PHYSIOLOGICAL DIFFERENTIATION IN A SALT-MARSH GRASS

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Sporobolus virginicus (L.) Kunth. var. *minor* Bailey is a creeping perennial grass of coastal areas around Australia. Along the N.S.W. coast it forms a polyploid complex with, to-date, only tetraploid populations being observed north of Jervis Bay (Smith-White, 1979). The species spreads by vigorous vegetative growth of stolons and rhizomes and in tetraploid variety *minor,* the development of viable pollen (Smith-White, 1979), suggests that sexual reproduction is also an important factor in establishment and survival of this cytotype.

Preferred habitats of tetraploid plants are either tidal salt marshes or river banks within the range of tidal movement. In such places the extent of its distribution is significantly influenced by topography. Rapid changes in elevation, such as river banks, produce very narrow disjunctive zones. In areas where the land surface is almost flat, as is common in salt marshes in eastern Australia, *Sporobolus* forms wide dominant zones and is often present as a sub-dominant in neighbouring vegetation zones. This correlation of distribution to elevation above tidal water directly reflects the gradient in soil salinity (Clarke and Hannon, 1967). As well, some phenotypic characters respond plastically and can be correlated with the salinity of the soil (Smith-White, 1977). In the higher salinity zones, such as the *Sarcocornia quinqueflora* zone, leaf blades are short as are internode distances. Gradual decreases in soil salinity across the zone produce gradual change in phenotype. The tussocky habit of clones usually persists into the seaward edge of the *Juncus kraussii* zone, above which tillers too long to support themselves take on a decumbent habit.

Physiological salt tolerance in the species has generated interest in its potential economic value, particularly in regard to stabilizing dunes and reclaimed areas in coastal localities. Prior to efficient applied usage, however, detailed knowledge is required of the ecological preferences and tolerances within the species if the most suitable genotypes are to be selected for particular situations. The following describes a glasshouse experiment set up to examine comparative growth of tetraploid var. *minor* plants in high and low salinity.

Six clones, each ten metres apart, were collected along transects from three dissimilar and widely separated habitats along the coast of N.S.W. Habitats included a wide salt marsh at Port Stephens, a lake system open to the sea at Tuggerah and a river bank at Fuller's Bridge on the Lane Cove river. Propagules from each clone were grown for four months during summer in coarse sand in containers suspended over reservoir tanks containing the culture solution of either 10% or 100% seawater supplemented with nutrient. Five blocks were included to provide sufficient replication. At the conclusion of the experiment shoots were harvested and dried for two days at 60° C.

Analysis of variance of dry shoot mass values showed a significant reduction in the mean value in 100% seawater as compared to that in 10% seawater, however, no significant difference was determined between localities. Comparative vigor of clones has been assessed from mean values in the most preferred treatment, that was 10% seawater in this experiment. Salinity tolerance has been determined from the plants ability to maintain growth rates in the higher salinity treatment.

The comparison of clonal means within localities and between treatments (Table 1) demonstrates considerable genetic variation in vigor and salinity tolerance. The most vigorous clones from each locality are also the least tolerant of high salt concentrations producing significantly less growth in the higher treatment. Similarly the least vigorous clones appear to be the least affected by high salinity and are therefore the most tolerant. Inverse relationships between vigor and salinity tolerance have previously been reported by Hannon and Bradshaw (1968) in *Festuca rubra* and *Agrostis stolonifera* from non-saline upland and upper marsh populations in Wales.

Clones exhibiting similar or non-significantly different growth between treatments must physiologically be better able to tolerate high internal salt concentrations than those clones suffering significant reduction in the higher salinity treatment. Clones 4 and 5 from the Tuggerah location, however, grew significantly more in 100% seawater demonstrating the existence of a specific requirement for some component of the treatment, at least in concentrations above 10% seawater.

These results suggest the existence, in tetraploid populations of *S. virginicus* var. *minor,* of a gene pool in which genotypes for vigor and tolerance are differentially selected by the prevailing conditions. Stable habitats of either high or low salinity could lead to genotypically homogeneous populations for salinity tolerance and vigor. Habitats in which seasonal changes produce marked fluctuations in the soil salinity could lead to populations which are genotypically heterogeneous for vigor and tolerance. Increased vigor in low saline conditions would clearly be of advantage in competing with other species. Inherent slower growth by the more tolerant populations may also be advantageous in highly saline conditions because of reduced water availability and the necessity to selectively absorb essential nutrients in the presence of other elements in toxic concentrations.

The preceeding results illustrate that even within one chromosome race of this species a range of physiological forms are present which could be selected for transplanting to specific situations. The relative attributes of diploid, triploid and tetraploid populations of this variety with respect to growth and salinity tolerance are currently being examined.

Table 1.

Comparison of Mean Dry Shoot Mass of Clones for each Locality

Locality	Clone Number	Mean Dry Mass (g) 10% Seawater	Mean Dry Mass (g) 100% Seawater	Change in Mass (g) 100%-10% Seawater
Port Stephens	1	4.746	1.801	- 2.945*
	2	3.944	1.242	- 2.702*
	4	3.575	0.580	- 2.995*
	3	1.991	2.234	+ 0.244
	5	1.724	1.038	- 0.686
	6	1.063	0.533	- 0.530
Tuggerah Lake	2	12.880	1.081	-11.799*
	1	4.510	2.062	- 2.448*
	3	2.729	1.468	- 1.261
	6	1.508	1.485	- 0.023
	5	0.202	0.546	+ 0.344*
	4	0.128	0.616	+ 0.488*
Lane Cove	2	3.550	0.822	- 2.728*
	5	2.755	0.550	- 2.205*
	6	1.928	0.811	- 1.117
	3	1.762	0.908	- 0.854
	1	1.076	0.522	- 0.554
	4	0.535	0.685	+ 0.150

In the 10% seawater treatment vertical lines span means not differing at the 5% probability level or better. The asterisk denotes a significant change in mean dry shoot mass between treatments. Calculated by Duncan's Multiple Range Test.

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COASTAL LAGOONS IN NEW SOUTH WALES

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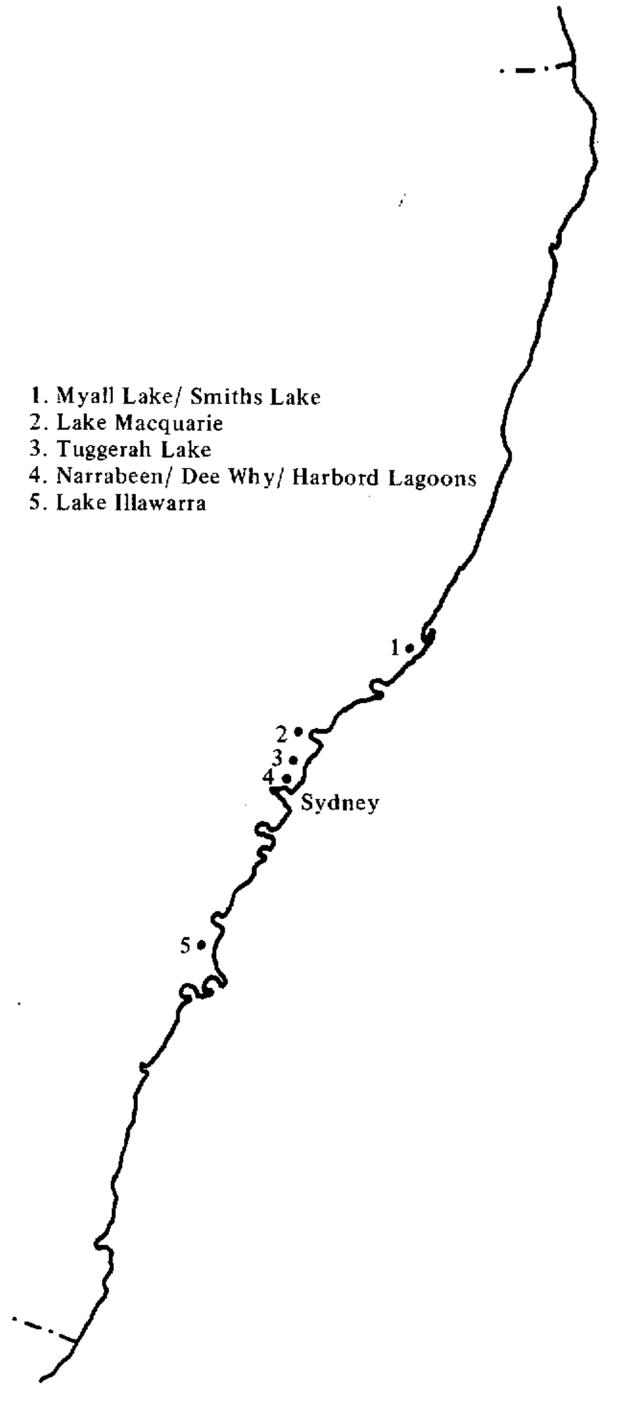

N.S.W. coast showing location of major coastal lagoons.

With the exception of Tasmania, Australia as a whole is deficient in surface waters. There are only a few sizable inland lakes in New South Wales and most of these, certainly the ones around the major population centres along the coast, are water supply reservoirs which are protected and not accessible to the public. There are however, numerous brackish "lakes" along the New South Wales coast many of which are important holiday centres for the populations of Sydney, Newcastle and Wollongong. These so called "lakes" are in fact coastal lagoons. A coastal lagoon is defined by Barnes (1980) as a body of brackish or salt water separated from the adjacent sea by a low lying sand or shingle barrier and these coastal "lakes" certainly fit well into this definition. The literature on the Australian coastal lagoons is sparse and partly inaccessible. The Lake Macquarie study by the CSIRO was by far the most comprehensive and resulted in the publication in 1959 of a series of 12 papers on various aspects of the lagoon's ecology. (Baas Becking, Thomson and Wood, 1959; Spencer, 1959; Baas Becking, 1959; Wood, 1959a,b; Davies, 1959; MacIntyre, 1959; Thomson, 1959a,b,c,d,e).

Typically, the lagoons are shallow with sandy bottoms and are usually fed by one or more short streams. Although the normal freshwater input is not great, floods do occur at irregular intervals due to the relatively large catchment areas surrounding the lagoons. The greatly increased hydraulic gradient generated by the extra quantity of water during floods frequently is sufficient to sweep away the sand barriers, allowing free interchange with the sea. Otherwise the sand barriers, which are constantly being reformed, are quite effective barriers and a lagoon may be isolated from the sea for many years at a time. Under normal conditions, there is very little exchange between the sea and the lagoon so that salinity and water level of the lagoon are functions of rainfall and evaporative loss of water. The extent of salinity fluctuation can be very large. In Tuggerah Lakes, during the period 1979-1980 the measured salinity ranged from 20ppt to 42ppt (hypersaline). But salinity as low as 5ppt had been recorded at the end of previous floods (Higginson), 1865). The effect of rainfall on salinity changes can be more dramatic in a smaller lagoon. In Narrabeen Lagoon for example, each major fall of rain can cause steep vertical and longitudinal salinity gradients to be developed due to the rapid input of freshwater from the feeder creeks.

In general, the open water of the lagoons is well mixed and oxygenated due to wind action and the shallowness of the water column. In Lake Macquarie, there was one recorded case of severe oxygen depletion in the bottom water lasting 5 weeks due to the influx of flood water and the subsequent development of salinity stratification (MacIntyre, 1968). Lake Macquarie is however, a relatively deep lagoon with a mean depth of 6 metres.

Typically, the concentrations of key nutrients in the open water of the lagoons are low with total phosphorus averaging less than 0.05ppm and inorganic nitrogen less than 0.5ppm. The bulk of the nitrogen is in the form of nitrate due to the high dissolved oxygen level in the water. In contrast, the bottom sediments of many lagoons are an immense reservoir of nutrients. Due to the oxidised nature of the water column it is expected that the nutrients are available to attached plants such as seagrasses and relatively unavailable to phytoplankton.

The dominant plant life in the lagoons are seagrasses and the associated algae. The major seagrasses are *Zostera capricorni, Zostera maritima*, *Zostera mulleri, Ruppia spiralis, Halophila ovalis* and *Posidonia australis.* The major algae commonly associated with the seagrasses are *Chaetomorpha, Enteromorpha, Cystophyllum, Gracillaria, Lamprothamium, Dictyota* and a diverse group of microscopic epiphytes including diatoms, green filaments, brown and red and blue-green algae. Seagrass beds are important nurseries and habitats for a large number of invertebrates and fish which feed on them and the epiphytic algae. The phytoplankton present in the lagoons are typically of estuarine forms, dominated by diatoms and dinoflagellates. With few exceptions the phytoplankton density is low, reflecting the low nutrient status in the water column.

The coastal lagoons harbour large populations of commercial species of fish and prawns. Lake Macquarie was the principal source of fish for Sydney and Newcastle during the period 1883-1893 although its significance has