NATURAL TIMING DEVICES AS BIOLOGICAL CLOCK IN LIVING ORGANISMS

Seyed Parsa Saadatjoo. Andishe Farda High School, Mashhad, Tehran, parsasaadatjoo86@gmail.com

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Advisor: Ali Qaraee Najafabadi

Accepted by Ariaian Young Innovative

Minds Institute , AYIMI

http://www.ayimi.org ,info@ayimi.org

ABSTRACT

Biological clocks are natural timing devices in living organisms such as plants, animals, humans, microbes and many others. They mostly work throughout the day-cycle and react based on the light they receive. Most daily activities are seen in the Circadian rhythms which are 24-hour cycles, but we can see behaviors in other cycles as well, such as Circalunar rhythms which are monthly activities, or the Circannual rhythms which are yearly cycles; we can see behaviors like seed germination, flowering and leaf fall in plants in the Circannual rhythms.

Key Words : *Biological Clock, Living Organisms, Circadian Rhythms*

1. Introduction

Biological clocks are natural timing devices that are organized by the day-cycle. They are spread throughout all our body and interact with several kinds of cells.

Biological clocks are fundamental to the functioning of life and to the organization and coordination of behavior. Simple behavioral functions, such as timing active and inactive periods during the day/night cycle to maximize productivity and minimize risk rely on internal clock functions.

The main secretion point of Melatonin is a part of the brain called the SCN inside the hypophysis.

Circadian Rhythms are physical, mental, and behavioral changes that follow a 24-Hour cycle that primarily react to light and darkness and affect lots of living organisms like people, plants, microbes and animals.

Biological clocks in birds are critical components of their physiology and behavior . However, as the properties of the pineal gland's function became clearer and the identification of new pacemakers in the hypothalamus and retinae made the system appear more complex.

Being a derivative of serotonin, melatonin is one of the main hormones affecting many species throughout the day-cycle.

2. Method

Examples of timing processes in living organisms are plants opening their flowers at particular times of the day or sleep-wake cycles in humans. To Propose a problem concerning rhythms and timing in the species we have examined in both plants and animals (Fig. 1).

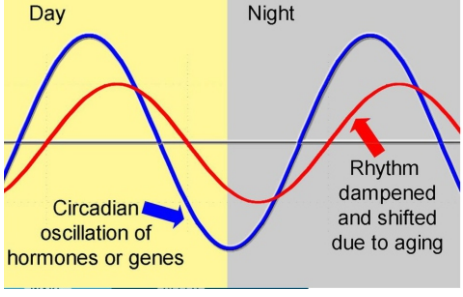

Fig. 1: Circadian Rhythms

2.1 Circadian Rhythms in Plants

Because the function of a biological clocks is to anticipate environmental changes they tend to be set to environmental rhythms such as daily, tidal and seasonal changes. While, the behavior or response itself is mediated by the endogenous (internal) biological clock, the clock is set to these exogenous (external) environmental cycles. As a result the following are commonly observed periods for biological rhythms:

Circadian –daily activity (~24hrs) E.g. Sleep movements, the opening and closing of flowers and solar tracking

Circatidal –tidal activity period (~12.4hrs)

Circalunar –monthly activity period (~29days)

Circannual –Yearly activity period (~365 days) Seed germination, flowering, and leaf fall

3. Experiments

3.1. Comparing Leaves in Plants

Plant A: 6 hours of light and 6 hours of darkness

Plant B: 12 hours of light and 12 hours of darkness

*Both watered at the same time

*Both with the same conditions (Fig. 2)

Fig. 2: Two identical plants

Number of leaves in this two identical plants are compared in different times (Fig. 3).

3.2. Comparing Stems in Plants

Plant A: 6 hours of light and 6 hours of darkness
Plant B: 12 hours of light and 12 hours of darkness
*Both watered at the same time
*Both with the same conditions (Fig. 4)

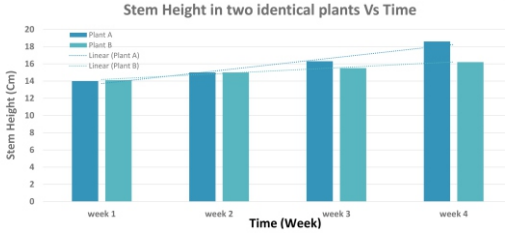

Fig. 4: Stem height vs time

3.3. Comparing Flowers in Plants

Plant A: 6 hours of light and 6 hours of darkness
Plant B: 12 hours of light and 12 hours of darkness
*Both watered at the same time
*Both with the same conditions (Fig. 5)

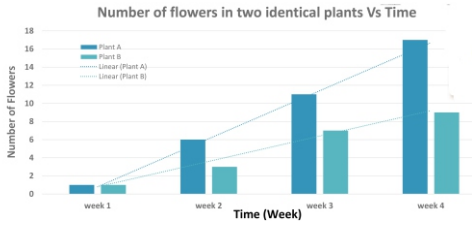

Fig. 5: Number of flowers vs time

3.4. Comparing the Amount of Light in Plants

Some of the plants open and close their flowers according to the changes in the amount of light during the day and night. Chinese rose flower was used in this experiment (Fig. 6).

Fig. 6: Changes in plants in front of light and darkness

3.5. Comparing the Roots in Plants

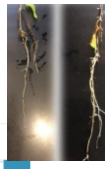

Fig. 7: Root's height vs time

3.6. Comparing Biological Clock in Animals

Chicken A: 12 hours day- cycles
Chicken B: 24 hours day- cycles
*Both chickens were fed 40 gr a day
*Both chickens grew in the same conditions (Figs. 8 and 9)

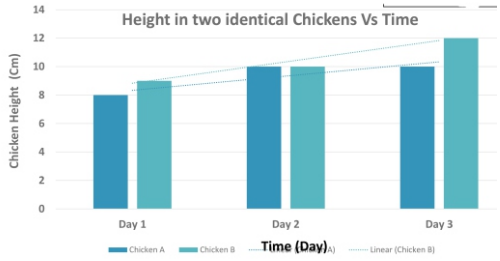

Fig. 8: Height in two identical chickens vs time

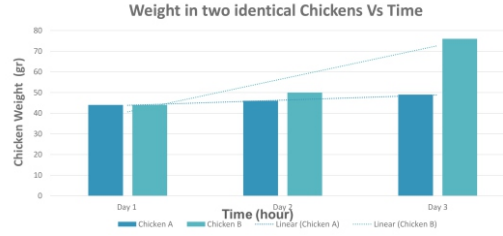

Fig. 9: Weight in two identical chickens vs time

4. Results

Comparison in plants resulted in (Figs. 10-12):

Fig. 10: Growing the stem and increasing the number of leaves in plants

Fig. 11: Increasing the number of flowers in plants

Fig. 12: Growing the roots and increasing its height in plants

Results in animals:

Increasing the weight and height of chickens (Figs. 13 and 14).

Fig. 13: 12 Hour day-cycles 49 gr — 24 Hour day-cycles 76 gr

5. Conclusion

In our study we found:

- Circadian rhythms can affect the growth and development of living organisms, both in plants and animals.
- In the study related to plants, the reduction of the circadian rhythm to half of the normal state resulted in an increase in the number of leaves, flowers, and an increase in the length of the roots and stems.
- In the chicken study that was conducted over three days, the chicken with the shorter circadian rhythm was removed from the experiment after three days due to weakness and inability to treat and help him recover. We think the reason why chicks are weaker with a shorter circadian rhythm is jet lag.
- The chicken with a longer circadian rhythm showed more growth and development in the same and equal period of time by receiving sufficient and equal amount of water and food compared to the chicken with a shorter circadian rhythm.

References

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