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Herbaceous Riparian Ecotonal Species along the Dzücha River, Kohima, Nagaland and Their Ethnomedicinal Uses

Khrielietuo Keretsu, Maibam Romeo Singh, Wati Temjen

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ABSTRACT

Background: Riparian vegetation maintains the river ecosystem. This vegetation acts as a filter for the water body. The vegetation also hosts naturally rich flora which the tribal people utilize as traditional herbal drug. With the increase in anthropogenic disturbance, there is a need to document and inventory this rich bioresource.

Methods: Vegetation analysis of the Dzücha River was conducted by line transect quadrat method and the diversity Indices were recorded. Ethnobotanical information on the traditional use of the various plants was collected via oral interviews with the indigenous inhabitants.

Result: A total of 31 species belonging to 15 families were recorded from the study site. Species diversity (Shannon-Wiener Index) = 2.775, Species richness (Margalef's Index) = 4.163, Species evenness (Pielou's Evenness) = 0.808 and Species dominance (Simpson's Index) = 0.101, were reported. Maximum IVI (38.45) value was recorded for *Ageratina riparia*. 11 herbaceous species in the study site were utilized as ethno medicinal items. Such traditional knowledge of medicinal plant species is crucial for the development of novel drugs.

Key words: Diversity index, Ethnobotany, Indigenous tribal knowledge, Riparian vegetation.

INTRODUCTION

The ecotonal community contains several organisms from each of the overlapping communities. Such characteristics are restricted to the ecotone (Odum, 1971). The word "riparian" has not been defined as a single entity but in close association with various suffixes such as riparian area, riparian zone, riparian reserve, riparian system, riparian ecosystem, riparian corridor and riparian ecotone. Verry *et al.* (2004) state that the meanings of all the suffixes are more or less similar. Among the suffixes used, the riparian zone and riparian buffer zone are the most common ones. Other than these suffixes, the word "riparian zone" has also been synonymously used as stream corridor, river corridor, riparian forests, riparian buffer zones, riparian zones, *etc.* (Zaimes *et al.*, 2010). The riparian ecotone acts as a filter for the river. Pinay *et al.* (2018) terms it "skin for the river". The water draining downwards *via* the riparian ecotone undergoes a natural filtration process which absorb sediments, pollutants, *etc.* The vegetation and microbial fauna in the riparian ecotone aid in the filtration process (Silvan *et al.*, 2002; Palviainen *et al.*, 2004). Therefore, riparian vegetation is crucial in maintaining the river environment, including river water temperature and organic-inorganic inputs. Such vegetation affects the intensity of light reaching the river water; the dense canopy lowers the river water, while the open canopy raises the river water (Garner *et al.*, 2017).

Vegetation analysis is an important aspect of ecology that enables us to understand the structure and function of a community. This analysis provides key information regarding diversity, structure, resource utilization and turnover rate of a species (Mandal and Joshi, 2014). Plants within the same community have a mutual relationship between themselves and the environment (Mishra *et al.*, 1997). Nagaland, a state in the northeast corner of North East India, is rich in biodiversity. However, various anthropogenic factors are reported to be affecting riparian vegetation globally (Richardson *et al.*, 2007; Njue *et al.*, 2016). The increased rate of agriculture and invasive species has caused a decrease in species diversity (Vivero *et al.*, 2006; Meragiaw *et al.*, 2016). Owing to the rich flora in the region, the tribal people utilize various parts of the plant as a traditional herbal drug (Jamir *et al.*, 1999). Therefore, there is a need to document the rich, unwritten indigenous tribal knowledge (Hussain *et al.*, 2018). Keeping in view the need to document the diverse riparian vegetation present in the state and its varied utilization by the indigenous inhabitant of Nagaland, the present work has been carried out.

Department of Botany, Centre for Biodiversity, Nagaland University, Lumami-798 627, Nagaland, India.

Corresponding Author: Watitemjen, Department of Botany, Centre for Biodiversity, Nagaland University, Lumami-798 627, Nagaland, India. Email: temjen.wati29@gmail.com

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MATERIALS AND METHODS

Study site

Dzücha River is a tributary river that flows along the Dzü River. The river is located adjacent to Kohima district, Nagaland, North East India (Fig 1). Dzücha River is located at 25°39′39′N latitude and 94°08′11′′E longitude with an elevation of 1100.023 m above sea level. The water body is utilized by the indigenous inhabitant for irrigation, fishing activities, recreational sites and other domestic uses. The study site also possesses many wild herbaceous plants which are widely utilized by the indigenous inhabitants as herbal drugs for various ailments.

Vegetation analysis

The vegetation analysis was conducted by the line transect quadrat method (Fig 2A and 2B). For the study of vegetation along the river, a total of 20 plots were laid, with each plot measuring 5 m × 5 m. A total of 10 plots on the right side and 10 plots on the left side of the river were recorded. Within each plot 3 quadrats of size, 1 m × 1 m were laid randomly. A photograph of each of the herb species observed at the study site was taken. The observed herb species occurring within the quadrats were identified with the help of literature (Prain, 1903; Bennet 1987; Kanjilal *et al*., 1940). Herbarium specimens were deposited in the Department of Botany, Nagaland University.

Data analysis

The vegetation data collected from the study site were analyzed for relative frequency, relative density, relative abundance and Important Value Index (IVI) following the standard formulas given by Curtis and Mcintosh (1950), Mishra (1968) and Mueller-Ellenberg (1974). The data were calculated using the following formulae:

Percentage frequency =

$$\frac{\text{No. of quadrats in which species occured}}{\text{Total no. of quadrat studied}} \times 100$$

Relative frequency =

$$\frac{\text{Percentage frequency of all species}}{\text{Total percentage frequency of all species}} \times 100$$

Density =

$$\frac{\text{Total no. of individuals of a species in all quadrat}}{\text{Total no. of quadrat studied}}$$

Relative density =

$$\frac{\text{No. of individuals of the species in all quadrats}}{\text{No. of individual of all species}} \times 100$$

Abundance =

$$\frac{\text{Total no. of individuals of a species}}{\text{Total number of quadrats in which the spices occured}} \times 100$$

$$\text{Relative dominance} = \frac{\text{Basal area of a species}}{\text{Basal area of all the species}} \times 100$$

The basal area for the herb species was calculated by measuring the diameter of the emerging stem on the ground level using Caliper.

$$\text{Basal area of a particular species} = \pi r^2$$

Important value index (IVI)

The IVI (Curtis, 1959) of each species was calculated by summing the Relative Frequency (RF), Relative Density (RD) and Relative Dominance (RD)

$$IVI = RF + RD + RD$$

The shannon-wiener diversity index

(H′) was calculated from the IVI values (Shannon and Wiener, 1963):

$$H' = -\Sigma_{i=o}^{s} p_{il} pi$$

Where

s = Number of species.

pi = Proportion of individuals or abundance of the i^{th}species expressed as a proportion of total cover.

ln = Log base n.

Margalef's index was calculated by using the formula given by Margalef (1968).

$$K= \log S/\log N$$

Where

S = The number of species

N = The total number of individuals in the sample.

Pielou evenness (E) is measured as suggested by Pielou (1966).

$$E = I_{SH} /\log 2(Rs)$$

Where

Rs = Specific richness

Simpson's dominance was calculated by using the formula given by Simpson (1949).

$$\text{Simpson's dominance} = \frac{1}{\Sigma_{i=o}^{s} pi2}$$

Ethnobotanical methodology

Oral interviews were conducted with the ingenious inhabitants and local healers from Kohima Village, Nagaland, North East India. The plant samples and their photos collected from the study sites were then presented to local healers. Different parts of the plant used for treating ailments, based on ethnobotanical information, were recorded based on their response.

RESULTS AND DISCUSSION

Vegetation analysis

A total of 31 species belonging to 15 families were reported (Table 1). The family *Asteraceae* was dominant, with 12 species. This was followed by *Urticaceae*, with 3 species. While *Polygonaceae, Lamiaceae* and *Commenlinaceae* had 2 species each, respectively. *Ageratina riparia* (24.1) possessed the highest density, followed by *Ageratina* *adenophora* (11.34), *Ageratum conyzoides* (8.90) and *Pneumatopteris penningera* (8.82), respectively. The lowest density was recorded in *Phaseolus vulgaris* (0.22). The distribution analysis of the herb species also displayed that the maximum IVI was recorded for *Ageratina riparia* (38.45). The co-dominating species were *Ageratina adenophora* (IVI=22.44), *Ageratum conyzoides* (IVI =22.35) and *Pneumatopteris pennigera* (IVI=21.44), respectively. High IVI value of a species indicates its dominance and ecological success, power of regeneration and greater ecological amplitude. A higher value of IVI by any individual species indicates that all the available resources are being utilized by that species (Shameem *et al*., 2010). The lowest IVI value was observed in *Phaseolus vulgaris* (1.74). The lower value of IVI could be due to the damage caused by the high moisture content at the site, which leads to infestations of fungi within the roots. The lower IVI values may also be correlated with anthropogenic pressure (Mandal and Joshi, 2014). Moreover, vegetation types along the environmental gradient are largely affected by altitude, light, topography,

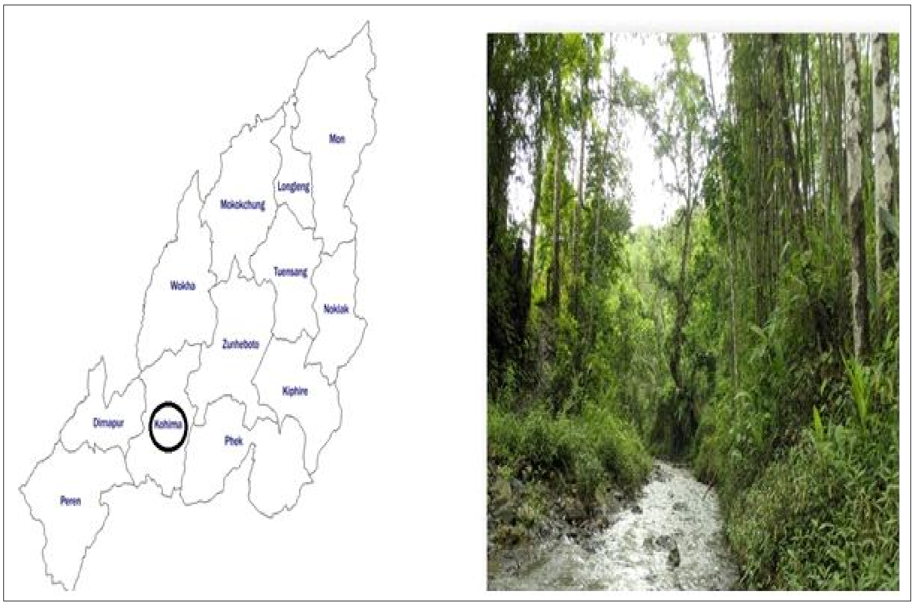

Fig 1: Map of the study area with a photograph of vegetation along the Dzücha River.

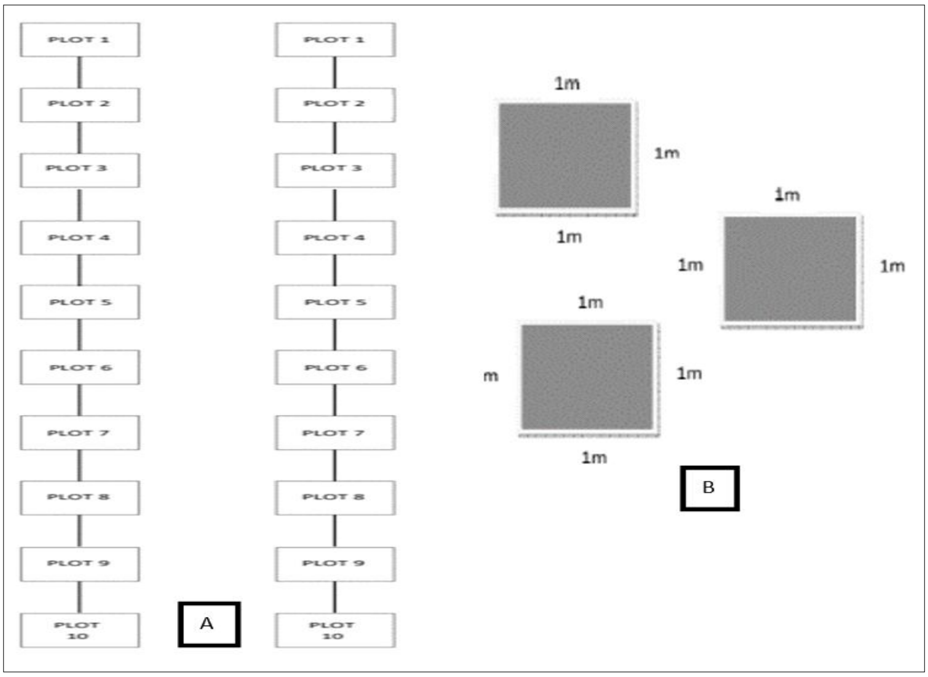

Fig 2: A. Schematic representation of the plots taken from the right and left side of the Dzücha River.

Table 1: Distribution analysis of herbs species recorded in Dzücha River.

Plant species	F	R.F	D	R.De	A	B.A	R.Do	IVI
Aegopodium podagraria L.	21.68	3.70	0.64	2.81	292.30	0.8	6.95	13.46
Ageratina adenophora (Spreng.) King and H.Rob.	58.34	9.97	2.55	11.35	437.14	0.13	1.12	22.44
Ageratina altissima (L.) King and H.E.Robins.	5	0.85	0.21	0.96	433	0.8	6.95	8.76
Ageratina riparia (Regel) R.M. King and H.Rob	78.34	13.40	5.44	24.1	693.61	0.11	0.95	38.45
Ageratum conyzoides L. 1753 not Hieron. 1895 nor Sieber ex Steud. 1840	53.34	9.11	2	8.90	375	0.5	4.34	22.35
Bidens bipinnata L. 1753	8.34	1.42	0.23	1.03	280	0.8	6.95	9.4
Bidens pilosa L. 1753	11.67	2	0.44	1.92	371.42	0.6	5.21	9.13
Boehmeria cylindrical (L.) Swartz	11.67	2	0.24	1.03	200	0.15	1.30	4.33
Boehmeria nivea (L.) Gaudich	8.34	1.42	0.16	0.74	200	0.14	1.21	3.37
Circea lutetiana L.	10	1.70	0.24	1.03	233.34	0.10	0.86	3.59
Cleome rutidosperma DC.	8.34	1.42	0.27	0.18	320	0.14	1.21	2.81
Commelina erecta L., Sp. Pl. 1: 41. 1753.	6.67	1.15	0.11	0.51	175	0.21	1.82	3.48
Commelina diffusa Burm. F	13.34	2.28	0.47	2.07	350	0.9	7.8	12.15
Crassocephalum crepidioides (Benth.) S.Moore 1912	16.67	2.84	0.41	1.85	250	0.10	0.86	5.55
Curcuma longa L.	13.34	2.30	0.51	2.29	387.5	0.14	1.21	5.8
Eupatorium cannabinum L.	18.34	3.13	0.57	2.52	309.09	0.8	6.95	12.6
Erechtites hieraciifolius (L.) Raf. Ex DC.	6.67	1.15	0.15	0.67	225	0.24	2.08	3.9
Erigeron Canadensis L.	23.33	3.98	0.67	2.96	285.71	0.13	1.12	8.06
Galeopsis tetrahit L.	6.67	1.15	0.11	0.51	175	0.11	0.95	2.61
Galinsoga parviflora Cav. 1796	40	6.83	1.5	6.67	375	0.10	0.86	14.36
Hypericum punctatum Lam. 1796	6.67	1.15	0.14	0.59	200	0.4	3.47	5.21
Mentha arvensis L.	11.67	2	0.31	1.40	271.42	0.7	6.08	9.48
Mikania scandens B.L.Rob.	26.67	4.55	0.6	2.67	225	0.4	3.47	10.69
Persicaria maculosa Gray	3.34	0.57	0.08	0.37	250	0.9	7.81	8.75
Persicaria lapathifolia (L.) Delarbre 1800	38.34	6.55	1.28	5.71	334	0.8	6.95	19.21
Phaseolus vulgaris L.	3.34	0.57	0.05	0.22	150	0.11	0.95	1.74
Pilea pumila (L.) A.Gray	5	0.85	0.11	0.51	233.34	0.12	1.04	2.4
Plantago major L.	13.34	2.28	0.48	2.15	362.5	0.11	0.95	5.38
Pneumatopteris pennigera (G.Forst.) Holttum	38.3	6.54	1.98	8.82	517.39	0.7	6.08	21.44
Ranunculus sceleratus L.	10	1.70	0.28	1.26	283.34	0.13	1.12	4.08
Solanum americanum Mill	8.34	1.42	0.21	0.96	260	0.14	1.21	3.59

*F=Frequency (%), RF (%) = Relative frequency, D = Density (individual m^{-2}), R.De (%) = Relative density, A = Abundace (%), B.A = Basal area (cm^2m^2), R.Do (%) = Relative dominance and IVI (%) = Important value index.

temperature and precipitation, as these factors determine the composition and distribution of the vegetation (Sağlam, 2013). Meanwhile, the lower importance value of species is an index of low grazing pressure by herbivores on the study sites, as vegetation is a reflex of interactions between the plants, animals, soils and climate. Moreover, each species of a community plays a specific role and there is a definite quantitative

Table 2: Diversity indices recorded at Dzücha River.

Indices	Values
Species diversity (Shannon-wiener index)	2.775
Species richness (Margalef's index)	4.163
Species evenness (Pielou evenness)	0.808
Species dominance (Simpson's index)	0.101

Table 3: List of plant species and their medicinal uses.

Plant species	Plant parts used	Medicinal uses
Ageratina adenophora	Leaf	Treatment of cut wounds, itching and various skin diseases
Ageratina altissima	Root	Treatment of diarrhea and toothache.
Ageratum conyzoides	leaf	Treatment of cuts wound and bruises.
Bidens pilosa	Whole Plant	Treatment of wounds, inflammation and digestive disorders.
Boehmeria cylindrica	Leaf	Treatment of fluxes and wounds.
Circaea lutetiana	Leaf and Root	Treatment of infection and fever.
Crassocephalum crepidiodes	Leaf	Treatment of indigestion.
Erigeron canadensis	Leaf and Stem	Treatment of diarrheoa and dysentery.
Galinsoga parviflora	leaf	Treatment of wounds and disinfectant.
Mentha arvensis	Leaf	Used for stomach problems and allergy.
Plantago major	Leaf	Treatment of wounds, insect stings and other skin diseases.

relationship between abundant and rare species (Bhandari *et al.,* 1999). Bhatti *et al.* (2014) in Yusmarg forest also report that the higher value of IVI indicates that all the available resources are being utilized by that species and leftovers are being trapped by other species as the competitors and associates.

Diversity indices

The various diversity indices recorded at the sampling station (Table 2) are as follows: Species diversity (Shannon-Wiener Index) = 2.775, Species richness (Margalef's Index) = 4.163, Species evenness (Pielou's Evenness) = 0.808 and Species dominance (Simpson's Index) = 0.101. The higher values of Shannon-wiener's diversity Index may indicate the high diversity of species present on the site. It also observed that the low diversity and consequently greater concentration of dominance in vegetation could be due to the lower rate of evolution and diversification of communities in the environment (Connel and Orias, 1964). More species in a community are ecologically important since diversity increases as the community become more stable.

Ethnobotanical uses

The use of ethnomedicinal plants for various ailments has been recorded extensively (El-Seedi *et al*., 2013). From the herbaceous species recorded, 11 herb species were utilized by the indigenous inhabitants (Table 3). Traditional knowledge of medicinal plants is critical as they enable for development of novel drugs (Fabricant and Farnsworth, 2001). Similar studies on the ethnobotany of riparian vegetation by Mohanan *et al*. (2020) report the presence of about 106 medicinal plants belonging to 48 families in the study. One of the biggest threats to such medicinal plants is both over harvesting and destruction of habitats (Cunningham, 1992). The distribution of medicinal plants in the riparian zone is greatly affected by anthropogenic activities. As urbanization rapidly spreads and modern medicines are implemented, the indigenous tribal knowledge which has not yet been documented is being lost. Therefore conservation strategies of the knowledge and sustainable utilization of the plant species are vital. This can be achieved by selecting the endangered important ethnomedicinal plants and understanding their management by the indigenous inhabitants (Woldeab *et al*., 2018).

CONCLUSION

The present study concludes that 31 species belonging to 15 families are reported from the riparian zone of the Dzücha river. Eleven herb species were reportedly utilized by the indigenous inhabitants. The warm and humid condition in the area has created an ideal environment for the genus Ageratina. Further, the diverse vegetation in the area hosts a variety of plants possessing traditional ethnobotanical medicinal values. Anthropogenic activities which negatively impact the important vegetation should also be monitored. Inventory of the bio resources of the region may further shed light on the high biodiversity of the region and its sustainable utilization by the stakeholders.

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Conflict of interest

The authors declare no conflict of interest.

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