PROCEEDINGS

OF THE

THIRD JOINT SYMPOSIUM

ON THE

NATURAL HISTORY AND GEOLOGY OF THE BAHAMAS

Edited by

David Griffing, Mark Kuhlmann and Troy Dexter

ORGANIZER:

Troy A. Dexter

Executive Director
Gerace Research Centre
University of The Bahamas
San Salvador, The Bahamas

2023

ISBN: 978-0-935909-71-5

INVESTIGATION OF FLORAL DIVERSITY AND SPATIAL DISTRIBUTION OF SPECIES IN COASTAL PLANT COMMUNITIES

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ABSTRACT

There are six coastal plant communities in The Bahamas, determined by their distance from the ocean, substrate composition, and relative degree of disturbance. These communities are dynamic, ever subject to wind and water, including significant disturbances due to tropical storms and hurricanes. Coastal plant communities are important ecologically and economically; they reduce erosion by stabilizing sediments and protect inland communities by absorbing the energy of storm surge. To better understand interactions between plants from different communities that share pollinators, we investigated the species composition, relative species abundance, and spatial distribution in four of the six community types. In this preliminary study, we surveyed seven 100-m^2 plots on San Salvador, two each in the *Coccothrinax*-shrub, beach-foredune, and rock terrace communities, and one in the shrub-thicket community. All plant species were identified, their canopies mapped, and the total canopy coverage for each species was estimated for each plot. To compare the relative floral diversity, as perceived by insect pollinators, the relative canopy coverage of each species was used to calculate species evenness and the Shannon diversity index for each community. Our preliminary results demonstrate that the *Coccothrinax*-shrub and shrub-thicket communities have the greatest canopy coverage and floral diversity. Ultimately, these data will be compared to insect visitation records to determine whether pollinator diversity is correlated with floral diversity, or if the presence of communities with greater floral diversity influences pollinator diversity in adjacent communities with less floral diversity.

INTRODUCTION

The purpose of this long-term study is to understand interactions between plants from different communities that share pollinators. There are six coastal plant communities on San Salvador (Smith 1993); these communities are dynamic, ever subject to wind and water, including significant disturbances caused by tropical storms and hurricanes. Coastal plant communities are important ecologically and economically, in part because they reduce erosion by stabilizing sediments and protect inland communities by absorbing the energy of storm surge (Miller *et al*. 2010). The formation and persistence of each community type is determined by several factors, including the distance from the ocean, substrate composition, and relative degree of disturbance.

In this preliminary investigation, we determined species composition, estimated relative species abundance, and described the spatial distribution of plants in four of the six community types: shrub-thicket, *Coccothrinax*-shrub, beach-foredune, and rock terrace. To estimate the relative floral diversity as perceived by insect pollinators, we used the relative canopy coverage as a proxy to calculate a Shannon diversity index for each community. Ultimately these data will be compared with insect visitation records to determine if pollinator diversity and abundance is correlated with floral diversity, and to determine whether the diversity and abundance of pollinators observed in one community type is influenced by the floral diversity of adjacent plant communities.

FIELD SITE DESCRIPTION

This work was performed at two general locations in the coastal ecosystem on San Salvador Island: along Snow Bay (aka Sandy Hook) on the southeastern end of the island, and at the northern end of East Beach near the United Estates Settlement. Snow Bay is a biologically diverse area that includes all six coastal plant communities. It is bordered by the ocean to the south and east and the Pigeon Creek lagoon system to the north. The north end of East Beach includes beach-foredune and coppice thicket communities.

METHODS

A total of seven 100-m^2 plots were established in June 2017 at two locations on San Salvador Island. Along Snow Bay, two plots were established in *Coccothrinax*-shrub and rock terrace communities, and one plot was established in a shrub thicket community; two plots were also established in a beach foredune community at East Beach. GPS coordinates were recorded for each plot, and the directional orientation of each plot was determined using a compass.

All animal-pollinated plants within the plots were identified and mapped. The canopy area of each individual (or group of individuals, when their canopies were continuous) was estimated using measuring tapes, and the areas were summed to estimate the total canopy area of each species in the plot. Canopy area estimates for were then used to calculate the Shannon diversity index (H) and the species evenness (E_H) within each plot, using the following equations:

$H = (-1)\Sigma p_i * \ln p_i$, where $i = 1, 2, \ldots N$ species, and p_i = the proportion of the ith species in the plot; and

$E_H = H/\ln(S)$, where S = # species in the plot.

Vines were treated differently because the plants climb over and through the branches of other plants, making it difficult to determine the actual "canopy" size. For these species, the overall area where the vines were located was measured to estimate the relative area they occupied. Vining species were excluded from Shannon diversity index and species evenness calculations.

RESULTS

A total of 38 species and 12 morphospecies of animal-pollinated plants were identified during the study, but only a subset were found in each community type (Table 1). The most speciose communities were shrub thicket (24 species, 7 morphospecies) and *Coccothrinax*-shrub (19 species, 5 morphospecies); in contrast, the beach-foredune and rock terrace communities had far fewer species (7 and 4 species, respectively). The relative contribution of floral resources made by each species was relatively even in shrub thicket (E_H = 0.77) and *Coccothrinax*-shrub (E_H = 0.80 – 0.83) communities (Figure 1), contributing to the highest diversity indices (H = 2.50 and 2.22 – 2.43, respectively; Figure 1). The plots in rock terrace communities were variable in terms of species evenness (E_H = 0.28 – 0.67; Figure 1) and diversity indices (H = 0.31 – 0.73; Figure 1), while these metrics were more consistent in beach-foredune plots (E_H = 0.53 – 0.72; H = 1.03 – 1.40; Figure 1). In addition, the canopies of plants in the shrub-thicket community provided near-complete coverage of the total plot area (81%), and plants in the *Coccothrinax*-shrub community plots provided considerable coverage (54 – 59%). In contrast, the total canopy coverage was quite limited in beach-foredune (14 – 21%) and rock terrace (12 – 13%) communities.

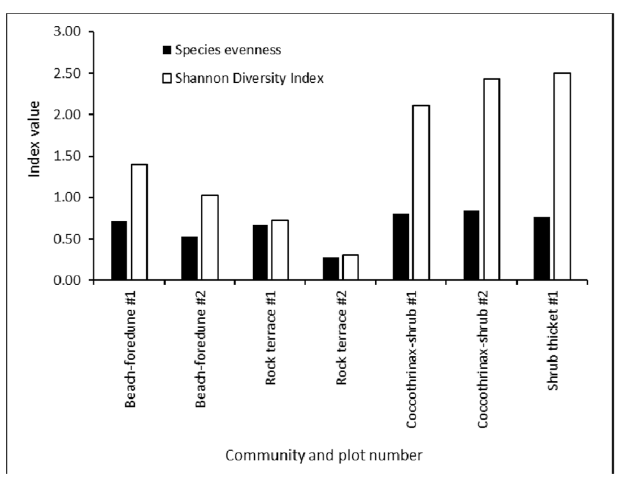

Figure 1. Species evenness and Shannon diversity indices for each plot

Table 1: List of plant species identified in each community type, with number of plots in each community that included the species indicated. Morphospecies were excluded from this list.

Family	Species	Community type			
		Beach-foredune	Rock terrace	*Coccothrinax*-shrub	Shrub thicket
Aizoaceae	*Sesuvium portulacastrum* (L.) L.	1			
Apocynaceae	*Metastelma bahamense* Griseb.			2	1
Apocynaceae	*Pentalinon luteum* (L.) B.F. Hansen & Wunderlin				1
Arecaceae	*Coccothrinax argentata* (Jacq.) L.H. Bailey			1	
Arecaceae	*Leucothrinax morrisii* (H. Wendl.) C. Lewis & Zona			1	1
Arecaceae	*Sabal palmetto* Thunb.			2	1
Asteraceae	*Borrichia arborescens* (L.) DC.		1		
Asteraceae	*Gundlachia corymbosa* (Urb.) Britt.			1	1
Asteraceae	*Iva imbricata* Walt.	2			
Boraginaceae	*Bourreria baccata* Raf.				1
Boraginaceae	*Tournefortia gnaphalodes* L.	2			
Boraginaceae	*Varronia bahamensis* Urb.			1	1
Brassicaceae	*Cakile lanceolata* (Willd.) O.E. Schutz	2			
Combretaceae	*Conocarpus erectus* L.		2		
Convolvulaceae	*Jacquemontia cayensis* Britt.			2	1
Euphorbiaceae	*Croton discolor* Willd.				1
Euphorbiaceae	*Euphorbia lecheoides* Millsp.			2	1
Euphorbiaceae	*Euphorbia mesembryanthemifolia* Jacq.	2			
Fabaceae	*Chamaecrista lineata* (Sw.) Green			2	1
Fabaceae	*Pithecellobium keyense* Britt. Ex Britt. & Rose			2	1
Goodeneaceae	*Scaevola plumieri* (L.) Vahl	1			
Lauraceae	*Cassytha filiformis* L.				1
Tiliaceae	*Corchorus hirsutus* L.			1	
Myrtaceae	*Mosiera longipes* (Berg) McVaugh				1
Passifloraceae	*Passiflora cuprea* L.			1	1
Passifloraceae	*Passiflora pectinata* Griseb.				1
Polygonaceae	*Coccoloba uvifera* (L.) L.			2	1
Rhamnaceae	Reynosia septentrionalis Urb.			2	1
Rubiaceae	*Antirhea myrtifolia* (Griseb.) Urb.			2	
Rubiaceae	*Erithalis diffusa* Correll			2	1
Rubiaceae	*Erithalis fruticosa* L.				1
Rubiaceae	*Ernodea littoralis* Sw.			2	1
Rubiaceae	*Rachicallis americana* (Jacq.) O. Ktze.		2		
Rubiaceae	*Strumpfia maritima* Jacq.		1		
Sterculiaceae	*Waltheria bahamensis* Britt.				1
Surianaceae	*Suriana maritima* L.	2			

DISCUSSION

Our preliminary findings demonstrate that shrub-thicket and *Coccothrinax*-shrub communities have the greatest canopy coverage and floral diversity. This is somewhat expected because these communities are further from the shoreline, so the severity of disturbance events like hurricanes is tempered – particularly with respect to the surge typically associated with these storms. Plants in these communities frequently grow in mixed stands, with smaller individuals growing below taller plants, and with vines growing over and among the branches of shrubs and trees. Greater complexity in the vertical structure of the community can contribute to greater diversity in the animals that utilize these plants, including birds (e.g. Suarez-Rubio and Thomlinson 2009) and arthropods (e.g. Gardner *et al*. 1995).

In contrast, plants in beach-foredune and rock terrace communities have sparse canopy coverage and lower floral diversity due to lower species richness and greater unevenness of floral resource contributions made by each species. In combination, these characteristics may help explain the reduced pollinator abundance and diversity previously observed in the beach-foredune communities along East Beach (Landry *et al*. 2013), where pollinator activity was confined to a few plant species that provided a large fraction of the floral resources available (data not published).

More surveys need to be performed to better estimate the floral diversity present in these plant communities, and in the other coastal communities found on San Salvador that are not represented in this study. Ultimately these data will be compared with insect visitation records to determine if pollinator diversity and abundance is generally correlated with floral diversity or if the presence and abundance of a subset of plant species is more informative. In addition, we will determine whether the diversity and abundance of pollinators observed in one community type is influenced by the floral diversity of adjacent plant communities, or if other factors, such as the availability of nesting sites, are more important.

ACKNOWLEDGEMENTS

This research was supported by travel and research grants from the Ohio State University at Mansfield, and performed with permission of the Bahamas Environment, Science, and Technology (BEST) Commission, Ministry of the Environment and Housing. We thank the Gerace Research Centre for its continued support of our research activities on San Salvador; we also give special thanks to Dr. Agustin Munoz-Garcia for assistance with data analysis.

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