Recent blooms of the dinoflagellate *Ceratium* in Albert Falls Dam (KZN): History, causes, spatial features and impacts on a reservoir ecosystem and its zooplankton

Rob C Hart* and Peter D Wragg

School of Biological and Conservation Sciences, University of KwaZulu-Natal, Pietermaritzburg, South Africa

Abstract

A lake-wide bloom of the dinoflagellate *Ceratium hirundinella*, discovered in Albert Falls Dam in October 2006, exposed a significant ecological change indicative of reduced water quality in this historically mesotrophic reservoir. The spatial distribution of the bloom was examined synoptically in October 2006 and January 2007; these surveys revealed generally higher dinoflagellate densities in inshore reaches of the lake, and especially in the discharge plume of the inflowing Mgeni River. *Ceratium* totally dominated the phytoplankton assemblage, accounting almost completely for coincident chlorophyll levels, which generally increased with depth to generate a 'deep' chlorophyll maximum. Vertical oxygen profiles during the bloom differed substantially from corresponding profiles during non-bloom conditions historically typical in this reservoir. Direct count data and ordination analysis using non-metric multidimensional scaling exposed marked changes in zooplankton community structure compared to seasonally congruent non-bloom conditions in other years. Changes included the effective replacement of *Moina* by *Bosmina*, substantial reductions in *Daphnia* and *Ceriodaphnia*, and smaller but definite increases in abundance especially of calanoid copepods, as well as cyclopoid copepods and of *Chaoborus*, although not all of these differences were apparent in both survey months. These compositional changes are attributable to intrinsic differences in feeding biology among taxa and their associated susceptibility to the altered food environment, which was commensurate with *Ceratium*'s emergence. In addition, chydorid cladocerans appeared as a new (but spatially restricted) eutrophic bio-indicator component of the zooplankton, and the species diversity of cyclopoid copepods was enriched.

The historical incidence of *Ceratium* in the lake since 1995 coincided with low NO_3-N:TP values (used here as an N:P ratio proxy), particularly of inflow waters, and with broadly coincident values in the open lake. *Ceratium* was present but sparse in 1995, at average N:P ratios around 5.5. It disappeared in 1996 when the ratio increased radically to >10, and reappeared in 2004 after an erratic decline of the ratio to < 5 in the lake. The decline in N:P ratio of inflow waters since 1996 was clearly associated with a consistent rise in TP levels in inflows, most plausibly attributable to inputs of (Howick) wastewater treatment (WWT) plant origin. The appearance of *Ceratium* blooms is accordingly related to progressive elevations in mean annual P concentrations in inflows from ~40 µg/ℓ in 1995 to 120 µg/ℓ in 2007 (broadly mirrored in annual TP loadings), suggesting that improved operational efficiency (and capacity) of the WWT plant offers a plausible prospect for mitigation and reversal.

Keywords: dinoflagellate blooms, eutrophication, water-quality, plankton community composition, ecosystem consequences, mitigation prospects