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Activity of Amphipods in Beach Sediments and Nearshore Environments; Playa Ladeira, N.W. Spain[1]

Federico Vilas

Colegio Universitario de Vigo
Universidad de Santiago de Compostela
División de Ciencias (Geología)
Apartado 874, Vigo Spain

ABSTRACT

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This paper deals with the interactions between organisms and sediments in a high-energy open beach of N.W. Spain. The activity of the amphipod *Talitrus saltator* (Montgomery) deeply modifies several sedimentological features of the beach. As the studied coast has a mesotidal regime, and the animal lives preferentially in the intertidal area, the modifications of its behavior, especially burrowing habits, were investigated.

ADDITIONAL INDEX WORDS: **Amphipods, beach environments, sediments**

INTRODUCTION

The work of a number of investigators in recent years has been directed toward gaining a knowledge of biogenic sedimentary structures found in the modern marine environment. This knowledge is often applicable to the recognition and interpretation of similar facies in ancient sediments. The purpose of this paper is to describe such an investigation conducted on a modern amphipod, *Talitrus saltator* (Montgomery), and to list some observations on the, distribution, and morphology of their burrows as related to zonations of the beach environment.

Field work was done during several field campaigns from summer 1982 to winter 1983. Work included the complete profiling of the beach, monitoring parameters of grainsize and sedimentary structures, and distribution of the different subenvironments. Several species of amphipods were found along the nearshore up to the border of the backshore. These species had well-defined preferential living areas. *Talitrus saltator* was the most abundant and its behavior caused the largest modifications on sediments, so this research focused on its interaction with sediments in the foreshore and backshore environments.

REGIONAL AND LOCAL SETTING

The research was conducted at Ladeira Beach, in the southern part of the Bayona Bay, Vigo Ria, N.W. Spain (Figure 1). Ladeira Beach is a coastal spit enclosing a protected lagoon called "La Ramallosa" and facing Bayona Bay. Intertidal flats are well developed in "La Ramallosa" lagoon. A longitudinal profile of the beach shows a relatively steep foreshore, 20 m, wide, and a narrow back shore, 3 to 6 m wide and dipping very gently landwards. The berm is 3 to 4 m above the low-tide watermark. Prevailing storm winds are W.S.W. and the spit trends NE-SW, almost perpendicular to them. Important deflation takes place in the backshore area with sand accumulating in dune complexes. Wave action accumulates brown and green algae in several areas of the foreshore. These algae serve as an important food source for several organisms living in the bay. The swash area, the dynamic area dominated by wave runup, and backwash, coincides with the foreshore during normal wave and tide conditions. The backshore area only

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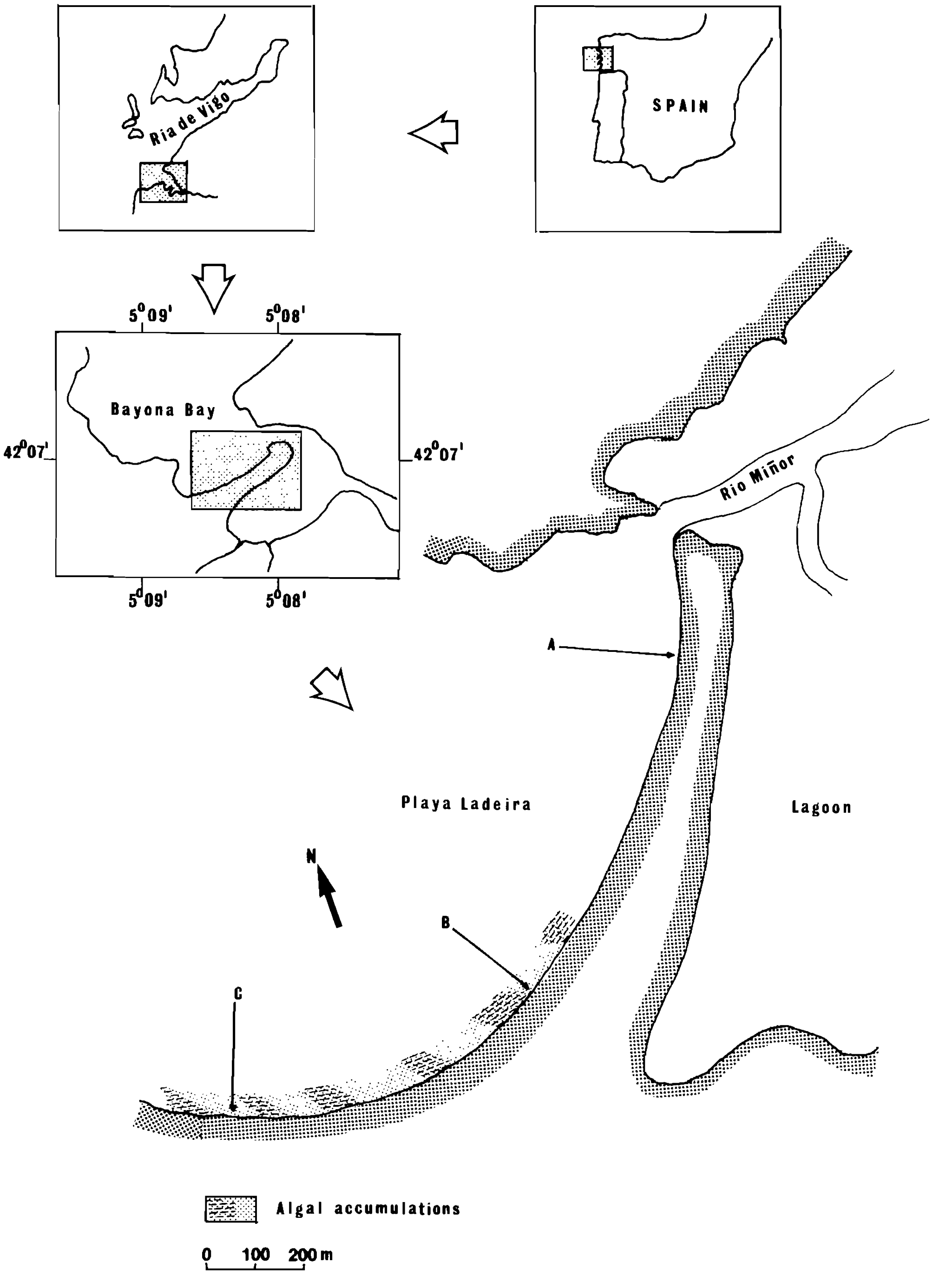


Figure 1. Location of the study area and limit of algal accumulations.

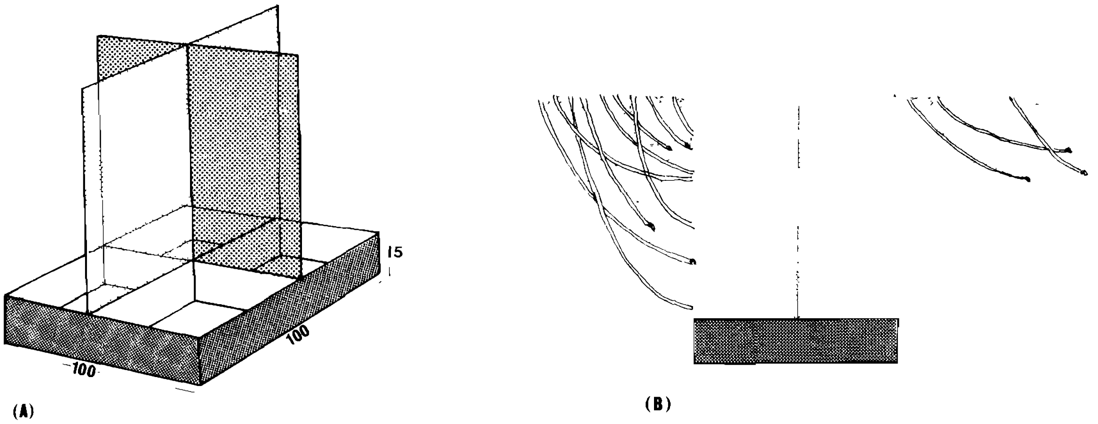


Figure 2. (A) Sampling Method. (B) A section of its operation procedure. Movement of the amphipods through the sand and deposition in different trays..

receives sediments during storms when waves pass over the berm, but suffer deflation during fair-weather periods, the sand moving landwards. Winter gales can also cause important erosion in the foreshore and backshore areas.

THE ANIMAL: *Talitrus saltator*

The amphipod *Talitrus saltator* (Montgomery) is a small crustacean (2-8 mm long) living on littoral or estuarine sandy beaches, especially where alga accumulations occur. It is an active burrower and its colour closely resembles that of the beach sand. It has been observed feeding for several hours after sunset, jumping on the beach surface or burrowing the beach surface covered by algae in search of food either in the foreshore or in the backshore.

SAMPLING METHOD

A method was devised to monitor the animal movements and the distribution and morphology of their burrows (Figure 2) along a complete ebb-flood tidal cicle. A trap made of two 0.2 cm mesh frames, 40 cm wide and 100 cm long, depending on the desired depth of the sample, was used. With the frames in position (Figure 2A), the base is divided into four parts with a tray (50 x 50 x 1S cm each) at the bottom. Some water was poured in the trays whose edges should be of a colour resembling the sand to make trapping easier. The traps were laid down along transects A, B and C (Figure 1) at several positions of the beach profile. The experiment was repeated in different times of the year and in different periods of the tidal cycle.

DISTRIBUTION OF THE AMPHIPODS

To observe and evaluate the behavior of the amphipods in the different subenvironments of the beach profiles, a combination of night and day and high and low tide should be considered.

(A) Diurnal high tide conditions. Adult and young animals do not behave identically. The former (Figure 3A) move landwards with the rising tide, influenced by both the ascent of the watertable and the increased infiltration caused by their galleries. The general tendency of the displacement is from lower foreshore to middle foreshore. The younger animals (Figure 3B) escape from the erosion zone situated just seaward, emigrating toward the accumulation zone just above, where they produce new burrows reaching as far as the upper foreshore.

The border of the upper foreshore (Figure 3C), that limits with the backshore (trays three and four), shows a tendency towards major concentrations, which is a consequence of the communities of amphipods. The animals move towards levels about the limit of the swash. Trays one and two, in the lower backshore, show a relative increase if compared with trays three and four, which may be explained as a consequence of internal movements

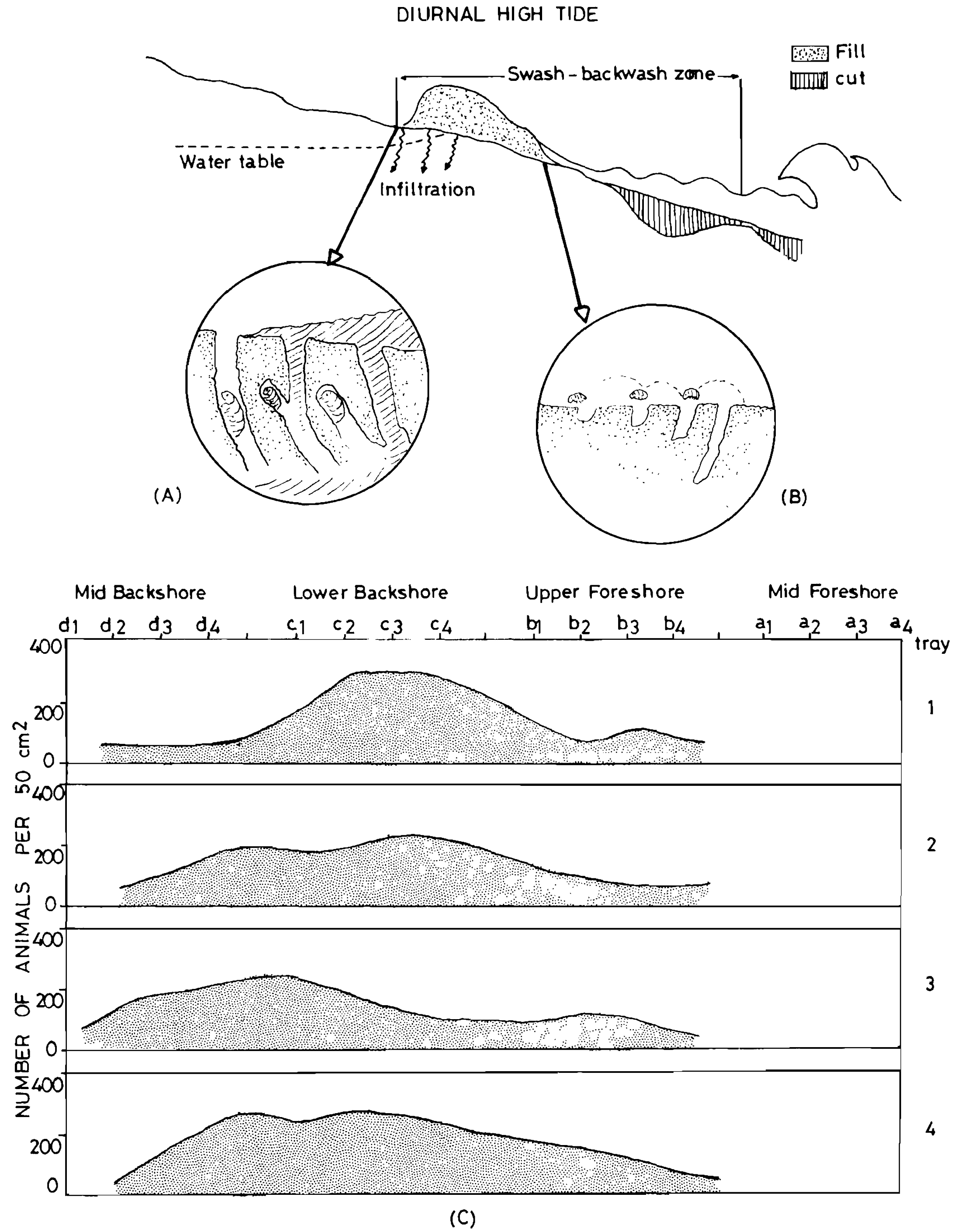


Figure 3. Diurnal high tide situation. (A, B) Interrelationship between water table and tidal stage in the foreshore with expression of the movement of amphipods. (C) Abundance and distribution of *Talitrus saltator* as a result of average number trapped in each sampling station.

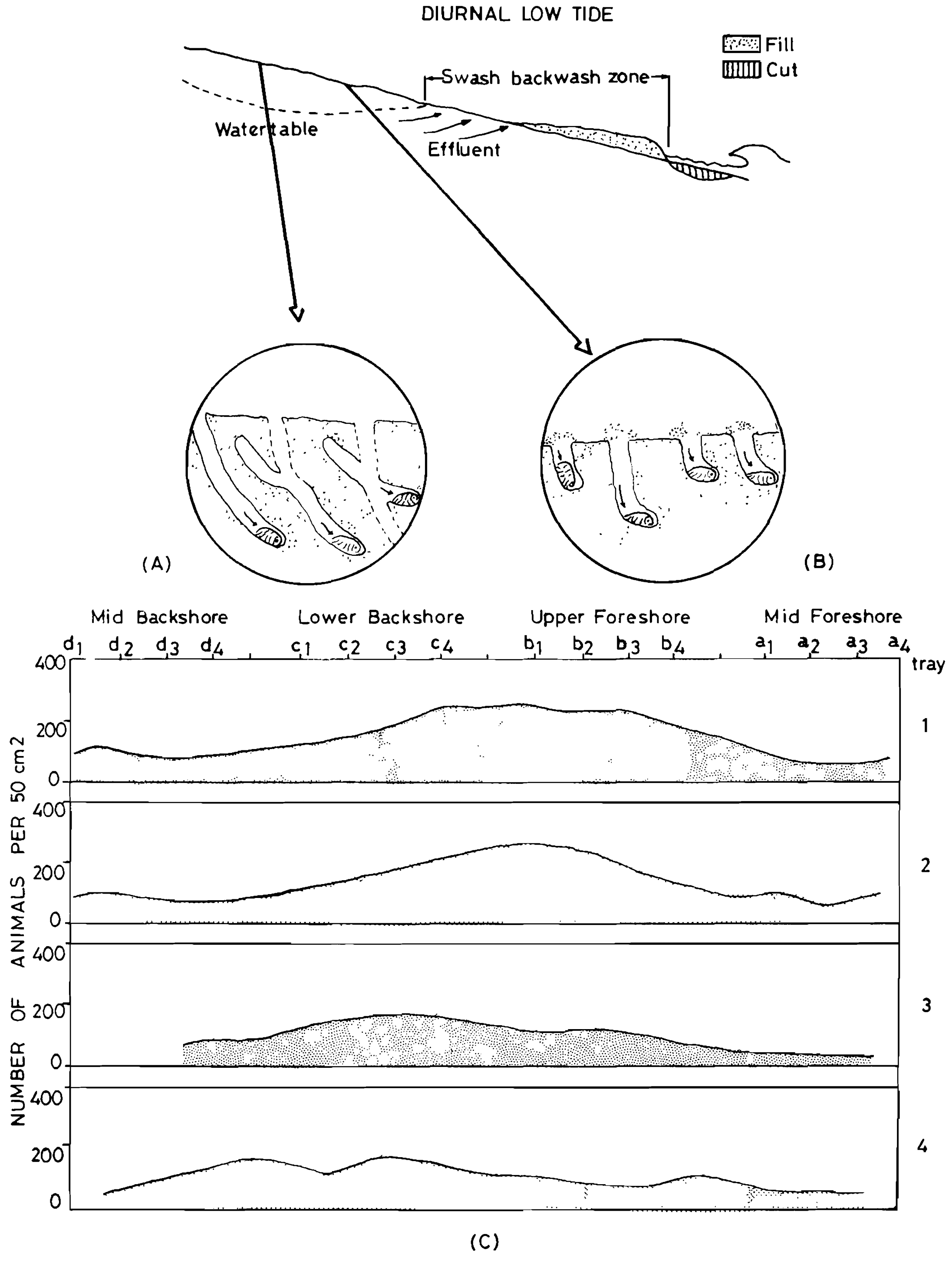

DIURNAL LOW TIDE
Fill
Cut
Swash backwash zone
Water table
Effluent
(A)
(B)
Mid Backshore
Lower Backshore
Upper Foreshore
Mid Foreshore
d1 d2 d3 d4
c1 c2 c3 c4
b1 b2 b3 b4
a1 a2 a3 a4
tray
1
2
3
4
NUMBER OF ANIMALS PER 50 cm2
400
200
0
(C)

Figure 4. (Preceeding page). Diurnal low tide situation. (A, B) Interrelationship between water and tidal stage in the foreshore with expression of the movement of amphipods. (C) Abundance and distribution of *Talitrus saltator* as a result of average number trapped in each sampling station.

of amphipods as the level of the water table rises. This does not influence the mid backshore, because of its topographic level, so the four trays show a low concentration of amphipods and homogeneous distribution.

(B). Diurnal low tide condition. The adult animals (Figure 4A) tend to move seaward by digging vertically, occupying different depths in the mid-lower backshore and upper foreshore. The younger animals (Figure 4B) which remain still during the day in the superficial layers, move towards more humid zones following the gradual drying of the sand. The greatest number of specimens (Figure 4C) are found in trays number one and two which are oriented seaward, in the upper foreshore, and trays three, and four, in the lower backshore. This can be explained by a oblique movement usually greater than 48° off sand surface in search for levels of higher humidity, following the descent of the water table due to the retreat of the tide. During the rest of the time the animals remain still.

(C) Nocturnal high tide condition. The tendency of the adult amphipod the younger ones (Figure 5B) move mostly superficially, getting as far as the upper foreshore. As it shows in (Figure 5C), there is a regrouping at the border of the swash on the upper foreshore (trays three and four) and in general in the other subzones. High numbers are found at the levels of algal accumulations.

(D) Nocturnal low tide condition. Adult amphipods (Figure 6A) produce an internal displacement toward the water table on the mid foreshore, which is the place where they emerge. At the same time, young and adult animals can jump (Figure 6B) up to the limit line of the swash. There is a wide distribution (Figure 6C) of amphipods concentrations. There is a small increase on the upper foreshore and on the lower backshore.

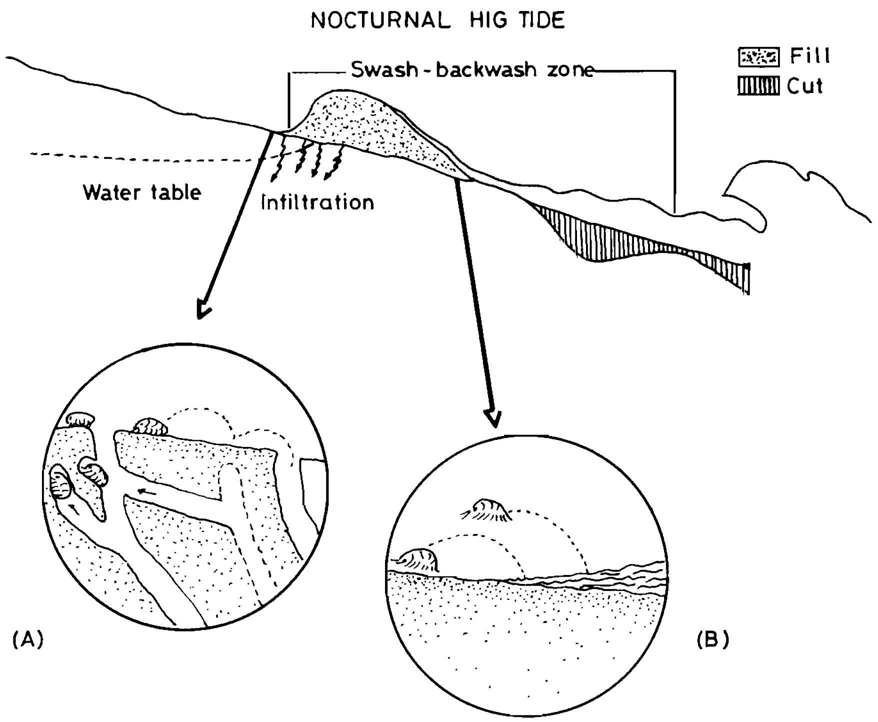
BURROW MORPHOLOGY AND DENSITY

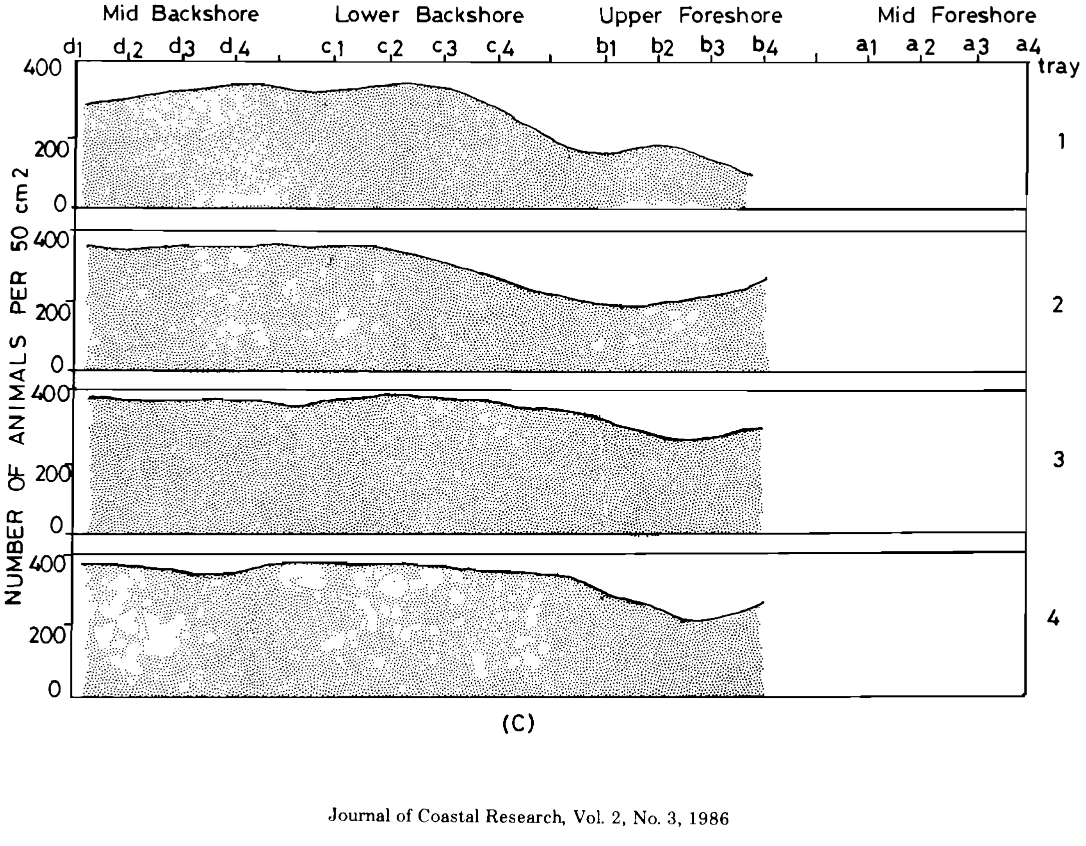
Burrow morphology and density were determined using the method of HILL and HUNTER (1973) for the Texas coast. Their results are similar to those of other studies along the Atlantic coast WILLIAMS (1965), FREY and HOWARD (1969), FREY and MAYOU (1970, 1971), HOWARD and ELDERS (1970), and ALLEN and CURRAN (1972) A modification of the burrow-casting technique described by MAYOU, HOWARD, and SMITH (1969), was used to measure the burrow openings. The counting was made in each sector by considering 1-m^2 areas perpendicular to the shoreline, and measuring the burrow diamenters at the same time.

Variations exist in the densities of these organisms on the beach and in the diameters of their burrows in the different areas and in each of their corresponding subzones (Figure 7). The greater concentrations of burrows (over 200 per m^2) were found in area B in the lower backshore, decreasing in number toward the upper foreshore and gradually diminishing toward the mid foreshore. The same happens in zone "C," although with smaller concentrations. Nevertheless, in area A the number of burrows is far smaller (about 100 per m^2) in the upper foreshore, considerably diminishing in the other subzones. Average burrow diameter increase from the mid foreshore to the upper foreshore in the three considering areas "A," "B," "C." Burrows with larger diameter are found in the highest part of the beach, especially in the mid and lower backshore, caused by adult animals, and they decrease in length and diameter in the vicinity of the swash area. In the foreshore, *Talitrus saltator* burrows (Figure 8) are short, vertical, or J-shaped, averaging 3 to 6 mm in diameter and 5 to 15 cm in length. In the upper foreshore to the backshore, the length of the burrows increase; Y-shaped or J-shaped oriented generally perpendicular to the shoreline, averaging 8 to 10 mm in diameter and 20 to 70 cm in length, extending to a depth of nearly one meter in some cases.

DUNCAN (1964) investigated the combined influence of semidiurnal tidal and ground water fluctuations on deposition and erosion in the swash zone. He found that the accumulation zone varied with the position of water table and sea level. The material forming Ladeira beach (Figure 9), has a composition of coarse-medium grained sands, with a gradual increase in the grain size across the foreshore, and with differences between the mid foreshore and the backshore in sectors "B" and "C." In sector "A" coarse-grained sand prevailed across the backshore and upper foreshore, decreasing to

Figure 5. (Following page) Nocturnal high tide situation. (A, B) Interrelationship between water and tidal stage in the foreshore with expression of the movement of amphipods. (C) Abundance and distribution of *Talitrus saltator* as a result of average number trapped in each sampling station.


NOCTURNAL HIG TIDE
Swash - backwash zone
▨ Fill
▥ Cut
Water table
Infiltration
(A)
(B)


Mid Backshore
Lower Backshore
Upper Foreshore
Mid Foreshore
d1 d2 d3 d4 c1 c2 c3 c4 b1 b2 b3 b4 a1 a2 a3 a4
tray
1
2
3
4
400
200
0
NUMBER OF ANIMALS PER 50 cm2

(C)

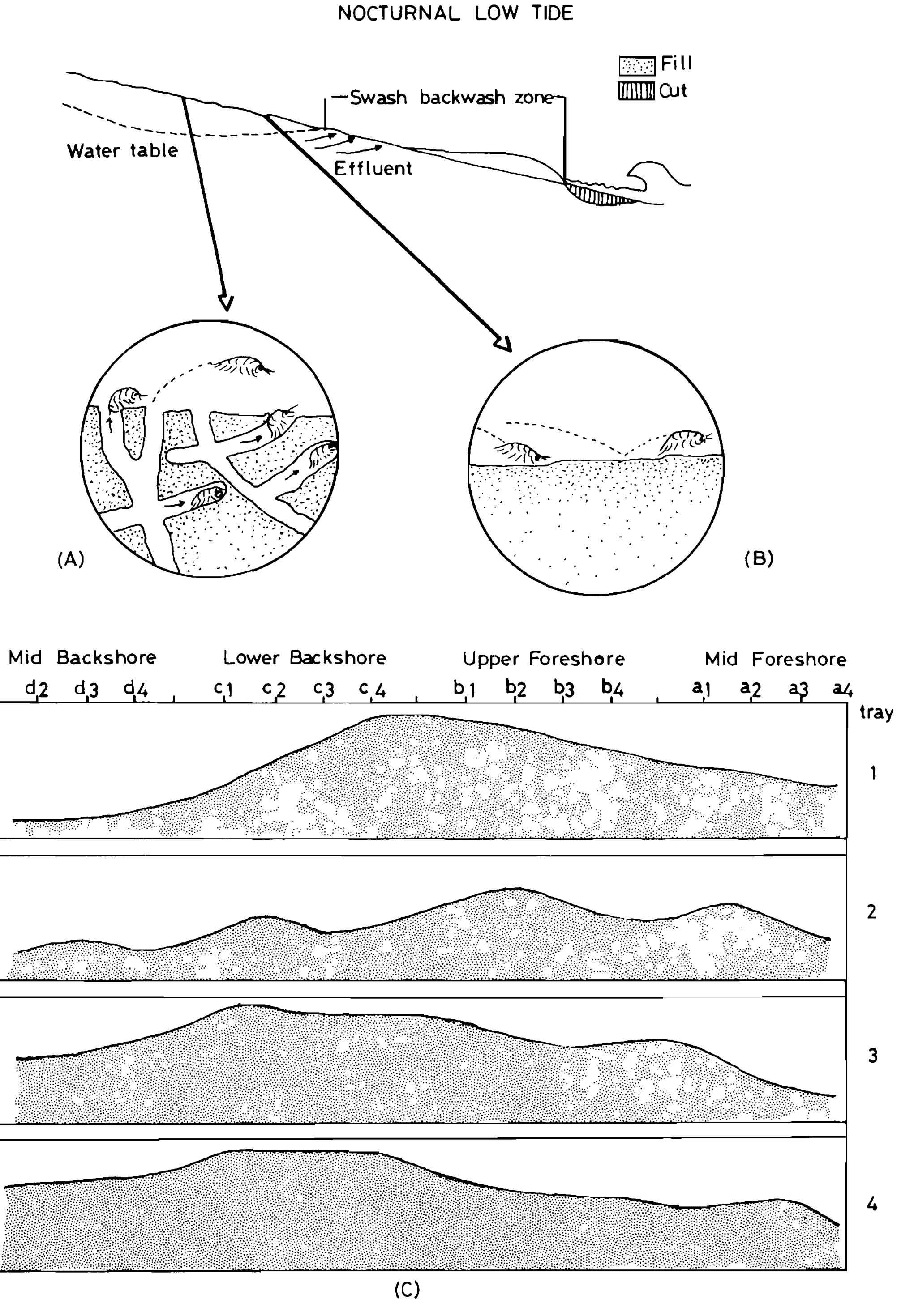

NOCTURNAL LOW TIDE
Fill
Cut
Swash backwash zone
Water table
Effluent
(A)
(B)
Mid Backshore
Lower Backshore
Upper Foreshore
Mid Foreshore
d1 d2 d3 d4
c1 c2 c3 c4
b1 b2 b3 b4
a1 a2 a3 a4
tray
1
2
3
4
NUMBER OF ANIMALS PER 50 cm2
400
200
0
(C)

Figure 6. (Facing page) Nocturnal low tide situation. (A, B) Interrelationship between water table and tidal stage in the foreshore with expression of the movement of amphipods. (C) Abundance and distribution of *Talitrus saltator* as a result of average number trapped in each sampling station.

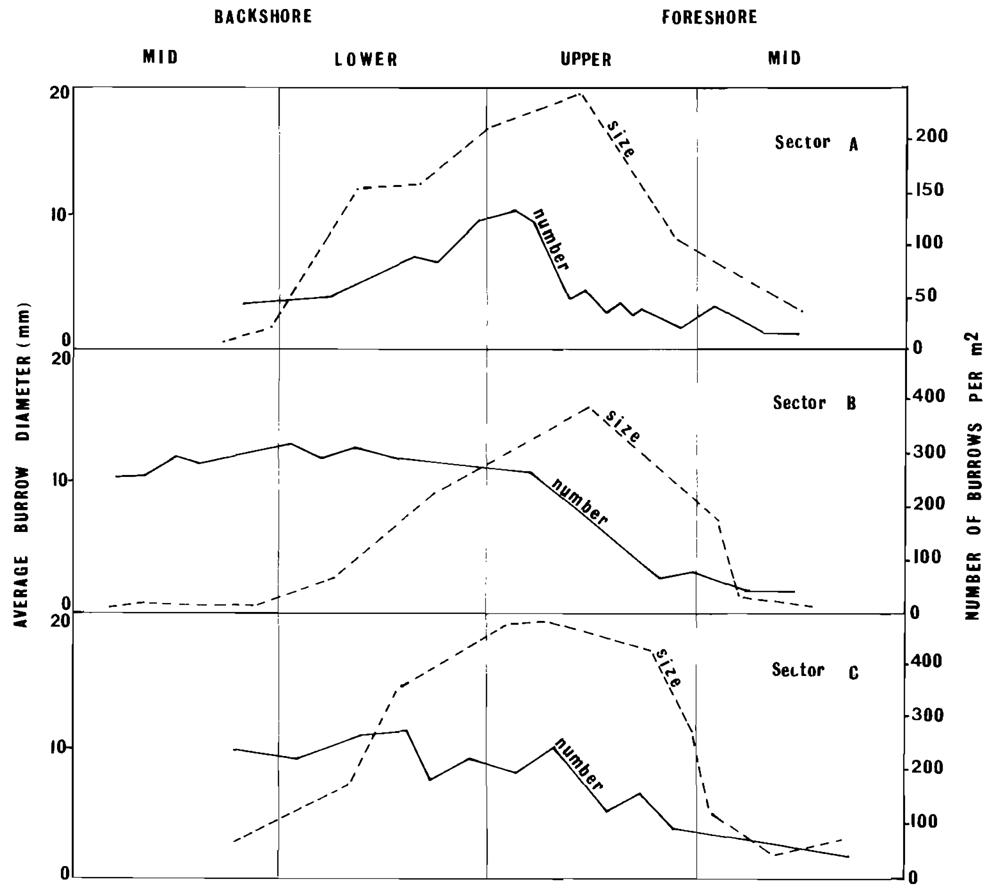


Figure 7. Burrow density and diameter in three beach sections in different subenvironments.

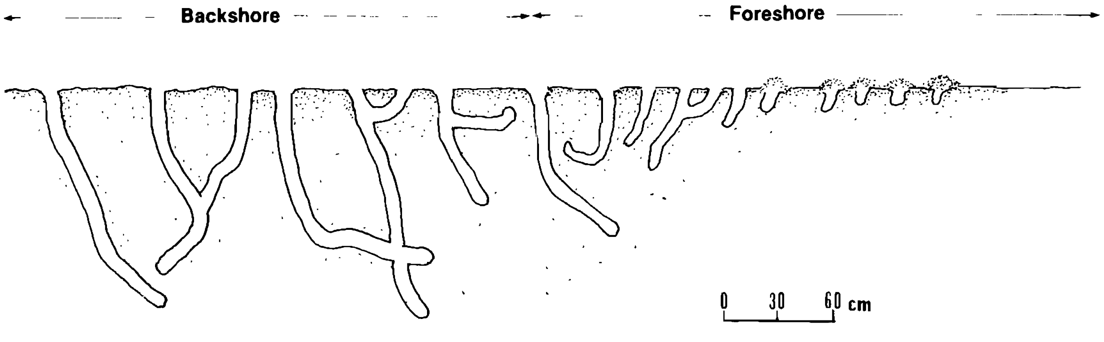


Figure 8. Representative *Talitrus saltator* burrows in a beach cross section.

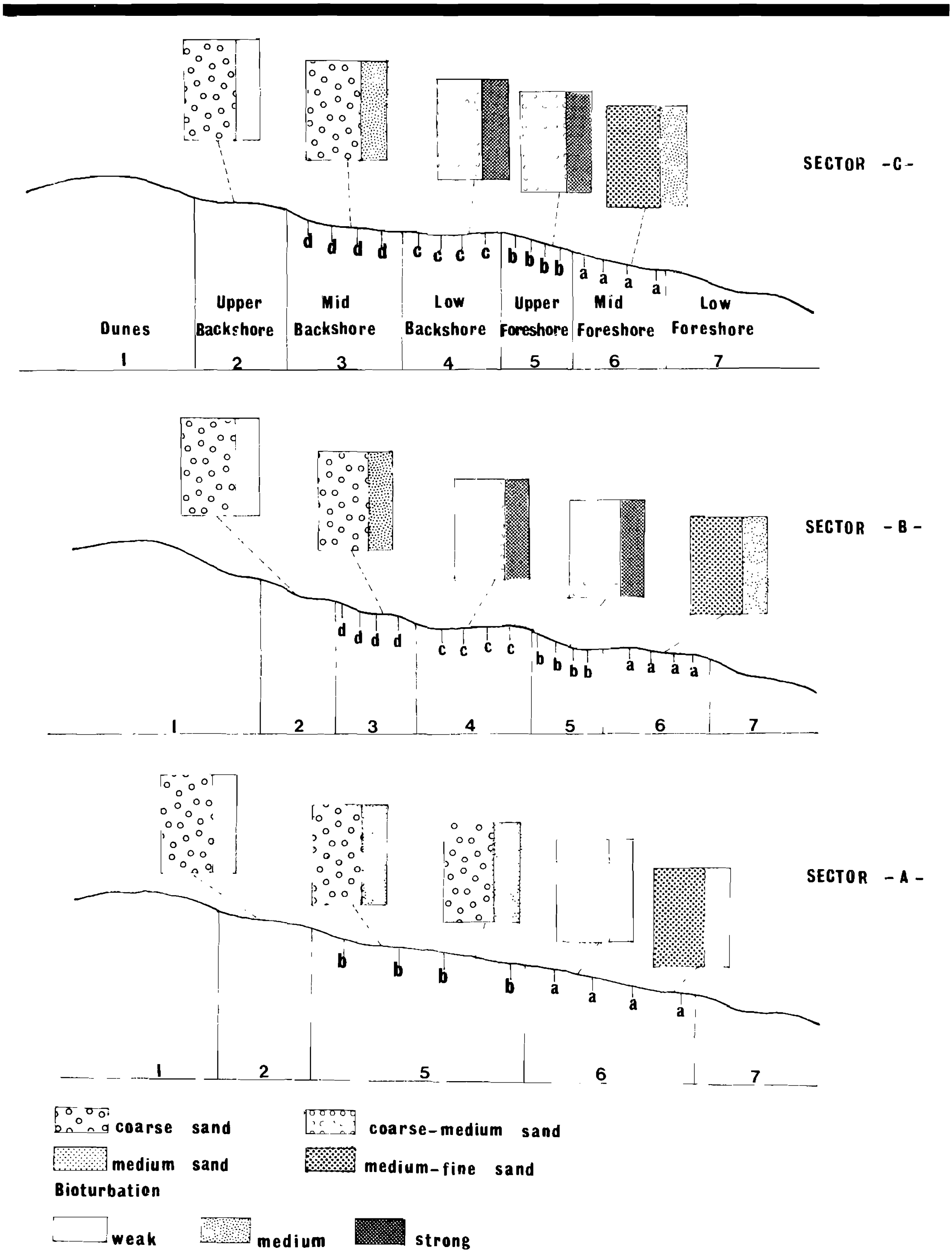


Figure 9. Diagram showing major geomorphic features and sampling stations.

medium-fine sands in its lower limit. In profiles "B" and "C" there are frequent small elevations as a result of the accumulation of materials in the upper foreshore. We could suspect that there is an apparent relationship between the facies in the profiles made in sectors "B" and "C" and those incipient berms where the density of burrows is higher. Burrowing action of *Talitrus saltator* increases percolation during the swash processes, depositing sediment brought in by the low tide. In successive periods they are transported upwards while their respective backwash decreases progressively until they reach the levels of maximum accumulation of amphipod burrows situated above the elutriation zone. The amphipod density is much lower in sector "A." However, the granulometry is coarser, which causes a more homogeneous water infiltration and not in such a selective way as in the aforementioned sectors "B" and "C."

CONCLUSIONS

The main concentrations of the amphipod *Talitrus saltator* are in sectors where there are major algal accumulations. Their movement is determined by the diurnal or nocturnal situation of the tide, which causes the amphipod communities to move landward or seaward, twice within each tidal cycle. Variations in diameter, length, density and orientation of their burrows can be used to differentiate subenvironments of a beach because these burrows increase in diameter and length from the lower foreshore up to lower backshore.

Finally, it could be suggested that there is an apparent relationship between beach facies and the formation of small berms, where the density of burrows is higher. Nevertheless we are aware of the need for further investigation in order to reach definitive conclusions with regard to this last observation.

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