Trans-Generational Impacts of Paternal Irradiation in a Cricket: Damage, Life-History Features and Hormesis in F$_1$ Offspring

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Model

*Acheta domesticus (House Cricket)*

- Ideal model to study the impacts of radiation on a long lived insect species
- Lifespan ~6 months
- Males and females are discernible before sexual maturity
Focus & Goals

Focused specifically on paternal effects as they are largely ignored or considered not as relevant as maternal effects, especially in species lacking paternal care

- Can radiation impacts be inherited through the paternal line?
- What are the impacts to life-history traits i.e. survivorship, growth, and longevity?
- Are the impacts to F1 offspring more pronounced than in irradiated fathers?
Methods

- Crickets were irradiated at 0.25Gy/min using a Cs-137 source
  - Doses consisted of 0Gy, 2Gy, 7Gy, 10Gy, 12Gy
  - Males were isolated from containers once sex was evident (prior to sexual maturity to ensure virginity)
  - Males were then mated with virgin control females
  - Life history features were monitored for both F0 fathers and F1 offspring
  - Sample size: F0: ~120 & F1: ~500, ~57 for F1 10GY due to reproductive issues, 12Gy males were sterile)
Reproductive Impacts

• Doses >10Gy show significant reproductive decline
• Hatching success was reduced by about half in 10Gy fathers

• NO F1 12Gy offspring due to apparent sterility
• F1 10Gy sample size reduced by reproductive decline

F0 Hatching Success

![Graph showing hatching success vs. dose (Gy)](image)
Results: Growth Rate

- Significant declines in doses between 4-12Gy (** ** p < 0.0001)
  - Offspring also showed declines in almost all groups compared to controls 4Gy & 7Gy (** ** p < 0.0001) 10Gy (** p < 0.001)
  - These reductions were not as pronounced as in their irradiated fathers.
- Surprisingly the 10Gy group with only 57 individuals had growth rates most like controls.
  - Data displayed as mean +/- SEM
Results: Survivorship

F0 Male

F1 Offspring
Results: Survivorship cont.

F0 Males: A Gehan-Breslow-Wilcoxon test showed significant differences in survivorship in both 7Gy (**** p < 0.0001) and 10Gy (**p < 0.01) as compared to the 0Gy sham group.

F1 Offspring: A Gehan-Breslow-Wilcoxon test, indicating variation in survivorship curves showed significant differences in survivorship in all groups; 4Gy (**** p <0.0001), 7Gy (**** p <0.0001) and 10Gy (**** p <0.0001) as compared to the 0Gy sham group.
Results: Longevity

- Almost all F0 males showed a significant increase in maximal longevity for 2Gy, 7Gy, 10Gy, 12Gy (p < 0.0001) compared to controls.
- A slight decrease in the 4Gy (** p=0.0022) and slight increase in 7Gy (** p = 0.0046), while 10Gy showed significant increases (**** p<0.0001) which constitutes a 39% increase relative to the control.
- Data displayed as the mean age of the last surviving 10% of individuals +/- SEM.
Conclusions

- Despite most research focusing on maternal inherited impacts, paternal inheritance does indeed impact F1 life history traits.
- Life history traits of F1 offspring are impacted by F0 paternal exposure.
- F1 offspring generally have more exaggerated or pronounced trends than their parents for Longevity and Survivorship.
- Growth rate was less impacted, offspring growth rate generally recovered from F0 exposure.
- **F1 offspring tended to inherit the beneficial aspects of paternal exposure while mostly avoiding the negative life history outcomes.**