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## ALGAL DIVERSITY AND DISTRIBUTION IN THE ESP FISH PONDS IN THARAKA-NITHI COUNTY, KENYA

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### ABSTRACT

The algal species composition, distribution, abundance and the water chemistry of the ESP fish ponds in Tharaka-Nithi County have remained unknown, although these greatly influence fish production in ponds. The Results presented here are from investigations over a period of six months of a that is an ongoing study Preliminary findings indicate that the major algal taxa in the ESP fish ponds in Tharaka are Chlorophyceae and Bacillariophyceae, both with a ubiquitous distribution in the study area. Cyanobacterial species exhibited a higher abundance (with an average of 235 cells ml<sup>-1</sup>) in the lower zone (Tharaka) than the middle (Itugururu) or upper (Chuka and Chogoria) zones. Among the cyanotoxin-producing species were *Aphanocapsa*, *Anabaena*, and *Microcystis* spp. Algal abundance exhibited a seasonal pattern with higher values during the rainy than the dry seasons. The highest pond water temperature recorded was in the lower zone, reaching a maximum of 31.9 °C in Tunyai (Tharaka). The minimum level of dissolved oxygen was 3.2 mg l<sup>-1</sup>. Molecular characterization of the algae cyanotoxin level determination and algal biomass are important aspects of and form the next phase of the present study. The results obtained are expected to play a vital role in formulating informed management policies in order to boost fish production in the ESP ponds of the Tharaka-Nithi County and at the national level.

**Keywords:** *Abundance, Cyanobacteria, ESP*

### INTRODUCTION

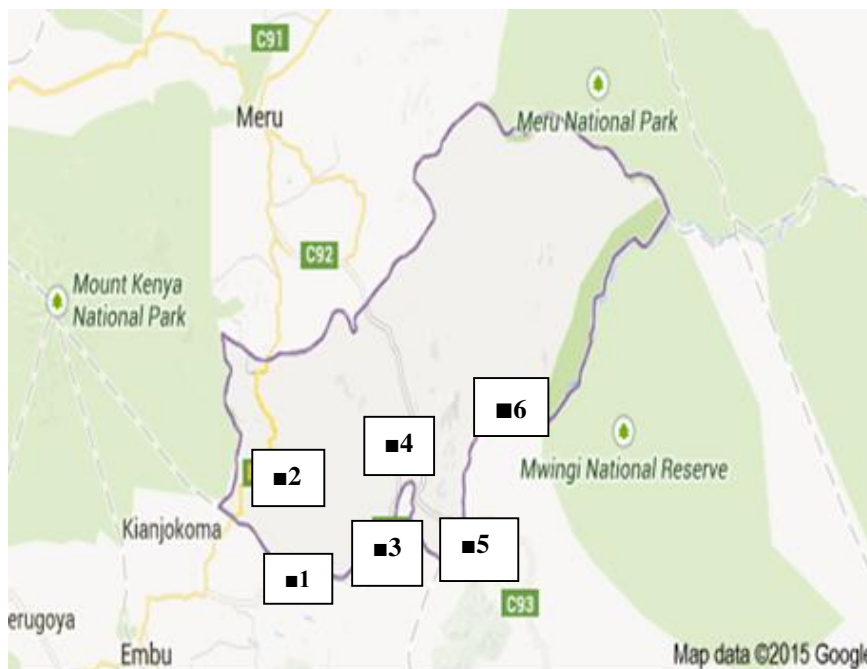
Algae form an important part of the diet of culture fish even where artificial feeding is practiced. They are the producers, occupying the first level of trophic status in the aquatic food chain as they use solar energy to convert carbon dioxide into organic matter that can be utilized by fish (Gross, 2003). Algal abundance in aquaculture systems can be used in the estimation of potential fish yields (Paulette et al., 2011). Cyanobacteria growing alongside the algae in the aquatic fish ponds also form a part of the culture fish (*Oreochromis nilotica*) diet. These have been shown to have undesirable effects on the fish, the environment and human health (Zimba et al., 2001; Reichwaldt and Ghadouani, 2012). The over-abundance or blooms of certain forms in aquaculture ponds poses a threat not only to the culture fish

themselves but to human health as well. When produced in high quantities with sufficient potency, cyanotoxins kill fish and other aquatic organisms (Shumway, 1990). Besides leading to decreased feeding rates of the fish and other aquatic organisms and imparting undesirable odours and tastes (Tucker, 2000). Ingestion of toxic cyanobacteria causes stress, sluggish movements and reduced reflexes accompanied by a reduction in overall health in *Oreochromis niloticus* (Marzouk *et. al.*, 2013). An understanding of the processes influencing algal assemblage in the ESP fish ponds in Tharaka-Nithi is crucial to sound management of the ponds for sustainable fish production in the county. This study seeks to investigate the algal forms occurring in the ESP ponds in relationship to changes in the aquatic environment.

## MATERIALS AND METHODS

### The Study Area

Tharaka-Nithi County lies between the longitudes 37° 18" and 37° 28" East, bordering the Meru County to the north and the Embu County to the south. The County boundary is marked by Mt. Kenya to the west and the Tana River to the east. It comprises the former Tharaka and Meru South Districts. The County has a bi-modal rainfall pattern with rains falling during the months of March to May and October to December (Republic of Kenya, 2016). The lower areas of the county are classified as semi-arid. The map of the county is presented in Figure 1.



**Figure 1.** Map of Tharaka-Nithi County showing Location of the Study Ponds: 1. Chuka; 2. Chogoria; 3. Itugururu; 4. Magutuni; 5. Kiaritha; 6. Tunyai (Source: Google Maps, 2015)

The ponds chosen for investigation was done following the Randomized Complete Block Design (RCBD). The study area was divided into 3 zones: Upper-, Middle- and Lower zones. The upper zone comprised Chuka and Chogoria areas, the middle zone Itugururu and Magutuni areas while the lower zone comprised Kiaritha and Tunyai areas. The zones were chosen to represent the three subcounties of Tharaka-Nithi. Each zone included two areas—one in the north and one in the east with 3 ponds in each area. Thus a total of 18 ponds were chosen for investigation.

### Sampling

Sampling was done once every month at regular intervals (on the same date of the month for each pond). Investigations were carried out between 10.00 and 15.00 H each time. Water temperature, pH, dissolved oxygen and conductivity were measured *in situ* using a digital multimeter readable to 0.01 units. Water

transparency or light penetration was measured using a 20-cm diameter Secchi disc bearing alternate black and white quadrants.

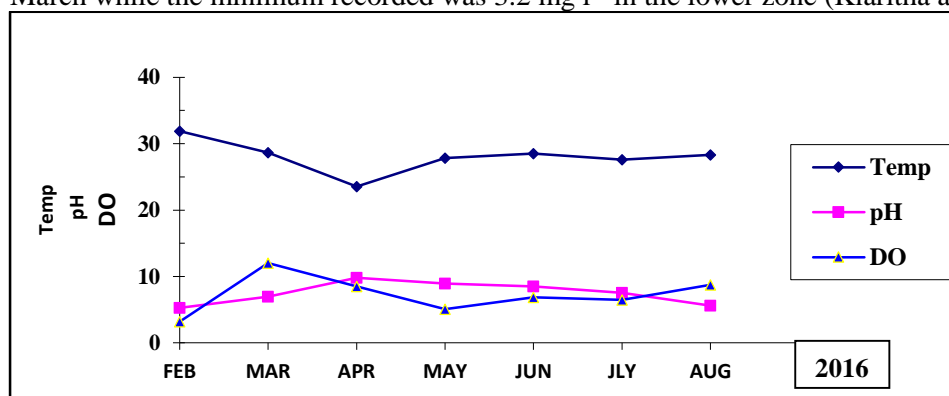
Samples for morphological characterization and enumeration were collected using a horizontal, opaque, plastic 2-litre van Dorn sampler at approximately 20 cm depth of each pond. Duplicate samples were obtained from three different points (near both edges and middle) in each pond. Immediately after collection, the samples were fixed using 0.5 ml of Lugol's solution per sample. Besides preserving the algae, Lugol's solution aids to accelerate cell settling and facilitates cell enumeration (WHO, 2000). Its composition is 100 g potassium iodide dissolved in 100 of distilled water, 50 g iodine crystals dissolved in 100 ml of glacial acetic acid. For algal cell enumeration, concentration was enhanced by settling 100 ml of the water sample in a Utermohl chamber of 2.5 cm diameter and a height of 1 cm, holding about 5 ml of the sample. Prior to enumeration, samples were allowed to stand in the chamber for 4 hours for complete settling of the algae. Counting was done on an AMSCOPE IN200TA digital inverted microscope at x400 magnification with oil emersion.

## RESULTS

### Physicochemical Data

Changes in water temperature exhibited a pattern influenced by the prevailing (rainy or dry) season. In the period of study it ranged between 23.52 °C in the upper zone during the wet season and 31.9 °C in the lower zone during the dry season. Other physicochemical parameters of the pond water, too, seemed to exhibit a seasonal pattern. Pond water pH generally dropped during the rainy season and to rise during the dry months. Higher pH values were recorded in the lower zone than in the middle- and upper zones. Ponds in this zone showed the largest variation in pH among the ESP ponds. It was between 5.26 in February (dry season) and 9.8 in April (rainy). Secchi depth ranged from 0.2-0.5 m.

Change in dissolved oxygen among the ESP ponds did not exhibit any seasonal pattern. For instance, the highest value of 12.0 mg l<sup>-1</sup> was recorded in the upper zone (Chuka area) during the dry month of March while the minimum recorded was 3.2 mg l<sup>-1</sup> in the lower zone (Kiaritha area) ( Figure 2).



**Figure 2.** Changes in water temperature, pH and dissolved oxygen in the ESP fish ponds

### Algal Assemblage

Following algal examination and enumeration, three main phyla were found to dominate the ESP ponds in the study area: Chlorophyta, Cyanophyta and Bacillariophyta. These three were found to be ubiquitous with Chlorophyta constituting the largest portion of the algal assemblage throughout the study period. Besides these three phyla, others were encountered but constituted a minor portion of the total algal assemblage. Table 1 shows the genera encountered of these three dominant phyla.

**Table 1. The dominant algal phyla in the ESP Ponds**

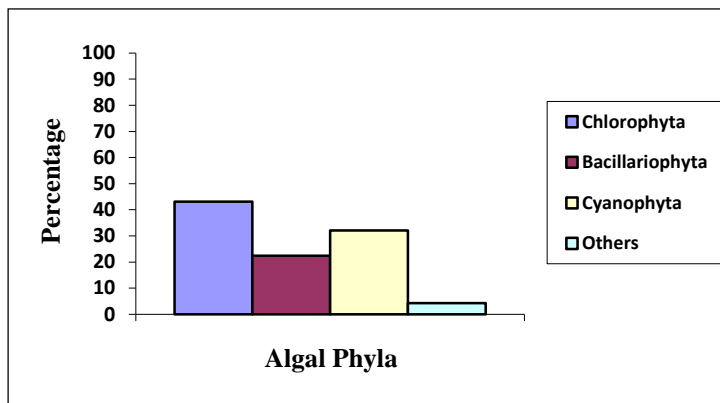
Phylum	Genus
Chlorophyta	<i>Scenedesmus</i>
	<i>Chlorogonium</i>
	<i>Pediastrum</i>
	<i>Kirchneriella</i>

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	<i>Staurastrum</i>
	<i>Coelantrum</i>
	<i>Treubaria</i>
	<i>Monoraphidium</i>
	<i>Chlorella</i>
	<i>Chlamydomonas</i>
	<i>Melosira</i>
Bacillariophyta	<i>Navicula</i>
	<i>Synedra</i>
	<i>Nitzschia</i>
	<i>Gomphonema</i>
	<i>Asterionella</i>
	<i>Microcystis</i>
Cyanophyta	<i>Chroococcus</i>
	<i>Aphanocapsa</i>
	<i>Oscillatoria</i>
	<i>Anabaena</i>
	<i>Lyngbya</i>

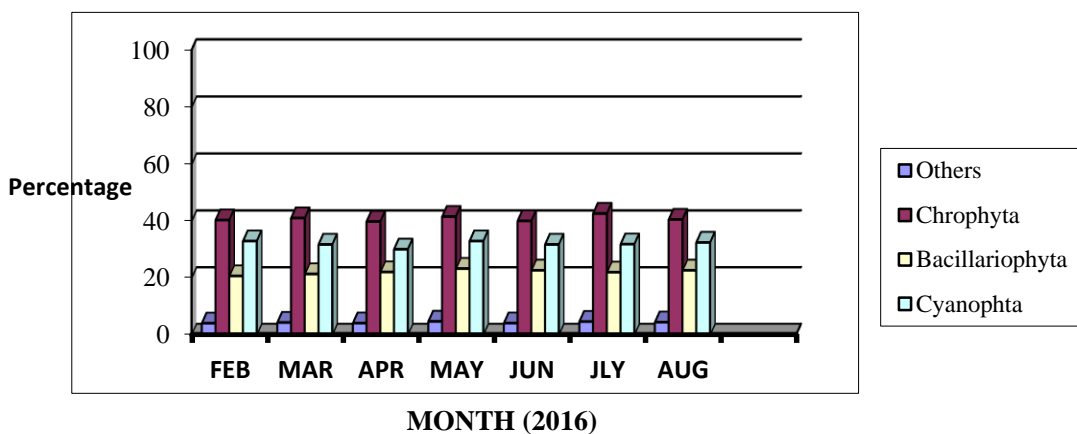
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Of the three phyla shown in Table 3, Chlorophyta genera were the majority, constituting 41.3% of the assemblage. Bacillariophyta constituted 22.4%, Cyanophyta 32.1% while 4.2% was composed of all other genera (Figure 2).



**Figure 3. Dominant algal groups in the ESP Fish Ponds**

This pattern of assemblage was observed during the seven months of investigation over the entire study area (Figure 4).



#### **Figure 4. Monthly distribution of the dominant algal groups in the ESP fish ponds**

#### **DISCUSSION**

The physicochemical properties of the pond water in the ESP ponds in the study area exhibit a seasonal pattern. Water temperature tends to decline during the rainy months (March and April) and to rise again in June through August at the onset of the dry season. Thus, air temperature seems to influence water temperature to some extent. Overall, levels of dissolved oxygen too, exhibited a seasonal pattern during the period of study. The high levels in March are likely associated with increased photosynthetic activity of algae and macrophytes in response to increased irradiance although this could result from addition of nutrients by through fertilization of the ponds together with application of artificial fish feeds. Pond water pH rose during the rainy season as a result of dilution with precipitation whose pH is normally about neutral (7.0). During the dry months, there is a higher concentration of ions, lowering the pH. The very low Secchi depths measured in the ponds are indicative of low transparency, which may reduce photosynthetic activity in the lower portions of the water column in the ponds. The higher prevalence of the chlorophytes, bacillariophytes and cyanopytes than other algal groups in the ESP fish ponds is an indicator of their better adaptation for the aquatic environment in this area. This could be due to the prevailing physicochemical conditions.

Among the cyanopytes there were encountered some genera are known to form blooms (usually referred to harmful algal blooms or HABs). These are known to pose problems in fish ponds because they lead to massive fish kills as a result of toxins (cyanotoxins) they release, usually in concentrations high enough to kill fish and other aquatic organisms. Among such genera were *Anabaena*, *Microcystis*, *Aphanocapsa* and *Lyngbya* spp. Besides killing fish directly, blooms kill fish by depleting dissolved oxygen from the water as they die off and as they undergo decomposition.

#### **CONCLUSION**

The results presented here are from investigations of a period of seven months. It is at the end of one complete year of investigation that concrete conclusions can be made with respect to the various aspects of algae in the ESP fish ponds in Tharaka-Nithi County. For instance, the effects of the incidences of cyanobacterial blooms in the ESP fish need to be understood with a view to averting them prior to their commencement. Equally important is an understanding of the dynamics of algal growth in relation to nutrients and eutrophication. Although algal groups have hitherto been identified from their morphology, their characterization by molecular technique is vital.

#### **ACKNOWLEDGEMENTS**

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