POLLINATION ECOLOGY OF NEOTROPICAL SAVANNAS VEGETATION

Nelson Ramírez
Universidad Central de Venezuela, Fac. Ciencias, Instituto de Biología Experimental, Centro Botánica Tropical, Caracas, Venezuela.

Keywords: Diversity, habitat, horizontal disposition, life form, plain, pollination class, pollination system, richness, savanna, time of pollination activity, vegetation structure, vertical disposition.

Contents

Summary

Pollination ecology of Neotropical savannas is reviewed in relation to pollination agent classes, pollination systems and times of pollination activity in the Venezuelan Central Plain. Bee pollination is the most frequent pollination agent class in the Venezuelan plain and Brazilian cerrados where savanna vegetation is represented by a mosaic of forest-bushed-grassland. Conversely, in Montane Savanna, characterized by treeless grassland, the frequency of pollination modes is dominated by wind, followed by bee. The variation of pollination agent classes is also considered in relation to habitats, life form frequency, flowering phenology, successional stage and disturbance. The diversity indices of pollinating agent classes were higher for the Venezuelan Central Plain than for Montane savanna, associated to diversity of habitats and life forms. The association between life forms and habitats has effects on the frequency of pollination agent classes in habitats. For example, wind pollination decreases from disturbed areas or savanna to forest because wind pollination is related to herbaceous life forms. In other areas wind pollination species are at similar frequency in disturbed and undisturbed savannas. Horizontal disposition seem to have no direct consequences on pollinating agent classes. Conversely, vertical disposition is related to pollination type: wind pollination

is confined to the lowest strata because of the relation between herbaceous life form and wind pollination in the Venezuelan Central Plain. In this community, bee-, butterfly-, fly-, wasp-, moth-, beetle-, and wind-pollinated species increase from the dry to the rainy season, which is associated with the high number of species that flower during the rainy season. Pollination overlap of flowering phenology with the same pollinating agent class is related to the habitat type and plant life-form. Low values of pollination overlap occur among contrasting life and decrease from adjacent habitats, within or among herbaceous habitats, to distant habitats, within or among herbaceous and woody habitats. Polyphily is the most abundant category of pollination specialization in the savanna vegetation and decreases from forest to disturbed area. In contrast, the proportion of polyphilous species is higher in disturbed than non-disturbed savannas, and the proportion of monophilous species is higher in non-disturbed than disturbed savannas for montane areas, indicating that under natural conditions, savanna vegetation have predominantly specialized pollination system. Pollination system specificity changes throughout the year: polyphily peaks during the dry season in the Venezuelan Central Plain. In contrast, monophily peaks during the dry season in disturbed areas and oligophily peaks at the end of the rainy season in the forest-savanna transition. Diurnal pollination dominates savanna vegetation, followed by diurnal-nocturnal pollination, and is absent or in a low proportion for plant species exclusively pollinated during the night time. The frequency of plant species decrease in the order diurnal - diurnal-nocturnal - nocturnal pollination for all life forms, habitats and strata. In a temporal scale, the largest proportion of nocturnal and nocturnal-diurnal pollination species occur during the rainy season, avoiding interference on a temporal scale and where plant species diversity is high.

1. Introduction

Savanna represents one of the most extensive vegetation types in the tropics, including a great variation of physiognomic types and floristic units. Despite of this, pollination studies of plant species from tropical savannas have been poorly explored at the community level. The exceptions are some studies of particular species in African and Neotropical savannas, and a few others at the community level in the Brazilian Cerrados. There are some areas of savanna that have been examined intensively in pollination ecology at the community level. These studies have demonstrated the importance of life forms and habitats on:

- pollination modes frequency,
- pollination system specificity,
- time of pollination activity,
- pollination agent class overlap, and
- temporal variation of pollination classes.

The frequency of life forms and their relative importance in habitats are correlated with the frequency of pollination modes, the type of pollination system specificity, and time of pollination activity and what habitats and life forms may reduce pollination agent class overlap.

In addition to the studies in the Venezuelan Central Plain, a non-formal published study

in a montane savanna in the Gran Sabana Plateau examined pollination biology for a representative number of plant species. In this report, the author evaluates many of the subjects examined in the Venezuelan Central Plain, using the same methodology, which allow adequate comparisons. Under such circumstances, a comparative analysis of both studies gives an approximation of pollination biology of different neotropical savannas at the community level. Moreover, the structure and floristic composition differ between Venezuelan Central Plain, which is characterized by a mosaic of habitats ranging from disturbed areas to forest, including areas of grassland or savanna, and the montane savanna in the Venezuelan Guayana Plateau, characterized by typical grassland, where herbaceous life forms dominate vegetation. The present chapter allows a comparative analysis of both types of savanna, including information from other studies on pollination ecology at the community level.

-
-
-

Bibliography

Medina E. (1980). Ecology of tropical American Savanna: an Ecophysiological approach. *Human Ecology in Savanna Environments*. (ed. D.R. Harris). 297-319. Academic Press Inc. London, Ltd. [This is a review of neotropical savanna on the basis of ecophysiological approach]

Oliveira P.E. and Gibbs P.E. (2000). Reproductive biology of woody plants in a cerrado community of Central Brazil. *Flora* (195, 311-329. [The reproductive biology of some woody species of Brazilian cerrado vegetation is examined including pollination systems]

Ramírez N. (2002). Reproductive phenology, life-forms, and habitats of the Venezuelan Central Plain. *American Journal of Botany* **89**, 836-842. [The evaluation of phenological patterns of flowers, unripe fruits and ripe fruits of 171 species, showing differences between habitats caused mainly by life-forms, which promote a wider distribution of reproductive events in habitats and overall community]

Ramírez N. (2003). Diversidad de especies y estructura de la vegetacion de una comunidad de sabana en los Altos Llanos Centrales Venezolanos. *Acta Biológica Venezuelica* **23(2-3)**, 47-75. [The abundance, and horizontal and vertical distribution of plant species are evaluated according species richness, habitat specialization and their relationship to plant life forms and plant recruitment in the Venezuelan Central Plain]

Ramírez N. (2004a). Ecology of pollination in a tropical Venezuelan savanna. *Plant Ecology* **173**, 171-189. [Pollination modes and ecology of 164 plant species were evaluated according to habitat and plant life forms in the Venezuelan Central Plain, indicating that the frequency of pollinating agent classes varied for habitats and life forms]

Ramírez N. (2004b). Pollination specialization and time of pollination on a tropical Venezuelan plain: variation in time and space. *Botanical Journal of Linnean Society* **145**, 1-16. [In this paper, the data at the community level show that the relative frequency of each type of pollination system and the time of

pollination activity are influenced by community structure and plant species richness, and may change from season to season]

Ramírez N. (2005). Temporal overlap of flowering species with the same pollinating agent class: the importance of habitats and life forms. *International Journal of Botany* **1**, 27-33. [One hundred and fifty five plant species were evaluated monthly in relation to flowering phenology, habitats and life form in the Venezuelan Central Plain. Pollination overlap could be attenuated by life form and habitat seasonality, in such a way that plant species from the same life form in the same habitat have the highest values of pollination overlap]

Ramírez N. (2006). Temporal variation of pollination agent classes in a tropical Venezuelan plain: the importance of habitats and life forms. *Canadian Journal of Botany* **84**, 443-452. [The distribution of pollinating agent classes is affected by seasonality in habitats and life forms, so life form is considered a proximate element, reducing interference in the pollination process at the community level]

Ramírez N., N. Dezzeo and N. Chacón (2007). Floristic composition, plant species abundance, and soil properties of montane savanna in the Gran Sabana, Venezuela. *Flora* [In this paper the relation between soil properties and vegetation attributes are examined for four areas of savanna with different slope and substrate characteristics]

Ramírez N., H. Briceño and C. Várela (2000). Biología reproductiva de la vegetación de sabana en la Alta Guayana Venezolana. Informe Final Proyecto FUNDACITE GUAYANA. *Mimeografía* 100 pp. Puerto Ordaz, Venezuela. [This is an unpublished report in which vegetation structure, reproductive phenology, pollination, breeding system, reproductive efficiency, and mechanisms of seed dispersal were examined for the vegetation of an area of montane savanna in the Venezuelan Guayana Plateau]

Sarmiento G. and Monasterio M. (1975). A critical consideration of the environmental conditions associated with the occurrence of savanna ecosystems in tropical America. *Tropical Ecological Systems* (eds. Golley F.B. and Medina E), 223-250. Springer-Verlag, New York. [This is a review of savanna vegetation that examines the origin, distribution and physiognomies of savanna in tropical America]

Silberbauer-Gottsberger I. and Gottsberger G. (1988). A polinização das plantas do cerrado. *Revista Brasileira de Biologia* **48**, 615-663. [This article is one of the few studies realized on pollination biology at the community level, vegetation type cerrado, which is considered as savanna (*sensu lato*). This paper describe the frequency distribution of pollination classes and floral characteristics of the community]

Biographical Sketch

Nelson Ramírez is Emeritus Professor of Botany and Plant Reproductive Biology at the Facultad de Ciencias, Universidad Central de Venezuela. He has conducted research on Plant Systematic, Reproductive Biology and Ecology in Venezuela since 1978, and has published more than 70 articles in local and international journals.