Paternal and Sperm Age Effects on Reproductive Success of Drosophila melanogaster

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Abstract

The correlation between advanced paternal age and autism spectrum disorder (ASD) in humans has drawn increasing attention. This project set out to determine whether Drosophila melanogaster is an effective model to study paternal age effects and sperm age effects. In a mating assay, a striking infertility (85%) was found in never-before-mated 12 day old males. This unexpected finding led to subsequent studies of sperm age effects. A rapid decrease in the number of progeny yielded by males over the age of 3 days was observed. However, when assessing the ability of males to copulate and the motility of their sperm, age had no significant effect. Overall, 79.2% of males successfully copulated and 70.0% had motile sperm in the female reproductive tract. These findings lead to testable hypotheses about which factors could be affecting sperm quality with increasing age in D. melanogaster.

Introduction

Recent studies have shown that genetics, environment, and paternal age impact sperm function in humans. Aitken (2013) suggests that a correlation exists between advanced paternal age and the disruption of sperm DNA methylation, with potential impacts on fertility and health status of offspring. However, in human studies, it is difficult to determine cause and effect.

This study was designed to ask whether Drosophila melanogaster is a suitable model system to investigate male age effects on fertility and paternal effects.

Methods and Results

Test 1 Goal: To test the fertility of never-before-mated 12-day-old males Virgin males (n=20) were collected, aged for 12 days, then allowed to mate with differing numbers of females for 16 hours. The majority (85%) of the crosses did not yield offspring. The few fertile males (15%) yielded 100.0% progeny in the number of progeny yielded by males over the age of 3 days was observed. However, when assessing the ability of males to copulate and the motility of their sperm, age had no significant effect. Overall, 79.2% of males successfully copulated and 70.0% had motile sperm in the female reproductive tract. Additional studies were performed to characterize the timeline and potential cause of the observed male age and sperm age effects.

Test 2 Goal: To determine when fertility declines for never-before-mated males

It was observed that males that store sperm for up to 3 days are fertile but sperm storage for over 3 days show low fertility. Fertility appears to decrease most rapidly between 3 and 6 days as determined by the comparison of progeny counts shown in Table 1.

Test 3 Goal: To determine whether mating success and sperm motility varies with male age

ST2 males of ages 3, 6, 9, and 12 days old were given two hours to potentially mate. Their courtship behavior was observed and recorded. It was observed that copulation success and sperm motility did not vary with age. Males ranging from ages 3-12 days old were overall successful, with 79.2% successfully copulated and 70.0% had motile sperm.

To determine if low fertility of males was due to reduced quantity of sperm stored in the reproductive tract, the seminal vesicles were dissected and quantity of sperm was scored in a semi-quantitative manner using microscopy. The strain, called ST, was used in all studies, so sperm could be tracked using fluorescent markers.

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Table 1: Progeny yields of never-before-mated males of different ages.

<table>
<thead>
<tr>
<th>Fly Age (Days)</th>
<th>Progeny Yield Average</th>
<th>Progeny Yield Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (n=5)</td>
<td>128.8</td>
<td>1-180</td>
</tr>
<tr>
<td>3 (n=5)</td>
<td>34.2</td>
<td>3-111</td>
</tr>
<tr>
<td>6 (n=5)</td>
<td>7.8</td>
<td>2-23</td>
</tr>
<tr>
<td>9 (n=5)</td>
<td>3.0</td>
<td>1-6</td>
</tr>
<tr>
<td>12 (n=5)</td>
<td>6.0</td>
<td>1-21</td>
</tr>
<tr>
<td>15 (n=5)</td>
<td>4.6</td>
<td>1-14</td>
</tr>
</tbody>
</table>

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References