

Zeekoevlei - Water chemistry and phytoplankton periodicity

WR Harding

Scientific Services Branch, City Engineer's Department, PO Box 1694, Cape Town 8000, South Africa

Abstract

The paper provides a two-year record of Zeekoevlei's water chemistry and phytoplankton periodicity between April 1989 and March 1991. Zeekoevlei is a large (256 ha), shallow (mean depth 1.9 m) and well-mixed freshwater hyper-eutrophic lake situated in the winter-rainfall climatic region of South Africa. Water temperatures ranged from 10°C to 24°C. Due to the presence of dense cyanophyte phytoplankton populations, water transparencies ranged from 0.1 to 0.6 m with a mean of 0.28 m. Zeekoevlei experienced year-round, non-limiting nutrient concentrations. Accumulated algal sediments occupied 20% of the volume of the lake. Typical mean annual total nitrogen and phosphorus concentrations were 3.6 and 0.55 mg/l, respectively, reaching maxima during the winter. Chlorophyll *a* concentrations typically averaged 0.2 mg/l, reaching maxima of up to 0.8 mg/l.

The phytoplankton population had a low generic diversity and an atypical seasonal periodicity dominated by *Microcystis* spp., which completely muted the seasonal periodicity of other phytoplankton taxa present. Zeekoevlei is an example of a poorly-flushed, nutrient-rich "reactor" which perpetuates dominance by cyanophyte algae.

Introduction

South Africa has a number of shallow, natural lakes which lie adjacent to the coastline. These coastal lakes are found in the Southern and South-Western Cape, and in Northern Natal, from where they extend into the wetland and floodplain systems of Mozambique (Noble and Hemens, 1978). Most of these systems are estuarine in character, with 196 estuaries listed for the South African coastline (Noble and Hemens, 1978.). Others such as Swartvlei (Howard-Williams and Allanson, 1981) and Zandvlei (Morant and Grindley, 1982; Begg, 1976), in the Southern and Western Cape respectively, are seasonally estuarine in character, whilst Lake Sibaya in Natal (Hart and Hart, 1977) and Zeekoevlei (this study) are isolated from the coast and are now entirely freshwater systems.

Certain South African coastal lakes (e.g. Lake Sibaya and Swartvlei), have been the focus of intensive studies, the results of which are reviewed in Allanson et al. (1990). There is, however, a paucity of available information for the lakes of the South-western Cape with its Mediterranean climate (Mephram, 1987).

The principal lakes of the Cape Peninsula are Zeekoevlei, Zandvlei, Princess Vlei, Rondevlei and Little Princess Vlei (see Fig. 1). Of these, comprehensive details only of Zandvlei have been published, and this largely due to the establishment of a marina on its eastern shoreline (e.g. Begg, 1976; Howard-Williams, 1976; Morant and Grindley, 1982; Stewart and Davies, 1985; Byren and Davies, 1986). The phytoplankton diversity, assemblages and periodicity of Zeekoevlei (this study), and of Princess Vlei (Harding, 1992) and Zandvlei (Harding, unpub. data) have been studied since March 1989, while the water chemistries of all three lakes have been monitored by the Cape Town City Council for the past nine (Zeekoevlei) to thirteen (Zandvlei) years. The accumulated ecological data for Zeekoevlei and Princess Vlei have been summarised by Harding (1991).

Phytoplankton periodicity studies in South Africa have chiefly formed part of investigations undertaken on large impoundments such as Rietvlei Dam (Ashton, 1979 and 1981), Hartbeespoort Dam (NIWR, 1985; Zohary and Robarts, 1989; Zohary and

Breen, 1989), Roodeplaat Dam (Pieterse and Rohrbeck, 1990), Rhenosterkop Dam (Heath et al., 1988; Robarts et al., in press), Lake Midmar (Breen, 1983), Lake Le Roux (Allanson and Jackson, 1983) and on two large coastal lakes, Lake Sibaya (Hart and Hart, 1977) and Swartvlei (Robarts, 1973; Howard-Williams and Allanson, 1981). In addition, Pieterse et al. (1986), Pieterse (1987), Pieterse and Roos (1987a;b) and Pieterse and Van Zyl (1988) have reported on aspects of the phytoplankton ecology of the Vaal River. With the exception of Swartvlei, these water bodies are all situated in the summer rainfall region of South Africa, and all have typical phytoplankton periodicities (Ashton, 1985).

This paper reports on a two-year record of Zeekoevlei's phytoplankton assemblage and periodicity in relation to the prevailing physical and chemical regimen of the lake. The aims of the study were to determine the dominant phytoplankton genera in the open waters of the lake and to follow their seasonal dynamics. The analysis provides a synthesis of the conditions prevailing in a shallow, well-mixed, hyper-eutrophic water body.

Study area

Zeekoevlei is a large (256 ha), shallow (mean depth 1.9 m) freshwater coastal lake situated on the Cape Flats of the Cape Peninsula (Fig. 1). Aspects of its limnology have been reviewed by Bickerton (1982) in a synopsis of the Zeekoevlei estuary. Early work was conducted by Stephens (1929) and Hutchinson et al. (1932). More recently, various short-term investigations have been carried out by Harrison (1962), Van Wyk (1970), King (1973), Curtin et al. (1975), Howard-Williams (1976), Hamman et al. (1977), Brummer (1981), Davies (1983), Rudnick (1986), Hall (1990), CCC (1990) and Harding (1990a-d), many of which are only available in the form of unpublished reports. In addition, the results of the routine monitoring carried out by the Cape Town City Council (CCC) are summarised annually in the reports of the City Engineer.

Zeekoevlei has for many years been characterised by its "pea-soup" green colour, this feature being reported as far back as the 1920s (Stephens, 1929). Between 1920 and 1948, alternating dominance of the water body by the alga *Microcystis* spp. and the rooted macrophyte *Potamogeton pectinatus* (L.) appeared to be controlled by drying phases of the system, or hydraulic flushing

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