Pollination Biology of *Harrisia portoricensis* (Cactaceae), an Endangered Caribbean Species

INTRODUCCION

Information on the breeding system of endangered plants is often useful piece of information for conservation and management of wild populations. This is so as the foraging behavior of the pollinators and the plant breeding system are factors that may also affect fruit-set and therefore plant reproductive success (Boch & Waser 2001).

Harrisia portoricensis (Fig. 1) is an endangered cactus endemic to Puerto Rico and geographically restricted to three small Caribbean Islands located to the west of Puerto Rico: Mona, Monito and Desecheo (USFW 1990). The population at Mona Island is the largest population identified to date.

Fig 1. Predated fruit (left)and flower buds

Little is known about the breeding system of this cactus species but we do know that *Harrisia portoricensis* appears to be genetically uniform throughout its distribution range based on studies of allelic variation in allozymes (Santiago-Velez 2000). This is somewhat surprising given that most of the columnar cacti studied so far in the tropics have been characterized as self-incompatible hermaphrodite plants (Valiente-Banuet *et al*. 1997, Fleming 2002). Based on this general observation one would have expected *H. portoricensis* individuals to be more variable. One possibility for this lack of variation may relate to the presence of breeding systems conducive to inbreeding.

Here we present data on the floral traits, floral visitor, and breeding system of *H. portoricensis* to address the extent by which this cactus breeding system promotes self-fertilization events.

STUDY SITE

The work presented here was performed in Mona Island Reserve (Fig. 2). The island is located between Puerto Rico and Hispaniola and covers and area of 5517 ha. Annual mean precipitation is 810 mm and mean annual temperature is 25°C. *Harrisia portoricensis* is an endemic columnar cactus with threatened species status since 1990.

Fig 2. Mona Island Reserve

METHODS

A. Floral Traits

Twenty mature flowers were collected from different individuals. For each flower, we performed morphological measures of floral structures to assess floral similarity to other cactus species (Fig. 3).

B. Floral Visitors

Thirty flowers from 20 different plants were video-recorded from flower opening to flower closing. A total of 210 h of video-recording was examined, taking detailed notes on the number and time of flower visits to assess their potential as pollinators. In addition, we performed 112 h of direct flower observations.

METHODS

C. Pollination Experiments

We performed five different pollination treatments in 1flower on different plants to determine the breeding system and potential for self-compatibility. Pollination treatments were:

- *Natural pollination* (open flowers)
- *Autogamy* (covered flowers)
- *Artificial self-pollination (covered)*
- *Artificial cross-pollination (covered)*
- *Agamospermy (emasculated + covered)*

D. Germination and multiplicative fitness

We performed a germination experiment using different subsets of seeds selected randomly from each fruit produced in each pollination treatment. For each plant in each pollination treatment we calculated the multiplicative fitness (*w*) as the product of the probability of setting fruits (*fr*), the number of seeds per fruit (*se*), and the proportion of seeds germinated after 4-months (*ge*):

$$w = fr \times se \times ge$$

RESULTS

•Like other cacti, *Harrisia portoricensis* has solitary and funnel shaped sessile flowers that are fragrant. Flowers were fairly large, hermaphroditic (Table 1) and lasted 24 h. Ovule number is high suggesting a high capacity for seed production.

•Results from 322 hours of direct observations and videotaping showed that visits to flowers by animals were uncommon events. Only 5 visits by hawkmoths were recorded.

•There was no evidence for auto fertilization of flowers nor asexual production of fruits (Table 2). Natural and artificial pollinations yielded fruits although the percentage is higher for natural pollinations (Table 2).

• We detected differences in seed size, seed mass, germination success (Fig. 4), and multiplicative fitness estimates for self- and cross-pollination treatments (Fig. 5).

•We found that progeny resulting from natural and self-pollination treatments showed signs of inbreeding depression compared with progeny resulting from cross-pollination; however, the magnitude of the inbreeding depression was less than 50% (Fig.5).

Table 1. Floral traits of *Harrisia portoricensis*. Means SE. N=20 flowers

External length cm	Internal length cm	Perianth width cm	Anthers height cm	Stigma height cm	Number stamens	Number ovules
21.16	18.85	5.25	12.76	17.18	774	2413
(0.98)	(0.82)	(0.27)	(0.97)	(0.61)	(3.94)	(21.09)

Table 2. Fruit : flower ratio from each pollination treatment.

ISI=proportion fruit-set via self-pollination/proportion of fruit-set via cross pollination

Treatment	Flowers	Fruits	Fruit:flowers ratio	ISI
Cross-pollination	17	11	0.65	0.727
Self-pollination	17	8	0.47	
Natural	17	15	0.88	
Autogamy	17	0	0	
Agamospermy	17	0	0	

DISCUSSION

Given its flower morphology, *H. portoricensis* could be pollinated by moths or bats. However visits to flowers are uncommon events.

Controlled pollinations demonstrated that *H. portoricensis* has partially self-compatible breeding system (based on ISI). Nevertheless, this species is not capable of autofertilization and a pollen vector is required for sexual reproduction.

Our combined results suggest that for this species an endogamous breeding system should be favored by natural selection: (1) levels of inbreeding depression detected should be enough for selfing to be favored by selection, (2) selfing should be favored as a mechanism of reproductive assurance in situations where pollinators are scarce or unreliable.

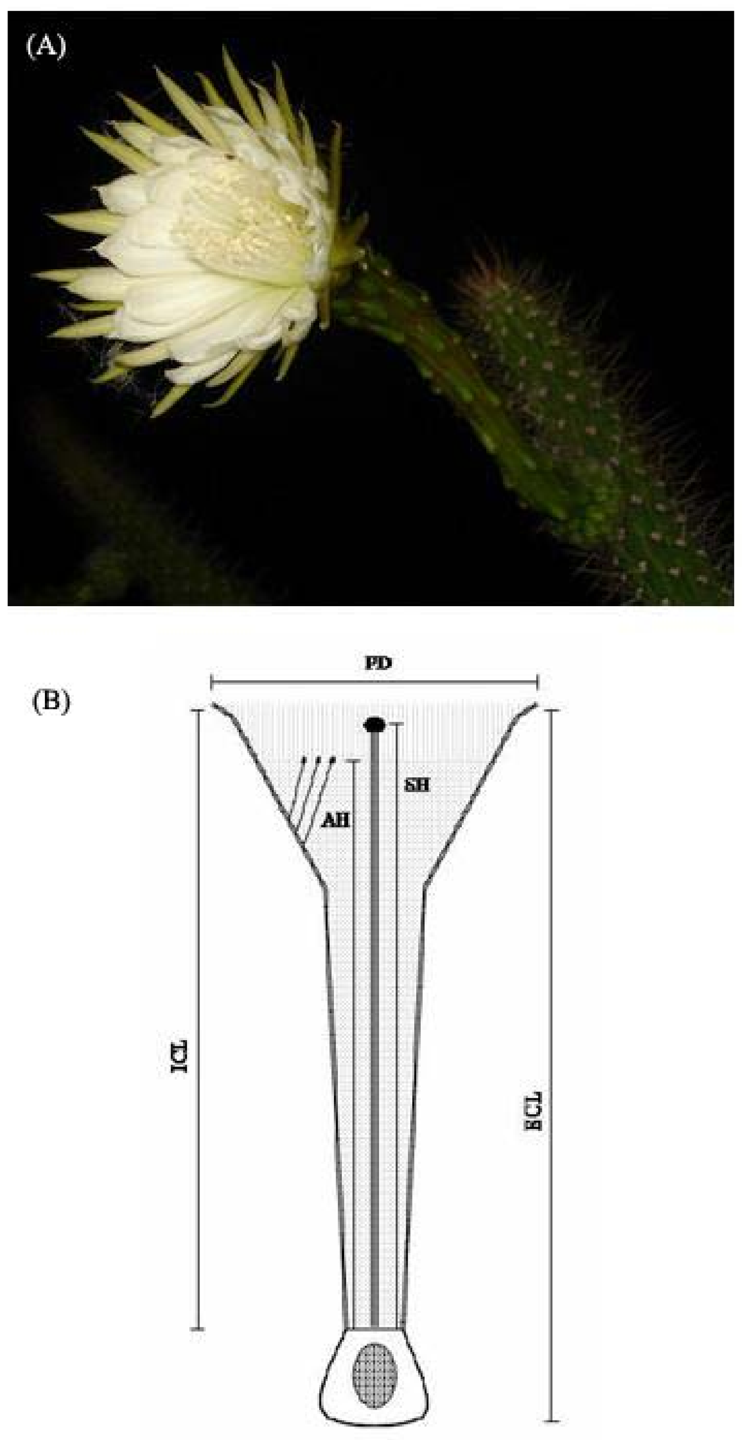

Fig 3. Harrisia flower (A) At anthesis. (B) Morphological measurements: ECL, external corolla length; ICL, internal corolla length; PD, perianth diameter; AH, anther height; and SH, stigma height.

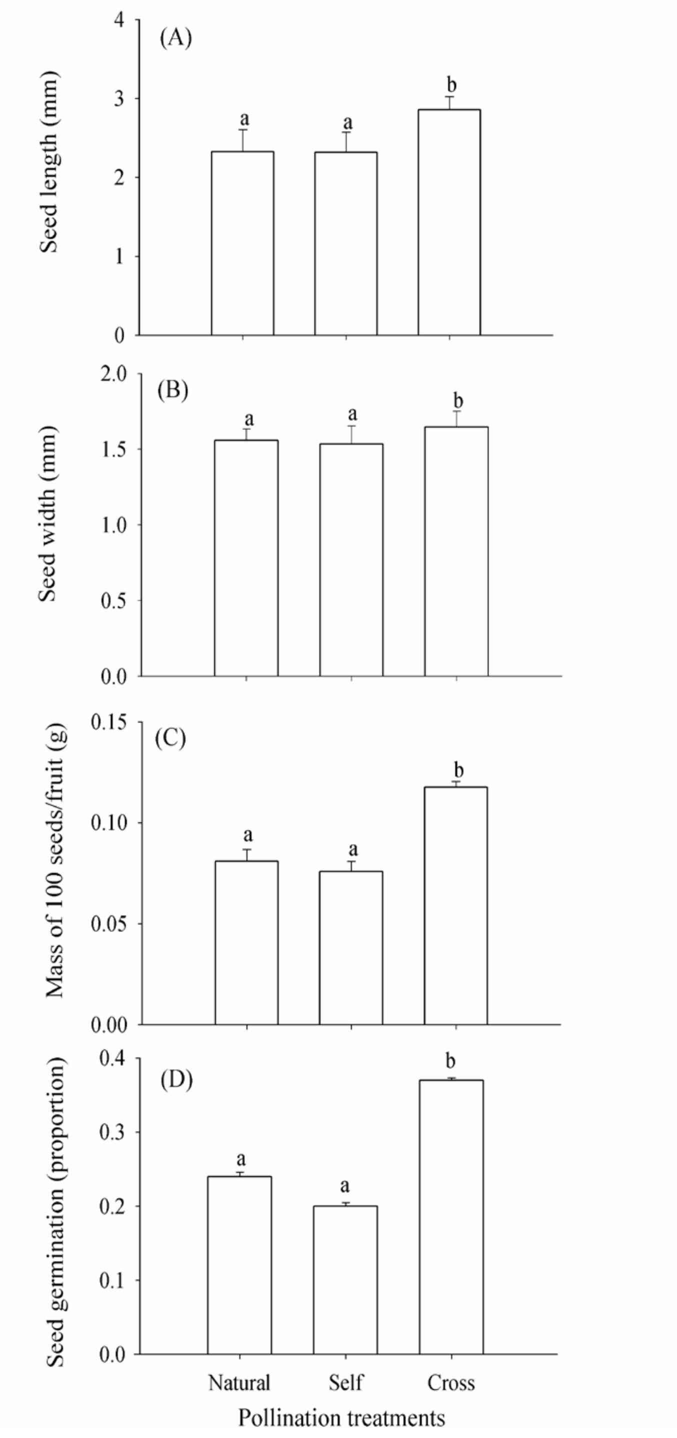

Fig. 4. Means for (A) seed length, (B) seed width, (C) seed mass, and (D) germination rate for *H. portoricensis* in three pollination treatments. Different letters indicates significant differences between pollination treatments (P < 0.001).

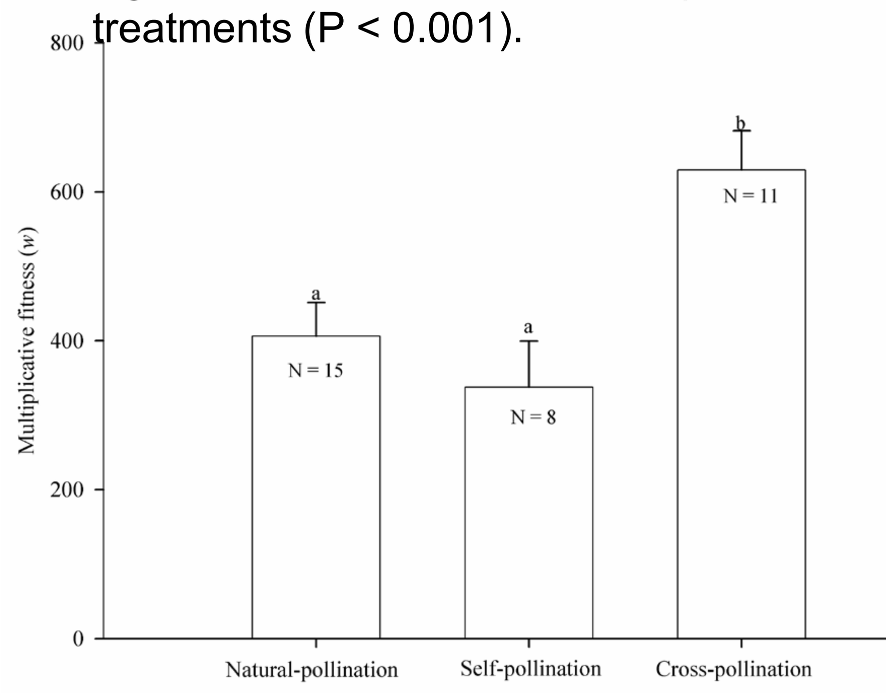

Fig. 5. Multiplicative fitness (*w*) estimates for each pollination-treatment performed in *H. portoricensis* that set fruits. Different letters indicates significant differences between pollination treatments (P < 0.001).

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