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Genotype-by-environment effects of dietary yeast on sperm traits in *Drosophila melanogaster*

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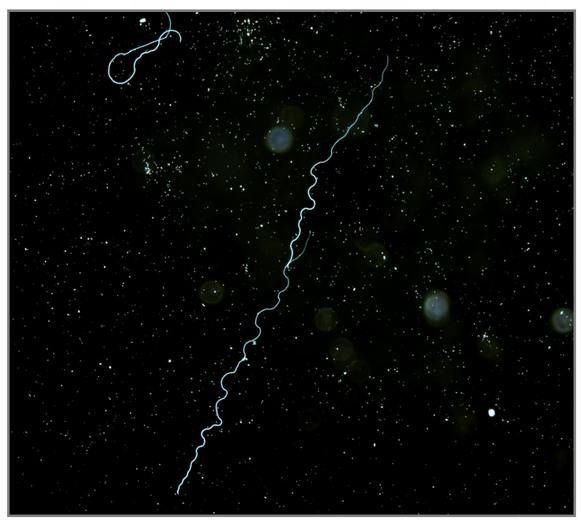
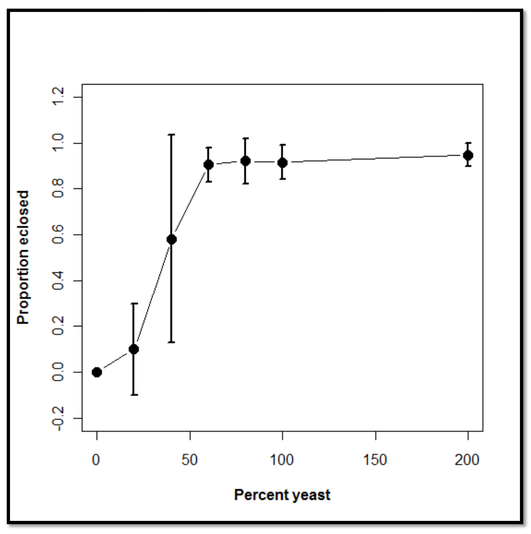
Introduction

Most current models of the evolution of sperm function and sperm morphology assume that changes are the result of a response to sexual selection (e.g. Immler et al. 2011). Because of this, sperm studies (whether comparative, quantitative genetic, or using experimental evolution) usually involve the measurement and/or manipulation of sexual selection parameters (e.g. Friberg et al. 2005). However the abiotic environment can also play an important role in influencing sperm physiology and morphology (Amitin & Pitnick 2007, Morrow et al. 2008). Because of this, we decided to carry out an investigation of the effect of dietary protein on sperm traits in *Drosophila melanogaster*. For this study we are using a set of sequenced inbred lines provided by the Drosophila Genetic Reference Panel.



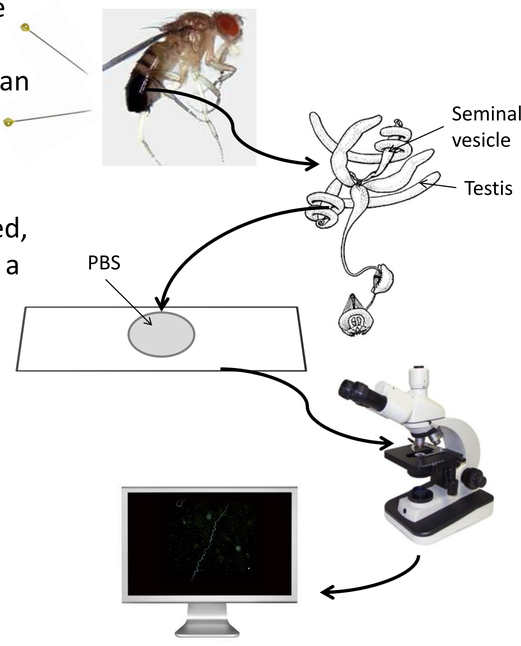
A *Drosophila melanogaster* sperm. *D. melanogaster* have sperm that are approximately 1.8 mm long (300 times longer than a human sperm) which makes them easy to see under modest levels of magnificantion.



A pilot study using various yeast levels determined that development time increased at yeast levels <60%. Variance in the number of eclosed flies on day 12 was highest at 40% yeast, so this level was selected for the experiment. Error bars denote SDs.

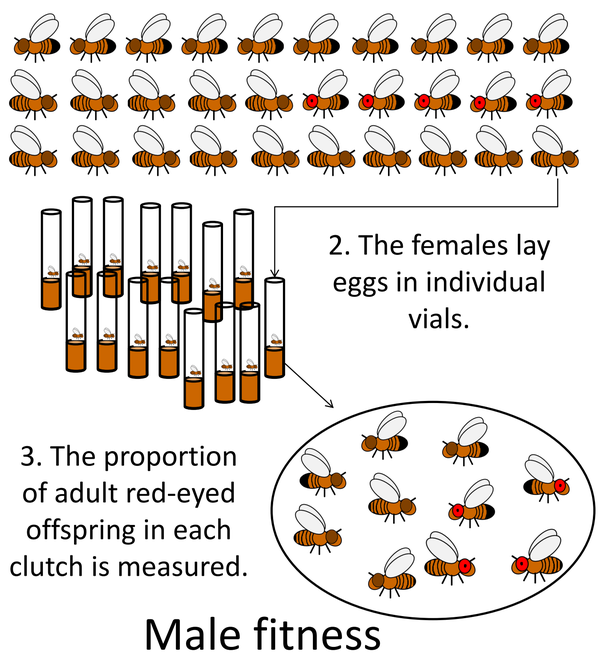
Project plan

1. The reproductive organs are dissected out of an adult male.
2. The seminal vesicle is removed, and opened into a drop of PBS on a slide.
3. The slide is processed and sperm are photographed through a microscope.

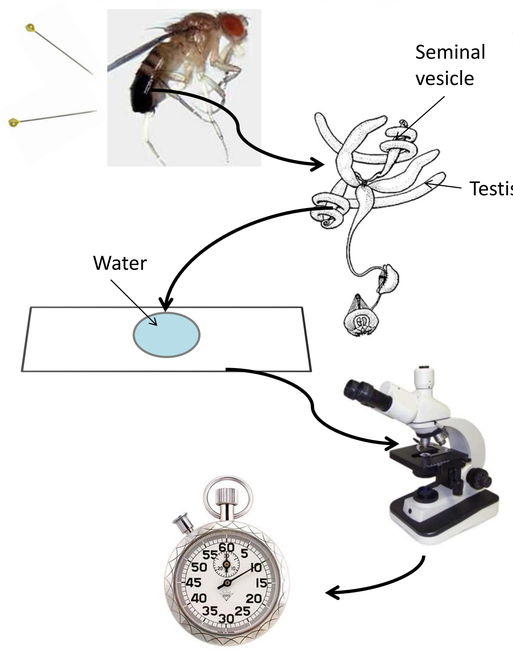


Sperm length

1. 5 red-eyed target males compete for matings with 10 brown-eyed competitor males.
2. The females lay eggs in individual vials.
3. The proportion of adult red-eyed offspring in each clutch is measured.



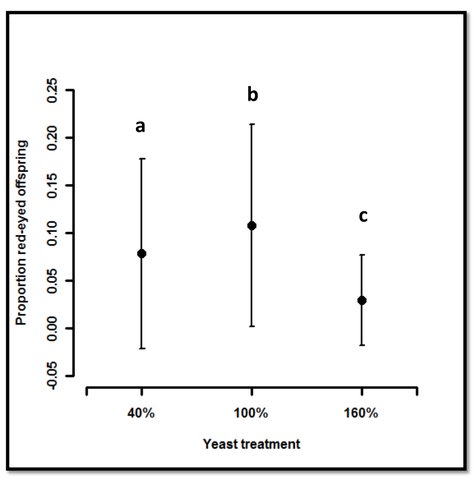
Male fitness



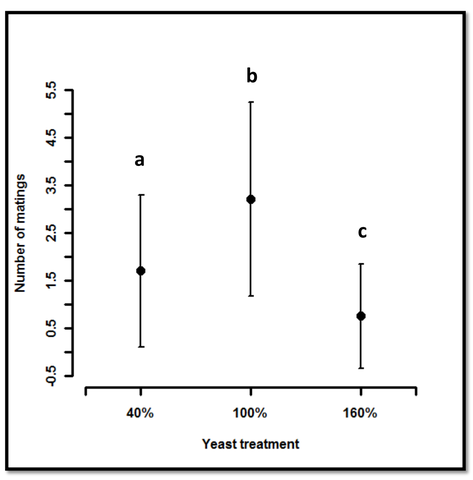
1. The reproductive organs are dissected out of an adult male.
2. The seminal vesicle is removed, and opened into a drop of water on a slide.
3. Sperm survival over time is measured.

Sperm survival under osmotic stress

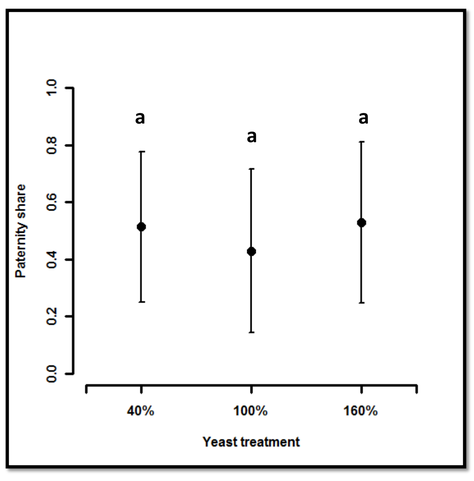
Preliminary results



The proportion of red-eyed offspring was significantly affected by yeast treatment ($P < 10^{-10}$). The large standard deviations (error bars) are the result of overall differences between the inbred lines ($P < 10^{-15}$). The interaction between yeast treatment and line trended towards significance ($P < 0.1$).



The number of matings obtained by the target males was significantly affected by yeast treatment ($P < 10^{-15}$). Again there were large differences between the lines ($P < 10^{-15}$). The interaction between yeast treatment and line was not significant ($P > 0.1$).



The paternity share obtained by target males showed a trend towards a significant effect of yeast treatment ($P < 0.1$). However there was no significant effect of inbred line and no interaction. More detailed analysis should help resolve whether this a true effect or not.

Conclusions

- As expected from previous studies on longevity (e.g. Pum Lee *et al.* 2008), increased yeast is not necessarily beneficial. Increased yeast resulted in reduced fitness and attractiveness in males.
- Decreased yeast was also deleterious, resulting in decreased fitness and attractiveness, but less so than in the increased yeast treatment.
- There were highly significant differences between lines, consistent with a substantial genetic component to the traits that were measured.
- Currently no indication of significant differences in plasticity among lines, although sampling is not complete.
- Some suggestion of a trade-off between attractiveness and performance in sperm competition. This requires further investigation.

References

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Friberg U, Lew TA, Byrne PG, Rice WR. 2005. Assessing the potential for an ongoing arms race within and between the sexes: selection and heritable variation. Evolution 59(7):1540-1551.
Immler S, Pitnick S, Parker GA, Durrant KL, Lüpold S, Calhim S, Birkhead TR. 2011. Resolving variation in the reproductive tradeoff between sperm size and number. PNAS 108(13):5325-5330.
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Pum Lee K, Simpson SJ, Clissold FJ, Brooks R, Ballard JWO, Taylor PW, Soran N, Raubenheimer D. 2008. Lifespan and reproduction in *Drosophila: new insights from nutritional geometry.* PNAS 105(7):2498-2503.

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