Jimmy D. Laughlin

GUT ANALYSIS OF POLYCHAETES AND AMPHIPODS

The infaunal organisms inhabiting the sediments in Santa Monica Bay and off Palos Verdes Peninsula, including those near municipal waste outfalls, make up a major part of the diets of the fish in the same areas (Kleppel, Word and Roney 1980). However, very little is known about the diets of these infaunal organisms.

In this study the gut contents of four invertebrates that are known to be eaten by fish were examined: *Cistena californiensis, Capitella capitata, Ampelisca brevisimulata,* and *Rheopoxinius bicuspidatus.* The idea was to collect these animals which exist at the bottom of the food web at increasing distances from two outfalls to determine what they are feeding on and if the sewage outfalls altered their diets. The sediments in which they lived were also analyzed for potential food items (e.g. bacteria, diatoms, larvae, etc.) to compare with the gut contents.

All four study organisms fed primarily on detrital aggregates (an accumulation of very fine organic debris) and their related fauna (e.g. bacteria and diatoms). *Cistena* living near the two outfalls ingested less bacteria even though the total bacterial counts in the sediments were higher. *Cistena* ingested fewer bacteria in the winter than in the summer and concentrated those bacteria 1-2 orders of magnitude higher than the sediment concentration. *Cistena* also showed only slightly less and sometimes more bacteria in the hindgut than in the foregut. It is, therefore, assumed that they are not utilizing much of the bacteria they ingest or that there was a bloom in *in situ* bacteria in their guts, that made it difficult to determine if they are utilizing the bacteria for food.

Capitella removed large amounts of bacteria from the materials ingested. In the summer *Capitella* changed its ingestion of bacteria at the two outfalls so that it was completely opposite to the amounts of bacteria ingested during the winter.

The two amphipods *Ampelisca* and *Rheopoxinius* occurred only at the less contaminated stations. They ingested large amounts of bacteria and removed much of the bacteria they ingested.

Although bacteria appears to play a major role in the diets of these organisms, they also ingested diatoms, Foraminifera, invertebrate larvae and dinoflagellates to varying degrees. There were no differences in diets near or away from the outfalls.

METHODS

On 1 December 1980 and 19 January 1981 stations 1-4 (Figure 1) were sampled for the winter sampling. On 28 May and 1 June 1981 stations 1-6 were sampled for the summer sampling. Stations 4 and 6 were not sampled in the winter because the weather was rough and a boat could not be scheduled. Stations 1-6 (Figure 1) correspond to stations PV 7-3, PV 3-1, SMB 12-3, SMB 7-3, SMB 5-4 and SMB 4-3 respectively from the general survey of 1978 (Bascom, 1978). Two replicate grabs were taken at each station during the summer and winter (except stations 5 and 6) with a Van Veen grab sampler. As the grabs were brought on board, the top of the Van Veen was flamed by passing the flame of a propane torch over the top opening. Then the top door of the grab was opened and a sub-sample of the upper 5 cm. of sediment was taken. This was then preserved in 5% Borax buffered formalin for later bacterial analysis. The remaining portion of the grabs were then screened through a 1.0 mm. mesh screen on top of a 0.5 mm. mesh screen. The debris and organisms on the screens were transferred to whirl-packs and preserved with 10% Borax buffered formalin. All samples were brought back to the lab. The screened samples were sorted and identified. The sediment subsamples were run through a modified epifluorescence technique described by Moriarty (1975) to determine total bacterial counts. The technique was modified by using a 0.2 μ pore size, nucleopore poly-carbonate filter membranes stained with Irgalon Black for 12-24 hours, then rinsed to get rid of excess stain. This gave a much flatter field for easier counting and reduced background fluorescence.

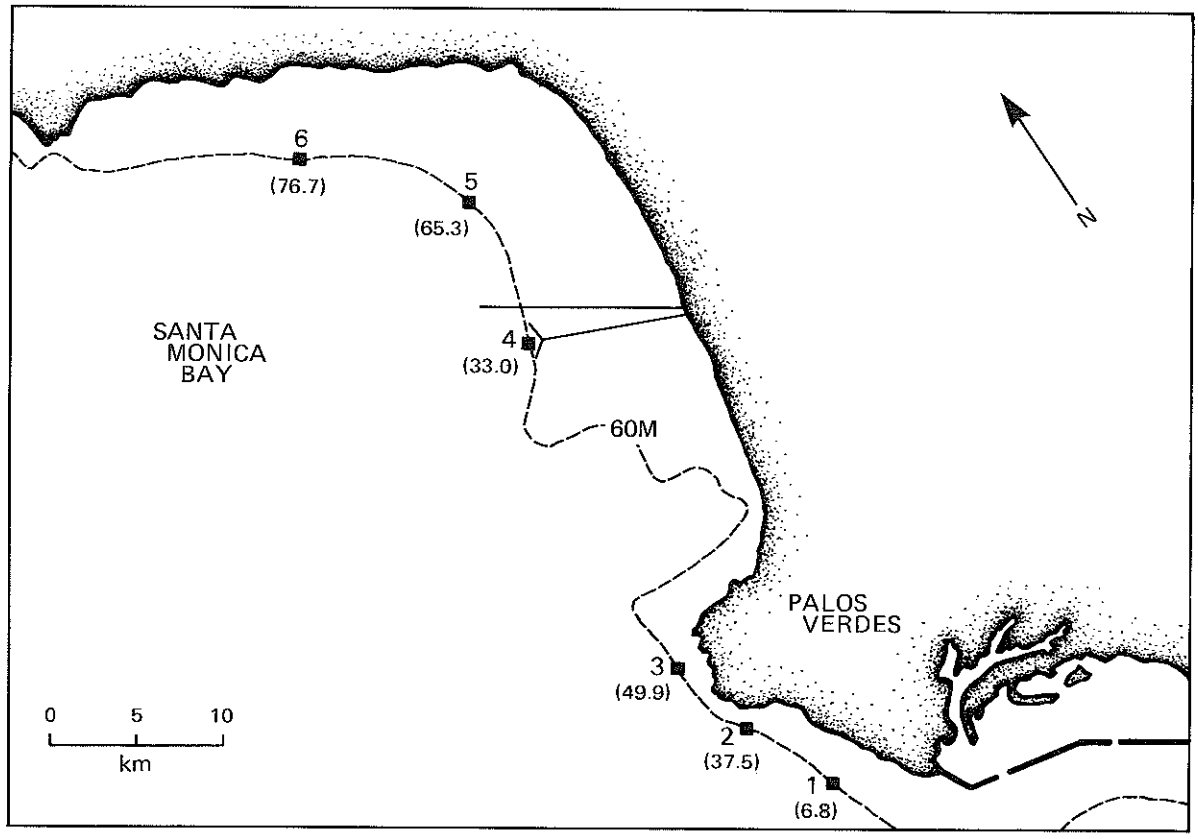

Figure 1. Map showing location of the six stations sampled. Infaunal Index values are in parenthesis.

The four species used in gut analysis were selected using the following criteria: 1) Using the data from the 1978 general survey, each species had to occur at at least two of the six stations. 2) Each species must occur in numbers sufficient for adequate sample size. 3) The species had to be easily identifiable.

The gut contents of each species were separated into foregut and hindgut portions. The foreguts of ten individuals were combined into a composite to obtain a sufficient quantity of material to run through the epifluorescence technique. The total bacterial counts were compared foregut to hindgut and foregut to surface sediment.

After the samples were run using the epifluorescence techique a 0.1 ml. subsample was removed from each sample and observed on a standard compound microscope using a Palmer Slide for other possible food items. (e.g. diatoms, Foraminifera, larvae, etc.). A Palmer Slide has a shallow well which allows one to quantify the number of cells (diatom, Foraminifera) in a known volume of sample (0.1 ml.). The abundance of these other items were calculated by counting the number of each item in twenty random fields in the Palmer Slide.

Sediment samples were also analyzed for Percent Volatile solids using the same method used in the 1978 survey. These Percent Volatile Solids values were then compared with the total bacterial counts and BOD values (Bascom 1978) (Table 1).

Table 1. This table shows that when the total bacterial counts in the sediments increase the % Volatile Solids (% V.S.) and BOD increases while the Infaunal Index values decrease.

Station	Words Infaunal Index	Total Bacterial Counts in Sediments ($\times 10^9$ cells/gr) Summer	Winter	% V.S.	Bod**
6	76.7	2.5	*	1.2	770
5	65.3	4.3	*	1.1	330
3	49.9	17	14	3.0	3,450
2	37.5	9	4.1	2.3	11,120
4	33.0	3.8	4.0	6.2	910
1	6.8	30	11	9.9	15,000

* No data was collected at these stations during the winter sampling period.

** Taken from Bascom 1978.

RESULTS AND DISCUSSION

Total bacterial counts, Percent Volatile Solids, and BOD all follow the same general trends when ranked along a gradient of decreasing Infaunal Index values (Word 1978) (Table 1). The concentration of bacteria in the foreguts of *Cistena* is roughly one to two orders of magnitude higher than the concentration of bacteria in the sediments where they feed (Figure 2). Apparently they are selecting for detrital particles with high bacterial counts. In the summer samples *Cistena* decreased its ingestion of bacteria as it occurred nearer to the two outfalls even though the bacteria counts in the sediments increased. The bacterial counts in the hindguts of *Cistena* varied only slightly from those found in the foreguts. It is not certain why this occurs, but it could be because of a bloom of *in situ* bacteria known to occur in the guts of invertebrates (Yingst 1976). *Cistena* ingested less bacteria overall in the winter, but otherwise showed no clear trends as seen in the summer. *Cistena* also ingested diatoms, polychaete larvae, dinoflagellates, Foraminifera, and fecal pellets (Table 2).

Concentrations of bacteria in the foreguts of *Capitella* were up to 10,000 times higher than in the surface sediments (Figure 3). This indicates that they too are selecting detrital particles which have high bacterial counts. In the summer, *Capitella* changed its ingestion of bacteria at the two outfalls so that it was completely opposite to the amounts of bacteria ingested during the winter. They were also found to occasionally ingest diatoms (Table 2).

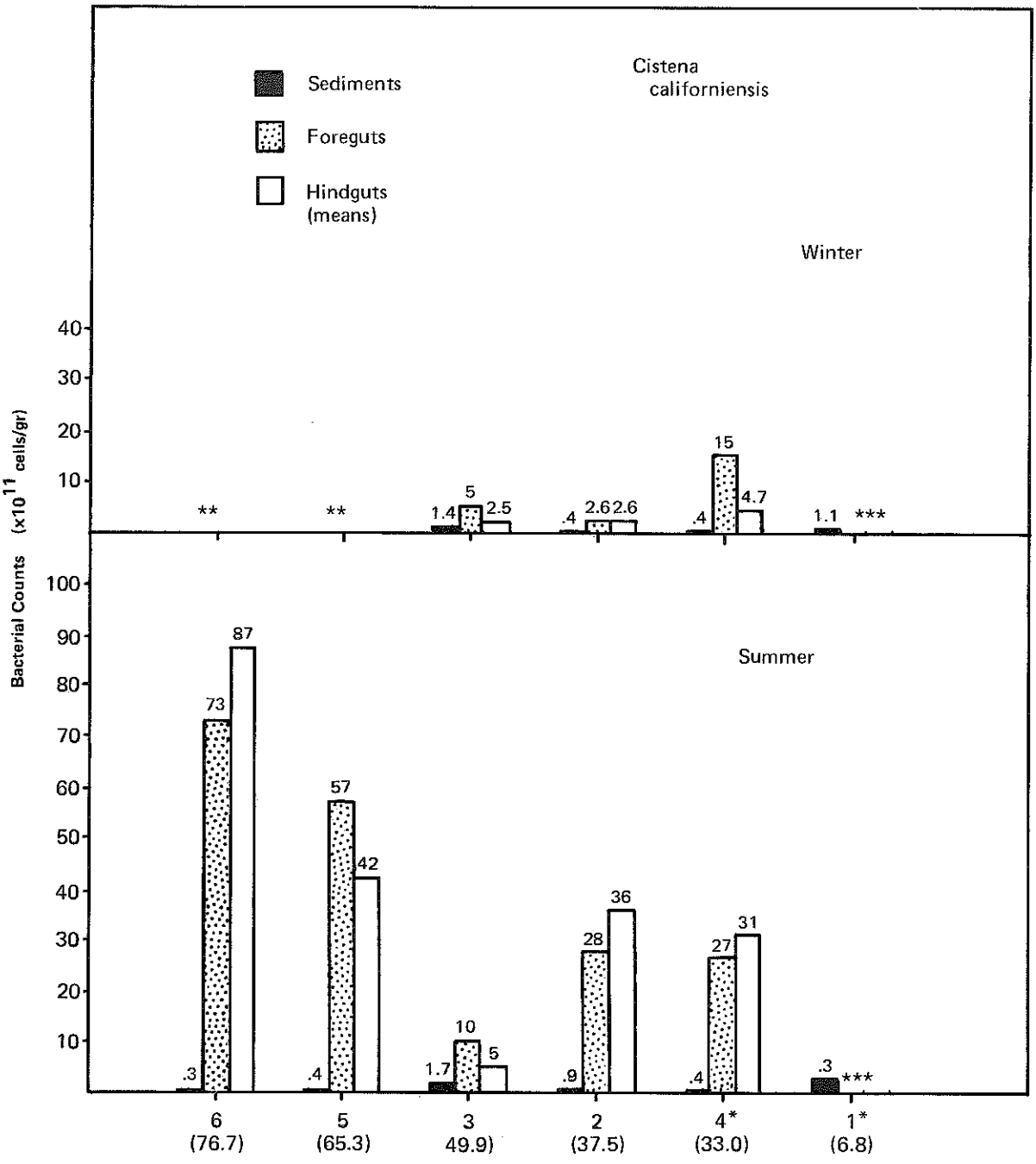

Figure 2. Total bacterial counts in the polychaete Cistena californiensis. As the infaunal index values descrease (the sediments become more contaminated) ingestion of bacteria decreases despite an increase of bacteria in the sediments. *Sewage outfall; **No data collected at these stations during winter sampling period; ***Organism not found here.

Table 2. Mean contents and % occurrance of food items ingested by each species. Means are calculated from 10 replicate counts.

Species	Food Items	X Counts	% Occurance (Qualitative)
Cistena californiensis	Bacteria	$2.7 \times 10_6^{11}$ cells/gr	10
	Diatoms	$1.4 \times 10_1^6$ cells/gr	5
	Foraminifera	2.0×10^1 cells/gr	4
	Dinoflagellates	Present	0.5
	Polychaete larvae	Present	0.5
	Fecal pellets	-	
	Detrital aggregates		80
			100%
Capitella capitata	Detrital aggregates	-	85
	Bacteria	$1.4 \times 10_3^3$ cells/gr	12
	Diatoms	2.6×10^3 cells/gr	2
	Foraminifera	Present	0.5
	Dinoflagellates	Present	0.5
			100%
Ampelisca brevisimulata	Detrital aggregates	-	30
	Bacterial	$1.2 \times 10_2^{12}$ cells/gr	10
	Diatoms	$2.6 \times 10_2^2$ cells/gr	2
	Foraminifera	$2.1 \times 10_4^4$ cells/gr	2
	Ostracod larvae	2.1×10^4 cells/gr	5
	Dinoflagellates	Present	1
			100%
Rheopoxinius bicuspidatus	Detrital aggregates	-	80
	Bacteria	$1.6 \times 10_2^{17}$ cells/gr	15
	Diatoms	2.3×10^2 cells/gr	1
	Foraminifera	Present	0.25
	Ostracod larvae	$2.2 \times 10_2^4$ cells/gr	3
	Mollusc larvae	1.3×10^2 cells/gr	1
	Dinoflagellates	Present	0.25
			100%

The bacterial counts in the foreguts of *Ampelisca* are one to three orders of magnitude higher than in the sediments (Figure 4). This suggests that they also may be selecting for detrital aggregates with bacterial fauna. The high bacterial counts in the hindguts of the third-ranked station may be due to a bloom of the *in situ* bacteria or concentration of the bacteria in the hindgut. They were also found to feed on diatoms, dinoflagellates, ostracod larvae, and Foraminifera (Table 2).

Rheopoxinius also showed a concentration of bacteria 10,000 times greater in the foreguts than in the sediments (Figure 4), thus indicating that they too are selecting for detrital particles with high bacterial counts. They also ingested diatoms, dinoflagellates, ostracod and molluscan larvae and Foraminifera (Table 2).

SUMMARY

Cistena, as did the other three study organisms, fed primarily on detrital aggregates and their related bacterial fauna. As the population of *Cistena* occurred closer and closer to the two outfalls, they ingested less and less bacteria even though there was more bacteria available to them. *Capitella* and *Rheopoxinius* showed the largest concentrations of bacteria in the foreguts relative to the sediments. *Capitella* also showed a curious change in the amounts of bacteria ingested at the two outfalls between summer and winter. *Ampelisca* fed primarily on bacteria and detrital aggregates also, but showed no clear trends along the gradient.

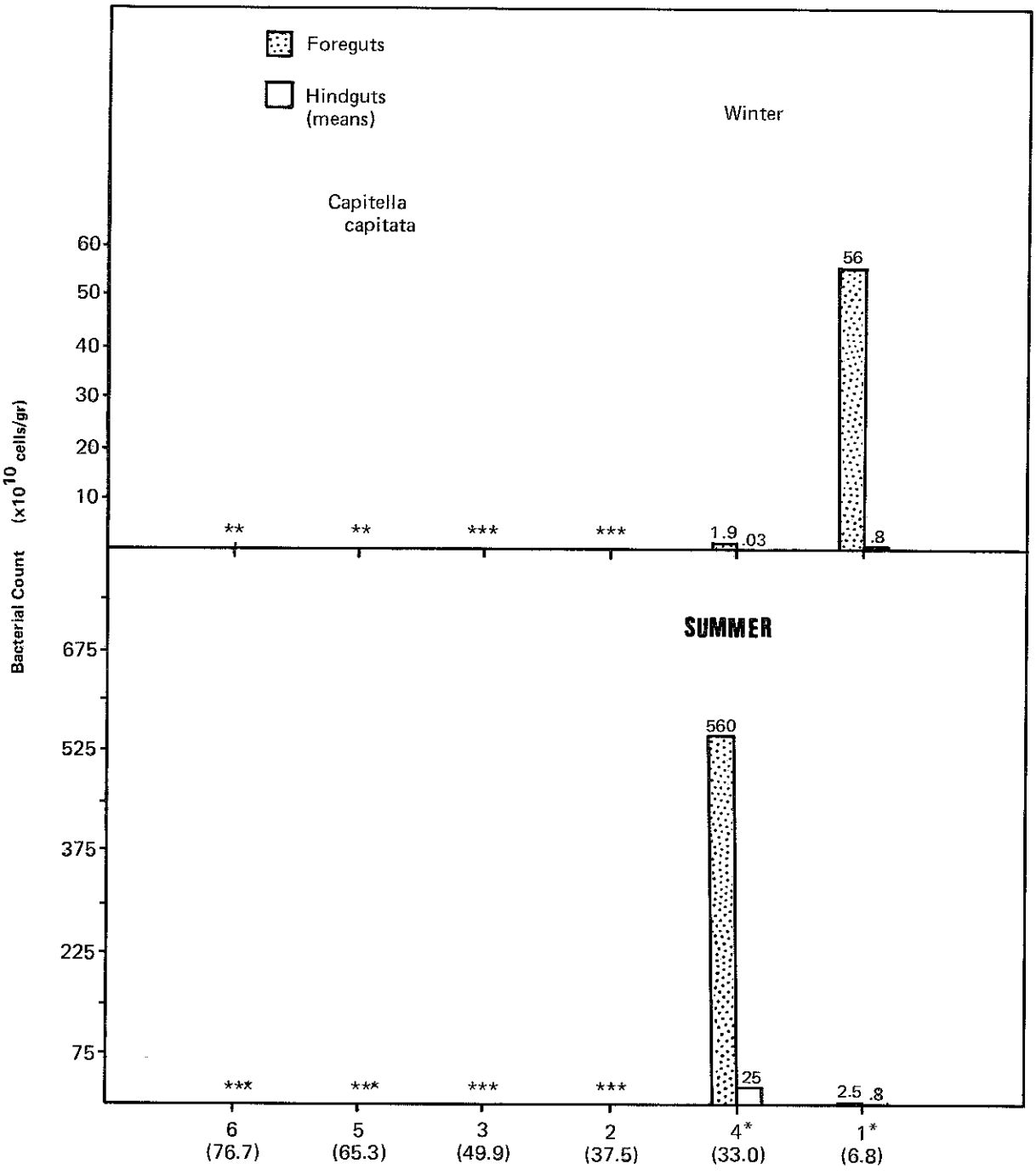

Figure 3. Total bacterial counts in the polychaete Capitella capitata. This figure shows a curious switch of bacterial ingestion between summer and winter. *Sewage outfall; **No data collected at these stations during the winter sampling period; ***Organism not found here.

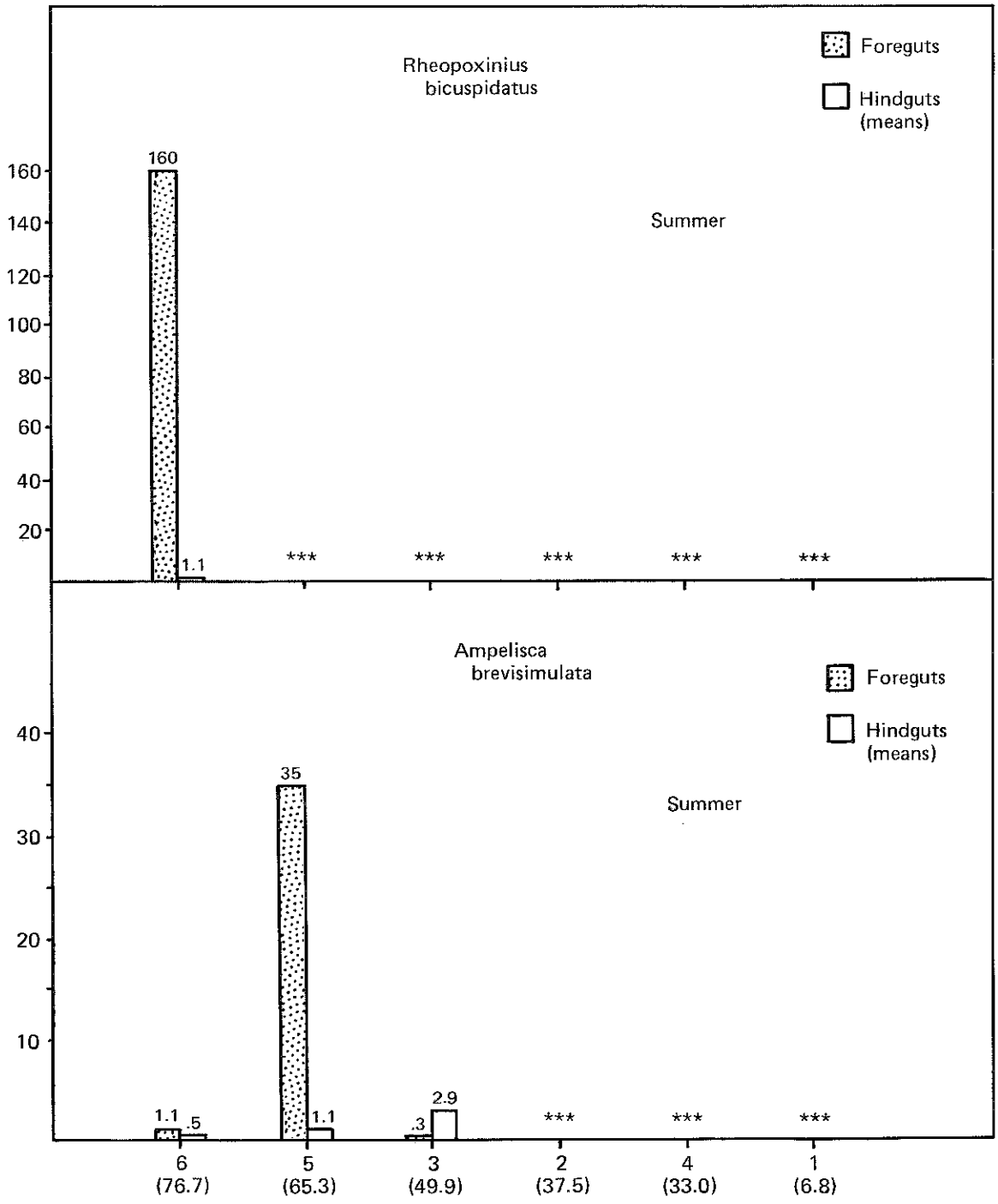

Figure 4. Total bacterial counts in the two amphipods Ampelisca brevisimulata and Rheopoxinius bicuspidatus. *Sewage outfall; **No data collected at these stations during the winter sampling period; ***Organism not found here.

With the possible exception of *Capitella* all of the study organisms ingested diatoms, dinoflagellates, Foraminifera, and molluscan and ostracod larvae to various degrees.

The discharge from the sewage outfalls does not appear to be altering the diets of the four species examined. However, it does appear to be affecting the amount of food ingested.

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