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The Riparian Vegetation has Effects on the Faunal Diversity

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ABSTRACT

Riparian vegetation is the floral diversity found across water streams and rivers. It is also indicated as a transitional zone between terrestrial and aquatic ecosystems. There is direct or indirect involvement of riparian vegetation in maintaining nutrient balance, and energy flow in the ecosystems and it also provides various resources to the aquatic micro and macroinvertebrates. It also contributes to controlling sediment load to the water bodies which affects the water quality. This study attempted to add new information and the current status of riparian vegetation at Devprayag across the river Ganga and to analyze its impact on water quality and the occurrence of aquatic micro and macroinvertebrates including aquatic mites. A total of 71 species of plants belonging to 33 different families were collected and identified during the present study. It was observed that Poaceae is the dominant family with a maximum of 15 species.

Keywords: Aquatic mites, Aquatic macroinvertebrates, Devprayag, Ganga River, Riparian vegetation.

INTRODUCTION

Riparian habitats are considered a connecting link between terrestrial and aquatic biota owing to the exchange of nutrients and energy flow between them (Gregory et al., 1991; Verry et al., 2000). Riparian vegetation also has a significant role in maintaining the natural functioning of the riverine and other aquatic ecosystems (Rios and Bailey, 2006) along with accommodating varied aquatic, amphibious, and terrestrial species (Capon, 2020). Riparian vegetation obstructs surface overflow thereby stabilizing river beds which in turn lowers the sediment load into the river or streams (Schlosser and Karr, 1981). A low sediment rate enhances light penetration and increases visibility and has a positive impact on fish size, predators as well as on algal growth (Zum Berge et al., 2003).

Furthermore, the ecological significance of riparian zone is due to the interrelationship between vegetation, soil, and water in that area (Pandey et al., 2022). Variation in bioclimatic, geomorphological, and land-use conditions, with time under natural and anthropogenic interferences, results in high spatial and temporal variability in the riparian zone. Riparian zones are considered effective sinks for dissolved inorganic nitrogen and phosphorus discharging from neighboring areas (Naiman and Decamps, 1997), thus playing a significant role in regulating the eutrophication of water bodies. Riparian vegetation act as green cover which not only mitigates pollutants but also improves the ecological conditions/ aesthetics and micro-climatic conditions.

Pusey and Arthington (2003) and Rios and Bailey (2006) have studied the importance and influence of riparian vegetation on benthic and other aquatic communities. Fierro et al. (2017) studied the influence of riparian vegetation on aquatic macroinvertebrates, the findings were also supported by the studies conducted by numerous researchers (Iniguez-Armijos et al., 2018;

Burdon et al., 2020; Silva-Araujo et al., 2020; Forio et al., 2020 and Cole et al., 2020). Aquatic plants along with riparian vegetation provide the substrate required for the completion of the life cycle of numerous aquatic faunal communities including aquatic mites and their hosts and thus aquatic plants are exploited by several species of aquatic mites. Balodi et al., (2004) detailed the riparian vegetation of Eastern Nayar while Sagir and Dobriyal (2017, 2018) and Sagir et al., 2018 studied the riparian vegetation of Western Nayar. Chamoli (2020) worked on the weed flora of the riparian areas of the Rudraprayag district, Uttarakhand.

The present paper is an attempt to provide documentation of the riparian vegetation found across the river Ganga at Devprayag, Uttarakhand, India along with the impact of the riparian zone on the aquatic micro and macro invertebrates including aquatic mites.

STUDY AREA

The present study has been conducted at Devprayag, Uttarakhand, where the confluence of rivers Alaknanda and Bhagirathi occurs. Beyond this point, the river is recognized as the holy river Ganga. Devprayag lies between latitude 30.1459^0 N and longitude 78.5993^0 E at an altitude of 830 masl. The riparian vegetation was collected from both banks of the river after the confluence zone. Regular monitoring was done for the period of two years to recognize the vegetational pattern seasonally as well.

MATERIAL AND METHODS

Riparian vegetation of both the river banks of the Ganga has been collected and identified with the help of local inhabitants and then was confirmed with the help of different keys of available floras of Uttarakhand and the Himalayas for their taxonomical specification (Gaur, 1999). For the validation and authenticity of the information gathered numerous subject matter experts have been consulted. The information gathered is further categorized into the family, vernacular name, availability, and habit to analyze the riparian vegetation precisely. The specimen's information on plants was processed, documented, and finally deposited in the herbarium of the Department of Zoology, SGRR University, Dehradun as reference material.

RESULTS

During the present course of study, a total of 71 species of plants belonging to 33 different families were collected, identified (Table 1), and preserved as herbarium sheets.

It was recorded that out of these 71 species identified maximum 22 (31%) were shrubs followed by 15 (21%) trees and grasses each, 12 (17%) herbs, three (04%) climbers and weeds each and only one (02%) fern (Figure 1).

In addition, it was also reported that the Poaceae was the dominant family with maximum 15 species followed by Asteraceae with seven species, Euphorbiaceae with four species and Fabaceae, Lamiaceae, Rosaceae, and Solanaceae with three species each. Availability wise 43 species were common, 25 were abundant and only three species were rarely recorded during the present study (Figure 2).

DISCUSSION

Lotic ecosystems are characterized by multi-dimensional environmental gradients (Ward, 1989). Cummins and Spengler (1978) observed in their study that the riparian vegetation enormously impacted the water streams as they work as processing units for these water systems. The vegetation across the river provides shade to the river by its branches and hangings which in turn keep it cool and also come up with dead organic matter or detritus. Shading just not only influences the water quality but also regulates the activities of algae and macrophytes which are known as primary producers.

Heterogeneous microhabitats provided by riparian zones are due to its transition from a terrestrial ecosystem to an aquatic ecosystem (Rykken et al., 2007), for both terrestrial and aquatic populations, thereby supporting biodiverse communities (Ramey and Richardson, 2017). Naiman et al. (2005) define riparian vegetation of riverine systems as a network of diverse vegetation units across a river belt that functionally relates to the other components of the fluvial system and surrounding area. The riparian ecosystems are characterized by the interplay of soil, water and vegetation components which determine their ecological significance (Pandey et al., 2022).

Tree branches, dead leaves, needles, twigs, logs, buds, fruit and dissolved organic matter are organic matters supplied by riparian vegetation. This additional availability of organic matter is a prime requisite to the aquatic biota as they act as its primary energy source (Hynes 1963, Cummins 1974). As per Fisher and Likens (1973), the riparian vegetation covered with the heavy forest canopy having a higher frequency of shade might provide 99% of the annual input of energy to the aquatic ecosystem.

The various ways opted by the aquatic organism to make use of and to process the organic matter provided by riparian vegetation is studied by Cummins 1973, 1975; Cummins and Klug 1979; Anderson and Sedell 1979; Howkins and Sedell 1981 and Hefting et al., 2005. Fungi, bacteria, parasites, and microorganisms quickly establish

a colony on the leaves going through leaching (Cummins and Spengler 1978).

The taxon richness of aquatic mites is also related to the physicochemical parameters and riparian vegetation (Zawal et al., 2017). As per the studies conducted by Biesiadka and Kowalik (1991), Rousch et al. (1997), Di Sabatino et al. (2002) and Dohet et al. (2008) the aquatic mites are considered to be eminent water quality biomarkers. Riparian vegetation is a basic living space utilized by many adult insects for feeding, resting and hiding. Many insect adults lay their eggs on overhanging of riparian vegetation in the stream in such a way after hatching the young larvae will drop into the stream for further aquatic life stages. As the larvae of aquatic mites parasitize various groups of macroinvertebrates that includes Collembola, Coleoptera, Diptera, Heteroptera, Odonata, Plecoptera, and Trichoptera), it enables aquatic mites to disperse and colonize various habitats (Martin 2008).

Aquatic mites provide a high integration power due to their complex interaction with other members of the macroinvertebrate fauna (mainly insects). Macrophyte plants offer favorable surroundings for numerous host taxa, playing a vital role in the colonization and dispersion of new patches by aquatic mites (Martin 2008). Therefore, the presence of macrophytes in general across river beds probably is a factor influencing aquatic mite diversity (da Silva et al., 2017). The dependence of a few species of Arrenurus on the abundant growth of macrophytes has been reported by Wiecek et al. (2013).

The river system and riparian vegetation are interdependent on each other; as per Foote et al. (1996) riparian wetlands, deltas and estuaries normally have high productivity with higher species richness but the scenario can be altered with any variation in river flow regulation. A stable substrate for biofilm and other macroinvertebrates is provided by the river system having a sandy, unstable substrate and woody debris (Wallace and Benke 1984; Thorpe and Delong 1994; Sheldon and Walker 1998) which helps in the constitution of major elements of the food chain and food source for higher aquatic taxa. The sediment load of stream increases from unstable soils along the banks (Allan, 2004; Vondracek et al., 2005) which can be one of the reasons for the presence or absence of an important species that impact the biota of that system.

Rich riparian vegetation of Kyunja stream as studied by Baluni and Chandola (2019) exhibited enhancement in the biological productivity of the stream. Several authors observed detritus standing stock and rich epilithic periphyton accompanied by macrozoobenthos. Periphyton diversity and distribution concerning stream physicochemical parameters have a huge impact on the occurrence of several aquatic mites (Pesic et al., 2019 a,b; 2020 a,b; 2022a,b; Bahuguna et al., 2019a, 2020a; Negi et al., 2021a,b), macrozoobenthos (Bahuguna and Dobriyal, 2018; Kumar and Dobriyal, 1999; Mamgain et al., 2021; Rautela et al., 2006) and drifting behavior of macrozoobenthos (Bahuguna et al., 2019b, 2020b; Bahuguna and Dobriyal, 2020) and on fish diversity (Rayal et al., 2021 a, b; Bahuguna 2020, 2021; Bahuguna and Joshi, 2012; Bahuguna et al., 2010).

The present study demonstrates that the region harbors a high variety of floral diversity thereby providing high macroinvertebrate density and diversity including aquatic mites. River systems and streams are described by a variety of physicochemical factors along the riverside and throughout the length of the river or stream. Alteration in the system to any extent either from natural or anthropogenic activities impacts the water quality of the system and also hampers the biological association (Thoker et al., 2015).

Table 1: List of species recorded from both the banks of the Ganga River at Devprayag

Sl. No.	Botanical Name	Family	Vernacular name	Availability	Habit
1.	*Adhatoda vasica*	Acanthaceae	Adusa	A	Shrub
2.	*Mangifera indica*	Anacardiaceae	Aam	C	Tree
3.	*Rhus parviflora*	Anacardiaceae	Taugla	A	Herb
4.	*Carissa spinarum*	Apocynaceae	Karonda	R	Shrub
5.	*Agave americana*	Asparagaceae	Ram bans	A	Shrub
6.	*Asplenium trichomanes*	Aspleniaceae	-	A	Fern
7.	*Artemisia nilagirica*	Asteraceae	-	C	Shrub
8.	*Eupatorium odoratum*	Asteraceae	Gandha	C	Herb
9.	*Parthenium hysterophorus*	Asteraceae	Gajar ghas	A	Weed
10.	*Sonchus oleraceus*	Asteraceae	Dhadi phool	C	Herb
11.	*Tridax procumbens*	Asteraceae	Keshraj	C	Herb

12.	*Vernonia cinerea*	Asteraceae	-	C	Herb
13.	*Xanthium strumarium*	Asteraceae	Chota dhatura	C	Weed
14.	*Berberis asiatica*	Berberidaceae	Kilmoda	C	Shrub
15.	*Opuntia vulgaris*	Cactaceae	Cactus	A	Shrub
16.	*Cannabis sativa*	Cannabaceae	Bhang	C	Shrub
17.	*Celtis australis*	Cannabaceae	Khadic	C	Tree
18.	*Stellaria media*	Caryophyllaceae	Baderu	C	Herb
19.	*Cuscuta* sp.	Convolvulaceae	Amar bel	C	Climber
20.	*Dioscorea belophylla*	Dioscoreaceae	Taidu/ Tarud	C	Climber
21.	*Dioscorea bulbifera*	Dioscoreaceae	Gethi/ Ratalu	C	Climber
22.	*Euphorbia hirta*	Euphorbiaceae	Dudhi	C	Weed
23.	*Euphorbia royleana*	Euphorbiaceae	Thor	C	Shrub
24.	*Mallotus philippensis*	Euphorbiaceae	Rohini	C	Tree
25.	*Ricinus communis*	Euphorbiaceae	Arand	A	Shrub
26.	*Cassia fistula*	Fabaceae	Amaltas	C	Tree
27.	*Dalbergia sissoo*	Fabaceae	Sheesham	C	Tree
28.	*Tamarindus indica*	Fabaceae	Imli	C	Tree
29.	*Colebrookea oppositifolia*	Lamiaceae	Binda/ Pansra	A	Shrub
30.	*Pogostemon benghalensis*	Lamiaceae		C	Shrub
31.	*Scutellaria scandens*	Lamiaceae	Jungali pudina	C	Herb
32.	*Woodfordia fruticosa*	Lythraceae	Dhaula	C	Shrub
33.	*Malvastrum coromandelianum*	Malvaceae		A	Herb
34.	*Toona ciliata*	Meliaceae	Tun	C	Tree
35.	*Ficus benghalensis*	Moraceae	Badh/ Bargad	C	Tree
36.	*Ficus roxburghii*	Moraceae	Timla	R	Tree
37.	*Bougainvillea* sp.	Nyctaginaceae	Kagaj ke phool	C	Shrub
38.	*Argemone mexicana*	Papaveraceae	Satyanashi	A	Herb
39.	*Bridelia retusa*	Phyllanthaceae	Ekdania	C	Tree
40.	*Emblica officinalis*	Phyllanthaceae	Aonla	C	Tree
41.	*Apluda mutica*	Poaceae	Charol	A	Grass
42.	*Calamagrostis* spp.	Poaceae	-	A	Grass
43.	*Chrysopogon serrulatus*	Poaceae	Golden beared grass	A	Grass
44.	*Chrysopogon fulvus*	Poaceae	Bhuri	A	Grass
45.	*Cynodon dactylon*	Poaceae	Dub ghas	A	Grass
46.	*Digitaria* spp.	Poaceae	-	C	Grass
47.	*Eragrostis* spp.	Poaceae	-	A	Grass
48.	*Oplismenus compositus*	Poaceae	Dumdobra kukaria	C	Grass
49.	*Paspalidium* spp.	Poaceae	-	A	Grass
50.	*Paspalum notatum*	Poaceae	-	C	Grass
51.	*Phragmites australis*	Poaceae	Dadu ghas	A	Grass
52.	*Phragmites karka*	Poaceae	Narkul	C	Grass
53.	*Phragmites* spp.	Poaceae	-	C	Grass
54.	*Poa annua*	Poaceae	Annual blue grass	A	Grass
55.	*Stenotaphrum secundatum*	Poaceae	Buffalo ghas	A	Grass
56.	*Rumex hastatus*	Polygonaceae	Almoda	C	Shrub

57.	*Rumex* spp.	Polygonaceae	Jungli palak	C	Herb
58.	*Ziziphus mauritiana*	Rhamnaceae	Ber	A	Shrub
59.	*Pyracantha crenulata*	Rosaceae	Ghigharu	C	Shrub
60.	*Pyrus pashia*	Rosaceae	Mehal	C	Tree
61.	*Rubus ellipticus*	Rosaceae	Hinssar	C	Shrub
62.	*Galium* spp.	Rubiaceae		C	Shrub
63.	*Aegle marmelos*	Rutaceae	Bael	A	Tree
64.	*Murraya koenigii*	Rutaceae	Karri patta	A	Shrub
65.	*Datura stramonium*	Solanaceae	Dhatura	C	Herb
66.	*Nicotiana tabacum*	Solanaceae	Van tambakhu	R	Shrub
67.	*Physalis minima*	Solanaceae	Tulati pati	C	Herb
68.	*Grewia optiva*	Tiliaceae	Bhemal	A	Tree
69.	*Holoptelea intergrifolia*	Ulmaceae	Papari/ Kanju	C	Tree
70.	*Urtica dioica*	Urticaceae	Kandali	C	Shrub
71.	*Lantana camara*	Verbenaceae	Kurri/ Big sage	A	Shrub

A= Abundant, C= Common, R= Rare

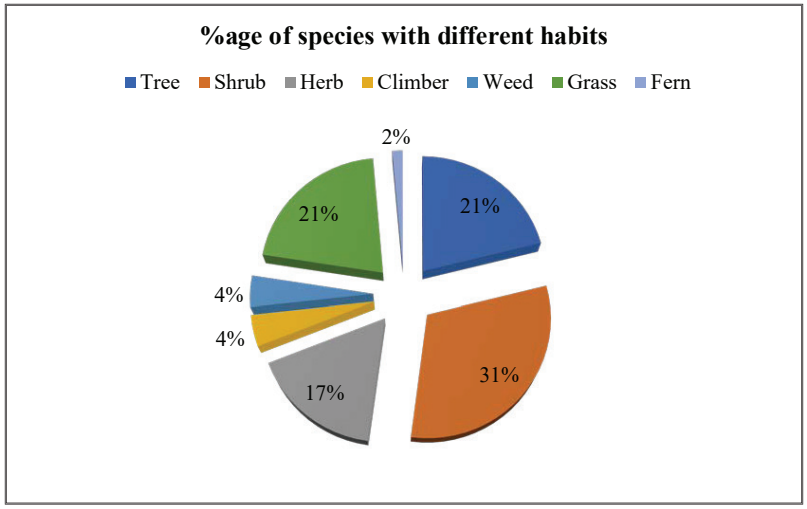

Figure 1: Pie diagram showing habit-wise percentage of species recorded

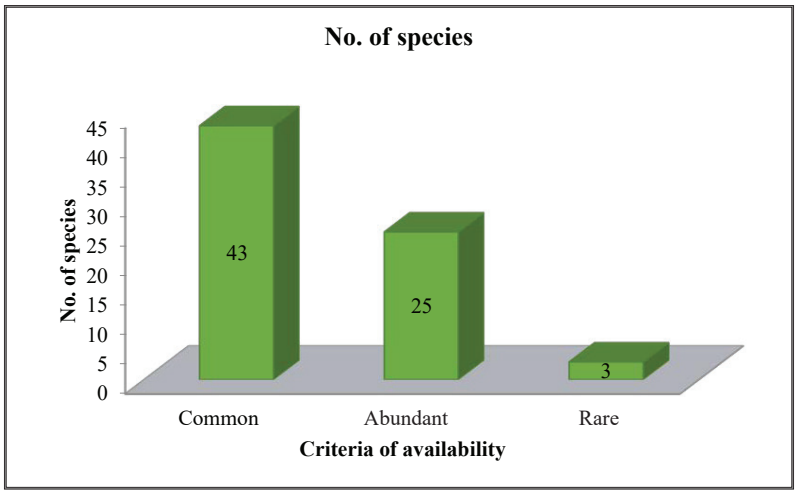

Figure 2: Graph showing species availability based on their occurrence

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Declaration: *We also declare that all ethical guidelines have been followed during this work and there is no conflict of interest among authors.*

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