Journal of Coastal Research	SI 39	1243 - 1245	ICS 2004 (Proceedings)	Brazil	ISSN 0749-0208

Regeneration of *Ipomoea pes-caprae* after Coastal Erosion (Moçambique Beach, Santa Catarina Island, Southern Brazil)

T. T. Castellani† and F. A. M. Santos‡

†Dept. Ecologia e Zoologia
Universidade Federal de Santa Catarina
Florianópolis, SC 88040-900, Brasil
ttcastel@ccb.ufsc.br

‡ Dept. Botânica
Universidade Estadual de Campinas
Campinas, SP 13083-970, Brasil
fsantos@unicamp.br

ABSTRACT

CASTELLANI, T. T. and SANTOS, F. A. M, 2006. Regeneration of *Ipomoea pes-caprae* after coastal erosion (Moçambique Beach, Santa Catarina Island, Southern Brazil). Journal of Coastal Research, SI 39 (Proceedings of the 8th International Coastal Symposium), 1243 - 1245. Itajaí, SC, Brazil, ISSN 0749-0208.

It is suggested that the strategy of establishment of a strand plant may be influenced by the intensity of perturbation imposed in the beach and foredune. This study evaluated the establishment mechanism (vegetative growth of re-sprouting stolons and seedling recruitment) and the population regeneration of the strand plant *Ipomoea pes-caprae* after an overwash event which removed and burrowed stolons at Moçambique Beach, Southern Brazilian coast. Three re-sprouted stolons and 20 seedlings were monitored by an year to evaluate survival, growth and reproduction. The re-colonization of the area was evaluated in 12 permanent plots of 1m^2, where all the stolon segments, short branches and leaves were monitored. The regeneration of *Ipomoea pes-caprae* was fast and restored the population of modules to densities higher than those registered before the perturbation. An increase from 2.9 to 13.2 short branches/m^2 was observed in the permanent plots and just 0.6% of the total branches came from seedlings. The re-sprouted stolons expanded up to 15 m length, produced 0.67 stolons/primary stolon.year^{-1}, and a net increase from 23 to 33 new branches and from 73 to 166 leaves were observed. The highest rates of expansion occurred at the summer with posterior stabilisation and all stolons reproduced in this season. Although the high seedling survival (90%), no seedling developed stolon in this period and the vegetative growth of re-sprouted stolons was the main mechanism of population regeneration after the overwash disturbance.

ADDITIONAL INDEX WORDS: *Natural disturbance, foredune vegetation, establishment strategy.*

INTRODUCTION

The strand and foredune vegetation can be subjected to natural disturbances caused by sea overwashes which promote massive sand transport, temporary inundation and can remove partially or completely the established populations (HESP, 2000; SNYDER and BOSS, 2002).

Natural disturbances play an important role in the structure of communities interrupting an established rank of species abundance, opening up space and freeing up resources that can be taken over by new individuals (BEGON *et al.*, 1996). The recovery of a community will be based on the dispersal of seeds, but depending on the intensity of the disturbance the seed bank and vegetative tissues may survive.

Although SNYDER and BOSS (2002) refer to a quickly regeneration by vegetative fragments after severe storm, some kind of sea erosion disturbance may completely destroy the habitat and the regeneration will depend only on the incoming of seeds after the rebuilding of the sand deposit (CASTELLANI, 2003).

Santa Catarina Island was disturbed by intense events of coastal erosion in 1996 and 1997. At some localities, monitored populations of the pioneer plant *Ipomoea pes-caprae* were completely removed in consequence of dune ridge destruction and in this cases the population reestablishment began three years later, after reconstruction of the ridge and depending on seeds dispersed by the sea (CASTELLANI, 2003).

If the intensity of erosion varies along the coast, the mechanisms of regeneration may differ between the sites. This study aimed to evaluate the rate of population regeneration of *Ipomoea pes-caprae* and the efficiency of the establishment mechanism (vegetative growth of re-sprouting stolons and seedling recruitment) at a locality with lower intensity of disturbance, affected by overwash but without habitat remotion.

METHODS

The study was carried on the central portion of Moçambique Beach (27°31'21.5"S and 48°25'01.6"W) at the east side of the Santa Catarina Island, State of Santa Catarina, Brazil. The local climate, Cfa Koeppen, shows an annual pluviosity of 1700 mm, and a mean monthly temperature varying from 16°C in July to 25°C in January and February (CASTELLANI, 2003).

The central portion of Moçambique Beach is classified as a sector of erosive tendencies (CRUZ, 1998), medium to coarse sand grain and abundant detritus due to high energy level (LEAL, 1999). The study area presented a fore dune of 1 m height where a population of *Ipomoea pes-caprae* (L.) R. Brown (Convolvulaceae) was monitored from January 1996 to April 1997. This population was overwashed in July 1997 and the stolons and short branches were removed or burrowed by sand. The seawater penetrated 30 m inland affecting 12 other species associated to *Ipomoea pes-caprae.*

Ipomoea pes-caprae presents stolons and short branches that develop at the nodes. In April 1997, before the disturbance, the population presented 5,8 branches/m^2, 29,3 leaves/m^2, about 8 viable seed/m^2 of soil and an associated vegetation cover of 60%. *Remiria maritima, Canavalia rosea, Panicum racemosum, Paspalum vaginatum* and *Polygala cyparrissias* were the most frequent species associated to *Ipomoea pes-caprae* at this site (CASTELLANI, 2003).

To evaluate the re-colonization of the fore dune by *Ipomoea pes-caprae*, 12 permanent plots of 1 m X 1 m were regularly displaced on a 20 m X 20 m area. At each plot, the stolon segments, short branches, leaves and reproductive structures were monitored and counted in September 1997 and September 1998. At these plots, the occurrence and percentage cover of associated species were registered.

To analyse the growth and survival of re-sprouted stolons of *Ipomoea pes-caprae*, three stolons were marked and monitored. Samplings were realised in September and December 1997, March, May and September 1998, when the length, number of short branch, leaves and reproductive structures were counted. Plastic tags were put along the stolons permitting the growth analyses.

At December 1997, 20 emerged seedlings at this area were marked for the study of survivorship and growth analyses.

Table 1. *Production of secondary stolons, short branches and roots in three stolons of Ipomoea pes-caprae monitored at Moçambique Beach, Santa Catarina Island. Mean, (standard deviation) and (range) are presented in some parameters.*

	Stolon 1		Stolon 2		Stolon 3	
	Sept/97	Sept/98	Sept/97	Sept/98	Sept/97	Sept/98
Stolon: primary	1	1	1	1	1	1
secondary						2
Annual increase:	0/primary stolon		0/primary stolon		2/primary stolon	
Short branches: total	1	54	12	65	23	81
desiccated	0	30	0	29	1	26
alive	1	24	12	36	22	55
Annual increase:	23 branches alive/ primary stolon		24 branches alive/ primary stolon		33 branches alive/ primary stolon	
Length of short branches (cm)	1	17.3 (12.9) (1.0 -43.0)	3.0 (2.0) (1.0 -7.0)	9.9 (8.2) (1.5 -40.0)	6.8 (7.8) (1.0 -36.0)	14.2 (11.9) (2.0 -70.0)
Leaves on short branches	1	3.5 (3.2) (0-11)	1.7 (1.1) (1-4)	5.1 (4.6) (0-15)	2.6 (1.9) (0-5)	4.3 (3.4) (0-12)
Roots on stolon	0	9	0	21	2	28
Leaves on stolon	11	0	19	0	17	1
on short branches	1	85	21	184	57	239
total	12	85	40	184	74	240
Annual increment:	73 leaves/ primary stolon		144 leaves/ primary stolon		166 leaves/ primary stolon	

RESULTS

All the re-sprouted stolons survived and produced from 0 to 2 new stolons (0.67 stolons/primary stolon.year^{-1}) (Table 1), being the new ones registered in December 1997 (Figure 1). The stolons expanded up to 15 m of length and the highest rates of expansion occurred from December to March (summer) with posterior stabilisation (May to September). Some stolons did not expand and presented the apical meristem desiccated. The net increment in length varied from 17 cm to 13.11 m (Figure 1).

The production of short branches followed the stolons expansion, showing some reduction after March or May. Just one of the secondary stolons presented a continuous production of branches until December (Figure 1).

The vegetative growth of *Ipomoea pes-caprae* promoted a net increase from 23 to 33 new branches in the re-sprouted stolons representing an increase of 2.5 to 24.0 branches/stolon.year^{-1}. The number of leaves increased from 73 to 166 (rates of 3.24 to 4.42 leaves/stolon.year^{-1}) and the number of roots increased up to 21 times (Table 1).

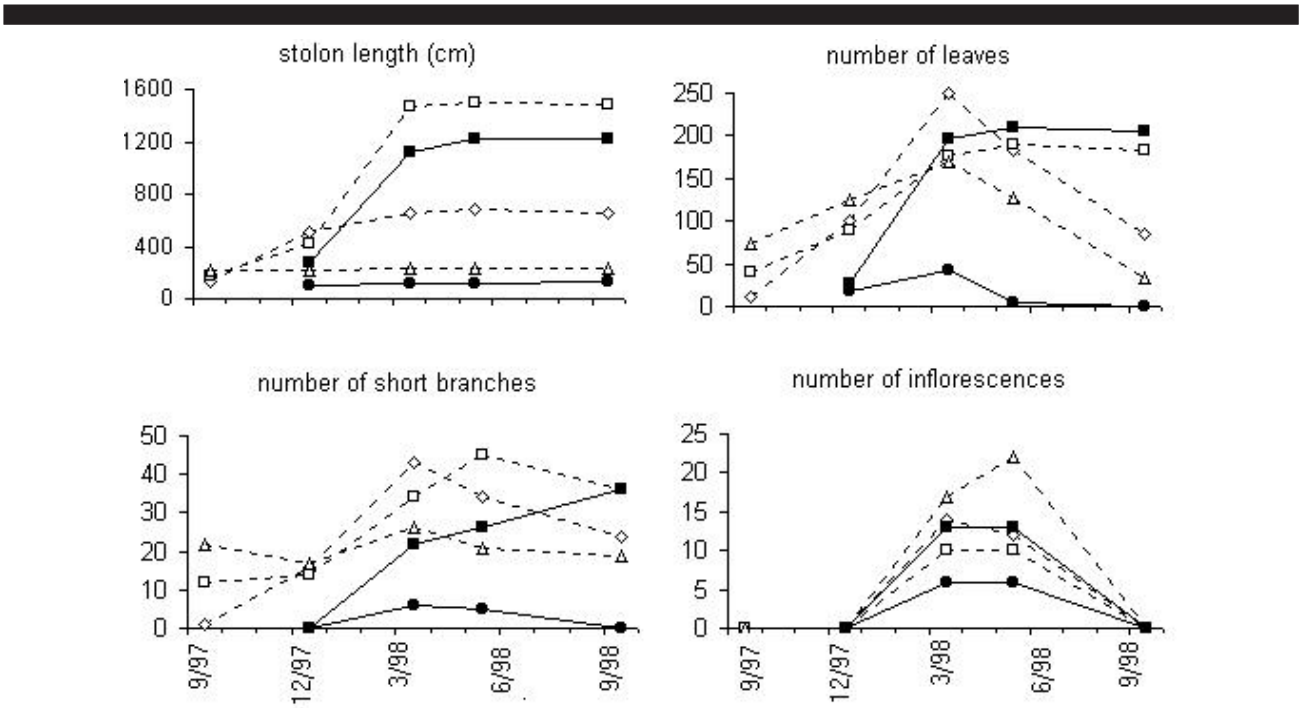

Figure 1. Length (cm) and number of short branches, leaves and inflorescences in re-sprouted monitored stolons of *Ipomoea pes-caprae* at Moçambique Beach from September 1997 to September 1998. Primary (□,◇ and △) and secondary stolons (● and ■).

Table 2. *Survival and growth of seedlings of Ipomoea pes-caprae emerged in December 1997. Mean and standard deviation ( ) are presented in some parameters.*

	12/97	3/98	5/98	9/98
Seedlings alive	20	19	18	18
Primary branch				
Length (cm)	1.5 (0.8)	8.1 (3.2)	9.1 (4.5)	11.4 (5.3)
Leaves number	2.3 (1.5)	4.9 (2. 5)	4.0 (2.4)	2.6 (1.7)
Scars number	0	6.0 (2.1)	9.9 (3.9)	13.2 (4.5)
Shoots/plant	0	0.3 (0.6)	0.7 (1.0)	0.9 (1.4)
Shoots				
Length (cm)	-	3.3 (2.1)	3.7 (2.9)	6.0 (4.8)
Leaves number	-	4.0 (2.1)	2.9 (1.8)	2.1 (2.1)
Scars number	-	0	2.4 (2.9)	4.8 (5.0)
Total/plant				
Leaves number	2.3 (1.5)	6.2 (1.8)	6.1 (1.9)	4.6 (2.2)
Scars number	0	6.0 (2.1)	10.3 (4.1)	15.0 (5.8)

All stolons reproduced in the summer 1998. Although the number of alive short branches was related to the length of the stolons ($r_s = 0.97$, $P<0.01$), the number of inflorescences present in May did not show any correlation ($r_s = - 0.10$, $P>0.05$).

The survival of seedlings was high, 18 in 20 plants monitored. However, no seedling developed stolon in this period, with ten months of age. The seedlings presented an average of 11.4 cm of height, 4.6 leaves and sustained 0.9 new branches in September 1998 (Table 2). No signals of reproduction were observed in the plants established.

The re-colonization of *Ipomoea pes-caprae* in the permanent plots showed an increase from 2.9 to 13.2 short branches/m^2, from September 1997 to September 1998. Just one seedling was registered in these plots representing 0.6% of the total branches counted in September 1998. The leaves density increased from 10.58 to 28.2 leaves/m^2 in this period.

The vegetation cover of other associated species increased from 12.3% to 57.1% and from 10 to 14 species (Table 3). *Remiria maritima, Canavalia rosea, Hydrocotyle bonariensis, Panicum racemosum, Paspalum vaginatum, Acicarpha spatulata* and *Ipomoea imperati* were the most frequent species (≥ 50% of the plots) in September 1998.

The final density of branches and leaves of *Ipomoea pes-caprae* were not related to the degree of vegetation cover (r_s= 0.35 and r_s=0.007, respectively, $P>0.5$). Also, the density of branches did not differ between sectors of fore dune at different distances from the sea ($H=5.97$, $P>0.5$).

DISCUSSION

The regeneration of *Ipomoea pes-caprae* was fast and restored the population of modules to densities higher than those registered before the perturbation in April 1997 (CASTELLANI, 2003). The percentage cover of associated species returned to mean values near those existing before the overwash, and the associated species *Remiria maritima, Canavalia rosea, Panicum racemosum* and *Paspalum vaginatum* were maintained between the most frequents in the community. Although some inter-specific competition is suggested to affect populations of *Ipomoea pes-caprae*, specially the interference from *Canavalia rosea* (WILSON, 1977), no correlation between cover and densities of *Ipomoea pes-caprae* was found to suggest such interference at this stage of regeneration.

From September 1997 to September 1998 no other overwash occurred which permitted the high survival of seedlings and stolon growth of *Ipomoea pes-caprae*. The greatest expansion of stolons occurred on summer when temperature and rainfall are high and erosion events are expected to be less frequent (CRUZ, 1998).

DEVALL *et al*. (1991) suggested that the greatest rates of ramet production of *Ipomoea pes-caprae* may occur at beaches in progradation, about one stolon/primary stolon.year-1. Moçambique Beach is under erosion pressure (CRUZ 1998, Leal 1999), but the period of stability conditions observed permitted high rate of propagation (0.67 stolons/primary stolon.year-1) and the population regrowth.

Table 3. *Number of alive branches and leaves of Ipomoea pes-caprae and associated cover vegetation in September 1997 and September 1998 in 1m² permanent plots (n=12).*

	Total branches		Leaves		Vegetation cover (%)	
	1997	1998	1997	1998	1997	1998
mean	2.9	13.2	10.6	28.2	12.3	57.1
standard deviation	3.2	13.9	11.3	35.5	12.3	21.0
range	0-9	0-42	0-37	0-121	0-40	20-90

The seedling survival registered in this study was very high in relation to seedlings affected by erosion (BACH 1998, CASTELLANI 2003). Although this high seedling survival, their rate of growth was low and the vegetative growth of re-sprouted stolons was the main mechanism of population regeneration.

Besides the fast growth of the stolons, all of them early reproduced permitting a replenishment of the seed bank. At this stage of development, longer stolons did not present more reproductive structures, which may reflect differences in age or in microhabitat exploitation.

The regeneration observed at Moçambique Beach, after overwash without habitat remotion, was faster than those observed in other localities of Santa Catarina Island, where the population of *Ipomoea pes-caprae* initiated regeneration three years after habitat destruction depending only on the dispersal of seeds (CASTELLANI 2003).

ACKNOWLEDGEMENTS

To CAPES for grants to Tânia Tarabini Castellani.

LITERATURE CITED

BACH, C. E., 1998. Seedling survivorship of the beach morning glory, Ipomoea pes-caprae (Convolvulaceae). Australian Journal of Botany, 46, 423-445.

BEGON, M.; HARPER, J. L. and TOWSEND, C. R., 1996. Ecology: individuals, populations and communities. Osney Mead, Oxford: Blackwell, 1068p.

CASTELLANI, T.T., 2003. Estrutura e dinânica populacional de Ipomoea pes-caprae (L.) R. Brown (Convolvulaceae) na Ilha de Santa Catarina. Campinas, São Paulo: Universidade Estadual de Campinas, Ph.D. thesis, 206p.

CRUZ, O., 1998. A Ilha de Santa Catarina e o continente próximo. Florianópolis, Santa Catarina, Editora da UFSC, 280p.

DEVALL, M. S.; THIEN, L.B. and PLATT, W. J., 1991. The ecology of Ipomoea pes-caprae, a pantropical strand plant. Proceedings of the Symposium on coastal sand dunes (University of Guelph, Ontario, Canada), pp.231-249.

HESP, P. A., 2000. Coastal sand dunes: form and function. CDVN Technical Bulletin, 4, 1-28.

LEAL, P. C., 1999. Sistema praial Moçambique-Barra da Lagoa, Ilha de Santa Catarina, SC, Brasil: aspectos morfológicos, morfodinâmicos, sedimentológicos e ambientais. Florianópolis, Santa Catarina: Universidade Federal de Santa Catarina, Master's thesis, 132p.

SNYDER, R. A. and BOSS, C. L., 2002. Recovery and stability in Barrier Island plant communities. Journal of Coastal Research, 18(3), 530-536.

WILSON, D. E., 1977. Ecological observations on the tropical strand plants Ipomoea pes-caprae (L.) R. BR. (Convolvulaceae) and Canavalia maritima (Aubl.) Thou. (Fabaceae). Brenesia, 10/11, 31-42.