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ECOLOGICAL STUDIES ON <u>SPOROBOLUS</u> <u>VIRGINICUS</u> (L.) KUNTH. WITH SPECIAL REFERENCE TO LAKE ST.LUCIA

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ECOLOGICAL STUDIES ON *SPOROBOLUS VIRGINICUS* (L.) KUNTH. WITH SPECIAL REFERENCE TO LAKE ST. LUCIA.

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Abstract:

Sporobolus virginicus is shown to occupy low-lying areas on the shores of Lake St. Lucia, where it is subjected to periodic inundation and widely varying salinities. Whilst seeds are not permanently affected by storage under waterlogged saline conditions, young plants are markedly influenced by both inundation and salinity. Older plants are more tolerant of these conditions.

Introduction:

Sporobolus virginicus (L.) Kunth. is a perennial species narrowly restricted in habitat to coastal strand. In South Africa *S. virginicus* is widely distributed in the coastal districts of the Cape, Natal and Zululand and is considered by Bayer (in Meredith, 1955) to be the most important pioneer under saline conditions along coastal lagoons and estuaries. In spite of this it has not been studied in any detail.

This paper reports on investigations of the effects of salinity and inundation on the growth of *S. virginicus*.

Methods:

Two sites at False Bay, Lake St. Lucia were selected for field study. These were regarded as 'typical' since they traversed both low-lying mud-flats and littoral pools. At each site two transects were set out at right angles to the shore, extending from the water's edge to beyond the *S. virginicus* zone. Transect profiles were surveyed on the same day so that the water level served as a common datum that could be related to mean estuary level through the water level recordings. Presence of an individual was recorded at 5 cm. intervals and the data grouped in 50 cm. classes (i.e. 10 points) along the transect.

Depth of root penetration was estimated by examination of 1 m deep soil cores. The holes, after removal of cores, were used to collect soil water for the estimation (optical salinometer) of soil water salinity and to measure water table depth. The latter parameter is given as depth of free water below the soil surface after a period of 24 hours.

The cation content of plants collected at intervals along each site was determined by wet digestion of ash and atomic absorption spectroscopy (Peach and Tracey 1956).

The effect of salinity on germination was investigated by using three replicate pots, each containing 50 seeds exposed to the following treatments: 0^{o}/oo (¼ strength Hoagland's solution) and 5, 10, 20 and 25^{o}/oo W/V NaCl in Hoagland's solution. Seeds were sown in river sand and watered daily with the relevant solution by total immersion of the pots to limit accumulation of salts at the sand surface.

Response to storage under saline conditions was examined by testing germination after 7 weeks storage in 0, 15, 30, 60, 90 and 120^{o}/oo at room temperature. Three 50 seed replicates were used for each treatment and seeds were germinated on filter paper moistened with ¼ strength Hoagland's solution.

The influence of inundation under varying salinities (0, 10, 20 and 30^{o}/oo) was determined by exposing plants of different ages to three inundation treatments; pots watered daily keeping the substrate moist but not waterlogged and pots with the water level either 3 cm. below or 3 cm. above the surface of the sand. Prior to inundation seedlings were grown in pots and watered daily alternately with either ¼ strength Hoagland's or distilled water. At the start of the experiment five uniform plants were selected in each pot and the others removed. Each treatment comprised 3 replicates yielding 15 plants which were harvested after 38 days. Material was dried at 105°C for 2 days and the dry weights recorded.

Results and Discussions:

Sporobolus virginicus and *Dactyloctenium australe* occupy distinct positions on the lake shore. *S. virginicus* dominates the lower regions colonising areas from less than 3 cm. (Fig. 1, transect 4) to 150 cm. (transect 1) above the water level. *D. australe* however, never occurred below the 60 cm level but extended higher, being common at the highest levels of all transects.

Considering the relationship between the distribution of roots and water table (Table 1) it is evident that roots of *S. virginicus* are commonly found below the water table whereas *D. australe* roots were not. Thus growth of *S. virginicus* can be influenced by inundation due to increased lake levels, wave action or seiche movements and also by the salinity of both lake water and soil water. *D. australe* would only be influenced by the lake when the level was exceptionally high in which case the salinity would be low. The highest lake level recorded during the 10 years previous to this study was +76 cm. (Hutchison 1974) which is 69 cm. higher than that illustrated in Fig. 1.

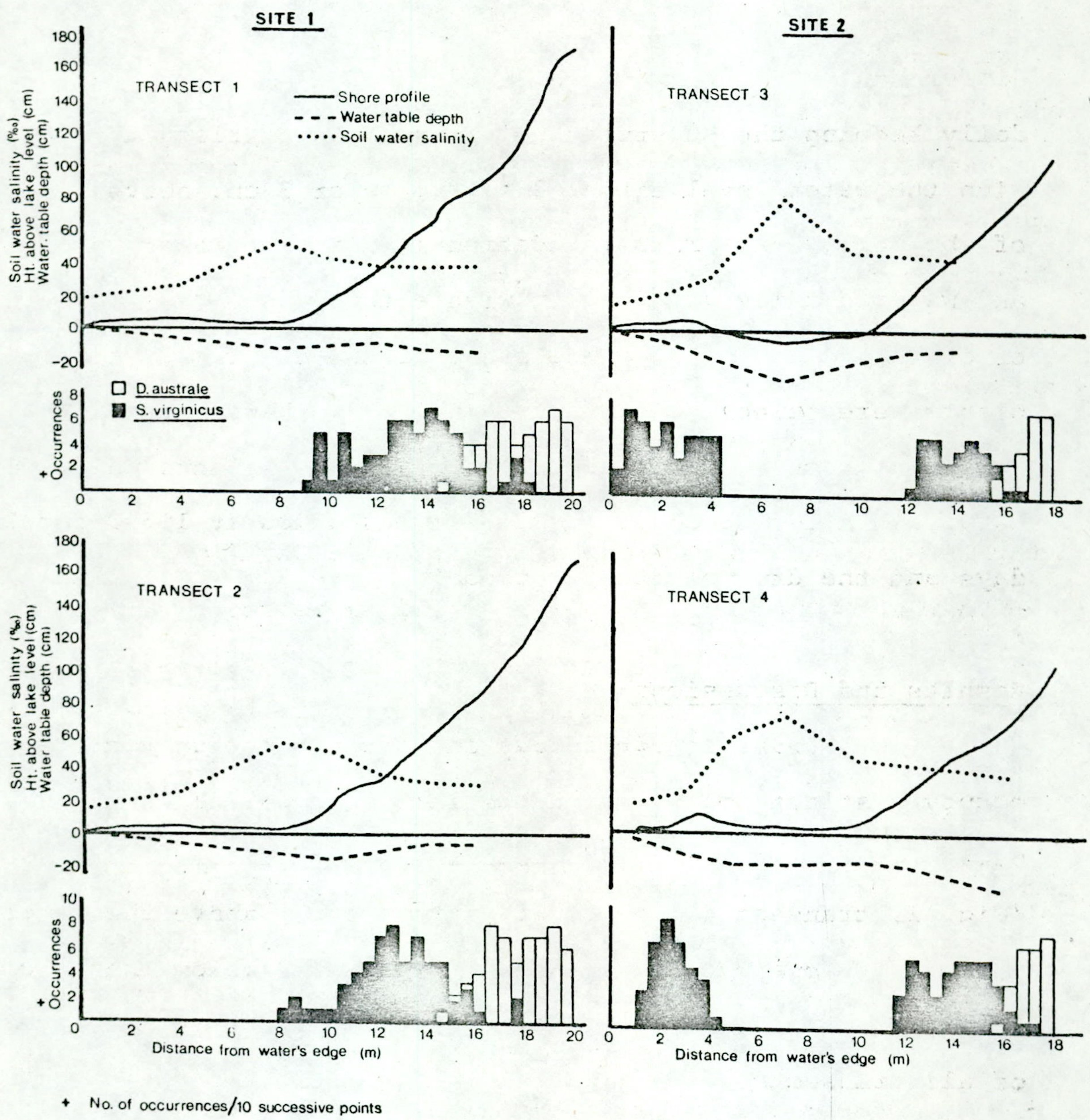

Fig. 1. The relationships between species distribution, shore profile, water table depth and salinity of the soil water in four transects at two sites.

Table 1. **Maximum depth of root penetration (cms), estimated from cores taken along the transects, and depth of the water table below the substrate surface (cms).**

Distance (m) from watersedge	Species present	Transect 1		Transect 2		Transect 3		Transect 4	
		Root depth	Water table	Root depth	Water table	Root depth	Water table	Root depth	Water table
0	S.v.	-	-	-		50	0	-	
1	S.v.	-	-	-		-		60†	5
2	S.v.	-	-	-		53†	10	-	
3	S.v.	-	-	-		-		54†	21
4	S.v.	-	-	-		45†	17	-	
10	S.v.	8	30	10	26	-		-	
12	S.v.	50†	40	56	43	30	28	44	42
14	S.v.	65	63	78†	73	33	45	40	74
16	S.v. D.a.	90*	92	90*	100	45	>100	45	100
18	D.a.	97*	>100	50*	>100	42†	>100	43†	>100
20	D.a.	60*	>100	50*	>100	-	>100		

S.v. *Sporobolus virginicus*

D.a. *Dactyloctenium australe*

\- No roots

† Rocks struck at this level roots still present

* Tree roots present results unreliable

At this time the salinity was low and the lake level would have been at the lower limit of *D. australe* in all transects.

In spite of its higher position in the zonation and consequent lesser exposure to saline conditions than *S. virginicus*, *D. australe* may contain cation levels equal to or greater than those found in *S. virginicus* (Table 2). Under saline conditions *S. virginicus* secretes salt onto the surface of the leaves whereas *D. australe* does not (unpublished data) and consequently *S. virginicus* is better adapted to colonising the lower-lying areas of the shore.

Seeds of *S. virginicus* do not germinate when completely immersed in aqueous solutions although even after storage for 7 weeks in saline solutions of up to 120^{o}/oo, the highest ever recorded at St. Lucia (Hutchison 1974), there was no significant reduction in viability when seeds were transferred to moist filter paper to test germination (Fig. 2). Since viability was not impaired it may be concluded that the saline solutions exert only osmotic effects and that there is no toxic accumulation of Na^{+}. Uhvits (1946) described similar osmotic effects under saline conditions.

The process of germination is markedly influenced by salinity, being reduced significantly at 15^{o}/oo and completely inhibited at salinities of 20^{o}/oo and above. Inhibited seeds germinated normally when returned to favourable conditions, supporting the evidence that the major influence of salinity is on water imbibition through increased water potential of the external solution. These observations support those of Ungar (1962) and Seneca (1969) who found that in other halophytes germination decreased markedly when salinity exceeded 10^{o}/oo.

Thus whilst the seeds are able to survive the most

Table 2: The cation content (mg/g dry wt.) of plant samples collected from Sites 1 & 2.

Distance from shore (m)	Species	Sodium	Potassium	Calcium	Magnesium
Site 1					
10	S.v.	24,40	34,40	7,04	8,96
12	S.v.	24,21	36,90	3,78	6,35
14	S.v.	23,76	19,60	3,24	4,16
16	S.v.	27,21	25,20	5,04	3,36
18	S.v.	16,64	15,20	3,77	5,76
16	D.a.	24,24	28,80	7,60	3,24
18	D.a.	26,24	28,00	10,80	3,82
20	D.a.	23,04	27,60	9,12	3,28
Site 2					
2	S.v.	18,40	16,24	3,84	4,8
4	S.v.	16,00	15,76	4,12	4,96
14	S.v.	15,60	15,76	4,45	4,32
16	S.v.	13,60	14,00	4,96	3,78
16	D.a.	23,76	28,80	8,08	4,02
18	D.a.	19,60	23,20	7,84	3,56

S.v. *Sporobolus virginicus*

D.a. *Dactyloctenium australe*

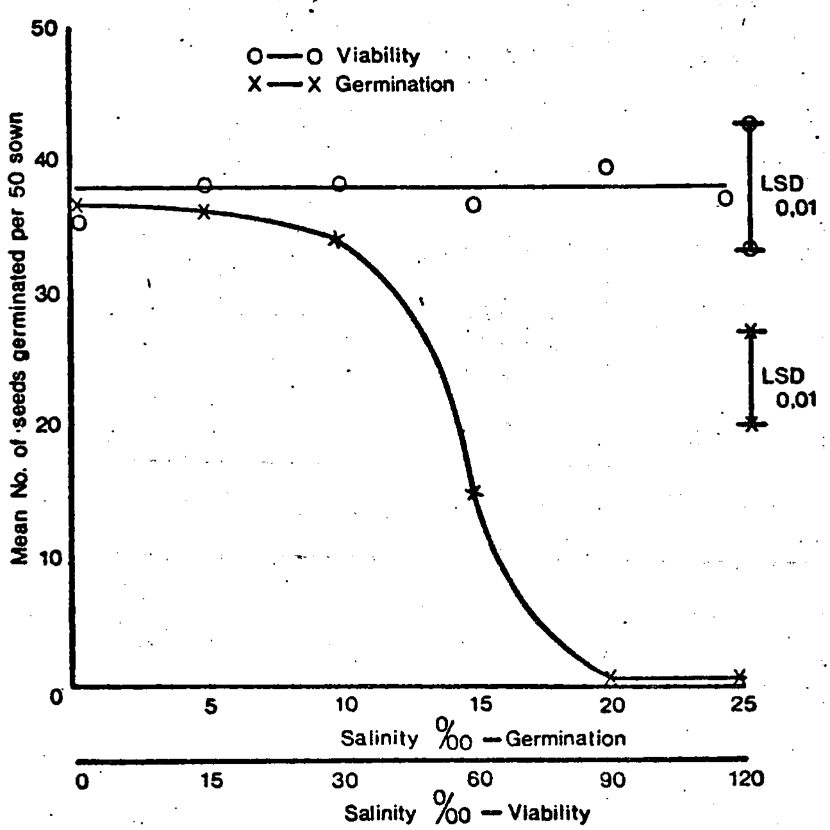

Fig. 2. The effects of salinity on germination and on the viability of seeds stored for 7 weeks in varying salinities. After storage seeds were germinated in ¼ strength Hoagland's solution.

adverse conditions experienced at the lake and provide a reservoir of seed for the colonisation of exposed substrate, it would only occur when the seeds are stranded on a moist substrate with salinities of 15°/oo or less. Once buried, the seeds would not germinate since they require alternating light and dark cycles for germination (unpublished data). It is not surprising however that *S. virginicus* has been regarded as the most important pioneer grass under saline conditions (Bayer in Meredith 1955).

Once germination has occurred and the seedling is established, it becomes progressively more tolerant of saline conditions, possibly due to the development of salt secreting glands (Unpublished data). However increasing salinity results in a significant reduction of growth up to 30°/oo (Tables 3 and 4). One and two month old seedlings watered with 10°/oo yield significantly less dry weight after 38 days than the control watered with ¼ strength Hoagland's solution, and increase in dry weight is completely prevented by salinities of 30°/oo (Fig. 3). Thus young plants show similar salinity tolerances to those observed in germinating seeds. Three month old plants were not inhibited markedly by 10°/oo (Fig. 3) although growth was reduced at 20°/oo and inhibited at 30°/oo. However even when growth, measured as a net increase in dry weight, was completely inhibited, the youngest plants exposed to the highest salinities survived the 38 day experiment.

These results are similar to those of Taylor (In Adams 1963) who observed that the typically sea-shore plants *Spartina alterniflora*, *S. patens* and *Distichlis spicata* grew best under fresh water conditions but were able to tolerate increased salinity.

<u>Table 3</u>: The effect of age, salinity and inundation on the increase in dry weight expressed as a percentage of the control for each age group, of *S. virginicus* plants grown for a period of 38 days under different treatments of salinity and inundation.

Salinity (°/oo)	Age (months)	Level of inundation		
		Normal watering	Level 1	Level 2
0	1	100	48	0
	2	100	79	40
	3	100	117	135
10	1	43	19	0
	2	83	81	41
	3	92	43	94
20	1	11	0.3	0
	2	8	0	50
	3	45	0.2	55
30	1	0	0	0
	2	0	0	0
	3	0	0	4

Table 4: Results of analysis of variance on total dry weight of *S. Virginicus* plants of different ages exposed to varying conditions of salinity and inundation.

Sources of variation	Degrees of freedom	Sum of squares	Mean square	Variance ratio	
Replication (R)	2	0,217	0,108	0,725	NS
Age (A)	2	0,113	56,809	379,24	xxx
Salinity (S)	3	0,221	7,380	49,20	xxx
Inundation (I)	2	0,701	0,350	2,34	NS
AS	6	0,972	1,620	10,80	xxx
AI	4	0,261	0,653	4,36	xx
IS	6	0,101	0,169	1,13	NS
AIS	12	0,207	0,173	1,15	NS
Error	70	0,105	0,150	-	
(Total)	(107)	(0,162)			

SE of a single yield = 0,387

NS = Not significant

xxx = Significant at 0,01 probability level

xx = Significant at 0,05 probability level

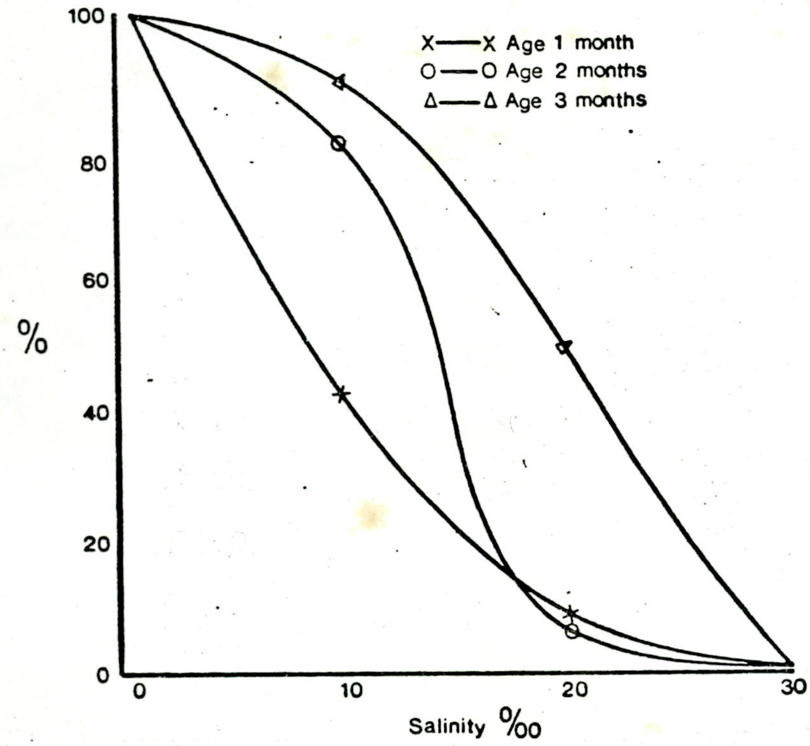

Fig. 3. Increase in dry weights, expressed as as percentage of the increase observed at 0°/oo, of *S. virginicus* seedlings of different ages exposed to various salinities for 38 days.

Growth of 1 month old seedlings is inhibited significantly by inundation (Table 3). When the water level is maintained 3 cm. below the top of the substrate (level 1, Table 3) the soil is permanently wet at the surface because of capillarity. All plants survived this degree of waterlogging even though few (10°/oo Table 3) showed any increase in dry weight during the experiment. All plants exposed to level 2 died and final weights were lower than original weights indicating decomposition had taken place. Small plants are therefore sensitive to both inundation and salinity.

When the data for all three age groups is considered, it is apparent that inundation is not a significant factor in determining yield (Tables 3 & 4). This is because older plants, unlike young ones, are not adversely affected. Yields tended to decrease between normal watering and level 1 (Table 3), but this is ascribed to a salinity effect because of salt accumulation in the surface layers of the soil due to evaporation. This is supported by the observations that as salinity increases at level 1 growth is less than observed in the control and, under more waterlogged conditions (level 2) where salt does not accumulate, yields are equal to or more than the control. Increases above the control may be explained by the greater availability of water. Inundation is therefore important only during the early stages of seedling growth and as the plants become older they tolerate inundation better because they are taller and project above the water level. Since more than two thirds of the shoots system was submerged in 2 month old plants at level 2 it seems likely that waterlogged conditions can be tolerated provided some of the aerial system is above the water level. Salinity on the other hand, affects all age groups but it is critical in young seedlings.

Kenen (in Waisel 1972) has shown similarly arrested growth of shoots of *Nitraria retusa* following inundation particularly in young actively growing plants. Both *N. retusa* and *S. virginicus* differ from plants such as *Salicornia foliosa* which derives benefit from waterlogged conditions (Adams 1963).

Conclusions:

Since increased salinity causes an inhibition of growth it may be concluded that *S. virginicus* is not an obligate halophyte (a plant which has optimal growth under saline conditions), it merely tolerates high salinities. It is unlikely therefore that *S. virginicus* could be readily established in saline areas although once established it will not be adversely affected by increased salinities. The ability of the plant to tolerate waterlogged conditions has obvious advantages considering the habitat in which it grows.

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