Mapping microalgal resources of Idukki District, Kerala in Western Ghats, India

Jose John[1], Mannancheril Sebastian Francis[2]

[1]Department of Botany, K.E. College, Mannanam, Kottayam, Kerala 686561, India, Email: jthuravackal@hotmail.com; [2]Department of Botany, Sacred Heart College, Thevara, Kochi, Kerala 682013, India

ABSTRACT

The algal biodiversity of Western Ghats (Idukki District, Kerala) is an unexplored area to a great extent. This first systematic study conducted on the 'Algal Flora of Western Ghats', and other parts of Idukki district revealed the rich wetland microalgal resource of that region. Through extensive field visit during various seasons, algal specimens are collected, preserved and identified. The specimens are located with the help of a GPS and digital images are produced through advanced digital photomicrography. Special emphasis is given to demarcate endemic species. A good number of them are new to science and many others are new reports from Indian subcontinent and Kerala state.

Keywords: Algal biodiversity, GPS, digital photomicrography, Western Ghats, endemic.

INTRODUCTION

Biodiversity is the wide spectrum of living organisms including plants, animals and microbes inhabiting the terrestrial, aquatic and other habitats. Biodiversity provides the basis of life on earth. With the explosive growth of human population, the life supporting system of earth is becoming increasingly threatened as the rate of global change accelerates. India is not an exception to such an extent of biodiversity depletion mainly due to man-made endeavors.

Monographing the algal flora of India was started as early as 1959. However, so far no systematic study has been conducted on the algal flora of fresh waters of Kerala [1]. The present investigation includes a systematic study on the freshwater algal flora of Western Ghats (Idukki District, Kerala, India), one of the biodiversity hotspots in the world which is an unexplored virgin land enriched with great many a species of algae. Idukki (9º 15' and 10º 21' of north latitude and 76º 37' and 77º 25' of east longitudes), the largest district of Kerala with an area of 5105.22 sqkm, is rich in algal flora.

It shows tremendous diversity and uniqueness with respect to geographical, topographical and climatic conditions. The highlands slope down from Western Ghats, which rise to an average height of 900 meters, with a number of peaks well over 1900 m in height, where the temperature is very low especially during winter; temperature varying between -1ºC to 15ºC in November/January and 5ºC to 15ºC during March/April. This area receives plenty of rains from both the South-West monsoon during June-August and the North-East monsoon during October-November.

MATERIALS AND METHODS

This study comprised of extensive field visit to different parts of the Western Ghats region of Idukki district during various seasons. Algal specimens are collected, preserved and identified. The specimens are located with the help of a GPS. Special emphasis is given to demarcate endemic species. Digital images of various taxa are taken with the help of a digital camera attached to the microscope and are transferred to the computer for further analysis.

RESULTS AND DISCUSSION

The state Kerala in general and Idukki district in particular is known for its luxuriant greenery, moderate climate and rich biodiversity. Idukki district with tropical ever green forest and rich freshwater resources is rich in microalgal diversity. Out of the eleven classes of algae, seven are represented in the present study. Out of the 33 taxa of algae recorded, 19 belong to Chlorophyceae, 1 to Xanthophyceae, 4 to Bacillariophyceae, 1 to Dinophyceae, 5 to Euglenineae, 2 to Rhodophyceae and 1 to Cyanophyceae. Of these 3 are new reports (1 from Rhodophyceae and 2 from Euglenineae). Algal samples were collected with the help of plankton net, in the case of smaller forms and direct mass collection for larger ones. Collections were made from the surface level, shallow bed, underside of rocks, mucilage masses attached to dripping rocks, tree trunks, streams, pools, rocky water bodies, ditches, canals, etc. The temperature and pH were noted. The locations of collections were measured with the help of GPS.

Botryococcus protuberance W. et G.S. West

M.T. Philipose, 1967, p. 197, Fig. 109

Colony irregular with 4-8-16 or more cells held together by a tough gelatinous membrane. Frequently joined together in compound colonies by long tough hyaline strands of mucilage. Cells ovoid, obovoid or ovoid-cuneate with their inner narrower ends embedded in the envelope, the outer ends being not so enclosed and projecting out of the colony. Cells 9.5-11.5µm broad, 16.5-20.0µm long. Colonies 100-120µm in diameter [2].

Found in site: Marayoor [N 09 53' 35.91"; E 77 12' 20.04"; pH 8.9; Temp 27ºC]

Dimorphococcus lunatus A. Braun

M.T. Philipose, 1967, p. 205, Fig. 115

Colonies irregular. Cells in groups of four and arranged alternately in a zigzag fashion. Outer cells of each group reniform or somewhat crescent shaped. Inner cells elongated-ovoid to ellipsoid. Ends of cells rounded. Chloroplast a parietal plate nearly covering the entire cell wall in mature cells. Cells 4-15µm broad, 9-25µm long. Colonies up to 100µm in diameter [2].

Found in site: Koduvely [N 09 57' 16.65"; E 76 46' 01.57"; pH 8.1; Temp 22ºC]

Thorakomonas sabulosa Kors.

M.O.P. Iyengar and T.V. Desikachary, 1981, p. 347, pl. 200, Figs. 1-4

Cells ellipsoidal in front view, up to 16µm long, 14µm broad; lorica rough, chloroplast cup-shaped; pyrenoid single, axial; eyespot anterior; contractile vacuoles 2, anterior [3].

Found in site: Iravikulam [N 10 09' 08.91"; E 77 01' 14.56"; pH 8.1; Temp 19ºC]

Tetraedron trigonum (Naeg) Hansg. fa. *gracile* (Reinsch) De Toni

M.T. Philipose, 1967, p. 142, Fig. 58a

Cells with more markedly concave sides than in the type. Cell membrane smooth. Cells 19-35µm in diameter, 6-8µm thick. Spines 6.2-7µm long[2].

Found in site: Mulappuram [N 09 57' 17.06"; E 76 45' 59.75"; pH 7.3; Temp 22ºC]

Glaucocystis nostochinearum Itzigsohn

M.T. Philipose, 1967, p. 188, Fig. 101

Colonies of 2-8 (usually 4) cells enclosed within the old mother cell wall. Cells oblong-ellipsoid and with a number (less than 20) of radiating chromatophore-like bodies inside, which are vermiform and blue green and belong to a member of the Chroococcales. Cells 10-18µm broad, 15-30µm long. Colonies 26-51µm broad, 39-63µm long[2].

Found in site: Karimannoor [N 10 03' 04.84"; E 76 52' 19.64"; pH 9.3; Temp 22ºC]

Ecballocystis courtallensis Iyeng.

M.T. Philipose, 1967, p. 168, Fig. 124

Thallus microscopic forming many celled branched dendroid colonies. The colony is attached to the rocky substratum with the help of a mucilaginous pad. Cells elongate, cylindrical with rounded or slightly conical ends. Cells 45-49µm long and 8-9.5µm broad; chloroplast parietal; lamellated polar nodular thickenings seen in mature cells [2].

Found in site: Iravikulam [N 10 09' 08.91"; E 77 01' 14.56"; pH 8.1; Temp 19ºC]

Trentepohlia umbrina (Kütz) Bornet

V. Krishnamurthy, 2000, p. 190

Filaments form a thin, crustaceous and fairly granular layer, reddish-brown. Cells of prostrate system rounded or ellipsoid, torulose, readily separating from one another and probably helping in dispersal by wind; 13-20µm in diameter, with smooth cell-wall. Sporangia stalked, terminal on poorly developed erect filaments [4].

Found in site: Nedumkandam [N 10 08' 39.07"; E 77 06' 25.42"; pH 9.1; Temp17ºC]

Temnogamatum tirupatiense Iyengar

M.S. Randhawa, 1959, p. 184, fig. 114 A,B.

Vegetative cells 11-13µm broad and 12-16 times as long as broad; chloroplast narrow plate-shaped with 10-15 pyrenoids in a row. Filaments monoecious, conjugation unique in being brought about between gametangia situated apart from each other in the same filament, through the coiling of the intervening portion of the filament; gametangia 11-13µm × 12-15µm; zygospores about 40-45µm in diameter [5].

Found in site: Vattavada [N 09 54' 41.27"; E 76 55' 00.47"; pH 7.8; Temp 19ºC]

Netrium digitus (Ehrbg.) Itzigs. & Rothe

Prescott, 1961, p. 8, pl. 1, fig. 5

Cell body 147-153µm long, 44-45µm wide; chloroplast parietal with fibricate margins [6].

Found in site: Kulappuram [N 09 57' 45.27"; E 76 42' 37.81"; pH 4.5; Temp 27ºC]

Arthrodesmus curvatus Turner var. *latus* Prescott

Prescott, 1961, p. 76, pl. 33, figs. 1-3

Larger and much wider than the species, both with and without spines. Chloroplast furcate with one pyrenoid per semicell. Cells W. ssp. 31µm; W. csp. 62µm; 34.1µm long; isthmus 9.3µm wide [6].

Found in site: Kaliyar [N 09 57' 17.04"; E 76 47' 03.21"; pH 7.6; Temp 26ºC]

Stigeocloniun faciculare Kützing

V. Krishnamurthy, 2000, p. 48

Plants tufted, 1-5cm long, bright green and slimy; prostrate system palmelloid or rhizoidal; erect filaments dichotomously or alternately branched below, primary branches often opposite above; rarely 2-4 primary branches forming a whorl on main axis; secondary branches mostly alternate, forming a fascicle on primary branches. Cells of the main axis cylindrical, but may be slightly inflated; cells of main axes 6-18.5µm in diameter, 2-4-7 times as long. Chloroplast a dense band [4].

Found in site: Kodikulam [N 09 57' 21.63"; E 76 47' 47.76"; pH 6.1; Temp 24ºC]

Mougeotia operculata Transeau

M.S. Randhawa, 1959, p. 151, fig. 69

Vegetative cells 18-21µm × 60-285µm; chloroplast with 4-8 pyrenoids, usually 4. Conjugation scalariform; zygospores in the conjugating tubes, compressed-spheroid, 27-30 × 21-27µm, with a prominent equatorial ridge and suture on the wall; spore wall pale yellow, shallow-scorbiculate [5].

Found in site: Udumbannoor [N 09 57' 06.76"; E 76 45' 31.77"; pH 7.4; Temp 21ºC]

Spirogyra longata (Vauch.) Kutz.

M.S. Randhawa 1959, p. 304, fig. 268

Vegetative cells 19-27µm × 99-165µm; septa plane; chloroplasts 1, making 6-8 turns. Conjugation scalariform and lateral; tube formed by both gametangia; female gametangia enlarged up to 37µm in diameter; zygospore globose, 23-30µm × 44-66µm and ovoid, mesospore brown and smooth [5].

Found in site: Vannappuram [N 09 55' 23.71"; E 76 47' 31.37"; pH 7.3; Temp 20ºC]

Spirotaenia condensata Breb

Prescott, 1961, p. 8, pl. 1, figs. 1, 2

Vegetative cells large, cigar-shaped, 60-334µm long, 10-30.4µm diameter, spiral band-form chloroplasts [6].

Found in site: Devikulam [N 09 59' 36.82"; E 77 02' 37.85"; pH 7.9; Temp 21ºC]

Onychonema laeve Nordst var. *latum* West & West

Prescott, 1961, p. 121, pl. 60, fig. 13

Cell body 15-22µm long, 17-25µm wide, constriction 7-8.6µm wide; semicells elongated ellipsoidal or broad hexagonal reniform, from both sides two short spines directing inward; apex flat with two long projections to connect with adjoining cell [6].

Found in site: Kaloor [N 09 57' 16.65"; E 76 46' 01.57"; pH 8.1; Temp 22ºC]

Pleurotaenum ovatum Nordst var. *intermius* Mobius

Prescott, 1961, p. 17, pl. 6, figs. 3,4

Cell body 212-307µm long, 79-95µm wide, isthmus 46-49µm wide [6].

Found in site: Kulamavu [N 09 51' 16.29"; E 76 58' 19.20"; pH 8.9; Temp 22ºC]

Staurastrum tohopekaligense Wolle var. *trifurcatum* West & West

Prescott, 1961, p. 114, pl. 48, fig. 2

Cell body 39-60µm long, 29-90µm wide, isthmus 18 µm[6].

Found in site: Paingottor [N 09 57' 16.65"; E 76 46' 01.57"; pH 8.1; Temp 22ºC]

Triploceras gracile Bail var. *undulatum* Scott & Pres

H. Hirosh, et al, 1977

Cell body 206-(310-360)-668µm long, (20-28)-53µm wide (including spines), L/W=10-15; semicells not swelled at base, slightly tapered at terminal, wavy lateral margin with short spines, 2 arm-like projections at each end, each projection equipped with two spines; cell wall smooth; axial chloroplasts with radially-arranged laminae [7].

Found in site: Ezhalloor [N 09 57' 17.06"; E 76 45' 59.75"; pH 7.3; Temp 22ºC]

Vaucheria uncinata Kutz

G.S.Venkataraman, 1961, p. 72, figs. 48a-f

Filaments 42-76µm broad. Oogonia and antheridia on fruiting branches which are trifurcate, furcations recurved, pendulous; oogonia spherical or compressed-spherica, two to seven, 135-175µm broad, 120-150µm long; antheridium short cylindric or saccate, occasionally circinate, antheridial wall disintegrating soon after opening [8].

Found in site: Koviloor [N 10 10' 54.12"; E 77 15' 33.49"; pH 9.4; Temp 20ºC]

Ophiocytium parvulum (Perty) A. Braun

L.H. Tiffany, 1952, p. 208, pl. 56, fig. 632

Cells 3-15µm broad, without polar spines, curved or bent, often very long and much intertwined [9].

Found in site: Painigottor [N 09 57' 16.65"; E 76 46' 01.57"; pH 8.1; Temp 22ºC]

Stauroneis agrestis Pet

Krammer and Lange-Bertalot, 1986, p. 247, fig. 90:21-22

Length 19-28 µm. breadth 4-6µm. striae 27-34 in 10µm [10].

Found in site: Viripara [N 10 14' 18.94"; E 77 11' 04.19"; pH 7.6; Temp 20ºC]

Pinnularia crucifera A. Cl. var. *subcapitata* A. Cl.

Sarode and Kamat, 1984, p. 139, fig. 360

Valves 42-52µm long, 7.5-7.8µm broad, linear with parallel margins and slightly capitate ends; raphe thin and straight with unilaterally bent central pores and curved terminal fissures; axial area wide, linear; central area large, reaching the margins; striae 12 in 10µm, almost parallel to one another or slightly radial [11].

Found in site: Kudakkallu [N 10 05' 21.57"; E 77 03' 47.72"; pH 8.8; Temp 12ºC]

Pinnularia braunii (Grun.) Cleve var. *amphicephala* (Mayer) Hustedt

Sarode and Kamat 1984, p. 136, fig. 351

Valves 51.5-54µm long, 8-8.5µm broad, linear elliptical with slightly constricted, somewhat produced, rounded capitate ends; raphe thin and straight; axial area somewhat narrow, linear lanceolate; central area very wide, rhomboid, reaching the margins; striae 10-11 in 10µm, radial in the middle and convergent at the ends [11].

Found in site: Pothamedu [N 09 39' 26.65"; E 76 55' 22.91"; pH 8.4; Temp 20ºC]

Gymnodinium fuscum (Ehr.) Stein

G.W.Prescott, 1951, p. 426, fig. 23

Cells large, ovoid, the epicone dome-shaped, the hypocone as broad as or broader then the epicone, narrowed, posteriorly to form an inverted cone with a slightly produced tip; transverse furrow slightly spiral; the longitudinal furrow extending about half way into the hypocone, but scarcely at all into the epicone; chromatophores numerous ovoid discs or rods, radially arranged; cells 55-60µm in diameter, 80-100µm long [6].

Found in site: Mailakkombu [N 09 57' 06.76"; E 76 45' 31.77"; pH 7.4; Temp 21ºC]

Astasia fustis Pringsheim

Wolowski, 1998, p. 45, figs. 158-161

Cells 73.5-90.0µm long, 11.1-17.7µm wide, cylindrical-elongated; each cell rounded at the anterior end, slightly tapering and tail-like towards the posterior end. The pellicle finely and spirally striated. The nucleus rounded without constant position, translocated. Canal opening apical. Flagellum up to 1/4 of the cell length. Paramylon grains abundant, ovate, usually translocated. Movement by wave like expansion to anterior or posterior cell, slight and rather constant [12].

Found in site: Mailakkombu [N 09 57' 21.25"; E 76 47' 31.56"; pH 8.4; Temp 24ºC]

Phacus ankylonoton Pochmann

Wolowski, 1998, p. 78, figs. 267-269

Cell 33.0-39.6µm long, 10.5-17.0µm wide, oval with long fold at the back, slightly curved cauda at the posterior end [12].

Found in site: Cheenikuzhy [N 09 58' 23.14"; E 76 42' 47.17"; pH 5.2; Temp 28ºC]

Trachelomonas hispida (Perty) Stein var. *hispida* (Starmach)

Wolowski, 1998, p. 56, figs. 186-187

Lorica 22.5-30.0µm long, 12.5-25.2µm wide, elliptical or broadly elliptical, covered with spines and small pores [12].

Found in site: Gaproad [N 09 53' 47.13"; E 77 11' 20.43"; pH 8.8; Temp 29ºC]

Batrachospermum vagum (Roth) C. Agardh.

T.V. Desikachary & V.N. Raja Rao 1980, p. 229.

Plants large, 2-20cm high; colour olivaceous with a tinge of blue green; profusely branched, the branching somewhat irregular. The terminal portions of axes and branches blunt. Whorls of branchlets distinct only in the younger portions, terminal cells of branchlets prolonged into long hairs. Sexual plants monoecious. Spermatangia terminal on branchlets, solitary or in clusters of 2-4. Carpogonial branches 7-14 celled, straight, curved or contorted, cells of carpogonial branch short, the lower ones bearing short 2-5 celled lateral branches reaching up to the level of the carpogonium, which is symmetrical, terminal on the carpogonial branch and provided with an inverted skittle shaped trichogyne: the carpogonial branch usually arising from the basal cell of branchlets. Carposporophyte one, rarely two, in each whorl, rather large, compact and subspherical: carposporangia terminal on the gonimoblast filaments.

Found in site: Oorkad [N 10 10' 49.78"; E 77 15' 20.59"; pH 9.2; Temp 16ºC]

Lyngbya birgei Smith

T.V. Desikachary, 1959, p. 296

Filaments straight, seldom coiled, free-floating, 20-24µm broad; sheath firm, colourless, mostly unlamellated; trichomes not constricted at the cross-walls, 18-23µm broad, ends rounded, not attenuated, not capitate, cells shorter than broad [13].

Found in site: Valara [N 09 55' 23.62"; E 76 58' 07.33"; pH 9.3; Temp 22ºC]

Cylindrospermum majus Kützing ex Born et Flah

T.V. Desikachary, 1959, p. 360, pl. 80, fig. 1

Thallus expanded, mucilaginous, blackish green; trichomes 4-5µm broad, constricted at the cross-walls, light blue-green; cells cylindrical, 5-6µm long; heterocysts oblong, up to about 10µm long; spores ellipsoidal, 10-15µm broad, 20-30µm long, epispore brownish with distinct papillae [13].

Found in site: Nettimedu [N 10 05' 47.78"; E 77 05' 59.00"; pH 10.8; Temp 04ºC]

Audouinella kurisukuthii sp. nov.

Family: Batrachospermaceae

Order: Batrachospermales

Class: Rhodophyceae

The thallus consists of a main axis (erect filament) and a basal rhizoidal system. The thalli are densely tufted, attached to substratum by the rhizoidal system. The cells of the erect filaments are cylindrical with uniform thickness and measuring 15-20µm in diameter and 35-40µm in length. Cells have a single lobed parietal chromatophore, devoid of pyrenoid. Branching is usually alternate and rarely opposite. The branches usually arise just below the septa of cells of the main axis. Single type of monosporangia born at the distal end of one celled branch of limited growth and they occur alone. The mature sporangia are usually almost spherical measuring 14-15 µ m in diameter. The stalk of the sporangium is oblong with 16-18µm length and 7-8µm width.

Found in site: Kurisukuthi [N 10 15' 27.52"; E 77 10' 04.61"; pH 7.3; Temp 21ºC]

Trachelamonas koduveliensis sp. nov.

Family: Euglenaceae

Order: Euglenales

Class: Euglenineae

Test cylindrical, bottle shaped, broadly rounded posteriorly, truncate at the anterior end and abruptly narrowed to form a comparatively longer cylindrical collar (6-7µm); wall smooth, thickened at the base of the collar; test 14-15µm broad at the middle, 12µm at the base; 36-38µm long.

Found in site: Koduvely [N 09 58' 23.14"; E 76 42' 47.17"; pH 5.2; Temp 28ºC]

Euglena kanthallorensis sp. nov.

Family: Euglenaceae

Order: Euglenales
Class: Euglenineae
Cells 43.4-78.5µm long, 11.0-20.5µm wide, fusiform; each cell slightly narrowing at the anterior end, posterior end attenuated. Chloroplast single, grass green, with undulated margins, seems detached from the pellicle. Eye spot prominent.
Found in site: Kanthalloor [N 10 13' 32.77"; E 77 11' 36.13"; pH 8.1; Temp 20ºC]

Although Kerala is known for its luxuriant greenery, moderate climate and rich biodiversity, it is under severe threat in the name of eco-tourism and various developmental activities. Being the primary producers in the grazing food chain, microalgae hold the key for the productivity of all water bodies. All animals living in water are directly or indirectly linked with microalgae in their life cycle. Mapping and enlisting all these taxa is the preliminary step to understand their links with other life forms. It would help to understand various possibilities of utilizing them as well as to take measures to withstand various anthropogenic pressures on their habitat.

REFERENCES

[1] Rao PSN, Gupta SL. In: Floristic diversity and conservation strategies in India, Mudgal V, Ajra PK (eds.), Botanical Survey of India, Culcutta, 1997.
[2] Philipose MT. Chlorococcales. Indian Council of Agricultural Research, New Delhi, 1967.
[3] Iyengar MOP, Desikachary TV. Volvocales. Indian Council of Agricultural Research, New Delhi, 1981.
[4] Krishnamurthy V. Alage of India and Neighbouring countries. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 2000.
[5] Randhawa MS. Zygnemaceae. Indian Council of Agricultural Research, New Delhi, 1959.
[6] Prescott GW. Algae of the western great lakes area. Cranbrook Institute of Science, New York, 1951.
[7] Fritsch FE. The structure and reproduction of the Algae. Cambridge University Press, London, 1935.
[8] Venkataraman GS. Vaucheriaceae. Indian Council of Agricultural Research, New Delhi, 1961.
[9] Tiffany LH, Britton ME. The Algae of Illinois. Hafner Publishing Co., New York, 1952.
[10] Krammer K, Lange-Bertalot H. Süßwasserflora von Mitteleuropa - Bacillariophyceae, Vol. 1, Gustav Fisher Verlag, Stuttgart, 1986.
[11] Sarode PT, Kamat ND. Freshwater diatoms of Maharashtra. Saikripa Prakashan, Aurangabad, 1984.
[12] Wolowski K. Taxonomic and environmental studies on Euglenophytes of the Krakow - Czestochowa upland (South Poland). W. Szafer Institute of Botany, Polish Academy of Sciences, Krakow, 1998.
[13] Desikachary TV. Cyanophyta. Indian Council of Agricultural Research, New Delhi, 1959.