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The Effect of Day Length on the Longevity of *Drosophila melanogaster*

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ABSTRACT

This paper looks at how different photoperiods can affect the longevity of *Drosophila melanogaster*. To do this, three groups of flies were placed in three different periods of light and dark. The control group had 12 hours light/dark, the long group had 16 hours light/dark, and the short group had 8 hours light/dark. I found that the control group lived significantly longer then the long treatment group. I also found that the short treatment group lived significantly longer then the long treatment group. There was no significant difference in longevity between the control group and the short treatment group.

Keywords: *Circadian rhythm, Drosophila melanogaster*

INTRODUCTION

The study of circadian rhythms has been going on for many years. Circadian rhythms are the natural biological clocks that consist of approximately 24-hour cycles of biochemical activity. There have been some major breakthroughs recently on how these clocks work. The discovery of the genes Period (per) and Timeless (tim) in *Drosophila melanogaster* and Frequency (frq) in *Neurospora crassa* and their effects have been the main focus of the recent circadian rhythm literature.

In *Drosophila*, tim and per are thought to be the major clock components. Most of the research to date shows that the proteins PER and TIM are associated with a negative feedback loop (Crosthwaite, 1997). These proteins cycle up and down daily and feedback on their genes to regulate their own cycling (Barinaga, 1996). Researchers have spent a lot of time trying to figure out how the feedback loop works and how the clock is reset.

Scientists now believe that light is the reset button for the clock in *Drosophila* (Barinaga, 1996). Light input is perceived through photoreceptor molecules, which generate a signal that is transduced to the circadian oscillator where it acts to change the level or activity of a component of the clock (Dunlap, 1996). TIM levels have been shown to decrease in less then one hour of exposure to light (Zeng, 1996). PER is unstable in the absence of TIM but TIM functions normally without PER (Zeng, 1996). Because of this data, TIM is thought to be the major clock component in circadian rhythms.

Researchers have also looked at how mutations in the per gene affect *Drosophila*. Mutations in the per gene can lengthen, shorten, or abolish the periodicity of some behavioral rhythms in flies. This has been seen in *Drosophila*'s eclosion rhythms in a study done by Sehgal, et al (1994). They showed that any mutations in the per gene causes arrhythmic patterns in eclosion times of flies.

In my research, I want to look at how different cycles of light affect *Drosophila*. I want to find out if the length of day, shorter or longer then 24-hours, will affect the longevity of the flies. My hypothesis is that the length of day will have a significant effect on the longevity of *Drosophila melanogaster*. I will test this by exposing the flies to different amounts of light and dark and record how many die each day. I will then use a survivorship curve to see if there is a significant difference in the life span of each group of flies.

MATERIALS AND METHODS

I obtained one culture of wild-type *Drosophila melanogaster* from the Carolina Biological Supply Company. I emptied the culture vial of all flies so only the pupae were left. I came in the next day and retrieved the newly emerged flies. I used FlyNap, obtained from Carolina Biological Supply Company, to put the flies to sleep. I used a microscope to determine the sex of each fly. I placed each sex in a different vial. I did this to keep the flies from reproducing during the procedure. The vials were labeled with the date, sex of flies, number of flies, and which treatment they were in (L for long, S for short, and C for control). I then placed the vials in an incubator from Carolina Biological Supply Company. The temperature was kept at approximately 25°C for all the treatment groups.

I repeated this procedure every day for each group. The short treatment group was given an alternating period of 8 hours light/dark, the long treatment group was given an alternating period of 16 hours light/dark, and the control group was given an alternating period of 12 hours light/dark. Every day, I came in and checked the vials to record how many flies had died. I made sure to check the flies only when the lights were on. This was to ensure that I did not reset their clock.

After all the flies in all the treatment groups were dead, I gathered the data for analysis, treating each group as a single cohort. I then used the Kolmogorov-Smirnov test for two samples to see whether there were any significant differences between the survivorship curves of the treatment groups.

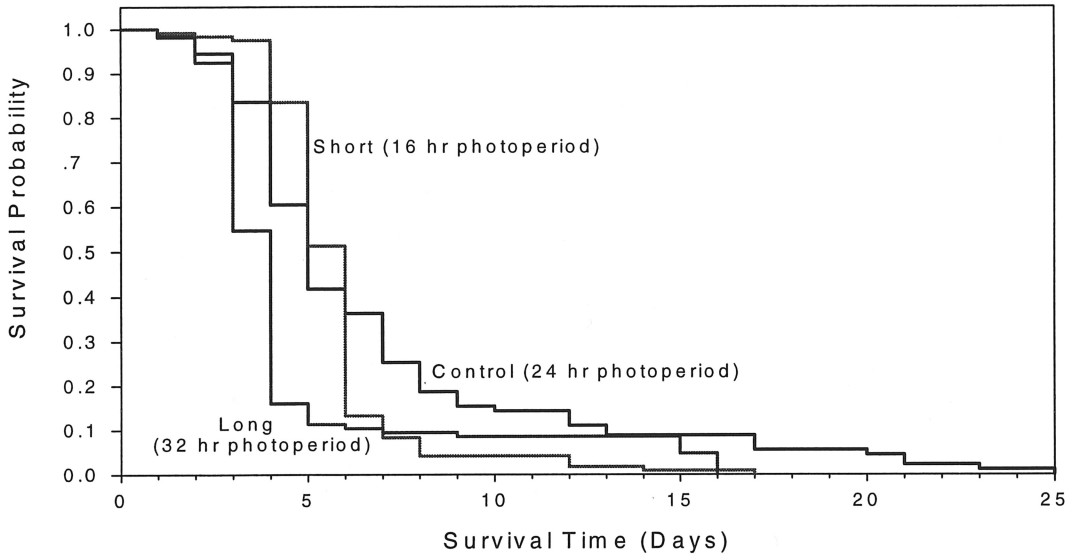

Figure 1. The survivorship curves for all three of the treatment groups. The short group had alternating periods of 8 hours light/dark, the long group had alternating periods of 16 hours light/dark, and the control group had alternating periods of 12 hours light/dark.

RESULTS

I found that there is a difference in the survivorship of the flies in each group. Figure 1 shows the survivorship curves for each of the three groups. There is no significant difference between the control group and the short group. There was, however, a significant difference between the control group and the long group and also between the long group and the short group. The data for this can be seen in Table 1.

Table 1. I used the Kolmogorov-Smirnov test for two samples to find the significant difference in *Drosophila melanogaster* between the control group (n=25), the short group (n=17), and the long group (n=16). The constant c was 1.36 with a level of significance at 0.05.

	Dmn	K-S	Significant/Not Significant
Control X Long	0.44	1.374	Significant
Control X Short	0.23	0.732	Not Significant
Short X Long	0.67	1.924	Significant

I used a life table to calculate what the life expectancies from eclosion were for each of the three groups of flies. The life expectancy from eclosion for the short group was 5.23 days, the life expectancy for the long group was 4.07 days, and the life expectancy for the control group was 6.26 days.

There were a few days when the timer for the short group and the long group malfunctioned. The timer either did not come on or go off when it was scheduled to. The temperatures for each group were kept at approximately 25°C.

DISCUSSION

Although I did find a significant difference between some of the groups, they were not exactly what I had expected. I thought the long group would have the longest life expectancy from eclosion and the short group would have the shortest life expectancy. It turns out that the long group had the shortest life expectancy from eclosion and the control had the longest life expectancy.

One reason for this could be the temperature. I tried to keep all the groups at the same temperature, 25C. There were, of course, some fluctuations. The short group was kept in an incubator that automatically controlled the temperature. The other two groups were just kept in enclosures that I had made. Since the lights were kept on for such a long period of time for the long treatment, it could have raised the temperature above 25C. The range of temperatures best suited for the growth of *Drosophila* is between 20C and 25C. Any temperature higher then this may shorten the life cycle because higher temperatures are conducive to the growth of bacteria, fungi, and mites (Flagg, 1988). If I did this experiment again, I would use incubators with

temperature control for all the treatment groups.

Another factor that might have affected my data is the fact that the timer malfunctioned. This could have reset the clock of the flies and caused them to die earlier or live longer then they should have. Since the timer only malfunctioned a day or two in a row, I don't know if this is a big factor. I would definitely watch the timers more closely if I did this experiment over.

LITERATURE CITED

Barinaga, M. 1996. Researchers find the reset button for the fruit fly clock. Science 271: 1671-1672.

Crosthwaite, S.K., J.C. Dunlap, and J.J. Loros. 1997. Neurospora wc-1 and wc-2: transcription, photoresponses, and the origins of circadian rhythmicity. Science 276: 763-768.

Dunlap, J.C. 1996. Genetic and molecular analysis of circadian rhythms. Annual Review of Genetics 30: 579-601.

Flagg, R. 1988. Carolina Drosophila Manual. Burlington, North Carolina. p 4.

Sehgal, A., J.L. Price, B. Man, and M.W. Young. 1994. Loss of circadian behavioral rhythms and *per* oscillations in the *Drosophila* mutant *timeless*. Science 263: 1603-1605.

Zeng, H., Z. Qian, M.P. Myers, and M. Rosback. 1996. A light-entrainment mechanism for the *Drosophila* circadian clock. Nature 380: 129-135.