Journal of Global Biosciences
ISSN 2320-1355
Volume 6, Number 6, 2017, pp. 5088-5094
Website: www.mutagens.co.in

Research Paper

INFLUENCE OF pH ON THE DIVERSITY OF SOIL ALGAE

Binoy T Thomas, Reshma Rajan , S. T. Saranyamol and M. V. Bhagya

Post Graduate & Research Department of Botany,
Phycotechnology Lab,
Catholicate College, Pathanamthitta, Kerala,
India.

Abstract

Soil algae are the significant biotic component in a tropical ecosystem. Diversity of soil algae in the area of Catholicate College, Pathanamthitta, Kerala in respect of various soil pH has been undertaken for the first time. A regular collection of soil samples has been made during the southwest and northeast monsoon seasons of Kerala. Altogether thirteen species of soil algae were isolated from the soil. They were observed directly from the field soil samples [strongly acidic and neutral to alkaline soil] as well as in the BG11 and Pringsheims nutrient medium of culture of soils. Soil *pH* was measured using a pH meter .Identification was based on the morphological features using the LX 400 Trinocular microscope and photographs were taken by using BioLinkz Cmos Cam [3.0m pixels] attached to the microscope. The highest distribution of green algae was observed from the strongly acidic soil, where pH ranges from 4.6 to 5.7. While at the neutral to alkaline soil [pH ranges from 7.2 to 7.8] distribution of blue green algae was more perceived. Pringsheims soil culture medium was highly effectual for the growth of green algae. It was found that pH as one of the major factors influencing the distribution of algae in the soil.

Key words: Nutrient medium, Physico-chemical factors, Biotic component, Ecosystem, Soil algae.

INTRODUCTION

Every soil is a complex and unique natural ecosystem [1] with specific biotic components. In all soils, algae represent the significant autotrophic community with diverse roles [2] . Soil algae are one of the integral parts of the soil ecosystem that depends upon complex environmental factors [3] . They are photoautotrophic microorganisms occurring in various natural habitats [4] and anthropogenically modified soils. They participate in many edaphic interactions and also involved in numerous food webs [5]. As primary producers; they play an important role in colonization of barren soils [6, 7].

Soil algae help in aggregation of soil particles and sand grains to form microbial crusts [8]. These soil microalgae bind the soil through the secretion of extracellular polymeric substances [EPS] mainly polysaccharides [9, 8]. These extracellular secretions allow soil microbes to create a habitat that protects the microalgal cells. Soil algae also take part to stabilize the soil surface of bare eroded soil against erosion and soil removal by wind [10, 11]. Thereby they serve as soil conditioners.

The Western Ghats of South India is one of the globally known biodiversity hot-spots of biological diversity [12]. Impacts of global climate change and diverse kinds of anthropogenial habitat destructions currently challenge the survival of many of the soil inhabitants everywhere in the world. Moreover, exact knowledge of the complex soil communities of specific soils is essential to the development of better conservation strategies for all the soil biota. Knowledge of the ecology and diversity of all soil biota in turn are significant to develop alternative sustainable agriculture at global levels. The major aim of the work was to investigate the diversity of soil algae in response to soil pH.

MATERIALS AND METHODS

Soil samples were taken on the upper 0- 2cm soil layer [13] from 10 different spots of Catholicate College, Pathanamthitta [9.2648^{0}N, 76.7870^{0}E] , Kerala [Figure 1]. The climate of the entire area is humid with a short summer [January to April] and plentiful rainfall [average annual rain fall in the district is 2610.3 mm] available in two monsoon seasons - the southwest [May to August] and the northeast [September to December] monsoons. The annual average temperature of the area is 28.00 ºC [14] .

1 kg of composite soil samples were taken for chemical analysis and culturing. Samples of soil collected during south-west [May to August 2016] and northeast monsoon [September to December 2016]. The samples collected from the field were immediately put in sterile cotton bags, brought to the laboratory and kept open in the laboratory shelves for air drying till the physico-chemical analyses, which were completed within two weeks after the collections.

Soil *pH* was measured from 1:2 [neutral distilled water] soil pastes of air dried sample. Soil *pH* was measured using a pH meter [Systronics 324]. Direct microscopic counts and culture count techniques were the process of assessing algal biomass in soils [15]. BG11 and Pringsheims medium were used to reveal the spectrum of algal species [16].

Two procedures were used to identify the algae. First, the colonies grown on agar plates were not identifiable by direct observation, so it was necessary to isolate the strains as unialgal mass. Uni algal culture was obtained by transferring a small amount of the cells from the mother plate to sterile test tube with the medium and allows incubation. Second, the 'growth slides' method was used. Soil samples were placed in sterile Petri dishes, covered with sterile cover slips, moistened with sterile water and incubated in the incubation chamber. The cover slips were removed and actively growing algae adhering them were examined under the microscope [13]. Microscopic features were observed by using the Olympus LX 400 Trinocular microscop0e and photographs were taken by using BioLinkz Cmos Cam [3.0m pixels] attached to the microscope.Characterization and classification of algae were carried out in accordance with on-line databases [16] and the systematic keys [17, 18,19].

RESULTS

From the current investigation, it was evident that distributions of algae were influenced by the chemical characteristics of the soil, mainly pH. pH ranges from 4.2 to 7.3, where highest pH was noted at the 7th site [7.3] and lowest was observed at the 1st site [4.2]. At the sites of 5, 6 & 7, pH was strongly acidic and ranges from 4.2 to 5.7. In the remaining sites pH was neutral to alkaline, where pH ranges from 6.0 to 7.3.

Altogether thirteen species of algae [Plate 1& 2] were isolated from the soil belonging to green, blue green algae and diatoms. *Chlorella vulgaris, Chlorococcum macrostigmatum, Coelastrella terrestris, Myrmecia bisecta, Microspora wittrockii, Klebsormidium sp.*and *Cosmarium sp.*were the common green algae isolated from the strongly acidic soil of which pH ranges from 4.6 to 5.7. *Chlorella vulagaris* was unicellular, spherical with trough or band shaped chloroplast and consist of large pyrenoid at the base. *Chlorococcum macrostigmatum* was also unicellular and spherical with parietal chloroplast and seen as irregular clumps. *Colesterella terrestris* had lemon shaped cell with sculptured cell wall. Its chloroplast was fragmented and parietal in appearance. Another unicellular spherical alga was *Myrmecia bisecta* with parietal or cup shaped chloroplast. *Microspora wittrockii* was filamentous algae composed of cylindrical cells with reticulate chloroplast and without pyrenoids. Cell wall made up of 'H shaped pieces' without intermediate septa. *Klebsormidium* sp. was another unbranched filament of uniseriate cylindrical cells with thin parietal chloroplast. *Cosmarium* sp. was a unicellular alga with median constriction in its cell. Cells of them have axile chloroplast and one pyrenoid. The species such as *Microcoleus, Oscillatoria* and *Leptolyngbya* were the common cyanophycean members identified from the soil. The trichome of *Microcoleus* sp.lacked heterocyst and their cells had equal diameter throughout whole length. In *Oscillatoria*, trichomes were short, straight with a bent or curve at the apical ends. The filaments of *Leptolyngbya* sp. were long, solitary and coiled as clusters and form fine mats. Usually colorless sheaths opened at the apical end. The cyanophyceaen members were usually present at the neutral to alkaline soil where pH ranges from 7.2 to 7.8.

Bacillariophycean members such as *Navicula membraneous, Navicula grimmi* and *Nitzchia palea* were the dominant diatom investigated from the soil. They were usually present at the acidic-alkaline soils where pH varies from 5.5 to 7.5. In *Navicula membraneous,* valves were linear with slightly convex margin and of straight raphe. *Navicula grimmi* was also lanceolate and possessed thin and straight raphe. Bilaterally symmetrical valves were present in *Nitzchia palea.*

Cyanophyceae and bacillariophyceae were present in the sites with higher pH, where as the green algal members under chlorophyceae, trebouxiophyceae, klebsormidiophyceae and zygnematophyceae found in more acidic soils. Cyanophyceae used to prefer steeper slopes of the sites.

BG11 and Pringsheims were the effective nutrient medium for the growth soil algae. Pringsheims medium was highly efficient for the growth of green algae. However bacillariophycean algae were usually developed in both the medium; preferably explored in the Pringsheims medium. BG11 medium was more suitable for the growth of cyanophycean algae.

DISCUSSION

Among the three major groups of terrestrial micro-algae [20], Chlorophyta predominate in acidic soils and Cyanobacteria in neutral and alkaline soils [6]. Tropical wet soils of the southern Western Ghats, in general are slightly acidic [21] but soil algal community

of the study area were sensitive biological zone, yet remains quite unexplored. Green-algal populations of topsoil are large and diverse group that performs valuable services both in the natural and cultivated soils [22, 6].

Systematic study of soil algae from the unexplored soil regions deserves great attention because of their high ecological and economic potentials. Moreover, natural biodiversity and ecology of algae from the tropical soils of India is remains quite meager. Therefore, the present pioneer effort to explore the common soil-algal community from the southern Western Ghats has global significance and relevance. pH as one of the major factor influencing the distribution of soil algae. 54% of the green algae belong to chlorophyceae, trebouxiophyceae, klebsormidiophyceae and zygnematophyceae flourished in more acidic soils. 23% of cyanophyceae present in the sites with higher pH. Bacillariophyceae preferably grow in both acidic and alkaline pH. The present investigation was supported by the different investigations [23, 7]. They examined the occurrence of green algae in highly acidic substrates and their dominance in acid soil. Cyanophyceae occupy in soil habitats with pH higher than 4.4. The higher pH values contribute to algal development mainly due to the enrichment of soil algae .The composition of green algae and cyanobacteria can serve as an indicator of soil quality. pH of the soil not only affecting the distribution pattern of algae but also controlling the algal growth [24].

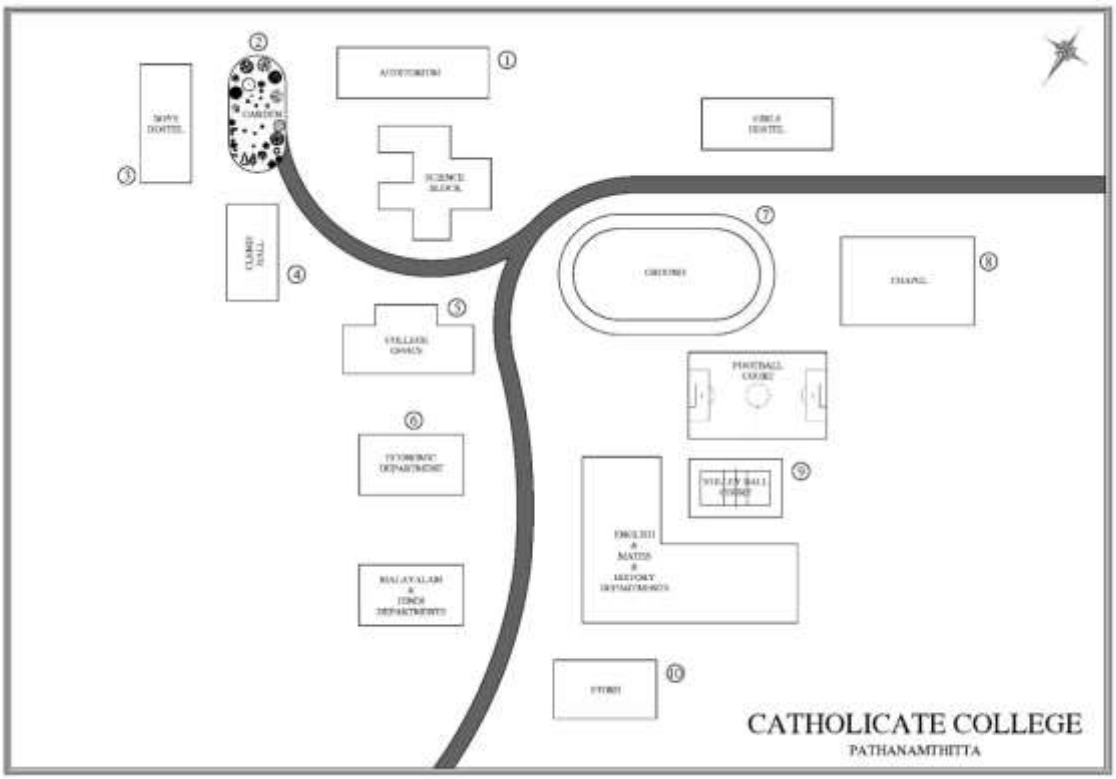

FIGURE 1

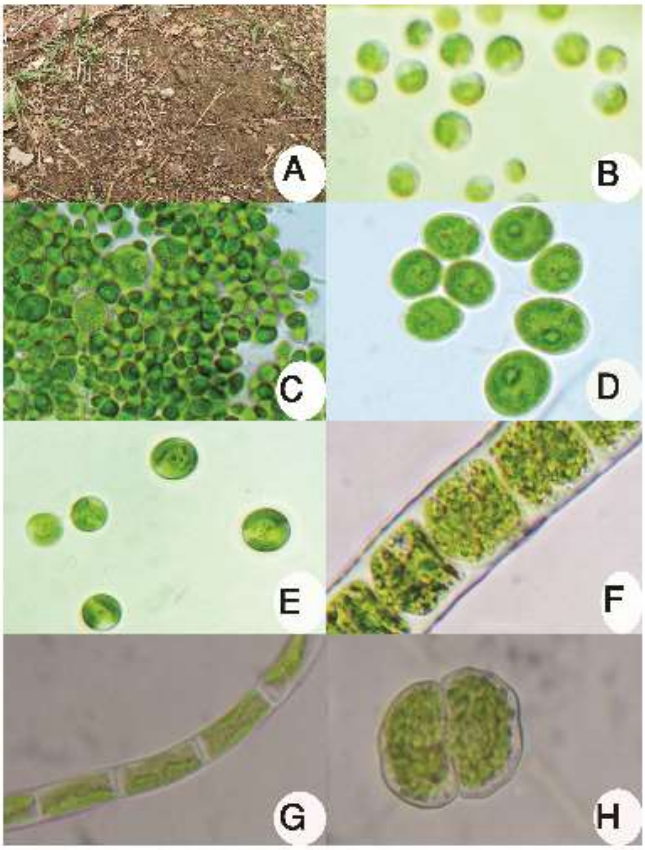

PLATE 1

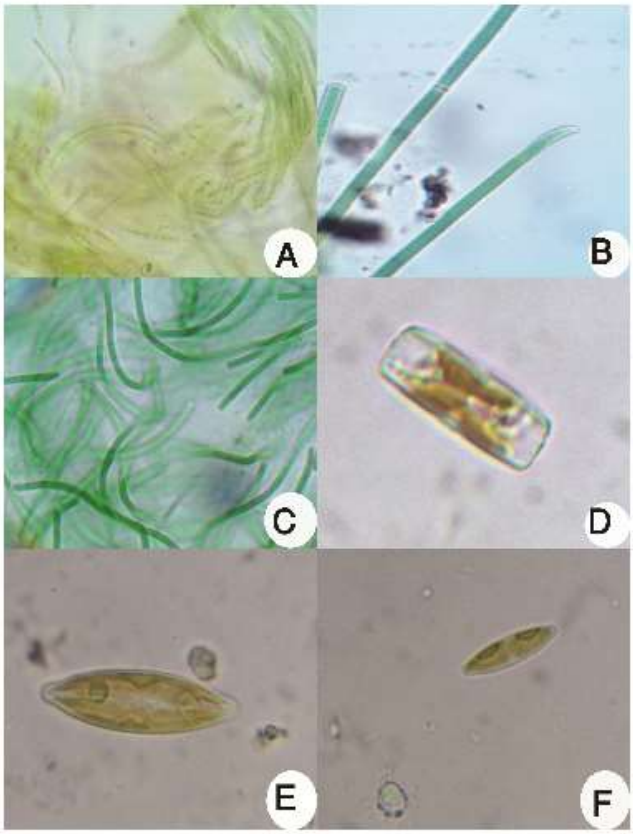

PLATE 2

CONCLUSION

Soil algal communities flourished in the region where human intervention is very less. Intensive ploughing and fertilizer application decreased the diversity of soil algae. The representative study area was more or less undisturbed. The pioneer investigation in this region revealed that the southern Western Ghats had rich algal diversity and their diversity is controlled by pH factor of the soil.

ACKNOWLEDGEMENTS

Authors recognised the support of Kerala State Council for Science, Technology and Environment [KSCSTE] for providing financial assistance to the completion of the student project. Also express sincere thanks to Department of Botany, Catholicate College, Pathanamthitta for the back support.

REFERENCES

[1] Robinson, D.A., Hockley N., and Dominati , E.S, 2012, Soil Science must embrace an Ecosystems Approach, CSA News **,** 57, 4-11.

[2] Garraza , G. G., Mataloni , G., Fermani , P, and Vinocur , A., 2011, Ecology of algal communities of different soil types from Cierva point, Antartica , Peninsula. Pol. Biol , 34, 339-351.

[3] Neustupa , J., 2001, Soil algae from marlstone-substratum based biotopes in the nature park Dzban [Central Bohemia, Czech Republic] with special attention to the natural treeless localities,Algological studies , 101, 109-120.

[4] Hussain, F., Anjum, G., Akhtar , P., and Durrani , M. J., 2010, Some members of class Xanthophyceae and Euglenophyceae from soils of Peshawar Valley, Khyber.

[5] Zenova , G.M., Shtina , E. A., Dedysh , S.N., Glagoleva, O.B., Likhacheva, A.A., and Gracheva , T.A., 1995, Ecological relations of algae in biocenoses, Mikrobiologiya 64, 121-133.

[6] Metting, B ., 1981, The systematics and ecology of soil algae, The Botanical Review 47, 195-312.

[7] Maxwell, C.D ., 1991, Floristic changes in soil algae and *cyanobacteria* in Recliamed Metal-contaminated land at Sudbury, Canada, Water, Air and soil pollution 60, 381-393.

[8] Hu, E.X ., Liu, Y. D., Paulsen , B.S., Petersen, D., and Klaveness, D., 2003, Extracellular carbohydrate polymers from free desert soil algae with different cohesion in the stabilization of fine sand grain,. Carbohydrate Polymers 5, 33-42.

[9] Decho , A.W., 1990, Microbial exopolymer secretions in ocean environment: their role[s] in food webs and marine processes, Oceanography and Marine Biology, 28, 73-153.

[10] Issa, O. M., Trichet, J., Defarge, C., Coute,A ., and Valentin, C., 1999, Morphology and microstructure of microbiotic soil crusts on a tiger bush sequence [Niger, Sahel], Catena 37, 175–196.

[11] Issa , O.M., Le Bissonnais , Y., Defarge , C., and Trichet , J., 2001, Role of a microbial cover ons structural stability of a sandy soil in Sahelian part of western Niger, Geoderma , 101,15–30.

[12] Gadgil , M., Daniels, R. J. R., Ganeshiah, K. N.,and Prasad ,S. N., 2011, Mapping ecologically sensitive, significant and salient areas of Western Ghats; proposed protocols & methodology, Current Science , 100,175-182.

[13] Zancan, S., Trevisan, R., and Paoletti , M.G., 2006, Soil algae composition under different agro ecosystems in North-Eastern Italy, Agriculture, Ecosystems and Environment,112, 1-12.
[14] Soil Survey Organisation., 2007, Bench mark soils of Kerala. Agriculture Department, Govt.of Kerala p 622
[15] Broady, P.A., 1979, Quantitative studies on the terrestrial algae of Signy Island, South Orkney Islands, British Antarctic Survey Bulletin 47, 31-41.
[16] Novakovskaya, I.V., and Patova, E.N., 2008, Green algae in the north-east of European Russia, Biologia , 63, 836-842.
[17] Pham, M. N., Tan, H. T. W., Mitrovic, S., and Yeo, H. H. T., 2011, A checklist of the algae of Singapore, Raffles museum of biodiversity research, National university of Singapore, Singapore.
[18] Prescott, G. W., 1962, Algae of the Western Great Lakes Area Dubuque, Lowa, William C.Brown Company Publishers, 977.
[19] Iyenger , M. O. P., and Desikachary, T. V.,1981, Volvocales, *ICAR*, New Delhi.
[20] Rindi , F., Allali, H.A ., Lam , D.W., and Lopez-Bautista, J.M., 2009, An overview of the Biodiversity and Biogeography of terrestrial Green algae In: Biodiversity hotspots, Nova Science Newyork, 105-122.
[21] Chandran ,P., Ray , S.K ., Bhattacharyya, T., Srivastava, P., Krishnan, P., and Pal, D.K., 2005, Lateritic soils of Kerala, India: their mineralogy, genesis, and taxonomy, Australian Journal of Soil 43: 839-852.
[22] Bongale , U.D., 1981 , Abundance of algal species in relation to soil types and major crops in cultivated soils of Karnataka state [India], Plant and Soil, 60, 289-293.
[23] Hoffmann, L.,1989, Algae of terrestrial habitats ,The Botanical review, 55,77-105.
[24] El-Gamal , A.D ., Ghanem, N.A.E ., El-Ayouty, E.Y., and Shehata, E.F., 2008, Studies on soil algal flora in Kafr El-Sheikh Governorate, Egypt, Egyptian Journal of Phycology, 9,1-23.