Radiation exposure causes developmental alterations in size and shape of wings and structures associated with song production in male crickets (*Acheta domesticus*)

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Introduction

Ionizing radiation has become a focus of ecological research, due to expanding nuclear power generation and nuclear disasters. These disasters mediate the release of Cs-137. On a species level, exposure can have drastic impacts to the subtle traits of reproduction. In crickets, male's use species specific acoustic signalling to attract females. Female's have been shown to be preferential to specific qualities of male acoustic signals. Furthermore, male acoustic signaling has been shown to be condition dependent. Stress, such as radiation exposure may alter the male's ability to produce the "correct" mating signal, thus compromising their mating ability.

Here we analyze male cricket wings using geometric morphometric analysis. We show that both size and shape of male wings are being altered by radiation exposure. Specifically, wings are smaller, and the shape of key resonance structures, the harp and mirror are being altered. It is likely these impacts will have drastic effects on male courtship songs and therefore reproduction and mating success.

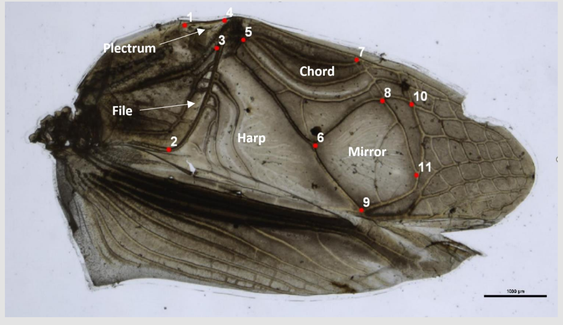

Fig 1: Position of 11 landmarks (red dots) superimposed on a photograph on a control *Acheta domesticus* wing.

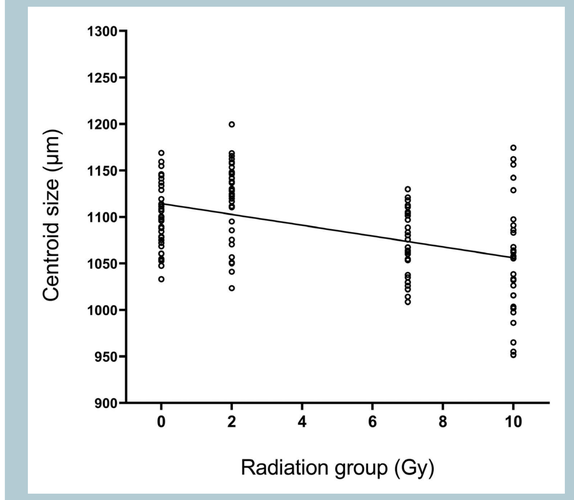

Fig 2: Centroid size (um) of control and irradiated wings. Significant declines were evident in 7Gy and 10Gy groups.

Methodology

Experimental groups:

- 4th instar crickets
- Cs-137 exposure
- Dose rate of 0.25 Gy/min per min totaling 0, 2, 7, or 10 Gy.
- All experimental individuals were males.

Sample Preparation:

- Wings were dethatched and photographed using a Nikon 16.25 megapixel camera mounted on a SMZ18 stereoscope
- Photos were digitized with tpsUtil32 and tspDIG2 and analyzed using MorphoJ
- Sample sizes included 60-80 wings per group totaling 284 images.

Results

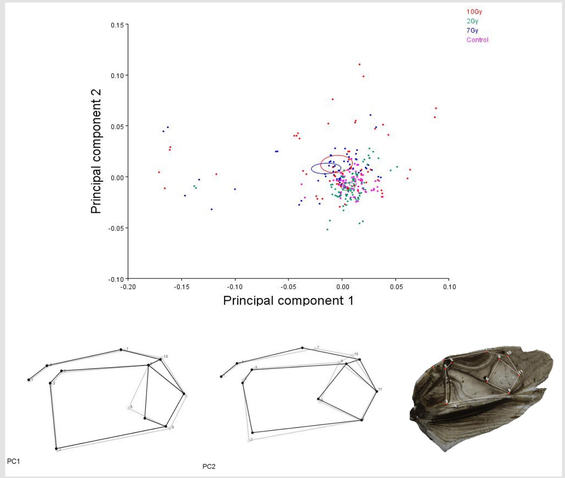

Fig 3: PCA analysis of shape alterations between control and irradiated groups. Wireframe drawings represent the variation in wing shape, with the gray outline representing the average control shape and the black outline where group variation is occurring

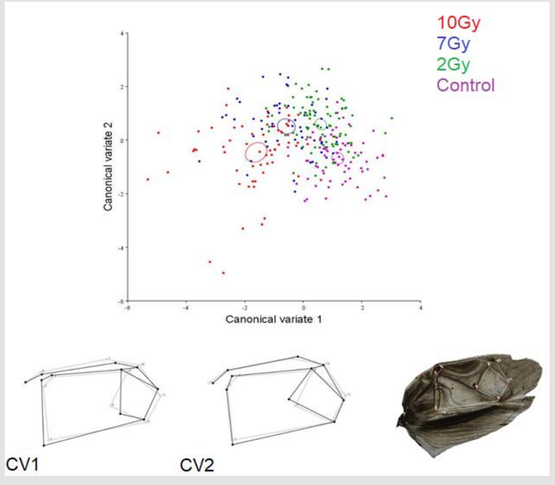

Fig 4: CVA analysis of shape alterations between control and irradiated groups. Wireframe drawings represent the variation in wing shape, with the gray outline representing the average control shape and the black outline where group variation is occurring

Conclusion

- Radiation induced variation in wing shape associated with the harp and mirror region.
- These areas function as amplifiers of sound
- Significant reduction in centroid size at 7 and 10Gy.
- Reduced wing size has been shown to impact the amount of muscle power available for stridulating as well as song quality i.e frequency/amplitude

Significance

- These alterations will likely cause auditory change in male courtship songs
- As male cricket courtship songs have been shown to require specific acoustic specifications, any acoustic abnormalities are likely to negatively impact male mating success.
- Radiation impacts to a variety of species and endpoints are needed to fully understand contamination sites and ecosystem harm.

Acknowledgements

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