DIURNAL VERTICAL MIGRATIONS OF MEIOFAUNA IN AN ESTUARINE SAND FLAT

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ABSTRACT

Diurnal vertical migrations of meiofauna were observed in an estuarine sand flat and these were related primarily to desiccation and temperature. The migrations, which occurred in the top 10 cm of the sediment, had a mean range of 5 cm and were most strongly exhibited by the interstitial flatworms, polychaetes and oligochaetes, followed by the nematodes and harpacticoid copepods. It is concluded that vertical migrations are restricted to areas experiencing some degree of desiccation and would not be significant in waterlogged areas such as mud flats.

INTRODUCTION

There is a paucity of information on meiofaunal movements in sediments and the observations are scattered and sometimes contradictory. Bush (1966) observed a downward movement of meiofauna after rain but McLachlan (1975) found no such relationship. Meiofaunal vertical distributions have been related to tides (Boaden 1968), season (Renaud-Debyser 1963; Dye & Furstenberg 1978) and desiccation (McLachlan 1975). Whatever the reason, the possibility of vertical movements of meiofauna introduces a variable which must be taken into account when interpreting population distribution. Since regular sampling is usually done during low spring tide and at approximately the same time of day each time, a more or less "fixed" pattern is obtained. However, this pattern may vary greatly throughout the tidal cycle, and it is therefore important to know the degree of variation, particularly during the early stages of a study when details such as maximum sampling depth are being determined. In order to ascertain whether diurnal vertical migrations of meiofauna occur in sheltered areas such as estuarine sand flats a study was made of the vertical distribution over a 24-hour period in a sand flat near the mouth of the Swartkops Estuary near Port Elizabeth. This formed part of a larger study of the meiofauna of this estuary (Dye 1978; Dye & Furstenberg 1978; Dye *et al.* 1978).

METHODS

The site chosen was a point midway between HWST and MW on a sand flat on the south bank of the river 500 m from the mouth. The physical and chemical features of this area were described by Dye (1978). The sediment consists of fine sand with a mean particle size of 180

μm. The mean annual meiofauna population was $9,6 \times 10^5$ individuals/m^2 to a depth of 20 cm (Dye & Furstenberg 1978).

The experiment was carried out in April 1976 when conditions approximated the annual mean. Two steel stakes were hammered into the sand 20 m apart along a line parallel to the water. A string was tied between the stakes at a height of 1 m above the substrate and marked at 2 m intervals. Sampling was done every two hours using a 20 cm hand-held corer 10 cm^2 in area. Cores were taken from the left-hand end of each 2 m section so that 10 cores were obtained each time. Each core was cut into ten 2-cm sections and those from the same depth were pooled and sealed in glass jars. The meiofauna was extracted by flotation (Dye & Furstenberg 1978) and the animals were stained in Rose Bengal for counting. Subsequent cores were taken 14 cm to the right each time and by the end of the experiment 13 such cores had been taken from each 2 m section. Temperature at 1 and 10 cm depths and the depth of the water table were measured every two hours, the latter being done by measuring the depth at which water collected in holes dug in the sand. Note was also kept of sunset and sunrise times as well as the length of time for which the sampling site was covered by water during

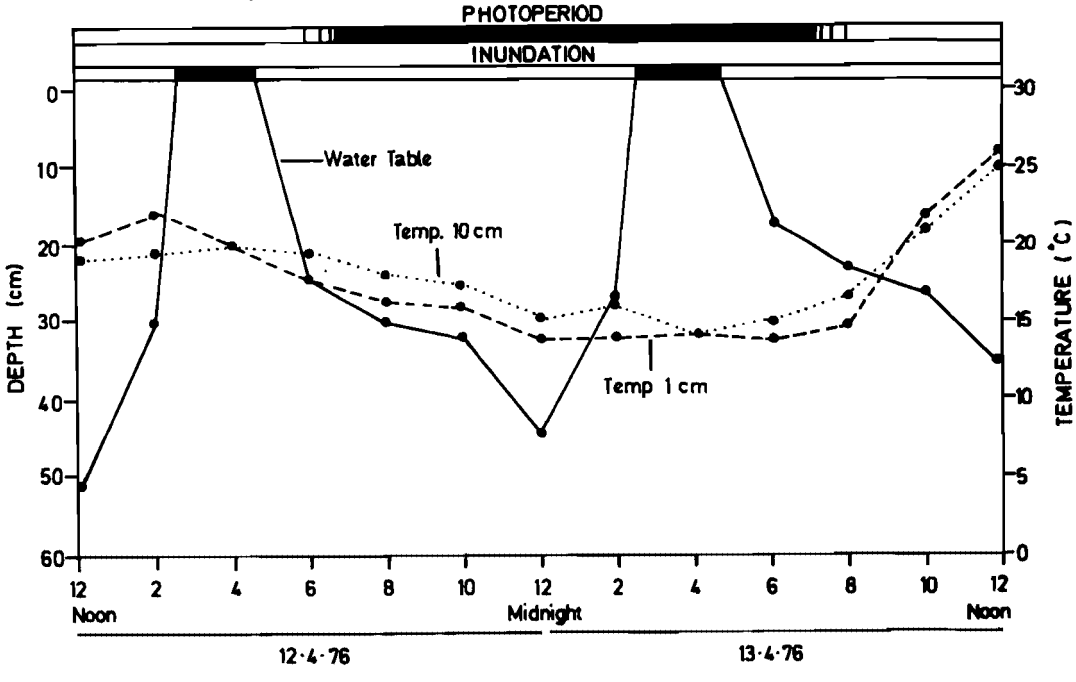

FIGURE 1

Diurnal fluctuations in temperature and water table depth in an estuarine sand flat, measured in April 1976. Included are the inundation times and photoperiod.

the tidal cycle. The weather was fine and a light breeze blew for most of the experiment which ran from 12 noon on Day 1 to 12 noon on Day 2.

RESULTS

Figure 1 shows the diurnal variation in temperature and water table depth as well as photoperiod and inundation. The maximum water table depth was 52 cm, recorded at the start of the experiment. The water table rose rapidy until 14h15 when the area became inundated to a depth of 6 cm, a condition which lasted for approximately two hours. By midnight the water table had dropped to 45 cm after which the cycle repeated itself. Temperature dropped steadily from 14h00 (Day 1) to 06h00 (Day 2) when the minimum of 13,8° C was recorded at 1 cm depth. The maximum temperature of 26,9° C was recorded at the end of the experiment. Although the water content of the sediment dropped during low tide the sand did not actually dry out.

Figure 2 shows the vertical distribution of the meiofauna during the experiment. The

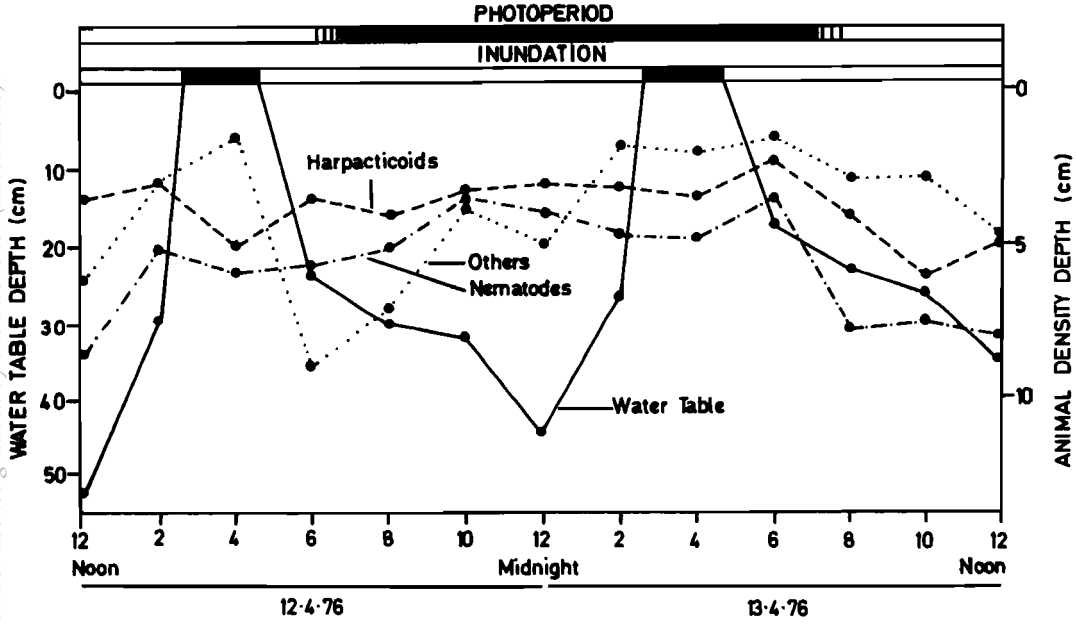

FIGURE 2.

Diurnal variations in the vertical distribution of meiofauna in an estuarine sand flat in April 1976. The lines indicate the depth above which 1 500 nematodes, 120 harpacticoids and 50 "others" occurred. Included are the water table depth, inundation times and photoperiod.

method of analysis was that of McLachlan (1975) in which the depth above which a certain arbitrary number of animals occurred is plotted against time. The meiofauna consisted of nematodes, which dominated, harpacticoid copepods and a miscellany of other taxa occurring in low numbers collectively referred to as "others". This group consisted of flatworms, polychaetes and oligochaetes and exhibited the greatest migration (1–9 cm). This was followed by the nematodes (4–7 cm) and finally the harpacticoids (3–5 cm). All taxa exhibited an upward movement with the incoming tide but they remained in the top 10 cm during the night and only moved down again after the following high tide. In all cases it was found that the lower the temperature, the closer to the surface were the organisms ($p \leqslant 0{,}025$).

DISCUSSION

The results indicate that a limited movement of meiofauna takes place in the sediment on a daily basis. The fact that the upward movement with the incoming tide was not followed by a downward movement at night suggests that the primary driving force is desiccation. During the day some drying of the substrate takes place due to the higher temperatures and the animals are forced to move downwards towards the water table. At night this effect is less pronounced and if high tide occurs just before sunset, as in the present case, the animals will tend to remain near the surface until the next day. These findings, which are in agreement with those of Boaden (1966) and McLachlan (1975) indicate that vertical migration of meiofauna will only occur in areas subjected to desiccation and where large movements of the water table take place. Thus, migrations are not completely dependent on tides in that there will always be an upward movement on an incoming tide but the subsequent downward movement depends on other factors related to desiccation, i.e. temperature and substrate particle size. The former exerts its effect by determining the rate of evaporation, while fine substrates, for example, will tend to offset this to a certain extent because of the upward movement of water by capillarity. The extreme is the mud flat where desiccation does not occur. It follows that the diurnal migrations will be largely confined to the top few centimeters of the sediment.

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