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The saltmarsh vegetation of Langebaan Lagoon

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ABSTRACT

The saltmarshes of Langebaan Lagoon are the most extensive in southern Africa. These marshes, as sampled along six transects, are described. A general marsh, consisting of three species assemblages, was recognized and elevation above mean sea level (MSL) is discussed as a probable determinant of species distributions. However, minor variations in species distributions have been induced by changes in soil characteristics, the effects of wind on inundation depth and differences in water salinity.

UITTREKSEL

Langebaan se soutmoerasse is die mees uitgebreide in suidelike Afrika. Hierdie moerasse, soos bestudeer langs ses lynopnames, word beskryf. 'n Algemene soutmoeras, bestaande uit drie spesiegroepe, kan herken word. Hoogte bo seevlak (MSL) is waarskynlik bepalend vir die verspreidingspatrone van spesies. Nietemin kan klein variasies van hierdie patrone veroorsaak word deur veranderinge in grondeienskappe, die effek van wind op waterdiepte en verskillende watersoutgehaltes.

INTRODUCTION

The saltmarshes of Langebaan Lagoon are the most extensive in the temperate zone of southern Africa. At 5 700 ha, this Lagoon contains over 30% of South Africa's saltmarsh areas (O'Callaghan 1990). Most of the Langebaan marshes have been protected since 1988 as part of a nature reserve.

These saltmarshes have developed under unique conditions as there is no riverine flow into the Lagoon. All other saltmarsh development along the South African coast occurs in estuaries where salinity and tidal characteristics result from interactions between marine and riverine water bodies. There is, however, an extensive fresh water seepage into Langebaan Lagoon at the southeastern corner (Shannon & Stander 1977) and the wetland vegetation in this area is different from the true saltmarshes. These less saline wetlands were excluded from this study. They have been described by Boucher & Jarman (1977) and Boucher (1987).

The saltmarshes are integral to the functioning of many biotic components of the Lagoon [Puttick 1980; Whitfield *et al.* 1989; see Christie (1981) for estimates of macrophyte production]. The biology of this Lagoon was discussed in detail at a symposium on the area (Siegfried 1977).

The most extensive development of marshes occurs at the southern and southeastern parts of the Lagoon. In these areas, complex channel systems allow water to flow into large low-lying backshore areas where marshes develop. The inundation and salinity features of the waters flooding these parts are highly variable and the backshore areas were excluded from this study.

Boucher & Jarman (1977) maintained that the marsh communities of Langebaan Lagoon can be distinguished by the presence of *Sarcocornia pillansii*. They divided the marshes into *Juncus kraussii* Dense Sedgelands and *Chenolea–Salicornia* Dwarf Succulent Shrublands. The former describes the fresher water marsh areas and the latter describes the saltmarshes. Boucher (1987) included the above data to establish a class of halophytic communities called *Sarcocornietea pillansiae*, although he mentioned that the establishment of clear-cut units is hindered by the low species densities of these communities. The associations included in this order are slight modifications of the concepts of Boucher & Jarman (1977).

Day (1959) briefly described the zonation of saltmarshes at Langebaan Lagoon. The top of the marsh is indicated by the presence of *Sporobolus virginicus* and terrestrial species which are found at the extreme high water spring tide level. From this point to MHWS (mean high water spring), a mixed zone of *Salicornia meyeriana*, *Limonium scabrum* and *Chenolea diffusa* occurs. Between MHWS and MHWN (mean high water neap), *Sarcocornia perennis* and *Triglochin bulbosa* dominate. *Spartina maritima* is found from the bottom of this zone to the top of the zone which occurs below MSL.

All the descriptions above correlate somewhat. *Zostera capensis* grows below MSL, followed by *Spartina maritima*. A mixed zone is found up to the MHWS mark, above which terrestrial species make an appearance. However, there is some confusion when these patterns are compared to Boucher's (1987) communities, particularly the required presence of *Sarcocornia pillansii*. The purpose of this paper is describe the marshes of Langebaan Lagoon in some detail.

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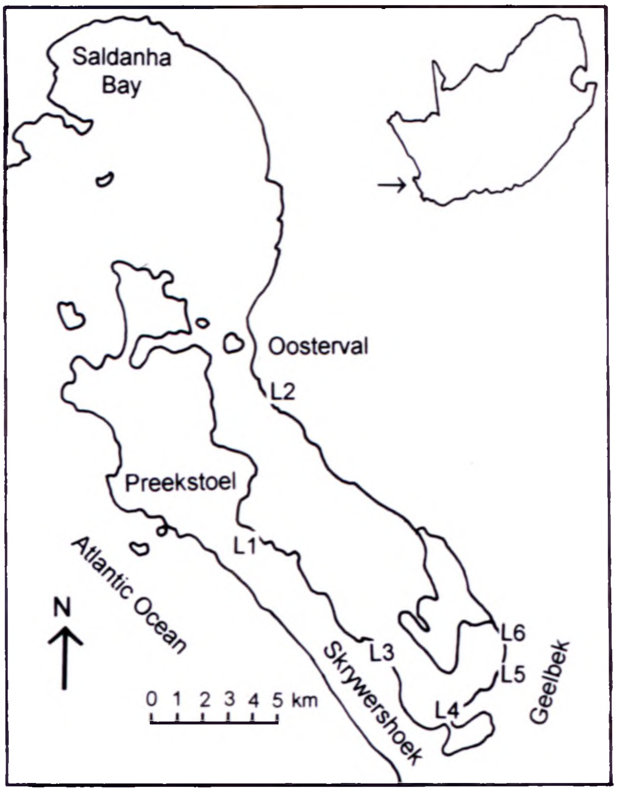

FIGURE 1.—Langebaan Lagoon, Transects L1 to L6.

METHODS

After studying aerial photographs, orthophotographic maps and following field reconnaissance, six transects were demarcated across the marshes of Langebaan Lagoon (Figure 1). The siting of these transects was determined subjectively according to variability in species composition and the relatively undisturbed nature of the vegetation. Details of these transects are presented in Table 1. Elevation profiles of the transects were surveyed using a theodolite, and at least one point on each transect was surveyed to sea level.

Sampling took place on four occasions during 1987 (March, June, September and November) in order to include all bulbous and annual plants. Contiguous 1 × 1 m plots were laid along each transect. The cover-abundance of each species within each plot was estimated according to normal phytosociological methods (Braun-Blanquet 1965). Excessive repetition was avoided by not sampling plots in which it was deemed that the floristic data were simply repetitions of data already recorded from adjacent plots. Taxon names follow Arnold & De Wet (1993) and voucher specimens are housed at the herbarium of the National Botanical Institute at Stellenbosch (STE), the National Herbarium (PRE) and at the Stress Ecology Research Unit at Kirstenbosch. These voucher specimens are listed by O'Callaghan (1994a).

As classical Braun-Blanquet values cannot be manipulated mathematically, these values were converted according to Table 2. To plot the distribution of species, each transect was divided into elevation classes of 10 cm. The converted factors were averaged within each 10 cm class and further averaged over the four sampling periods. As some of the species have annual geophytic or hemicryptophytic life cycles, the number next to the species name indicates the number of times this species was located through the year. The order in which the species occur along the transect is primarily determined by its lowest starting point and secondarily by its termination point along the elevation gradient.

RESULTS AND DISCUSSION

Species distributions along elevation gradients at Transects L1 to L6 are shown in Figures 2–7.

The zonation patterns at Transects L4 and L5 are considered to be typical of the saltmarshes at Langebaan Lagoon, for the following reasons:

1, these profiles were topographically regular with very few gullies or rapid changes in elevation. The shore extended gently into the Lagoon without promontories, rocks or outcrops which could affect currents and tidal fluctuation;

2, as a result, the species were distributed continuously along the elevation gradient. At L4, a single specimen of *Puccinellia angusta* was found in the mid-marsh during September, resulting in a split distribution. By November, this plant had disappeared. At L5, a path existed from 100 cm to 120 cm above MSL. This resulted in a split distribution for *Chenolea diffusa*. Sheep were removed from the area towards the end of this year and, by November, *Sarcocornia pillansii* and *Suaeda inflata* had expanded to cover most of the path;

3, the majority of species shown were present during the entire year, indicating that environmental conditions were relatively stable. However, all the species above an elevation of approximately 80 cm showed signs of grazing at

TABLE 1.—Details of transects

Transect	Description	Length (m)	Tidal range (cm at MSL)
L1	Western shore, 1.4 km south of Preekstoel in southwesterly direction	145	17.7–141.7
L2	Eastern shore, 0.3 km northeast of Oosterwal, in easterly direction	56	– 6.6–137.9
L3	Western shore, 1.3 km northeast of Skrywershoek, in southwesterly direction	57	66.0–143.5
L4	Southern shore, 1.3 km west of Geelbek, in southeasterly direction	137	8.3–133.8
L5	Southern shore, 0.3 km west of Geelbek, in southeasterly direction	130	4.6–126.6
L6	Eastern shore, 1 km northwest of Geelbek in westerly direction	276	14.0–123.5

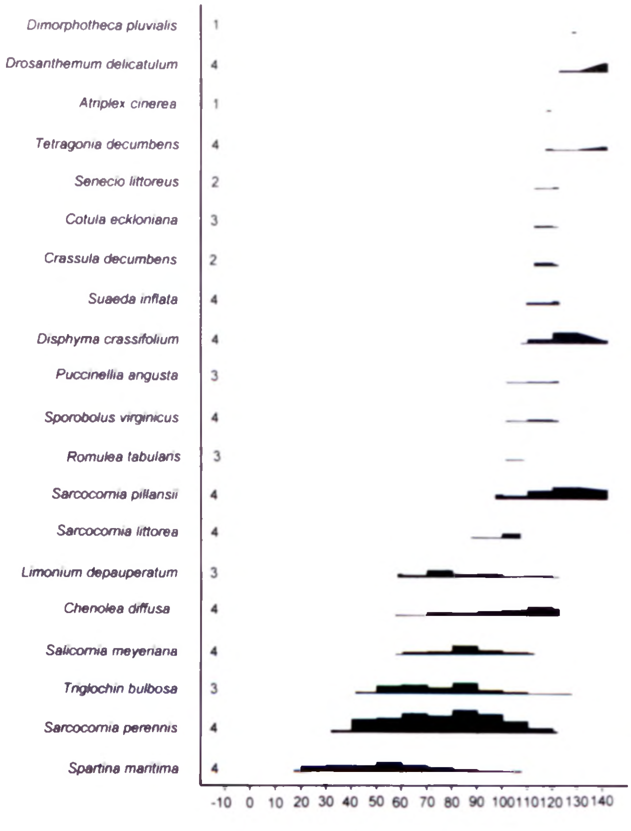

FIGURE 2.—Distribution of species along an elevation gradient on Transect L1. 1–4, number of times species located through the year.

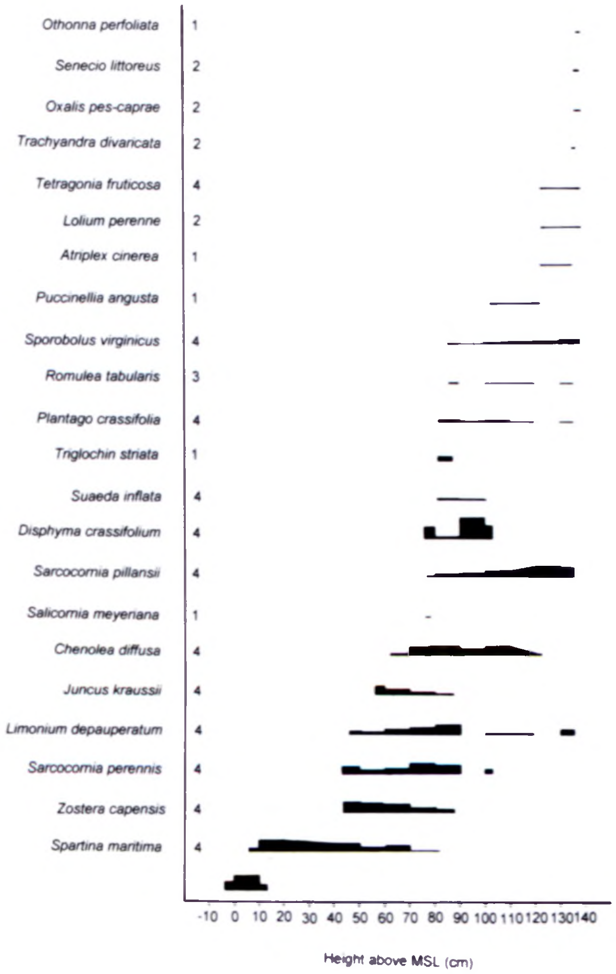

FIGURE 3.—Distribution of species along an elevation gradient on Transect L2. 1–4, number of times species located through the year.

L5. This might have had a differential effect on the presence of some of the species: a) *Puccinellia angusta* is an annual grass which germinates in winter and flowers by spring. At L4, the dead plants remained in place throughout the whole year. It was only recorded during November at L5, once the seeds had germinated in spring; b) at L5, *Limonium depauperatum* was not recorded in March. The growth form of *L. depauperatum* (a single stem growing higher than the surrounding vegetation) is such that it would have been most affected by grazing. This species was again evident from June onwards.

The distribution of species along these two transects will be discussed first and the other transects will be related to them.

Transects L4 and L5 (Figures 5 & 6)

Three groups of species could be distinguished in these transects:

TABLE 2.—Conversion factors

Cover/abundance	% Cover	Converted factor
0	present but dead	0.1
r	single plant < 0.01	0.2
+	0.01–1	0.3
1	1–5	1
2	5–25	5
3	25–50	10
4	50–75	15
5	75–100	20

1, the lower assemblage (*Zostera capensis, Spartina maritima*); from well below MSL to MHWN;

2, the middle assemblage (*Triglochin bulbosa, Sarcocornia perennis*, up to *Limonium depauperatum, Chenolea diffusa*);

3, the upper assemblage (*Suaeda inflata, Sarcocornia pillansii, Disphyma crassifolium* and others).

Although this terminology is similar to that of Chapman (1976, 1977), Beeftink (1977), Adam (1978, 1981), and others, it does not correspond with their concepts of

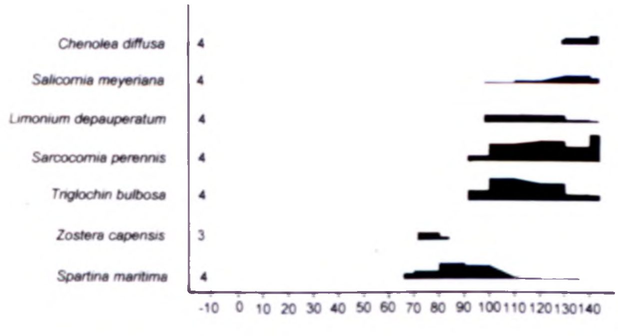

FIGURE 4.—Distribution of species along an elevation gradient on Transect L3. 3, 4, number of times species located through the year.

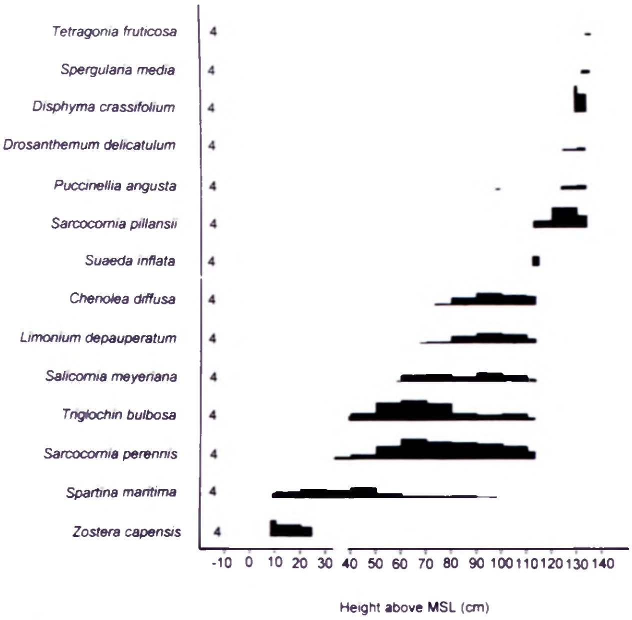

FIGURE 5.—Distribution of species along an elevation gradient on Transect L4. 1–4, number of times species located through year.

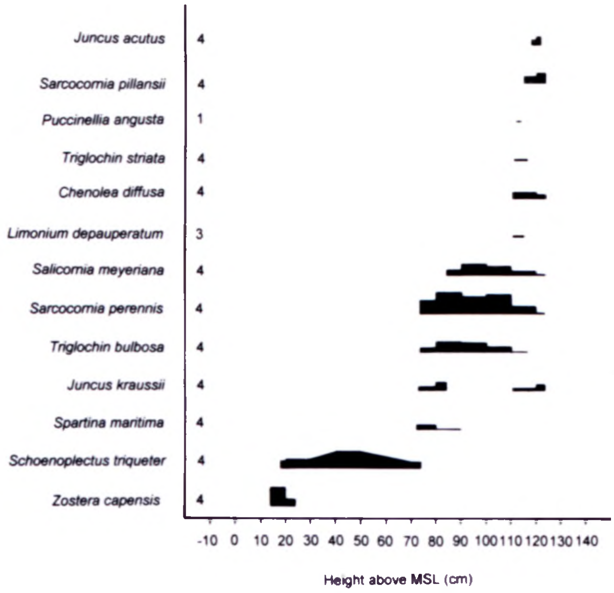

FIGURE 7.—Distribution of species along an elevation gradient on Transect L6. 1–4, number of times species located through year.

lower, mid and upper marshes. In the present paper, these divisions are used only to facilitate discussion.

In relation to L5, the upper limits of *Spartina maritima* and *Salicornia meyeriana* and the lower limits of *Salicornia meyeriana* and *Suaeda inflata* were extended at L4. These extensions are evident between the elevations of 60 cm and 100 cm. This phenomenon can be explained if the extensions are regarded as a tendency towards inversion rather than simply a displacement of species boundaries.

Two examples of inversion were noted at L5. The positions of *Triglochin bulbosa* and *Sarcocornia perennis* were inverted and *Limonium depauperatum* and *Chenolea diffusa* were inverted relative to the other transects. At L4, *Sarcocornia pillansii* and *Suaeda inflata* on the upper part of the transect were inverted.

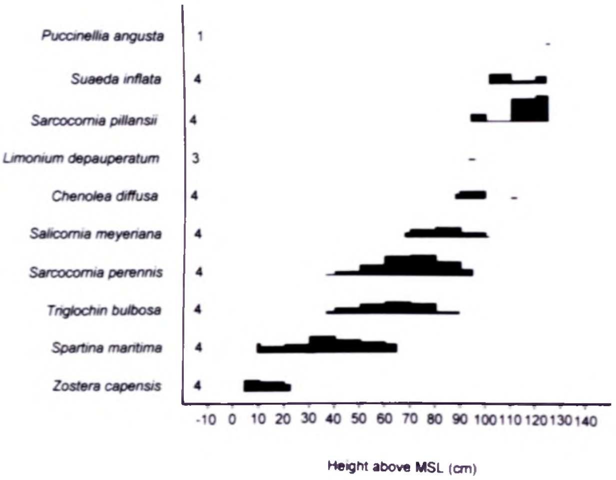

FIGURE 6.—Distribution of species along an elevation gradient on Transect L5. 1–4, number of times species located through year.

Inversion of species occurs when the normal controlling factors have been inverted. Figure 8a & b show that major changes in the relationship between conductivity and organic carbon take place at 45 cm and 85 cm above MSL at L5, and at 115 cm above MSL at L4. The reasons

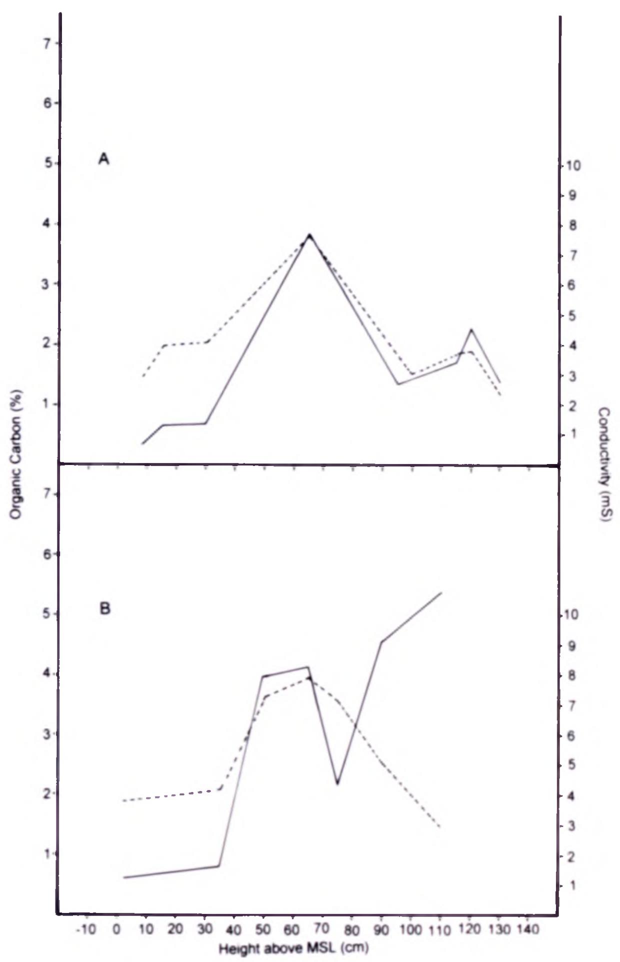

FIGURE 8.—Conductivity (broken line) and organic carbon (solid line) of the soils at A, Transect L4 and B, Transect L5.

for these changed relationships is uncertain, but they were observed where the species tended towards inversion.

Transects L1 and L3 (Figures 2 & 4)

Relative to L4 and L5, the species distributions were displaced up the shore by 10 cm at L1 and by 60 cm at L3. This can be accounted for by an interaction between major currents (Flemming 1977a) and the predominant southeasterly winds which continuously push the water high up onto the transect. The effect is more pronounced at L3 where a sand-spit to the north of the transect traps the water more readily.

Higher current speeds and coarser substrata along these western shores (Flemming 1977b) limited the growth of *Zostera capensis*. It was only found at L3 from July (i.e. with the seasonal abatement of the strong southeasterly winds) and had increased by November. It seems to have a seasonal or cyclical occurrence in this area. Furthermore, it was found relatively high on the marsh where some protection and possibly fine organic substrate was provided by *Spartina maritima*.

The presence of *Sarcocornia littorea* at L1 is unusual (Tölken 1967). This species usually grows in cracks and crevices on rocky marine shores, just above extreme high water. On such a rocky shore, the species would seldom be inundated, but would often be exposed to salt spray. The soils would be coarse with little organic content. The upper layers of the soil would be well aerated, but deeper root development would be limited. At L1, this species was found on a mound above MHWS, but low down on the transect. It would have been exposed to salt spray from the southeasterly winds. It occurred on coarse sands, but soil depth would be limited by a high water table. It could be speculated that the conditions under which this species was found on this transect were similar to those under which it normally grows on rocky shores.

More than half the species above the level of *Suaeda inflata* at L1 had an annual life cycle. *Cotula eckloniana* first appeared in June, *Crassula decumbens* and *Senecio littoreus* appeared in September. These three species are often found after spring and summer draw-downs in fresher water pans (pers. obs.). Heavy winter rains could briefly freshen the heavy soils of the upper parts of L1. As these species appeared above HAT, the environment could have briefly simulated fresher water pans.

The species at the top of L1 are often found on terrestrial arid and/or salinized soils.

Transects L2 and L6 (Figures 3 & 7)

Much of the saltmarsh development along the eastern shores of the Lagoon was similar to that already described. However, seepage of fresh water into the Lagoon was an added factor influencing the vegetation, particularly at L2 and L6.

Juncus kraussii was found in depressions near the top of L2 where occasional incoming saline water was diluted by a high terrestrial water table. Fresh water seeps into the Lagoon immediately north of L6 (Boucher & Jarman 1977; Boucher 1987). This fresher water floods L6 during parts of the year, supporting the growth of *Schoenoplectus triqueter* and restricting *Spartina maritima* to a narrow fringe higher up the marsh.

Juncus kraussii can survive in two distinct habitats: (1) around fresh water pans and wetlands (e.g. Kleinmond Lagoon, pers. obs.); and (2) on upper tidal marshes where salinities rarely exceed 20‰ (e.g. Breë River, O'Callaghan 1983). Although it prefers medium to low salinities, it can withstand occasional inundation by saline water. This species was found at 80 cm and again at 120 cm at L6. Conditions at the lower distribution might be interpreted as habitat 1 whereas conditions at the upper distribution might be similar to those in habitat 2. This split in the distribution of *Juncus kraussii* was also noted at the Berg River (pers. obs.).

CONCLUSIONS

A number of species recorded by Boucher (1987) were not found during the present study (*Limonium equisetinum; Diplachne fusca, Boucher 2820*; *Drosanthemum floribunda*). Some of these inconsistencies are due to differences in species concept (e.g. *Drosanthemum floribunda* and *D. delicatula*). However, some of the differences might be due to different sampling scales used in the different studies. *Diplachne fusca*, for example, is usually found in less saline areas (Kleinmond Lagoon, O'Callaghan 1994b). It is unlikely to be found in the saltmarshes *per se* at Langebaan Lagoon. But it might have been found in the fresher marshes north of L6. The less intensive but larger scale sampling techniques used by Boucher & Jarman (1977) and Boucher (1987) might have resulted in an erroneous inclusion of this species in the saline marshes.

With minor specific variations, the present description of the saltmarshes around Langebaan Lagoon corresponds well with those presented by Day (1959) and Macnae (1957), but not with Grindley's description of saltmarshes at Knysna Lagoon (1985).

However, variations in the relative distributions of the species can be brought about by an instability in the relationship between environmental controlling factors. Further investigation is required, especially as these areas are often exposed to other disturbances such as the deposition of wracks and trampling. Although there was some evidence of direct human-induced disturbance (e.g. grazing and trampling), this disturbance is relatively minor and should decrease as much of the area is managed as part of the West Coast Nature Reserve.

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