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Biodiversity of the Microalgal Population in Chettikulam Pond of Tenkasi District, Tamil Nadu, India

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Abstract--- *The number of natural ponds of Tamil Nadu is declining at a phenomenal rate. Consequently, there is not only water scarcity but also a loss of biodiversity of microalgae. The record of phytoplankton is essential in order to know the endangering algal species in these freshwater bodies. Chettikulam pond of Tenkasi Taluk was chosen to monitor the microalgal population as it is subjected to continuous exploitation by human beings. Totally 107 species were recorded from four main classes namely, Chlorophyceae, Bacillariophyceae, Euglenophyceae and Cyanophyceae. The class Chlorophyceae was dominant with 53 species followed by Bacillariophyceae with 31 species, Euglenophyceae with 6 species and Cyanophyceae with 17 species. Diversity indices calculated from the results show that the pond has a moderate level of diversity and Palmer index indicates that the ponds are polluted by organic compounds.*

Keywords--- *Microalgae, Chettikulam, Diversity Indices, Palmer Index.*

I. INTRODUCTION

Algae are crucial autotrophs dwelling in almost all of the aquatic ecosystems. About 90 percent of the algae are aquatic and algal growth in various habitats significantly influences the ecosystem. The freshwater ecosystem is classified into two major types namely lentic (standing) and lotic (running) systems. The water bodies such as lake, pond, and dams come under lentic ecosystem while water bodies like streams and rivers are lotic ecosystems (Hutchinson, 1957). The term pond is used for the class of very small shallow water bodies. Many factors determine the overall build up of the lentic ecosystem.

A plethora of research publications have focused on the water quality and nutrient content of Indian freshwater resources. There is an alarming rise in concern for these water bodies as they are contaminated by domestic waste, sewage, agricultural and industrial effluents (Senthilkumar and Kathiresan, 2008; Sultana and Gupta, 2009). The major organisms of these freshwater bodies are blue green algae, green algae, euglenoids, coccolithophytes and silicoflagellates that indicate either the health or the pollution states of their habitats (Bhatnagar and Devi 2013). Algal members of Cyanophyceae, Chlorophyceae, Bacillariophyceae, Euglenophyceae are maximum in the fresh water bodies and mostly microscopic in nature with potential industrial and economic values (Rai 2006). These classes of algae are influenced by abiotic factors such as chemical constituents, light and temperature (Sen, 2019).

The potential of these organisms can be utilized in various fields such as food, feed, fine chemicals, bioenergy and bioremediation. They are rich sources of protein, carbohydrates and especially essential fatty acids (Falkowski

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and Raven, 1997, Helena *et al* 2011). In the present study, the biodiversity of microalgae occurring in one of the frequently used ponds in Chettikulam, Tenkasi District, Tamil Nadu was analyzed.

II. MATERIALS AND METHODS

Water samples from Chettikulam pond (Fig.1) were collected during the period between October 2012 to September 2013. Samples were collected in the first week of every month.

Water samples had different types of algal communities. Some had large quantities of filamentous forms where as others were rich in phytoplankton in different shades of green. The filamentous forms were easily purified using needles in lower magnifications. The microscopic phytoplanktons were separated under higher magnifications with the help of capillary tubes. Those forms which could not be isolated from water samples were streaked on BBM plates and incubated for purification. This streaking method was continued until unialgal cultures were obtained (Parvin *et al* 2007).

The water samples were collected in clean, sterile plastic bottles. One portion of the sample was fixed in 4% formalin and the other portion was used for culture studies. Micro slides were prepared using glycerin as mounting solution. Few algae were stained with iodine and methylene blue. They were observed under light microscope and photomicrographs were taken in Nikon 8400 Microscopic Unit. Identification of the algal species was carried out with the help of standard books, monographs and research articles, (Krishnamurthy, 1954 & 2000; Desikachary, 1959; Philipose, 1967 &1988; Anand, 1998).

Temperature was measured by using a thermometer. Both atmospheric and water temperatures were recorded. The measurement unit of temperature is denoted in celsius (˚C). Light intensity was measured using LUX meter. pH was noted at the time of sample collection using the pH papers.

To analyze and evaluate the level of algal diversity from study area, the diversity indices such as Simpson's index, Shannon Wiener Index, Evenness, Berger-Parker index, Margalef's index and Palmer index were calculated. The diversity indices were derived using the software Biodiversity professional Vs 2.0 © 1997 and by conventional methods. The Natural History Museum and The Scottish Association for Marine Science.

III. RESULT AND DISCUSSION

A total of 107 species belonging to four classes were recorded from the study sites. Representative genera are in Fig.2.The members of Chlorophyceae dominated with 53 species followed by 31 species of Bacillariophyceae and 17 species of Cyanophyceae. Class Euglenophyceae was represented by 6 species.The order of dominance was, Chlorophyceae, followed by Bacillariophyceae, Cyanophyceae and Euglenophyceae.(Table 2). Chlorophyceae was represented by 49.53 % followed by Bacillariophyceae (28.97 %), Cyanophyceae (15.88 %) and Euglenophyceae (5.6 %) (Fig.3). similar percentage of the occurrence of micro algae in fresh water system has been reported by Sivakumar, 2016.

The dominant genera in this pond were *Tetraedron Cosmarium*, *Pediastrum*, *Scenedesmus* and *Closterium* of Chlorophyceae, *Gomphonema* and *Surirella* of Bacillariophyceae, *Lyngbya* and *Oscillatoria* of Cyanophyceae. Taxa

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belonged to 9 orders namely Volvocales, Chlorococcales, Ulotrichales and Conjugales of Chlorophyceae, Centrales and Pennales of Bacillariophyceae, Euglenales of Euglenophyceae and Chroococcales and Nostocales of Cyanophyceae. Totally 22 families were recorded in the water samples. Class Chlorophyceae was represented by 12 families namely, Chlamydomonaceae, Chlorellaceae, Oocystaceae, Selenastraceae, Hydrodictyaceae, Coelastraceae, Ulotricaceae, Cladophoraceae, Oedogoniaceae, Zygnemaceae, Mougeotiaceae and Desmidiaceae., (Table 2; Fig 4) Class Bacillariophyceae by 7 families, Coscinodisceae, Fragilariaceae, Achnanthaceae, Naviculaceae, Cymbellaceae, Nitzschiaceae and Surirellaceae, (Table 3) and Class Euglenophyceae by a single family Euglenaceae. (Table 4). Such a low level of contribution of Euglenophytes was reported in the freshwater habitats of Hawaii by Sherwood *et al* (2014) and in Brazil by Tavares *et al* (2010).

Scenedesmus obliquus, Scenedesmus dimorphus, Scenedesmus acuminatus of Chlorophyceae isolated from this pond are known producers of biodiesel. *Scenedesmus,* and *Chlorella* are known for their plant hormone production (Bajguz 2011; Stirk *et al* 2004). *Diadesmis confervacea* of Bacillariophyceae accumulates large quantities of oil and is used for the production of biofuel (Seckbach and Gordon 2019).

Class Cyanophyceae had two families, Chroococcaceae and Oscillatoriaceae. Totally 46 genera were recorded from the study pond. Among these organisms, 21 genera belonged to Chlorophyceae, 9 genera to Bacillariophyceae, 3 genera to Euglenophyceae and 8 to Cyanophyceae (Table 5). There was only a single species representation of the genera *Volvox, Oocystis, Crucigenia, Mougeotia, Aulacoseira* and *Microcoleus*.

Water and atmospheric temperature were checked in the first week of every month during the period from October to Sep 2014. The average atmospheric temperature of Chettikulam pond was between 26°C and 28°C and the average water temperature of the ponds was between 24°C and 27°C. Light intensities in the study pond were in winter 269 LUX in winter and summer 387 LUXin summer. The average pH of the pond water was between 8.2 and 8.5 in both winter and summer.

The diversity indices such as Simpson's diversity index, Shannon Wiener index, Evenness index Berger-Parker index and Margalef's index were calculated for the data obtained on the occurrence of microalgae in the study pond. The results are given in Table 6. In general, the value of Simson index ranges and between 0 and 1. In the current study, the value of Simpson's diversity Index was 0.352. The results show that the entire pond has a moderate level of diversity. The higher value of this index indicates greater species diversity. It also determines the pollution status of the water body. In this study, the Shannon Wiener Index was 0.504. Water of the study pond is not considered highly polluted as the average Shannon Wiener index is below 0.6. Evenness values range from zero to one, with zero signifying no evenness and one, a complete evenness. In the present study, the evenness value was 0.602 showing that the distribution of individuals was moderately even. Decrease in values indicates increase in diversity.

The value of Berger-Parker index in the present study was 0.495. The value of the Margalef's index of the study pond was 0.642 indicating that the aquatic environment of our study was species rich. Using the original Palmer's specifications (Palmer, 1969), index was calculated for the taxa collected during the study period. Palmer index calculated for the results of present study indicates that the ponds are polluted by organic compounds. (Table 7). The score was slightly on the higher side due to the presence of an extensive growth of the microalgae typical of

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eutrophic lakes such as *Anabaena*, *Microcystis* and *Fragilaria*. As mentioned by Jafari and Gunale (2006) and Sanap (2007), the presence of *Chlorella*, *Scenedesmus Ankistrodesmus* and euglenoids indicate nutrient-rich eutrophic nature of the pond.

These findings open up an avenue for further research on the density and diversity of the micro algae mentioned and raises an alarm for the preservation of economically important algae occurring in this pond.

Table 1: Classes of Microalgae recorded

S. No	Name of the Class	Species
1	Chlorophyceae	53
2	Bacillariophyceae	31
3	Euglenophyceae	6
4	Cyanophyceae	17
	Total	**107**

Table 2: Taxa belonging to the class Chlorophyceae

S.NO	ORDERS	FAMILIES	TAXA
	VOLVOCALES	**CHLAMYDOMONACEAE**	
	CHLOROCOCCALES	**CHLORELLACEAE**	
			Volvox aureus Ehr.
			Chlorococcum humicola (Naeg) Rebenh
			Chlorella variabilis Shihira *et*. Krauss
			Chlorella zofingiensis Dönz
			Tetraedron gracile (Reinsch) Hansg
			Tetraedron minimum (A. Br) Hansg
			Tetraedron triangulare Korshikov
			Tetraedron trilobulatum (Reinsch.) Hansg.
			Tetraedron tumidulum (Reinsch) Hans
		OOCYSTACEAE	*Oocystis solitaria* Wittr.
		SELENASTRACEAE	*Ankistrodesmus falcatus* var. *radiates*(Chodat) Lemmermann
			Monoraphidium circinale (Nygaard) Nygaard
		HYDRODICTYACEAE	*Hydrodictyon reticulatum* (L) Largerheim
			Pediastrum duplex Meyen
			Pediastrum duplex var. *reticulatum* Lagerh.
			Pediastrum duplex var. *subgranulatum* Racib
			Pediastrum ovatum (Ehrenb) A. Br.
			Pediastrum tetras (Ehrenb) Ralfs.
			Pediastrum tetras var. *apiculatum* Fritsch.
		COELASTRACEAE	*Crucigenia crucifera* (Wolle) O. Kuntze.
			Tedrastrum heteracanthum (Nordst.) Chodat.
			Scenedesmus armatus (Chodat) G. M. Smith .
			Scenedesmus armatus var. *bicaudatus* (Guglielmetti) Chodat
			Scenedesmus caudato-aculeolatus Chodat.
			Scenedesmus dimorphus Kutz.
			Scenedesmus longus Meyen .
			Scenedesmus obliqutis (Turp) Kutz.
			Scenedesmus perforates var. *major* (Turner) comb. nov.
			Scenedesmus quadricauda var. *longispina* (Chodat) G.M Smith.
			Scenedesmus quadrispina Chodat.
			Scenedesmus smithii Teiling.
	ULOTRICHALES	**ULOTRICHACEAE**	*Ulothrix subtilissima* Rabenhorst.
		CLADOPHORACEAE	*Cladophora glomerata* (Linn) Kutz.

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		OEDOGONIACEAE	*Oedogonium microgonium* Prescott.
			Oedogonium spheroideum Prescott
	CONJUGALES	**ZYGNEMACEAE**	*Spirogyra fluviatilis* Hilse.
			Spirogyra rectangularis Transeau.
			Spirogyra submaxima Transeau.
		MOUGEOTIACEAE	*Mougeotia tumidula* Transeau.
		DESMIDIACEAE	*Closterium jenneri* Ralfs.
			Closterium moniliferum (Bory) Her.
			Closterium parvulum Nägeli.
			Closterium pritchardianum W.Archer.
			Cosmarium abbreviatum var. *minus* (West & West) Krieger & Gerloff.
			Cosmarium bioculatum (Brébisson) *ex* Ralfs
			Cosmarium inane Turner
			Cosmarium nymannianum Grunow.
			Cosmarium ovulatum Turn.W.B.
			Cosmarium polygonum (Nageli) W.Archer
			Cosmarium porrectum Nordst
			Staurastrum anatinum Cooke & Wills.
			Staurastrum columbetoides West & West.
			Staurastrum recurvatum Turner
			Staurastrum trifidum Nordst

Table 3: Class Bacillariophyceae

S.NO	**ORDER**	**FAMILY**	**TAXA**
1.	**CENTRALES**	**COSCINODISCEAE**	
			Aulacoseira granulata var. *angustissima* O.Müller
			Cyclotella glomerata H. Bachm.
			Cyclotella stelligera Cleve & Grunow
			Melosira granulate (Ehrenb) Ralfs
			Melosira islandica var. h*elvetica* O. Muller
			Fragilaria capucina Desmaziers
2.	**PENNALES**	**FRAGILARIACEA**	*Fragilaria crotonensis* Kitton
			Fragilaria intermedia Grun
			Synedra acus Kützing
			Synedra dorsiventralis O. Muller
			Synedra rumpens Kütz
		ACHNANTHACEAE	*Achnanthes inflata* Kutz
			Achnanthidium exiguum (Grunow) Czarnecki
			Achnanthidium minutissimum (Kütz) Czarnecki
			Cocconeis placentula var. *lineata* (Ehrenberg) Van Heurck
		NAVICULACEAE	*Craticula ambigua* (Ehrenb) D. G. Mann
			Diadesmis confervacea (Kutz) D. G. Mann
			Gomphonema dichotomum Kützing
			Gomphonema gracile Ehrenberg
			Gomphonema lanceolatum Ehrenberg
			Gomphonema parvulum Kutzing
			Navicula radiosa Kützing
			Navicula rostellata Kützing
		CYMBELLACEAE	*Cymbella tumida* breb.
			Cymbella ventricosa C. Ag
		NITZSCHIACEAE	*Nitzschia filiformis* (W.Smith) Van Heurck
			Nitzschia obutasa W. Smith
			Nitzschia pusilla Grunow
		SURIRELLACEAE	*Surirella elegans* Ehrenberg
			Surirella splendida (Ehrenb) Kützing
			Surirella tenera Greg

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Table 4: Class Euglenophyceae

S.NO	ORDER	FAMILY	TAXA
	EUGLENALES	EUGLENACEAE	
			Euglena deses Ehrenberg
			Euglena proxima Dangeard
			Euglena sociablis Dang.
			Phacus acuminatus Stokes
			Phacus chloroplastes Prescott
			Trachelomonas hispida var. *coronata* Lemmermann

Table 5: Class Cyanophyceae

S.NO	ORDER	FAMILY	**TAXA**
1.	**CHROOCOCCALES**	**CHROOCOCCACEAE**	
			***Merismopedia tenuissima* Lemm**
			***Microcystis aeruginosa* Kütz**
			***Lyngbya ceylanica* Wille**
			***Lyngbya gracilis* (Menegh) Rabenh**
			***Lyngbya majuscula* Harvey**
			***Lyngbya martensiana* Menegh *ex.* Gomont**
			***Microcoleus chthonoplastes* Thur.**
2.	**NOSTOCALES**	**OSCILLATORIACEAE**	***Oscillatoria chalybea* Martens**
			***Oscillatoria curviceps* Ag.**
			***Oscillatoria limosa* Ag.**
			***Oscillatoria obtusa* N.L.Gardner**
			***Oscillatoria sancta* (Kutz) Gomont**
			***Oscillatoria subbrevis* Schmidle**
			***Oscillatoria vizagapatensis* Rao, C.B**
			***Phormidium subfuscum* Kutz.**
			***Anabaena anomala* Fritsch**
			***Nostoc spongiforme* Ag *ex.* Born *et.* Flah**

Table 6: Diversity analysis

S. No	Indices	Diversity indices
1	Simpsons	0.352
2	Shannon-Weiner	0.504
3	Evenness	0.602
4	Berger-Parker	0.495
5	Margalef	0.642

Table 7: Palmer's pollution index (Palmer, 1969)

S. No	Genus	Pollution index
1.	*Chlamydomonas sp.*	0
2.	*Pandorina sp*	0
3.	*Chlorella sp.*	3
4.	*Ankistrodesmus sp*	3
5.	*Scenedesmus sp.*	4
6.	*Closterium sp.*	1
7.	*Melosira sp*	1
8.	*Synedra sp*	2
9.	*Gomphonema sp*	1
10.	*Navicula sp*	3
11.	*Nitzschia sp*	3
12.	*Euglena sp.*	5
13.	*Lepocinclis sp*	0
14.	*Phacus sp*	2
15.	*Arthospira sp*	0
16.	*Oscillatoria sp*	5
17.	*Phormidium* sp.	1
	Score	34

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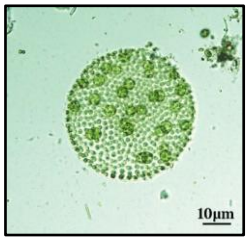
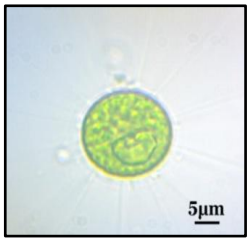
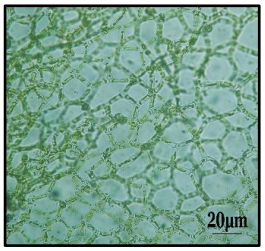
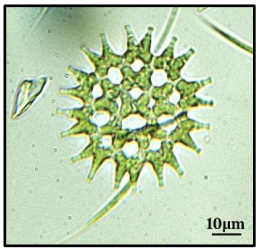
Fig.1: Study Pond

1	2	3	4
			
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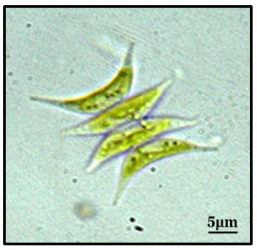	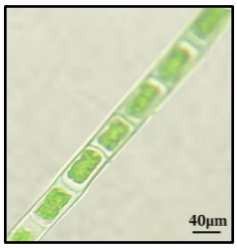	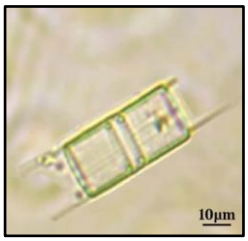	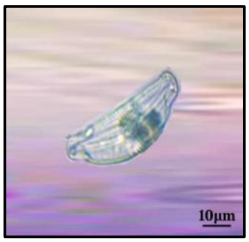
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	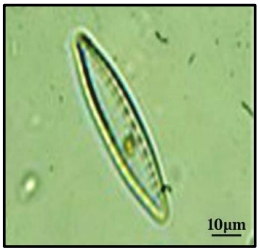	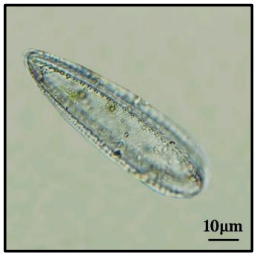	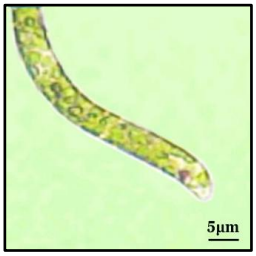
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		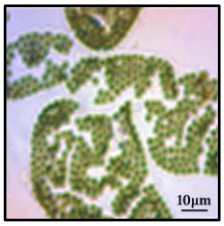	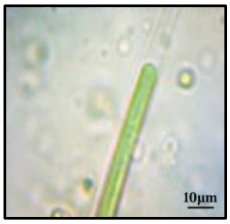

Fig.2: Representative algal species isolated from the study site

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1.*Volvox aureus* Her, 2. *Golenkinia radiata* Chodat, 3. *Hydrodictyon reticulatu*(L) Bory, 4.*Pediastrum duplex* var. *subgranulatum* Racib, 5. *Scenedesmus obliquus* (Turp) Kutz, 6. *Ulothrix subtilissima* Rabenhorst,7. *Aulacoseira granulata* var. *angustissima* O.Müller, 8. *Cymbella tumida* breb, 9. *Nitzschia kurzeana* Rabenh, 10. *Nitzschia pusilla* Grunow,11. *Surirella elegans* Ehrenberg, 12. *Euglena deses* Ehrenberg, 13. *Phacus acuminatus* Stokes, 14. *Euglena proxima* Dangeard , 15.*Microcystis aeruginosa*Kütz, 16. *Lyngbya ceylanica* Wille,

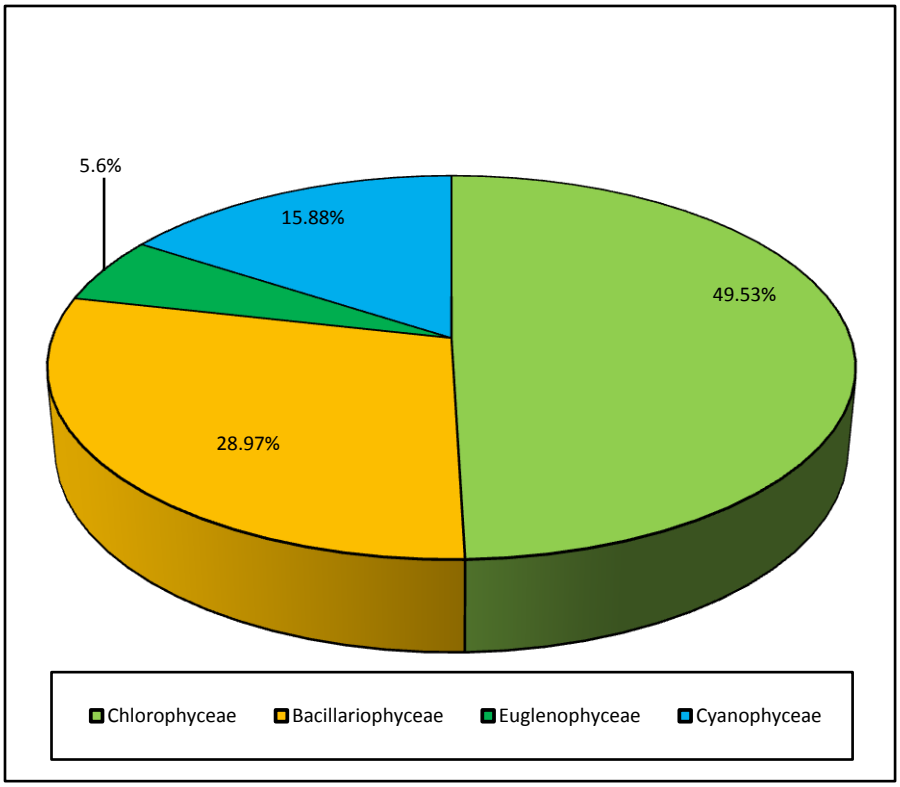

Fig. 3: Distribution of algal species in the study pond

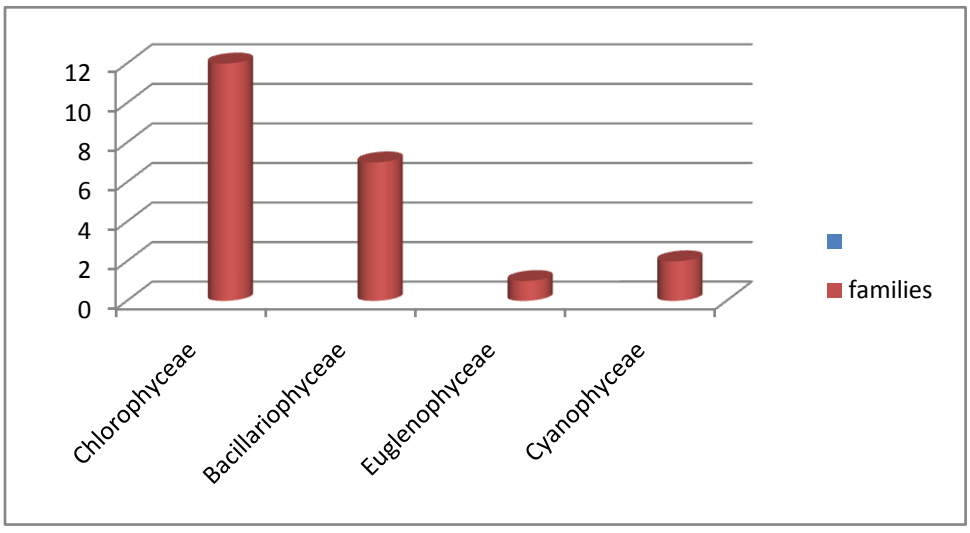

Fig. 4: Distribution of the families

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