Best wishes and thanks
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The Ecology of two Sandy Beaches near Walvis Bay

by

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CONTENTS

ABSTRACT

A very exposed beach and a moderately exposed beach near Walvis Bay were quantitatively surveyed in terms of their macrofauna and meiofauna abundance and biomass. With the exception of a new species of mysid, Gastrosaccus sp. nov., all intertidal macrofauna species have wide distributions in southern Africa. Macrofauna abundance and biomass was moderate and dominated by particulate feeders. The

meiofauna was rich and was distinguished by the abundance of large forms and concentrations of mystacocarids around the mid tide level. Trophic relations on these beaches are discussed.

1. INTRODUCTION

Although most of the South African coastline is sandy, reports on the ecology of sandy beaches have only appeared comparatively recently in the literature. Brown (1971) described the beaches of the Cape Peninsula, McLachlan (1977a, b, c) described beaches in the Eastern Cape and more recently beaches have been surveyed along the coasts of Natal (Dye et al., 1981), Transkei (Wooldridge et al., 1981) and the southern Cape (McLachlan et al., 1981) as well as the south-western Cape (Bally, 1981). There are no published reports of beach ecology between Rocherpan, where Bally (1981) worked, and the equator. Stuart (1975) and Kensley & Penrith (1977) do, however, provide faunal lists for the Sandwich Harbour area.

This paper describes a survey of two open sandy beaches near Walvis Bay and thus provides the first report on sandy beach ecology for the west coast of southern Africa north of St Helena Bay. The survey aimed to quantify abundance and biomass of the macrofauna and meiofauna, to assess physical features of these beaches and to evaluate their food chains.

2. STUDY AREA AND METHODS

Two beaches were selected to represent a fully exposed and a

less exposed situation. Paaltjies beach (22°59'S, 14°24'E) is fully exposed to the approaching southwest swell while Langstrand beach (22°47'S, 14°33'E) is slightly less exposed, being partly recessed behind Pelican Point (Fig. 1). Both are, however, open ocean beaches receiving continuous wave action and appear to be typical of the coastline around Walvis Bay. Hummocks of Trianthema hereroensis were common behind the backshore at Langstrand.

Sampling was done during spring low tide at each beach. The profiles were measured and at three representative tide levels, the driftline (HW), mid-shore level (MW) and low tide swash line (LW), sand samples were collected, the water table depth estimated, salinity measured with a refractometer and core samples taken for meiofauna. Surf water temperature was also taken and samples of foam for phytoplankton.

Macrofauna was sampled quantitatively at a series of points along each transect. At each point 0.1m^2 was excavated to 30cm and the sand passed through a 1mm screen. All animals were fixed in 10% formalin. In addition, general qualitative collections were made around the driftline and in the surf water with a small zooplankton net (500μm mesh).

Meiofauna was sampled with a 30cm long corer of 10cm^2 internal cross-sectional area. At Paaltjies LW and Langstrand LW and MW quadruplicate 15cm long cores were taken to below the water table while at the other levels duplicate 30cm cores were taken. Meiofauna was narcotised

in 7% MgCl and fixed in 5% formalin rose bengal mixture and extracted by four decantations through a 63µm screen.

In the laboratory all macrofauna was identified, counted and dry mass values determined at 70°C. Specimens collected but not recorded in the quantitative surveys were arbitrarily given an abundance of 1 per linear metre of shoreline. Meiofauna was counted to taxon and counts multiplied by 1.1 to correct for 90% extraction efficiency. Using average dry mass values previously obtained for the major taxa (McLachlan, 1977c, Dye et al. 1981), dry biomass was calculated to the depths sampled.

The sand was analyzed for particle size by wet sieving through a nest of screen at 0.5ϕ intervals. The usual parameters were calculated graphically. Calcium carbonate content was estimated after digestion in hydrochloric acid.

3. RESULTS

The main features of the two beaches are summarized in Table 1 and beach profiles are given in Figs. 2 and 3. Both beaches had well developed berms and consisted of very well sorted medium quartz sands with virtually no calcium carbonate present. The dark colour of the sand is due to the presence of iron oxides. On a 20 point exposure rating scale (McLachlan, 1980) Paaltjies was rated as very exposed and Langstrand was exposed. While the former is an intermediate type, neither steep not very flat, the latter is a reflective beach with waves breaking almost directly in the

intertidal. There was no sign of freshwater seepage at either beach and all salinities measured were 35$^{o}/_{oo}$. Reduced layers were absent and both beaches were well drained and oxygenated. The less exposed beach at Langstrand had a moderately well developed driftline consisting mostly of stranded kelps (Ecklonia) while this was virtually absent at Paaltjies, because of the absence of nearby rocks.

Macrofauna distribution is illustrated in Figs. 2 and 3 and abundance and biomass summarised in Table 2. On both beaches the sand hopper Talorchestia quadrispinosa and the isopod Tylos granulatus occurred around the drift line. At Langstrand the beetles Pachyphyleria capensis and Zophosis (Onychosis) gracilipes were common at an older driftline. In the midshore the isopods Excirolana natalensis, Pontogeloides latipes and Eurydice longicornis were widely distributed while the deposit feeding polychaete Scolelepis squamata formed a clear band with very high densities in places. Five specimens of amphipods of the families Lysianassidae and Phoxocephalidae were collected but could not be identified further. They were recorded on the mid and lower shore.

The greatest difference between the two beaches was on the lower shore and in the swash zone where a new species of the mysid Gastrosaccus dominated the less exposed beach and juvenile sand mussels, Donax serra, dominated the more exposed beach. No Gastrosaccus could be found on this

latter beach but larger Donax serra were present in the subtidal. As this is the first survey in this area these are all new distribution records for the marine species. No species of Bullia were found although they do apparently occur on these beaches.

Intertidal macrofauna biomass was low and made up largely of Donax serra at Paaltjies and Scolelepis squamata and isopods at Langstrand. As Donax serra populations occur in the surf zone on both beaches it may be expected, however, that total macrofaunal biomass in the intertidal and shallow surf zone may be quite high, possibly in excess of $1000g.m^{-1}$ at Paaltjies.

Figs. 4 and 5 illustrate the distribution and abundance of the major meiofaunal taxa and Table 3 summarises the abundance and biomass figures. The individual dry mass values used were 0,7µg for nematodes, 0,5µg for harpacticoids and mystacocarids and 2,0µg for other taxa. Nematodes were abundant and commonest at upper tide levels as were harpacticoids. Mystacocarids were concentrated at MW on both beaches. Amongst other taxa large turbanellid gastrotrichs were abundant at LW, archiannelids and oligochaetes at MW and oligochaetes at HW on both beaches. Biomass was high, particularly at MW at Paaltjies where 6.84g dry mass of meiofauna was recorded in one square metre down to 90cm.

The surf off both beaches was rich in phytoplankton with foam and scum deposited on the beach. Samples of the surface water and foam collected in the surf were dominated by dinoflagellates but also contained filamentous blue green algae and diatoms of the genera Navicula, Rhizosolenia, Nitschia, Campylosira, and Melosira.

No zooplankton was collected at Paaltjies but a rich zooplankton, dominated by the mysid Gastrosaccus sp. nov., was collected at Langstrand. Birds were abundant on both beaches and included many migrants. Gerbils (Gerbillurus paeba) burrowed just above the driftline and apparently fed on insects there. Jackal tracks patrolled all sections of beach investigated. Surf zone fish appear to be abundant and galjoen (Coracinus capensis) were caught in numbers during the sampling period.

4. DISCUSSION

In terms of physical features these beaches fall well within the range recorded around the southern African coastline. Both beaches have well sorted medium sands although particle size did not exhibit clear gradients across the shore. Coarsest sand was found at LW on the more exposed beach and finest sand at MW on the same beach. As expected, the more exposed beach had a flatter profile. The virtual absence of calcium carbonate is surprising as Bally (1981) recorded values of 6-41% on western Cape beaches and even higher values have been recorded elsewhere along the southern African coastline (McLachlan et al., 1981). Although swell

is smaller than along the south Cape coast, waves break close to the beach so that much of their energy reaches the intertidal. Because of this vigorous wave action and the well drained nature of these beaches they may be expected to filter about 10^3 litres of sea water daily per metre shoreline, as found in the Eastern Cape (McLachlan, 1979).

The macrofauna is very similar to that found on western Cape beaches by Bally (1981) although this represents the first record of most species north of Luderitz or Sandwich Harbour. The only major difference is the presence of a new species of Gastrosaccus as opposed to G. psammodytes recorded by Bally. Although no Bullia species were collected, fishermen reported that they are found on beaches near Walvis Bay and Stuart (1975) and Kensley & Penrith (1977) recorded B. callosa, B. digitalis and B. laevissima on sandbanks at the mouth of Sandwich Harbour. Although the white mussel Donax serra was only recorded in the low tide swash zone, it appears to be common lower down in the surf zone on both beaches and probably attains high biomass values at Paaltjies.

Intertidal zonation of the macrofauna was basically in accordance with the tripartite scheme proposed by McLachlan et al. (1981). The supralittoral is dominated by air-breathing crustaceans, Tylos granulatus and Talorchestia quadrispinosa. The sublittoral fringe is characterized by the bentho-planktonic mysid, Gastrosaccus sp. nov. and apparently also by Donax serra. The midshore harbours the

characteristic isopods, Eurydice longicornis, Pontogeloides latipes and Excirolana natalensis. Bally (1981) distinguished four zones, based on a subdivision of the midlittoral into an upper zone of retention and a lower zone of resurgence. He found the former characterized by these three isopods, Scolelepis squamata and Donax serra on fine grained beaches whereas D. serra occurred in the lower zone and S. squamata disappeared on coarse-grained beaches. Based on Figs. 2 and 3 it is difficult, however, to subdivide the midlittoral on these beaches as the isopods occur over most of the shore and S. squamata occurs in the upper midlittoral at Langstrand and the lower midlittoral at Paaltjies. The tidal migrations that most of these species undergo also serve to blur zonation.

The meiofauna recorded is typical of such beaches in terms of general abundance and taxonomic composition. Notable is the great abundance of mystacocarids (Derocheilocaris delamarei) at MW at Paaltjies beach and the abundance of gastrotrichs at LW on both beaches. For sands of this particle size nematodes would be expected to be more abundant than harpacticoids (McLachlan et al., 1981) which is the case on both beaches. However, the proportions of both are lower than predicted by McLachlan et al. (1981) - nematodes average 22% and 27% as opposed to a predicted value of 40% and harpacticoids average 13% and 16% as opposed to a predicted value of 34%. This is due to the abundance of gastrotrichs, archiannelids and oligochaetes.

Meiofaunal distribution conforms to the patterns described for similar beaches in southern Africa (McLachlan et al., 1981). Greatest numbers occurred near MW between the sand surface and the low tide water table. Sampling did not penetrate far enough through the water table to record a significant drop in numbers. Total meiofauna biomass falls within the recorded range of ca. 10-240g.m^{-1} (McLachlan et al., 1981), Paaltjies beach being near the top of this range with a biomass of 193g.m^{-1}, without correcting for depth. West and south coast beaches generally have higher biomass values than East coast beaches.

Though it is preliminary, this sampling of two beaches does allow some comments on trophic relations on beaches in the Walvis Bay area. Based on these two beaches average macrofaunal biomass in the intertidal is about 85g.m^{-1}. This is made up of filter feeders (54%), scavenger/carnivores (25%) and deposit feeders (21%). Large populations of Donax serra in the subtidal would probably give a total biomass for beach and surf zone in excess of 1000g.m^{-1} with filter feeders making up more than 90%. Clearly, particulate organic materials, both in suspension and deposited on the sand, represent the main food input to these beaches and the rich phytoplankton foam observed on all beaches must be a major component of this.

Predators on the macrofauna would include gerbils, birds, fishes and crabs. Bird numbers on these beaches are high and were estimated to be about 50-100 km^{-1} in this study.

The majority of these were Palaerctic migrants. Hockey (1982) reports on bird numbers near Luderitz with counts of 10-57 waders (including Palearctic migrants) per kilometre shoreline and 5-24 gulls per kilometre. On East Cape beaches the four dominant bird predators on macrofauna averaged 18.km^{-1} and they were estimated to consume 283 $kg.km^{-1}.y^{-1}$ (McLachlan et al., 1980). Average numbers of waders and gulls feeding on the macrofauna of beaches near Walvis Bay may be about 30-50 km^{-1} over the year, including the times when Palaerctic migrants have left. This would give consumption around 470-780 $kg.km^{-1}y^{-1}$ or 470-780 $g.m^{-1}.y^{-1}$. As total macrofauna production on these beaches would not exceed three times biomass, bird consumption alone could account for all the available production of about 510$g.m^{-1}$. Some drift line beetles must be taken by gerbils and some lower shore molluscs and crustaceans must be taken by fishes though both of these forms of predation are probably minor. It may therefore be concluded that birds are the major predators on the intertidal macrobenthos in this area.

In the subtidal the juvenile and adult populations of Donax serra probably fall prey mainly to fishes such as sand sharks Rhinobatos, white steenbras Lithognathus and galjoen Coracinus.

Although not collected in this survey, the three-spot swimming crab Ovalipes punctatus, has been recorded at Sandwich Harbour (Stuart, 1975; Kensley & Penrith, 1977).

It probably also occurs in the surf zone near Walvis Bay where it would be an important predator on Donax serra and Bullia species.

In conclusion it may be stated that the sandy beaches in the Walvis Bay area appear to conform to the typical pattern described for the west coast of southern Africa (McLachlan et al., 1981; Bally, 1981). They are exposed to very exposed temperate beaches with moderate macrofaunas dominated by particulate feeders. Most of the macrofauna are distributed along the entire west coast of southern Africa and several extend along the south coast as well. Only Gastrosaccus sp. nov. appears to be restricted to this area. The meiofauna is rich and has a high proportion of large forms. The great abundance of mystacocarids at MW is striking. Macrofauna food chains are based mainly on particulate materials and birds are the main predators in the intertidal.

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6. REFERENCES

BROWN, A.C.

1971: The ecology of sandy beaches of the Cape Peninsula, South Africa. Part 1: Introduction. Trans. roy. Soc. S. Afr., 39: 247-279.

BALLY, R.

1981: The ecology of three sandy beaches on the west coast of South Africa.
Ph.D. thesis, University of Cape Town.

DYE, A.H., McLACHLAN, A. and WOOLDRIDGE, T.

1981: The ecology of sandy beaches in Natal, South Africa.
S. Afr. J. Zool., 16: 200-209.

HOCKEY, P.A.R.

1982: Waders (Charadrii) and other coastal birds in the Luderitz region of South West Africa.
Madoqua, 13: 27-33.

KENSLEY, B.F. and PENRITH, M.J.

1977: Biological survey of Sandvis 1, introduction and faunal list.
Madoqua, 10: 181-190.

McLACHLAN, A.

1977a: Studies on the psammolittoral meiofauna of Algoa Bay. I. Physical and chemical evaluation of the beaches.
Zool. afr., 12: 15-32.

McLACHLAN, A.

1977b: Studies on the psammolittoral meiofauna of Algoa Bay. II. The distribution, composition and biomass of the meiofauna and macrofauna.
Zool. afr., 12: 33-60.

McLACHLAN, A.

1977c: Composition, distribution, abundance and biomass of the macrofauna and meiofauna of four sandy beaches.
Zool. afr., 12: 279-306.

McLACHLAN, A.

1979: Volumes of sea water filtered by East Cape sandy beaches.
S. Afr. J. Sci., 75: 75-79.

McLACHLAN, A.

1980: The definition of sandy beaches in relation to exposure: a simple rating system.
S. Afr. J. Sci., 76: 137-138.

McLACHLAN, A., WOOLDRIDGE, T. and DYE, A.H.

1981: The ecology of sandy beaches in Southern Africa. S. Afr. J. Zool., 16: 219-231.

STUART, C.T.

1975: Marine fauna collected at Sandwich Harbour, Namib Desert Park, South west Africa. Madoqua, 4: 101-102.

WOOLDRIDGE, T., DYE, A.H. and McLACHLAN, A.

1981: The ecology of sandy beaches in Transkei. S. Afr. J. Zool., 16, 210-218.

Legends to Figures

FIGURE 1: Southern Africa showing the two beaches studied and beaches sampled by other workers.

FIGURE 2: Paaltjies beach profile showing sampling positions and distribution of the fauna.

FIGURE 3: Langstrand beach profile showing sampling positions and distribution of the fauna.

FIGURE 4: Distribution of major meiofaunal taxa in Paaltjies beach.

FIGURE 5: Distribution of major meiofaunal taxa in Langstrand beach.

Table 1: Summary of main features of two beaches near Walvis Bay.

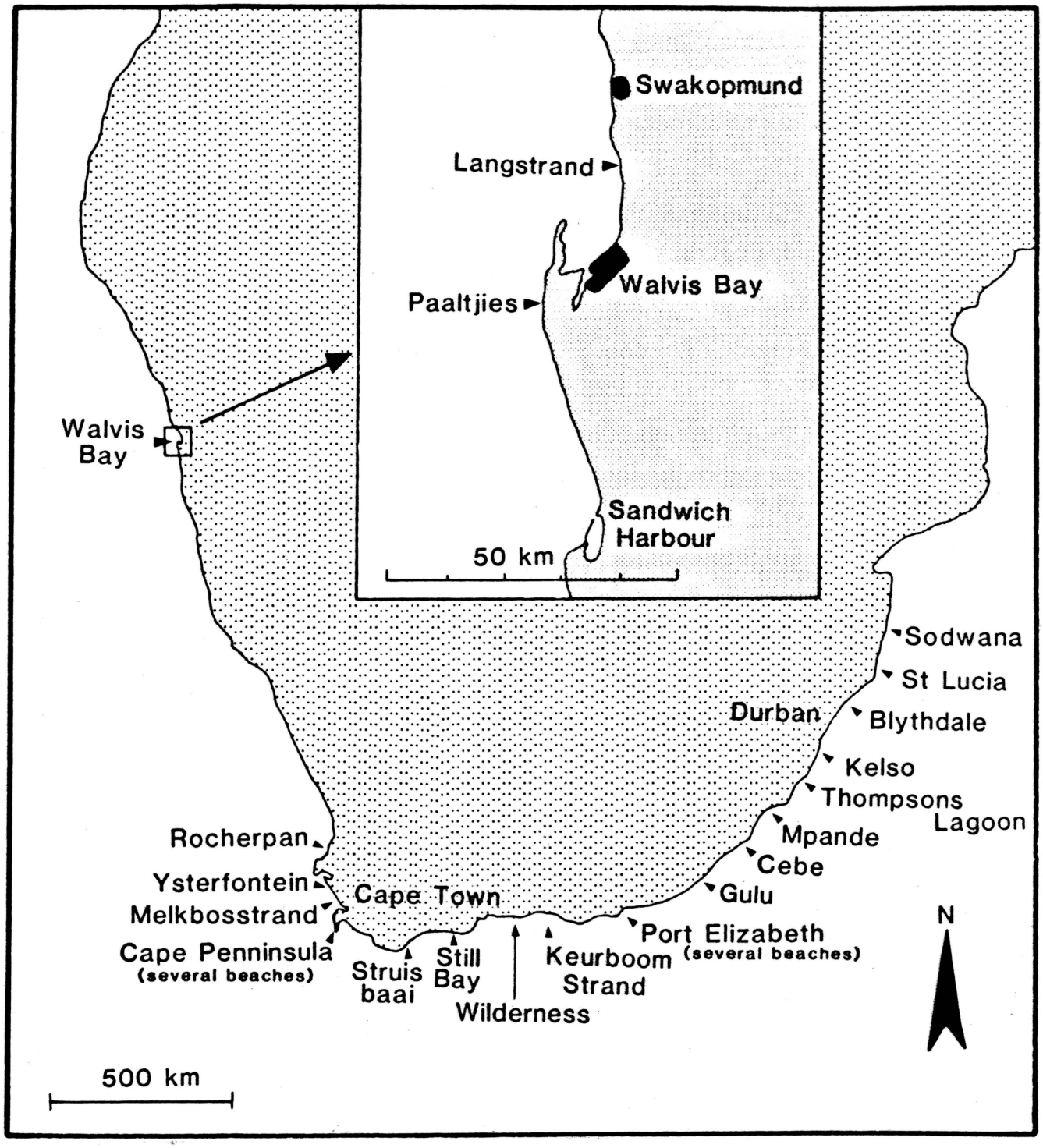
	LANGSTRAND			PAALTJIES		
	HW	MW	LW	HW	MW	LW
Sand mdμm	277	295	247	264	245	372
Sand Mzμm	281	291	254	274	255	398
Description	Well sorted medium sand			Well sorted medium sand		
Mean slope	$^1/_{13}$			$^1/_{24}$		
Exposure rating	13 - exposed			15,5 very exposed		
Water temp.	16.4°C			14.3°C		
Interstitial salinity	$35^o/_{oo}$ at all levels			$35^o/_{oo}$ at all levels		
Water table depth (cm)	85	40	0	109	83	0
Driftline	Present			Almost absent		
$CaCo_3$	0%	0%	0.4%	0.3%	0.7%	0.3%
Reduced layer	absent			absent		

Table 2: Abundance and dry biomass of the macrofauna on two beaches near Walvis Bay.

Beach	Species	Numbers.m^{-1}	Dry mass $g.m^{-1}$
Paaltjies	Donax serra	1250	91.3
"	Excirolana natalensis	830	12.5
"	Pontogeloides latipes	200	2.7
"	Scolelepis squamata	2120	14.8
"	Talorchestia quadrispinosa	350	1.1
"	Tylos granulatus	1	0.4
"	Amphipods	50	0.2
		TOTAL	123.00
Langstrand	Gastrosaccus sp. nov.	840	1.3
"	Eurydice longicornis	310	0.5
"	Scolelepis squamata	2800	19.6
"	Excirolana natalensis	1425	21.4
"	Pontogeloides latipes	150	2.1
"	Amphipods	190	0.6
"	Pachyphyleria capensis	60	0.7
"	Zophosis gracilipes	70	0.4
"	Tylos granulatus	1	0.4
"	Talorchestia quadrispinosa	1	0.0
		TOTAL	47.0

Table 3. Meiofaunal abundance and biomass on two beaches near Walvis Bay. Biomass in dry $g.m^{-1}$, abundance in $numbers.10cm^{-2}$ or $numbers.m^{-1}$. Abundance and biomass only calculated to the depth of sampling from the low tide swash line to the driftline at Paaltjies and to site 7 at Langstrand.

	PAALTJIES				LANGSTRAND			
	HW	MW	LW	whole intertidal	HW	MW	LW	whole intertidal
Total abundance	$3708.10cm^{-2}$	$12188.10cm^{-2}$	$243.10cm^{-2}$	$2.9x10^{8}.m^{-1}$	$5069.10cm^{-2}$	$3347.10cm^{-2}$	$316.10cm^{-2}$	$8.5x10^{7}.m^{-1}$
Total biomass	$3.11g.m^{-2}$	$6.84g.m^{-2}$	$0.45g.m^{-2}$	$193g.m^{-1}$	$4.87g.m^{-2}$	$2.46g.m^{-2}$	$0.50g.m^{-2}$	$77g.m^{-2}$
	Relative abundance (%)							
	HW	MW	LW	Mean	HW	MW	LW	Mean
nematodes	56	2	8	22	25	21	34	27
harpacticoids	28	10	2	13	35	14	0	16
mystacocarids	1	84	0	28	12	52	0	21
gastrotrichs	<1	<1	88	29	<1	<1	63	21
oligochaetes	12	<1	0	4	24	3	0	9
archiannelids	1	3	<1	1	1	6	<1	2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Mpande
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Keurboom
Strand
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Rocherpan
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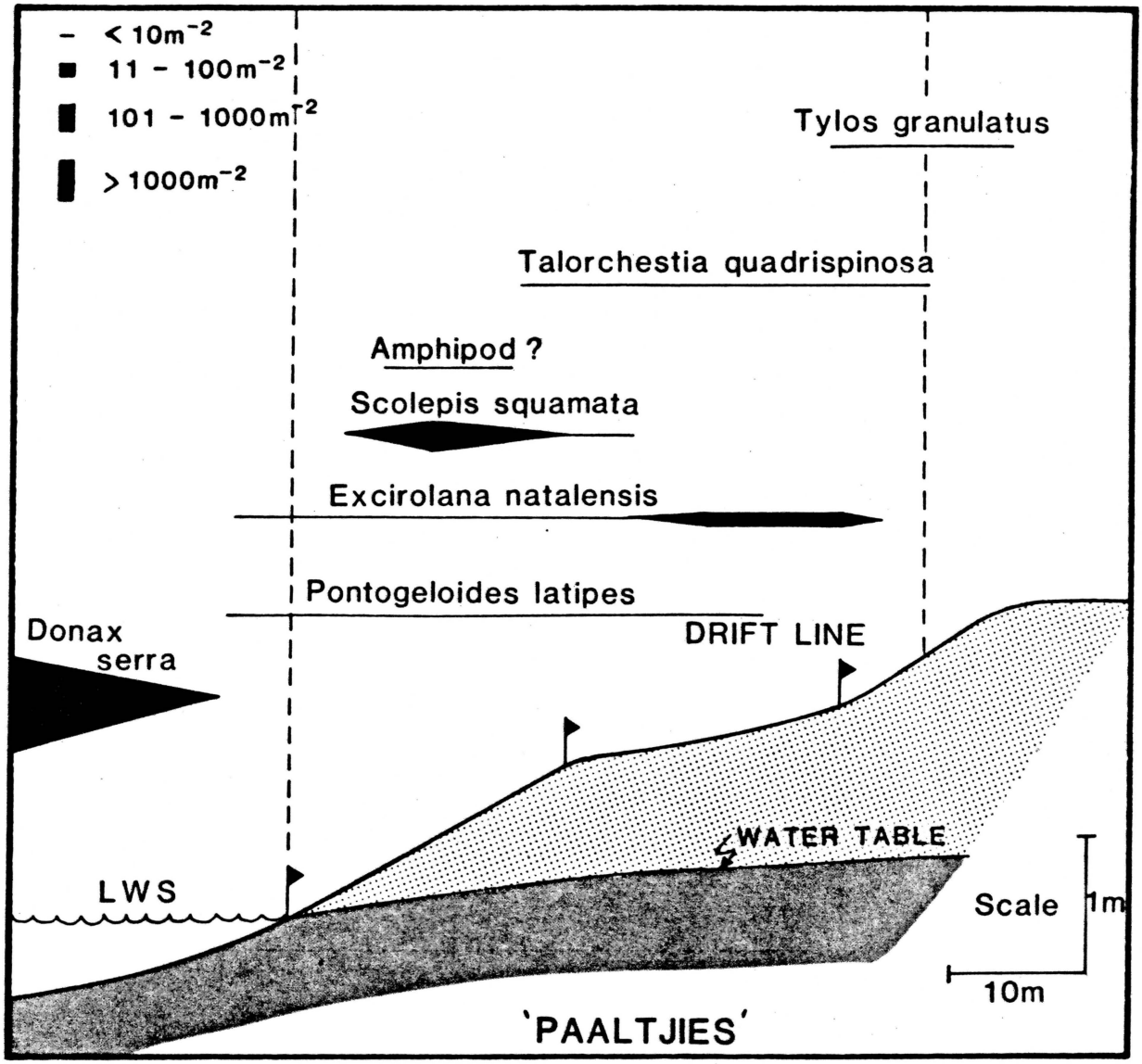
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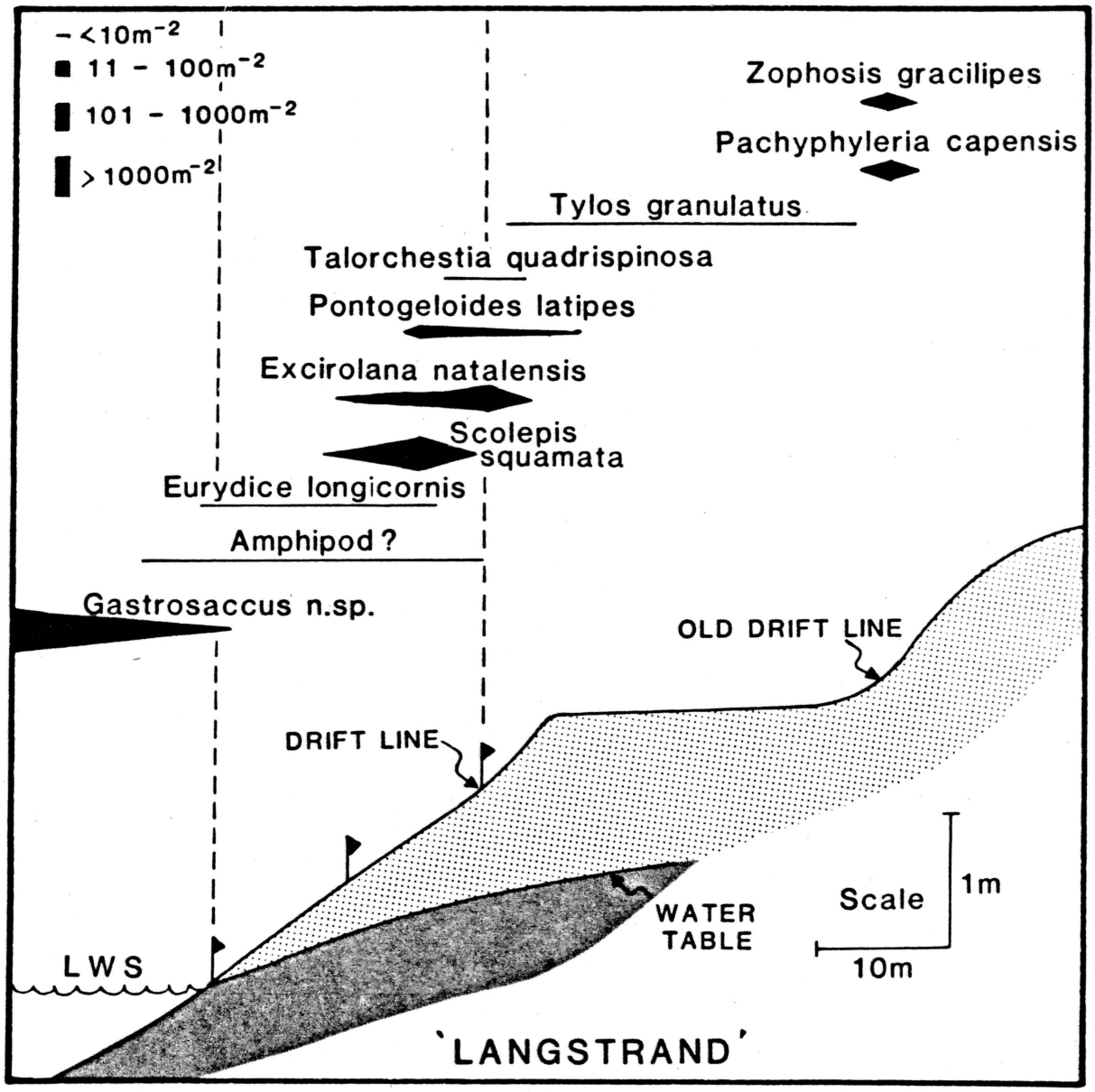
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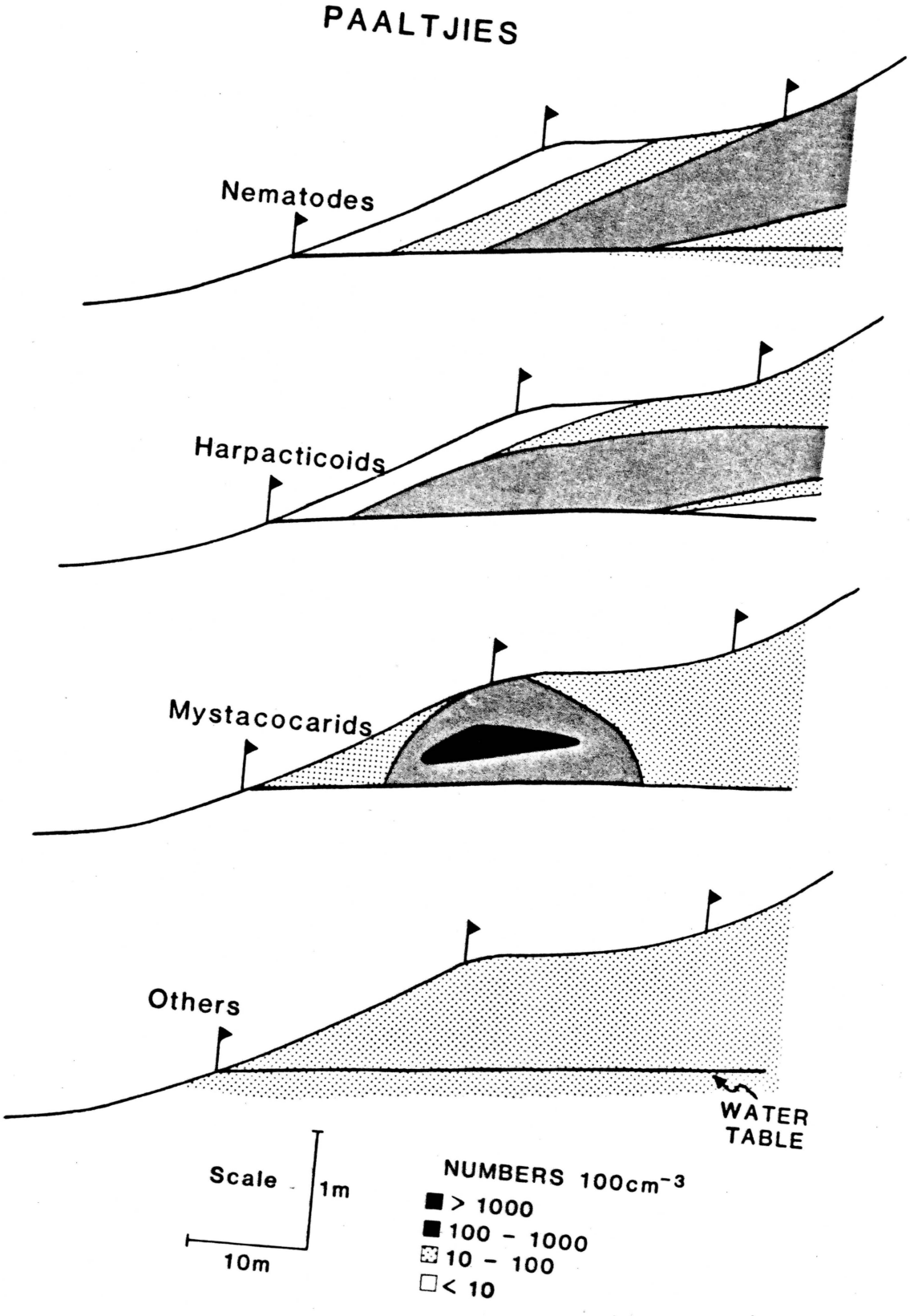
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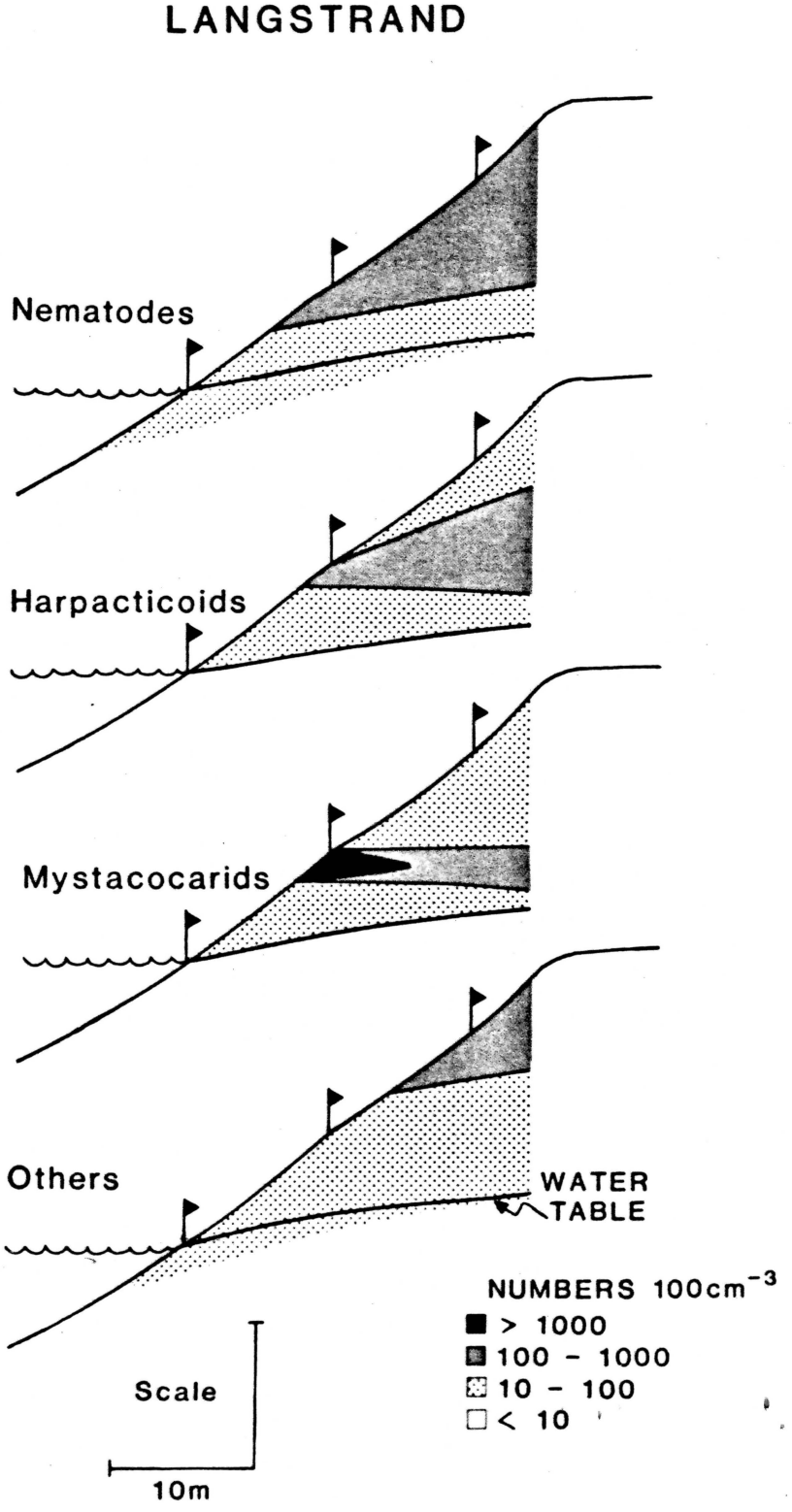
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