# Diel Migration of Zooplankton

## The Variation in Size Classes between Diurnal and Nocturnal Migrators

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## Abstract

The diel migration of zooplankton was studied in a coral reef habitat. Vertical tows were taken during the day and at night. Zooplankton ~~who~~ were identified to taxonomic groups and each individual measured.

Zooplankton densities were found to be greater at night with some taxonomic groups varying more than others. Both cyclopoid and calanoid copepods had similar densities between day and night samples. However large and small taxa were more abundant at night with the abundance of nauplii, hydrozoans and larvaceans all greatly rising.

The overall abundance of zooplankton was 1.44 times greater at night; the abundance of zooplankton over 1.00mm in length was 2.28 times greater at night. Mean lengths within taxa did not vary between day and night samples. This greater abundance of large zooplankton at night with less variation in abundance of other size classes suggests that visual predation may be a greater pressure for large zooplankton.


## Introduction

The diel migrations of zooplankton are thought to be mainly due to predation pressure by visual predators. Thus it is thought that the majority of zooplankton migrate into the water column at night when visual predation is less effective. Many zooplankton are seen to emerge shortly after dusk when plantivorous fish are in their period of least activity (Ohlhorst, 1982).

If this is the main factor influencing nocturnal migration, then smaller zooplankton might not show such migration or might show a diurnal emergence since their size would make them less susceptible to predation. It could be of more benefit for a zooplankton to be in the water column at all times to feed if predation isn't an overriding factor. It also could be advantageous for a small zooplankton to have opposite migration patterns from large zooplankton that prey on it. With this in mind I examined the distribution of sizes classes both within and between taxa for day and night samples of zooplankton taken over a coral reef habitat.

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## Methods

Zooplankton samples were collected on the West Fore Reef at Discovery Bay, Jamaica. The night sample was taken at 21:30h on March 3, 1985, and the day sample was taken at approximately 11:00h on March 6, 1985. A 48μm plankton net was used to take four vertical tows each of 10m for the night sample and of 12m for the day sample; this was done from a stationary boat at Mooring 1 where the depth is 15m.

Samples were fixed with 5-10% formalin and a twenty percent split was examined for each sample. Zooplankton were identified into taxonomic groups and each individual was measured using an ocular micrometer.

Zooplankton densities were calculated by modeling the vertical tow as a column with diameter equal to that of the net (.25m) and height equal to total vertical distance of tow.

## Results

In total I found 13 taxa, 9 of which were represented in both day and night samples, 3 that occured only at night and one that occured only during the day. All of those that occured in only one of the two sampling periods were represented by small numbers of individuals ($n<10$). Cyclopoid copepods were the most abundant taxa, followed by the calanoid copepods.

Table 1 shows that within a taxa the mean length was never different between day and night. This is most striking in the two copepods where there are large sample sizes and almost no difference. There is also no difference between the ~~combine~~ combined means for day versus night.

Table 2 shows the differences between taxa as to variations in total density between day and night. The distribution of sizes is shown in figure 1. The night sample has a wider distribution with greater densities in the small and large size classes than the day sample. When the total densities are compared the night is greater than the day by a factor of 1.44. If the samples are broken down into size classes of less than or equal to 1.00mm and greater than 1.00mm, then they vary by a factor of 1.38 for the ≤ 1.00mm group and 2.28 for the >1.00 group.

Figures 2 and 3 show that the distributions for the copepods do not vary greatly between day and night. In general the small sized taxa were better represented at night; hydrozoans (Figure 4), where there are 3.7 times as many at night and nauplii (Figure 6), where there are 6.2 times as many, are the most extreme examples of this.

The larger size classes were also better represented at night, due mostly to the increase of larvaceans in the night sample (Figure 7). Other groups such as the decapod larvae also showed an increase but not such a dramatic one (Figure 8). Mysids were only found in the day sample which goes against this trend since they are a relatively large zooplankton with the average length found to be 1.77 (Table 1); however there were only two found which provides little basis for difference between day and night samples. The taxa not graphically represented were similar in composition between day and night and had small sample sizes.

TABLE 1: Zooplankton Length for Different Taxa in Day and Night Samples.



| TAXA | Mean Lengths (mm) Day | Night |
|---|---|---|
| Cyclopoid Copepod | 0.52 ± 0.17 (n=389) | 0.52 ± 0.18 (n=346) |
| Calanoid Copepod | 0.63 ± 0.25 (n=124) | 0.62 ± 0.34 (n=107) |
| Nauplii | 0.20 ± 0.06 (n=22) | 0.17 ± 0.06 (n=114) |
| Larvacean | 1.53 ± 0.53 (n=15) | 1.32 ± 0.54 (n=51) |
| Decapod Larvae | 1.33 ± 0.55 (n=10) | 1.95 ± 0.62 (n=14) |
| Fish Larvae | 1.91 ± 0.48 (n=10) | 1.66 ± 0.51 (n=11) |
| Polycheate | 0.74 ± 0.46 (n=3) | 0.64 ± 0.35 (n=7) |
| Hydrozoans | 0.27 ± 0.08 (n=9) | 0.20 ± 0.06 (n=28) |
| Radidarians | 0.18 ± 0.04 (n=9) | 0.19 ± 0.05 (n=11) |
| Gastropod Veligers | | 0.26 ± 0.05 (n=8) |
| Echinoderm Larvae | | 0.83 ± 0.55 (n=5) |
| Amphipods | | 0.84 ± 0.33 (n=6) |
| Mysids | 1.77 ± 0.04 (n=2) | |
| Combined | 0.59 ± 0.36 (n=593) | 0.57 ± 0.45 (n=708) |

these are awfully small for hydrozoan medusae! Are you certain about the ID?

Table 2: Density for Different Taxa in Day and Night Samples.



| TAXA | Density (ind/m³) DAY | NIGHT |
|---|---|---|
| Cyclopoid Copepods | 828 | 887 |
| Calanoid Copepods | 264 | 274 |
| Nauplii | 46.8 | 292 |
| Larvacean | 31.9 | 131 |
| Decapod larvae | 21.3 | 35.9 |
| Fish larvae | 21.3 | 28.2 |
| Polycheate | 6.38 | 18.0 |
| Hydrozoan | 19.2 | 71.8 |
| Radiolarians | 19.2 | 28.2 |
| Gastropods Veligers | | 20.5 |
| Echinoderm Larvae | | 12.8 |
| Amphipods | | 15.4 |
| Mysids | 4.26 | |
| TOTAL | 1262 | 1815 |

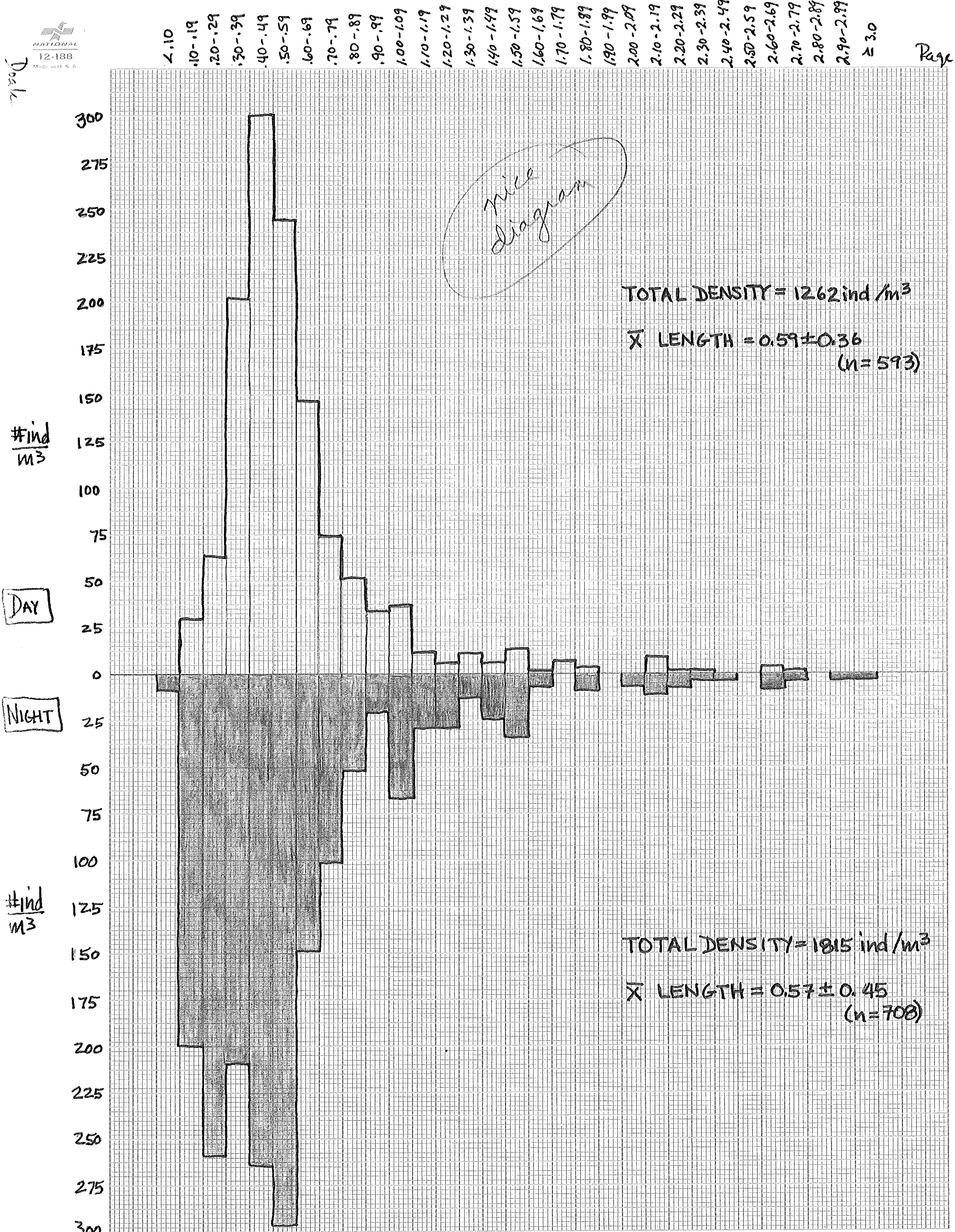


FIGURE 1: ZOOPLANKTON SIZE DISTRIBUTION IN DAY AND NIGHT SAMPES.
(LENGTH IN MM)

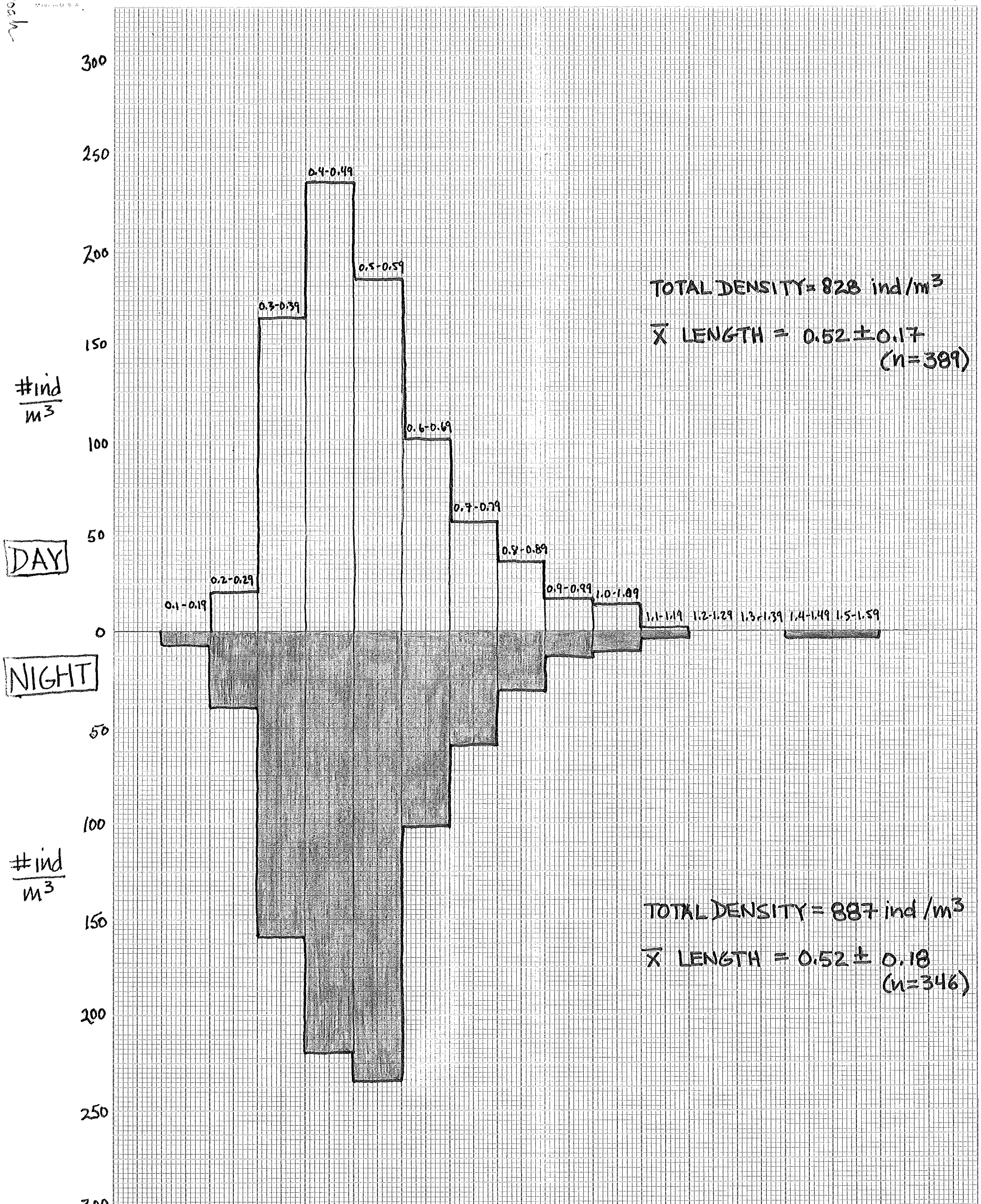


FIGURE 2: SIZE DISTRIBUTION OF CYCLOPOID COPEPODS IN DAY AND NIGHT SAMPLES. (length in mm)

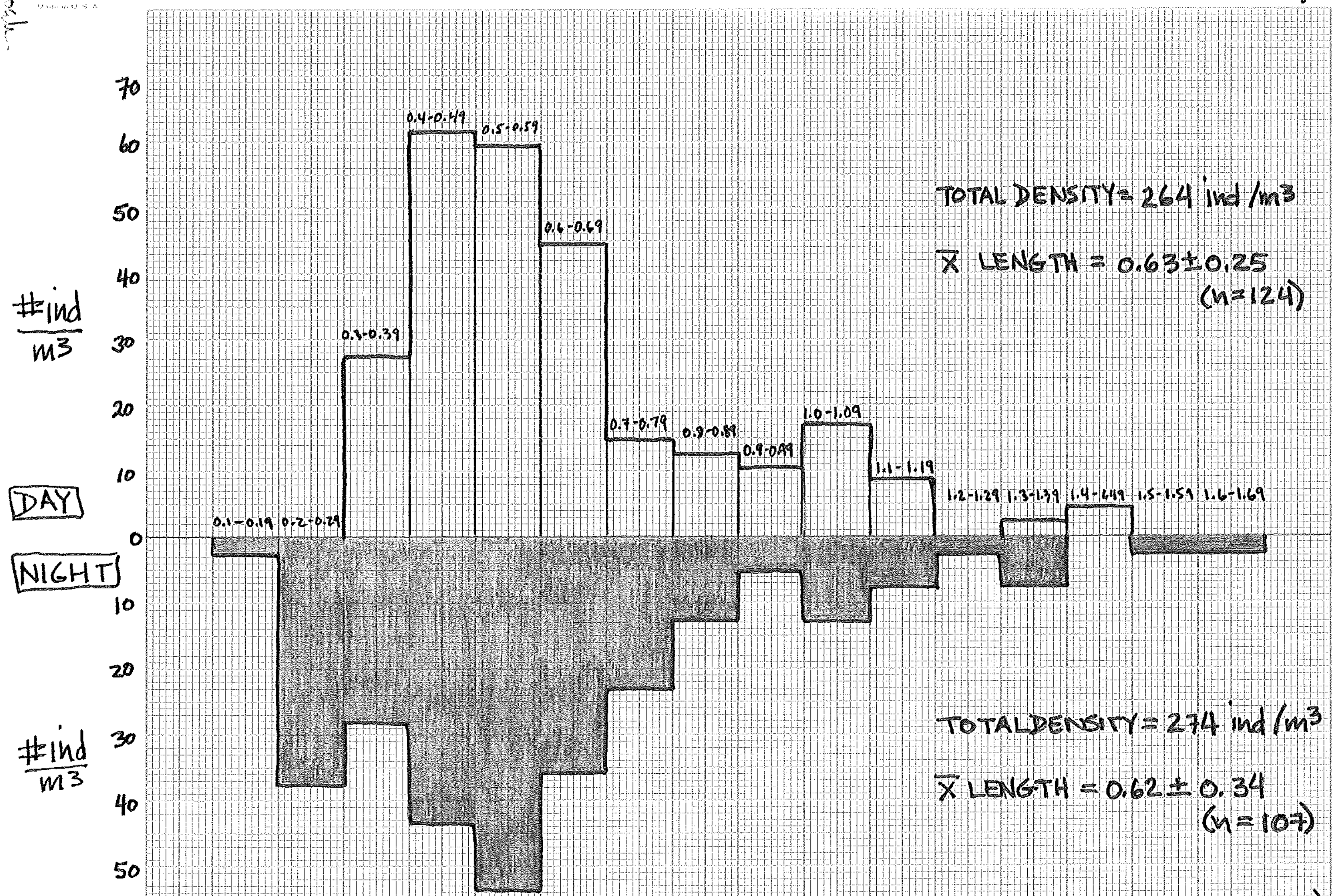


FIGURE 3 : SIZE DISTRIBUTION OF CALANOID COPEPODS IN DAY AND NIGHT SAMPLES (LENGTHS IN MM).

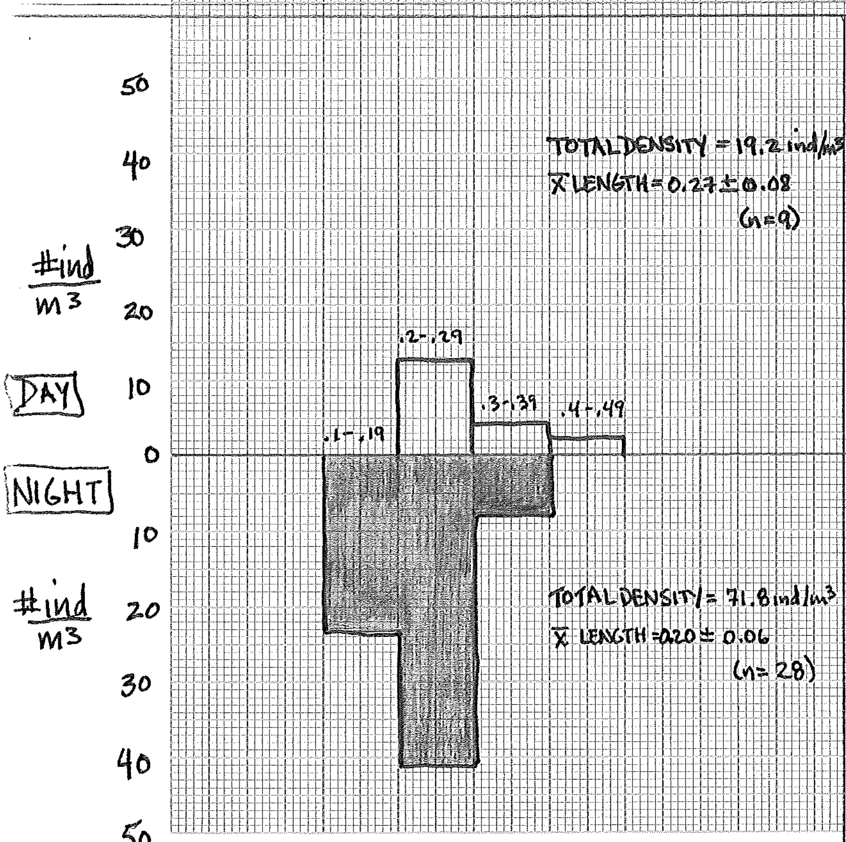


FIGURE 4 : SIZE DISTRIBUTION OF HYDROZOANS IN DAY AND NIGHT SAMPLES (LENGTH IN MM).

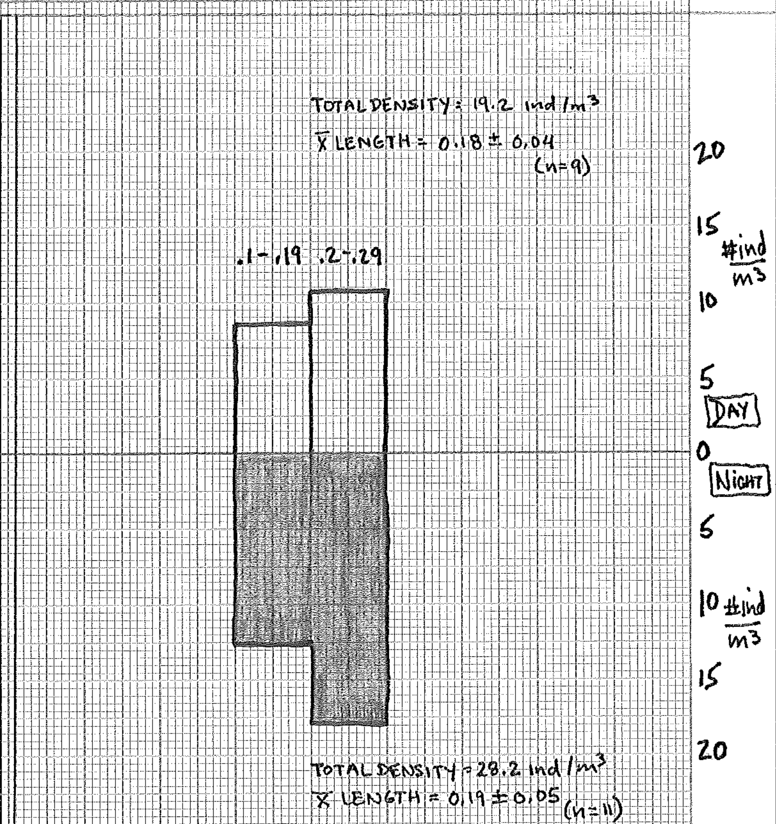


FIGURE 5 : SIZE DISTRIBUTION OF RADIOLARIANS IN DAY AND NIGHT SAMPLES (LENGTH IN MM).

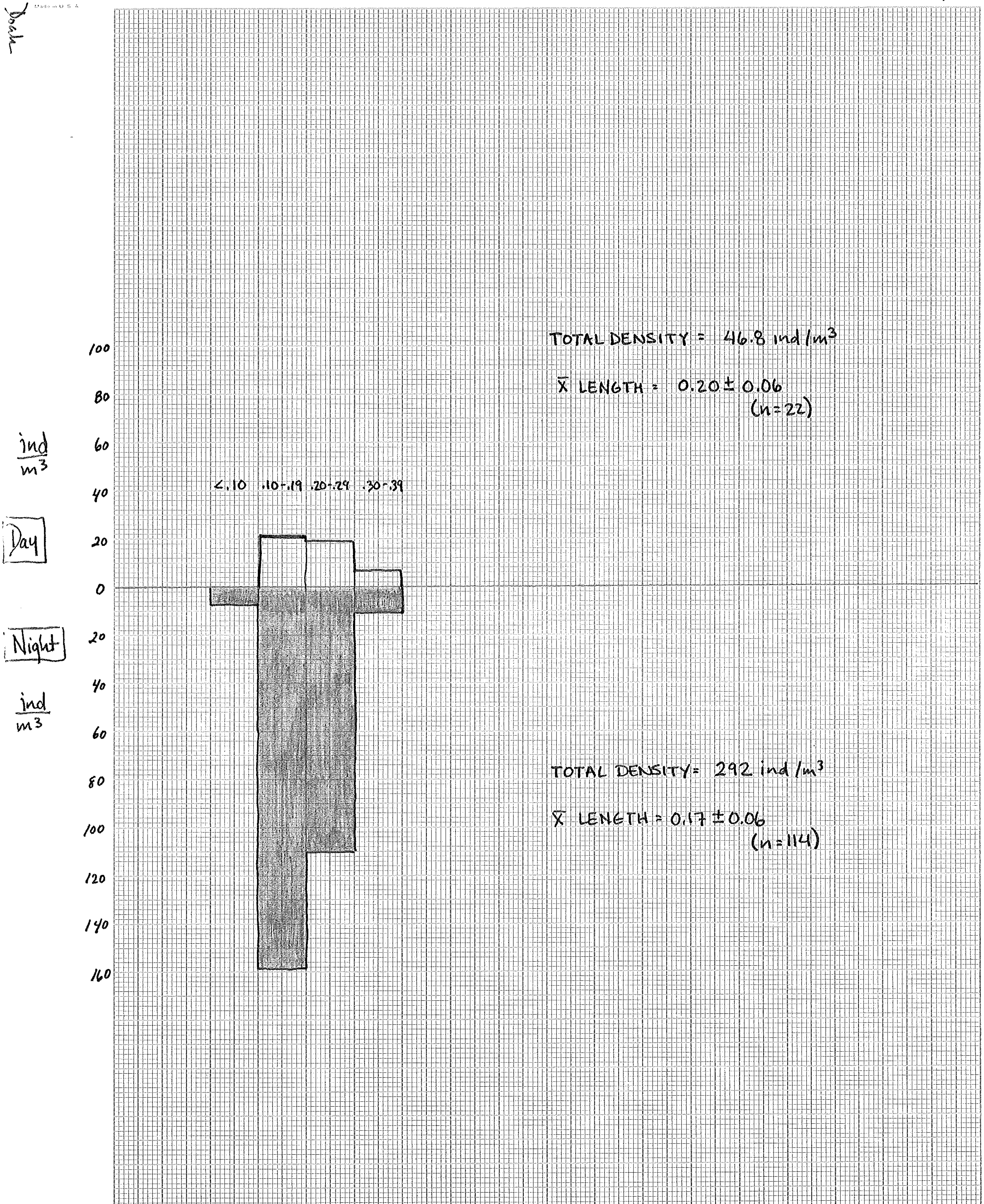


Figure 6: Size Distribution of Nauplii in Day and Night Samples (size in mm).

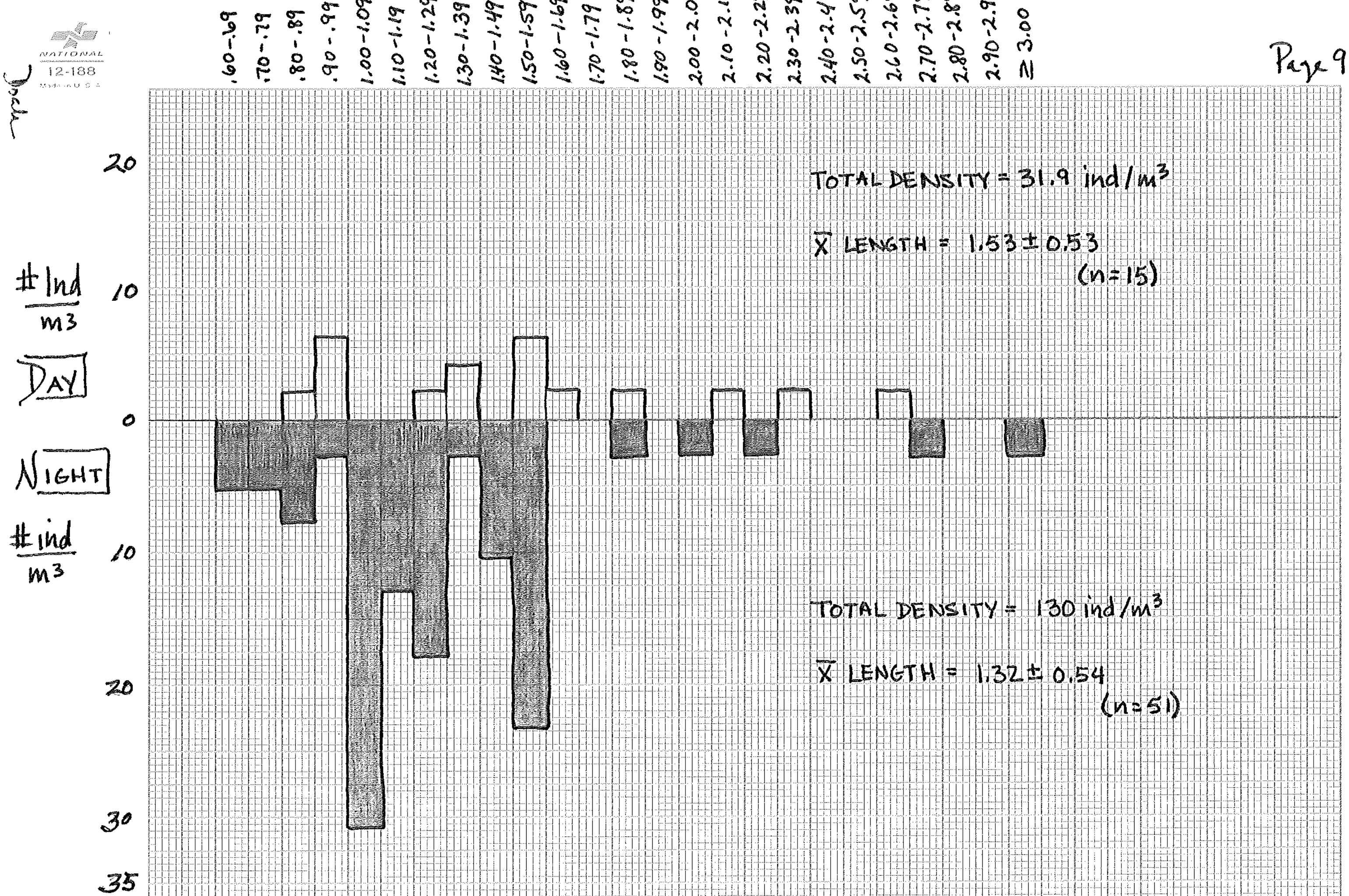


FIGURE 7: SIZE DISTRIBUTION OF LARVACEANS IN DAY AND NIGHT SAMPLES. (LENGTHS IN MM).

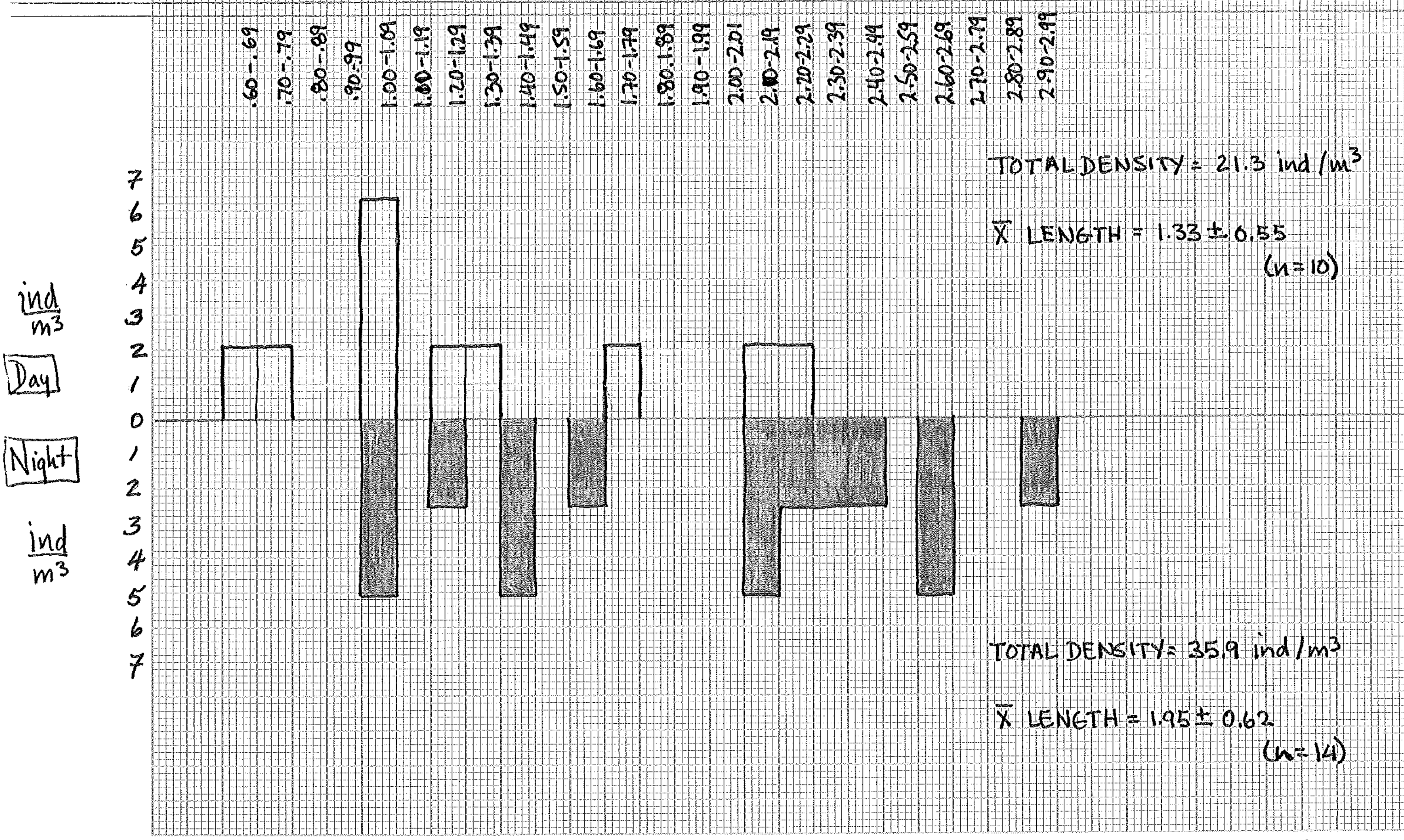


Figure 8: Size Distribution of Decapod Larvae in Day and Night Samples (Lengths in MM).

## Discussion

Due to my sampling techniques the data presented here is not suitable for statistical analysis but is better suited for examing general trends. Those trends are interesting when compared to the findings of other researchers. Ohlhorst (1982) looked at zooplankton emergence on the East Fore Reef at Discovery Bay. She also found cyclopoid copepods to be the dominant taxa and furthermore she found a single cyclopoid species, Oithona colcarva, to compose a larger percentage of the population than any other group. She found Oithona colcarva emerging at night but the majority of other cyclopoids emerging during the day. Other trends that can be related to my results are that she found that calanoid copepods did not have much variation in emergence between day and night, and that she found significantly higher numbers of copepod nauplii during the day. Decapod larvae, amphipods, and mysids were all more abundant at night. Vassiere et al. (1984) also found the presence of different species of copepods variable between night and day; some being clearly positively phototactic and some clearly negatively phototactic. He also found greater numbers of decapod larvae and larvaceans at night.

In general these two studies support what I have found. The lack of variation in copepod densities between day and night may be explained by different species being present at the different times, or, as Ohlhorst found with the calanoids, there may be little variation over time.

Those taxa with larger mean length (larvacean, decapod larvae, fish larvae, echinoderm larvae, amphipods) were found more at night with the exception of the mysids which were found only during the day and in this case only two were seen. With the exception of the larvaceans, only low numbers of individuals were found for any of these taxa. Since their reaction times are faster than those of small zooplankton, they may be better able to escape sampling such as was used. It also may be the case that their densities are much lower than those of the smaller taxa. Use of a larger mesh plankton net could give some idea as to whether these groups are being missed when a small mesh net is used (due to its slower movement through the water).

The most striking difference between my findings and those of Ohlhorst is the pattern of nauplii movement. Whereas she finds them emerging during the day, I found them in the water column at night (Figure 6). The fact that I found such low densities of nauplii compared to copepods (Table 2) would imply that there are more present that I was not finding; the abundance of nauplii should be equal to that of copepods and probably greater due to them being an earlier life stage. It could be that nauplii stay low in the water column so that they would be caught in emergence traps but not in my vertical tows. But this is not supported when my night sample is considered. Their abundance in the water column could also have been effected by turbulence. The day sample was taken in turbulent water whereas the night sample was taken when it was very calm. It is possible that turbulence interfers with zooplankton migration; a further study could look at this.

The lack of variation in mean lengths between day and night could have interesting implications as to the development of diel migration patterns. In the cases where the same species is present both night and day, a constant mean size would imply that their migration patterns do not change with increasing size but remain constant within a life stage even though it is possible that different migration patterns would be of different benefit to varying sized individuals.

My findings of greater abundances of large zooplankton at night, whereas smaller taxa vary less between day and night, supports the idea of large zooplankton being more effected by visual predation. However the fact that I don't find small taxa more abundant during the day leaves the question of whether they are uneffected by such predation unanswered. A more thorough investigation of this topic might provide some conclusive results.

Improvements in study methods are easy to find when looking at this project. Samples should be made on the same day and, maybe more importantly, during the same water conditions (turbulent versus calm). Duplicates should be taken over a series of days to account for variation over time. When samples are split, more and smaller splits should be done rather than one large one – this provides another level of duplication. The more the taxonomic groups are broken down into their component parts, the more useful the data becomes; even Ohlhorst's separating out of one cyclopoid species shows a variation (some being diurnal and some nocturnal migrators) that would be lost without the distinction. Samples using a large mesh net might give more representative samples of large zooplankton or at least answer the question of whether samples with the small net are representative of the natural population. More sampling periods could also give a better emergence pattern for different size classes.

Very nice presentation of data and discussion of trends and methodology. Another study, modeled after the one you suggest, should be done

## References

Ohlhorst, S.L., 1982. Diel Migration Patterns of Demersal Reef Zooplankton, Journal of Experimental Marine Biology and Ecology, Vol. 60, pp. 1-15.

Vaissière, R. and G. Seguin, 1984. Initial Observations of the zooplankton microdistribution on the fringing coral reef at Aqaba (Jordan), Marine Biology, 83:1-11.