Influences on the Distribution And Abundance of a Species Of Cyclopoid Copepod~~s~~ by the Sea Urchin *Tripneustes ventricosus*

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Abstract: A species of cyclopoid copepod has been found closely associated with the sea urchin Tripneustes ventricosus on the Discovery Bay reef, Jamaica. These copepods apparently remain on, or close to the surface of the Tripneustes, occassionally swimming in and out among the spines. No such association is seen for the Lytechinus species of urchin often found in the same area as the Tripneustes.

Densities of these zooplankton decrease at night, indicating a diel migration pattern. Mean body lengths of these species also decrease at night, suggesting migration of the smaller copepods rather than the larger ones.

There seems to be no direct relationship between surface area of the Tripneustes and copepod abundance.

Introduction

Certain species of copepods have been noted to have diel migration patterns, migrating into the water column at night. Among the theories proposed to explain this pattern is the "escape from predation" theory. Zooplankton, especially large ones, will be susceptible to visual predation during the day. Remaining close to or within the coral reefs during the day and migrating up only after sunset would increase their fitness. Many large zooplankton have been observed to do this, while the smaller ones have been found migrating up the column during the day (Ohlhorst, 1982).

Cyclopoid copepods were found to be the most abundant demersal zooplankton in night samples taken at Discovery Bay, Jamaica. These copepods had their peak vertical migration 2 hours after sunset. (Ohlhorst, 1982). At Discovery Bay, a species of cyclopoid copepods was observed to be closely associated with the common sea urchin Tripneustes ventricosus. These copepods range from approximately .5 to 1.5 mm and, in shallow water, are found in high densities around the sea urchins. One possible explanation for this is that the copepods use the urchins for protection, swimming in and out of the spines, out of reach of many predators. If the copepods are using the urchins only for protection, and since they are present in such high densities, they may need to migrate out, away from the urchins, in order to feed efficiently. Migration at night would avoid the threat of visual predators. Copepods should therefore be expected to stay close to the urchins during the day and migrate at night. If this predation-avoidance hypotharis is correct, and applies to these copepods, they should be expected to utilize any substrate with protective spines, including other species of urchins. A larger urchin has a larger number of spines and can protect greater numbers of copepods. Copepod abundance should therefore increase with increasing surface area. Finally, the mean body length of ~~urchins~~ copepods should be greater in the day. During the day the larger ~~urchins~~ copepods would stay closest to the *Tripneustes*, since they are in greater danger from visual predators. At night they too can migrate, lowering the mean body length of the copepods left close to the *Tripneustes*. This study examines these predictions in an effort to analyse copepod distribution and abundance in relation to urchins.

unclear! why should small copepods remain by urchins at night?

Study Site

The study was done on the west back reef of Discovery Bay Jamaica. *Tripneustes* were collected randomly from this area, the only criterion being approximate distance from the reef crest. Collections were made 20 to 25 metres from the crest in water $1\frac{1}{2}$ to $2\frac{1}{2}$ metres deep.

Methods

Collections were made during 3 days and 2 nights between February 26 and March 4, 1984. Night samples were collected from each of the 2 depths, as were day samples. A total of 6 _Tripneustes_ collected by day, 6 collected at night and 5 Lytechinus sp.? (4 collected by day and 1 by night) were examined. Collection times during the day were at approximately 10:00, 10:15 and 10:45 am. At night collections were made at approximately 10 pm and 10:30 pm. These night hours were chosen because Ohlhorst (1982) had shown that the migration of cyclopoid copepods in Jamaica peaked 2 hours after sunset. By 3 hours after sunset then, most of the migrating cyclopoids should have started up the water column and a significant difference should be found after this time.

Samples were collected by diving down with a plastic bag, flipping the urchin inside the bag and sealing the bag with the urchin and its surrounding water. These urchins were then brought back to the lab, where they were rinsed with cold water. Cold water was found to kill the copepods almost instantly, thereby providing a method of easy removal of the copepods from the _Tripneustes_. The rinse samples were then concentrated using a plankton cup.

fresh water?

Those which could not be immediately counted were preserved in formalin. The rinse sample was poured approximately 15 ml at a time into a gridded petri dish, (1 cm x 1 cm grid), and the number of copepods in the dish counted with the aid of a dissecting microscope. This was repeated until the whole sample was counted.

The radius of each urchin was recorded. Since the urchin is approximately a hemisphere with a flat, circular base, the surface area of the urchin was taken to be that of a hemisphere ($2\pi r^2$) plus the surface area of the circular base (πr^2), making the total surface area of the urchin $3\pi r^2$.

The mean body lengths of the first 20 copepods of 1 day sample, 1 night sample and the Lytechinus sample were measured by placing a millimeter ruler below the gridded petri dish and lining up the copepods by the millimeter markings.

An attempt was made to measure copepod abundance in the open water around the collection sites. Water was scooped up in a 3 quart bucket and concentrated by pouring through a plankton net. This was repeated 3 times and the collection attempted on two different days. In neither case were any copepods found in the collection

Results.

With the exception of 4 calanoid copepods, all of the copepods counted appeared to belong to 1 cyclopoid species. Table 1 shows the summary of the collection results. Copepod numbers ranged greatly between the 2 urchin species, from 1 to 13.75 Mean abundances and mean densities differed between day and night collections, *T. Tripneustes*, (Mann-Whitney $U = 30, p < .05$). Difference were also seen between the Tripneustes day sample and the Lytechinus day sample ($U = 24$, $p < .025$). Mean body lengths of copepods increased significantly at night in the *Tripneustes* species ($U = 27.5$ $p < .05$), Table 2. No trend was seen between numbers of copepods and surface area of *Tripneustes*, Fig. 1. Copepod abundance and density apparently increases with increasing depth. Fig. 2 and 3

Discussion

A species of cyclopoid copepod does appear to be closely associated with the *Tripneustes ventricosus* of the Discovery Bay coral reef system. The decrease in abundance of these copepods at night supports the demersal migration hypothesis. Copepods may be migrating away from the urchins and into the water column at

Table 1 Summary of Data Collected From Urchin Samples.

Urchin	When Collected	Number of Copepods	Radius of Urchin	Density of Copepods Number/cm^2	Depth Collected
Trip-neustes	Day	364	2.6cm	5.72	$1\frac{1}{2}$m
Trip	Day	946	4.2cm	5.69	$1\frac{1}{2}$m
Trip	Day	897	3.3cm	8.71	$1\frac{1}{2}$m
Trip	Day	1375	3.2cm	14.3	$2\frac{1}{2}$m
Trip	Day	1361	4.2cm	8.19	$2\frac{1}{2}$m
Trip	Day	748	4.0cm	4.96	$2\frac{1}{2}$m
Trip	Night	689	3.9cm	4.81	$2\frac{1}{2}$m
Trip	Night	511	2.3cm	10.25	$2\frac{1}{2}$m
Trip	Night	123		1.20	$1\frac{1}{2}$m
Trip	Night	362		4.27	$1\frac{1}{2}$m
Trip	Night	245		1.71	$1\frac{1}{2}$m
Trip	Night	419		5.28	$1\frac{1}{2}$m
Lyt	Day	40		0.582	$1\frac{1}{2}$m
Lyt	Day	1		0.017	$1\frac{1}{2}$m
Lyt	Day	2		0.040	$1\frac{1}{2}$m
Lyt	Day	7		0.095	$1\frac{1}{2}$m
Lyt	Night	42		0.569	$2\frac{1}{2}$m

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Table 2. Mean Densities, Abundances and Body Lengths of Day and Night Collections of Tripneustes and Lytechinus and Summary of the Other Organisms Found.

	Tripneustes Day Collection	Tripneustes Night Collection	Lytechinus Day Collection
Mean Densities	7.93 SD = 3.46	4.59 SD = 3.24	0.184 SD = 0.268
Mean Body Length	9.75 mm SD = 2.86	11.6 mm SD = 2.76	11.0 mm SD = 3.68
Other Organisms Found	4 mysids 1 unidentified organism	6 mysids, 2 worms, 1 ostracod	1 mysid, 6 worms, 2 unidentified organisms
Mean Abundance	94.8 SD = 38.4	39.1 SD = 19.9	12.5 SD = 18.5

20 Squares to the Inch

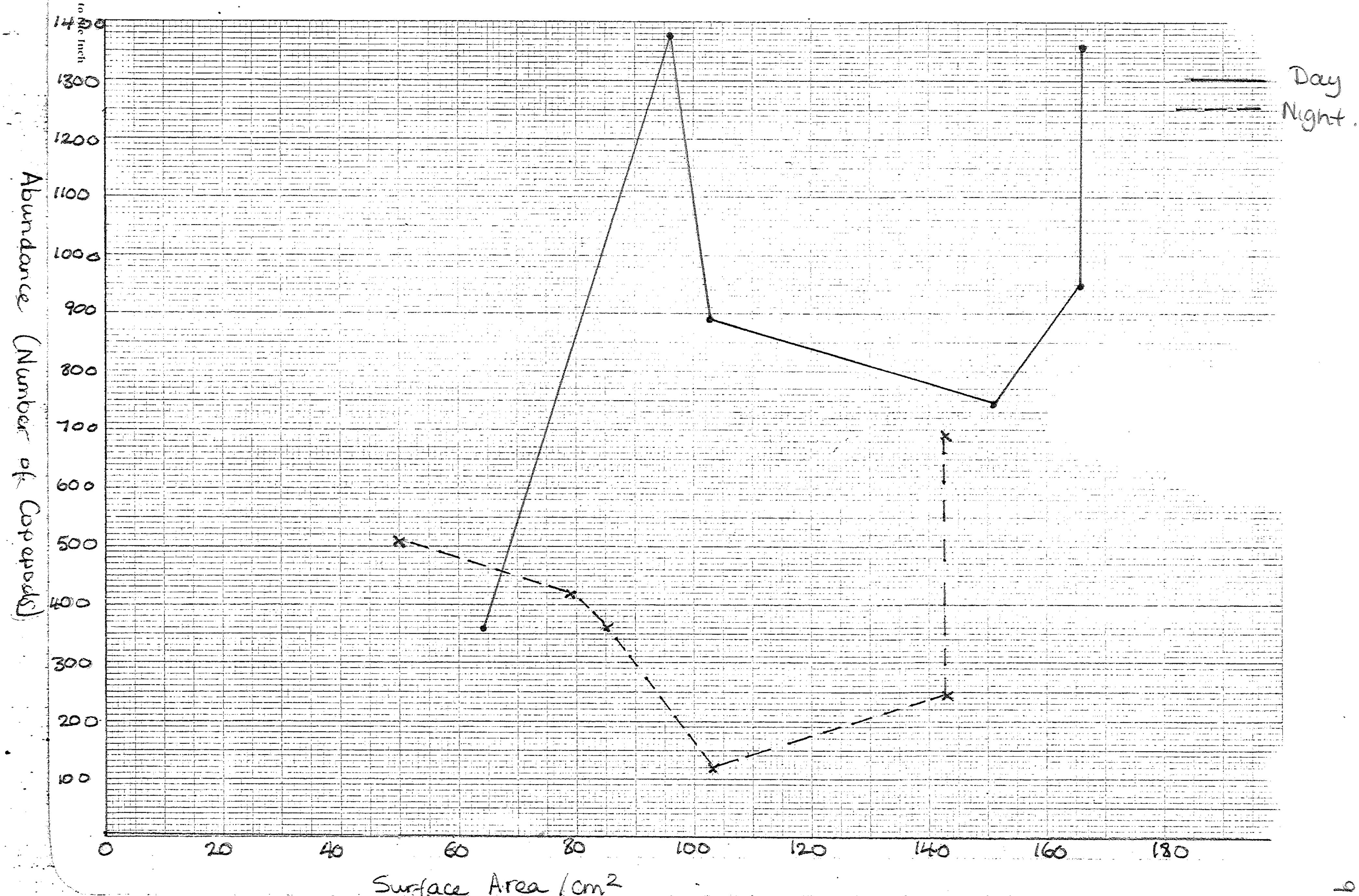

Fig. 1. Abundance of Copepods vs. Surface Area for Day and Night Tripnewter Samples.

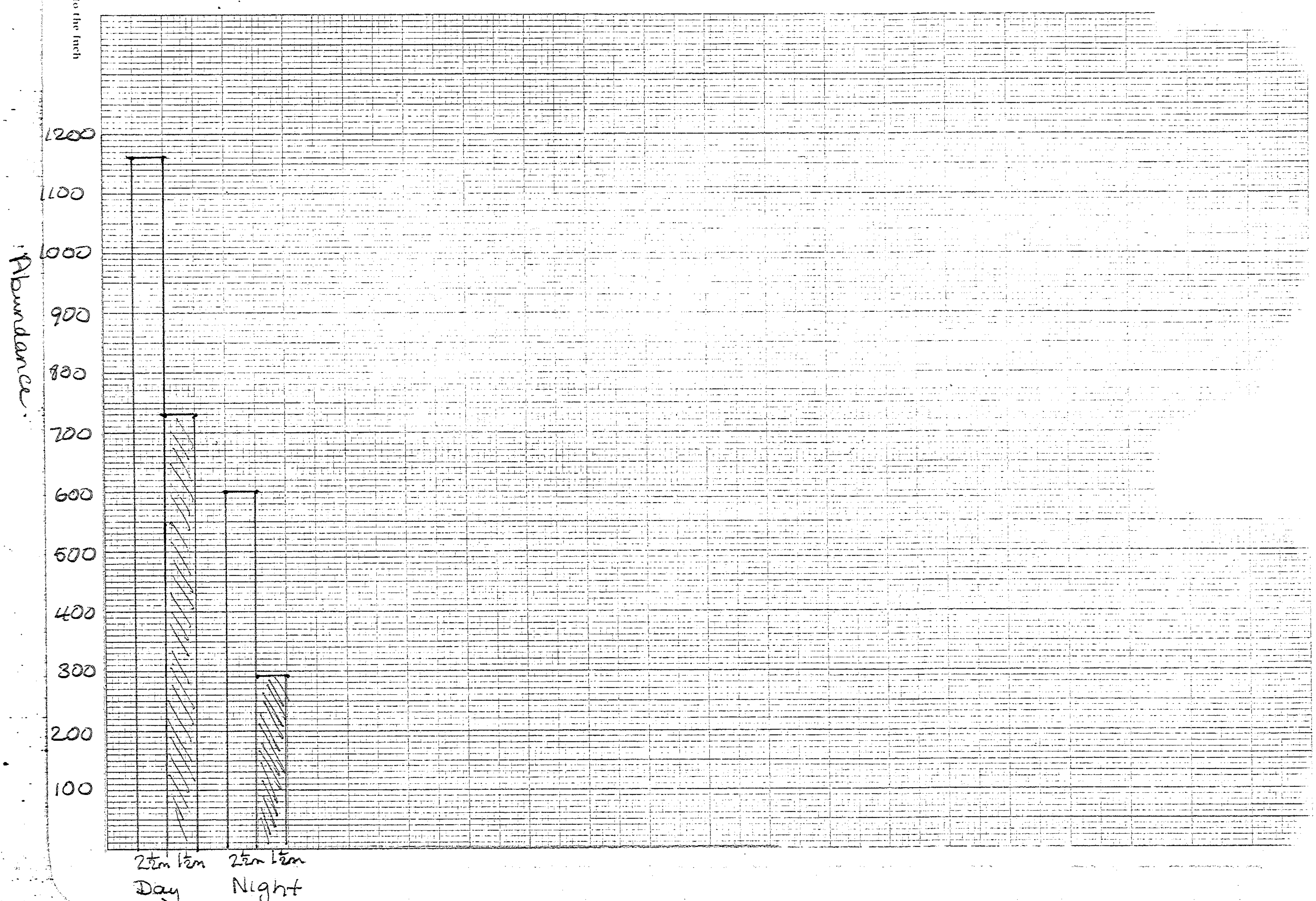

Fig 2. Comparison of Mean Abundance With Depth for Day and Night Samples.

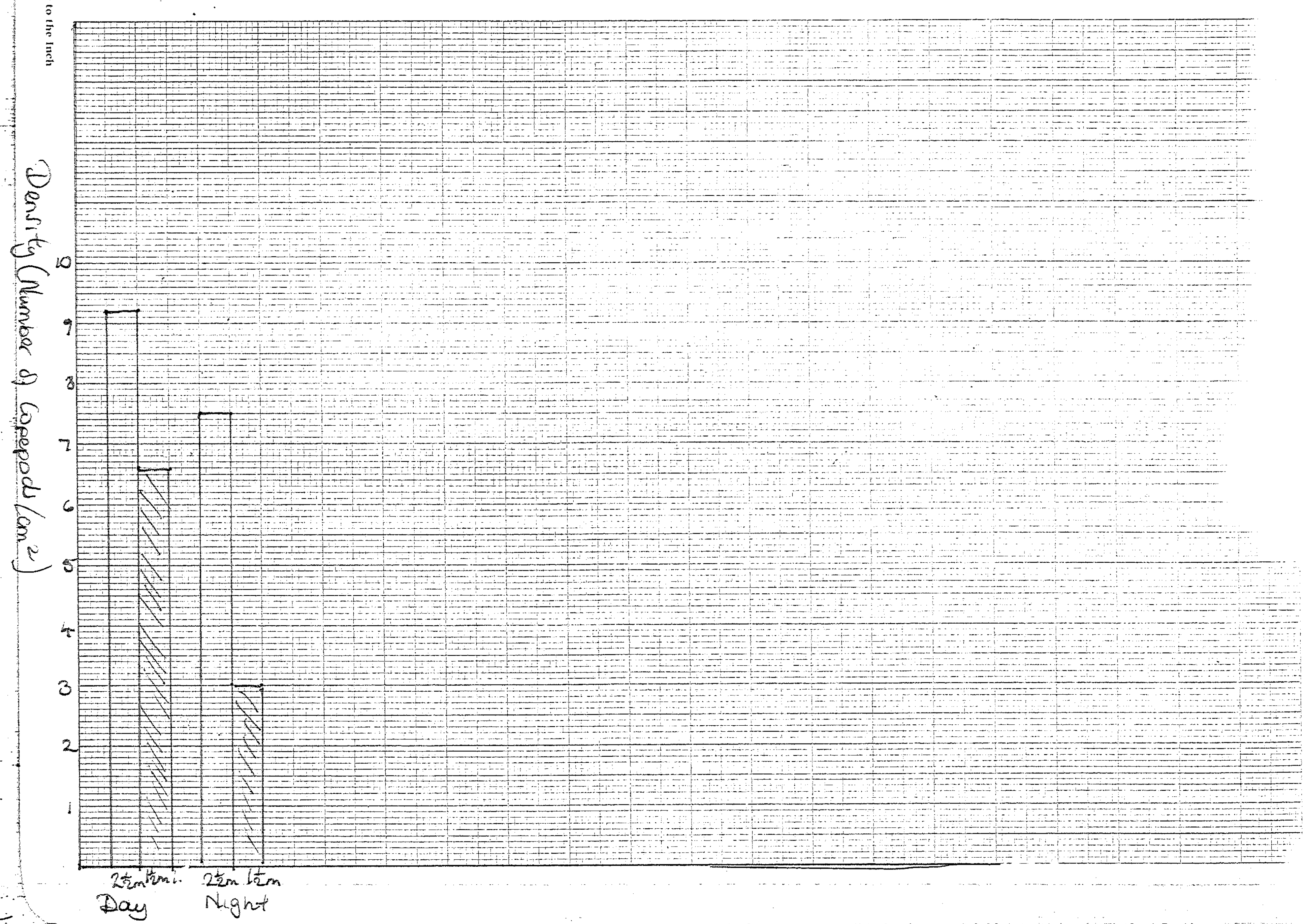

Fig. 3 Comparison of Mean Densities With Depth For Day and Night Samples.

20 Squares to the Inch

night. A test of the water column over the Tripneustes using a demersal zoo-plankton trap would help to clarify this. The increase in mean body lengths of the urchins at night indicates that it is the smaller ~~urchins~~ copepods which are migrating rather than the larger ones. One possible explanation for this is that the zooplankton, in addition to using the urchin for protection, are using them as a food source. Waste products excreted from the urchin may be a food source for these copepods, in addition to the detritus supplied by the Thalassia leaves on which the urchins feed. The copepods are present in very high densities however and there may still be competition for this food source. If this is the case, the larger copepods may be out competing the smaller ones and forcing the smaller ones to forage elsewhere for food.

Another possibility is that this decrease may have been due to experimental technique. If the smaller copepods burrowed further into the urchin at night and clung more tightly, the rinsing method employed may not have been strong enough to remore them; though there is no explanation for why the copepods should do this.

The body length measurements were only approximations made with a millimeter ruler. In order to make this more conclusive, much more accurate measurements of copepod lengths would have to be made.

There did not seem to be a general trend of increasing copepod abundance with surface area. Fig. 1. If the spines were the deciding factor then the urchins with the larger surface area, and therefore the larger number of spines should carry the largest number of copepods. It is possible that copepod abundance may be affected by more than just the surface area of the Tripneustes. The microhabitat around the individual Tripneustes may differ in terms of other factors such as degree of radiation and nutrient availability.

The lack of copepods around the Lytechinus suggests that the copepods may be host specific. It is possible that whatever they are able to derive from the Tripneustes cannot be supplied by the Lytechinus. In terms of protection, the Tripneustes should offer more protection than the Lytechinus. The spines of the Tripneustes are more abundant than those of the Lytechinus, and cover a greater amount of the Tripneustes surface area. Nevertheless the Lytechinus does have some spines, and if spines were the only consideration, more copepods would be expected around the Lytechinus species. One of the day Lytechinus collections was actually resting against a Tripneustes. Looking at the results it is possible that this was the Lytechinus with 40 copepods as opposed to 7, 2 and 1. If species close to the Tripneustes were compared to those further away and found to have a higher number of copepods, then this would indicate that the copepods were spreading out from the Tripneustes to the Lytechinus.

Another observation is that many of the copepods examined were carrying egg sacs, though the actual numbers were not quantified. It is possible that the copepods could be using the Tripneustes as some kind of refuge before egg laying.

The results of this study indicate the possibility of a commensal relationship between the copepods and the Tripneustes. Copepods may be seeking food, protection, or a combination of the two. Further study would be needed to make this explanation more conclusive. An increased sample size would more clearly show if there was no trend between surface area and copepod abundance. Larger sample sizes taken from more greatly differing depths would indicate whether the relationship between depth and abundance was a true trend. Since only a total of 6 samples were taken for day or night, the sample size for depths as well as time of day was reduced to only two or three. Other studies, such as recolonization of a nnsed urchin, comparison of copepod abundance around urchins in differing environments (e.g. rock, sand beds, Thalassia beds) may shed some more light on the reasons for this copepod-urchin association.

References:

Ohlhorst, S. L., 1982. Diel migration patterns of demersal reef zooplankton. J. Exp. Mar. Biol. Ecol. Vol. 60, pp 1-15.

Very good study and discussion of results!