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An Autecological Account of a Medicinal Plant *Elephantopus scaber* L.

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ABSTRACT

The present communication is an autecological account of *Elephantopus scaber* which is an ethnomedicinal plant with therapeutic reputation. The work reveals its requirements of the plant from and relationship with its environment. The dynamic behaviour of the species gets reflected in such phenological events as germination, vegetative growth, floral bud initiation; fruiting, seed shading and death which were carefully recorded. The species is rich in different types of secondary metabolites many of which are bioactive, thus reflecting its efficacy in adaptive and defensive strategies. The findings of the present work are likely to prove useful in cultivation of the species for its sustainable medicinal use and conservation.

Keywords: Autecology, ethnomedicine, relationship, environment, phenology

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INTRODUCTION

Elephantopus scaber L. of the family Asteraceae is a reputed medicinal plant for being used extensively by tribal communities almost all over India. A review of literature reveals a wide range of secondary metabolites with considerable therapeutic virtues [2]. It is traditionally used by the herbal healers almost since time immemorial which has presently been drawing the attention of scientists. For its excessive exploitation in medicine and for preparation of 'Bakhar', the augmenter used in brewing country liquor, by the tribal communities the plant has been perceiving threats of extinction. Furthermore the plants are uprooted by the tribal community for obtaining the rhizome for use as tooth stick or 'dantan'. While studying the distribution of the species [3], the present authors felt the necessity to undertake an autecological study on the species and find out the requirements of species from the environment and the relationship maintained with it. The findings of the present work are likely to prove useful in cultivation of the species for its sustainable use and conservation.

MATERIALS AND METHOD

Fresh specimens (Fig.1) were collected from natural habitats including nearby forests and cultivated lands of West Bengal during November, 2013 to December, 2014. Materials were identified, studied following standard taxonomic methods and finally processed for herbarium preservation. Certain aspects of their uses were recorded during field studies and the rest from literature. For the study of its association with other species different types of localities were selected, viz. Golapbag Campus of Burdwan University; Shibpur forest of Durgapur Forest Division, Burdwan and Medicinal plant garden of the University. Such soil characters as the pH, and concentrations of nitrogen, organic carbon, phosphate and potassium were determined by standard analytical methods [1].

Figure 1: From left A. Plant in vegetative condition and B. Plant in reproductive stage

The pollen grains and root of *Elephantopus scaber* were collected from the Golapbag campus of Burdwan University during June, 2014. The roots were mainly collected when the plants were in vegetative condition showing luxuriant growth.

The plants along with the roots entangled in the soils were brought to the laboratory and were dipped in a bucket of water to remove the adhering soils. The root system, thus exposed, was finally washed in running water and carefully blotted. The complete root system was spread out as neatly as possible on a drawing paper and then sketched accordingly.

Collected polleniferous materials were prepared by acetolysis method. To the material, 3-4 ml of freshly prepared acetylation mixture (to 9 volume of acetic anhydrite, 1 ml volume of conc. Sulphuric acid is added drop by drop) was added. Then acetylation mixture was discarded by centrifugation followed by thorough washing of the acetolysed pollen grains in distilled water. Prepared pollens were mounted in glycerin-jelly for observation under bright–field compound microscope.

The root system of collected plant was identified according to the characteristic types recognized by Cannon (1949) and brought into light by King (1974).

RESULTS

Various findings having pertinence with autecology of *Elephantopus scaber* L. are presented pointwise in the following:

Nomenclature

Botanical name: *Elephantopus scaber*L., Sp. Pl. 814. 1753; Hook. F. in Hook. F., Fl. Brit. India 3: 242. 1881; Prain, Bengal Pl. 1: 590. 1903 (Rep. ed. 1: 433. 1963) and in Rec. Bot. Surv. India 3: 225. 1905.

Common name: Bengali: Hasti Pad, English: Prickly leaved elephant's foot, Hindi: Adhomukha, Malayalam: Koonjirikka, Ottaveran, Thomunji, Aanayadiyan, Aanayadi, Aanachuvadi, Oriya: Mayurachula, Sanskrit: Prastarini, Gojihva Or Gojivha, Kharaparnini, Adhapata, Tamil: Yanai-c-cuvati, Telugu: Eddupattu, Urdu: Gobhi.

Systematic position: *Elephantopus scaber* L. family: Asteraceae, order: Asterales, subclass: Asteridae; class: Magnoliopsida of the Division Magnoliophyta.

Geographical distribution: *E. scaber* exists predominantly in tropical deciduous forest areas of India [3].

History: This plant, considered a native of Mexico, soon after introduction from outside (Neotropics, Europe, Asia, Africa and Australia) it dispersed in nooks and corners of the country.

Habit and Habitat: A terrestrial, scabrescent, aromatic, erect, stiff, perennial herb found in diverse habitats *viz*. in way side, open moist undisturbed sites, forest floor etc.

Plant Morphology: Plants scapigerous. Root system Centro-uniformal type (Fig 2). Stem rhizomatous, root-stock like bearing radical leaves and a scape for bearing flowers during its photoinductive cycle. Leaves are mostly radical in basal rosette and a few are cauline, finely dentate, obovate-oblong. Capitula numerous, homogamous, arranged in terminal dichotomous cymose clusters. Flowers small, actinomorphic, epigynous, purple to dull pink, each cluster being supported by a rigid ovate leaf like bract with inner bracts leafy, distinct, pale green. Fruit a cypsela, finely 10 ribbed, cuneate below, crowned by bristly, hairy pappus.

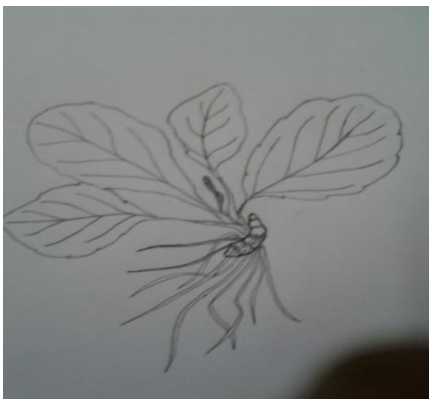

Figure 2: Root Morphology of *E. scaber*

Palynology: Radially symmetrical, spheroidal, aperture obscure, exine quite thick, crassinexinous, lopho-reticulate, surface spinate (Fig 3).

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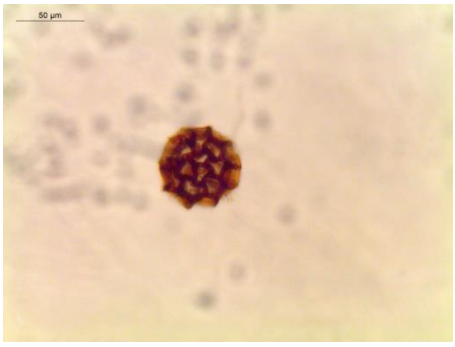

Figure 3: Pollen grain of *E. scaber* observed at X 40

Carpology:

Morphology: Cypsela heteromorphic, 3.41-3.75mm X 0.75- 0.882 mm excluding awn, dark yellow ochre with crimson red awn, oblanceolate, straight, base tapering, apex truncate, rimless, not echinate,both crown and beak absent, cross section elliptic; ribs 12, conspicous, straight. Surface pubescent, grandular, asperous, no warts found, mucilaginous when moistened. Hairs twin, 133.33-137.03 µm and 114.81 µm, biseriate forked type, tips of the body cells of hair situated in same plane, acroscopic sparsely distributed on the surface, not appressed. Stylopodium present, short column like, unlarged, free, ecoronate, eborded (Fig 4). Carpopodium present, asymmetric, incomplete, 2 lobed. Inturrupted ring like, cell out line not visible. Diameter of carpopodium wider than the base of cypsela. Insertation of the cypsela or detchment area obliquely lateral. Pappus present, awn type, arranged in one row, homomorphic, five, equal in length, unbranched.

Anatomy: Cypsela elliptic in cross section, ribs 12. Pericarp thick, differentiated into three zones: epicarp, mesocarp and endocarp. Epicarp wide, uniseriate, made up of thick walled, rectangular, compactly arranged, tangentially oriented, parenchymatous cells. A thin cuticle layer is present at outer periclinal wall of epicarp. Mesocarp consists of parenchyma tissue at mature state. Ells thick walled compactly arranged, rounded to elongated oval, parenchymatous with narrow lumen, present as discrete patch in between crusted parenchyma cells. Endocarp consists of irregular shaped parenchymatous cells and 14 vascular traces. Testa attached with pericarp, differentiated in outer and inner zone. Outer zone totally cellular, 3-4 layered, organized, made up of radially elongated parenchymatous cells with swollen walls and one vascular trace at ribs. Inner zone acellular disorganized, represented by a narrow layer of crusted translucent parenchyma cells. Endosperm persists in mature cypsela, uniseriate, thich walled, rectangular, parenchymatous, compactly arranged, tangentially oriented cells. Mature embryo occupies a smaller part of the cypsela; cotyledons two in number, plano-convex, anterior- posteriorly oriented. Secretory ducts three in each cotyledon.

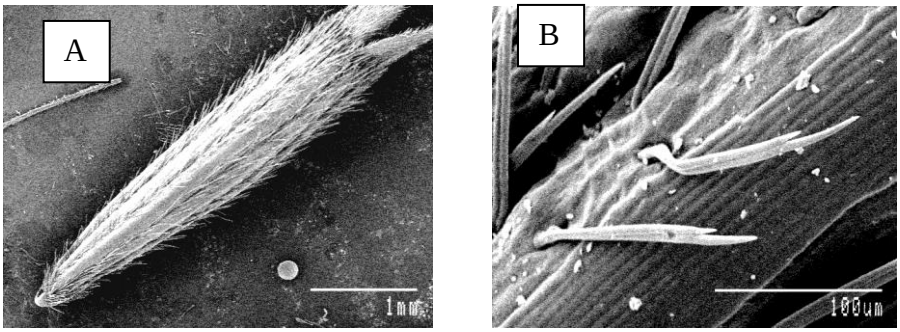

Figure 4: Scanning electron microscopic picture of Cypsela
From left A. Control at 30X and B. Control at 500X

Human concern: The species has been in age-long ethnomedicinal use, many cases of which have been pharmacologically proved, a precise account of which is presented below.

Ethnomedicinal use: Whole plant and leaves are used to brush teeth for ameliorating toothache [8]. Leaves are crushed and mixed with salt. The mixture is taken with curd to check dysentery. Root is used to cure gummosis and toothache [7].

Medicinal Uses proved: The root, leaves and whole plant of the plant can be used in medicine for the treatment of cancer, inflammation, bacterial infection, liver diseases, diabetes and a lot more [2].

Phenology

Life form: Cryptophyte, capable of perennating with subterranean rhizome and propagating with seasonally produced seeds. The subterranean rhizome sprouts into leafy shoot during pre-monsoon and monsoon seasons and remains dormant during the post monsoon or winter season.
Life cycle: Seeds germinate in late February and continues till March. Plants generally disappear during December and January. They are facultative sciophyte having a period of vegetative growth from April to July, the grand period being June and July. Flowering period extends from August to October, the optimum period being September and October. Fruiting occurs from late October to November. Seed maturation Starts from November to mid-December. Death starts from late December to January. From about nearly July population of *E. scaber* gets succeeded by such herbaceous species which are resistant to water logging during the monsoon.
Variability: This species has wide adaptive amplitude with the ability to undergo certain quantitative and temporary changes in phenotypic expression. Individual encountering desicating stress stresses (in dry habitat) produce smaller leaves shorter flowering escape.
Germination: Due to long dormant seeds the plant is under threat which it tries to overcome by perennial root-stock. The germination is of epigeal type. Scarification by sand paper and cold treatment at 5±1°C for a period of 40 days and application of gibberellic acid at a concentration of 1000mg L^{-1} are found to be effective in breaking seed dormancy.

Growth responses under natural condition

Climatic factor: *E. scaber* L sprouts as a summer season plant. The maximum and minimum temperature during its growth and development range from 28° to 42° C (megathermus), where as the relative humidity it tolerates ranges from 30 to 90 percent. They prefer high light intensity.
Edaphic factor: The plant usually prefers sandy-loam to lateritic soil. The organic carbon content of soil that sustains the plant ranges from 0.64 to 1.89%. In case of phosphorus the concentration ranges from 0.92 to 6.1 mg/L. Other supporting parameters include pH which is alkaline in all cases ranging from 7.97 to 8.47 mg/L, nitrogen from 31 to 50 mg/L and potassium from 105 to 245 mg/L (Table1).
Biotic factor: Young leaves of this species are generally eaten by grazing animal. *Colletotrichum dematium* is the major foliar disease causing pathogen in *E. scaber* [6]. The root- stock obtained after uprooting the plant is used to brush teeth. The whole plant is exploited for medicinal purpose and brewing country liquor.
Stress factor: Heavy rain, temperature below 15°C, grazing animal may partly or completely stop the growth, flowering and establishment of this plant.
Phytosociological features: Data point 1: While assessing IVI of *E. scaber* and its associates in the community. *E. scaber* was found to be maximum followed up by *Hybenthus* whereas least important is *Lantana camara*.
Data point 2: *Desmodium gangeticum* was to be having the maximum impact on the community followed up by *E. scaber*. *Rouvolfia serpentina* having minimum impact and other spp. has similar IVI.
Data point 3: *Euphorbia hirta* found maximum impact and *E. scaber* had an avarage impact (Table 2).
Phytochemical analysis: While identifying various secondary metabolites in leaf extracts of *Elephantopus scaber* in different solvents through routine chemical tests anthraquinones were found to remain totally absent. Alkaloids could be detected with all solvents except acetone. Presence of quinones, steroid, flavonoids, phenols, cardiac glycoside, cholesterol, tannins and terpenoids is indicated in extracts obtained using all the solvents. Aqueous extract could indicate presence of saponins. Coumarins could be marked when methanol and water were used as solvent.

Thus the preliminary analysis of secondary metabolites in the leaves of *Elephantopus scaber* (Asteraceae) using standard procedures reveals a wide diversity in form of alkaloid, cardiac glycoside,

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cholesterol, coumarin, flavonoids, phenols, phlobatannins, quinones, saponins, steroid, tannins and terpenoids and high therapeutic potential [4].

Table 1: Physicochemical properties of soils sample

Soil sample	Source	Organic carbon (%)	Phosphorus (mg/L)	P^H	Nitrogen (mg/L)	Potassium (mg/L)
Data Point 1	A	0.92	1.5	8.47	49	105
	B	1.89	0.9	8.44	50	195
Data point 2	A	1.65	4.3	8.06	42	245
	B	1.68	6.1	7.97	58	220
Data point 3	A	0.64	4.2	8.33	31	125
	B	0.84	2.1	8.37	40	115

Where A= Surface soil, B= Sub-surface soil

Table 2: Associate Plants of *E. scaber*

Name of the plant	Relative Frequency (%)	Relative Density (%)	Relative Abundance (%)	IVI
DATA POINT I				
Evolvulus nummularius	6.25	4.645	7.953	18.848
Aristida adscensionis	4.166	2.200	5.651	12.017
Vernonia cinerea	12.5	4.889	4.185	21.574
Elephantopus scaber	20.833	53.301	27.376	101.51
Tylophora indica	4.166	1.955	5.923	11.144
Hybenthus enneaspermus	8.333	20.048	25.744	54.125
Flacourtia indica	12.5	4.645	3.975	21.12
Gymnema sylestres	4.166	1.222	3.139	8.527
Lantana camara	2.083	0.244	1.255	3.582
Clerodendrum viscosum	4.166	0.978	2.512	7.656
Ziziphus oenoplea	4.166	0.489	1.255	5.91
Andrographis paniculata	6.25	0.978	1.674	8.902
Desmodium triflorum	4.166	3.178	8.163	15.507
Diosperous melanoxylon	6.25	1.222	2.092	9.564
DATA POINT II				
Ruelia tuberosa	9.259	3.71	4.446	17.415
Commelina benghalensis	3.704	1.326	3.969	8.999
Vitis reticulatus	9.259	5.039	6.034	20.332
Vernonia cinerea	7.407	1.592	2.382	11.381
Gymnema sylestres	9.259	3.71	4.446	17.415
Elephantopus scaber	18.518	28.117	16.832	63.467
Desmodium gangeticum	12.963	37.401	31.986	82.35
Rowlfia serpentina	1.851	0.531	3.176	5.558
Evolvulus nummularius	7.407	6.366	9.528	23.301
Ruelia prostrata	11.111	5.039	5.027	21.177
Synedrella nodiflora	5.555	2.918	5.821	14.294
Kyllinga monocephala	7.407	4.244	6.352	18.033
DATA POINT III				
Euphorbia hirta	11.111	28.833	23.640	63.5844
Acalypha indica	11.111	8.467	6.941	26.519
Eragrostis tenella	7.407	10.984	13.509	31.9
Nicotiana plumbaginifolia	5.555	3.890	6.378	15.823
Elephantopus scaber	18.519	6.865	3.377	28.761
Aerva lanata	7.407	6.407	7.880	21.694
Kyllinga monocephala	11.111	13.043	1.782	25.936
Phyllanthus fraternus	7.407	4.577	5.629	17.613
Vernonia cinarea	7.407	5.721	7.036	20.164
Synedrella nodiflora	3.704	4.119	10.132	17.955
Ruelia tuberosa	3.707	2.517	6.192	12.413
Cyperus cyperoides	5.555	4.577	7.504	17.636

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CONCLUSION

Autecology deals with ecology of an individual species of any organism including the effect of other organisms and environmental conditions on every stage of its life cycle. Each step of a life cycle of a plant is greatly influenced by a number of environmental factors. In nature no species grows singly. It is always in association with others at any locality growing in such a pattern as to give the area a particular appearance. Study of all stages of life cycle of a particular species in nature in association with other species of the community, completely bathed in environment both above ground and underground is the core of autecology. Each stage of life cycle is recorded in detail in the field. The behavioral perspectives of the species can contribute to the understanding of its biology for rationalization of harvesting of plant parts in appropriate time for best utilization of its secondary metabolites rendering different environmental properties. The diversity of secondary metabolites as seen in *Elephantopus scaber* is the reflection of its evolutionary advancement and its potential for therapeutic efficacy against diverse pathogenic organisms. The findings of the present work may be useful in formulating Standard Agronomic Procedure (SAP) for *E. scaber.* The species being regionally threatened needs to be conserved through its cultivation and sustainable use for medicinal purposes.

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