

Evolution of foraging behavior of *Drosophila melanogaster* and its implications in the growth and development

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Abstract

In the local area of Nepal, the foraging behavior and its relationship with growth and development of *Drosophila Melanogaster* has not been evaluated yet. Therefore, an experiment was conducted in the Department of Entomology of Agriculture and Forestry University, Chitwan, Nepal during February 2017 to February 2018 to determine the evolution of foraging behavior of *D. Melanogaster* and its effect in their growth and development. The larvae of *Drosophila Melanogaster* with an average 500 population were collected and reared in the laboratory condition. Five samples with each 100 numbers of *Drosophila* were divided for the study. A cage was maintained with appropriate food for the adult *D. Melanogaster*. Average Area covered for foraging by the rovers found higher than that of sitters. The pathways for foraging were found significantly proportional with the growth of the samples of *D. Melanogaster*. Thus, the evolution of foraging behavior or foraging path of *Drosophila* species have direct impacts in the growth and development of the species investigated in the laboratory condition of Chitwan district.

Keywords: Evolution, foraging, growth, path

Introduction

Life histories rely on the timing and duration of development and growth before reproduction and the levels and duration of reproductive events after sexual maturity. The variation of organisms in the environment due to the evolutionary causes have been the interesting subject for biologist to understand the forces that mold life histories because of their great variability in nature (Stearns, 2000; Roff, 2000) [14, 18]. Many life-history traits, for example development time and the number of offspring produced, are nearly linked to fitness.

Numerous studies have been carried in *Drosophila* species, such as, the populations of *Drosophila* that have evolved in areas with high population density show inclined rates of population growth at high densities but lower rates of growth at low densities relative to populations maintained at low density (Mueller & Ayala, 1981; Mueller *et al.*, 1991) [9, 10].

In *Drosophila*, the immature larval stages apply substantial energy on growth and maintenance, while the adults expend most of their energy on the activities related to reproduction and maintenance. Considerable amount of energy and time is used in movement and foraging in case of *Drosophila* larvae (Berrigan & Lighton, 1993) [1], with resulting the foraging behavior of *Drosophila* larvae of interesting to behavioral geneticists and evolutionary biologists. Contemporarily, two dimensions of foraging behavior have been investigated in a detail manner. Larval feeding frequency are a simple measure of the rate of movement of the larva's cephalopharyngeal mouthparts. Linked with the movement of the larva's mouth is the movement of the larvae in two dimensions. The distance travelled by a foraging larva is known as the foraging path length.

The larval feeding rate and the larval foraging path length occupy to natural and artificial selection (Burnet *et al.*, 1977; Sokolowski *et al.*, 1983, 1997; Joshi & Mueller,

1988) [3, 7, 16]. There is the specific gene that regulates foraging path length directly (Osborne *et al.*, 1997) [12]. Usually, these two behaviors are investigated differently. However, in a few spaces, there is documentation of feeding frequency that heightens as the foraging path length increases (Sokolowski *et al.*, 1997) [17].

The study was concerned with the foraging path length and behavior of foraging that have been evolved in *Drosophila Melanogaster* in the local condition of Chitwan district.

Materials and methods

The larvae of *Drosophila Melanogaster* with an average 500 population were collected and reared in the laboratory condition of Agriculture and Forestry University, Chitwan, Nepal during February 2017 to February 2018. A cage was maintained with appropriate food for the adult *D. Melanogaster*.

Foraging path lengths were assessed on rectangular Plexiglass sheets that had six circular wells (depth 0.5 mm, diameter 8.5 cm). Each of these wells was evenly filled with a yeast paste mixture (50 g yeast in 105 mL of water). For each population, 50, 72-h-old larvae were recorded. A single larva was placed in each well and allowed 5 min to forage. Because the experiments were always carried out with paired populations (AX1 with AUC1, etc.), three of the wells on a provided Plexiglass sheet were from the population of experiment and three from the control population. Thus, both experimental and control populations experienced the same Plexiglass sheets and were measured over the same time intervals. After 5min, the larva were eradicated and a Petri dish placed over the well. The path was traced onto a Petri dish. The path was later scanned, and the digital image used to measure the length of the path with Image J software (<http://www.rsb.info.nih.gov/ij/>). These experiments were run in blocks. On any day, one experimental and one control population were tested (e.g. ACO2 and CO2 or AX3, UX3,

and AUC3). The relationship of foraging behavior and growth pattern of *D. Melanogaster* were also assessed. The recorded data were all tabulated and systematically arranged treatment wise under three replications using MS-Excel which were subjected to Analysis of Variance

(ANOVA) and Duncan’s Multiple Range Test (DMRT-0.05 level) for mean separations using Gen stat software.

Results and Discussion

1. Foraging paths of the larvae

Table 1: Foraging paths by larvae of *Drosophila*

	Number of Rovers (av.)	Number of Sitters (av.)	Av. area covered by rovers (cm ²)	Av. area covered by sitters (cm ²)
Sample 1-100	50	50	10	8
Sample 100-200	60	40	12	7
Sample 200-300	70	30	10	8
Sample 300-400	70	30	11	6
Sample 400-500	60	40	13	8

It was observed that the rovers are higher in population than sitters. Sitters travelled lesser distance than rover in five minutes sampled in the feeding materials. The average of maximum of 13 cm² were covered by sample from 400-500 which were 60 in numbers (rovers) while only the average of 6 cm² were covered by sitters with their number 30 which were sampled in 300-400 counted for five minutes in the available food material (Table 1).

In every population examined, if feeding rates increase then their foraging path length also increases. Similar study was carried by (Borash *et al.*, 2000) [1] where rovers cover

larger area for feeding and have potential foraging behavior and vice-versa.

This has been demonstrated in populations artificially selected for high and low feeding rates (Burnet *et al.*, 1977) [3], and for populations that have evolved different feeding rates in response to density (Joshi & Mueller, 1988) [7] and parasitoids (Fellowes *et al.*, 1998) [5].

Our investigations were supported by many past studies carried by Joshi & Mueller (1988) [7] Santos *et al.* (1997) [15] and Sokolowski *et al.* (1997) [17]

2. Growth versus foraging path of the larvae

Table 2: Description of foraging behavior versus body size of *Drosophila* samples

Area covered by rovers (av. In cm ²) in 1-100 sample	10	Area covered by rovers (av. In cm ²) in 100-200 sample	12	Area covered by rovers (av. In cm ²) in 200-300 sample	10	Area covered by rovers (av. In cm ²) in 300-400 sample	11	Area covered by rovers (av. In cm ²) in 400-500 sample	13
Body size (length*width in mm) in 1-100 sample	3*2	Body size (length*width in mm) in 100-200 sample	3.2*2.2	Body size (length*width in mm) in 200-300 sample	3*2.1	Body size (length*width in mm) in 300-400 sample	3.1*2.1	Body size (length*width in mm) in 400-500 sample	3.3*2.3
Area covered by sitters (av. In cm ²) in 1-100 sample	8	Area covered by sitters (av. In cm ²) in 100-200 sample	7	Area covered by sitters (av. In cm ²) in 200-300 sample	8	Area covered by sitters (av. In cm ²) in 300-400 sample	6	Area covered by sitters (av. In cm ²) in 400-500 sample	8
Body size (length*width in mm) in 1-100 sample	2.5*1.7	Body size (length*width in mm) in 100-200 sample	2.4*1.6	Body size (length*width in mm) in 200-300 sample	2.5*1.7	Body size (length*width in mm) in 300-400 sample	2.3*1.5	Body size (length*width in mm) in 400-500 sample	2.5*1.7

It was found that the foraging behavior of *Drosophila* species have direct effect in their body size. Highest area (av. In cm²) of foraging path with 13 found to have body size of 3.3*2.3 mm, while smallest foraging path of 6 cm² in average found to have body size with 2.3*1.5 mm in the respective samples of *Drosophila* species (Table 2).

The above investigation were supported by numerous researches of Mueller (1990) [11], Joshi & Mueller (1996) [6], Borash *et al.* (2000) [1], and Prasad *et al.* (2001) [13]. Burns *et al.* (2012) [4] and McConnell & Fitzpatrick (2017) [8] have revealed the similar correlation between foraging path and growth of the *Drosophila* species.

Thus, the evolution of foraging behavior or foraging path of *Drosophila* species have direct impacts in the growth and development of the species.

Conclusions

The larvae of *Drosophila Melanogaster* with an average 500 population were collected and reared in the laboratory

condition of Agriculture and Forestry University, Chitwan, Nepal during February 2017 to February 2018. A cage was maintained with appropriate food for the adult *D. Melanogaster*. The study was conducted to evaluate foraging pathways and its interrelationship with the growth and development of *D. Melanogaster*. Average Area covered for foraging by the rovers found higher than that of sitters. The pathways for foraging were found significantly proportional with the growth of the samples of *D. Melanogaster*.

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