Macroinvertebrate communities in intertidal mudflats at the Sabaki River Estuary, Kenya: An important habitat for resident and migratory shore birds.

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INTRODUCTION

The Sabaki River Estuary is one of the most important bird areas on the Kenyan coast and has been identified as a globally important site under the category "congregations" of the Important Bird Areas criteria (Bennun & Njoroge, 1999). The Sabaki River Estuary is characterised by large numbers of gulls and terns, a resident of group of non-breeding Lesser Flamingos, *Phoeniconaias minor* and some rarer species such as Broad-billed Sandpiper *Limicola falcinellus* (Seys, 1995). The sandbanks at the mouth of the river are an important roosting site for many of the gulls and terns, while the intertidal mudflats provide a feeding ground for thousands of shorebirds and hundreds of lesser flamingos (Seys, 1995).

Benthivores, birds that rely mainly on estuarine invertebrates for food, make up approximately 38 % of the Sabaki River Estuary bird population (Seys, 1995). The majority of these shore birds feed on very small prey at low tide, with benthic species such as polychaetes, crustaceans and molluscs being the most suitable food (Ens et al, 1990). However, conversion of surrounding land from natural forest vegetation to agriculture and grazing over the last few decades has greatly increased soil erosion and subsequently increased river sediment discharge (Katwijk et al, 1993, McClanahan, 1997). Intertidal mudflats utilized by shore birds at the Sabaki River Estuary are particularly vulnerable to frequent depositional events and their degradation may eventually threaten some of the bird populations found there.

Before 1960, the estimated annual sediment discharge from the Sabaki River mouth was approximately 58,000 tons. In 1981 this figure was estimated to have increased to between 7.5 and 14.3 million tons yr^{-1} (Brakel, 1984, Katwijk et al, 1993). Considerable expansion of the dune fields near the mouth of the Sabaki River (Abuodha, 1998) as well as rapid expansion of mangrove areas in areas of high deposition in the last few years indicates that this trend has continued.

Recent studies have shown sediment run-off from land is a significant threat to marine invertebrate communities with the potential to cause broad-scale, long-term alteration of habitats (Hewitt et al, 2003, Lohrer et al, 2004). Sedimentation events, depositing thick layers of fine terrestrial sediments over short periods of time, as observed at the Sabaki River Estuary, can lead to mass mortality of benthic fauna and the possibility for long term alteration and/or destruction of habitat (Hewitt et al, 2003).

To date, there are few studies that have examined the soft sediment inter tidal invertebrate communities along the Kenyan coast (Ruwa, 1996). Those that have focus on epifaunal communities associated with mangrove forests (Kamau, 1998) or coral reefs (see Katwijk et al, 1993, McClanahan & Obura, 1997). Consequently, there is little information about the invertebrate species that serve as an important food source for shore bird communities, and the possible impact further habitat degradation may have on these communities as well as the subsequent long term effects on resident shore bird populations.

This study aims to;

(1) Identify and quantify the macro invertebrate communities present in areas of high shore bird density.
(2) Elucidate possible reasons for the macro invertebrate communities identified in response to biogeochemical processes and periodic exposure to high levels of sedimentation over an extended period of time.
(3) Identify future research priorities and management recommendations for the Sabaki River estuary in order to preserve shore bird habitat.

MATERIALS AND METHODS

Study area

The Sabaki river estuary is located on the Northern coast of Kenya, 5 km north of Malindi, discharging into the Indian Ocean. The Sabaki River (called Athi or Galana River further upstream) is the second largest river in Kenya, with a catchment area of approximately 40,000 km^2 (Katwijk et al, 1993). During the wet season (April-July) the river discharges approximately 5,000 m^3 of water s^{-1} and during the dry season approx. 20 m^3 s^{-1} (Katwijk et al, 1993).

The Sabaki River Estuary occupies an approximate 250 ha area consisting of intertidal mud and sand flats as well as salt marshes, dunes, seasonal and permanent freshwater pools, mangroves and scrub. Tides are semidiurnal with a tidal range of 2-4 meters. The area experiences a tropical monsoon climate with south-east trades prevailing from April to October and north-east monsoon from November to March (Abuodha, 1998). The estuary area forms extensive feeding grounds for the migrant and resident populations of shore birds.

Sampling protocol

Five sites were selected, two on the north bank and three on the south bank of the Sabaki River Estuary. Sites were selected to assess macro-benthic variability within the estuary at preferred feeding areas of resident and migrant shore birds. All sites were therefore located in areas of high shore bird density, established from bird count figures collected on previous visits to the estuary (C. Jackson pers com).

Samples were collected at low tide on the 14th and 15th of June, 2005. At each site, an area of 100 m^2 (10m x 10m) was selected, by walking a random distance into the foraging area to locate the first left hand corner of the site and recording its GPS location (Table 1). Six replicate sampling locations within each site were chosen using random distance (0 -10 m) horizontally along and then vertically into the site. Sites were selected with low shore gradients to ensure they all had similar inundation periods. However, the two sites located on the north side of the river were in an area close to sporadically growing and emergent mangrove trees, while on the south side there were no mangrove trees.

A total of 30 macro-invertebrate cores (13 cm diam, 15 cm depth) were collected. Macro-invertebrate samples were sieved through a 600-μm sieve and preserved in 70% Isopropyl alcohol with estuarine water. Macrofauna were sorted and identified to the lowest possible taxonomic level using low power (10-30 mag.) microscopy, counted and preserved in 70% isopropyl alcohol. The use of an unusual sieve size (instead of standard sizes 500-μm or 1mm) was solely determined by what was available in a remote location. However, the smallest possible sieve size available was used because a coarser sieve size would have resulted in under representation of the smaller macrofauna; including many polychaetes and juvenile macrofauna (a coarser sieve reduces the temporary effects of recruitment).

A sediment core (4 cm diameter, 8 cm depth) was also collected adjacent to each macro-invertebrate core. Each sample was stored in a watertight container, kept in a cool dark place and immediately frozen upon returning to the laboratory.

Table 1. Site number, description and GPS location for each macroinvertebrate sampling site, at the Sabaki River Estuary.

Site Number and description	GPS Location
Site 1 Mangrove site A - North bank	S 03º 09.747' E 040º 08.713'
Site 2 Mangrove site B - North bank	S 03º 09.683' E 040º 08.749'
Site 3 Seaside, South bank	S 03º 10.62' E 040º 08.433'
Site 4 Middle site, South bank	S 03º 09.983' E 040º 08.350'
Site 5 Landside, South bank	S 03º 09.918' E 040º 08.305'

RESULTS

Mean macroinvertebrate abundance was high on the north bank at both sites (site 1 & 2) but highest on the south bank at site 4 and lowest at site 3 (Fig.1). The mean number of taxa was extremely low with 1.66 species present at sites 1, 2 & 5 and 1.16 and 1.5 species at sites 3 and 4 respectively. The dominant species contributing to the high abundance observed was the Nereid polychaete, with up to 196 individuals detected in one individual core (site 4).

Other species included the occasional presence of Decapodae shrimp, isopods, mud whelks, the crab *Macropthalmus sp* and the polychaete *Capitellidae sp*, found only at site 5.

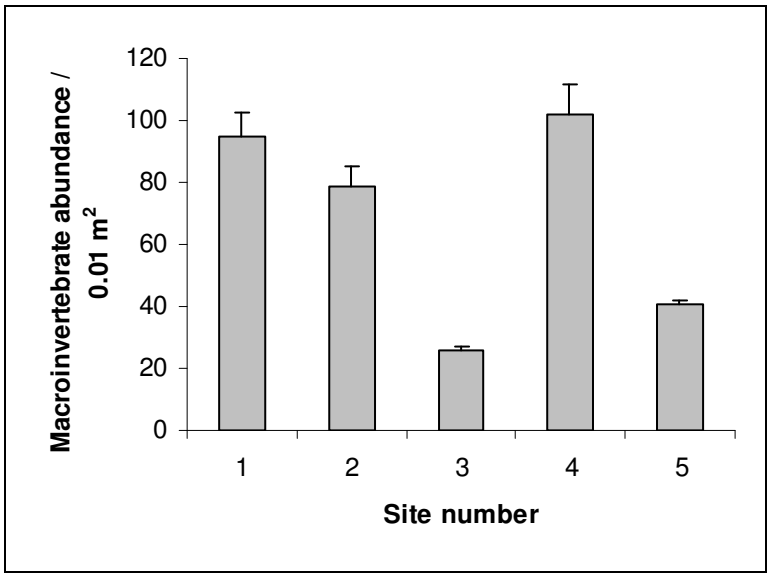

Fig.1. Mean macroinvertebrate abundance (1 SE, n = 6) at each sampling site (Site1 & 2 on the north bank and site 3, 4 & 5 on the south bank of the Sabaki River Estuary).

DISCUSSION

In this study, we found an unexpected large number of Nereid polychaetes, with some significant differences in abundance between the sites sampled. Both sites on the north bank recorded high numbers of individuals while on the south bank numbers were more variable, with only one site (site 4) with high numbers compared to the other two sites. More unusual however, was the complete dominance of the Nereid polychaetes in all samples collected. This phenomenon is completely contrary to anything documented in similar studies worldwide.

In a study that specifically investigated changes in benthic communities along sand to mud gradients for unvegetated intertidal flats in New Zealand estuaries, decreases in diversity were also recorded with increases in mud content, and interestingly a decrease in total density with increasing mud content was recorded (Thrush et al. 2003b).

Curvilinear models showed a strong positive effect of increasing sediment mud content on predictions of occurrence for *Helice crassa*, crab burrows, *Scolecolepides benhami*, *Nicon aestuariensis* and *Heteromastus filiformis*, as often intertidal muddy habitats contain low diversity but high densities.

CONCLUSIONS

Intertidal muddy habitats generally have lower species diversity but at higher densities. Models have shown a strong positive effect of increasing sediment mud content on predictions of occurrence on some benthic species such as polychaetes. Estuaries subjected to depositional events of terrestrial sediments are known to have a temporary decrease in diversity. Repeated depositional events, such as found at the Sabaki Estuary, will increase the likelihood of macro faunal disturbance. Repeated depositional events will do more damage than just a single one. Subsequent recovery will be by a few opportunistic species able to adapt quickly to the

disturbed environment. For a few species, such as the Nereid polychaete, the experience of repeated exposures may induce physiological or behavioural modifications that gradually increase the level of tolerance (to disturbances) over time. Hence, their observed high numbers at Sabaki.

With increasing defoliation and excavation of catchment hillsides, the frequency of depositional events of a given intensity is likely to quicken, indicating an enhanced likelihood of macro faunal disturbance and degradation in the estuaries tidal flats over time.

To ensure the protection of the Sabaki River Mouth we recommend catchment protection both upstream and downstream of the river mouth as the most appropriate way of ensuring the long term livelihood of the macro faunal communities and the bird populations that rely on them.

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