



Weird sex (including lack of it)

Ben Oldroyd, Sarah Aamidor, Madeleine Beekman

Behaviour and Genetics of Social Insects Laboratory



THE UNIVERSITY OF
SYDNEY

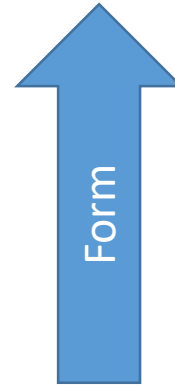
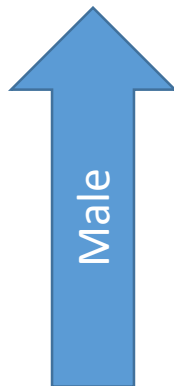
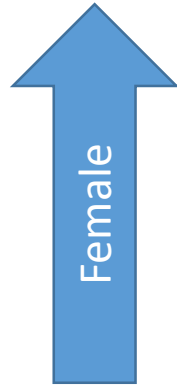


Have you ever seen a weird bee with drone bits and worker bits?

- If you have, it was a GYNANDROMORPH!



GYNANDROMORPH



Gynandromorphs

Chimeras comprised of both male and female tissues



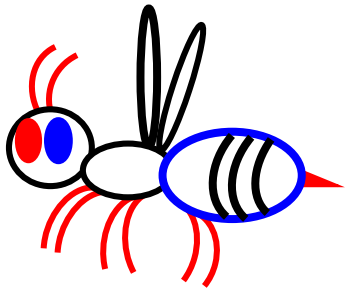
How do bee gynandromorphs arise?

- 2-3 sperm enter every honey bee egg
- Following fertilization the extra sperms should die.
- But sometimes they don't...

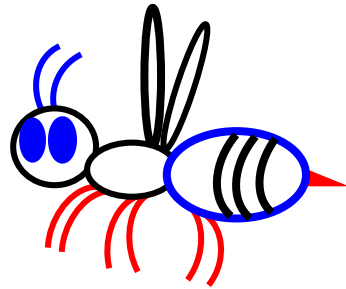


- We found 11 peculiar (gynandromorph) emerging bees in a colony in Richmond
- Dissected
 - Genotyped to determine the origin and sex of the tissue

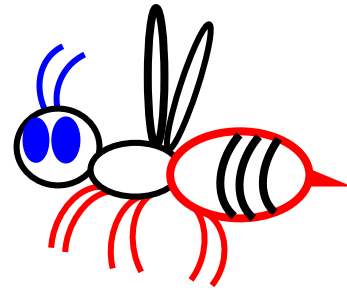




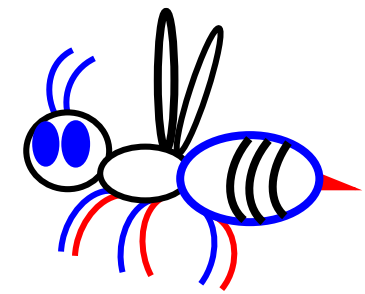
Worker ovaries
3 Fathers 1 Mother



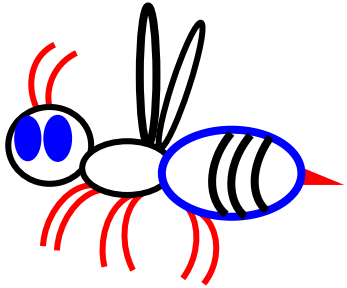
Testes
2 Fathers 1 Mother



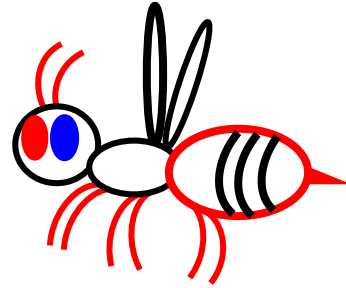
No ovaries or testes
2 Fathers 1 Mother



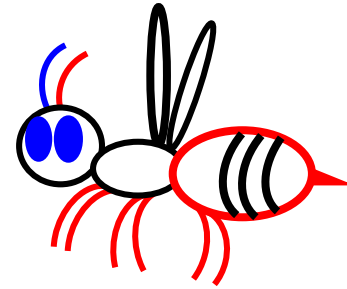
Queen-like ovaries
2 Fathers 1 Mother



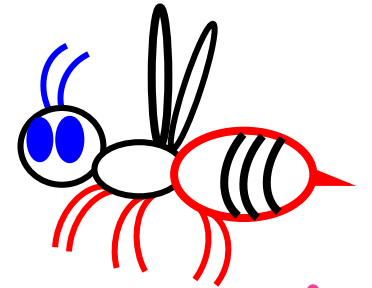
Worker ovaries
2 Fathers 1 Mother



Worker ovaries
2 Fathers 1 Mother

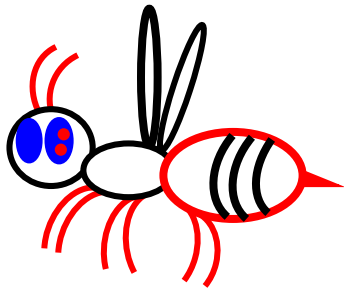


Queen-like ovaries
2 Fathers 1 Mother



Testes
2 Fathers 1 Mother

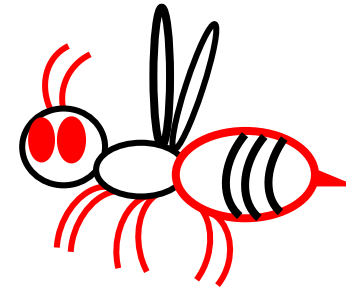
■ Female
■ Male



Queen-like ovaries
2 Fathers 1 Mother



Testes
1 Father 1 Mother



Worker ovaries
2 Fathers 0 Mother



0 ovaries or testes
2 Fathers 1 Mother



Queen like ovaries
3 Fathers 1 Mother



Queen like ovaries
2 Fathers 1 Mother



Testes
2 Fathers 1 Mother



Queen like ovaries
2 Fathers 1 Mother



Testes
1 Fathers 1 Mother

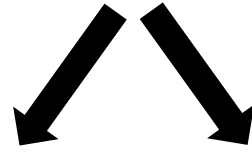


Worker ovaries
2 Fathers 0 Mother

■ Female

■ Male

More than one sperm per egg



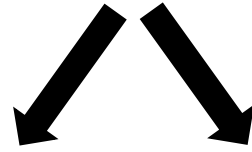
2 sperm + mum:
Gynandromorphs

2 sperm no mum:
Sperm fuse to make
females

Weird!



More than one sperm per egg



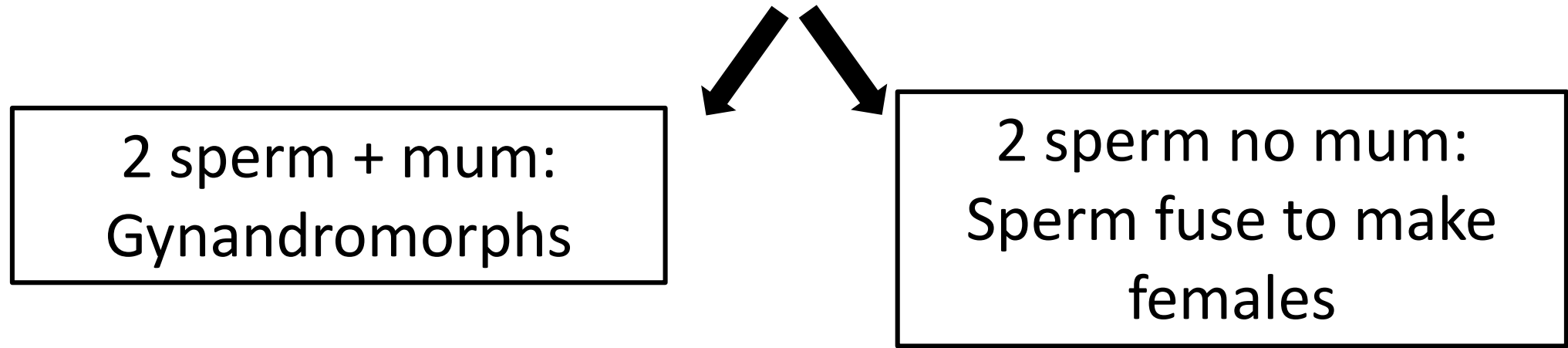
2 sperm + mum:
Gynandromorphs

2 sperm no mum:
Sperm fuse to make
females

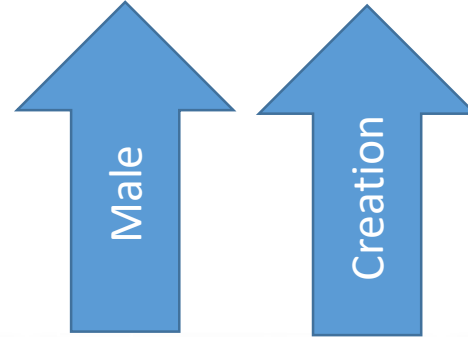
Androgenesis



More than one sperm per egg



Androgenesis

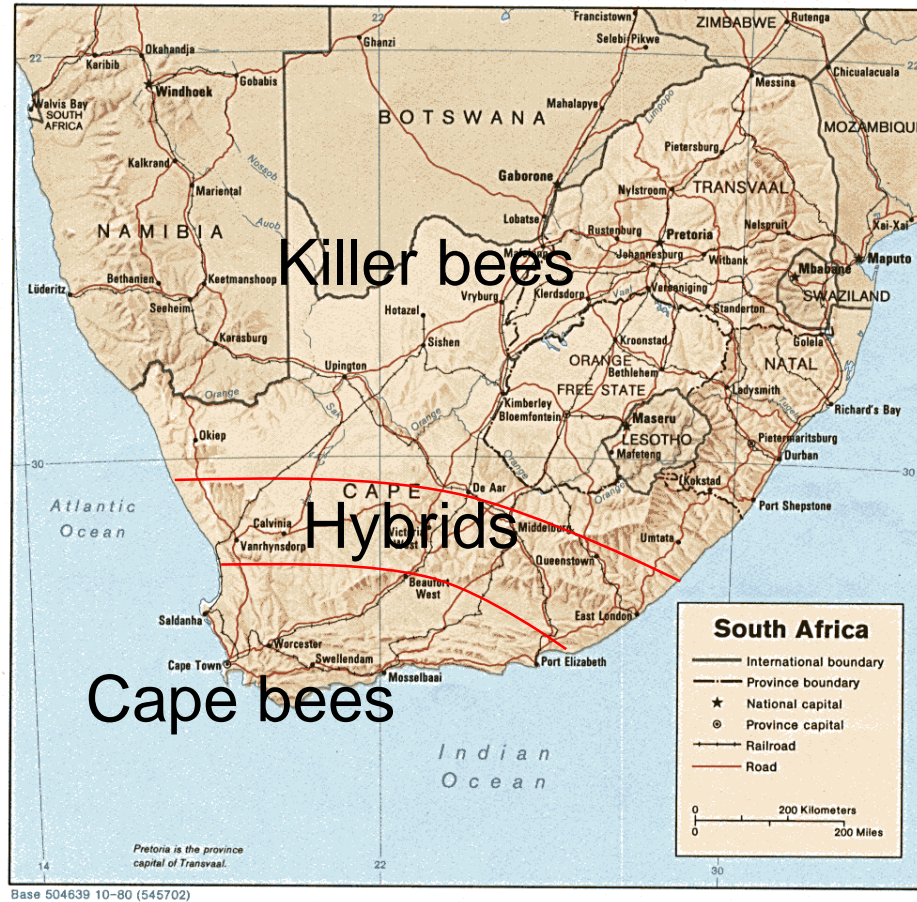




More bee weirdness: Do you remember the Cape bees of South Africa?

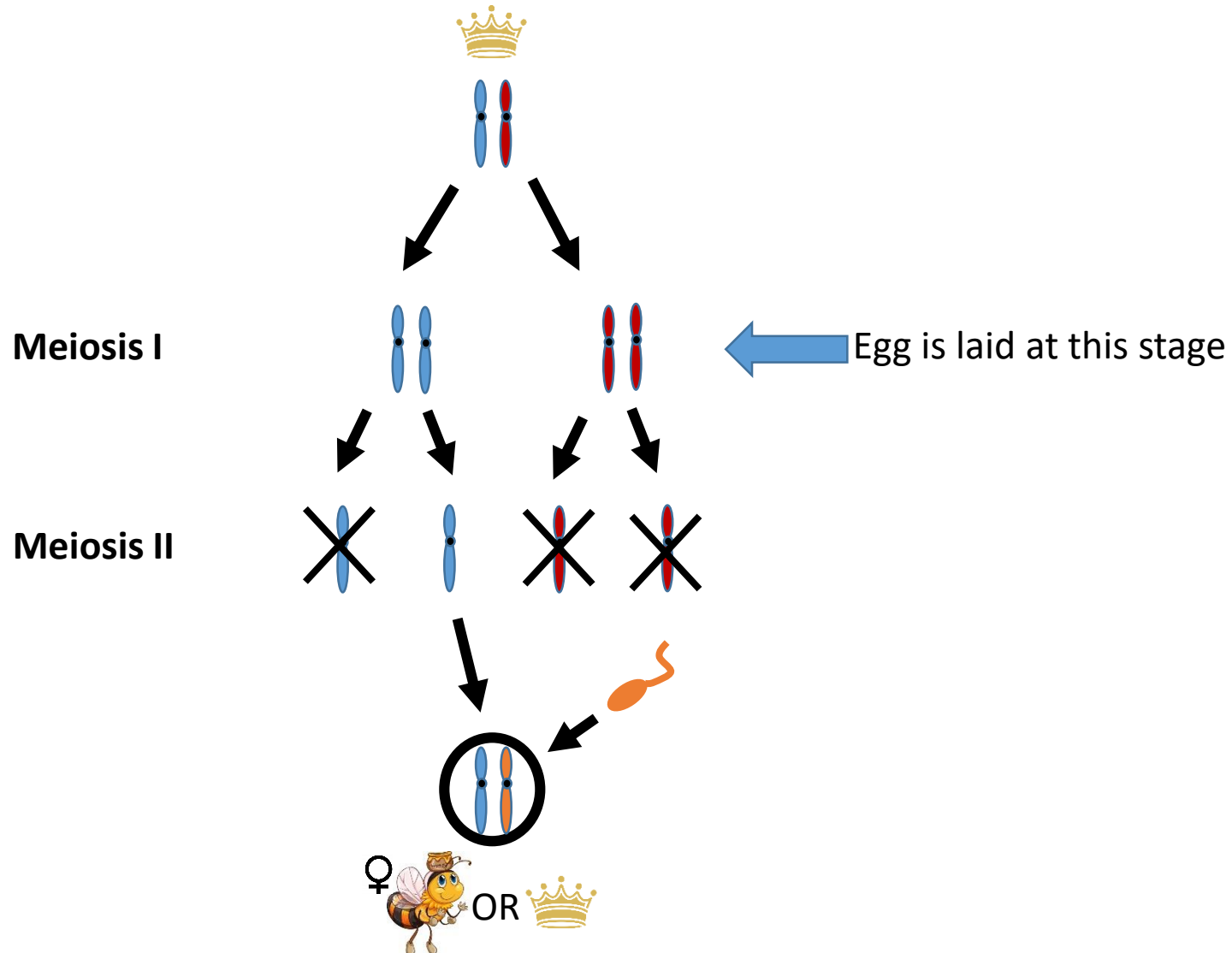


South Africa is home to two honey bee subspecies



Beekman, Allsopp, Wossler, Oldroyd (2008) *Heredity* 100: 13

Normal (non-weird Australian) sexual reproduction in bees

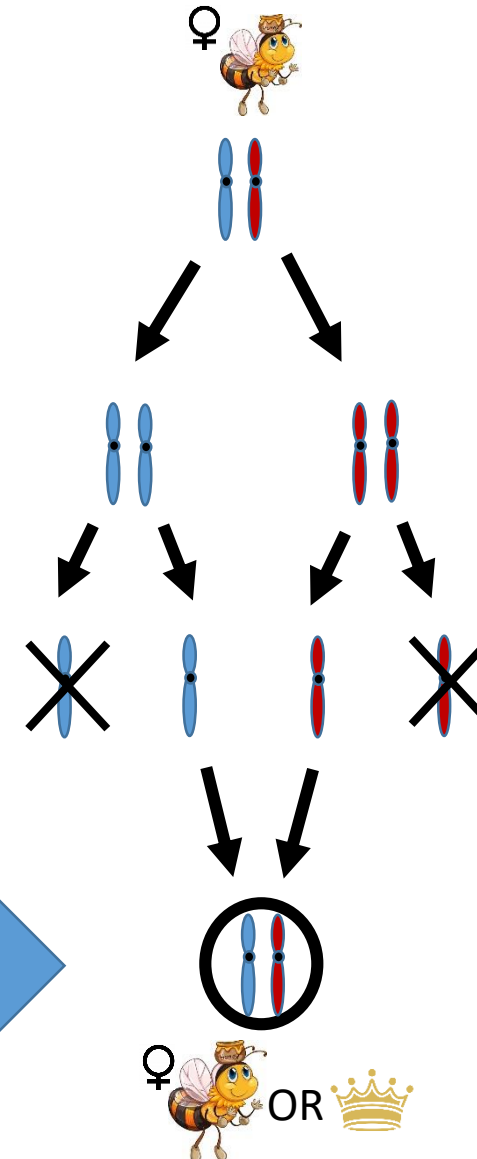


-
- The diagram illustrates thelytokous reproduction in honeybees. At the top, a queen bee (♀) is shown with two chromosomes (one blue, one red). Two arrows lead to two intermediate chromosome pairs. A blue arrow points to the right pair with the text "Egg is laid at this stage". From each intermediate pair, two arrows lead to four chromosome pairs. The leftmost and rightmost pairs are crossed out with a large 'X'. The two middle pairs (one blue, one red) lead to a final stage where the chromosomes are enclosed in a circle, representing an egg. A blue speech bubble points to this circle with the text "I don't need any sperm to become a girl, because I'm a thelytokous egg!". Below the egg, a queen bee (♀) is shown next to the word "OR" and a crown icon.



Jordan L.A., Allsopp M.H., Oldroyd B.P., Wossler T.C. and Beekman M. 2008 *Proc. Roy. Soc. Lond* 275:345
Allsopp M.H., Beekman M., Gloag R.S. and Oldroyd B.P. 2010 *Behav. Ecol. Sociobiol* 64: 567-574
Holmes, M.J., Oldroyd, B.P., Allsopp, M.H., Lim, J., Wossler, T.C., Beekman, M. 2010. *Mol Ecol.* 19: 2792-2799.

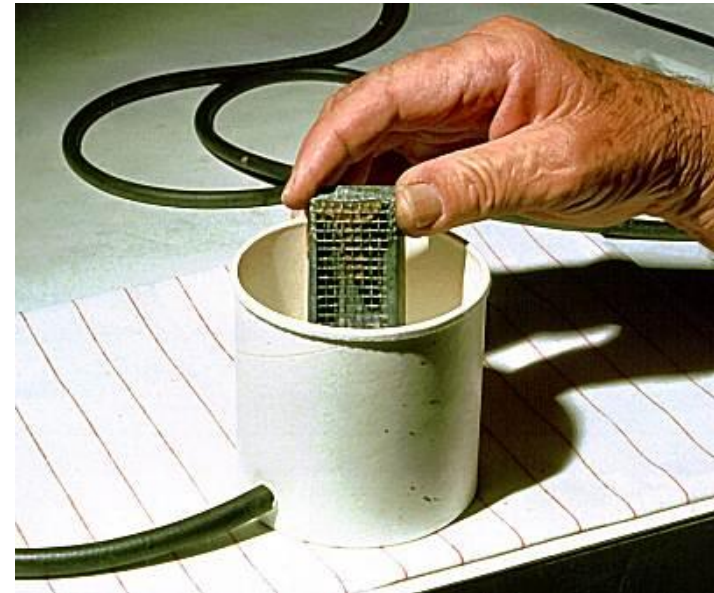




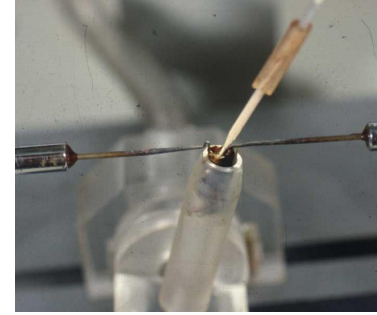
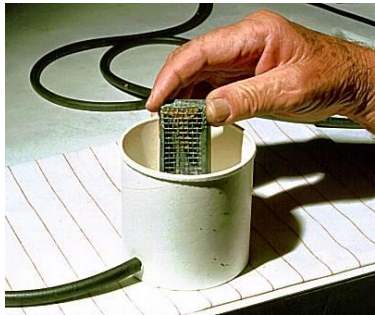
What would happen if this egg got fertilized?

Capensis **queens** don't lay thelytokously

- Only workers
- But you can induce thelytoky in virgin queens with CO₂ narcosis



Experiment



?

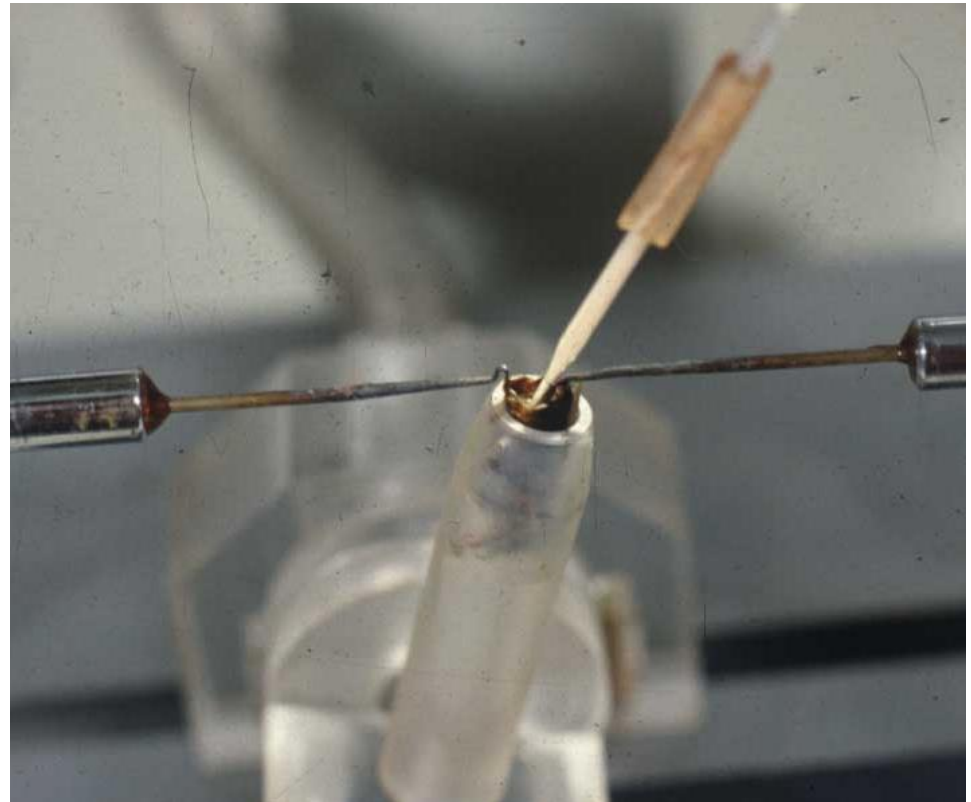
After AI up to 1/3 of progeny laying virgin
Capensis queens were triploid: both copies of
mum's chromosomes and 1 copy of dad's.

I've got three sets of
chromosomes. (But I
should only have 2)



We later found out that simply AI-ing a Capensis queen produces 1/3 triploid progeny.

Remember that you need CO₂ to keep the queen still during the operation.



Revision: What's the difference between a triploid bee and a gynandromorph bee?

Gynandromorph

- Two sets of chromosomes in some cells, one set in others
- Mixed male and female tissue

Triploid

- Three sets of chromosomes in every cell
- Always female

Meet AI 93, Green-73.

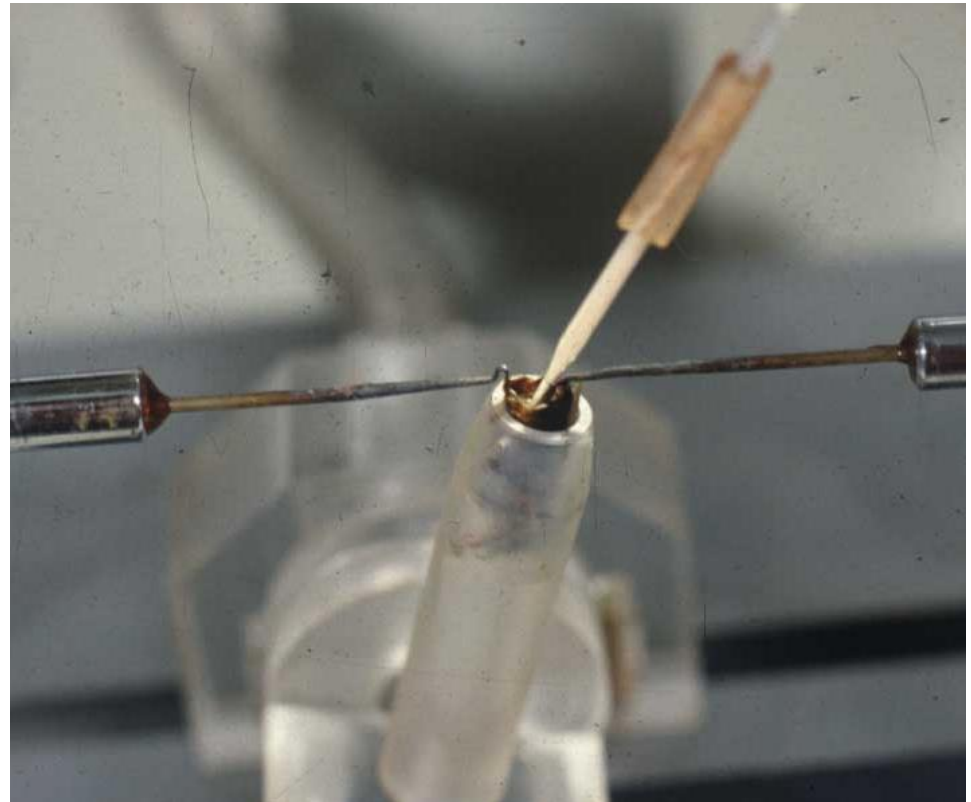


Hey BICWA conference, I'm triploid. But otherwise I'm a very normal bee. Check out my beautiful eggs on the left!



Is it the Carbon Dioxide (CO₂) or the laying without mating that makes triploids?

- When we simply AI Capensis queens, up to 1/3 of progeny are triploid.
- But AI needs CO₂
- So maybe its just CO₂





What would happen if I gassed an old lady?

Not a lot

- A couple superseded
- Most stopped laying for a while
- No triploids
- So CO₂ doesn't seem to be the cause.
- But maybe CO₂ only induces triploidy in virgins?

We need a plan to induce virgin *Capensis* queens to lay eggs without CO₂ narcosis

- Virgins that fly and interact with drones start laying, even though they have not mated.
- What we need is a bee chastity belt.





Acknowledgements

Sarah Aamidor
Mike Allsopp



Disclaimer: No beekeeping industry funds were used in the production of this research!



THE UNIVERSITY OF
SYDNEY



Australian Government

Australian Research Council