The Effect of Light Intensities on the Growth and Reproduction of *Daphnia magna* (Cladocera – Daphniidae) under Experiment Conditions

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Abstract

The Study was conducted on Daphnia magna which is cultured as live food for fish larvae and crustaceans in fish farms.

The first batch of these Crustaceans was collected from the fresh water bodies nearest to Tishreen University. Then, the individuals have been adapted in laboratory conditions to prepare them for a series of experiments. After that, we determined the effects of light intensities (0, 300, 800, 1500 lux) on some biological characteristics such as growth and reproduction rates. Experiments lasted from 15/02/2019 until 14/ 12/ 2019. *The results showed that the suitable light intensity for the growth and reproduction of D.magna is 800 lux which we can use in future cultures of D.magna.*

Keywords*: Cladocera, Daphnia magna, biology, light intensity, freshwater.*

I. INTRODUCTION

Micro-crustacean Daphnia play an important role in carbon transferring from primary producers to higher trophic levels. They are primary consumers that feed on algae and bacteria. They also form the primary preys for many fish species [1] , [2].

The biology and ecology of Daphnia depend on a number of biotic and abiotic factors. Individual Daphnia behaviour shows extreme plasticity as a response to both external and internal factors, such as temperature, light, individual size, food, presence of predator infochemicals and occurrence of toxic substances [3], [4],[5], [6], [7], [8], [9], [10]. Among the abiotic factors, light intensity plays a particularly important role.

Among several dozen taxa of the genus, one particular species, *Daphnia magna* Straus 1820, is the object of hundreds of scientific publications per year. Besides being used for ecological, evolutionary and physiological studies, it is also an important model for toxicological studies [11].

One of the interesting characteristics of Daphnia is cyclical parthenogenesis i.e. they have two different types of reproduction including sexual and asexual (parthenogenetic) reproduction modes in their life cycle [12].

Light can also be considered crucial for the growth of Daphnia as daily and seasonal vertical Daphnia migrations through the water column have been observed as being dependent on the light climate
[13].

The aim of this work is to investigate the effect of light intensity on the growth and reproduction of *Daphnia magna* in laboratory experiments.

II. Materials and Methods:

A. Experimental animals:

The experiments were conducted in the scientific research laboratories in the Faculty of Science.

D.magna was collected from the fresh water bodies nearest to Tishreen University. The individual have been adapted in the laboratory conditions; they were kept in a 12 litre aquarium (30×20×20cm), supplied by an air pump, and fed a mixture of green algae (*Scenedesmus obliquus)* and yeast. Water temperatures ranged from (22- 24) °C, DO (7.5 mg/L), pH (7-8). The test organisms for all the experiments were obtained from controlled cultures. All the individuals were measured at the beginning of the experiments. Individuals were placed on a glass slide with small pit and temporarily immobilised through the elimination of the surrounding water with a micropipette. Measures were immediately taken, trying to assure both accurate readings and a minimum stress or damage to the organisms. Healthy neonates (about 24 h) were taken and put in 14 glass beakers (50 ml), one Daphnia in each. The beakers were maintained at constant conditions of temperature (23 ± 1 °C), under cool white light,

humidity 5±70% and 14:10 h light/dark cycle, with continuous ventilation according to typical conditions in a laboratory incubator. Daphnids were fed daily with 1–2 mL mixture of green algae (*Scenedesmus obliquus)*. Size measurements of animals were performed using a microscope. The Daphnia were examined daily and were transferred to a new beaker of water and food. The effects of light intensity were studied. Four different light intensities were employed: (darkness, 300, 800, 1500 lux). Body length, width, and weight, the number of molts, the number of offspring, both living and dead, the number of broods, the number of partial and complete abortions, time required for sexual maturity and date of death were recorded daily. The experiments continued until the death of the last female.

III. RESULTS

- **Common names:** *Daphnia magna*
- **Taxonomic Standing**

Kingdom: Animalia
Phylum: Arthropoda
Subphylum: Crustacea
Class: Branchiopoda
Order: Cladocera
Family: Daphniidae
Genus: *Daphnia*
Species: *Daphina magna* Straus 1820

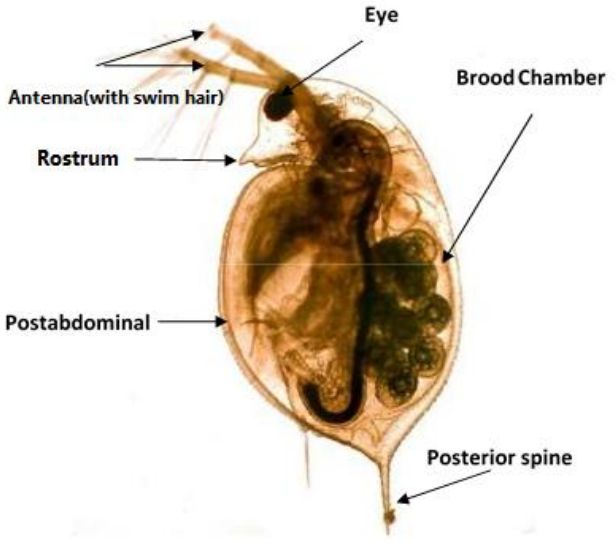

Figure 1: photo of *D. magna* [14].

Growth rate is comparatively rapid in young animals and progressively decreases as the animal ages. Light intensity significantly affected the mean body length. The lengths of individuals of the population under 800, 300, 1500 lux were significantly larger than those of the population under 0 lux. There were no significant differences in the numbers of pre-adult molts except for the population under 800 lux which was significantly higher than other populations. However, the population under 1500 lux took 6 .71 days to reach sexual maturity or to release broods and this was significantly greater than the number of days required by populations under 300, 0 and 800 which took, 6.57, 6, and 4.64 days, respectively.

Light intensity significantly affected the average number of young produced per adult during the experiment. Population under 0 lux produced less young than did populations under 1500, 300, 800 lux. Light did significantly affect growth, reproduction, survival, rate of oxygen consumption and filtering. (Table 1).

Table 1: Biological characteristics of *Daphnia magna.*

Biological characteristics	Light intensities (lux)			
	0	**300**	**800**	**1500**
Min Length (mm)	0.85	0.96	1.02	0.87
Mean Length (mm) $\pm sd$	2.42 $\pm$ 0.65	2.63 $\pm$ 0.66	2.95 $\pm$ 0.70	2.56 $\pm$ 0.58
Max Length (mm)	3.16	3.39	3.63	3.28
Min width (mm)	0.59	0.59	0.63	0.53
Mean width (mm) $\pm sd$	1.68 $\pm$ 0.47	1.81 $\pm$ 0.48	2.12 $\pm$ 0.54	1.74 $\pm$ 0.43
Max width (mm)	2.23	2.28	2.60	2.17
Min weight (mg)	0.03	0.04	0.05	0.03
Mean weight (mg) $\pm sd$	0.88 $\pm$ 0.52	1.11 $\pm$ 0.63	1.54 $\pm$ 0.76	0.99 $\pm$ 0.49
Max weight (mg)	1.64	2.02	2.48	1.83
Mean Days prior to release of broods	6	6.57	4.64	6.71
Mean Broods per an adult	4.7	6.92	12.14	8.78
Mean Live young per brood	5.87	7.11	10.50	5.67
Mean Young per an adult	23.14	44.28	101	41.92
Mean Survival in days	15	27	25	29

IV. DISCUSSION

Daphnia is primarily negatively phototropic and positively geotropic, but a reduction in light intensity reverses the signs of tropism. This reaction persists for a few minutes, showing that Daphnia exhibit labile behavior in relation to illumination [2].

Light intensity represents a key driver in the dynamics of Daphnia populations [4].

Light intensity has a twofold effect. Intensity 800 enhances the biological and metabolic activity of organisms, increasing energy available for locomotion and therefore the power available for thrust generation. At the same time, the darkness reduces the growth and reproduction of daphnia [15].

V. CONCLUSION

- Our outcomes indicate that *D. magna* can interact with its environment by adapting its behavior.
- In experiments with different levels of illumination (0, 300, 800, 1500 lux), the growth and reproduction of Daphnis were different.
- Increase in the level of illumination to 1500 lux reduced the body length and reproduction rate. The same results showed in the darkness too.
- Light intensity 300 lux was a good condition for the growth and reproduction of *D.magna* but was not optimal.
- The results of this study showed that the growth and reproduction of *D.magna* could be promoted when exposing Daphnia to the light intensity 800 lux which was the best light condition in the study.

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