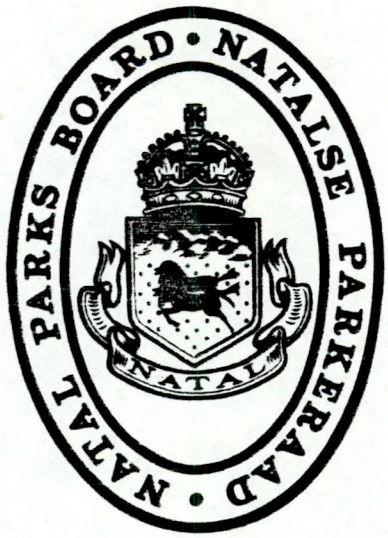

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ASPECTS OF THE ECOLOGY AND DISTRIBUTION OF SUBMERGED MACROPHYTES AND SHORELINE VEGETATION OF LAKE ST LUCIA

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(Editor's note: Mr Ward was indisposed at the time of the symposium. As the macrophytes are an important component of the estuarine system,this paper has been reprinted from the proceedings of the St Lucia Scientific Advisory Council Workshop Meeting - Charter's Creek, 15-17 February 1976; edited by A.E.F. Heydorn. Since 1976 estuarine conditions have passed through a very fresh period into a hypersaline period, and there have been considerable changes in lake levels. These conditions have led to a better understanding of the salinity tolerances of the plants, and to the effects of water depth. These varied conditions have also resulted in the expansion of the list of species present in the system.)

INTRODUCTION

Day et al (1954) and Millard & Broekhuysen (1970) have mentioned the occurrence, and importance, of certain plants on the shores or submerged in Lake St Lucia. Bayer & Tinley (1967) touched upon mangroves and similar shoreline and swamp vegetation, but did not deal with the hydrophytes within the lake. Ward (1962) reported on the submerged macrophytes of the lake with especial reference to those in the southern section of the lake. Apart from periodic field observations and reports from officers of the Natal Parks Board, little other work has been done on the vegetation; Ranger R.P. Nash has provided valuable data regarding submerged hydrophytes in the South Lake from 1975 to the date of this paper. The author has maintained an interest in the submerged and peripheral vegetation since he left the Board's service in 1963, but, of necessity, visits have been relatively sparse. Distribution maps and details of such vegetation will be submitted later since they form part of a wider project, dealing with the plant ecology of Natal's estuaries and lagoons, currently being undertaken. At this stage, in deference to the desire for brevity, only a few aspects of the ecology of the submerged macrophytes and shoreline vegetation will be mentioned.

METHOD

The June 1962 report, mentioned above, followed foot and boat traverses and aerial reconnaissance which gave an idea of species composition and distribution within the southern

portion of the lake. Later in 1962, brief visits were made to the northern section, but data gathered were still of a general nature. In addition, notes have been made and several specimens collected on other brief visits dating back to 1948. Photographs taken from the air, whilst carrying out other work for the Natal Parks Board in 1959, also provided valuable data in regard to the distribution of various species. Periodic visits have been made since the mid-60's; these have included aerial reconnaissance and photography to which has been added information gathered directly from the field. Vertical aerial photographs have also provided useful data.

SUBMERGED MACROPHYTES

Floating plants have been omitted from the present discussion since, it is considered, they form an unimportant role in the lake ecosystem, limited as they are to the immediate vicinity of some of the river mouths when salinity has been reduced to less than 3ppt.

Algae

Whilst there are several macroscopic algae in the lake the only two which are singled out for consideration as macrophytes are Enteromorpha sp. probably E. intestinalis which, amongst other habitats in the lake, forms conspicuous bright green, often extensive, masses in shallows left by receding lake waters where salinity is less than 20ppt.

The other alga is Nitella sp. which was observed in the southern lake in early February 1976. Nitella sp.(p). occurs in freshwater feeder streams to the lake, but this appears to be a first record for the lake itself. This and matters concerning its local ecology will be reported on later.

Vascular Plants

Four species are of particular local importance: Zostera capensis Setchell, Ruppia spiralis L. ex Dum., R. maritima L. and Potamogeton pectinatus L. Of these, P. pectinatus is the least salt-tolerant. In 1959 it was noted as being common in the Brodie's Crossing area, no doubt this was able to become established as satisfactorily as it did due to the drop in salinity in that region prior to the opening of the estuary mouth in 1960. By mid-1962 it had started to die out in this section (salinity 33.5ppt.), but it was still living in water of 26.5ppt. in the Eastern Shores, Old Jetty, area. Later that year it was noted living in the Selley's Lakes area (19ppt.). Although still common under

conditions of low salinities in the South Lake in 1964, it later died out. It was not until the return of low salinities that it was able to re-establish itself, probably in 1975; the actual field recordings were not made until 1976 when the high lake levels had a deleterious effect on other submerged macrophytes which, no doubt, had masked the presence of P. pectinatus.

Currently, it has been recorded as occuring relatively close to the shore for 2-3 km north of Thewati, in the Dead Tree Bay are particularly in the north of that part and in the Hluhluwe River channel prior to its joining the main body of False Bay.

R. maritima occurs in shallow water of peripheral pans and other shallows adjacent to the lake or False Bay.

It is doubtful whether any of the records of this species from the main body of the lake are actually of this species. The reason for this statement is that, at one time, R. maritima was considered to be the valid name for the species which is now known as R. spiralis. R. maritima has been recorded from much of the False Bay peripheral parts, and, in the general vicinity of the main lake, as far south as a shoreline pan on the southern side of Makakatana Peninsula.

R. spiralis and Z. capensis are the more common submerged hydrophytes of the main lake, occurring at times from the top end of the Forks to the North Lake. The greatest mass of these two plants within the lake was probably that which developed in 1962-1965. In this period these two species, together with P. pectinatus in less saline waters, formed very dense stands in the Southern Shallows and Makakatana area; along the Eastern Shores to west of Vincent Islands, where only a relatively narrow channel near the western mainland remained for boating to the north; north of Vincent Islands through Dead Tree Bay to Fanies Island; and, less widespread but still plentiful, along the eastern side of the North Lake extending to the Selley's Lakes area. Z. capensis became more abundant than R. spiralis in the Southern Shallows and, although it extended into the North Lake the bulk of the massive growth appeared to be that of R. spiralis. Both, however, were associated with epiphytic algae and gas-filled tangles of algae on dead or dying stems or leaves of R. spiralis or leaves of Z. capensis often were so dense and massive as to appear from a distance to be land.

As salinities increased these submerged hydrophytes died out with, however, pockets maintaining themselves in the southern lake. R. spiralis appeared to withstand - at least that part above the substrate - higher salinities than Z. capensis, such as that of the saline water which moved out

of the North Lake at the end of 1971. R. spiralis at that time was recorded in water of over 50ppt. - it was not determined, however, for how long individuals could have tolerated such salinities.

There has been a steady increase in the submerged macrophytes over the past two years, reaching its maximum in December 1975 when adverse factors, associated with a rise in lake level have had a deleterious effect on R. spiralis and Z. capensis, (and R. maritima in the shallows). P. pectinatus has not been adversely affected by this recent rise in level and is currently increasing rapidly. Although there are masses of loose R. spiralis and leaves, in particular, of Z. capensis, recent samplings have revealed that they are both still living in the now deeper waters and, in parts at least, there has been a recent marked vegetative growth of Z. capensis in waters of between 1000 and 1250mm in depth at the time of recording.

Ceratophyllum demersum L. is a submerged hydrophyte which just reaches the edge of the lake from rivers under fresh or near-fresh conditions.

Najas marina L. has been recorded from the South Lake in waters of 7.6-8.4ppt. (Millard & Broekhuysen 1970).

There are currently no submerge macrophytes south of the top of the Forks. Turbidity of the water associated with the clayey or silt substrate having originated from the Mfolozi River are regarded as being responsible for this. The situation has been further aggravated by dredging operations.

SHORELINE VEGETATION

Depending upon the amplitude of water-level fluctuation a large number of plants fall into this category - approximately 50 species would qualify, in the broad sense, in the Lake St Lucia area. Levels, salinities of inundating water and drainage are particularly important environmental factors for this group of plants, fire has also had an influence in several parts.

Briefly, the lake system can be divided into several major habitat types. From the south, the first is the estuary where fluctuations in levels and salinities are governed predominantly by the tidal regime so that there are basically two inundations daily, the amplitude of which differs daily and seasonally; salinities, however, do not usually rise above 35ppt., except in saltmarshes, and are often much lower; the tidal influence diminishes with distance from the mouth until it ceases in the upper Forks.

From the top of the Forks to Mitchell Island area, salinities are much the same as that of the estuary although fluctuations are more gradual while levels are influenced on a short term by prevailing winds and on a long term by floods or droughts. For the remainder of South Lake, levels are governed by the same factors, salinity changes are equally gradual, but the range is wider. Much the same applies to the southern half of the North Lake with still greater ranges in salinity. Likewise, but with still further range in salinity, is the northern half of North Lake. In all the above areas there is a freshwater influx from the surrounding area, but it is more pronounced and over a longer period from the east. The major supply of freshwater is, however, via the Mkuze Swamps. What has been said for the North Lake applies to False Bay with, however, higher salinities being maintained for longer periods and a generally less assured, only periodic, inflow of freshwater from the local rivers all of which are dammed. In all cases, topography plays an important part: the shoreline varies from eroded vertical cliffs with no vascular shoreline plants to wide, low-lying, poorly drained flats with herbaceous vegetation whose character and composition varies with, amongst other factors, salinity and/or water level.

Woody plants

Taking the system as a whole, the most abundant of these are the mangroves of which two are common: Avicennia marina (Forsk.) Vierh. and Bruguiera gymnorrhiza (L.) Lam. Rhizophora mucronata Lam. has been recorded only by Day et al (1954).

In spite of many mangroves having been destroyed by dedging operations (on the south of the lower estuary, for example, many hectars of mangroves were killed when local drainage was impeded), they are spreading in the estuary and, at least prior to the recent high levels, in the southern part of the lake. Amongst other factors, protection from fires of which mangroves are not tolerant has been to their advantage, particularly along the Narrows and Mpate River, in recent years. Deposition of sediments at approximately mean sea level and slightly higher, where not disturbed by dredging operations, has provided suitable substrates for colonization.

A. marina has been the first mangrove to colonize freshly exposed soils in the estuarine section. There are several good shoreline stands of this species which extends from just within the mouth up to Potters Channel and that vicinity. It is the dominant mangrove up to just below the Forks and along the banks of the lower part of the Mpate River.

B. gymnorrhiza occurs commonly from First Narrows, becoming dominant in the Forks area, into South Lake. In the lake it occurs patchily on the shore of the western mainland and on several islands, with the northernmost record being approximately 1 km north of Fanies Island camp. B. gymnorrhiza also occurs along the Mpate River, extending further up than A. marina. Although it is tolerant of prolonged basal inundation, if the water is of low salinity and is not stagnant, the effects of the current much-prolonged high lake level which has resulted in B. gymnorrhiza standing in up to 750mm water will be noted with interest.

Hibiscus tiliaceus L. occurs, at slightly higher levels than the mangroves, from the lower estuary to the main lake where it extends along the western shore to just south of Hell's Gates. This species is not tolerant of basal inundation by saline waters and several specimens which had become established on various islands and lower mainland shores under earlier conditions of lower lake levels were killed by the rise in level of saline waters in 1971 and 1972.

Barringtonia racemosa (L.) Spreng., the only other woody plant that will be mentioned in this account, occurs where freshwater influx is marked. This includes seepage areas on the Eastern Shores where several specimens occur in a generally stunted condition, but where the freshwater flow is stronger they are more vigorous. The better developed shoreline B. racemosa in the St Lucia Lake area are those in Dead Tree Bay and on feeder streams in other parts of the South Lake, mostly above ordinary lake levels.

Reeds and rushes

Phragmites australis (Cav.) Trin. ex Steud., Common Reed, is widespread and dominates the islands and much of the shoreline of the main lake. Whilst exposed parts have been killed by waters of high salinities its subterranean parts have been able to withstand such inundation for longer periods, with the result that stands have regenerated on the return of more favourable conditions. Prolonged high salinities have, on the other hand, caused the plants to die out completely; earlier observations and photographs, together with relict rhizomes, show that P. australis was once more common on the shores of False Bay and more abundant in the north-eastern shallows of the main lake than is the case today, or in recent years.

Scirpus littoralis Schrad. generally occurs in estuarine waters where there is a freshwater influx. Consequently it is frequent in the Narrows and near seepage zones of

freshwater streams in the main lake and in parts of False Bay. One particular stand was recorded in water of over 50ppt. during the time that saline water was moving down from the North Lake, in 1971: the aerial parts were in fair condition, but later may have died, whereas the subterranean parts apparently survived since there is currently a vigorous colony at this site.

Juncus kraussii Hochst. extends throughout the peripheral parts of the estuarine section into the main lake; it dominates a few hectares in the vicinity of the Narrows and Forks and generally indicates saltmarsh conditions where abundant. It is frequently cut, often in large quantities, for making traditional Zulu mats.

Creeping grasses

Three such grasses are important along most of the shoreline of the lake and False Bay, these are Sporobolus virginicus (L.) Kunth, Paspalum vaginatum Swartz and Stenotaphrum secundatum (Walt.) Kuntze. In the estuary they occur at a level slightly higher than that occupied by mangroves, at least Avicennia marina.

S. virginicus appears to tolerate higher salinities for longer periods than P. vaginatum, it also occurs on sandier soils although it will occur with P. vaginatum on muds. P. vaginatum is particularly abundant in clayey soils which do not become unduly dry and where salinities are not excessive. Compared with the above two species, S. secundatum occurs at slightly higher levels, it is less tolerant of salt and prolonged inundation, but it is more shade tolerant. All three species, particularly the first two, are grazed by mammals and, when inundated, by aquatic herbivores. In addition they form very useful stabilizers of banks.

Other herbs

The following are included among the more conspicuous of the many shoreline herbs not already mentioned.

Acrostichum aureum L., a coarse fern, extends from approximately high water ordinary spring tide in the lower estuary into the South Lake at least as far as Fanies Island; it is often associated with Bruguiera gymnorrhiza or Juncus kraussii and is particularly common in the Forks area.

Diplachne fusca (L.) Beauv. ex Stapf, a tufted grass, is widespread on shorelines throughout the system, but it is

not tolerant of high salinities.

Succulent members of Chenopodiaceae are early colonizers of exposed saline or brackish soils and periodically cover extensive areas as, for example, the low flats peripheral to False Bay or, following the reed and grass mortality in 1970/71, the mud flats in the north of the North Lake. The species concerned include Arthrocnemum natalense (Bunge ex Ung.-Sternb.) Moss, A. perenne (Mill.) Moss ex Fourcade, A. pillansii Moss, Salicornia pachystachya Bunge ex Ung.-Sternb. and Atriplex patula L. which is not a true succulent, but is a member of the same family. Some of these extend down to the lower estuary. These succulents are not tolerant of prolonged inundation and are thus killed by rises in lake level. In addition Salicornia and Atriplex patula are annuals.

DISCUSSION

Together with smaller algae, the submerged macrophytes and shoreline plants are the main primary producers in Lake St Lucia. They are eaten as living material by a wide range of organisms, including many invertebrates, fish, birds and mammals, and they are the main suppliers of detritus in the lake which, however, is supplemented by material brought into the system, mainly by water, from further afield.

Portions or whole plants of submerged macrophytes washed onto or adjacent to the shores from important sources of food for, i.a., crustacea, insects and birds. Such material, when dense, may smother existing shorter vegetation or sedentary animals; on rotting, marked anaerobic conditions often develop to the detriment of existing organisms and, on the shore, piles of such material on drying provide a source of fuel, thereby introducing a potential fire factor into vegetation which is not normally subject to fire, or increasing the effects of fire in other shoreline vegetation. Such jetsam is of value in improving the soil quality particularly of leached sandy beaches.

Submerged macrophytes and submerged parts of emergent plants provide a substrate for many smaller plants and animals which locally include epiphytic algae, encrusting polyzoa and hydrozoa, small anemones and mussels, thereby adding to the potential food value of these plants.

These submerged plants or basal parts of emergent plants also offer protection for small fish and other organisms. They have a restraining effect on water movement, consequently where they occur there is less wave action, less turbidity and less erosion. They encourage sediment deposition thereby helping accretion of banks whilst, at the

same time, reducing siltation in uncolonized channels. The more robust, or taller, shoreline plants projecting above the level of water also offer a refuge for various animals during rises in lake level: exposed stems of basally inundated mangroves, for example, are often seen with many snails and crabs.

The use of plants rather than inanimate material for stabilization of banks has several advantages in that the plants are generally biologically far more useful, they are generally more aesthetically acceptable and they involve far less expense, not only for the initial works but also for maintenance. Once established, suitable living vegetation will accomodate itself to changes within certain limits: the choice of plant(s) for stabilization would vary with existing environmental factors.

In the estuary where there are daily fluctuations in water level of varying amplitude and the salinity of the water reaches that of the sea, the most suitable plant for the stabilization of the lower banks is Avicennia marina. Whilst the young plants may be able to become estblished only above mean sea level (approximately high water ordinary neap tide at Isipingo Beach, Ward 1971), their shallow roots bearing upright pencil-like pneumatophores are able to extend to lower levels. These radiating roots and their pneumatophores are particularly valuable in sediment consolidation while, at the same time, they provide a habitat for estuarine organisms thus they provide shelter and/or food for other organisms: this, in turn, is advantageous to fishermen. Well established stands of A. marina have been seen to protect banks with no adverse effect following moderate to severe flooding of rivers elsewhere on the coast. In all, A. marina fulfils a very useful role as a member of an estuarine ecosystem.

Elsewhere and under different environmental conditions, reeds, grasses, rushes or woody plants other than A. marina would be more desirable or suitable as bank stabilizers.

Turbidity, salinity and height of water level are probably the three more important factors governing the establishment of vegetation in and around the lake; in more limited parts flow-rate appears to be an important factor as well. It might be as well to point out that the correlation between salinity and lake level, at least nowadays, is not merely a simple inverse one: basically this is so, but lethal salinities at higher than ordinary lake level are able to be reached following prolonged drought. This was shown in 1971 when the influx of freshwater, following a drought, raised the lake level which had been able to remain relatively high because of increased inflow from the sea. Although the high salinities were reduced by this influx of freshwater, the

water which spread over the banks or into the more dilute southern portion had a salinity still lethal to many established plants. Water of almost 50ppt. passed out through Potter's Channel in November 1971, it having been higher in other parts of the South Lake prior to this. By the end of January 1972, however, salinities in the Potter's Channel area had returned to normal, salinities in the lake continued to drop and within another three months there was the first return to a normal salinity gradient in the system after the long period of hypersalinity. Although the artifically increased inflow of sea-water under the circumstances destroyed certain organisms, this must be viewed against the overall benefit derived from the dredged channel in attempting to maintain a reservoir of organisms in the South Lake under conditions of hypersalinity further north.

RECOMMENDATIONS

1. General monitoring of vegetation relative to environmental factors should continue.

2. Quantitative data concerning the main species of various communities including the submerged hydrophytes, their interrelations with each other, other organisms and abiotic environmental fctors are required.

3. It is considered desirable that a project should be sponsored for determining primary productivity including, or separately, one dealing with detritus production and utilization.

4. It is recommended that temperature gauges be installed near selected level recorders which form salinity stations. These need to be no more elaborate than maximum and minimum thermometers read when salinity readings are taken.

5. It is recommended that a flow-meter, reflecting direction of flow, should be installed at Esengeni. This was initially suggested for hydrological reasons, but it would provide valuable data, especially if this instrument measured direction of surface flow, concerning the dispersal of hydrophytes, mangroves and other shoreline species.

6. It is recommended that more use be made of living plants for stabilization of banks or, when cutting or construction banks, provision for suitable slopes or beaches or other favourable situations should be made to encourage the natural establishment of desirable plants. This is said without prejudice to the very good liaison

which exists locally between the engineers and conservationists.

ACKNOWLEDGEMENTS

It is desired to record my sincere appreciation of the kind co-operation and sponsorship of the Natal Parks Board and the friendly assistance of the several officers who have been stationed at the Estuary, the Lake and False Bay over the past twenty years and who have willingly given up their time to accompany me in the field, sometimes under the most adverse conditions, or to provide information of various kinds. I wish to thank also the Board's Principal Scientific Offier, Mr. R.S. Crass, and those who have skilfully and patiently flown me over the system: Messrs. A. Eldridge, R.D. Guy and, particularly, M.P.G. Skinner. The more recent sponsorship by the Natal Town and Regional Planning Commission for the current estuarine project is also acknowledged with gratitude.

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