

Trans-Generational Impacts of Paternal Irradiation in a Cricket: Damage, Life-History Features and Hormesis in F₁ Offspring

Tamara M. Fuciarelli, David C. Rollo
McMaster University, Hamilton, Canada

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

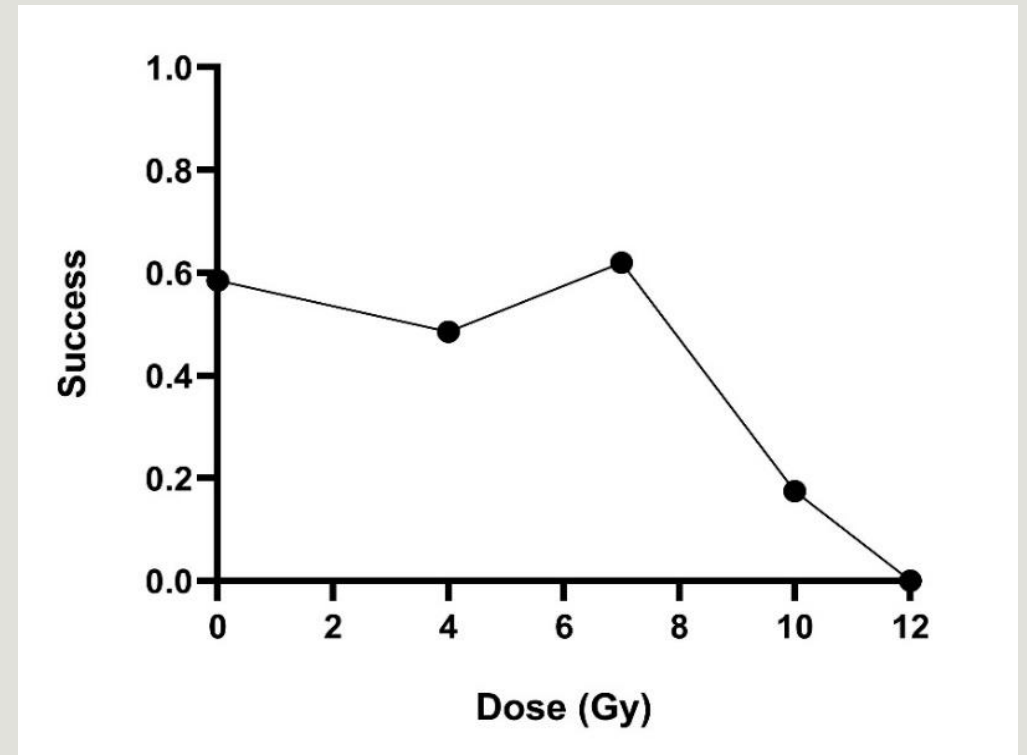
- Crickets were irradiated at 0.25Gy/min using a Cs-137 source
 - Doses consisted of 0Gy, 2Gy, 7Gy, 10Gy, 12Gy
 - Males were isolated from containers once sex was evident (prior to sexual maturity to ensure virginity)
 - Males were then mated with virgin control females
- Life history features were monitored 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

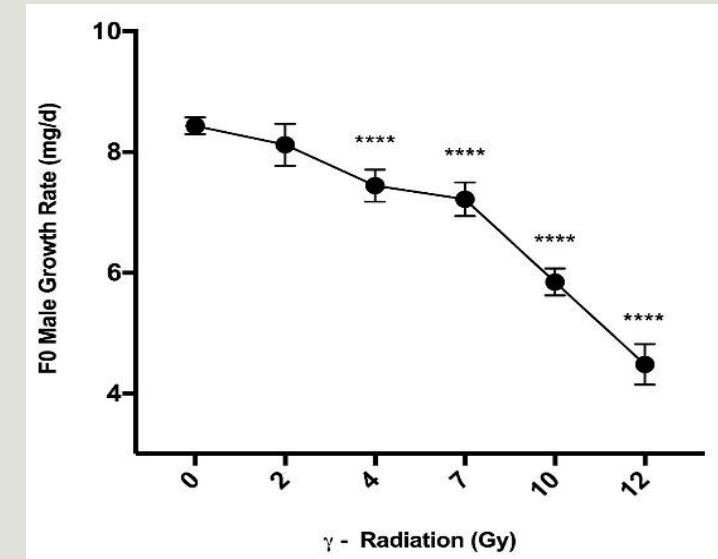
F0 Hatching Success



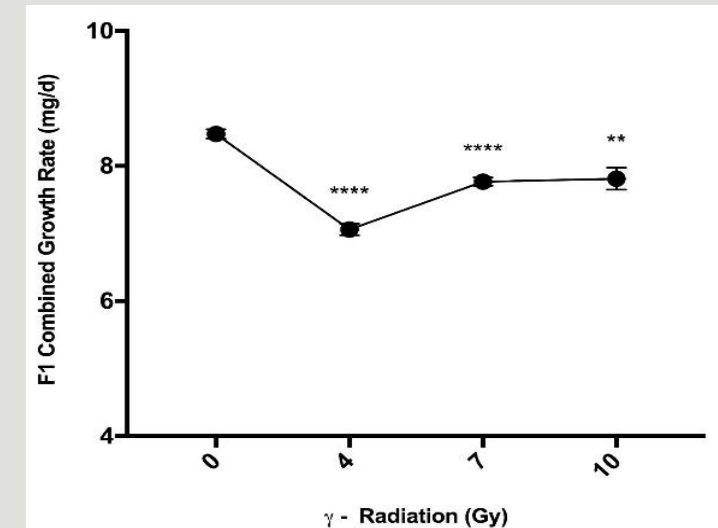
Results: Growth Rate

- 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

F0 Male

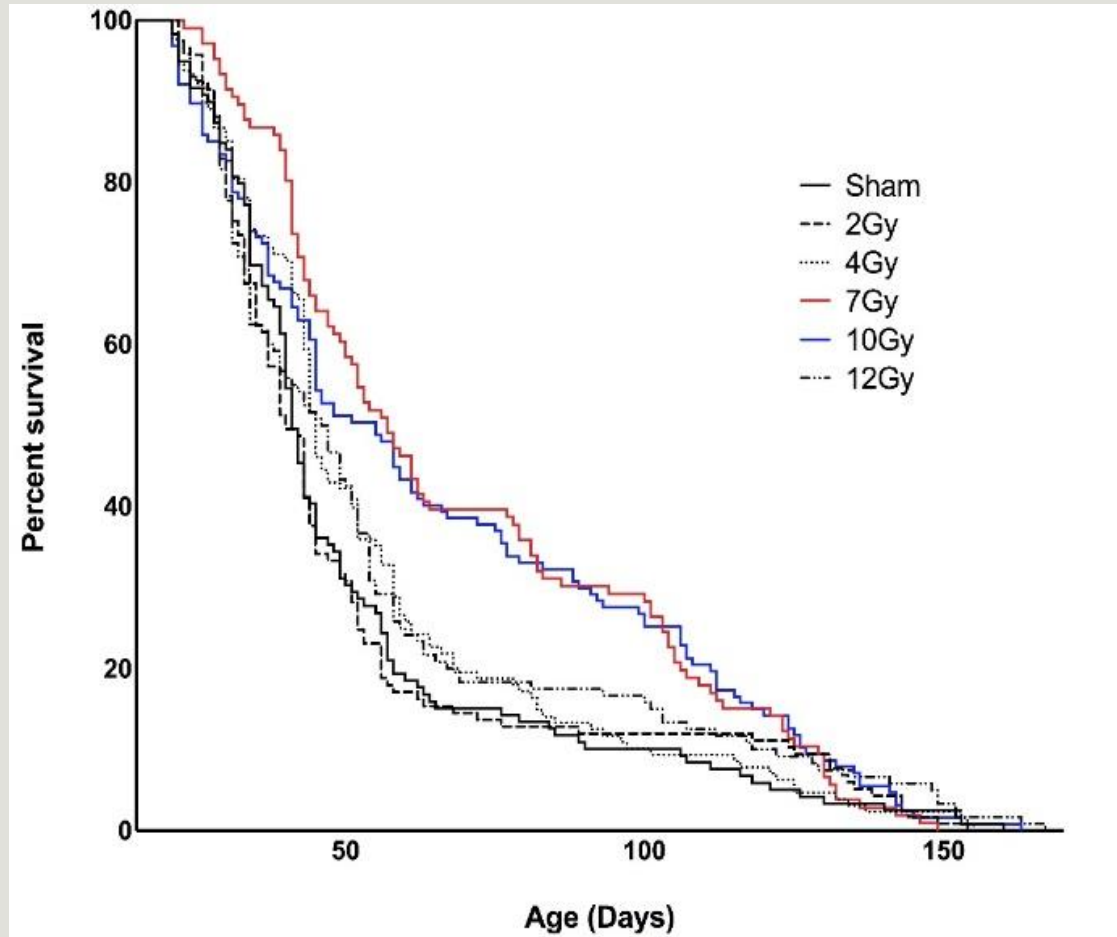


F1 Offspring

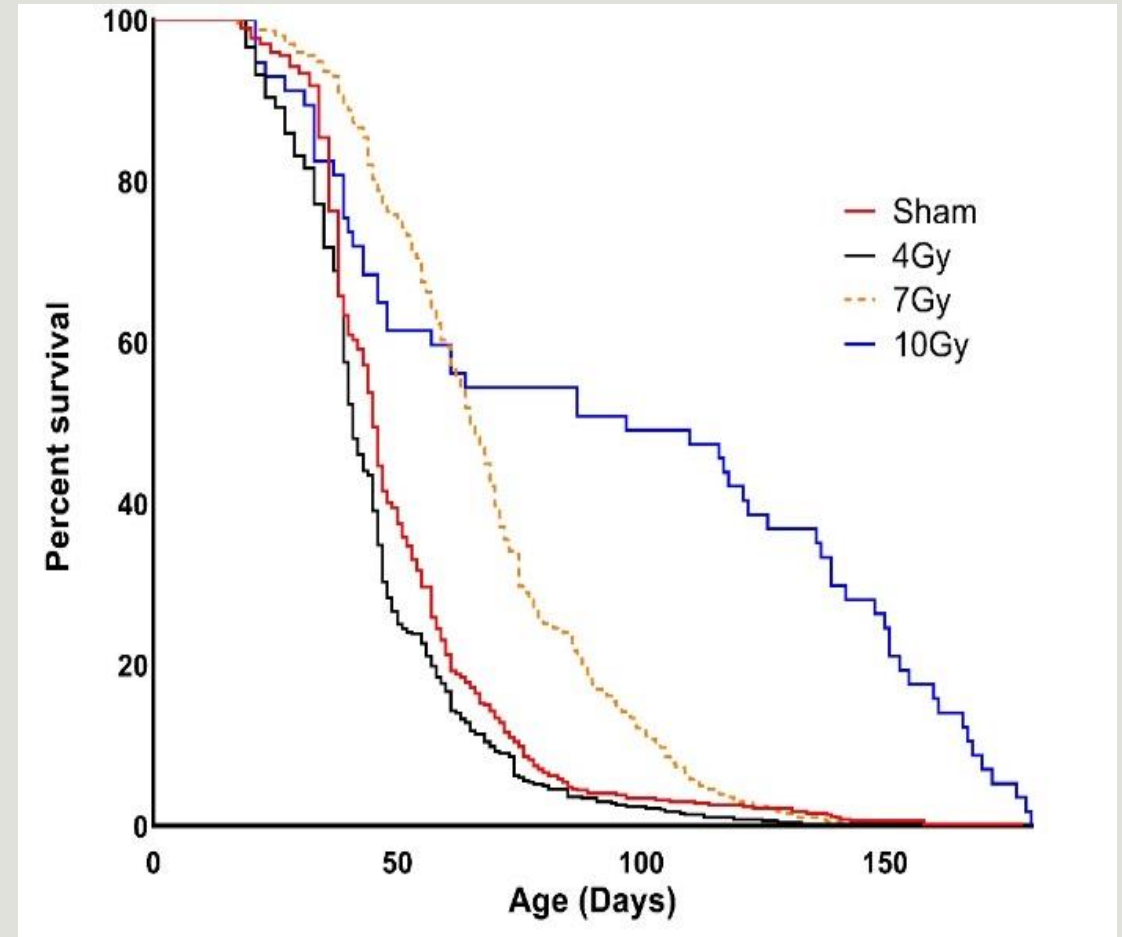


Results: Survivorship

F0 Male



F1 Offspring



Results: Survivorship cont.

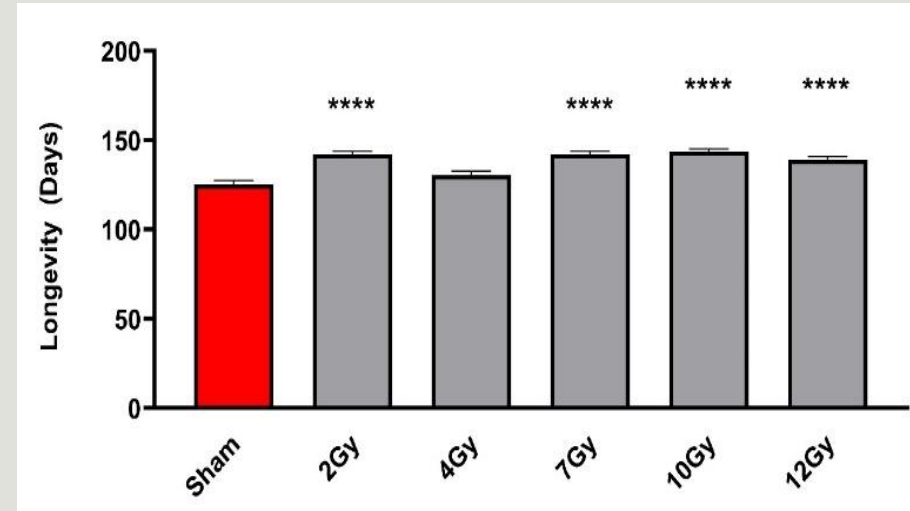
F0 Males: A Gehan-Breslow-Wilcoxon test showed significant differences in survivorship in both 7Gy (** $p < 0.0001$) and 10Gy (** $p < 0.01$) as compared to the 0Gy sham group**

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**

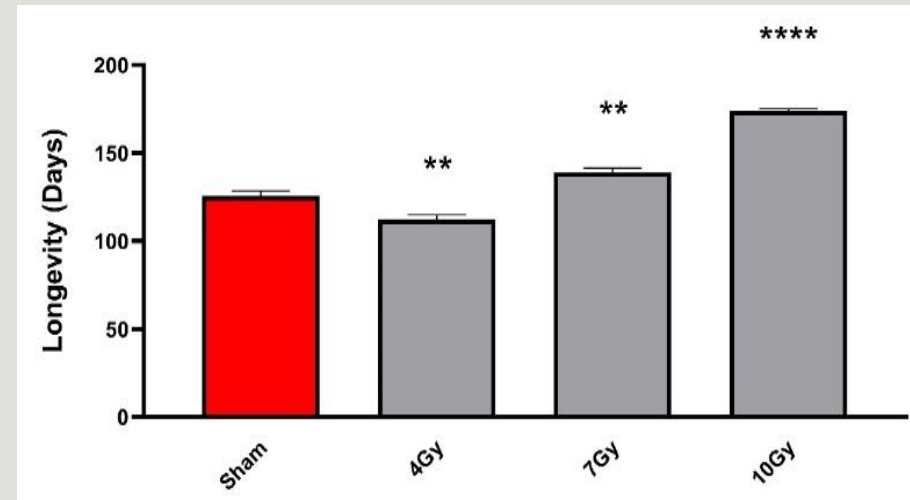
Results: Longevity

- 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

F0 Male



F1 Offspring



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**