

The decomposition of estuarine macrophytes under different temperature regimes

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Abstract

The Great Brak Estuary is a temporarily open/closed system situated along the warm temperate coast of the Western Cape, South Africa. The estuary is subject to a variety of anthropogenic impacts (e.g. freshwater abstraction and sewage discharge) that increases its susceptibility to prolonged periods of mouth closure, eutrophication, and ultimately the formation of macroalgal blooms. The aim of this study was to determine the decomposition characteristics of the most dominant submerged macrophyte and macroalgal species in the Great Brak Estuary. Laboratory experiments were conducted to determine the effect of different temperature regimes on the rate of decomposition of 3 macrophyte species and the extent of inorganic nutrients released. The results demonstrated that anaerobic decomposition of *Zostera capensis*, *Ruppia cirrhosa*, and *Cladophora glomerata* resulted in high levels of inorganic nutrient release over the 28-day study period. Ammonium (NH_4^+) was the dominant form of dissolved inorganic nitrogen (DIN) released during the decomposition process for all three species. The low levels of total oxidised nitrogen (nitrate and nitrite) released during decomposition were attributed to the inhibition of nitrification by heterotrophic bacteria under anoxic conditions. The relative levels of dissolved inorganic phosphorus (DIP) released were lower than that observed for DIN, and peaked early on in the experimental period (ca. 7 days), thereafter stabilising or decreasing. The DIP levels were explained, in part, by the varying nutrient requirements and limitations of each species (e.g. nitrogen-limited). The release of inorganic nutrients was greatest at higher temperatures (i.e. 25°C and 30°C), due to the reduced bacterial activity experienced at lower temperatures (i.e. 15°C). Ultimately, estuarine health deteriorates during macroalgal blooms, and therefore it is important to implement mitigation measures, such as artificial mouth breaching and plant harvesting, in order to minimise or reverse the effects of eutrophication.

Keywords: Great Brak Estuary, decomposition, temperature, inorganic nutrient release, *Cladophora glomerata*, *Zostera capensis*, *Ruppia cirrhosa*

INTRODUCTION

The rate and extent of anthropogenic pressures on estuaries have increased greatly over recent times due to the demands of an ever-increasing global population. Some of the most prominent consequences of anthropogenic activities for the ecological integrity of estuaries include eutrophication, altered freshwater inflow regimes, accelerated rates of sedimentation, habitat destruction and over-exploitation of resources (Snow and Adams, 2007). It is critical to manage and, where possible, prevent these changes from occurring due to the fact that they influence aspects such as salinity, nutrient loading, flushing time and turbidity maxima, which are responsible, to varying degrees, for determining the spatial distribution and composition of biotic communities (e.g. macrophytes) (Snow and Adams, 2007).

In estuarine systems, free-floating macroalgae and submerged macrophytes play an important role in nutrient cycling, in that they act as both nutrient sources and sinks (Hanisak, 1993). Presence or absence of the various floral communities within estuaries is controlled by factors such as estuarine morphometry, nutrient and light availability, herbivory, exposure to waves and currents, and substratum type (Pedersen and Borum, 1996). In recent history, the incidence of fast-growing ephemeral macroalgae proliferations has increased globally due

to eutrophication caused by excessive nutrient inputs (mainly nitrogen and phosphorus) into coastal ecosystems (Paalme et al., 2002; Lomstein et al., 2006; Berezina and Golubkov, 2008; Gubelit and Berezina, 2010). Under these conditions macroalgae, either attached or free-floating, accumulate in very high biomass (approx. 40 to 400 kg wet weight m^{-2}) in estuaries (Paalme et al., 2002; Lomstein et al., 2006). The consequences of such macroalgal blooms are numerous, and include oxygen depletion (anoxia), altered biogeochemical cycling in the water column and sediments, changes to the composition of higher trophic levels, shading of slow-growing, submerged macrophytes (such as seagrasses), and an overall reduction in biodiversity and recreational value (Hanisak, 1993; Pedersen and Borum, 1996; Paalme et al., 2002; Lomstein et al., 2006; Gubelit and Berezina, 2010).

Management of blooms can be improved by having better knowledge of the decomposition rates of algal species in order to validate their role in the nutrient dynamics of estuaries (Paalme et al., 2002). Moreover, understanding the decomposition of aquatic plants allows for the determination of their role in providing organic matter to detrital food chains, or alternatively being a source of regenerated inorganic nutrients for autotrophic assimilation (Twilley et al., 1986). Studies such as these are important because under macroalgal bloom conditions, the timing and magnitude of nutrient releases during decomposition are likely to have significant ecological impacts in estuaries (Hanisak, 1993).

The Great Brak Estuary is situated along the warm temperate coast of the Western Cape Province of South Africa, and is classified as a temporarily open/closed estuary in fair condition

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