows the five taxonomic groups with a total number of species of 9,8,3,6,2 respectively adding up to 28 and percentages of 32.1%, 28.6%, 10.7%, 21.4%, 7.2% respectively. This shows the total number of the types of species isolated and identified from the samples taken from the earthen pond, concrete pond and shaded concrete pond for the four weeks.

Table 4: Number of species in each taxonomic group of phytoplankton sampled (June –July 2015).

Taxonomic Group	Total number of species	Percentage
Chrysophyta	9	32.1%
Chlorophyta	8	28.6%
Euglenophyta	3	10.7%
Cyanophyta	6	21.4%
Pyrrophyta	2	7.2%
Total	**28**	**100**

Discussion And Conclusion.

Discussion.

Cyanophyta (also known as Blue green algae, *Cyanobacteria* and *Myxophyceae*) surpassed the phytoplankton in terms of abundance while *Chrysophyta* surpassed in terms of number of species/genus. The dominance of *Cyanophyta* has been observed by several authors among which are: Sekadende et al., (2004) who observed *Cyanophyta* dominance in Lake Victoria basin, Ogato, (2007) who observed dominance of *Cyanophyta* in Lake Bishoftu, Deng et al., (2007) who reported dominance of *Cyanobacteria* in summer and autumn in Lake Chaohu; Shakily and Natarajan (2012). The abundance of *Cyanophyta* observed in this study must have been caused by the polluted nature of the water. The dominance of *Cyanophyta* is a signal that the pond is polluted and the water is not constantly changed over a four days period in the earthen pond. Consequently, there is therefore need to regulate the amount of pollutants discharged and population of fishes in the pond. The presence of the low result in the number of species and their abundance identified was due to the fact that the pond is not a matured water body (oceans, lakes, rivers). The earthen pond possesses a near natural condition (presence of light, large aquatic plants and abundant sunlight. These conditions are responsible for the high abundance of phytoplankton in the earthen pond compared to the concrete and shaded concrete pond. The genus *Cyanophyta* has the highest in terms of abundance (99) out of 6 species identified, this was caused by the slightly nature of the source of the water used or pumped into the pond and from fertilizers and animal wastes products that are used to feed the fishes. It is also considered that the low concentration of phytoplankton was due to the fact that the earthen pond is not from a mature water source and the water being changed periodically, especially during harvesting the fishes.

Both the concrete and shaded concrete ponds showed low result in the number of species of phytoplankton identified. A total of 22 and 14 species of phytoplankton were identified from both ponds. This low figures from was as a result of the regular changing of the water in the ponds, the concreted nature of the pond and also the lack of vital minerals (phosphorus and silicic acid) which are vital to the growth and development of phytoplanktons, (Richtel, 2007). In the case of the concrete shaded pond, the shaded condition has a limiting effect on the phytoplankton present in the water as sunlight is blocked or stopped from reaching the surface of the water. The phytoplanktons won't be able to produce organic substances vital for their life processes through photosynthesis and they eventually die off, (Ghosal *et al.,* 2011).

Conclusion.

A total of (28) phytoplankton species belonging to 5 taxonomic groups, which are listed in order of dominance: *Cyanophyta, Chrysophyta, Chlorophyta, Euglenophyta and Pyrrophyta.* The low concentration of phytoplankton in these fish pond indicates the unpolluted nature of the pond and can be useful information as a check list to the management of the ponds as to the need for the regular change of the water in the fish pond especially the earthen pond.

Reference.

1. Antoine, D. (2005). "Bridging ocean colour observations of the 1980s and 2000s in search of long-term trends". *Journal of Geophysical Research* 110.
2. Arrigo, K.R. (2005). "Marine microorganisms and global nutrient cycles". *Nature* 437: 349–355.
3. Boyce, D.; Lewis, M.; Worm, B. (2010). "Global phytoplankton decline over the past century". *Nature* 466 (7306): 591–596.
4. Boyce, D.G. (2014). "Estimating global chlorophyll changes over the past century". *Progress in Oceanography*. Ocean. 2014.01.004.
5. Boyd, (2002). "Modelling regional responses by marine pelagic ecosystems to global climate change". *Geophysical Research Letters*-Wiley Online Library".
6. Cavalier-Smith T (1991). "Cell diversification in heterotrophic flagellates". Patterson DJ, Larsen J. The biology of free-living heterotrophic flagellates. Systematics Association Publications.
7. Cermeño, Pedro; Dutkiewicz, Stephanie; Harris, Roger P.; Follows, Mick; Schofield, Oscar; Falkowski, Paul G. (2008). "The role of nutricline depth in regulating the ocean carbon cycle". *Proceedings of the National Academy of Sciences* 105 (51): 20344–20349.
8. Cox, Peter M.; Betts, Richard A.; Jones, Chris D.; Spall, Steven A.; Totterdell, Ian J. (2000). "Acceleration of global warming due to carbon-cycle feed backs in a coupled climate model". *Nature* 408 (6809): 184–187.
9. Deng D. G., Xie P., Zhou Q., Yang H., and Guo L. G., (2007), Studies on temporal and spatial variations of phytoplankton in Lake Chaohu, *Journal of Integrative Plant Biology*, 49 (4): 409–418.
10. Edmondson W. T., ed. (1959), *Freshwater Biology*; John Wiley and Sons Inc, New York, USA.
11. Else J.J. (2007). The pathway to noxious *Cyanobacteria* blooms in lakes: the food web as the final turn. *Fresh water biology* 42: 537-543.
12. Emiliani.C. (1991). "Planktic/Planktonic, Nektic/Nektonic, Benthic/Benthonic". Journal of Palaeontology (Journal of Palaeontology, Vol. 65, No. 2) 65 (2): 329.
13. Encyclopædia Britannica, (2012), 'Phytoplankton' *Encyclopædia Britannica.*
14. Fanning, K.A. (1989). "Influence of atmospheric pollution on nutrient limitation in the ocean". *Nature* 339 (6224): 460–463.
15. Faust MA, Gulledge, R.A. (2002). Identifying Harmful Marine Dinoflagellates. Contributions from the United States National Herbarium 42. Washington, D.C.: Department of Systematic Biology, Botany, National Museum of Natural History.
16. Fogg, (1991). "*The phytoplankton way of life*". Volume 118, 1991, pp. 191–232.
17. Ghosal; Rogers; Wray, S. (2011). *"The Effects of Turbulence on Phytoplankton"*. Aerospace Technology Enterprise. NTRS.
18. Gregg. (2003) "Ocean primary production and climate: Global decadal changes. *Geophysical Research Letters* - Wiley Online Library".
19. Haddock SH, Moline, M.A., Case, J.F (2009). "Bioluminescence of the sea". Annual Review of Marine Science 2: 443.
20. Hallegraeff, G.M., Andewrson, D.M. and Cembella, A.D. (2003). *Manual on Harmful Marine Microalgae.* UNESCO, Paris.

21. Hastings JW (1996). "Chemistries and colours of bioluminescent reactions: *a review"*. Gene 172 (1): 5–11.
22. Henson, S. A. (2010). "Detection of anthropogenic climate change in satellite records of ocean chlorophyll and productivity". *Biogeosciences* 7(2): 621–640.
23. Hofmann, M.; Worm, B.; Rahmstorf, S.; Schellnhuber, H. J. (2011). "Declining ocean chlorophyll under unabated anthropogenic CO2 emissions". *Environmental Research Letters* 6 (3): 034035.
24. Hutchinson G.E. (1961). "The paradox of the plankton". *American Nature*. 95(882): 137–145.
25. Jeje C.Y, Fernando C.H (1986). A practical guide to the identification of Nigerian plankton, Kanji Lake Research Institute Nigeria 141.
26. Klausmeier, C.A.; Litchman, E.; Daufresne, T; Levin, S.A. (2004). "Optimal nitrogen-to-phosphorus stoichiometry of phytoplankton". *Nature* 429: 171–174.
27. Klausmeier, C.A.; Litchman, E.; Levin, S.A. (2004). "Phytoplankton growth and stoichiometry under multiple nutrient limitations". *Limnology Oceanography* 49: 1463–1470.
28. Knorr, W. (2009). "Is the airborne fraction of anthropogenic CO2 emissions increasing?". *Geophysical Research Letters* 36 (21).
29. Lindsey R., Scott M., and Simmon R., (2010), what is Phytoplankton? *NASA Earth Observatory*, http://earthobservatory.nasa.gov/Library/ phytoplankton/.2010.
30. Mackas, D.L. (2011). "Does blending of chlorophyll data bias temporal trend?" *Nature* 472: E4–E5.
31. McVey, James P., Nai-Hsien Chao, and Cheng-Sheng Lee. (1993). *CRC Handbook of Mariculture Vol. 1*: Crustacean Aquaculture. New York: C R C P LLC.
32. Microsoft Corporation, (2008), 'Phytoplankton' *Microsoft Encarta Dictionaries.*
33. Monastersky, R. (1995): "Iron versus the greenhouse." *Science News*, p. 220.
34. Moncheva S., and Parr B., (2010), Manual for phytoplankton sampling and analysis in the black sea, Phytoplankton Manual, UP-GRADE Black Sea Scene Project, FP7 No: 226592 Black sea Commission.
35. Mora, Camilo; Wei, Chih-Lin; Rollo, Audrey; Amaro, Teresa; Baco, Amy R.; Billett, David; Bopp, Laurent; Chen, Qi; Collier, Mark (2013). "Biotic and Human Vulnerability to Projected Changes in Ocean Biogeochemistry over the 21st Century". *Journal Public Biology*.1001682.
36. NASA, (2005). Satellite Sees Ocean Plants Increase, Coasts Greening".
37. NASA, (2009). "NASA Satellite Detects Red Glow to Map Global Ocean Plant Health.
38. Pfiester, Anderson (1987). "Ch. 14". In Taylor FJ. The Biology of dinoflagellates. Botanical monographs 21. Blackwell Scientific.
39. Raitsos, D. (2005). "Extending the SeaWiFS chlorophyll data set back 50 years in the northeast Atlantic". *Geophysical Research Letters* 32(6).
40. Redfield, A.C. (1934). In James Johnstone Memorial Volume (ed. Daniel, R.J.) 176–192. Liverpool University Press, Liverpool.
41. Reynolds C. S, (1984), the ecology of freshwater phytoplankton, Cambridge University Press, Cambridge, UK, pp.384.
42. Richtel, M. (2007). "Recruiting Plankton to Fight Global Warming*". New York Times.*
43. Rykaczewski, R. R.; Dunne, J. P. (2011). "A measured look at ocean chlorophyll trends". *Nature* 472: E5–E6.
44. Sarmiento, J.L. (2004). "Response of ocean ecosystems to climate warming". *Global Biogeochemical Cycles* 18 (3).
45. Schnepf E, Elbrächter M (February 1992). "Nutritional strategies in dinoflagellates: *A review with emphasis on cell biological aspects"*. Eur. J. Protistol. 28 (1).
46. Sekadende B. C., Mbonde A. S. E., Shayo S., and Lyimo T. J,(2004), Phytoplankton species diversity and abundance in satellite lakes of Lake Victoria basin (Tanzanian side), Tanz. J. Sci., 31(1): 83-91.
47. Shakily H., and Natarajan S,(2012). Phytoplankton diversity and its relationship to the physic-chemical parameters in the temple pond of Thiruporur, Chennai, International Journal of Environmental Biology 2(2): 81-83.
48. Steinacher, M. (2010). "Projected 21st century decrease in marine productivity: a multi-model analysis". *Biogeosciences* 7 (3): 979–1005.
49. Sterner, R.W. Elser, J.J.(2002). Ecological stoichiometry: *the biology of elements from molecules to the biosphere*. Princeton University Press, Princeton.
50. Stoecker DK (1999). "Mixotrophy among Dinoflagellates". The Journal of Eukaryotic Microbiology 46 (4): 397–401.
51. Tadesse O., (2007), Dynamics of phytoplankton in relation to physico-chemical factors in Lake Bishoftu, Ethiopia, M.Sc. Thesis, School of Graduate Studies, Addis Ababa University, Ethiopia.
52. Taucher, (2011). "Can we predict the direction of marine primary production change under global

warming?". *Geophysical Research Letters* - Wiley Online Library".
53. Thurman, H. V. (2007). Introductory Oceanography. Academic Internet Publishers.
54. Ultimate Reference Suite, Chicago*:* *Encyclopædia Britannica* University Press, Cambridge, UK, pp.384.
55. Verlecar X. N., and Desai S.R.,(2004). Phytoplankton Identification Manual. National Institute of Oceanography, Goa.

Appendix.

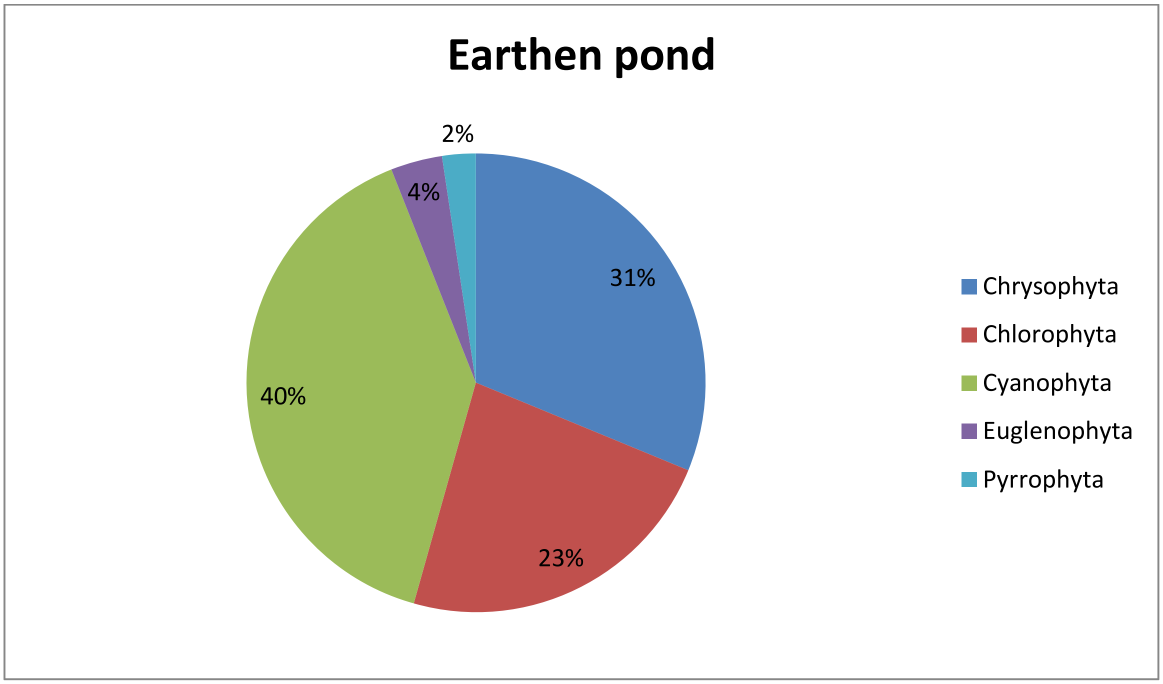

Figure 1: Taxonomic abundance of phytoplankton in earthen pond in Efugo Farm (June- July, 2015).

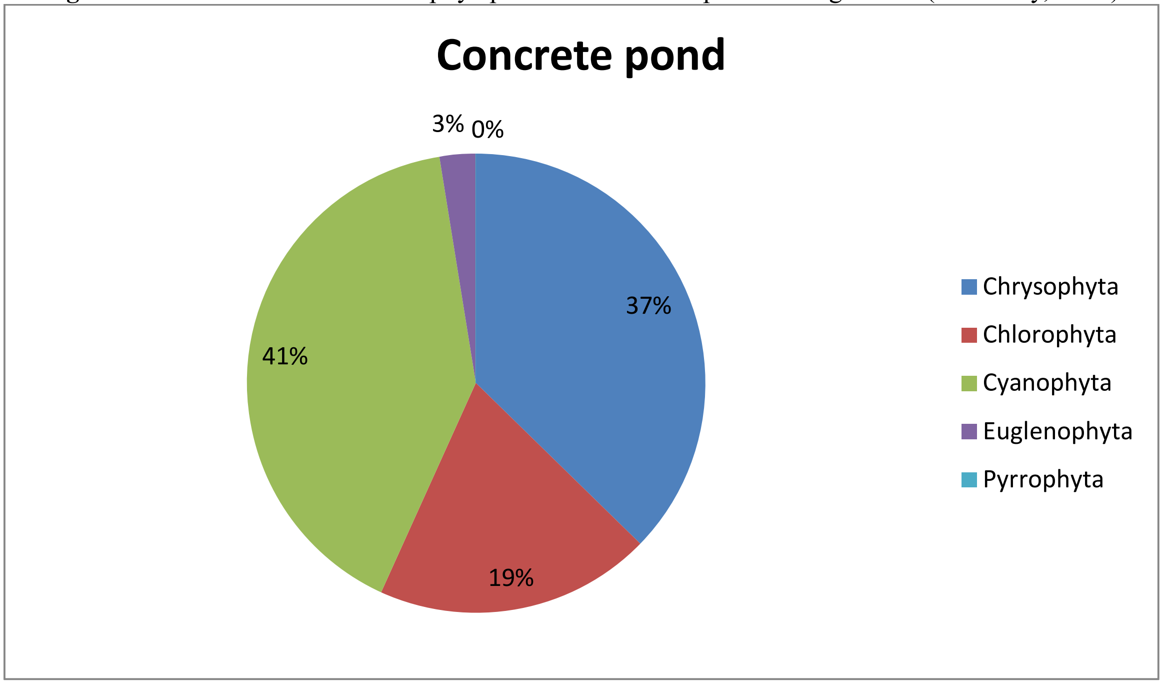

Figure 2: Taxonomic abundance of phytoplankton in Concrete pond in Efugo Farm (June- July, 2015).

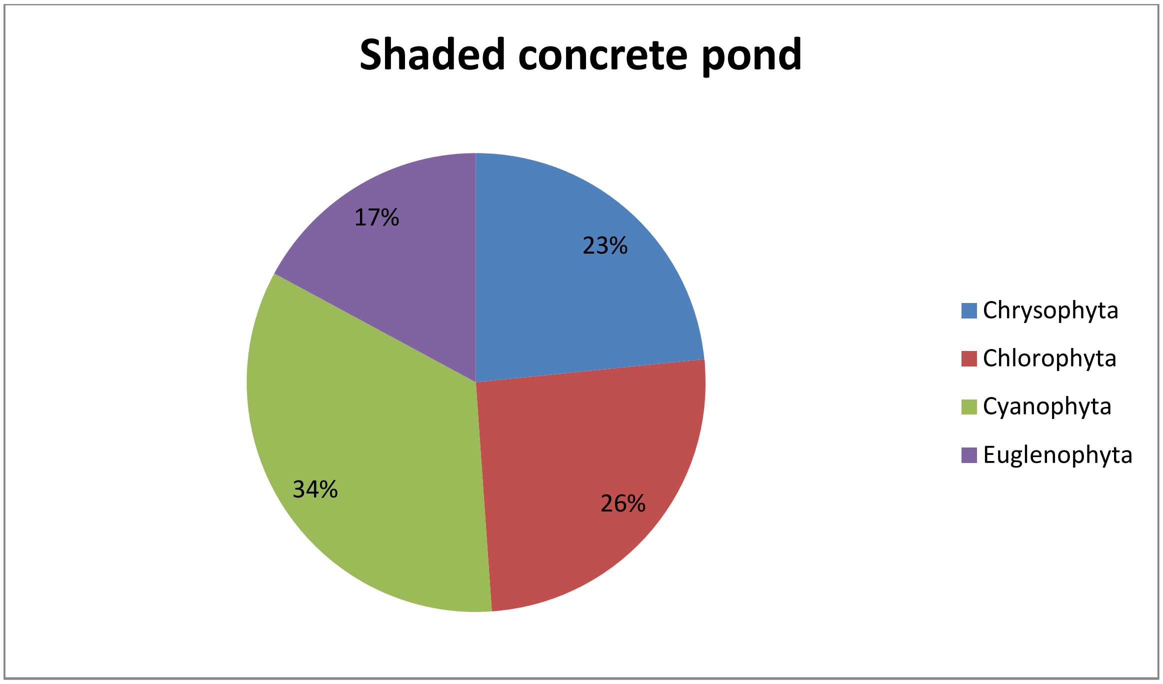

Figure 3: Taxonomic abundance of phytoplankton in Shaded concrete pond in Efugo Farm (June- July, 2015).

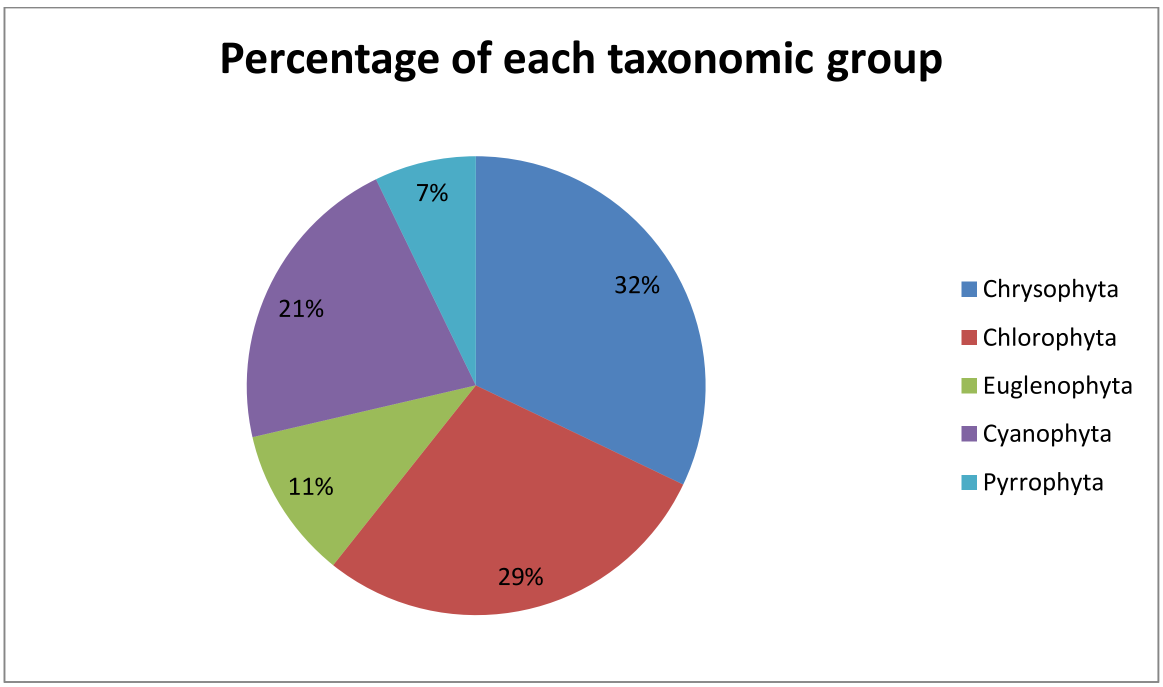

Figure 4: Taxonomic group abundance of phytoplankton in earthen pond, Concrete pond and Shaded concrete pond in Efugo Farm (June- July, 2015).

04/17/2017