

The Effects of Oxidative Stress on the Development and Overwintering Success of the Alfalfa Leafcutting bee, *Megachile rotundata*



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BACKGROUND

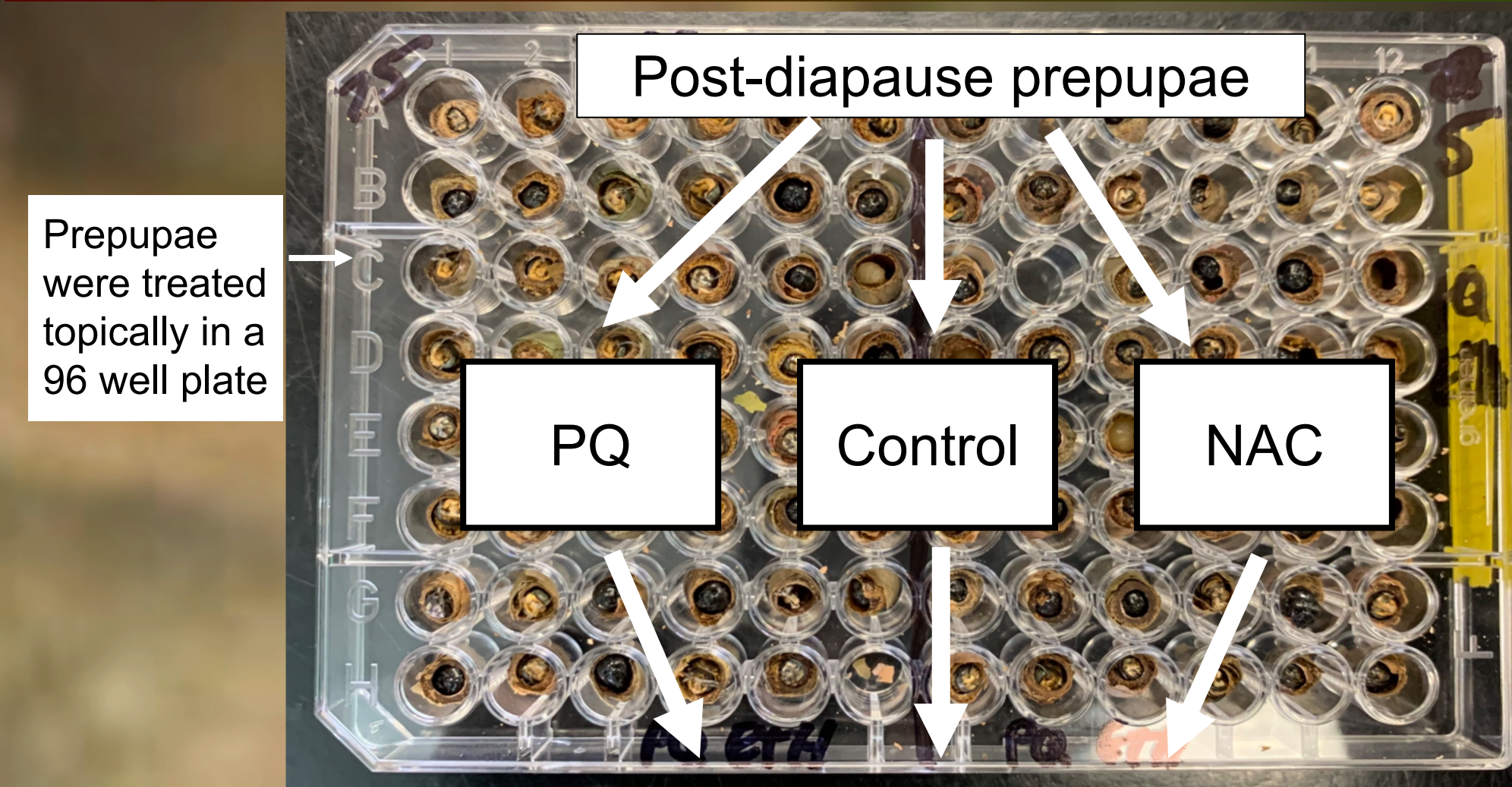
- The alfalfa leafcutting bee, *Megachile rotundata*, is an important pollinator, especially for alfalfa¹
- They overwinter in diapause as prepupae and eclose as adults during the summer when pollination is ideally at its peak¹
- Oxidative damage occurs during long term storage at cold temperatures²
- Reactive oxygen species (ROS) promotes diapause and sequestering reactive oxygen species increases chances of survival through diapause³
- Paraquat (PQ) is a highly toxic quaternary nitrogen herbicide known to generate ROS⁴
- N-acetylcysteine (NAC) is an amino acid which acts as an antioxidant⁵

Objective: By using PQ to induce and NAC to sequester ROS, our goal was to assess the effects of entering diapause (pre) vs exiting diapause (post) with elevated ROS.

Prediction: Bees entering diapause with elevated ROS will be capable of sequestering ROS and/or minimizing damage.

Bees exiting diapause with elevated ROS will lead to delayed development and a reduction in flight ability.

METHODS



1 Development Time

- The number developing to each stage was counted everyday.

2 Flight capability

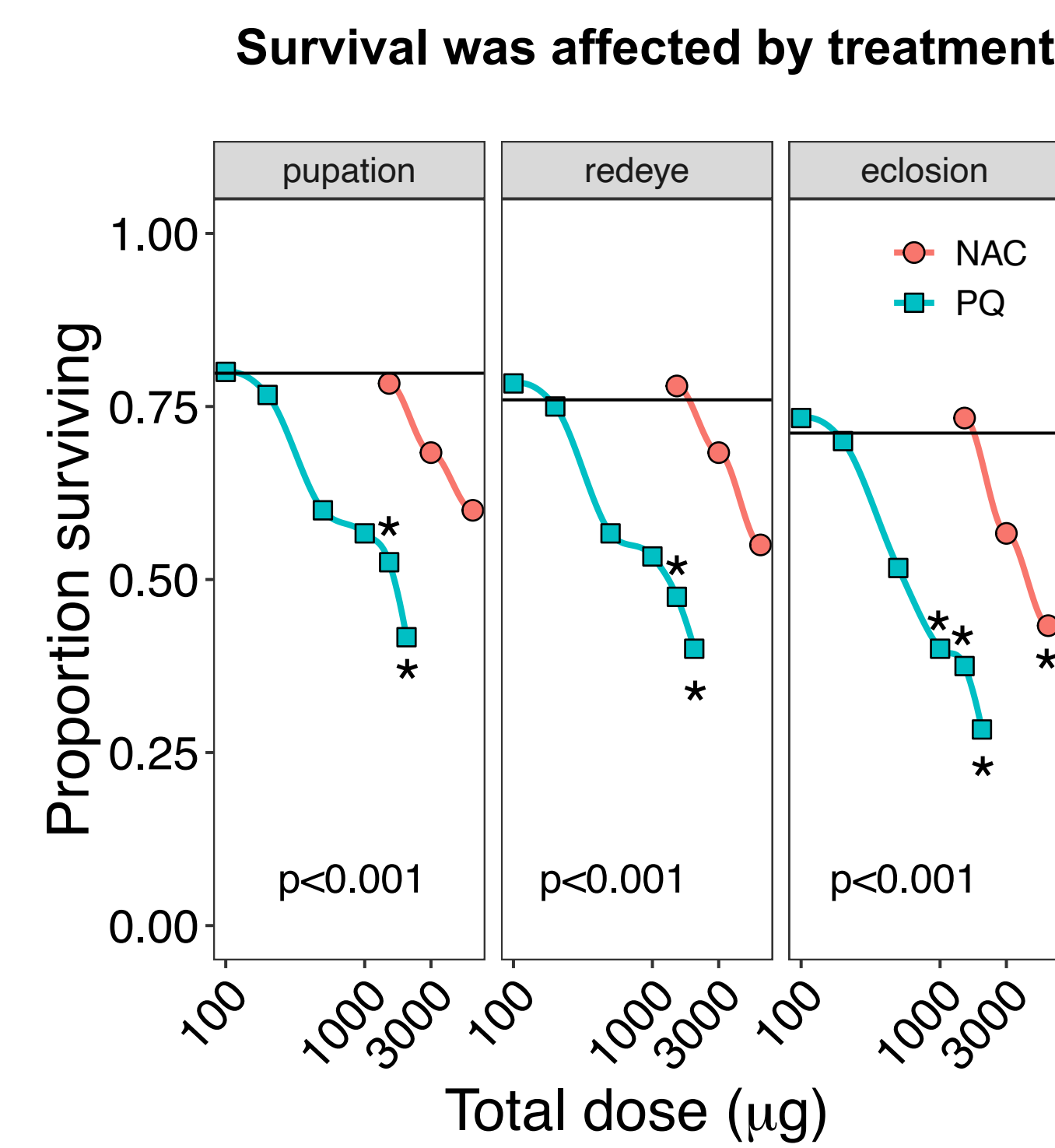
- Activity was measured using the drop method
- Bees were given three chances to fly

3 Mass

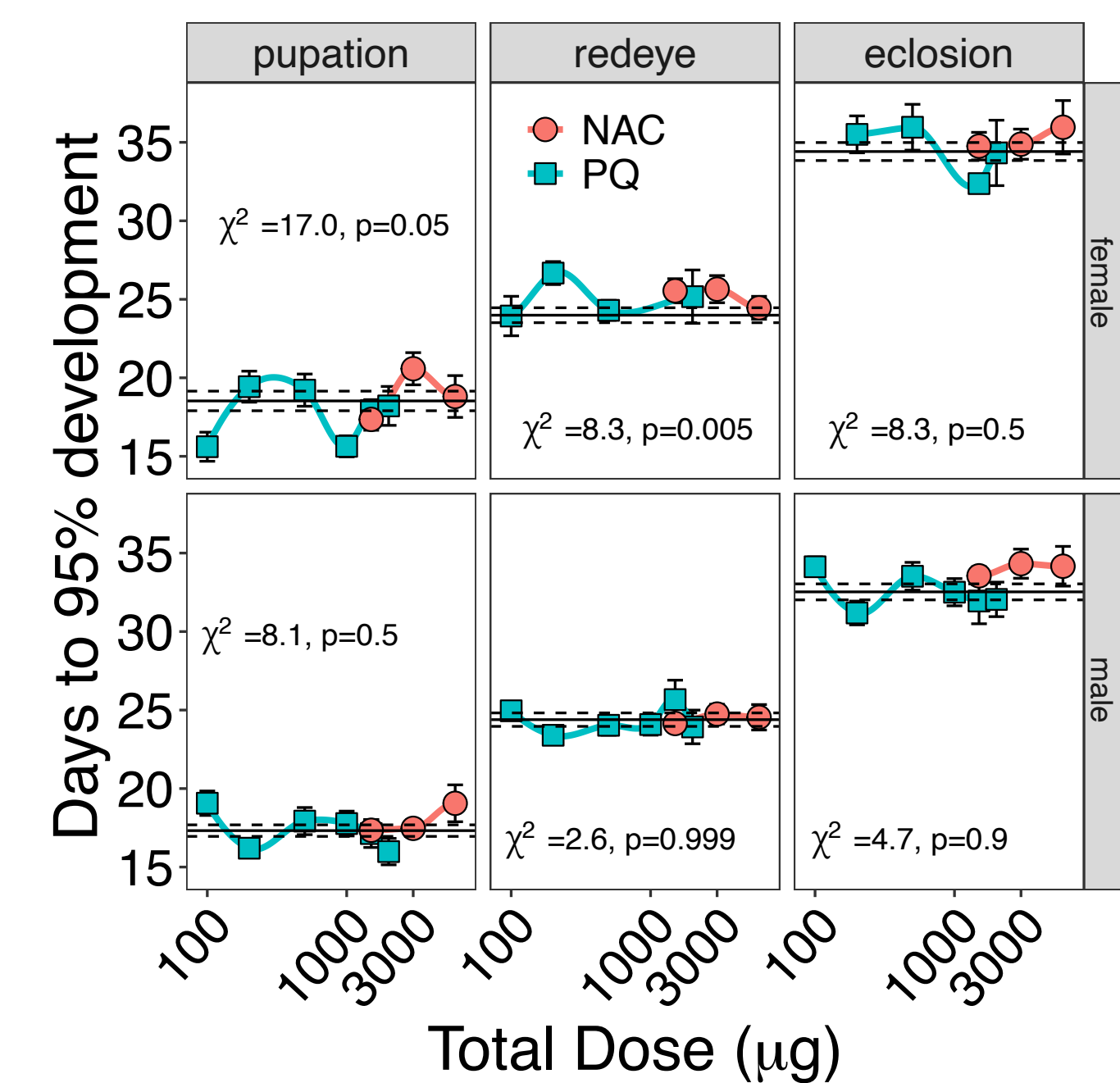
- Newly eclosed adults were weighed after every flight test to determine if the treatment had any effect on mass

RESULTS

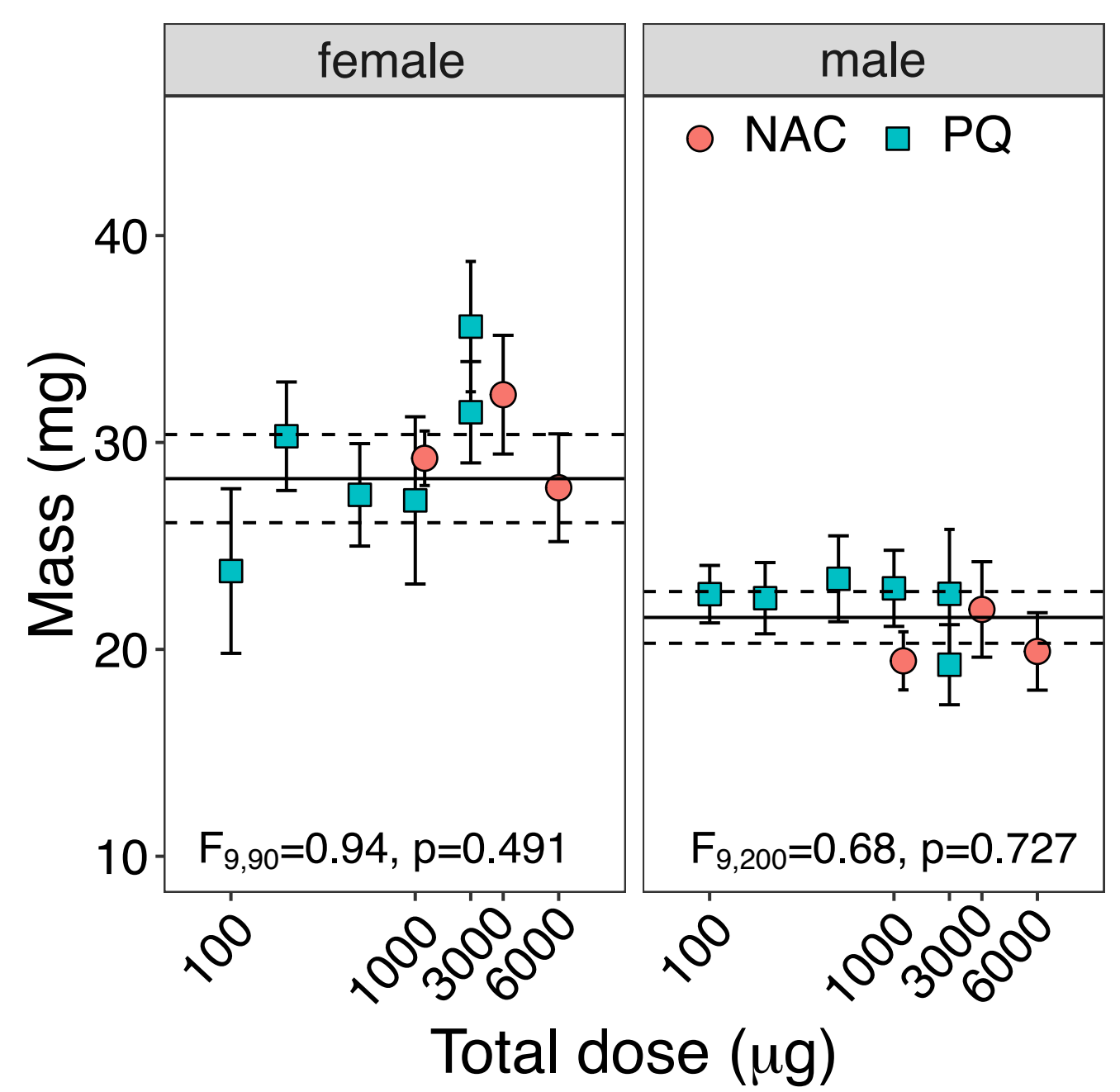
Does entering diapause with elevated ROS affect overwintering success?



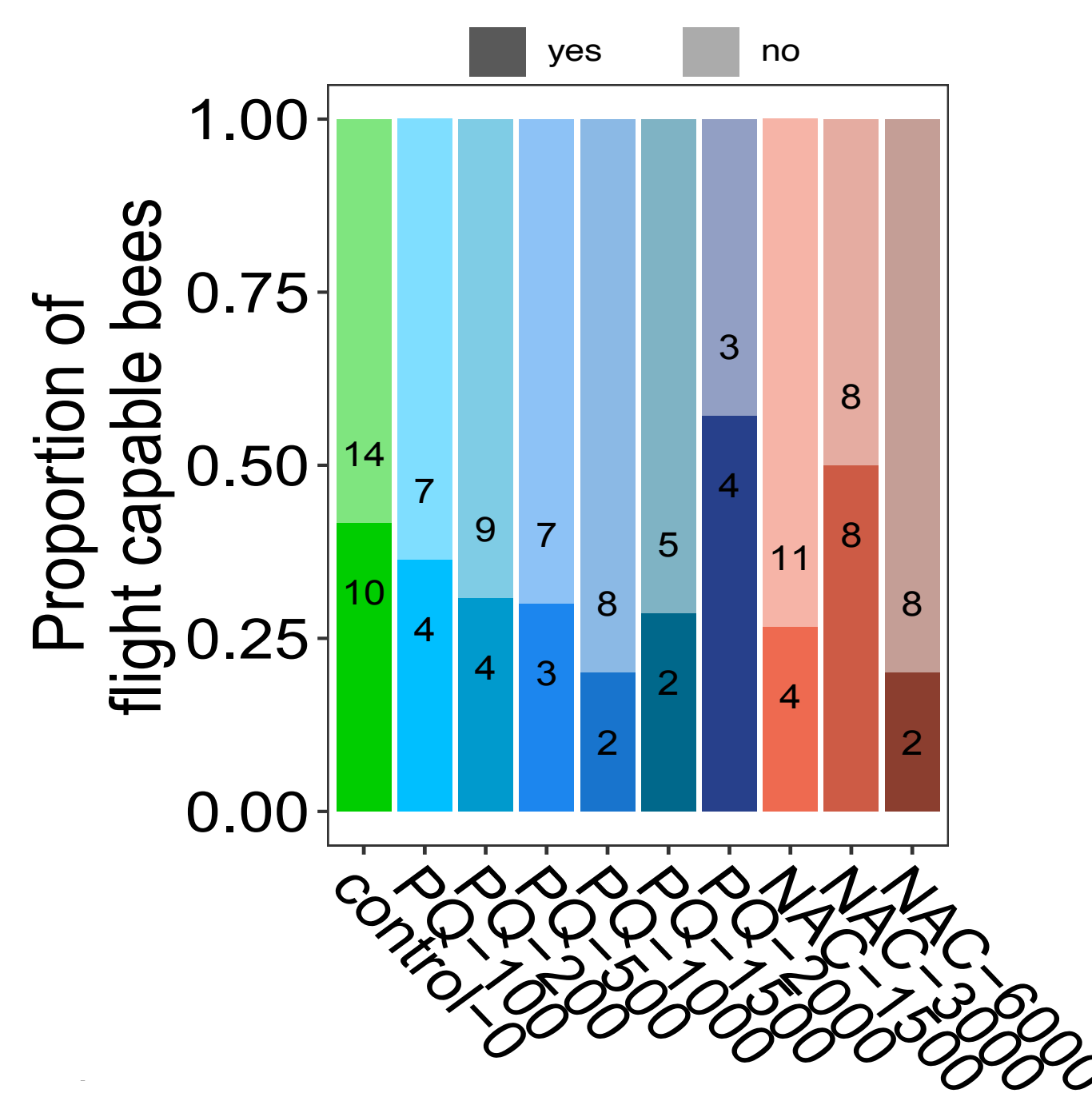
Bees entering diapause with elevated ROS show little to no affect on development



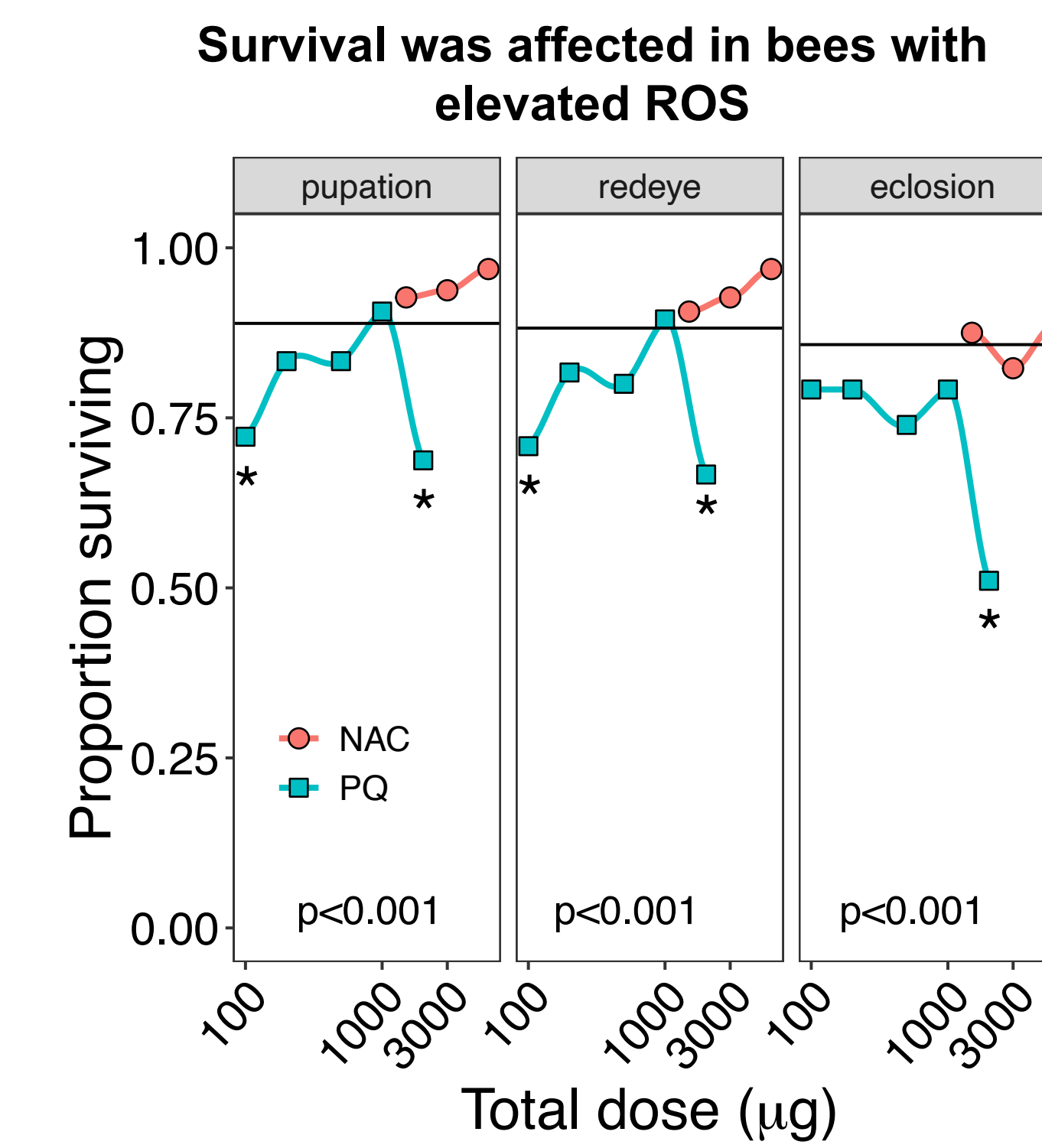
Mass was not affected by treatment



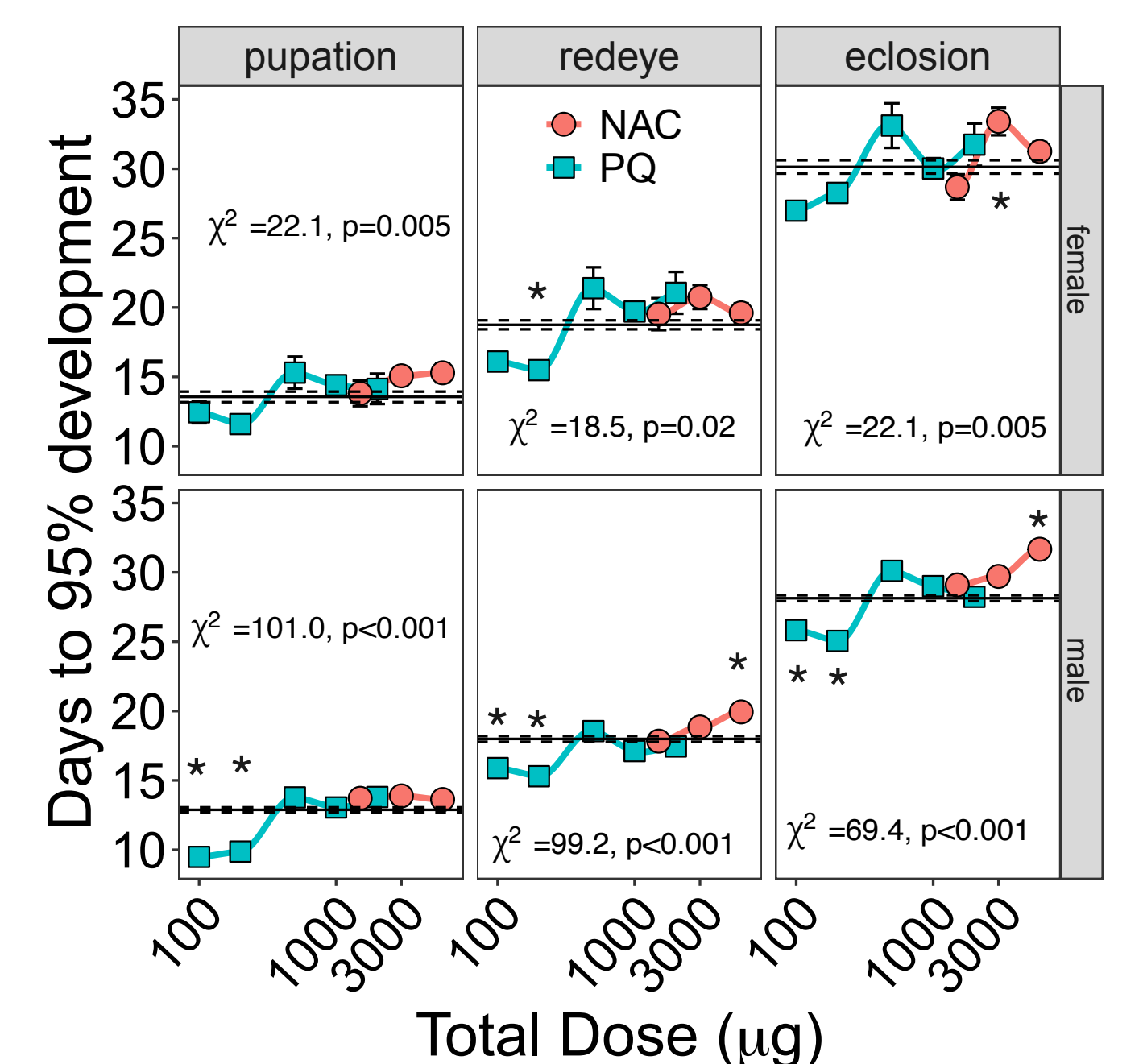
Flight ability was unaffected by treatment ($\chi^2 = 6.35, p = 0.705$)



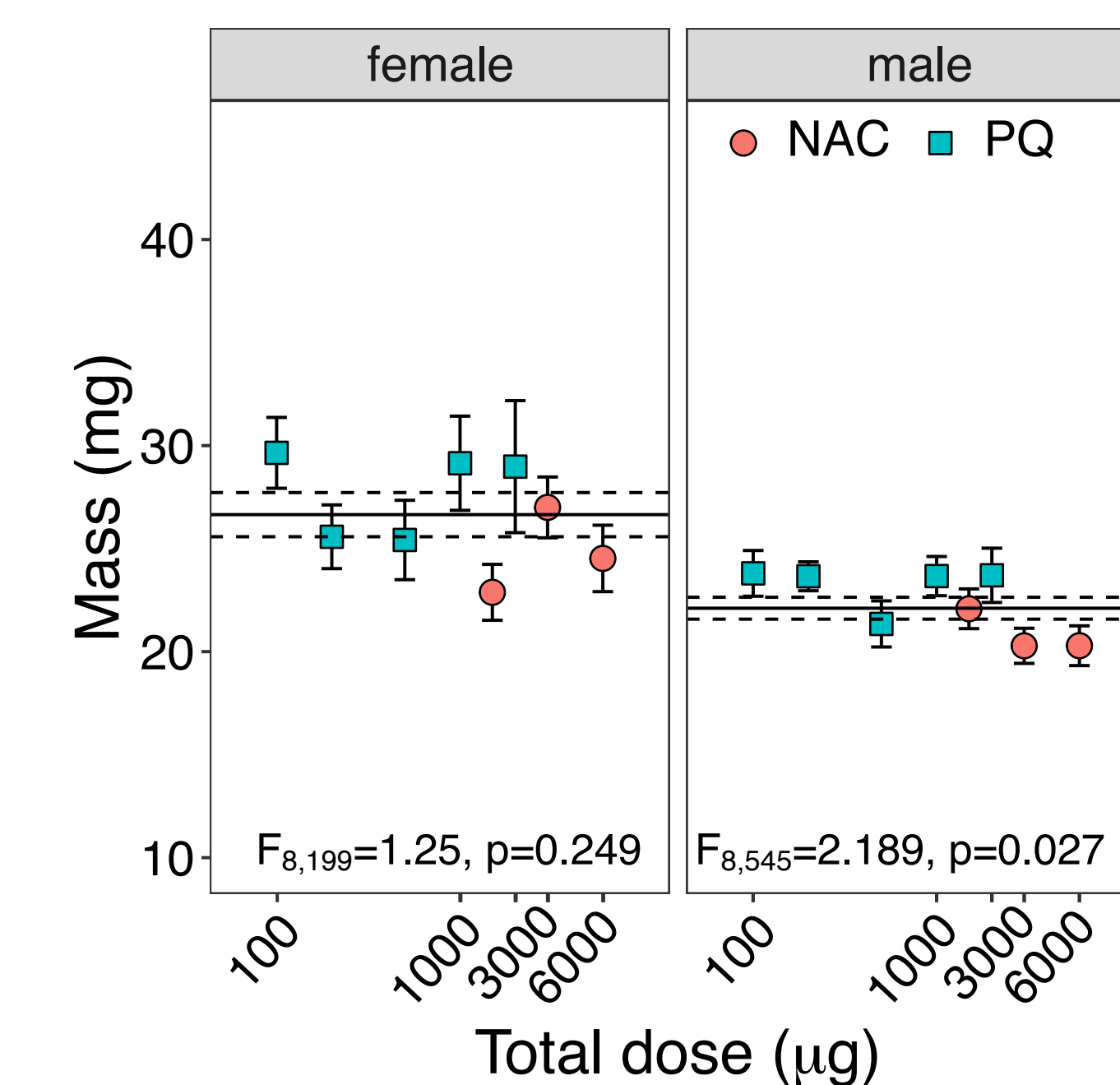
Does exiting diapause with elevated ROS affect overwintering success?



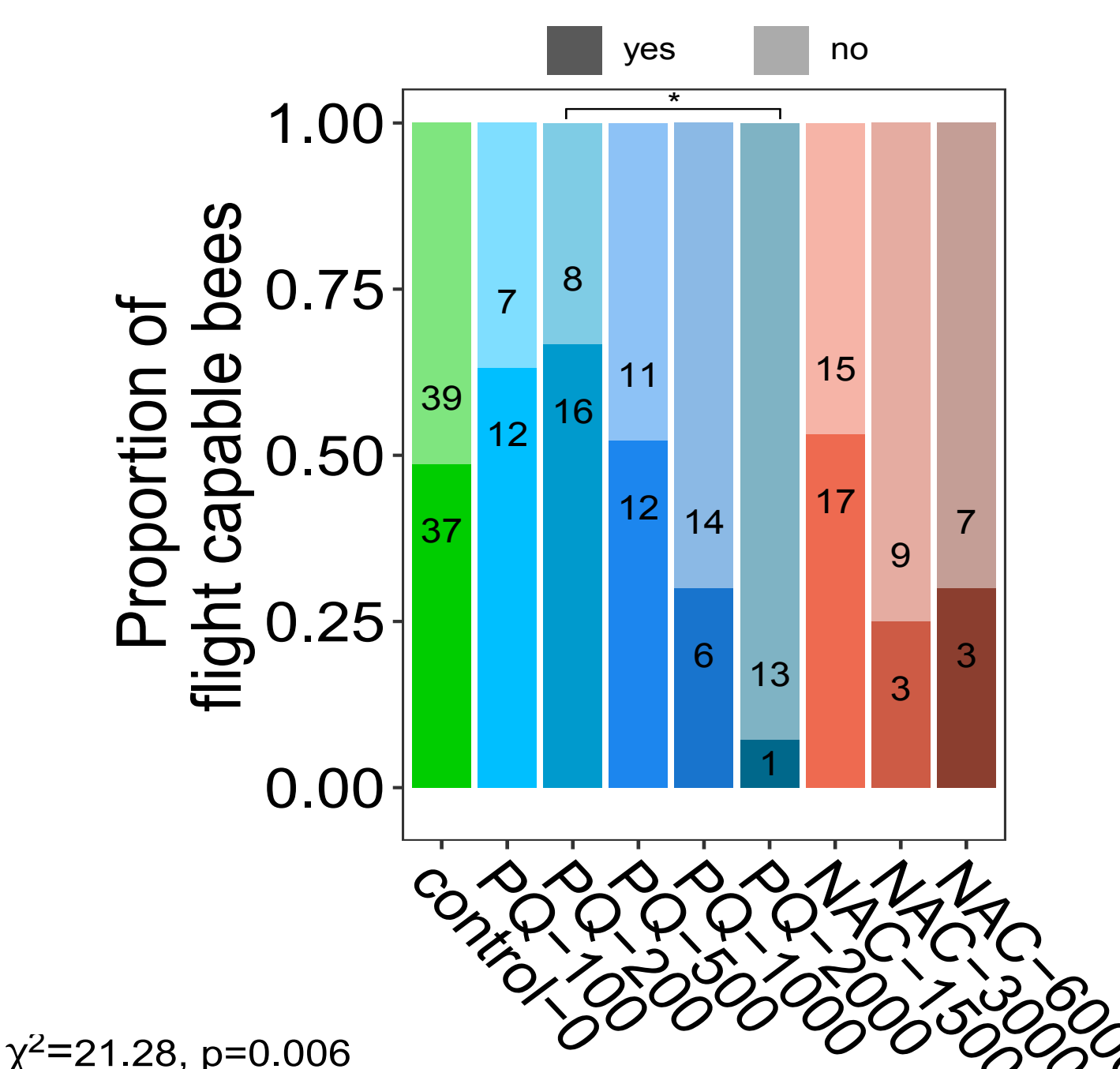
Bees exiting diapause with elevated ROS develop faster



ROS levels show little to no affect on mass



Flight ability was affected by treatment ($\chi^2 = 21.28, p = 0.006$)



CONCLUSIONS

- Survival was affected in a dose dependent manner. The highest levels of PQ and NAC reduced survival to eclosion.
- Males show no signs of ROS effects on development time, while females show minimal effects. Time to pupation and redeye were influenced by ROS levels, however development time returned to normal by eclosion.
- Despite the appearance of treatment effects on body mass, there were no significant changes to adult body mass.
- Flight was unaffected by treatment.
- Overall, entering diapause with elevated ROS shows minimal consequences on the adult phenotype, suggesting that overwintering in diapause may allow for the removal of ROS or damaged tissue.**

- Treatments influenced survival, with the highest PQ dose significantly reducing survival.
- Contrary to our prediction, increased ROS led to faster development, while lower oxidative stress delayed development.
- All though the treatments appear to influence mass, there was no significant change in mass between treatments.
- Increased oxidative stress led to lower flight capability.
- It appears that the emergence from overwintering with elevated (but not too high) levels of ROS may be beneficial for speedy development and higher productivity.**

REFERENCES

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