South African Journal of Botany xxx (2016) xxx–xxx

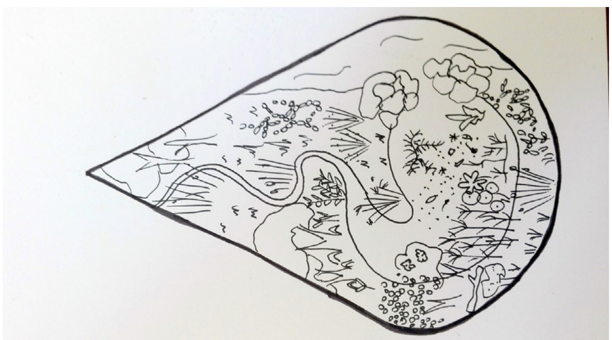
Contents lists available at ScienceDirect

South African Journal of Botany

journal homepage: www.elsevier.com/locate/sajb

Editorial

Ecology and biodiversity of estuaries



This special issue explores the botany of South African estuaries. These are complex, dynamic and productive ecosystems as they form the interface between marine and freshwater environments. Estuaries are threatened by development, changes in freshwater inflow, deterioration in water quality and resource utilization. For these reasons a sound understanding of their structure and function is required to provide inputs to conservation and management. Research on the botanical aspects of estuaries has been important in linking the science, policy and management of these systems in South Africa. The manuscripts published in this special issue clearly show the role of microalgae and macrophytes as indicators of change. They have been used to assess the ecological health and importance of estuaries and are the foundation for biodiversity conservation

Ecological Water Requirement studies, as required by the National Water Act, have included a detailed botanical component leading to a good understanding of responses of microalgae and macrophytes to changes in abiotic factors. Field visits allowed for detailed vegetation maps to be produced and information on macrophyte habitat types and species composition to be collated in an Estuary Botanical Database (Adams et al., in this issue). This is the first paper in the special issue as it provides an overview of the distribution of habitats in South African estuaries; thereafter articles on microalgae, macroalgae, seagrass, mangroves and salt marsh are presented. The last group of manuscripts covers whole estuary studies that highlight the dynamic nature of these systems.

1. Published botanical outputs

A brief assessment was made of previous articles published on the botany of estuaries. An updated version of Whitfield's "Bibliography of South African estuaries" (Whitfield and Baliwe, 2013, http://www.saiab.ac.za) was used to extract the journal articles. Books, popular articles, theses and dissertations were not considered. General ecology papers were excluded, with the focus on botanical aspects being a prerequisite. The 233 papers extracted were divided into five different categories: 1) microalgae, 2) submerged macrophytes and macroalgae, 3) salt marsh, reeds and sedges, 4) mangroves and 5) others which addressed more than one botanical component. These were then divided into decades from 1981 (Fig. 1), with the exceptions being the period of 2011–2016 (i.e. five years) and articles earlier than 1981 (i.e. grouped together due to low numbers).

Research outputs in terms of manuscripts published peaked from 1981 to 1990 for both submerged macrophytes / macroalgae as well as mangroves which could be related to specific researcher's interests. For example Profs Naidoo and Steinke's work on mangroves. The highest outputs for salt marsh, reeds and sedges were during the period 1991–2000. Microalgal research only really began in the 1990s with a peak in publications from 2001 to 2010. The total number of papers published focusing on microalgae (54), submerged macrophytes / macroalgae (54) and mangroves (57) is remarkably similar, in contrast to the notably lower number for salt marsh, reeds and sedges (37). This special issue has contributed a further 22 articles.

2. Microalgae

There have been significant advances in our knowledge of microalgae in estuaries; in the early days this was an under researched area. However much has been written on the topic over the last 20 years. The review of microalgal research in South Africa (Lemley et al., in this issue) showed that detailed assessments of microalgal community composition are needed as well as an investigation of indicator species which requires knowledge of taxonomy. Short term experimental research aligned with the turn-over time of the microalgae should be prioritized for future research. Monthly or even seasonal sampling of microalgae does not represent the daily responses and successional changes of these organisms. The growing eutrophication problem, bloom species and their autecology also needs further investigation

Snow (in this issue) describes the use of microalgae in determining estuary health and the application of the Estuarine Health Index. Benthic diatom indices, using the program OMNIDIA, did not provide reliable results possibly because these have been developed for freshwater environments. Phytoplankton biomass (water column chlorophyll-a) and community structure remain reliable indicators of water quality conditions and estuary health. Benthic diatom species diversity was also shown to be useful. Dalu et al. (in this issue) investigated the various factors that structure benthic diatom community composition within the Kowie Estuary, a permanently open system. A multivariate approach

http://dx.doi.org/10.1016/j.sajb.2016.08.019

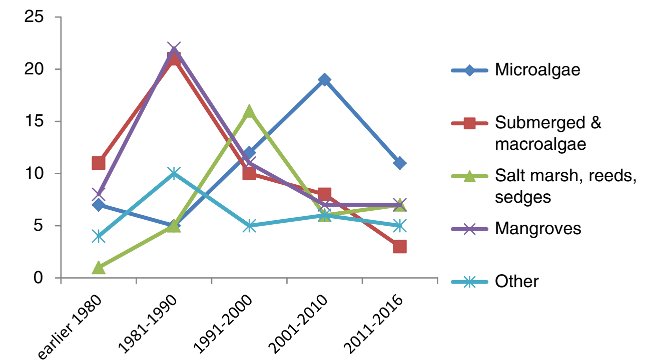


Fig. 1. Total number of journal articles published focusing on estuary botany. Publications earlier than 1980 were grouped together.

showed that the diatom community structure was influenced by a variety of factors including nutrient (ammonia, nitrate) concentrations, hydrology (e.g. water depth and flow) and pH. Hierarchical cluster analysis revealed the absence of any spatial patterns, although distinct benthic diatom communities were recorded during the different sampling periods.

3. Macroalgae

Nutrient enrichment and blooms are the focus of the macroalgal manuscripts presented in this special issue as this is a growing problem in South African estuaries. Human et al. (in this issue-b) describe the situation for the temporarily open/closed Great Brak Estuary where prolonged residence time and the re-cycling of nutrients from the benthos make this system an ideal environment for the prolific growth of the filamentous green alga *Cladophora glomerata*. The conditions that favour macroalgal blooms in the shallow waters of the lower estuary are the prolonged residence time of the water body during the closed mouth state and the availability of remineralised nutrients. This is an impact of the upstream dam and freshwater abstraction. Without effective flushing the estuary will continue to experience the macroalgal boom and bust cycles.

Allanson et al. (in this issue) reported on the extensive macroalgal bloom "green tide" in the Ashmead Channel of Knysna Estuary; South Africa's most important estuary in terms of biodiversity conservation. Using stable isotopes Human et al. (in this issue-a) showed that one of the sources for the eutrophication was input from the Waste Water Treatment Works. The sediment now serves as a permanent source of nutrients for the expansive *Ulva lactuca* blooms that cover the intertidal zone and outcompete the seagrass *Zostera capensis*. However the patches of *Ulva* vary in abundance and frequency of appearance as they are disseminated by wind and tides (Allanson et al., in this issue).

4. Submerged macrophytes

Zostera capensis is the dominant seagrass in South African estuaries and as such it is appropriate that this special issue has a manuscript describing status and present distribution. Adams (in this issue) highlights the dynamic changes in the cover abundance of this submerged macrophyte which fluctuates in response to floods and freshwater abstraction. Nationally it is difficult to predict the future trajectory of change for *Zostera capensis* as sea level rise will increase salinity in estuaries and *Z. capensis* is likely to expand upstream. However any increase in storminess and high intensity rainfall events might remove *Z. capensis* beds. For these reasons studies tracking the changes over time of the *Z. capensis* beds in specific estuaries are needed to understand dynamic responses. A national status assessment is also needed for this keystone species.

5. Salt marsh

While there are many conservation and management problems in estuaries there are some success stories such as the successful eradication of the invasive grass *Spartina alterniflora* at the Great Brak Estuary (Riddin et al., in this issue). Through regular chemical treatment only a few stems now remain in the estuary. Rapid removal was important as this salt tolerant grass is an aggressive ecosystem engineer that converts open intertidal mudflats to dense monospecific marshes.

An investigation of the phylogeographic pattern of the salt marsh plant species, *Juncus kraussii*, showed a break along the south coast with a west and east distribution of common haplotypes. This may have been driven by the rapid shifts in shoreline along the south coast in response to Pleistocene climate cycles (Potts et al., in this issue). Such biodiversity at the genetic level needs further investigation. Indeed the National Biodiversity Assessment (2018) will strive to include genetic diversity but unfortunately there is little to no data for the estuary primary producers.

The distribution of estuarine salt marsh macrophytes (i.e. *Bassia diffusa, Juncus kraussii, Sarcocornia pillansii, Sarcocornia tegetaria* and *Sporobolus virginicus*) in relation to physicochemical variables showed that they are poor bioindicators as they occurred over a broad range of values across the measured physicochemical variables. It is therefore suggested that rare species be studied further to establish relationships with physicochemical variables so that they can be used as indicators to monitor responses to environmental change (Veldkornet et al., 2015).

Bornman et al. (in this issue) determined the change in elevation structure of the Swartkops salt marsh. Rod Surface Elevation Table results showed that salt marsh surface elevation is keeping pace with historic sea level rise in the estuary, although the short period of assessment is cautioned. This type of research needs to be extended to our mangrove estuaries to establish whether there is accretion or subsidence of these important coastal habitats.

6. Mangroves

A comprehensive review of mangroves in South Africa and their adaptations to survive in a saline, waterlogged, low nutrient environment is provided by Naidoo (in this issue). Our temperate mangroves are compared with tropical systems. Lower net primary production with increasing latitude suggests that temperate mangroves may be more vulnerable to biotic and abiotic stressors, but this needs to be investigated further. Naidoo (in this issue) also calls for an accurate re-evaluation of the distribution of mangroves in South Africa. Future climate warming may enable temperate mangroves to extend their present distribution to higher latitudes but this depends on propagule dispersal between estuaries and the availability of suitable habitats that requires further investigation. Yessoufou and Stoffberg (in this issue) investigated the biogeography and phylogenetic structure of mangrove forest globally and in South Africa. They highlighted the value of phylogenetic information for informing conservation, restoration and management.

Extreme events have provided the opportunity to study mangrove response in a number of estuaries and thus contribute to a global understanding of the response of mangroves to stress.

Adams and Human (in this issue) show that mangroves persist at the St Lucia Estuary despite the non-tidal closed mouth conditions. Micro-habitat differences in water level provided conditions for seedling recruitment and adult survival between sites and sampling periods. In the Kobonqaba Estuary the mouth closed due to sediment deposition from a sea storm coupled with drought and upstream freshwater abstraction. Non-tidal high water level conditions caused flooding of the *Avicennia marina* pneumatophores and die-back. Mbense et al. (in this issue) showed that the bare areas were rapidly colonized by succulent

Please cite this article as: Adams, J.B., et al., Ecology and biodiversity of estuaries, South African Journal of Botany (2016), http://dx.doi.org/10.1016/j.sajb.2016.08.019