International Journal of Agriculture and Animal Production
ISSN: 2799-0907
Vol : 03 , No. 01 , Dec 2022 - Jan 2023
http://journal.hmjournals.com/index.php/IJAAP
DOI: https://doi.org/10.55529/ijaap.31.10.17

Seasonal Variation of Herbaceous Plant Diversity Along the Urban - Rural Landscape in Aligarh, Uttar Pradesh, India

Mahdi Ali Mahdi Sedeq[1*], Athar A. Khan[2], Afifullah Khan[3]

[1]Department of Wildlife Sciences, Aligarh Muslim University, Aligarh - 202002, India. and Department of Environmental Sciences, Hodeidah University, Hodeidah, Yemen*
[2]Department of Botany, Aligarh Muslim University, Aligarh – 202002, India
[3]Department of Wildlife Sciences, Aligarh Muslim University, Aligarh - 202002

*Corresponding Email: [1]*mahdisedeq@gmail.com*

Received: 22 August 2022 **Accepted:** 11 November 2022 **Published:** 03 December 2022

Abstract: ***The present study aimed to understand the variation in herbaceous plant species diversity in urban (UR) and agricultural (AG) ecosystems of Aligarh. Data on herbaceous plant species richness (no. of species), diversity (Shannon-Wiener's 'H) and spices dominance (1-D) were collected by laying 270 plots of 0.5*0.5 m at each stratum. We recorded a total of 81 plant species belonging to 75 genera and 29 families. Among them, 62.5 % of species were found in the AG sites and 37.5% in the UR sites. Herbaceous plant richness, and spices dominance were higher in AG in comparison to UR. Conversely, species evenness lower lower in AG compared to UR. At both the strata, species richness was the highest during the monsoon season. The mean Shannon diversity (AG = 1.25±0.03, UR = 0.78±0.03) and dominance (AG = 0.64±0.01, UR = 0.48±0.01) were the highest during the monsoon season, whereas evenness (AG = 0.87 0.01, UR = 0.93 0.007) had maximum value during the summer season. The study concluded that human stresses and disturbance have a greater impact on herbaceous plant diversity in urban areas (UR). These conclusions may have consequences for the planning of green areas in urban landscape and the conservation of plant diversity. However, more research into the processes related to urbanization and plant diversity is required.***

Keyword: Herbaceous Plants, Species Richness, Plant Diversity, Seasonal Variations, Urban-Ecosystem, Agriculture.

1. INTRODUCTION

Urbanization is a natural corollary of man's material progress. The urban areas are extensively transformed landscapes, and they are most influenced by human induced environmental

International Journal of Agriculture and Animal Production
ISSN: 2799-0907
Vol : 03 , No. 01 , Dec 2022 - Jan 2023
http://journal.hmjournals.com/index.php/IJAAP
DOI: https://doi.org/10.55529/ijaap.31.10.17

changes. The majority of the world's population lives in urban areas, and by 2030, that number is predicted to increase to 60%. (United Nations, 2004). Natural habitat loss is caused by the conversion of natural ecosystems into urbanized areas, leading in ecological homogeneity (McKinney, 2002). In terms of plant diversity in urban areas, anthropogenic activities are responsible for the disturbance of natural vegetation and plant richness in urban settings (Carrión et al., 2007; Cui and Zhang, 2005; Wang and Liu, 2003). With the emergence of additional cities, particularly large cities, the intensity of human disturbance has increased greatly in recent decades, resulting in significant landscape fragmentation (Ojala and Louekari, 2002) and in urban areas (Chen et al., 2002; Bouchair, 2004; Jones & Leather,2013). Consequently, the native plant diversity is clearly compromised (Van der et al., 2004; Jiang andLiu, 1999). It is true that the last century, has witnessed tremendous urbanization, agricultural and industrial development, as well as railway and highway construction (Wang et al., 2009) and therefore. the impact of urbanization on rural landscape and natural environment is predicted to grow substantially in the future (United Nations, 2004). Rapid urbanization can result in the creation of unnatural and impermeable surfaces (McDonnell and Hahs, 2008), leading to establishing unique land cover types and plant biotic assemblages. As a result, the types and frequency of terrestrial ecosystems may change (Elmqvist et al.,;Walton et al.,2007 and Kuttler et al.,2007) within and between landscapes. The urbanization therefore has the power to affect the circulation of nutrients, organisms, energy, and water (McDonnell and Hahs 2008).
The impact of urbanization, however, can meaningfully be reduced if urban areas are managed properly. There are still ways the human communities may support and manage a diversity of plant species richness. However, understanding the ecosystem's response to urbanization is critical in ensuring nature's long-term sustainability (Williams et al., 2009). In the current study area, the developmental activities have rapidly increased in during last few decades (Ghasera et al., 2021) and the impacts of urbanization has not yet been studied. This study assesses the diversity of herbaceous plants in both urban and rural area of Aligarh to fill the gap in knowledge and create a baseline data on the herbaceous plant diversity.

2. MATERIAL AND METHODS

Study area

Aligarh district is located in western Uttar Pradesh (UP), between latitudes 27˚34' N and 28˚11' N and longitudes 77˚29' E to 78°38' E, in the middle part of the Gnaga-Yamuna doab, with a total area of 5,498 square kilometers. The climate of Aligarh district is characterized by monsoons. The months of July, August, and September received the majority of the precipitation (252.5 mm, or 92 percent of total precipitation). The winter season begins in November and lasts until the end of February. The temperature drops to its lowest point in January, with an average of 15 degrees Celsius. In the winter, cold weather storms may bring a little rain. The summer season begins in March and continues until mid-June. In the months of May and June, the maximum temperature may reach 45 °C. Aligarh's soil is primarily alluvial.

Design of Sampling and Data Collection

To study the herbaceous plant diversity and richness at two different sites in Aligarh viz. pure urban area (UR) and agriculture area (AG). A thorough field investigation was carried out over

International Journal of Agriculture and Animal Production
ISSN: 2799-0907
Vol : 03 , No. 01 , Dec 2022 - Jan 2023
http://journal.hmjournals.com/index.php/IJAAP
DOI: https://doi.org/10.55529/ijaap.31.10.17

three prominent seasons; winter (November -March), summer (April-June), and monsoon season (July-September) in 2020-2021. The floristic characteristics of plant species were investigated by randomly placing 270 quadrats of 0.5*0.5 m at each site. Every two quadrats were placed within 100 m^2 area. During the period of study, plant specimens were enumerated, collected and identified, and a herbarium was prepared and specimens were deposited at the Department of Wildlife Sciences, Aligarh Muslim Universitys.

Data Analysis

Four indices viz. species richness, Shannon-Wiener diversity ('H), Simpson index (1-D) and evenness (J) for plant species were calculated for each quadrat and mean values were calculated for each site.

Shannon-Wiener index (Shannon-Wiener, 1963)

$$H' = -\sum_{i=1}^{S}(ni/N)\ln(ni/N)$$

Simpson index (Simpson, 1949)

$$D = \sum_{i=1}^{S}(ni/N)^2 \text{ or Pi Where, } Pi = (ni/N)$$

ni = number of individuals belonging to the each species
N = Total number of individuals in the sample

Evenness (J) (Pielou, 1966)

$$Evenness\ (J') = \frac{H'}{\ln S}$$

A one-way ANOVA was used to examine the seasonal differences in plant diversity.

3. RESULTS AND DISCUSSION

A total 81 species of herbaceous plant (dicots) were recorded during the study, belonging to 75 genera and 29 families. In agriculture, area (AG) higher number of species (71 plant species) were recorded as compared to urban area (UR) where only 44 species (37% less) were found. The low species occurrence in UR can be attributed to high degree of fragmentation and soil characteristics such as soil moisture, compactness, nutrient availability as also demonstrated in several other studies (Gupta and Narayan, 2006; Liang et al. 2008; McKinney, 2008; Wang et al., 2020). Species richness was also subjected to seasonal variations due to climate condition. In AG, the highest species number was recorded during monsoon season (48), followed by summer season (40), and the lowest (33) in winter. The same scenario was observed in UR area, where the minimum species number was during winter (24), which increased by 20 % and 37.5 % during summer and monsoon seasons, respectively (Figure 1). The presence of moisture in the form of rain as well as other environmental factors may be the reasons for increased occurrence of species throughout these two seasons (monsoon and summer season). This is also suggested by Shameem et al. (2010) and Alhassan et al. (2006) where they found positive correlation with seasonal variations and species richness.

International Journal of Agriculture and Animal Production
ISSN: 2799-0907
Vol : 03 , No. 01 , Dec 2022 - Jan 2023
http://journal.hmjournals.com/index.php/IJAAP
DOI: https://doi.org/10.55529/ijaap.31.10.17

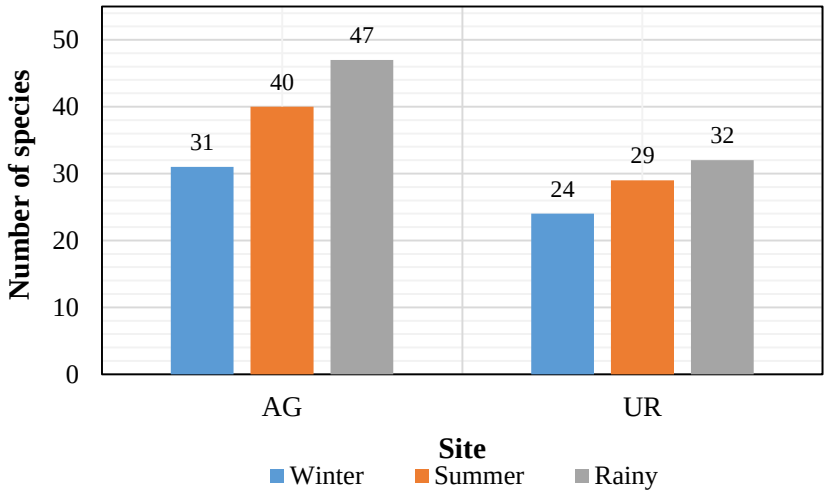

Figure 1. Species richness (number of species) recorded in each season in AG and UR

Species Diversity, Dominance, and Evenness

The diversity indices results indicate seasonal variation in AG (Table 1, Figure 2). Species diversity ('H) obtained almost identical mean values in winter and monsoon season (1.24 ± 0.03 and 1.25 ± 0.03, respectively). However, in summer the mean diversity value (0.74 ± 0.04) decreased by 40.3 % as compared to other seasons. Similarly, although with less variation magnitude, dominance index (Simpson 1-D) obtained identical mean values (0.64 ±0.01) in both winter and monsoon season, whilst in summer the mean value was 0.44 ± 0.02 (31.25%. less than the other two seasons). Unlike the diversity and dominance values, the mean evenness values were identical in summer and monsoon season (0.87 ± 0.01), and was much lower during winter season. ANOVA test result showed that the values of diversity, dominance and evenness were significantly different among different seasons (Table 3). Whereas the observations of the diversity indices show seasonal fluctuation in the UR site. where, the mean value of species diversity ('H) and species dominance (1-D) in urban areas increased gradually from winter(0.56 ± 0.04 and 0.35 ± 0.02, respectively) to summer (0.69 ± 0.03 and 0.44 ± 0.01, respectively) to monsoon season (0.78 ± 0.03 and 0.48 ±0.01, respectively). Contrary, the Evenness index obtained the lowest mean value in urban areas during the monsoon season (0.93 ± 0.007) and the highest mean value was in the summer and winter seasons (0.93 ± 0.007 and 0.92 ± 0.0, respectively). The outcomes of the ANOVA test show that all of the variables mentioned are significantly different across seasons (see Table 2).

Table 1. Mean values of diversity indices and ANOVA test of AG site

Season	Mean value of diversity indices in AG		
	Shanon ('H)	**Simpson (1-D)**	**Evenness (J)**
Winter	1.24 ± 0.03	0.64 ± 0.01	0.79 ± 0.01
Summer	0.74 ± 0.04	0.44 ± 0.02	0.87 ± 0.01
Monsoon	1.25 ± 0.03	0.64 ±0.01	0.87 ± 0.01
$p<0.01$,58.8 = $_{2,267}F$			

International Journal of Agriculture and Animal Production
ISSN: 2799-0907
Vol : 03 , No. 01 , Dec 2022 - Jan 2023
http://journal.hmjournals.com/index.php/IJAAP
DOI: https://doi.org/10.55529/ijaap.31.10.17

Table 2. Mean values of diversity indices and ANOVA test of UR site

Season	Mean value of diversity indices in UR		
	Shanon ('H)	**Simpson (1-D)**	**Evenness (J)**
Winter	0.56 ± 0.04	0.35 ± 0.02	0.92 ± 0.01
Summer	0.69 ± 0.03	0.44 ± 0.01	0.93 ± 0.007
Monsoon	0.78 ± 0.03	0.48 ±0.01	0.90 ± 0.01
$p<0.01$,9.47 $= {}_{2,267}F$			

At both sites, the species diversity was observed highest during the monsoon season, which then fell as the winter and summer seasons approached. This means that during the monsoon season, new species sprout based on the root / seed supply in the soil, leading to a greater diversity of species. Shadangi and Nath (2005) indicated that during harsh climatic conditions there is reduction in the ratio of root to seed sprouting and hence the number of species decreases. Shameem et al. (2010) reported that the diversity of species decreases in the winter and summer seasons. However, the AG had more species diversity than the UR site, which could be because agricultural areas are less disturbed than urban areas, contains better soil moisture and nutrient contents thus facilitating better germination of seeds and survival of sprouting plants. Further, species diversity is higher in intermediary disturbed ecosystems as compared to undisturbed systems (Connell 1978 and Decocq et al. 2004), The dominance at AG site ranged from 0.44 (summer) to 0.64 (monsoon and winter) and from 0.35 (winter) to 0.48 (monsoon) at UR site, indicating that diversity was directly related to species dominance. The lower dominance score at the AG site indicated that herb plant dominance is shared by different plant species. Further, over three seasons, the evenness at UR was greater than at AG, showing low dominance and a somewhat regular pattern of distribution of herbaceous plant species in UR site (Shameem et al. 2010).

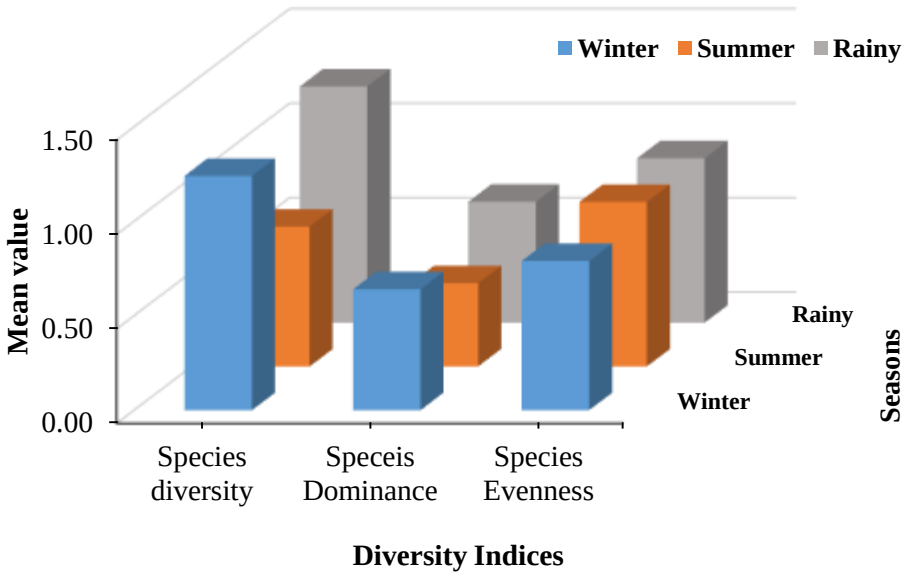

Figure 2. Seasonal variations in species diversity, dominance and evenness at AG sites.

International Journal of Agriculture and Animal Production
ISSN: 2799-0907
Vol : 03 , No. 01 , Dec 2022 - Jan 2023
http://journal.hmjournals.com/index.php/IJAAP
DOI: https://doi.org/10.55529/ijaap.31.10.17

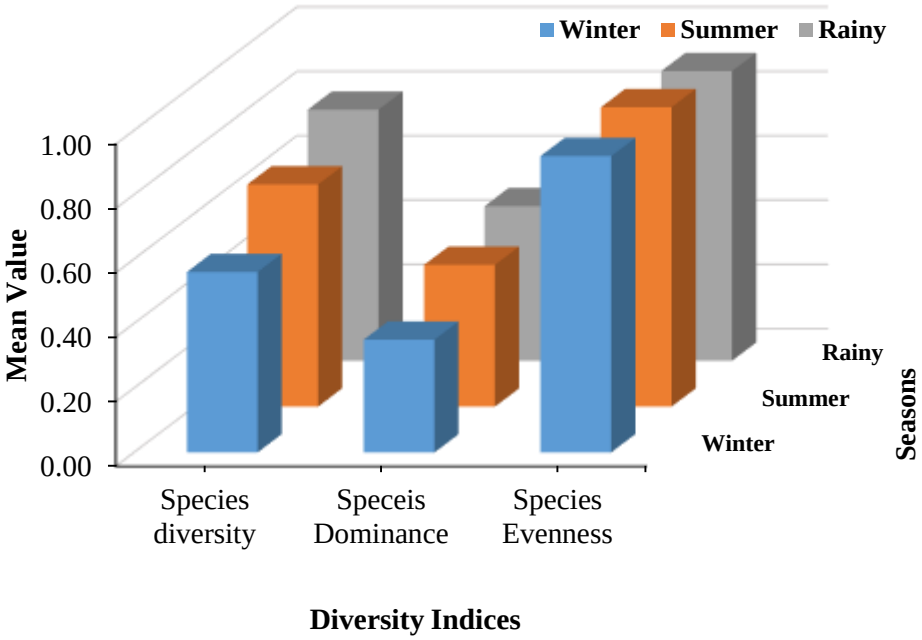

Figure 3. Seasonal variations in species diversity, dominance and evenness at UR sites

4. CONCLUSION

The study revealed the significant impact of urbanization on herbaceous plant species richness, diversity, spices dominance and evenness. The agricultural landscape is more rich in terms of species richness, diversity and dominance as compared to urban landscape, despite the fact that agricultural areas are frequently weeded off. The reasons attributed to the decline in plant diversity in urban areas include, fragmentation, low availability of pervious spaces and physico-chemical properties of soil which are typical characteristics of urban landscape. On the other hand, the seasonal variations are related to soil moisture and availability of nutrients instead urbanization. The study concluded that the anthropogenic stresses and disturbance have a greater impact on herbaceous plant diversity in urban areas (UR) and therefore better planning in urban landscape can help in maintaining and conserving plant diversity. However, more research into the processes related to urbanization and plant diversity is required.

5. REFERENCES

1. Alhassan, A. B., Chiroma, A. M., & Kundiri, A. M. (2006). Properties and classification of soils of Kajimaram oasis of Northeast Nigeria. International Journal of Agriculture and Biology (Pakistan).
2. Bouchair, A. (2004). Decline of urban ecosystem of Mzab valley. Building and environment, 39(6), 719-732.
3. Carrión, J. S., Fuentes, N., González-Sampériz, P., Quirante, L. S., Finlayson, J. C., Fernández, S., & Andrade, A. (2007). Holocene environmental change in a montane

International Journal of Agriculture and Animal Production
ISSN: 2799-0907
Vol : 03 , No. 01 , Dec 2022 - Jan 2023
http://journal.hmjournals.com/index.php/IJAAP
DOI: https://doi.org/10.55529/ijaap.31.10.17

region of southern Europe with a long history of human settlement. Quaternary Science Reviews, 26(11-12), 1455-1475.

4. Connell, J. H. (1978). Diversity in tropical rain forests and coral reefs: high diversity of trees and corals is maintained only in a nonequilibrium state. Science, 199(4335), 1302-1310.
5. Cui, L.J., Zhang, M.Y., (2005). Impact study of the biodiversity of Yangtze beaches wetland in Anqing with human interference. Forest Res. 18 (4), 441–445.
6. Decocq, G., Aubert, M., Dupont, F., Alard, D., Saguez, R., WATTEZ-FRANGER, A. N. N. I. E., ... & Bardat, J. (2004). Plant diversity in a managed temperate deciduous forest: understorey response to two silvicultural systems. Journal of Applied Ecology, 41(6), 1065-1079.
7. Elmqvist, T., Zipperer, W. C., & Güneralp, B. (2015). Urbanization, habitat loss and biodiversity decline: solution pathways to break the cycle. In The Routledge Handbook of Urbanization and Global Environmental Change (pp. 163-175). Routledge.
8. Ghasera, K. M., Rashid, S. A., & Gupta, K. (2021). Heavy metals abundance and distribution in soil, groundwater and vegetables in parts of Aligarh, Uttar Pradesh, India: implication for human health risk assessment. Current Science, 121(8), 1056-1063.
9. Gupta, S., & Narayan, R. (2006). Species diversity in four contrasting sites in a peri-urban area in Indian dry tropics. Tropical Ecology, 47(2), 229-242.
10. Jiang, Y., & Liu, S. (1999). Flora features under urban land use. J. Nat. Resour, 14, 359-362.
11. Jones, E. L., & Leather, S. R. (2013). Invertebrates in urban areas: a review. EJE, 109(4), 463-478.
12. Kuttler, W., Weber, S., Schonnefeld, J., & Hesselschwerdt, A. (2007). Urban/rural atmospheric water vapour pressure differences and urban moisture excess in Krefeld, Germany. International Journal of Climatology: A Journal of the Royal Meteorological Society, 27(14), 2005-2015.
13. Liang, Y. Q., Li, J. W., Li, J., & Valimaki, S. K. (2008). Impact of urbanization on plant diversity: a case study in built-up areas of Beijing. Forestry Studies in China, 10(3), 179-188.
14. McDonnell, M. J., & Hahs, A. K. (2008). The use of gradient analysis studies in advancing our understanding of the ecology of urbanizing landscapes: current status and future directions. Landscape Ecology, 23(10), 1143-1155.
15. McKinney, M. L. (2002). Urbanization, Biodiversity, and ConservationThe impacts of urbanization on native species are poorly studied, but educating a highly urbanized human population about these impacts can greatly improve species conservation in all ecosystems. Bioscience, 52(10), 883-890.
16. McKinney, M. L. (2008). Effects of urbanization on species richness: a review of plants and animals. Urban ecosystems, 11(2), 161-176.
17. Pielou, E. C. (1966). Species-diversity and pattern-diversity in the study of ecological succession. Journal of theoretical biology, 10(2), 370-383.
18. Shadangi, D. K., & Nath, V. (2005). Impact of seasons on ground flora under plantation and natural forest in Amarkantak. Indian Forester, 131(2), 240-250.

International Journal of Agriculture and Animal Production
ISSN: 2799-0907
Vol : 03 , No. 01 , Dec 2022 - Jan 2023
http://journal.hmjournals.com/index.php/IJAAP
DOI: https://doi.org/10.55529/ijaap.31.10.17

19. Shameem, S. A., Soni, P., & Bhat, G. A. (2010). Comparative study of herb layer diversity in lower Dachigam National Park, Kashmir Himalaya, India. International Journal of Biodiversity and Conservation, 2(10), 308-315.
20. Shannon, C. E., & Weaver, W. (1963). The mathematical theory of communications. University of Ilinois press. Urbana. ISBN: 0-252-72548-4.
21. http://www.alibris.com/search/books/qwork/4233417/used/Mathematical%20theory%20of communication,117.
22. Simpson, E. H. (1949). Measurement of diversity. nature, 163(4148), 688-688.
23. United Nations. (2004). World Population Prospects: The 2004 revision population database. http://esa.un.org/unpp/.
24. Van der Veken, S., Verheyen, K., & Hermy, M. (2004). Plant species loss in an urban area (Turnhout, Belgium) from 1880 to 1999 and its environmental determinants. Flora-Morphology, Distribution, Functional Ecology of Plants, 199(6), 516-523.
25. Walton, B. M., Salling, M., Wyles, J., & Wolin, J. (2007). Biological integrity in urban streams: Toward resolving multiple dimensions of urbanization. Landscape and Urban Planning, 79(1), 110-123.
26. Wang, M., Li, J., Kuang, S., He, Y., Chen, G., Huang, Y., ... & Łowicki, D. (2020). Plant diversity along the urban–rural gradient and its relationship with urbanization degree in Shanghai, China. Forests, 11(2), 171.
27. Wang, Y., Meng, D., Zhu, Y., & Zhang, F. (2009). Impacts of regional urbanization development on plant diversity within boundary of built-up areas of different settlement categories in Jinzhong Basin, China. Landscape and urban planning, 91(4), 212-218.
28. Williams, N. S., Schwartz, M. W., Vesk, P. A., McCarthy, M. A., Hahs, A. K., Clemants, S. E., ... & McDonnell, M. J. (2009). A conceptual framework for predicting the effects of urban environments on floras. Journal of ecology, 97(1), 4-9.