Space Partitioning in *Tripneustes ventricosus*

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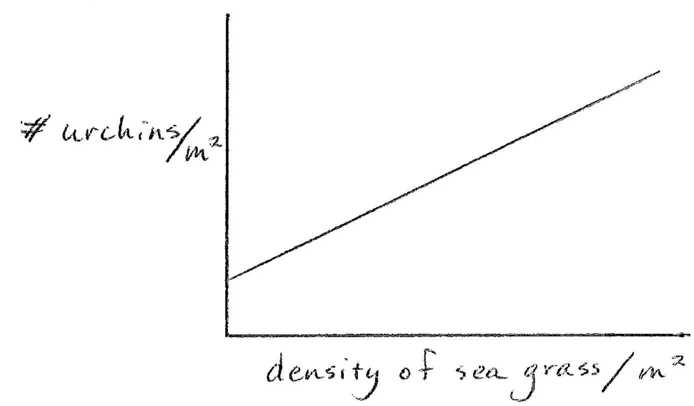
INTRODUCTION

The sea urchin, Tripneustes ventricosus, has been found to eat Thalassia leaves by day and algae on promontories at night (Todd and Kilmarx, 1983). If Tripneustes were optimal foragers, they would spend the most time in Thalassia beds with denser sea grass growth than those with sparse vegetation. In denser sea grass, they could conserve energy by not having to move far for food. They could stay in one place for a longer time and would have more sea grass available to eat, to hide in, and to cover themselves up with so as to camouflage themselves and avoid predation. One would therefore expect to find more sea urchins in denser patches than in less dense patches of sea grass as follows:



Also, if Tripneustes feed upon the algae on coral rock promontories at night, one would expect to find a greater proportion of urchins on the rocks at night compared to in the Thalassia beds.

STUDY SITE

I studied *Tripneustes ventricosus* on a 25 square meter transect approximately 50 meters south of the reef crest on the west back reef at Discovery Bay, Jamaica (in the West Indies). The transect ran parallel to the reef crest and comprised a plot of ground about 1.5 meters below sea level. Over three-quarters of the transect was a *Thalassia* bed of various degrees of growth density. The remaining portion of the area was composed of coral rocks, most of them lying in the western area of the transect.

METHODS

After several unsuccessful attempts to mark urchins in order to determine and quantify individual *Tripneustes'* movements through time and space (Appendix A), I set up a transect to study space partitioning in this sea urchin. To mark off the transect, I first cut a five meter long string and marked the meters on it. I then wrapped 36 rocks with bright red flagging to use as the cornerstones of 25 square meters within a 25 m^2 transect. I swam with the rocks and the measuring string to the spot I had chosen the day before (on the west back reef) and had marked with a buoy. There I laid out the transect.

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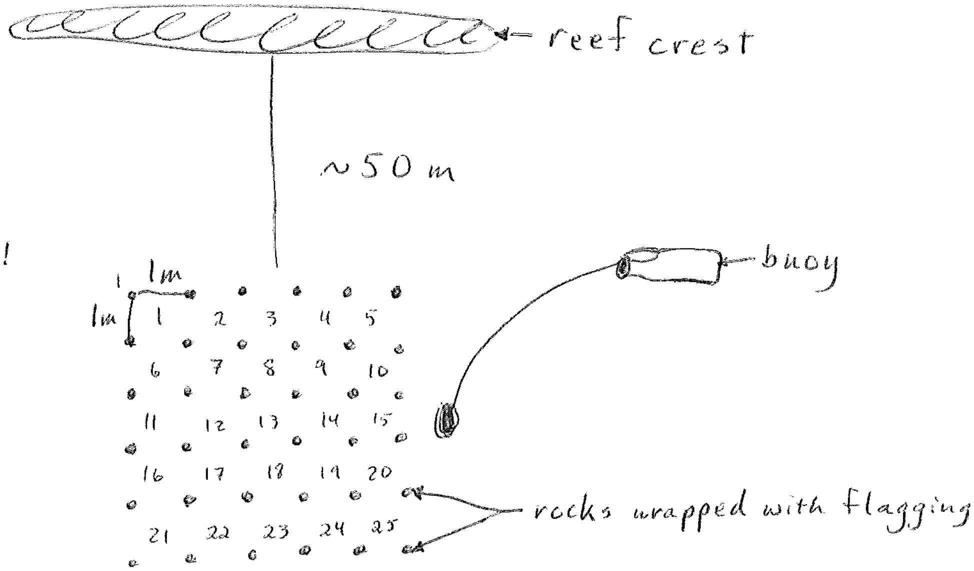

I counted the number of Tripneustes in each square meter and recorded whether it was in the sea grass or on a rock promontory for four mornings at 900 (March 1, 2, 3, and 4, 1984), four afternoons at 1600 or 1630 (February 29, March 1, 3, and 4, 1984) and only one night at 2100 (March 3, 1984) because of stormy weather on the other nights.

I also recorded the amount of grass in each square meter on a scale from 1 to 5, with 1 being very sparse grass and 5 being dense grass, and I noted the percent rock cover in each square meter.

RESULTS

I found the relationship between the numbers of urchins per square meter and the grass densities of the square meters the urchins were found in to be insignificant, yet a trend in the direction of my

how did you test this?

hypothesis can be seen [Fig. 1].

The mean numbers of *Tripneustes* in each of the 25 square meter areas had large standard errors, showing *Tripneustes'* movements among areas to be fairly high [Fig. 2].

Times? days?

I found the mean number of urchins per square meter rock to be 1.80 and the mean number per square meter grass to be similar - 1.63 urchins [Table 1].

There was a decrease in the total number of urchins in the transect on February 29, March 1, and March 2, which were the first, second and third days of a storm. As soon as the storm ended, however, on March 3, the numbers of urchins increased dramatically and stayed fairly constant for the next two days of good weather [Fig. 3].

The average number of *Tripneustes* decreased to a low of .88 ± .194 (standard error) on the afternoon of the second day of the storm [Fig. 4]. When the storm was over, the average number of urchins increased to a mean of 2.0 ± .59 (standard error) urchins per m^2 over a two day period, which seemed to reflect the normal distribution in this area.

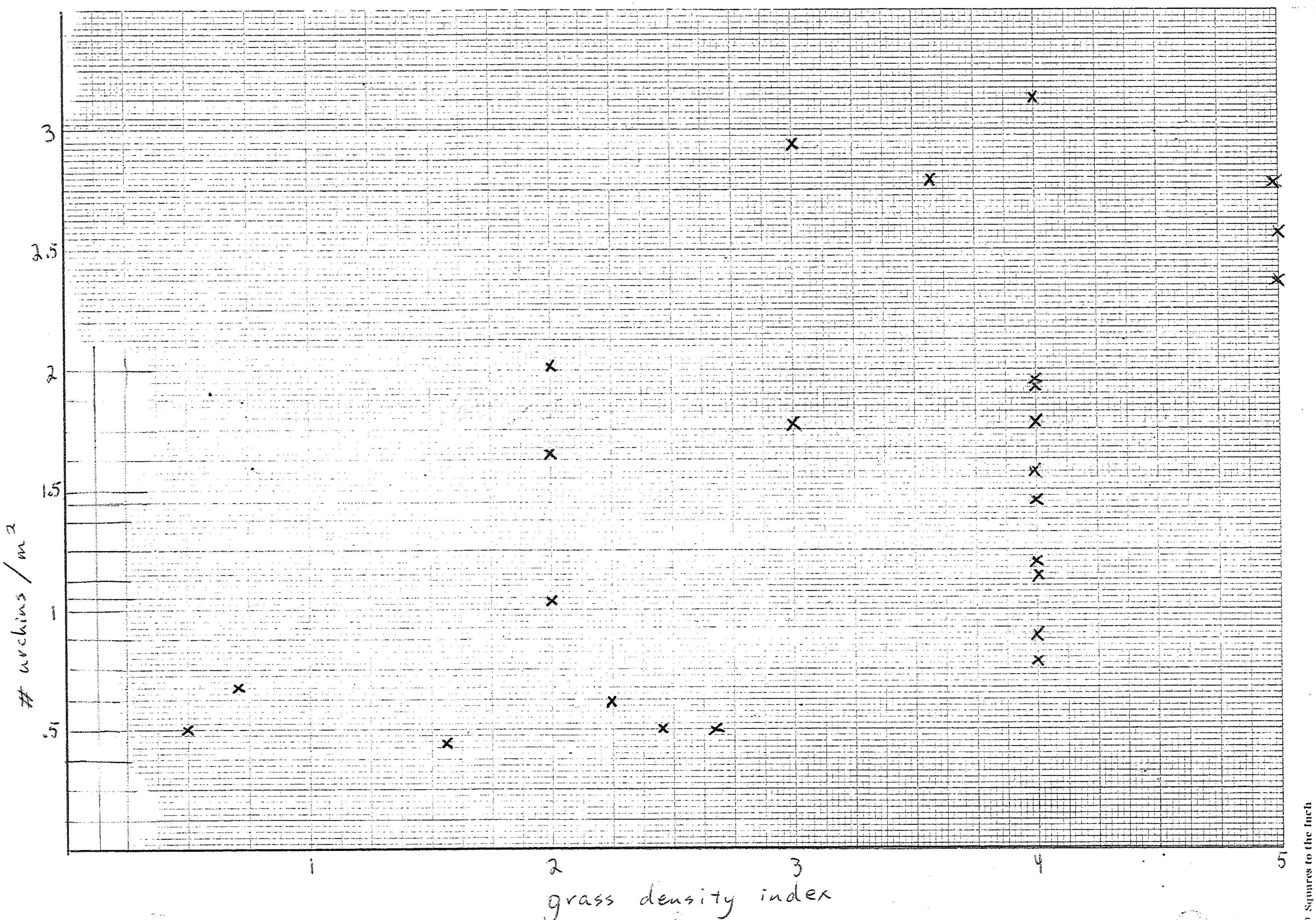

Figure 1: Number of <u>Tripneustes</u> /m² as a function of grass density/m²

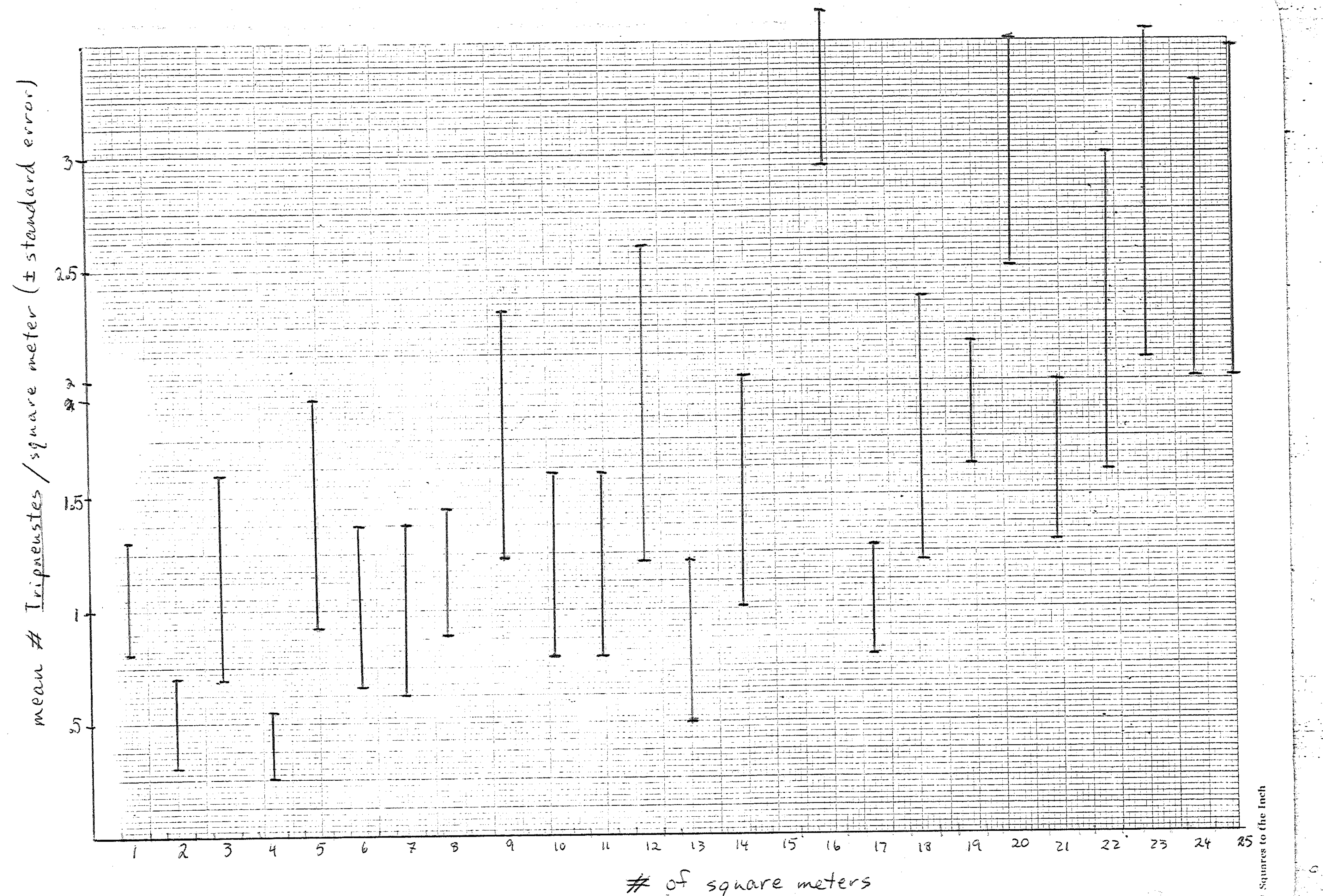

Figure 2: Mean numbers of *Tripneustes* / m^2 ± standard deviation for 25 sites

Table 1: Transect data for rock versus grass-covered substrates

	ROCK	GRASS
m^2	2.25	22.75
mean # urchins	4.06	37.3
mean # urchins/m^2	1.80	1.63

Table 2: Weather over the 5 day study period

Feb. 29 : storm started in the afternoon

March 1 : 2nd day of storm; large waves

March 2 : 3rd day of storm; large waves; rain

March 3 : clear day; sunny and calm

March 4 : 2nd clear day

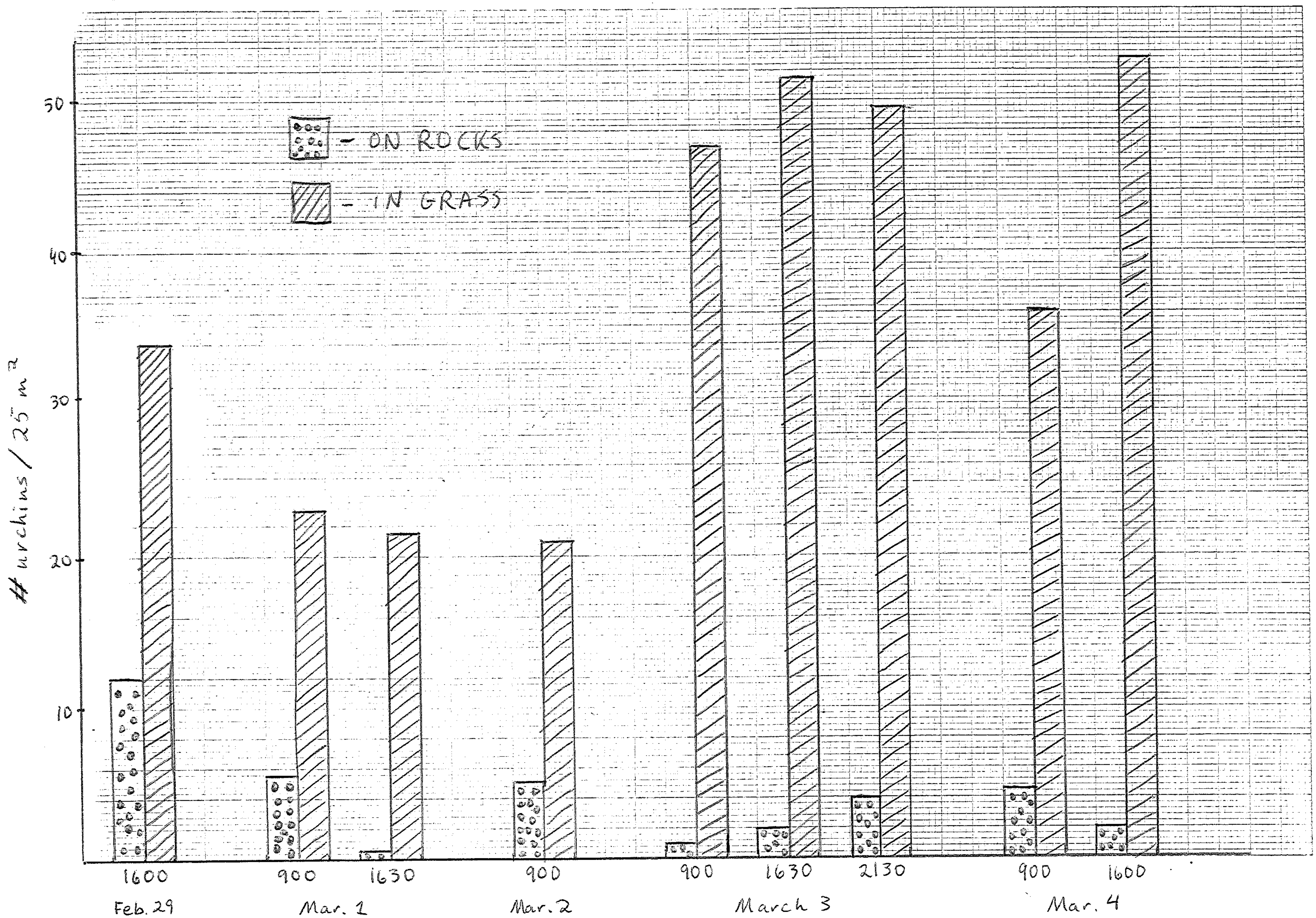

Figure 3: Total number of urchins found on rocks and in the grass within the transect over the five day study period

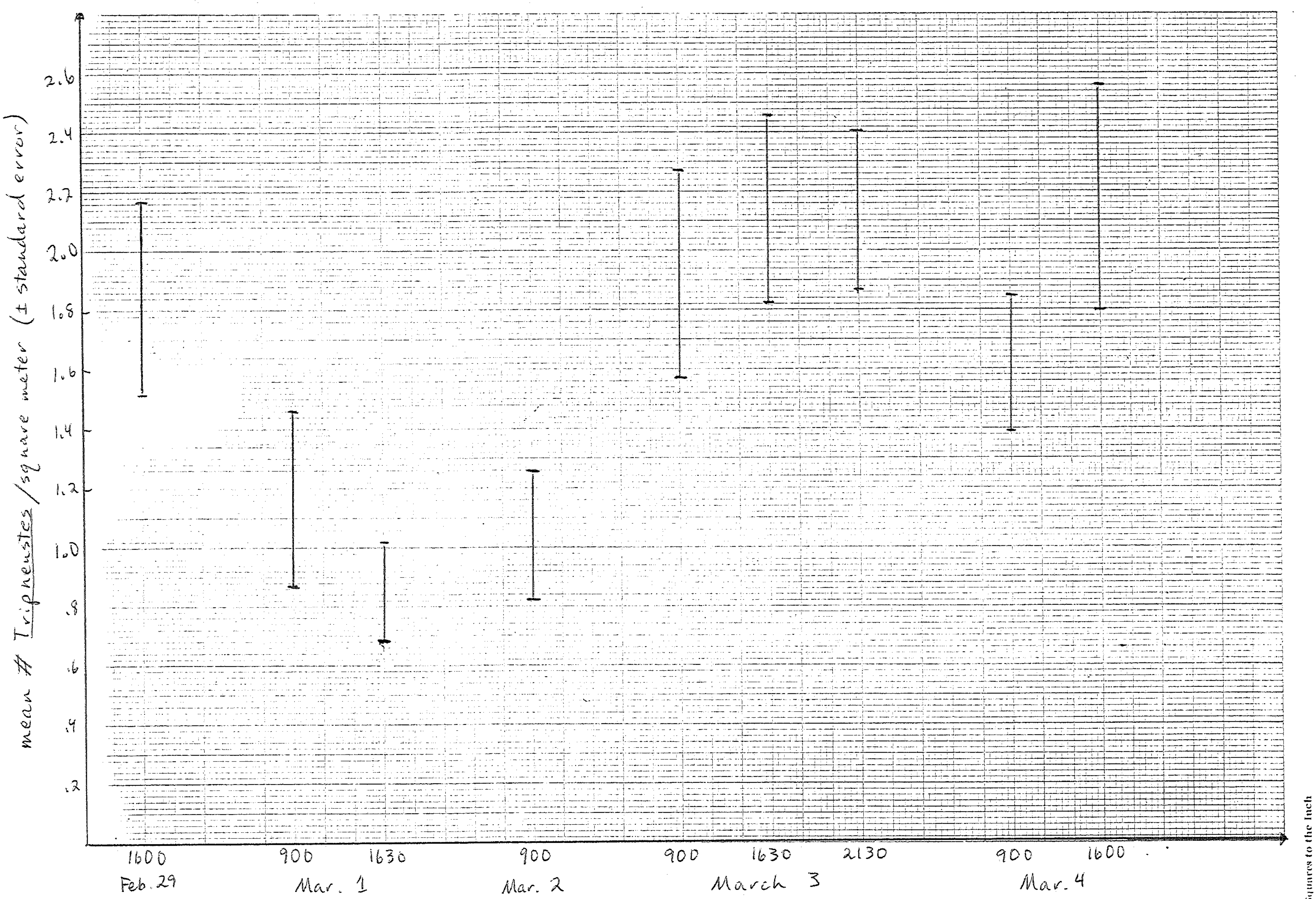

Figure 4: Mean number of Tripneustes per square meter within the transect over the five day study period

DISCUSSION

Although a trend can be seen in the data [Fig. 1], I did not find a significant increase in the number of Tripneustes with increasing density of Thalassia. This may be because within the transect the densities of sea grass did not differ very greatly from square meter to square meter. (There were no completely bare patches, for example.) If the range of grassiness were greater, a significant trend might be found. Also Tripneustes may not differentiate between the grass densities in such small areas as meters square, but rather may differentiate between the densities of much larger patches. Furthermore, the Thalassia may be so abundant relative to the urchin abundance that urchins might not conserve much energy by feeding in a dense patch of grass. Urchins may not require such a large food source at one time. Lastly, it would have been better had I had the time to count the leaves in each of the 25 square meters to correlate with the urchin densities as I had originally planned to do.

The variation, in terms of standard error, from the mean number of Tripneustes per square meter was quite high in each of the square meters, showing quite a lot of urchin movement to be taking place among the various areas within the transect [Fig. 2]. A trend can be seen in that the areas closest to the reef crest (1, 2, 3, 4, and 5) have low mean numbers of urchins per square meter, whereas the areas farther from the reef crest (e.g. 21, 22, 23, 24, and 25) have much higher urchin means per square meter.

This may be explained by the fact that, in general, the grass was denser in the southerly portion of the transect. Urchin density appeared proportional to _Thalassia_ density on a larger scale than a per square meter scale. Perhaps if one looked at urchin densities in larger plots one might find a more significant correlation with grass density.

The mean number of urchins per square meter of grass-covered substrate was about the same as that for those per square meter of rock for both day and night (although I had only one night data set due to the storm) [Table 1]. The urchins appeared to show no preference for either rock, or _Thalassia_ and sand substrate.

A storm that blew up on February 29, 1984 and lasted until March 3 [Table 2] seemed to affect the urchin density in my transect [Figs. 3 and 4]. The urchins in the transect decreased greatly in number during the storm. The day after the storm, the urchin density increased to a fairly constant level, almost twice that of during the storm. The waves and the turbulence may have partially caused the decrease in _Tripneustes_ density during the storm by dispersing the urchins somewhat from this area of high urchin concentration. I did in fact see some _Tripneustes_ rolling about on the ocean floor during the storm. Also the urchins may have left this exposed area on their own for more sheltered habitats, such as rock crevices, where they would be protected from the force of the waves and the sediment load.

The numbers of urchins observed on rocks seemed fairly constant throughout my observation period. On the one night I counted the urchins in the transect, there were no more urchins on the rocks than usual; the urchins were, however, less covered than during the day.

APPENDIX A

I also spent three days attempting to mark individual Tripneustes so as to determine any diel patterns of movement through space and time that might exist. I will briefly record my efforts here.

First I tried using indelible, waterproof ink on the urchin spines, but found that this method of marking would only be useful for an extremely short-term project, since the ink began to fade considerably within a day. I then tried wrapping a thin string around each of several urchins and attaching numbered flagging to the string, but found that urchins could easily remove string tied around them in such a manner, by relaxing their spines and using their tube feet to push the string off. When left for longer periods of time (e.g. overnight) most of them were also able to remove two strings tied longitudinally from the oral to the aboral apertures. So lastly I tried tying three strings around them, knotting the strings together very tightly at both ends. No urchin observed in the wet lab escaped from this treatment, so I decided to use this method of marking.

I collected 20 urchins from an area on the west back reef (which I marked with a buoy) and brought them back to the wet lab where I wrapped them all with three strings each and attached a strip of numbered flagging to each. In the process of wrapping, I made sure not to cover the oral or the aboral openings of the urchins. Having marked the urchins and recorded their sizes, I brought them out to the buoy around which I randomly placed the _Tripneustes_. Next to each urchin I tied to the nearest blade of _Thalassia_ a strip of flagging with the same number as was attached to the corresponding urchin, so I would be able to determine exactly how far and in what direction each urchin traveled after certain lengths of time. I then checked the urchins after 4, 8, and 12 hours, but found that all of them moved very little or not at all. I figured that the strings must have inhibited the movement of the urchins, or else they had expended so much energy attempting to remove the strings that they had little energy left to spend wandering around.

The next day, I again checked the urchins, found them not to have moved, and therefore gathered them one by one and cut off their strings and set them free. I then tried a third marking technique of tying threads to the spines of urchins. I again collected 20 urchins (this time closer to the reef crest where the water was shallower and thus easier to work in) and marked the area with a buoy. Then in the wet lab I tied a single thread as tightly as I could onto a single spine of each urchin. At the end of each thread I attached a piece of numbered styrofoam and a piece of flagging. The styrofoam was meant to prevent the thread from getting tangled amongst the urchins' spines or in the grass, and the flagging was to make the marked urchins more noticeable, so I would be able to find them more easily. The threads, however, kept either slipping off the spines or taking the spines along with them. I ended up putting out only about 10 marked individuals, and the next day when I checked them, all of the threads were gone but two, only one of which was still attached to an urchin.

Needless to say, marking urchins for study without disrupting their behavior proved very challenging, if not downright difficult or even impossible. But a future naïve would-be urchin tracker could perhaps try using rubber-bands to hold numbered flagging in place on the urchins. (How rubber band cinching would affect their behavior, I don't know.) One's best bet would probably be to find some very resistant waterproof ink or paint that could actually remain on the spines for long periods of time, with which one could differentially mark the urchins. The spines' epithelial layers, however, might slough off any ink applied to them. One would have to try a variety of different paints to find out.

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