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Diversity of native and alien plant species in ruderal grasslands of Kashmir Valley, India

Pervaiz A. Dar[1]* and Zafar A. Reshi[2]

[1]*Department of Botany, Amar Singh College Srinagar-190008*

[2]*Biological Invasions Research Laboratory, Department of Botany, University of Kashmir, Srinagar-190006*

ABSTRACT

Grasslands are among the major terrestrial ecosystems with tremendous ecological and economic importance. In particular, Kashmir Himalayan grasslands are very important as they provide fodder for the domestic animals thus contributing to the economy of the state. Since these ecosystems have been put at risk on account of anthropogenic actives which has facilitated invasion of alien plant species, we studied distribution of native and alien plant species in four ruderal grasslands. We observed that these grasslands have been invaded to a very large extent as the number of alien species was higher than the number of native species in all the surveyed grasslands. In addition alien species have increased the similarity of these ecosystems thereby decreasing the distinctness of these ecosystems. These observations assume significance as anthropogenic activities which is fragmenting the ecosystems is inturn facilitating the spread of alien plant species and as such causing serious damage to native biodiversity for which Kashmir Himalaya is known.

Key words: Diversity, Grassland, Himalaya, Level of invasion

I INTRODUCTION

Grasslands represent vegetations that are dominated by grass and grasslike species mainly structured by spells of drought found in both temperate and tropical regions [1]. From ecological point of view, grasslands have diverse values as they provide habitat for occurrence of species, regularizing of water regimes, to the purification of fertilizers and pesticides and offer ecosystem services such as watershed protection, grazing, and scenery which result from their intrinsic structure and function [2]. Despite this, these ecosystems have been put at risk on account of globalization and there is an urgent need to ensure the safety of these vital ecosystems.

Worldwide grasslands are known to cover ca. 25 percent of the Earth's surface [3] and are widespread both in tropical and temperate areas. Presently the area under grassland biomes is being severely altered mainly because of anthropogenic activities urbanization, cultivation, livestock grazing etc. Most of this degradation is prominent in temperate grasslands which are very diverse and productive [4]. In Kashmir Himalaya, grasslands cover 16% land area [4] and play vital ecological and economic role in the region. In particular livestock rearing is largely dependent on these grasslands [5] and it accounts for a significant economic activity in the region.

Invasive species, being the second major threat to biodiversity, are threatening native taxas and biotas both at global level as well as local level [6] [7] [8]. These invasive species register their impact through variety of mechanism i.e. through direct competition [9] [10], alteration in hydrologic regimes [11], disruptions of mutualistic networks such as pollination and dispersal [12] [13], etc. In particular alien species are reported to alter fire regimes [14] a factor vital for existence of grasslands. Kashmir Himalaya has witnessed introduction of alien species from variety of sources like Europe, North America, South America and Asia (excluding Indian subcontinent) to such an extent that 29% of the flora is represented by these alien species [15]. These alien species are invading all the habitats and as such causing heavy ecological and economic damage.

Notwithstanding the ecological and economic importance of grasslands, these ecosystems have been put under serious threat on account of human mediated land use changes. In Kashmir Himalaya natural habitats (like large grasslands) have either been completed transformed into residential areas or have been fragmented to a very large extent [16]. This transformation and fragmentation has facilitated the introduction of alien species into these habitats. It is in this backdrop the present study was undertaken to address following question

a) What is the diversity of native and alien plant species in ruderal grasslands?
b) What is the level of invasion in these habitats?
c) To what extent alien species have increased similarity between grasslands?

II MATERIAL AND METHODS

For present study we selected 04 ruderal grasslands (semi-natural grasslands i.e. grasslands around human habitation). At each of the 04 study sites, a 200X200m plot was selected. A total of 20 quadrats were laid randomly for estimating abundance using following formulae:

$$\text{Abundance} = \frac{\text{Total number of individuals of a species}}{\text{Number of quadrats in which species occurred}}$$

For estimating the species diversity, richness and evenness, five different indices (i.e., Simpson, Shannon, Evenness, Fisher's alpha and Berger-Parker) were calculated. These indices were calculated in three different ways- firstly with all the species present (shown by subscript T with name), secondly with only native species (shown by subscript N with name) and thirdly with only alien species (shown by subscript A with name) for each study site using Past 3.0 and Estimate SWin820 software. Then site wise values of diversity indices were summed up habitat wise and mean was calculated by using the formula:

$Mean = \frac{n1+n2+n3\ldots\ldots\ldots}{Total\ number\ of\ sites}$ where n1, n2, n3..... are values of indices at site 1, site 2, site 3.....

Level of invasion at each site was expressed as

$$Proportion\ of\ alien\ species\ per\ site = \frac{Number\ of\ alien\ species\ recorded\ at\ a\ site}{Total\ number\ of\ species\ recorded\ at\ a\ site}\ X\ 100$$

$$Proportion\ of\ alien\ species\ per\ site = \frac{Number\ of\ invasive\ species\ recorded\ at\ a\ site}{Total\ number\ of\ alien\ species\ recorded\ at\ a\ site}\ X\ 100$$

We then used repeated measures ANOVA and Tukey's post hoc tests to test differences among mean values species diversity indices. The similarity between sites was measured using Jaccard's index which measures binary values as:

$$J = \frac{a}{a+b+c}$$

Where a is the number of species shared between two sites and b and c are the numbers of species unique to either site. Percent similarity was then expressed as Jaccard's index X 100. This was calculated in three different ways- one based on all species, second based on native species and third based on alien species.

III RESULTS

3.1 Species composition

A total of 113 plant species belonging to 91 genera and 31 families (Table 1) were recorded, out of which 85 (75.23%) species were alien and 28 (24.77%) were native. Of 85 alien species 39 were invasive, 42 were naturalized and 04 were casuals (Table 2). The most representative families were Asteraceae (20 spp.), Poaceae (12 spp.), Fabaceae (11 spp.), Brassicaceae (10 spp.) and Lamiaceae (08 spp.). The most representative genera were *Polygonum* (04 spp.), *Veronica* (04 spp.), *Medicago* (03 spp.) and *Ranunculus* (03 spp.).

The surveyed grasslands were found to differ with respect to number of native and alien plant species. The number of alien species was much higher than the number of native species at all sites (Table 2). Level of invasion also varied considerably among study sites (Fig 1).

3.2 Species diversity

As expected from the variations in the number of native and alien plant species, species diversity, richness and evenness values also differed between sites (Fig. 2). Among the surveyed sites the values of $Simpson_T$, $Shannon_T$ and $Evenness_T$ were highest for Pampore Grassland while as the values of diversity indices based on alien and native species separately showed mixed results thereby revealing that there is no specific association pattern between native and alien species. Mean values of Simpson, Shannon, Fisher's alpha and Berger Parker diversity indices were found to differ significantly from each other (Table 3) indicating that there is no association between native and alien species.

3.3 Flouristic similarity

In comparison to native species, the surveyed grasslands were more similar with respect to alien species (Table 4). Total and native similarity was highest for Barsoo-Nagbal site pair which means these two grasslands share more species particularly higher number of native species between them. Alien similarity was highest for

Pampore Galendar which indicates that these two grasslands share maximum number of alien species between them.

IV DISCUSSION

Present study revealed occurrence of high percentage of alien species than native species which is mainly due to the fact that these grasslands represent the fragmented habitats mainly created by anthropogenic activities with high propagule pressure from nearby human populated areas. Many studies have reported higher percentage of alien species in ruderal habitats close to human habitation [17] [18] [19] [20] [21]. Anthropogenic activities like land use changes resulting in fragmentation and reduction in habitat area facilitate invasion by alien species and extinction of native species [22] [23] [24]. This also explains the high levels of invasion in these grasslands.

The study revealed that surveyed grasslands were more diverse with respect to aliens than native species. The Shannon diversity index values obtained for these grasslands were relatively lower than those reported by [4] who studied natural grasslands. This decrease in species diversity may be due to higher incidence of alien plant species which have been reported by many species to decrease diversity levels of the habitats in which they invade [25] [26].

Present study also revealed that invasion by alien plant species has increased similarity of these grasslands which is consistent with the findings of [21]. This increase in similarity is due to the fact same aliens have invaded these grasslands. Invasive species increase similarity on account of their attributes like greater genetic and phenotypic plasticity which enable them to spread faster and thus assume wider distributions [27] [28].

V CONCLUSIONS

This study reveals that anthropogenic activities have facilitated spread of alien species in Kashmir Himalaya and these alien species have invaded ruderal grasslands, which represent human mediated grasslands, to a very large extent resulting. In addition alien species have significantly lowered the diversity levels in these habitats.

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Table 1: Total number of native and alien species belonging to monocots and dicots.

Plant group	Total number of native species	Total number of alien species	Number of casual species	Number of naturalized species	Number of invasive species
Dicotyledons	20	75	4	38	33
Monocotyledons	8	10	0	4	6
Total	28	85	4	42	39

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Table 2: Site wise number of native and alien plant species

Site	Code	Total number of species	Total number of native species	Casual	Naturalized	Invasive	Total number of alien species
Pampore	PAG	51	17	0	16	18	34
Barsoo	BAG	46	7	2	11	26	39
Nagbal	NAG	60	10	1	19	30	50
Pulwama	PUG	47	11	1	12	23	36
Gasoo	GAG	35	8	0	11	16	27
Galendar	GLG	42	5	2	15	20	37
Mean		46.83	9.66	1	14	22.16	37.16

Table 3: One way ANOVA for diversity indices across study sites

Diversity index	**Mean**				
	All species included	**Only native species included**	**Only alien species included**	**F-value (df=n-2)**	**p**
Simpson-D	0.90	0.52	0.89	16.18	0.001047*
Shannon H	2.89	1.15	2.80	58.4	7.01E-06*
Evenness (exp(H)/S)	0.37	0.40	0.42	0.1476	0.8648*
Fisher's alpha	13.91	2.39	12.13	32.85	7.31E-05*
Berger-Parker	0.21	0.62	0.21	20.2	0.000471*

*-values are significant (p=0.05)

Table 4: Flouristic similarity between surveyed sites

Site pair		**Percent similarity**		
		Total similarity	Native similarity	Similarity based on alien species
Pampore	**Barsoo**	24.4	14.3	28.1
Pampore	**Nagbal**	26.1	17.4	29.2

Pampore	**Galendar**	27.4	15.8	31.5
Barsoo	**Nagbal**	30.2	30.8	31.1
Barsoo	**Galendar**	29.3	20	30.3
Nagbal	**Galendar**	30.8	15.4	30.8

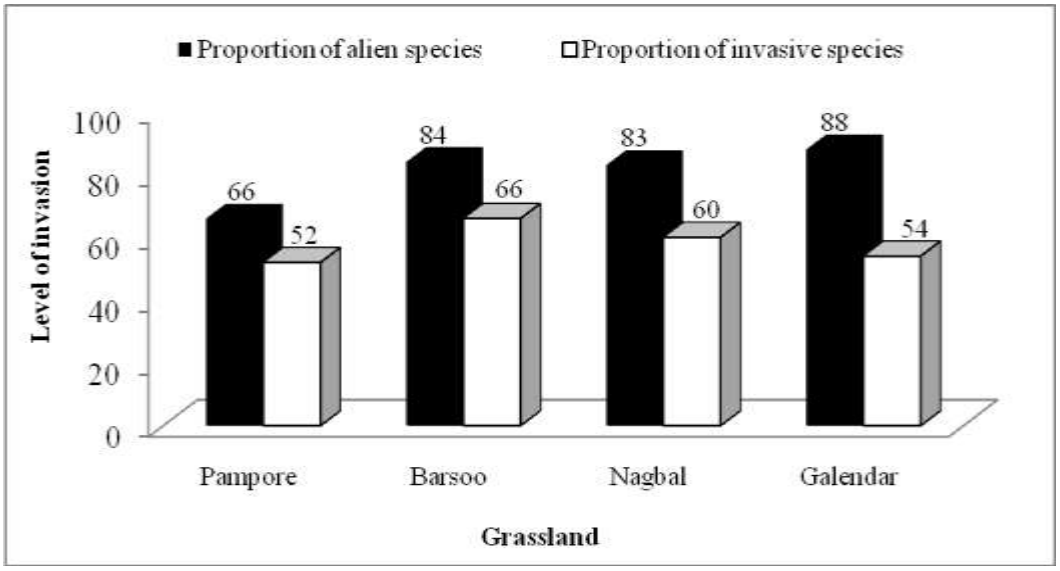
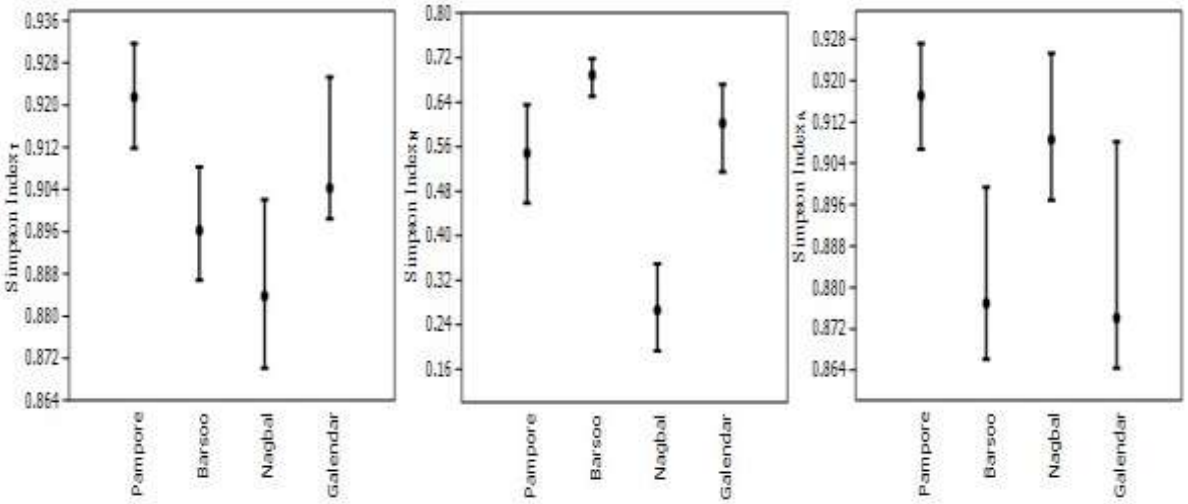
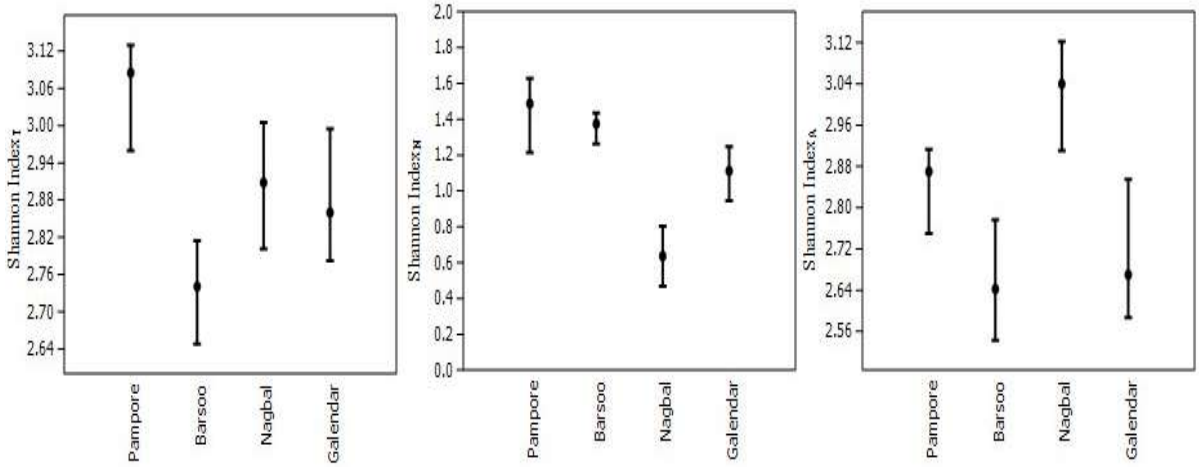


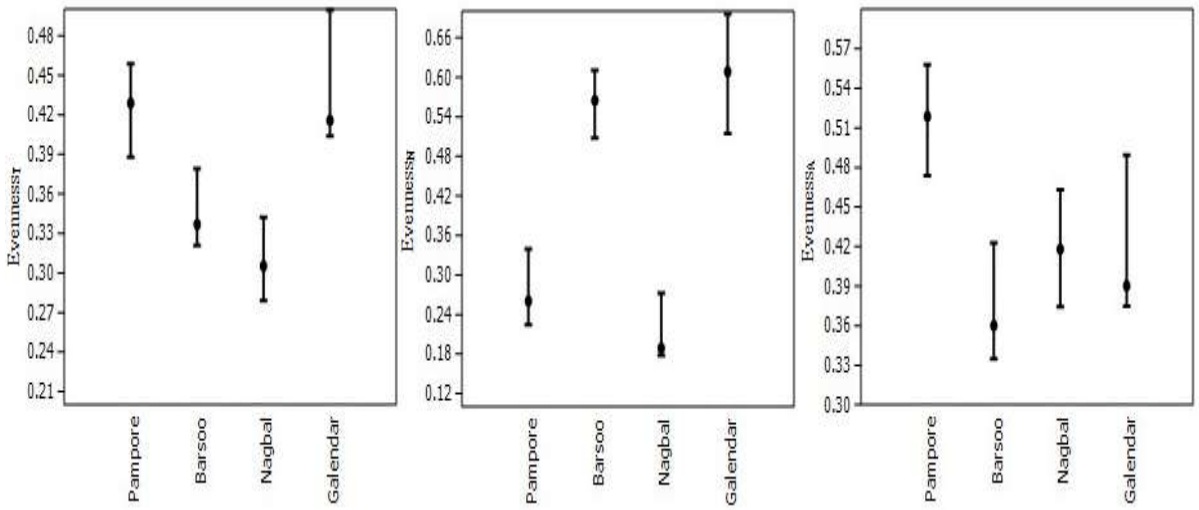
Figure 1: Level of invasion in surveyed grasslands



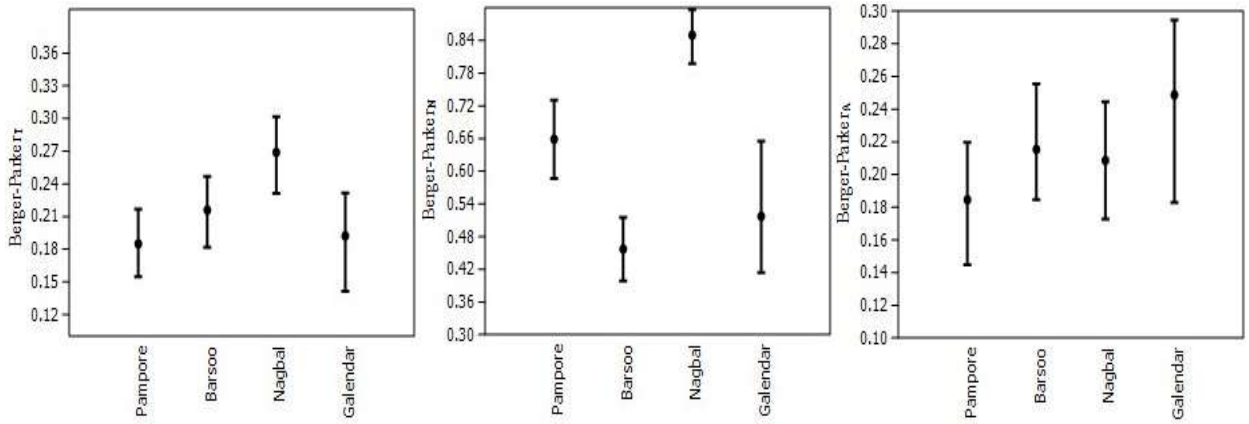
a)


Shannon Index
Pampore
Barsoo
Nagbal
Galendar

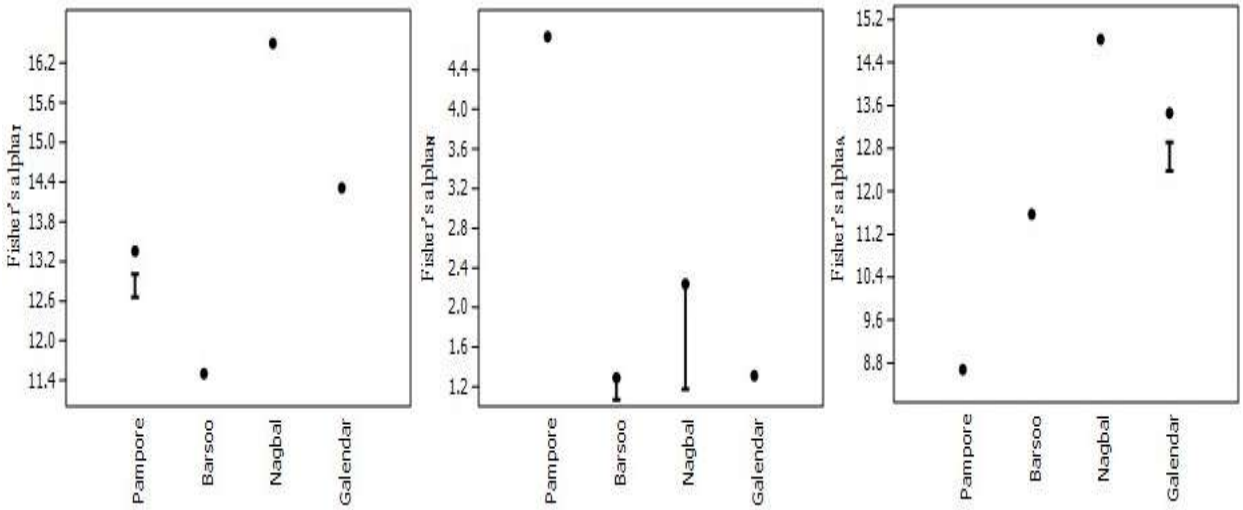
b)


Evenness
Pampore
Barsoo
Nagbal
Galendar

c)


Berger-Parker
Pampore
Barsoo
Nagbal
Galendar

d)



e)

Figure 2: Values of a) Simpson b) Shannon c) Evenness d) Berger Parker and e) Fisher's alpha diversity indices