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SOIL CHARACTERISTICS ASSOCIATED WITH BRYOPHYTES OF MELGHAT FOREST

WANKHEDE T.B.
Department of Botany Shri Shivaji Science College, Amravati
E-mail: tusharwan@gmail.com

ABSTRACT:
Bryophytes make a significant contribution to the floral diversity of this "watery planet" and since its inception constitute an important component of the forest ecosystem being the first colonizers on variety of habitats. They are highly specific group of plants with about 25,000 species distributed the world over, making it the second largest group of land plants after angiosperms. Certain bryophyte occurs at specific pH range and their presence can be used as indicator of soil pH. Bryophytes envelops the forest cover with moisture, temperature, prevents soil erosion can be used to monitor water pollution while many mosses are good indicators of air pollution. Present investigation shows that bryophytic vegetation of Melghat forest responds to soil texture, soil pH, and soil nutrients and also exhibits specificity to electrical conductivity, organic matter and soil depth. They are confined to slight acidic, moderately neutral and medium basic soil depending upon geographical distribution and also signifying specificity with the environmental conditions.

Key words: *Bryophytes, Soil Chemistry, Bio influence*

INTRODUCTION:

Soil is a vibrant ever-changing element and characterized not only by chemical and geological properties but also physical and biological characteristics. The quality of soil is rather dynamic and is the end product of soil degrative or conservative processes. It is controlled by chemical, physical and biological components of the soil and their interactions (Kennedy and Papendick, 1995). Bryophytes are more common in humid areas and during rainy seasons, but usually show a preference for microclimatic niches such as crevices of rocks and trees and the vicinity of small shady springs and can grow on wide range of substratum (Shaw and Renzaglia, 2004). However, Ganopadhyay (1992) showed that edaphic factors like organic matter, EC, temperature and N, P, K; ratio has a significant effect on vegetation as well as soil microflora. Bowen and Rovira (1999) believed that, the rhizosphere is a partnership between the plant, soil and soil organisms. Plant provide carbon and food source for soil organisms that bind the soil particles into aggregates and recycle soil nutrients while the soil provides the habitat, water and mineral nutrients for both soil organisms and plants.

Patel (1968) divided the soils of Melghat forest into Bouldery soil, Clay, Alluvium, Lateritic loam and Gritty loam type. The bouldery soil occurs mostly across the Melghat region and confined to the slopes. The soils found well drained and lacks moisture during dry season. The texture of soil varies as clay, loam or sandy loam and best vegetation of plants grow on this type of soil. The clay soil dominantly found in depressions and on flat areas. The clay soil generally found as black in colour and fertile. The soil occurs at low-lying areas and plains supporting good forest. The riversides and basins along the main rivers like Sipna, Gadga etc. represents a small area of alluvium type of soil. It varies from fine light brown silt to coarse masses favouring tree vegetation. The lateritic loam represents typical tropical forest soil occurring at hilltops and plateaus. It has characteristic red brown colour due to presence of iron oxides with small stones. Chikhaldara plateau generally resembles closely to lateritic showing fertility and trees growth. However, the Gritty loam occurs on the lower hills and derived from the weathering of the grey basalt

rock. Besides its fair quality, it is not fertile in real sense to favour tree growth. Soil serves as a medium for plant vegetation on the earth's surface. It consists of minerals as well as organic matter and air exhibits peculiar characteristics impressed by the physical and chemical action of tree roots, debris and forest humus. The soil dynamics are directly proportional to the growth of plants, ground cover vegetation, activity of organisms and climatic effects. Hence, several factors like climate, topology, organisms and parent material form a soil medium where root grows, anchor plants to absorb nutrients from soil and establishes a population or community (Brady and Weil, 2008).

MATERIAL AND METHODS:

Survey and site selection

For survey in Melghat forest, permission was taken by Principal Chief Conservator of Forest, Nagpur under wildlife protection rules, 1975. The core area of Melghat forest like Chikhaldara plateau, Semadoh, Kolkhas, Ghatang, Gugamal, Tarubanda, Belkund and their allied sites like Churani, Vairat, Bhimkund, Amazari, Koha, Khongada, Parsapur, Raipur and Makhala were selected for the study.

Soil analysis

Quantitative soil analysis was preferred than qualitative analysis for study of soil chemistry so that actual nutrient level can be assessed. Soil physico-chemical properties like Colour, Texture, pH, Temperature, TDS (Total Dissolved Solids), EC (Electric Conductivity) were evaluated using standard quality VSI Soil and Water Analysis Kit. The nutrient constitution like N (Nitrogen), P (Phosphorus), K (Potassium) and % C (Organic Carbon) were analysed in laboratory as per the procedure and protocols of Jackson (1973) and Mishra (1968).

The organic carbon from soil was determined by wet oxidation method as described by Nelson and Sommers, (1996).

RESULT & DISCUSSION:

Soil Analysis and bryophytic distribution:

A) Soil texture: The soil texture exhibits different characteristics at different locations. The upper plateau of Chikhaldara showed bouldery type of brown coloured soil across the allied regions also. However, the lower parts at the slopes like Semadoh, Kolkhas, and Tarubanda represents red coloured lateritic type of soil. The region of Raipur, Makhala, and Ghatang exhibit mixed type of soil with some patches of gritty loam, brown coloured soil. The basins of rivers like Sipna, Gadga represents black alluvium type of soil and allied regions also showed black soil along with the plains also (Table: 1).

B) Soil pH: The pH value of the soil was observed in between 6.73 to 8.06 representing slight acidic, neutral and slight basic nature across the region (Table 1). However, variations in pH values were observed across the different sites and among different bryophytic plants during the course of investigations. Plants like *Targionia* sp. found at pH value 6.73 while *Asterella* sp. found at 8.06 pH value near Belkund. pH is a good measure of the intensity of acidity and alkalinity of the soil-water suspension and provides appropriate information about the chemical nature of soil. pH of soil depends upon relative amounts of adsorbed hydrogen and metallic ions. Most of the bryophytes species occurs at neutral nature of soil and hence represents good biological indicator or ecological indicators in Melghat forest (Katznelson,1965)

C) Soil temperature (^{0}C) : The soil temperature observed in range of 16 ^{0}C to 29.1^{0}C among various samples, collected during the course of work (Table: 1). *Notothylas* sp. growing on brown coloured soil at Amazari showed lowest soil temperature of 16^{0}C while the plant *Hymenostylium* sp. near Madaki exhibited highest soil temperature of 29.1^{0}C collected during month of October (Fig: 1). The bryophytes occurring at low soil temperature showed maximum growth favouring prostrate or rosette

type growth at Belkund, Amazari, and Chikhaldara with plants like *Riccia* sp. and *Plagiochasma* sp. The soil temperature also depends upon slope, latitude of land, distribution of land and water, vegetation cover, nature of the soil and height of the location from mean sea level (MSL). As bryophytes are shade and moisture loving plants, their distribution favours the low temperature, high moisture and availability of water sources (Wang *et al.*, 1985).

D) Total dissolved soils (TDS): The total dissolved solids among the soil suspension observed in the range of 008 mg/l to 031 mg/l. The plants growing in different habitat at different locations showed variations in values of total dissolved solids (Table: 1). The plant *Folioceros* sp. of terrestrial habitat and found on red soil at Semadoh showed less TDS value of 008 mg/L while *Asterella* sp. at Belkund showed the highest TDS value of 031 mg/L collected during the rainy season. The total dissolved solids (TDS) offers on idea about presence of nutrients or salts present in soil with respect to concentration. Nutrient salts are important resources that limit the plant growth in tropical soil. The TDS range found in bryophytes of Melghat soil ranges from 008 to 031 mg/L (Table: 1). The plants like *Anthoceros* sp. and *Folioceros* sp. at Semadoh found in less TDS range while plants at Belkund and Koha like *Asterella* sp. and *Plagiochasma* sp. possess high TDS range as compared to others (Jordan and Herrera, 1981).

E) Electrical conductivity (EC): The electrical conductivity of soils of different locations was found in range between 0.073 mmhos/cm to 0.35 mmhos/cm (Table: 1). The terricolous hornwort *Folioceros* sp. found at Semadoh in red soil showed very less EC value of 0.073 mmhos/cm while *Asterella* sp. at Belkund showed 0.49 mmhos/cm. The electrical conductivity observed to be varying at different locations and habitats.

The electrical conductivity of the soil sample is the measure of current carrying capacity explaining the value of soluble salts present in it. The soil nutrient status in the rhizosphere will affect change in soil biological community, which ultimately has consequences on plant growth. The rhizosphere is a partnership between the plant, soil and soil organisms. Plants provide carbon and food source for soil organisms that bind the soil particles into aggregates and recycle soil nutrients while, the soil provides the habitat, water and mineral nutrients for both soil organisms and plants (Carling *et al.,* 1979).

F) Nitrogen content (N): The presence of nitrogen in the soil contributes to the vegetation stability in any habitat. The Nitrogen contents vary in different locations of the Melghat forest. Highest Nitrogen content was observed in Koha region among *Plagiochasma* sp. with 501.7 kg/ha and among *Phaeoceros* sp. at Semadoh region with 498 kg/ha collected during rainy season. The lower Nitrogen content were observed in *Targionia* sp. in black soil with saxicolous habitat with 134.1 kg/ha. However, most of the plants at different locations showed deficient to moderate nitrogen content in the soil. The terrestrial habitat of most of the plants showed moderate nitrogen content than the rupicolous or saxicolous habitat. The nitrogen content in the soil of Melghat forest and among bryophytic thalli ranges from 134-501 kg/ha (Table: 1). The nitrogen content found more in Belkund, Koha, Tarubanda region and few sites at Semadoh and Chikhaldara region. The plants like *Plagiochasma* sp.*, Asterella* sp.*, Reboulia* sp. and *Anthoceros* sp. in the region occurred in nitrogen rich soils of the forest with increase in vegetative growth. Low to moderate nitrogen contents found in the soils of Churani, Amazari, Gugamal and Ghatang showing good covering of bryophytes carpets. The organic matter formed from the decomposition of fallen debris is the most important constituent of the soil and the apex region of maximum biological activity. It is a primary source of plant nutrients, especially nitrogen and also determines the physical properties of the soil, like porosity and aeration (Ratnaparkhi, 2007).

G) **Phosphorus (P):** The phosphorus is a major nutrient block in plant metabolism, growth and development. The occurrences of phosphorus observed were variable from negligible condition to rich condition. Higher phosphorus content observed in Semadoh region among *Anthoceros* sp. with 102 kg/ha and among *Plagiochasma* sp. at Chikhaldara with 89.97 kg/ha collected during rainy season. However, lower phosphorus content was observed in nutrient deficient mosses growing on rocks along roadside or pools or pebbles like *Hymenostylium* sp. with 14.50 kg/ha and among *Plagiochasma intermedium* with 14.60 kg/ha growing on rocks of Gawilgarh in whitish soil. The moss *Hyophila* sp. also showed lesser content of phosphorus with 16.50 kg/ha growing on rocks at Madaki on Paratwada - Chikhaldara road. These soil samples collected during the month of December where winter season was prevailed in the region. The phosphorus content among bryophytes soil varies from moderate to high contents (Table:1) but deficient in the plants like *Plagiochasma intermedium* and among mosses growing on saxicolous habitats like *Funaria* sp., *Hyophila* sp. and *Hymenostylium* sp. due to epilithic substratum and nutrient deficient condition (Fig:1). However, the Chikhaldara and Semadoh exhibits high phosphate concentration in soil and the regions found rich in vegetation cover with maximum density of plants (Ratnaparkhi, 2007).

H) Potassium (K) : The potassium content among the soils of Melghat region was found quite higher and sufficient with respect to bryophytes (Table: 1) and parallel to other species like *Bryum* sp. or *Anthoceros* sp. etc. The lowest potassium content was observed in *Funaria* sp. at Gugamal forest with 200.48 kg/ha at terricolous habitat. The potassium played an important role in nutrient uptake and physiology of plant metabolism. The potassium contents among the soil of bryophytic thalli showed high value as compared to nitrogen and phosphorous. The regions like Koha, Belkund, Semadoh and Ghatang showed high concentration of potassium while Chikhaldara and other allied areas showed moderate value of potassium. Potassium is major contributor to osmotic potential of plant cells by balancing the charge of both diffusible and non-diffusible ions. It also acts as an activator of many enzymes in physiological processes like photosynthesis, respiration, carbohydrates metabolism, protein synthesis and stomatal movements (Jain, 2006).

I) Organic Carbon (C %): The percentage of organic carbon among the soils of bryophytes of Melghat forest ranges between minimum from 0.29 % to 0.53 % at maximum (Table:1). The bryophyte species *Cyathodium* of rupicolous habitat showed less 0.29 % organic carbon at Semadoh region while the species *Folioceros*, interestingly showed 0.53 % of maximum value in reddish lateritic soil in saxicolous and terrestrial habitat. The variable value of organic carbon observed during present investigation but related to vegetation and community. The percentage of organic carbon in bryophytes of Melghat forest found in moderate range of 0.29% - 0.53%. The regions like Semadoh, Chikhaldara, Khongada and Ghatang exhibits high organic content in the soil as compared to other regions. Hence, these regions show good quality of vegetation and forest cover (Glime, 2006).

J) Cation Exchange Capacity (CEC) : Bryophytes possess a typical cation exchange capacity (CEC) due to high concentrations of non-esterified pectates i.e. polyuronic acids called galacturonic acid within primary cell wall, than any of the other land plants (Clymo, 1963). These galacturonic acids have a carboxyl group ($COOH^+$) protruding on the outer surface of the wall. This carboxyl group freely exchanges its H^+ for other cations in its surroundings. K^+ ions often filter through the bryophyte layer and mostly bound on the bryophytes (Bates, 1982). Bryophytes have many exchange sites permitting differential binding of ions. Hence, the present investigations correlate with the findings of Glime (2006). From

above discussion, it is noteworthy that fungi are often associated with rhizoids of bryophytes because large numbers of bryophytes are afforded the advantages of fungal partner relationships providing them with considerably more surface area for acquiring nutrients.

Dhore, (2002) reaffirmed the characteristics of Melghat soil as Lateritic, Clay, Alluvium and Bouldery of Murrum types. The regions like Chikhaldara plateau, Semadoh, Ghatang road represents red bouldery soil in patches showing less fertility, nutrient deficiency and less water holding capacity. Certain saxicolous habitat of bryophytes like *Funaria hygrometrica, Targionia hypophylla* observed commonly on this soil. Nutrient deficient bryophytes can easily attach to the substratum of such soil. However, the regions like Amazari, Belkund, Tarubanda, Kolkhas and Semadoh show red brown lateritic type of soil. This represents high content of ferric oxides. Hornworts like *Anthoceros erectus, Folioceros udarii* and mosses like *Hyophila involuta, Funaria hygrometrica* were found on such type of soil. Frequent black soil clay patches found at the riversides of Sipna and Dollar at Semadoh, Kolkhas and near small creeks or water bodies at Chikhaldara and allied regions. The blackish clay or alluvium soil found at Semadoh, Churani, Madaki and on the plains show rich fertility and water holding capacity. The terricolous plants like *Riccia gangetica, Riccia discolor, Anthoceros erectus, Notothylas indica, Phaeoceros laevis* and sometimes *Plagiochasma appendiculatum* were found on this type of soil. The bright coloured, yellow green, fluorescent *Cyathodium tuberosum* also found on forest soil in shady conditions during rainy seasons. The brownish colour of soil observed at Semadoh, Gugamal and Chikhaldara region showing plants like *Targionia hypophylla, Hyophila involuta, Bryum coronatum* etc. in terricolous and rupicolous habitat. The colour of soil may be due to presence of humus (Ratnaparkhi, 2007). The mosses like *Brachythemium turgidum* and *Stereophyllum decorum* are of corticolous or epixylic in habitat found on the trees like *Mangifera indica* or *Ficus virens* due to rigid cortical cells and high moisture content in the region. The ability of mosses helps and enables them to occur on various habitats due to nutrient deficient trophic levels. This confirms that bryophytes can occur in wide range of different habitats (Slack, 1976).

CONCLUSION:

The distribution of bryophytes responds to topography, elevation, temperature, moisture as well as soil substrate and nutrients. At the higher altitude and maximum precipitation, rich bryophytes diversity observed in Gugamal, Chikhaldara, Semadoh and Belkund region. Most of the species occurs in pH range 6 to 8 i.e. slight acidic, neutral and slight basic nature. However, the distribution found variable among nutrient poor as well as nutrient rich vegetation. Hence, bryophyte species tends to be highly specific for particular microenvironment responding to temperature, light, humidity, precipitation and soil chemistry by making them good ecological indicator species. Considering the role of bryophytes in ecological succession in any ecosystem, much attention is now focused on this group by ecologists and conservation biologists.

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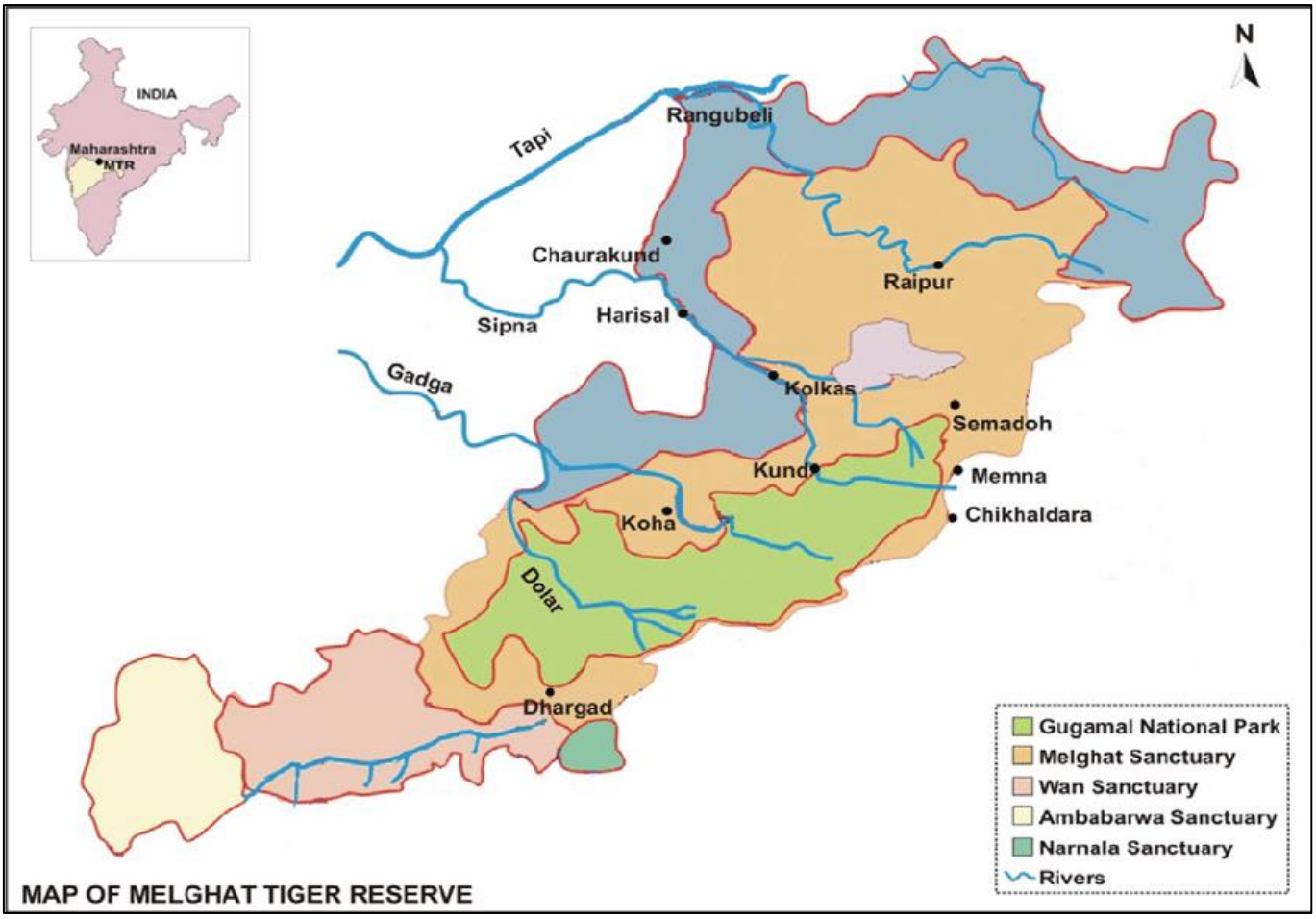

Fig 1. Melghat Forest Map

Table: 1 Physico-chemical analysis of the soil attached to the plant thallus.

Sr. No	Host Plant	Habitat	Colour	Texture (Type)	Location	pH (1-14)	Temp (°C)	TDS (mg/L)	*EC (mmhos/c	N (Kg/ ha) 281-420	P (Kg/ ha) 31-50	K (Kg/ ha) 181-240	C (%)
1	*Targionia hypophylla*	Saxicolous	Blackish	Clay	Semadoh	6.73	19.2	009	0.13	134.1	44.09	428.64	0.35
2	*Cyathodium tuberosum*	Terricolous	Blackish	Clay	Bhimkund	7.78	18.3	018	0.17	360.6	74.48	574.56	0.32
3	*Cyathodium cavernarum*	Rupicolous	Brownish	Lateritic	Semadoh	7.12	20.1	012	0.25	329.0	34.44	504.4	0.29
4	*Asterella angusta*	Saxicolous	Reddish	Bouldery	Belkund	8.06	21.0	031	0.26	428.3	45.0	683.7	0.33
5	*Reboulia hemisphaerica*	Terricolous	Reddish	Lateritic	Amazari	8.00	22	015	0.21	239.1	56.33	398.12	0.31
6	*Plagiochasma appendiculatum*	Terricolous	Reddish	Bouldery	Chikhaldara	6.89	18	010	0.14	403.2	89.97	478.2	0.47
7	*Plagiochasma intermedium*	Saxicolous	Whitish	Lime	Gawilgarh	8.00	16.2	009	0.21	211.1	14.60	398.1	0.31
8	*Plagiochasma rupestre*	Terricolous	Brownish	Lateritic	Koha	7.42	19	026	0.16	501.7	47.93	668.6	0.32
9	*Riccia gangetica*	Terricolous	Reddish	Lateritic	Khongada	7.56	20	012	0.29	239.1	41.52	396	0.41
10	*Riccia discolor*	Terricolous	Blackish	Clay	Churani	7.55	23	016	0.35	236	58.14	436	0.35
11	*Anthoceros erectus*	Terricolous	Blackish	Clay	Semadoh	7.18	24	009	0.18	266	102	346	0.34
12	*Folioceros udarii*	Saxicolous	Reddish	Lateritic	Semadoh	6.77	21	008	0.073	260	41.0	413	0.53
13	*Notothylas indica*	Terricolous	Brownish	Bouldery	Amazari	7.12	16	011	0.12	266	46.2	471	0.44
14	*Phaeoceros laevis*	Terricolous	Blackish	Alluvium	Semadoh	6.81	22	012	0.15	448	82.82	685.8	0.38
15	*Funaria hygrometrica*	Terricolous	Brown Red	Lateritic	Gugamal	7.6	19	011	0.21	250	27.14	200.8	0.41
16	*Brachythemium turgidum*	Epixylic	On tree	On tree	Gawilgarh	-	-	-	-	-	-	-	-
17	*Bryum coronatum*	Terricolous	Ash-black	Gritty-loam	Ghatang	6.89	26	012	0.09	241	32.87	680	0.47
18	*Stereophyllum decorum*	Epixylic	On tree	On tree	Bori	-	-	-	-	-	-	-	-
19	*Hyophila involuta*	Epilithic	Brownish	Lateritic	Kolkhas	7.85	24	013	0.25	321	16.50	463	0.37
20	*Hymenostyliu m recurvirostre*	Epilithic	Blackish	Clay	Madaki	6.90	29.1	017	0.14	230	14.50	390	0.43