

On the occurrence and distribution of *Psammophytes* and their local uses: a case study from Dibrugarh district of Assam, North East India.

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Abstract

Psammophytes are the important plant group that grow in sandy soil and play important role in managing sustainable ecosystem maintenance. The plants are also being used traditionally by many ethnic communities living adjoining forest and hill areas in Eastern Himalaya. However, there is short of information on their local uses from ethnobotanical prospective linking it's ecosystem services. Hence, a study was undertaken to understand distribution of Psammophytes and their interaction with existing niche and prospects of their use by local ethnic communities of Dibrugarh district, Assam. The study enlisted 49 species under 46 genera belonging to 24 families. Among these, family Poaceae has the highest representation with 12 species followed by Rubiaceae with 3 species having lowest numbers. The phytosociological quantification revealed that *Imperata cylindrica* (L.) Beauv (Mean IVI=32.93) is the most important species in ecosystem dominated by psammophytes. The important value index ranges from $IVI \geq 10$ to < 1 IVI with varied species compositions. A highly diverse interaction of species was recorded and the similarity index (QS) of the sampling plots estimated between 0.737 to 0.571. Besides, these species are also being used by local inhabitant in various purposes begins with cattle fodder to rituals. As many as 14 species have been recorded to have huge market potential and are being sale in the market by local farmers to meet their daily minor need.

The present article highlighted the distribution pattern and plant community interaction alongwith ethnobotanical perspective with focus on local uses of Psammophytes and their market potentials which would be helpful not only in understanding the plant community interaction but equally useful for formulation of location specific policy planning for future implementation.

Keywords: Phytosociology; Species interaction; Similarity Index; Fodder; Rituals.

1. Introduction

Psammophytes are the plants grow on sand where water retention is very low and the climate is dry. Warming (1895) classified the plant communities into five broad categories viz. Oxylophytes, Halophytes, Psammophytes, Lithophytes and Chasmophytes, based on the nature of the substratum. Later, it was included under the broad categories of Xerophytic group of plants [1]. This group of plants is generally designated as sand loving plants. The resistance to critical dry period through seeds and fruits of these plants exert ecological significance, wherein under favourable condition germinate to complete the life cycle in a week time [2]. Besides, they also play pivotal role in mitigating environmental hazard such as soil erosion and nutrient losses. The deeply rooted plants cleave to the loose sandy soil particle together and the whole plants act as vegetation cover [3,4] of the entire ecosystem so that loose soil will not erode from the soil surface. In recent past, it is reported that many of the psammophyte species are useful in developing socio-economic growth of rural society [5].

Within a diverse plant community, information on frequency, density, abundance and basal cover of species do not explain the total picture of ecological importance independently. So an important value index (IVI) is used as the marker of ecological magnitude of a given plant community. The IVI is evaluated by adding the values of relative density, relative frequency and relative dominance [6]. Thus, this helps in identifying keystone species of the community structure available on the given ecosystem. On the other hand, in heterogenous community, occurrence of different stands sometime become evident due to the influence of various environmental factors and

thus resulting different stands come into existence in the community. Sorensen (1948) had attempted to draw the factors influencing the type of community by comparing the similarity and dissimilarity characters between and among the stands [7]. Later, Looman and Campbell (1960) had established the ecological classification of plant community based on the floristic similarity on the site on the basis of species presence [8].

Several authors made contribution towards the phytosociological works on crop land weeds and grass communities [9, 10, 11]. Significant studies on phytosociological works have been reported from Varanasi on weeds of wheat and gram crops [12], rice fields at Mussorie [13], Korla [14] and Raipur [15] etc. in India. Besides, some other authors had made important contributions to phytosociological works in India in recent time [16, 17, 18]. However, there is very limited or no relevant information on psammophytes either in phytosociological studies or its ethnobotanical importance especially on psammophytic plant composition, hence it is imperative to prepare an account on the distribution and ethnic uses of psammophytes, how environmental factor and local population is governed by the local ecosystem. Keeping these factors in mind, a study was endeavoured to record the existing psammophytic plant species and their ethnic uses in Dibrugarh district of Assam, North East India.

Dibrugarh is located between 27° 5' 38" N to 27° 42' 30" N latitude and 94° 33' 46" E to 95° 29' 8" E longitude and occupying a total geographical area of 3381 km². It shares common boundary with Sivasagar district on the west, river Brahmaputra on the north, Tinsukia district on the East and Tirap district of Arunachal Pradesh on its south. Administratively, it has one sub division i.e. Dibrugarh, 9 developmental blocks, 9 revenue circles, 93-gram panchayat and 1362 villages. As per census 2021, the total population of the district is 1,472,232 where 51.77% is male and 48.23% is female. Majority of the populace (80.72%) of the district is living in rural area.

Climate of the district is known for high humidity, rainfall and moderate temperature without extremes of heat and cold. The average temperature ranges maximum 27°C -37°C and minimum of 9°C-17°C. Rainfall is heavy during the monsoon in summer in this area and the rainy season starts from June to September. The soil of the district is alluvial, less acidic consisting of sand, silt and clay. On the river side the soil contains high percentage of sand about (65-75%) followed by silt (12-26%) and clay (6-16%) with no humus content. NPK stint of the soil is also very low.

Due to relatively long rainy season and high rainfall, most of the areas are covered by ever green and semi ever green forests. The commonly occurring species of this forest are *Dipterocarpus macrocarpus*, *Artocarpus chaplasha*, *Duabanga sonneratioides*, *Shorca assamica*, *Adina cordifolia*, *Pterospermum acerfolium* etc. and several other shrubs, climber and herbs. Many marshy and swampy tracts are frequently met with low lying areas with shrubs, trees and some hydrophytic vegetation.

2. Materials and Method

The study was endeavored to explore the existing Psammophytes of Dibrugarh district of Assam. For the present work, a survey was conducted in five selected localities viz. Bogibil, Majorbari Ghat, Dihing Mukh, Rahmoria and Sessa of Dibrugarh district (Plate-I). To understand the distribution pattern, the quadrat method of 1x1 m² was followed in five randomly selected sites. Phytosociological analysis was carried out by quadrat method on 20 random samples at each study site. Then Importance Value Index of each species was quantified and average values of five sample sites were calculated. Vegetation information so obtained was analyzed quantitatively [7] and a comparative account between all sites was analyzed. The ethnic uses, senior inhabitants and knowledgeable personnel of neighbouring villages were selected randomly and interviewed by using semi structured questionnaire [19, 20] and documented their local uses. The collected specimens were identified with the help of taxonomist from Botanical Survey of India, Shillong and prepared herbarium by comparing with regional herbaria deposited at ARUN and ASSAM, consulting regional floras [21, 22, 23, 24, 25]. Literatures on uses of those scouted psammophytes were consulted in both national and global arena to ascertain their global importance on conservation perspectives.

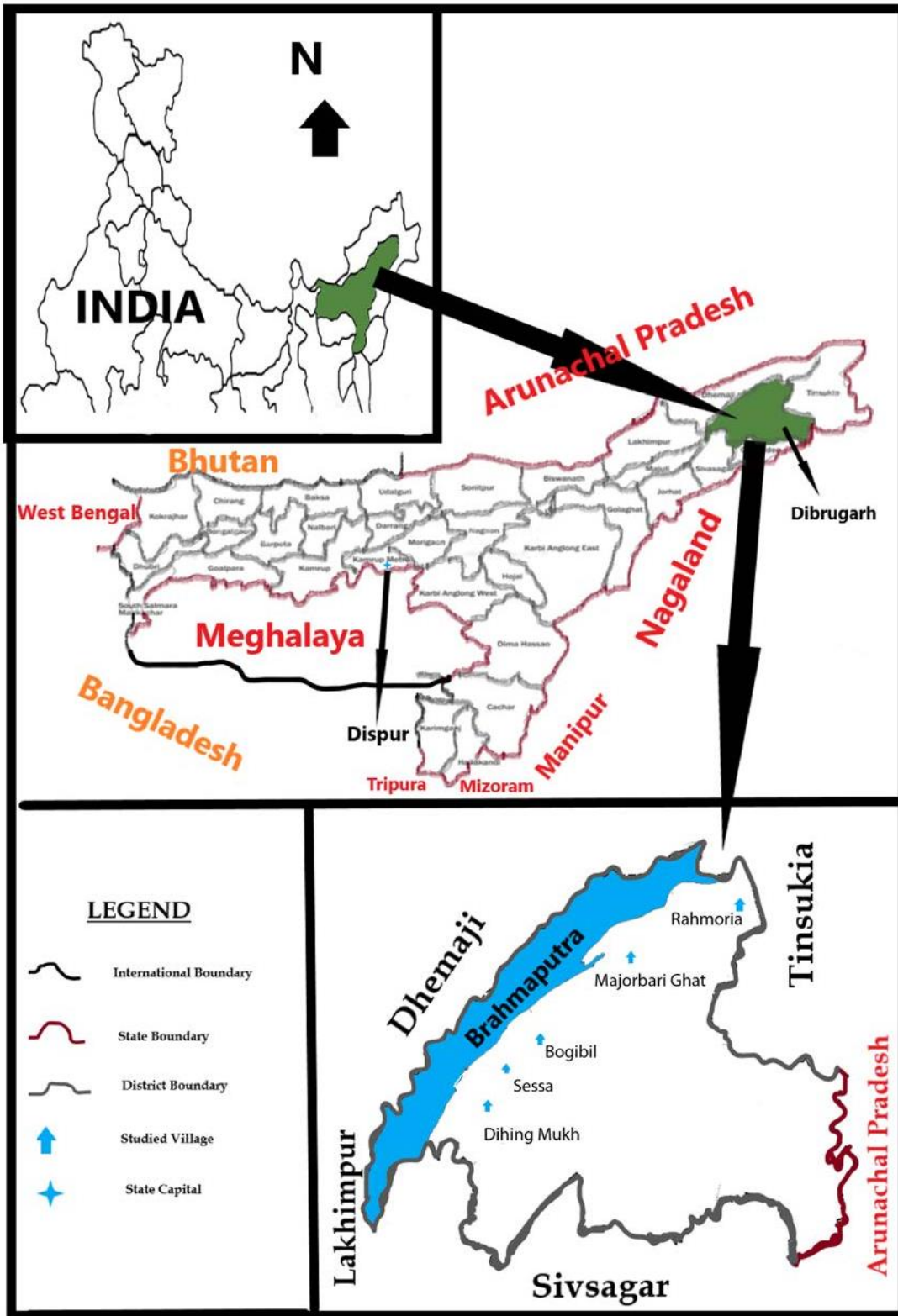


Plate-I: Map of the study site.

3. Results

Floristic composition and distribution of Psammophytes

During the survey, a total of 49 species under 46 genera belonging to 24 families (Table 1.) were recorded. Among the plant's group, angiosperms were more dominant throughout with 47 species while 2 species of Pteridophytes were also. Among the families, Poaceae represented by 12 species followed by Asteraceae (6 spp.), Scrophulariaceae (4 spp.) and Rubiaceae with 3 species. Other families namely Apiaceae, Cyperaceae, Euphorbiaceae and Solanaceae had represented with two species each while rest of the families had single species representation.

The phytosociological quantification revealed that *Imperata cylindrica* (L.) Beauv is the most dominant species across the study sites which has the highest Importance Value Index (Mean IVI=32.93) in three sites viz. Dihing Mukh, Rahmoria and Sessa out the five sampling sites (Table 1). It is followed by *Colocasia esculenta* (L) Schott. (Mean IVI=27.69) mainly dominated in Bogibil area. The significance of *C. esculenta* (L) Schott. is that it is evenly distributed throughout the sampling sites. The other important species are *Desmodium trifolium* L. (IVI=16.94), *Axonopus compressus* (Sw.) P.Beauv. (Mean IVI=16.92), *Axonopus compressus* (Sw.) P. Beauv (Mean IVI=16.81), *Amaranthus spinosus* L. (Mean IVI=15.46) and *Kyllinga brevifolia* Rottb. (Mean IVI=10.91). Meanwhile, out of the total Psammophytes, 8 species (16.33 %) have IVI ≥ 10.0 , 11 species (22.44 %) have ≥ 5.0 -9.9 IVI value, 23 species (46.94 %) have IVI ≥ 1.0 -4.9 and rest 7 species (14.29 %) have IVI < 1. From the IVI values, it may be stated that all the species in the community despite play varied range of ecological niche but are not equally important in sustaining ecological setup. The dominant species only exerted their influence in the community structure. Further, a very few species such as *Imperata cylindrica*, *Colocasia esculenta* etc. become dominant because of their well adaptive capacity as compare to those suppressive one from the essential environmental gradients. Moreover the biotic factors such as cattle's grazing, harvesting of fodders etc. also played important role in making some species dominant in the floristic community.

Site specific species interaction in psammophytes

The interaction of species in the study area was found heterogenous (Plate-II.). The highest number of species recorded from Bogibil (Site I) with 33 species while the lowest species was recorded from Sessa (Site V) with 17 species. Both Dihing Mukh (Site III) and Rahmoria (Site IV) have 30 species each which was little higher than Majorbari Ghat with 25 species (Site II). The commonly occurred species recorded maximum in between Dihing Mukh and Rahmoria (Site III & IV) represented with 20 species out of the 30 species each. It was followed by Bogibil and Dihing Mukh (Site I & III) represented with 22 species, Majorbari Ghat and Dihing Mukh (Site II & II), Majorbari Ghat and Rahmoria (Site II & IV) 21 species each. Meanwhile, the lowest common species occurred in between Rahmoria and Sessa (Site IV & V) with just 17 species which was followed by Bogibil and Majorbari Ghat (Site I & II), Bogibil and Rahmoria (Site I & IV), Dihing Mukh and Sessa (Site III & V) possessed 18 species respectively. Across the study site, the highest similarity index was recorded between site II and III and the site II and IV index value (QS) of 0.737 respectively (Figure 1). The least QS value of 0.571 was found between site I and IV. The other QS values recorded were 0.698, 0.667, 0.655, 0.654 and 0.6000 between site I and III, III and IV, III and V, I and V, II and V and I and II respectively. The result shows that the distribution of species in the community is highly diverse.

Local uses of Psammophytes

The study site is mainly occupied by both Assamese communities namely both the Ahom and Motok communities in Rahmoria while the Mising tribe is the main inhabitants of the rest sites.

The psammophytes and their local uses have been presented as follows:

1. *Achyranthes aspera* L.

Local Name: Ubti sot (As)

Family: Acanthaceae

Local uses: Juice extracted from leaf is used to induce delivery pain of pregnant woman.

Literature consulted: [26, 27]

2. *Amaranthus spinosus* L.

Local Name: Hati Khutura (As), Ge-nyak (M)

Family: Amaranthaceae

Local Uses: Medicinal- Cooked root is used for the treatment of stomach trouble.

Culinary-Leaves and stems are used as vegetable.

Literature consulted: [28, 29]

3. *Centella asiatica* (L.) Urb.

Local Name: Bor manimuni (As, M)

Family: Apiaceae

Local Uses:

Medicinal-Aerial plant part is used in the treatment of stomach trouble, loss of appetite, weak memory, chronic dysentery etc.

Rituals: Leaves used in rituals.

Literature consulted: [30,31,32,33,34,35]

4. *Hydrocotyle sibthorpioides* Lam.

Local Name: Horu manimuni (As), Manimuni (M)

Family: Apiaceae

Local Uses: Medicinal -Plant used in the treatment of stomach trouble, loss of appetite, weak memory, chronic dysentery etc.

Culinary: Aerial part is used as vegetable in curry.

Literature consulted: [31, 36,37]

5. *Colocasia esculenta* (L) Schott.

Local Name: Kochu (kola) (As), Yakan Enge (M)

Family: Araceae

Local Uses: Medicinal- Petiole is used in cut wound healing.

Culinary-Leaves and stems are used as vegetable.

Literature consulted:[36,38]

6. *Ageratum conyzoides* L.

Local Name: Gundhua bon (As), Namyng gomying (M)

Family: Asteraceae

Local Uses:

Medicinal-Leaf past is used in blood clotting.

Culinary: Leaf and young shoots are used as cattle food.

Literature consulted:[39,40,41].

7. *Crassocephalum crepidioides* (Benth.).S.Moore.

Local Name: Bon kopah (As)

Family: Asteraceae

Medicinal Not Known

Culinary: Leaf and young shoots are used as vegetable.

Literature consulted: [42,43]

8. *Eclipta alba* Hassk.

Local Name: Keheraj (As), Kenya bon (M)

Family: Asteraceae

Local Uses:

Medicinal-Leaf juice is used as hair dye and for treatment of respiratory trouble.

Culinary-Leaf and young shoots are used as vegetable.

Literature consulted: [30, 44,45,46,47].

9. *Elephantopus scaber* L.

Local Name: Hati khuj (A), Sita yepong (M)

Family: Asteraceae

Local Uses: Leaf juice is used as hair dye and for treatment of respiratory trouble.

Culinary: Leaf and young shoot are used as vegetable.

Literature consulted: [25].

10. *Chromolaena odorata* (L.) R.M. King & H. Rob.

Local Name: Bagh bon (As) Namyng iing (M)

Family: Asteraceae

Local Uses:

Medicinal-Plant is used as insect repellent. Juice extract is applied externally for healing wound and injuries.

Literature consulted:[48,49,50,51]

11. *Mikania micrantha* Kunth.

Local Name: Sina lota (As, M)

Family: Asteraceae

Local Uses: Medicinal-The plant is used for cut wound healing.

Literature consulted: [52,53].

12. *Cassia tora* L.

Local Name: Medelua (As), Kete kete (M)

Family: Caesalpiniaceae

Local Uses:

Medicinal-Leaf and young shoot are used as vegetable and in treatment of toothache.

Culinary: Young shoots and leaves are used vegetable.

Literature consulted: [54,55].

13. *Drymaria cordata* Willd.

Local Name: Lai jabori (As, M)

Family: Caryophyllaceae

Local Uses: Culinary-Fodder grass.

Literature consulted: [56].

14. *Fimbristylis miliacea* (L.) Vahl.

Local Name: Not known

Family: Cyperaceae

Local Uses: Culinary-Cattle fodder.

Literature consulted: [57].

15. *Kyllinga brevifolia* Rottb.

Local Name: Murphula Bon (As)

Family: Cyperaceae

Local Uses: Culinary- as cattle fodder.

Literature consulted:[58].

16. *Euphorbia hirta* L.

Local Name: Gakhiroti bon (As), Jigja lo-pang (M)

Family: Euphorbiaceae

Local Uses: Medicinal-Juice extracted from cooked aerial part taken by mother to induce lactation.

Literature consulted: [59, 60].

17. *Phyllanthus niruri* L.

Local Name: Bon Amlokhi (As, M)

Family: Euphorbiaceae

Local Uses: Medicinal-Plant extract is used as tonic.

Literature consulted: [61].

18. *Leucas aspera* Spreng.

Local Name: Boga Droon (As), Durun bon (M)

Family: Lamiaceae

Local Uses: Medicinal-Juice extracted from leaf is used as remedies for cough, influenza and skin disease.

Culinary-Aerial part of the plant is used as vegetable.

Literature consulted: [62].

19. *Cuphea carthagenensis* (Jacq.) J.F.

Local Name: Pani Jetuka (As), Jarmani iin (M)

Family: Lythraceae

Local Uses: Culinary- Cattle fodder.

Literature consulted: [25]

20. *Melastoma malabathricum* L.

Local Name: Phutu kola (As), Jo-jer (M)

Family: Melastomaceae

Local Uses: Cattle fodder.

Literature consulted: [25].

21. *Mimosa pudica* L.

Local Name: Lajuki lota (As), Yuptab Neming (M)

Family: Mimosaceae

Local Uses: Medicinal-Leaf past is used for pain killer.

Literature consulted: [63].

22. *Oxalis corymbosa* (DC.) Lourteig.

Local Name: Tengesi (As), Nepali Ku-suk (M)

Family: Oxalidaceae

Local Uses: Medicinal- Juice extracted from leaf is used in treatment of kidney stone.

Culinary: Aerial part is use as vegetable.

Literature consulted: [64].

23. *Desmodium triflorum* (L.) DC

Local Name: Tinkoriamoni (As)

Family: Papilionaceae

Local Uses- Whole part is used cattle fodder and pig food.

Literature consulted: [56].

24. *Axonopus compressus* (Sw.) P.Beauv.

Local Name: Dolicha Bon (As), Borta dubori (M)

Family: Poaceae

Local Uses: Culinary-Cattle fodder

Literature consulted: [65,66].

25. *Chrysopogon aciculatus* (Retz.) Trin.

Local Name: Bon guti (As), Sagoli nikket (M)

Family: Poaceae

Local Uses: Culinary-Fodder grass

Literature consulted: [67].

26. *Cynodon dactylon* (L)Pers.

Local Name: Dubori Bon (A), Dubori (M)

Family: Poaceae

Local Uses: Medicinal Young leaves are used in treatment of ring worm and skin allergy.

Others-Above ground part is used in different rituals and rites.

Literature consulted: [68].

27. *Eleusine indica* Gaertn.

Local Name: Bobosa bon (As)

Family: Poaceae

Local Uses: Culinary-Cattle fodder.

Literature consulted: [66].

28. *Eragrostis gangetica* (Roxb.) Steud.

Local Name: Kush (As)

Family: Poaceae

Local Uses: Other-Leaf is used in rituals and rites.

Literature consulted: [66].

29. *Imperata cylindrica* (L.) Beauv

Local Name: Ulu Kher (As), Taase (M)

Family: Poaceae

Local Uses: Other-The leaves are used in roofing house.

Literature consulted: [69].

30. *Ischaemum rugosum* Salisb.

Local Name: Jha (joya) (As)

Family: Poaceae

Local Uses: Other-Cattle fodder.

Literature consulted:[66].

31. *Paspalum scrobiculatum* L.

Local Name: Not known.

Family: Poaceae

Local Uses: Culinary-Cattle fodder.

Literature consulted: Subramanian *et.al.* 2010; Lakanmi and Okusanya 1990.

32. *Phragmites karka* (Retz.) Trid.

Local Name: Khagori (A), Kagori (M)

Family: Poaceae

Local Uses: Other-Stem is used in making wall, fencing and fuel wood. Leaf is used as cattle fodder.

Literature consulted: [70,71].

33. *Saccharum spontaneum* L.

Local Name: Kohua (As), Koaang (M)

Family: Poaceae

Local Uses: Other-Mature stems are used in making wall, fire wood. Leaves are used as fodder.

Literature consulted: [72,73].

34. *Setaria glauca* (L.) Beauv

Local Name: Sermi (M)

Family: Poaceae

Local Uses: Aerial part is cooked and served for pig meal.

Literature consulted:[74].

35. *Vetiveria zizanioides* (L.)Nash ex Small

Local Name: Birina (As), Birngang (M)

Family: Poaceae

Local Uses: Medicinal-Root paste is used for swellings and juice extract is used for treatment of Cholera.

Culinary- Leaves are being used for roofing house.

Literature consulted:[75, 76].

36. *Polygonum orientale* (L.) Spach

Local Name: Bihlongoni (As, M)

Family: Polygonaceae

Local Uses: Other-Aerial part of the plant is used by priest in various rituals.

Literature consulted: [25].

37. *Borreria articularis* (L.F.) F.N. Will.

Local Name: Gahori bon (As)

Family: Rubiaceae

Local Uses: Other-Cattle's feed

Literature consulted:[77].

38. *Spermacoce hispida* L.

Local Name: Not known

Family: Rubiaceae

Local uses: Medicinal-Leaf juice is used in the treatment of gall bladder.

Literature consulted:[78].

39. *Spermacoce ocymoides* (Burm.f.) DC

Local Name: Not known

Family: Rubiaceae

Local uses: Other- Aerial part is cooked and served for pig meal.

Literature consulted: [77].

40. *Bonnaya brachiata* Link. & Otto

Local Name: Horu kasidoria (As); Chagoli pe-ni (M).

Family: Schrophulariaceae

Local Uses: Medicinal-Leaf past is used in blood clotting.

Other-Leaf and young shoots are used as cattle food.

Literature consulted: [79].

41. *Scoparia dulcis* L.

Local Name: Godadhari (As), Ti-sur kosur (M)

Family: Schrophulariaceae

Local uses: Leaves are useful for skin disease treatment and wound healing. Leaves and young shoots are used for feeding cattle.

Literature consulted: [66, 80, 81].

42. *Torenia bicolor* Dalzell.

Local Name: Not known.

Family: Schrophulariaceae
Local Uses: Other-Cattle fodder
Literature consulted: [25].

43. *Torenia flava* Buch.-Ham. ex Wall.

Local Name: Not known.
Family: Schrophulariaceae
Local Uses: Other-Cattle fodder
Literature consulted: [25].

44. *Solanum nigrum* L.

Local Name: Pis kati (As)
Family: Solanaceae
Local uses: Medicinal- Used in treatment of liver, piles, dysentery and stomach trouble. Culinary-Leaves and young shoots are used as vegetable.
Literature consulted: [82,83].

45. *Solanum torvum* Sw.

Local Name: Hati bhekuri (As), Sita bangko (M)
Family: Solanaceae
Local uses: Other-Fruit is used as vegetable.
Literature consulted:[83].

46. *Tamarix dioica* Roxb.

Local Name: Jhaon bon (As), Jau bon (M)
Family: Tamaricaceae
Local Uses: Other-Stem is used as fire wood and wall making.
Literature consulted: [25].

47. *Pouzolzia indica* (L.) Gaudich.

Local Name: Borali bokua (As)
Family: Urticaceae
Local uses: Medicinal- Aerial part is in cuts, wounds, boils and fractured bone treatment etc.
Literature consulted: [84, 85, 86].

48. *Equisetum debile* Roxb. ex Vaucher.

Local Name: Nikset toset (M)
Family: Equisitaceae
Local Uses: Other- Cattle's feeding.
Literature consulted:[25].

49. *Pteridium aquilinum* Kuhn.

Local Name: Bon Dhekia (As), Yumrang okang (M)
Family: Polypodiaceae
Local Uses: Other- Cattle's feeding.
Literature consulted: [25].

(As: Assamese; M: Mising languages.)

Psammophytes are being used for various purposes ranging from fodder to ritualistic activities. Based on their uses, the entire plant species can be categorized into 8 groups i.e. fodder, medicine, vegetable, animal feeding, household uses, firewood and ritual activity. Out of these categories the highest species are used for fodder (34.85%) having 23 species followed by medicines with (28.79%) 19 species, vegetables (15.15 %) 10 species, etc (Plate- III).

Meanwhile, the least numbers of species are used for animal feeding and house construction material with 6.06% (4 spp) each and fuel-wood and ritual activity 4.55% (3 spp) each. Some of the species, for instance, *Phragmites karka* (Retz.) Trid., and *Saccharum spontaneum* L. are falling simultaneously into different used categories such as fuel wood, fodder and house construction material etc. This signifies that the Psammophytes are being contributing in the

Table 1. Phytosociology of Psammophytes of Dibrugarh district.

Sl.No	Name of the species	IVI					Cumulative IVI	Mean IVI
		Plot I	Plot II	Plot III	Plot IV	Plot V		
1	<i>Imperata cylindrica</i> (L.) Beauv	3.04	3.8	48.04	51.82	57.95	164.65	32.93
2	<i>Colocasia esculenta</i> (L) Schott.	26.36	29.62	14.17	45.11	23.18	138.44	27.69
3	<i>Desmodium trifolium</i> L.	11.66	3.12	25.93	17.77	26.13	84.61	16.92
4	<i>Axonopus compressus</i> (Sw.) P.Beauv.	19.68	29.03	23.72	11.61	0	84.04	16.81
5	<i>Amaranthus spinosus</i> L.	12.66	30.07	12.47	0	22.1	77.3	15.46
6	<i>Chrysopogon aciculatus</i> Trin.	13.42	16.57	3.43	6.85	14.4	54.67	10.93
7	<i>Kyllinga brevifolia</i> Rottb.	7.72	12.29	14.72	5.16	14.64	54.53	10.91
8	<i>Fembristylis miliacea</i> (L.) Vahl.	10.5	21.83	4.08	15.85	0	52.26	10.45
9	<i>Cynodon dactylon</i> (L)Pers.	12.69	2.85	21.8	10.45	0	47.79	9.56
10	<i>Phyllanthus niruri</i> L.	6.06	10.76	11.04	4.26	16.06	48.18	9.64
11	<i>Torenia bicolor</i> Dalzell	7.87	14.17	4.61	2.43	15.69	44.77	8.95
12	<i>Vitiveria zizanioides</i> (L.) Nash ex Small.	0	0	23.32	16.82	0	40.14	8.03
13	<i>Eragrostis gangetica</i> (Roxb.) Steud	0	14.92	0	6.38	16.37	37.67	7.53
14	<i>Equisetum debile</i> Roxb. ex Vaucher.	0	21.64	4.08	5.47	4.12	35.31	7.06
15	<i>Cassia tora</i> L.	26.09	9.2	0	0	0	35.29	7.06
16	<i>Pteridium aquilinum</i> kuhn.	6.07	8.38	9.17	7.07	0	30.69	6.14
17	<i>Drymaria cordata</i> Willd.	10.65	9.2	5.03	0	4.89	29.77	5.95
18	<i>Mimosa pudica</i> L.	3.48	9.29	6.43	4.56	3.8	27.56	5.51
19	<i>Bonnaya brachiata</i> Link. & Otto	0	7.23	7.98	3.43	8.18	26.82	5.36
20	<i>Tamarix dioica</i> Roxb.	0	8.85	4.3	11.23	0	24.38	4.88
21	<i>Scoparia dulcis</i> L.	10.02	0	0	0	13.02	23.04	4.61
22	<i>Chromolaena odorata</i> (L.) R.M. King & H. Rob.	12.47	0	0	0	10.46	22.93	4.59

23	<i>Ageratum conyzoides</i> L.	4.99	8.14	4.69	3.51	0	21.33	4.27
24	<i>Saccharum spontaneum</i> L.	0	3.5	7.52	2.52	7.52	21.06	4.21
25	<i>Eluesine indica</i> Gaertn.	10.64	0	0	8.61	0	19.25	3.85
26	<i>Cuphea balsamona</i> Cham. & Schlttdl.	5.3	0	3.51	4.41	5.25	18.47	3.69
27	<i>Ischaemum rugosum</i> Salisb.	1.55	2.01	0	7.54	7.17	18.27	3.65
28	<i>Solanum nigrum</i> L.	0	2	0	15.99	0	17.99	3.60
29	<i>Eclipta alba</i> Hassk.	0	4.13	5.69	3.07	4.69	17.58	3.52
30	<i>Elephantopus scaber</i> L.	5.59	0	6.64	0	4.59	16.82	3.36
31	<i>Leucas aspera</i> Spreng	7.93	0	2.74	0	6.07	16.74	3.35
32	<i>Pouzolzia indica</i> (L.) Gaudich.	4.46	4.79	3.87	0	3.1	16.22	3.24
33	<i>Melastoma malabathricum</i> L.	15.87	0	0	0	0	15.87	3.17
34	<i>Hydrocotyle sibthorpioides</i> Lam	6.99	0	0	0	6.11	13.1	2.62
35	<i>Borreria articularis</i> (L.F.) F.N. Will.	8.2	0	4.17	0	0	12.37	2.47
36	<i>Crassocephalum crepidioides</i> (Benth.) S. Moore.	7.2	0	0	2.47	2.54	12.21	2.44
37	<i>Euphorbia hirta</i> L.	4.17	0	0	7.54	0	11.71	2.34
38	<i>Centella asiatica</i> (L.) Urb.	4.91	0	4.54	0	0	9.45	1.89
39	<i>Paspalum scorbiculatum</i> L.	0	0	0	9.15	0	9.15	1.83
40	<i>Mikania micrantha</i> Kunth	2.7	0	4.14	0	0	6.84	1.37
41	<i>Achyranthes aspera</i> L.	0	6.58	0	0	0	6.58	1.32
42	<i>Setaria glauca</i> (L.) Beauv	0	6.03	0	0	0	6.03	1.21
43	<i>Polygonum orientale</i> (L.) Spach	4.61	0	0	0	0	4.61	0.92
44	<i>Spermacoce ocymoides</i> (Burm.f.) DC	4.45	0	0	0	0	4.45	0.89
45	<i>Phragmites karka</i> (Retz.) Trid.	0	0	4.44	0	0	4.44	0.89
46	<i>Spermacoce hispida</i> L.	0	0	0	4.37	0	4.37	0.87
47	<i>Oxalis corymbosa</i> (DC.) Lourteig.	0	0	0	1.97	1.97	3.94	0.79
48	<i>Solanum torvum</i> Sw.	0	0	3.73	0	0	3.73	0.75
49	<i>Torenia flava</i> Buch.-Ham. ex Wall.	0	0	0	2.58	0	2.58	0.52

N:B: Plot I: Bogibil, Plot II: Majorbari Ghat, Plot III: Dihing Mukh, Plot IV: Rahmoria and Plot IV: Sessa

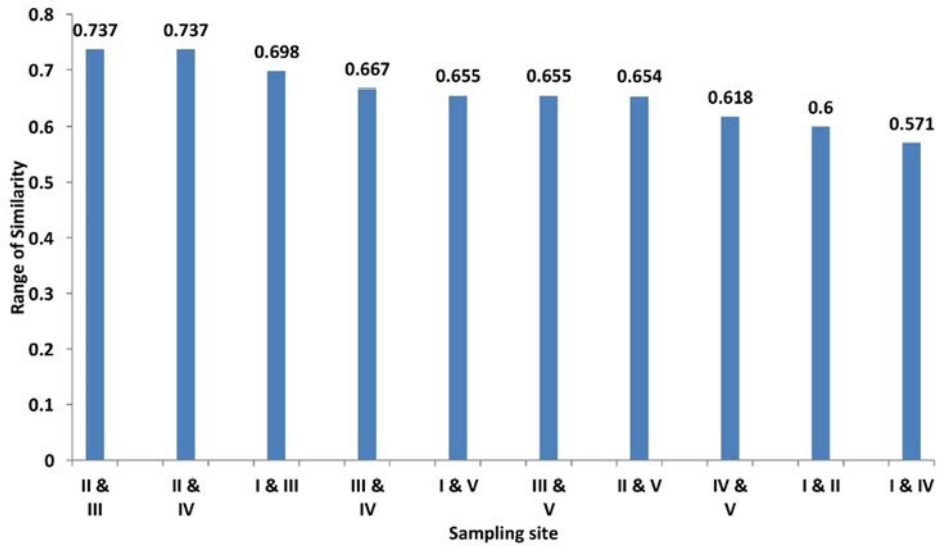


Plate-II: Similarity Index between the sampling sites.

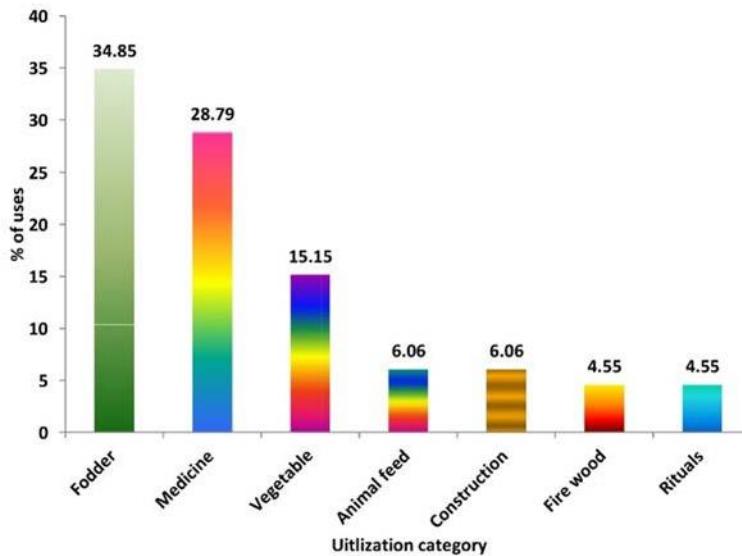


Plate-III: Utilization of Psammophytes and their categories (%).

livelihood sustenance of the local communities. Other important species are *Amaranthus spinosus* L. and *Eclipta alba* Hassk., used both for medicine and fodder. Meanwhile, important species such as *Eupatorium odoratum* L., *Cassia tora* L., *Leucas aspera* Spreng, *Oxalis corymbosa* (DC.)Lour., *Cynodon dactylon* (L)Pers., *Bonnaya brachiata* Link. & Ottoand *Scoparia dulcis* L. etc. are used in two categories while rest of the species have single use only. However, many of the species have been found to available in the market also. For instance *Leucas aspera*, *Amaranthus spinosus*, *Oxalis corymbosa* and *Eclipta alba* are being sale in the market by the vendors primarily for human consumption as vegetable followed by medicinal purposes as well.

Market survey was conducted in the local markets of Dibrugarh, Moran and Rahmaria area including two main markets- Dibrugarh City and Khowang market in Dibrugarh district. It has been recorded that a total of 14 species (Table-II) are marketed particularly for meeting the cash needs for purchasing rice, education and health care expenses. Both *Imperata cylindrica* and *Vetiveria zizanioides* are being traditionally used for roofing house while *Phragmites karka* and *Saccharum spontaneum* are used for wall construction. On the other hand, *Tamarix dioica* is a good source of firewood used locally and also available in market for sale. Rests are used as vegetable commonly available in the market. By value addition and creating market linkages, the income from psammophytes may be enhanced, which would help in developing alternative livelihood opportunities for the communities.

Table.2: List of Market potential psammophytes species of study area.

Species	Local Name	Part used	Market price (Rs./Kg)
<i>Centella asiatica</i> (L.) Urb.	Bor manimuni	Whole plant	1000
<i>Colocasia esculenta</i> (L) Schott.	Kochu (kola)/Yakan Enge	Rhizome/leaves/petiole	20
<i>Eclipta alba</i> Hassk.	Keheraj/Kenyabon	Aerial part	500
<i>Elephantopus scaber</i> L.	Hati khuj/ Sita yepong	Aerial part	500
<i>Drymaria cordata</i> Willd.	Lai jabori	Aerial part	300
<i>Euphorbia hirta</i> L.	Gakhiroti bon/ Jigja lo-pang	Aerial part	250
<i>Leucas aspera</i> Spreng.	Droon	Whole plant	700
<i>Oxalis corymbosa</i> (DC.)Lourteig.	Tengesi/ Nepali Ku-suk	Whole plant	700
* <i>Imperata cylindrica</i> (L.) Beauv	Ulu Kher/ Taase	Aerial part	5000
** <i>Phragmites karka</i> (Retz.) Trid.	Khagori/Kagori	Stem	20
** <i>Saccharum spontaneum</i> L.	Kohua/ Koaang	Stem	20
* <i>Vetiveria zizanioides</i> (L.)Nash ex Small	Birina/ Birngang	Aerial part	3000
<i>Solanum torvum</i> Sw.	Hati bhekuri/Sita Bangko	Fruit	300
* <i>Tamarix dioica</i> Roxb.	Jhaon bon/Jaubon	Stem	20

N.B:* Per 1000 lot (1 lot=1 handful); ** Per lot (1 lot= 8-10 nos)



Plate-IV (a): *Imperata cylindrica*as vegetation cover



Plate-IV (b&c): *Colocasia esculenta* (L) Schott.and *Tamarix dioica* Roxb. Are being used as vegetable and firewood

4. Discussion and conclusion

Distributions of Psammophytes have greatly been influenced by environmental factors both biotic and abiotic components. It's population is greatly affected due to anthropogenic pressure such as agricultural extension, grazing and forage collection and natural phenomenon like soil erosion may flood etc. The state of Assam has been experiencing frequent flood twice to thrice a year especially in the river basin of Brahmaputra including Dibrugarh District. The clay and other humus materials accumulated in huge quantity after the flood in the crop field and other riparian areas also creates difficulty in sustainable maintenance of such floras which not only alter the vegetation but equally change the existing ecosystem. Similarly soil erosion is one of the factors identified that is responsible for loss of vegetation as a whole in the district every year. The range of erosion ranges from slight to severe erosion in the district. In a report published by the state Government, Assam [87] that the rate of erosion in 16 km long section around Rahmoria in the south bank of the district was 0.06 Km² per Km during the period from 1915 to 1972 and is almost double of the overall erosion rate (0.03) of the mighty Brahmaputra. Again, between 1972 to 1996 year, the erosion of soil was estimated 0.26 Km² per Km which is four times higher than that of the previous one. The increasing rate of erosion in this place is due to direct action of the river flow as it takes a large concave turn and hits the bank directly. It to be added here that, during the flood of 2008, the Rahmoria area experienced tremendous flood pressure and erosion activity intensified.

It is an utmost important to document the species distribution by ecological quantification which may help in location specific conservation needs of the Psammophytic plant species. Besides, Psammophyte plays critical role in successional strata in community composition where they act as pioneer in conversion of sandy soil into clay. Further the important species such as *Imperata cylindrica*, *Colocasia esculenta*, *Desmodium trifolium*, *Axonopus compressus*, *Amaranthus spinosus*, *Chrysopogon aciculatus*, *Kyllinga brevifolia*, *Fimbristylis miliacea*, etc., have played significant role in maintaining the ecological balance of the habitat. These are the keystone species that balance the structure of an ecological community and whose impact on the community is greater than others. Further, the large proportionate of those have influenced on species diversity also and so it is obvious to become a much awaited target for conservation efforts. Therefore, removal of these species would severely affect the community composition and possibility of altering the habitat condition. Additionally, much of these species are being neglected in conservation perspectives especially in policy making strategies due to their common existence in the habitat except the species with market potentials. Extraction of non-timber forest produces are commonly observed in all North Eastern States of India, due to abundance of natural resources and Dibrugarh district is also rich in natural wealth. The forest resources have been playing very important role in the economy of the rural people of the district. In recent past, the species of vegetables under Psammophytes are being extracted from these localities due to their growing demands. This may lead to a critical crisis towards natural resource management especially on the path of erosion on the riversides. Unplanned extraction of these resources may alter the habitat condition which may not only impact the community spectrum but equally affect the stable state of the ecosystem.

Information on scouting and documentation of Psammophytes has been covered less in contemporary studies in North Eastern region of India. The result shows tremendous potential of this lesser known plant group though they have been utilizing extensively in day to day life by ethnic communities living in the margin of rivers, forest and adjoin areas. So, it is utmost important to document this group of plants and ascertain their importance through scientific evaluation.

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Conflict of interest

The authors declare that there is no conflict of interest.

Author's contribution

Present article is an outcome of M.Sc. dissertation work carried out at Department of Life Sciences, Dibrugarh University. The research was conducted under the supervision of Prof. M. Islam, Department of Life Sciences, Dibrugarh University as a student of M.Sc. Conceptualization of the paper was done by M. Islam. Rajiv Mili had conducted the survey, analysis of data at Dibrugarh University and final manuscript was redeveloped at National Innovation Foundation-India.

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