

Comparative Study of Locomotory, Sensory, Olfactory, Neurogenerative, Pupa Size and Pupa Count Between Light and Dark Grown *Drosophila*

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Abstract—This study examines the effect of environmental light conditions on developmental and behavioral parameters in *Drosophila melanogaster*. Fruit flies were cultured under light and dark conditions to compare locomotor behavior, olfactory response, pupal size, and pupal yield. Behavioral assays such as negative geotaxis, larval crawling, and olfactory preference tests were performed. Results showed differences in locomotor performance, pupal size, and pupal production between light-grown and dark-grown flies. These findings demonstrate that environmental lighting can influence developmental physiology and behavior in *Drosophila*.

Index Terms—*Drosophila melanogaster*, circadian rhythm, locomotor activity, olfactory response, developmental biology, light exposure.

I. INTRODUCTION

Drosophila melanogaster, commonly known as the fruit fly, has served as one of the most important model organisms in biological research for over a century. The organism is widely used in studies of genetics, developmental biology, neuroscience, and evolutionary biology. The popularity of *Drosophila* as an experimental model is due to its short life cycle, ease of maintenance, and the availability of powerful genetic tools. Scientists have used this organism to understand the genetic basis of development, behavior, and disease.

The life cycle of *Drosophila* consists of four main developmental stages: egg, larva, pupa, and adult. Under standard laboratory conditions of approximately 25°C, the entire life cycle is completed within 10 to 12 days. After the egg stage, larvae pass through three instar stages during which they feed

actively and increase in size. After the third instar stage, larvae transform into pupae where metamorphosis occurs, eventually leading to adult emergence.

Environmental factors play a significant role in shaping the development and physiology of living organisms. Among these factors, light is particularly important because it regulates circadian rhythms, behavioral patterns, and metabolic processes. In many organisms, biological clocks synchronize internal physiological processes with external environmental cycles.

In *Drosophila*, circadian rhythms are regulated by clock genes such as period (*per*), timeless (*tim*), clock (*clk*), and cryptochrome (*cry*). These genes control rhythmic patterns of activity and rest that occur approximately every 24 hours. Light acts as a powerful environmental signal that can reset the circadian clock and influence behavioral responses.

Because of the strong interaction between environmental cues and genetic pathways, *Drosophila* provides an excellent system for studying how environmental factors influence development and behavior. Researchers frequently use behavioral assays such as climbing tests, locomotor activity monitoring, and olfactory preference experiments to evaluate neurological and sensory functions.

The present study aims to investigate how different lighting environments affect multiple biological parameters in *Drosophila melanogaster*. Specifically, the study focuses on comparing locomotor performance, olfactory behavior, pupal size, and pupal yield between flies raised in light conditions and those raised in darkness.

II. REVIEW OF LITERATURE

Previous research has shown that environmental light conditions strongly influence circadian rhythms in *Drosophila*. Early genetic studies identified mutations in clock genes that altered rhythmic behavior in fruit flies. These discoveries provided the foundation for understanding circadian regulation in many organisms.

Yadav et al. reported that alterations in light cycles can influence developmental progression in *Drosophila* larvae and pupae. Changes in light exposure were shown to modify hormonal signaling pathways that control growth and metamorphosis.

Studies by Yamanaka and colleagues highlighted the role of neuroendocrine pathways in regulating metamorphosis. Hormones such as prothoracicotropic hormone (PTTH) trigger the release of ecdysone, which controls molting and metamorphic transitions. Research on locomotor behavior frequently employs the negative geotaxis assay. In this experiment, flies naturally climb upward against gravity after being tapped to the bottom of a vial. The climbing response reflects neuromuscular coordination and overall motor function.

Olfactory behavior in *Drosophila* is mediated by specialized sensory neurons located in the antennae and maxillary palps. These sensory neurons detect volatile chemicals in the environment and guide flies toward food sources or away from harmful substances. Environmental conditions during development can influence neural circuit formation and sensory processing. For example, flies raised under different environmental stresses may display altered locomotor activity or sensory responses.

Taken together, these studies demonstrate that environmental cues such as light have the potential to influence both development and behavior in *Drosophila*. The current investigation builds upon this knowledge by experimentally comparing flies raised in continuous light versus continuous darkness.

III. MATERIALS AND METHODS

Culture Medium Preparation: *Drosophila* culture medium was prepared using jaggery, semolina (rava), agar, propionic acid, and distilled water. The ingredients were mixed and heated to form a semi-solid medium suitable for larval growth.

Propionic acid was added as an antifungal agent to prevent microbial contamination.

Experimental Design: Four culture bottles were prepared at the beginning of the experiment. Two bottles were maintained under light conditions and two bottles were kept in complete darkness. All bottles contained identical food medium and were maintained under similar temperature conditions.

Fly Transfer Procedure: Adult flies were transferred from stock cultures into freshly prepared culture bottles using a transfer brush. Care was taken to ensure that approximately equal numbers of flies were introduced into each bottle.

Developmental Observation: The cultures were monitored daily to record the appearance of developmental stages. Egg deposition, larval instars, pupation, and adult emergence were recorded carefully.

Negative Geotaxis Assay: Adult flies were placed in a vertical tube marked at a height of 10 cm. The tube was gently tapped to bring the flies to the bottom, and the number of flies that crossed the 10 cm mark within 6 seconds was recorded.

Larval Crawling Assay: Larval movement was studied on agar plates divided into three zones containing odor source, control substance, and neutral area. The movement of larvae toward or away from the odor source was recorded.

Olfactory Preference Test: A T-junction apparatus was used to evaluate adult odor preference. Flies were exposed to different volatile chemicals including ethyl acetate, ethanol, butanol, propionic acid, and acetic acid.

Pupal Measurement: Pupal size was measured using a compound microscope equipped with an ocular micrometer. Measurements were taken at 10× magnification to compare size differences between treatments.

Pupal Count: The total number of pupae formed in each culture bottle was counted at the end of the developmental cycle.

IV. RESULTS

The developmental timeline of *Drosophila* was similar in both environmental conditions. Eggs were observed on 23/05/2025, first instar larvae appeared on 29/05/2025, second instar larvae on 30/05/2025, and third instar larvae on 31/05/2025.

Pupation was observed on 02/06/2025 in both light and dark cultures. This indicates that the basic developmental timeline was not significantly altered by lighting conditions.

In the climbing assay, flies grown in light conditions showed improved locomotor activity. On average, 3.6 flies crossed the 10 cm mark within six seconds compared with 2.4 flies in dark conditions.

Pupal size measurements indicated that pupae from dark conditions were slightly larger than those from light conditions. The average size measured under the microscope was approximately 67 μm for dark-grown pupae and 59 μm for light-grown pupae.

Pupal yield also differed between the two treatments. A total of 427 pupae were recorded in light conditions compared to 372 pupae in dark conditions.

Olfactory preference tests revealed that adult flies showed strong responses toward volatile chemicals such as ethyl acetate, ethanol, and acetic acid.

V. DISCUSSION

The results of the present study demonstrate that environmental light conditions influence several physiological and behavioral traits in *Drosophila melanogaster*.

The improved climbing performance observed in light-grown flies suggests that light exposure may support normal development of neuromuscular coordination.

The slightly larger pupal size observed in dark-grown flies may be explained by extended feeding periods during larval stages or slower metabolic rates.

The difference in pupal yield between the two treatments indicates that light conditions may provide a more favorable environment for survival and development.

The olfactory experiments demonstrate that *Drosophila* relies heavily on sensory cues to navigate its environment and locate food sources.

Overall, the results highlight the complex relationship between environmental signals and biological development.

VI. CONCLUSION

The study confirms that environmental light conditions influence locomotor behavior, pupal size, and pupal yield in *Drosophila melanogaster*. Although the overall developmental timeline remained similar, differences were observed in behavioral and morphological parameters. These findings emphasize the importance of environmental factors in shaping biological processes.

VII. FUTURE SCOPE

Future studies could examine gene expression patterns related to circadian rhythms and developmental pathways in *Drosophila* raised under different environmental conditions. Advanced imaging techniques and molecular analysis may provide deeper insights into how environmental signals influence neural development and behavior.

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