PROCEEDINGS

OF THE

FORTEENTH SYMPOSIUM

ON THE

NATURAL HISTORY OF THE BAHAMAS

Edited by
Craig Tepper
and
Ronald Shaklee

Conference Organizer
Thomas Rothfus

Gerace Research Centre
San Salvador Bahamas
2011

Cover photograph – “Iggie the Rock Iguana” courtesy of Ric Schumacher

Printed at the Gerace Research Centre

ISBN 0-935909-95-8

PRESENCE OF AUSTRALIAN PINE (*CASUARINA EQUISETIFOLIA*) REDUCES DIVERSITY OF NATIVE DUNE PLANT COMMUNITIES ON SAN SALVADOR ISLAND, THE BAHAMAS

Amy F. Coleman
Department of Biology
West Virginia University
Morgantown, WV 26505

Carol L. Landry
Department of Evolution, Ecology, and Organismal Biology
The Ohio State University
Mansfield, OH 44906

Lee B. Kass
Department of Biology and Division of Plant & Soil Sciences
West Virginia University
Morgantown, WV 26506
L. H. Bailey Hortorium, Department of Plant Biology
Cornell University
Ithaca, NY 14853

ABSTRACT

Australian pine (*Casuarina equisetifolia* L. [syn. *C. litorea*]; CASUARINACEAE) is an invasive species on San Salvador that has spread rapidly along beaches and in disturbed areas. Shade and increased soil acidity caused by stem/leaf litter from the trees may inhibit native dune plants from growing under these trees. This study identified the native dune plants found under live Australian pine trees at two study sites (Graham's Harbour Beach and Lindsay Reef Beach) and compared them to plants in plots that were not growing under the trees. The size of each tree and the stem/leaf litter volume was also measured to determine if these factors were correlated with the survey results.

We observed a slight decrease in the number of native plant species growing under *Casuarina* trees compared with plots without trees at Graham's Harbour and a greater decrease at Lindsay Reef. Tree size and stem/leaf litter did not seem to be directly correlated with the number of native species growing under or away from the tree. The study area at Lindsay Reef Beach, which had smaller trees and therefore less stem/leaf litter, did not have more native plant species growing beneath them compared with the area at Graham's Harbour/GRC Beach, which had larger trees. We conclude that fewer native plant species are found growing under Australian pine trees than in areas without Australian pines. Factors other than tree size and stem/leaf litter volume may be inhibiting plants under these trees.

INTRODUCTION

Australian pine (*Casuarina equisetifolia* L. [syn. *C. litorea*]; CASUARINACEAE) is a tree native to Australia, the South Pacific and the Indian Ocean region. The tree was imported to south Florida by settlers in the late 1800's and subsequently introduced to The Bahamas (Campbell, 1978). Originally planted as an ornamental and shade tree (Kass, 2009), Australian pines spread rapidly and can now be found growing along beaches and in disturbed areas throughout The Bahamas (Campbell, 1978).

When young, the tree's roots help stabilize dunes, but plants that require full sun are excluded as the tree grows (Craig, 1984). In addition, the large amount of stem/leaf litter that accumulates under the trees may increase the acidity of the soil as phenolic compounds leach out of the litter, further impeding the growth of native plants (Batish et al., 2001). The loss of dune plants due to unrestricted growth of Australian pines leads to increased dune erosion (Sealey, 2006; Sealey, 2009). It was expected that if shade and increased soil acidity caused by stem/leaf litter of *Casuarina equisetifolia* reduces the number of native plant species, then fewer native plants would be found in areas under *Casuarina equisetifolia* trees than areas without *Casuarina equisetifolia* trees.

METHODS

Five Australian pines were selected and tagged at Graham's Harbour, in front of the Gerace Research Centre, and at Lindsay Reef Beach, just north of the reef. In order to observe the effect of a single Australian pine, the trees selected were not growing within the shade of another Australian pine and were found in otherwise undisturbed areas. The circumference (cm) of the tallest trunk was measured at breast height and used to calculate the diameter at breast height (DBH = circumference/π). The height (m) of each tree was estimated using the Boy Scouts' thumb method. One person stood beside the tree while a second person backed away until their thumb and the first person were the same height; then the second person estimated the number of thumbs high the tree stood, and multiplied by the first person's height. The diameter (m) of the stem/leaf litter coverage zone under each tree was measured and used to calculate the total area of the zone (Area = π (diameter/2)^2. Three random samples of stem/leaf litter were collected under each tree and the average mass (g) and volume (mL) were measured. For each plot with an Australian pine, a plot of equal size without an Australian pine was established five paces to the south or east (depending on the site). Plants were surveyed in all plots, and species composition in plots with and without *Casuarina* trees were compared. The size of each tree and the stem/leaf litter volume were measured to determine if these factors were correlated with the survey results.

RESULTS

The average tree diameter at breast height was greater at Graham's Harbour (7.0-16.8 cm, average 10.7 cm) than at Lindsay Reef Beach (2.1-5.8 cm, average 3.62 cm) (Figure 1). The average tree height was greater at Graham's Harbour (5.7-8.1 m, average 6.98 m) than at Lindsay Reef Beach (2.4-6.5 m, average 4.65 m) (Figure 1). Tree size was positively correlated with stem/leaf litter mass, stem/leaf litter volume and the size of the stem/leaf litter coverage zone (Figure 1). The stem/leaf litter mass at Graham's Harbour ranged from 9.9-22.0 g (average 16.16 g), while the range at Lindsay Reef Beach was 3.0-4.8 g (average 3.86 g). The stem/leaf litter volume at Graham's Harbour ranged from 116.7-300.0 mL (average 221.68 mL), while the range at Lindsay Reef Beach was 33.3-91.7 mL (average 53.34 mL). The stem/leaf litter coverage zone at Graham's Harbour ranged from 7.1-28.3 m^2 (average 16.68 m^2), while the range at Lindsay Reef Beach was 0.8-12.6 m^2 (average 5.34 m^2).

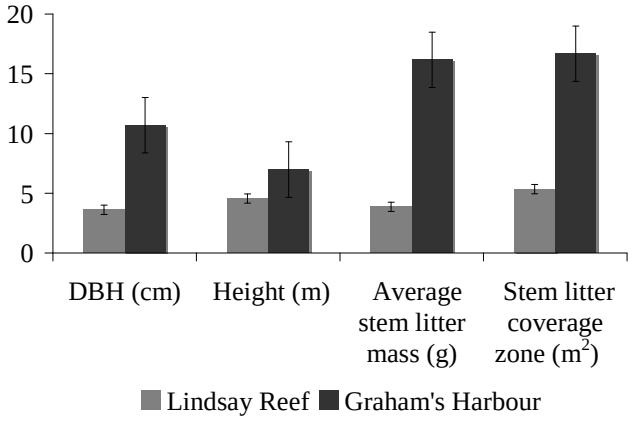

Figure 1. Mean values for tree diameter at breast height (DBH), tree height, average stem/leaf litter mass, and stem/leaf litter coverage zone of five Australian pine trees at Lindsay Reef Beach and Graham's Harbour San Salvador, The Bahamas, with SE bars.

Table 1. Plant species found in Australian pine stem/leaf litter zone and adjacent plots without Australian pine at Lindsay Reef Beach and Graham's Harbour, San Salvador, The Bahamas. = non-native plant species.*

	Graham's Harbour with Australian Pine	**Lindsay Reef Beach with Australian Pine**	**Graham's Harbour without Australian Pine**	**Lindsay Reef Beach without Australian Pine**
Plant Species				
Scaevola plumieri	X	X	X	X
*Scaevola taccada**		X		X
Suriana maritima		X	X	X
Erithalis diffusa	X	X		X
Uniola paniculata	X	X	X	
Cassytha filiformis	X		X	X
Casasia clusiifolia				X
Coccothrinax argentata				X
Ambrosia hispida	X		X	X
Ipomoea pes-caprae	X		X	
Sesuvium portulacastrum	X			
Unknown grass	X		X	
Gundlachia corymbosa	X		X	
Euphorbia mesembryanthemifolia	X		X	
Tournefortia gnaphalodes			X	
Ernodea littoralis			X	

The number of species differed between site locations, but at each site, we observed fewer native dune plants under Australian pines than in plots without Australian pines (Table 1).

DISCUSSION

Tree size and stem/leaf litter were not directly correlated with the number of native species growing under *Casuarina* trees at either site. The study area at Lindsay Reef Beach, which had smaller trees and therefore less stem/leaf litter, had fewer native plant species growing beneath them compared with the area at Graham's Harbour/GRC Beach, which had larger trees. At Graham's Harbour, 10 species of native plants grew under Australian pine trees versus 11 species in plots without Australian pines. At Lindsay Reef Beach, four species of native plants grew under Australian pine trees versus seven species in plots with no Australian pines. The non-native *Scaevola taccada* was observed in plots with and without *Casuarina* at Lindsay Reef Beach, but was not found at Graham's Harbour. In general, more species of native plants were found at Graham's Harbour than at Lindsay Reef, which could be due to a number of factors. For example, the offshore reefs at Graham's Harbour may provide greater protection from storms than Lindsay Reef Beach, which could result in an increase in biodiversity. Alternatively, the difference in species richness may be due to differences in land use at the two locations, with more intensive land use in the area adjacent to Lindsay Reef Beach.

In this study, *Erithalis diffusa* and *Sesuvium portulacastrum* were only found in the plots under *Casuarina* trees at Graham's Harbour, although both species have been observed in other areas of the beach without *Casuarina* plants (Landry, personal observations) and *E. diffusa* was found in plots with and without *Casuarina* at Lindsay Reef Beach. Similarly, *Uniola paniculata* has been observed in areas of Lindsay Reef Beach without *Casuarina*, although *U. paniculata* was not present in the plots without *Casuarina* at this location; it was found in both plot types at Graham's Harbour. There are not many *Casuarina* trees on these beaches relative to the area without the trees. Surveys conducted in plots with *Casuarina* may be sufficient to detect native species that can survive beneath the trees and identify native species that may be inhibited by *Casuarina*. However, the surveys conducted in plots without *Casuarina* were not sufficient to detect all the species present at the two sites.

We observed a slight decrease in the number of native plant species growing under Australian pine trees than in areas without Australian pines at Graham's Harbour and a greater decrease at Lindsay Reef. Factors other than tree size and stem/leaf litter volume such as tree age and proximity to other Australian pines may be inhibiting plants under these trees. Three plant species (*Scaevola plumieri, Erithalis diffusa, and Uniola paniculata*) were found in Australian pine stem/leaf litter zones at Graham's Harbour and Lindsay Reef Beach, suggesting that these native plants may be more tolerant of the shade and/or increased soil acidity caused by stem/leaf litter from the Australian pines. Four species were only found in plots without *Casuarina*, and may be intolerant of soil or light intensity conditions associated with *Casuarina*: *Casasia clusiifolia*, *Coccothrinax argentata*, *Tournefortia gnaphalodes*, and *Ernodea littoralis*. Future work is needed to determine whether these species are intolerant, or if their absence from plots with *Casuarina* was due to dispersal limitation.

ACKNOWLEDGMENTS

We would like to thank Dr. Donald T. Gerace, Chief Executive Officer, and Tom Rothfus, Executive Director of the Gerace Research Centre, San Salvador, Bahamas, for logistical support of this research project. We would also like to thank the West Virginia University Eberly College of Arts and Sciences for the Undergraduate Academic Enrichment scholarship, as well as the WVU Department of Biology, and The Ohio State University-Mansfield for providing additional funding for this project.

REFERENCES

Batish, D.R., H.P. Singh, and R.K. Kohli. 2001. Vegetation exclusion under *Casuarina equisetifolia* L.: does allelopathy play a role? Community Ecology 2(1): 93-100.

Campbell, D.G. 1978. *The Ephemeral Islands: A Natural History of the Bahamas*. London: Macmillan Educational Ltd. 151 pp.

Craig, R.M. 1984. *Plants for Coastal Dunes of the Gulf and South Atlantic Coast and Puerto Rico.* United States Department of Agriculture, Soil Conservation Service, Agriculture Information Bulletin 460. 24 pp.

Kass, L.B. 2009. *An Illustrated Guide to Common Plants of San Salvador Island, Bahamas*, 3rd edition, A.J. Kowalski, illustrator. Gerace Research Centre. San Salvador, Bahamas. 183 pp.

Sealey, N.E. 2006. *Bahamian Landscapes: An Introduction to the Geology and Physical Geography of the Bahamas*, 3rd edition. Oxford: Macmillan Education. 184 pp.

Sealey, N.E. 2009. *Casuarina*-Induced Beach Erosion Revisited. Pp. 52-58 *in* E. Cole and J. Baxter, eds., *Proceedings of the 13th Symposium on the Natural History of the Bahamas*. Gerace Research Centre, San Salvador Island, The Bahamas.