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Occurrence of the astigmatid mite *Tyrophagus* in estuarine benthic sediments

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The astigmatid mite species, *Tyrophagus putrescentiae*, was found to occur in meiobenthic collections from the Mdloti Estuary on the eastern seaboard of southern Africa. To examine whether these mites are actually components of estuarine systems or the result of contamination of collecting and laboratory materials, special sterilization procedures were incorporated into the collection protocol. Samples employing sterilization procedures still yielded *Tyrophagus* mites, providing evidence for their existence in the estuarine sediments. The origination of these mites in estuarine and fringe marine systems, in general, is discussed. These findings are significant in terms of the potential trophic importance of *Tyrophagus* mites.

Mites (Acari) are among the few chelicerate taxa to have colonized marine habitats. However, marine mites are generally intertidal, with one of the 431 known mite families (Halacaridae) occurring subtidally (Walter & Proctor, 1999). Of the intertidal, non-halacarid mites, representatives of two groups, the Oribatida and Astigmata, have strong marine associations. Unlike the Mesostigmata and Prostigmata, two other major groups known from marine habitats, the oribatid and astigmatid mites feed on marine algae (Luxton, 1966; Ganning, 1970; Schulte, 1976a; Pugh & King, 1985) or show tidal activity patterns (Schulte, 1976b; Procheş & Marshall, 2001). Typically, all marine oribatid mites belong to the superfamily Ameronothroidea, and all marine astigmatid mites to the family Hyadesiidae (Procheş & Marshall, 2001).

A recent survey of estuarine benthic sediments of Mdloti Estuary, Kwazulu/Natal, South Africa (June 1999–June 2000), revealed substantial abundances of the astigmatid mite *Tyrophagus* (Family Acaridae). This cosmopolitan genus is better known for infesting human storage products (corn, grain, hay and straw; Baker, 1999) than occupying estuarine or marine environments. Its occurrence in our estuarine samples was therefore initially suspected to have arisen from contamination of laboratory equipment and materials. An examination of the literature showed that the genus has indeed been previously reported in marine and estuarine collections, as follows: (1) upper rocky shore, St Croix Island, near Port Elizabeth, South Africa (Beckley, 1982); (2) mangrove pneumatophore sediments, Durban Harbour, South Africa (Ş. Procheş, personal observation); (3) saltmarsh habitat, UK (Luxton; 1967); and (4) estuarine (*Tyrophagus putrescentiae* (Schrank)) and supralittoral habitats (*T. longior* and *T. palmarum*) in the UK (Evans et al., 1961; Pugh & King, 1988). However, it is never indicated whether *Tyrophagus* actually lives in these habitats (in terms of feeding and completing its life cycle), or is merely a contaminant of the collections. The latter would seem likely, considering that specific adaptations are necessary for survival in marine environments, including osmoregulatory and aquatic gas exchange adaptations (see Ganning, 1970). In order to determine the source of *Tyrophagus* mites in our collections from Mdloti Estuary, and to eliminate the possibility of contamination, we included into our sampling protocol the sterilization of equipment and materials.

Routine sampling was undertaken in the Mdloti Estuary, situated on the Kwazulu-Natal north coast (29°38′S 31°08′E), 25 km north-east of Durban. Samples were collected at a fixed station near the mouth of the estuary at regular monthly intervals, from June 1999 to June 2000. Decontamination of all the sampling gear and storage bottles was initiated in July 2000 and then employed on all consecutive occasions until September 2000. Materials were first washed thoroughly with laboratory detergent (Amway (UK) Ltd, Milton Keynes) and subsequently sprayed with 99% analytical ethanol. This was followed by autoclaving at 121°C and 15 psi for 20 min, immediately prior to sampling. Sediment cores were collected using a Perspex corer of 20 mm internal diameter. Three replicate core samples were taken on each occasion. The top first centimetre of the sediment was cut and placed in a 50 ml glass vial and immediately fixed with 4% hexamine-buffered formalin solution and stained with rose Bengal. In the laboratory, each sample was then passed through 500 and 63 μm sieves, and the material retained on the 63 μm sieve was analysed. Meiofaunal organisms were identified and counted under a stereoscopic microscope at 40× magnification. Bottom temperature and salinity of field conditions were recorded on each occasion using a YSI 6920 Water Logger. Pearson's correlation analysis of mite density vs total meiofaunal abundance was performed using data transformed with the algorithm $\log_{10}(x+1)$ (Legendre & Legendre, 1983).

During the survey period, bottom temperature and salinity varied from 15.7 to 21.4°C and from 0.2 to 9.6 psu, respectively. *Tyrophagus putrescentiae* mites were observed in most monthly benthic samples from Mdloti Estuary and contributed on average 30.8% ±32.2 SD (range: 0–98.5%) to the total meiobenthic abundance (Figure 1). Their densities varied from 0 to 315×10^3 ind m^{-2}, while the rest of the meiobenthic assemblage ranged from 1.6×10^3 to 617×10^3 ind m^{-2}. Although there was considerable variability in the temporal abundance of mites, densities were similar to, but not significantly correlated with those of the other meiobenthic taxa (Pearson's r=0.189, N=44, $P>0.05$; Figure 1).

After sterilization of the collection vessels and materials, mites continued to occur in benthic samples. Although their abundances were considerably lower than those from the

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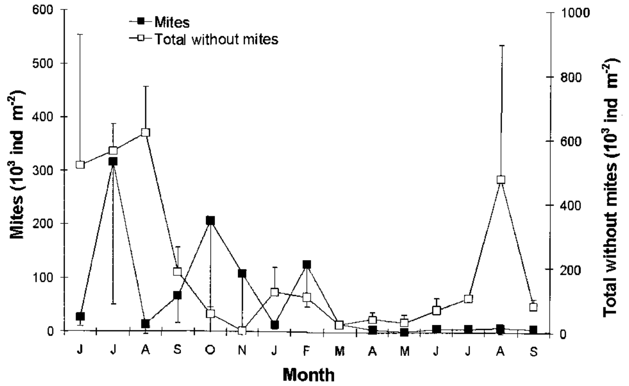

Figure 1. Temporal variations in the abundance of mites and the other meiofauna at the sampling station (June 1999 to September 2000). Mean values ±standard deviation of three replicate cores.

pre-sterilization period, on the whole these corresponded with the general pattern in abundance of the other meiofauna (5.3×10^3 to 7.4×10^3 ind m^{-2} compared to peaks of 315×10^3 ind m^{-2}) and with periods of estuarine scouring. The temporarily-open Mdloti Estuary breached naturally in November 1999 and underwent scouring of the sediment immediately thereafter. The general decrease in peak abundance of *Tyrophagus* mites (and of the total meiofauna) from November 1999 onwards probably relates to this scouring event and the consequent poor trophic conditions of the estuary (Nozais et al., 2001). Their consistent occurrence in samples during the three months over which sterilization was employed (Table 1), however, strongly suggests that they are components of marine communities and not artefactual laboratory or other contaminants.

The existence of *T. putrescentiae* in surficial benthic estuarine sediments indicates an ability to survive continuous submergence at moderate salinity. Although Mdloti may experience relatively high salinities after breaching, salinities are usually reduced due to freshwater inflow during periods of closure. Other studies report *Tyrophagus* from estuaries and fringes of marine littoral zones (Evans et al., 1961; Luxton, 1967; Beckley, 1982; Pugh & King, 1988), but none indicate the submergence of this mite in normal seawater. The general feeding habit of *Tyrophagus* will seemingly facilitate its colonization of littoral habitats. It is commonly known as fungivorous, but has also been reported to feed on nematodes (Walter et al., 1986; Baker, 1999). A high capacity of *Tyrophagus* for dispersal and colonization, is evident from the present study. Given the temporary nature of the benthic layer of Mdloti, which undergoes regular breaching and scouring episodes (Nozais et al., 2001), the benthic meiofauna must comprise itinerant, rapidly colonizing species. Only adult specimens were collected in the present study, and therefore it still needs to be established whether these mites complete their lifecycles submerged in estuaries and littoral fringe habitats, or whether the records represent recent dispersal events from adjacent terrestrial habitats. Given the potential abundances of *Tyrophagus* mites, it is possible that they play a significant role in the trophic functioning of the estuarine benthic systems in which they occur.

Table 1. *Average number (10^3 ind m^{-2}) ±SD of the all meiofaunal groups (including* Tyrophagus *mites) collected in samples after sterilization during 2000.*

	July	August	September
Nematodes	53.1 ±16.3	381.1 ±353.6	12.7 ±11.0
Mites	6.4 ±6.4	7.4 ±10.2	5.3 ±3.7
Harpacticoids	8.5 ±9.7	8.5 ±8.0	24.4 ±16.0
Crustacean nauplii	23.4 ±12.9	2.1 ±1.8	11.7 ±3.7
Chironomids	2.1 ±1.8	0	2.1 ±3.7
Turbellarians	9.6 ±9.6	13.8 ±8.0	19.1 ±14.6
Ostracods	3.1 ±5.5	7.4 ±8.0	0
Oligochaetes	5.3 ±9.2	24.4 ±8.1	3.2 ±3.2
Total	111.5 ±8.4	486.2 ±426.9	86 ±24.8

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