

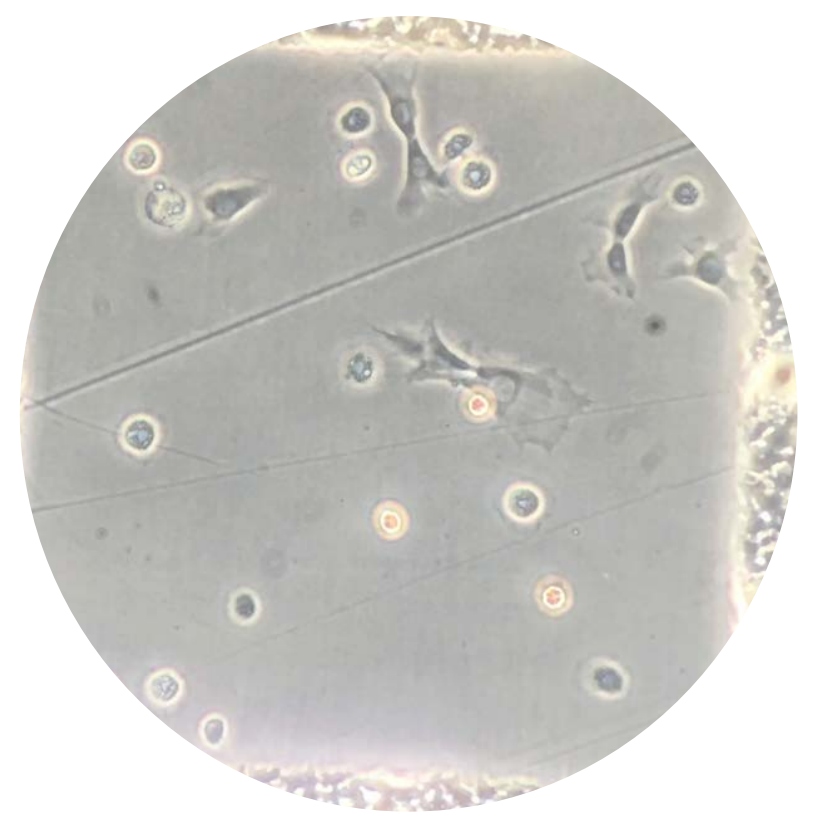
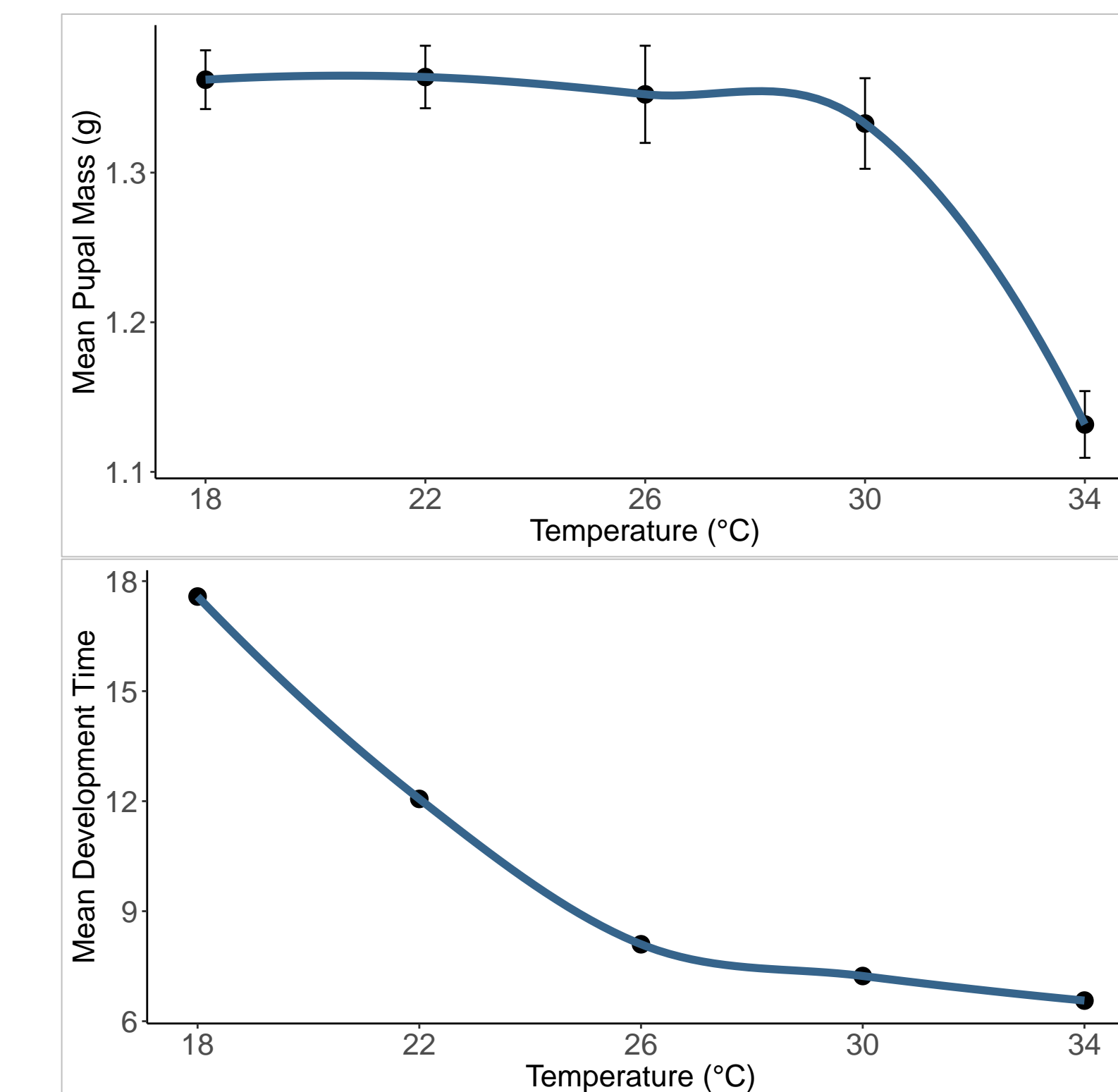
Extreme Heat Reduces Fitness of Monarchs & their Parasites

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Results

Figure 2. Average pupal mass (top) & development time until pupation (bottom)



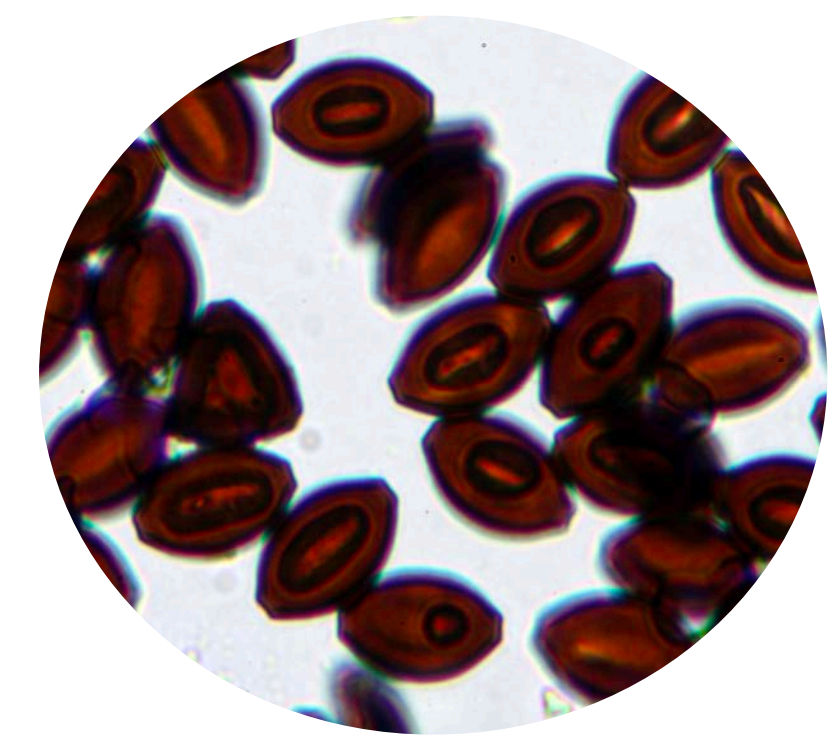
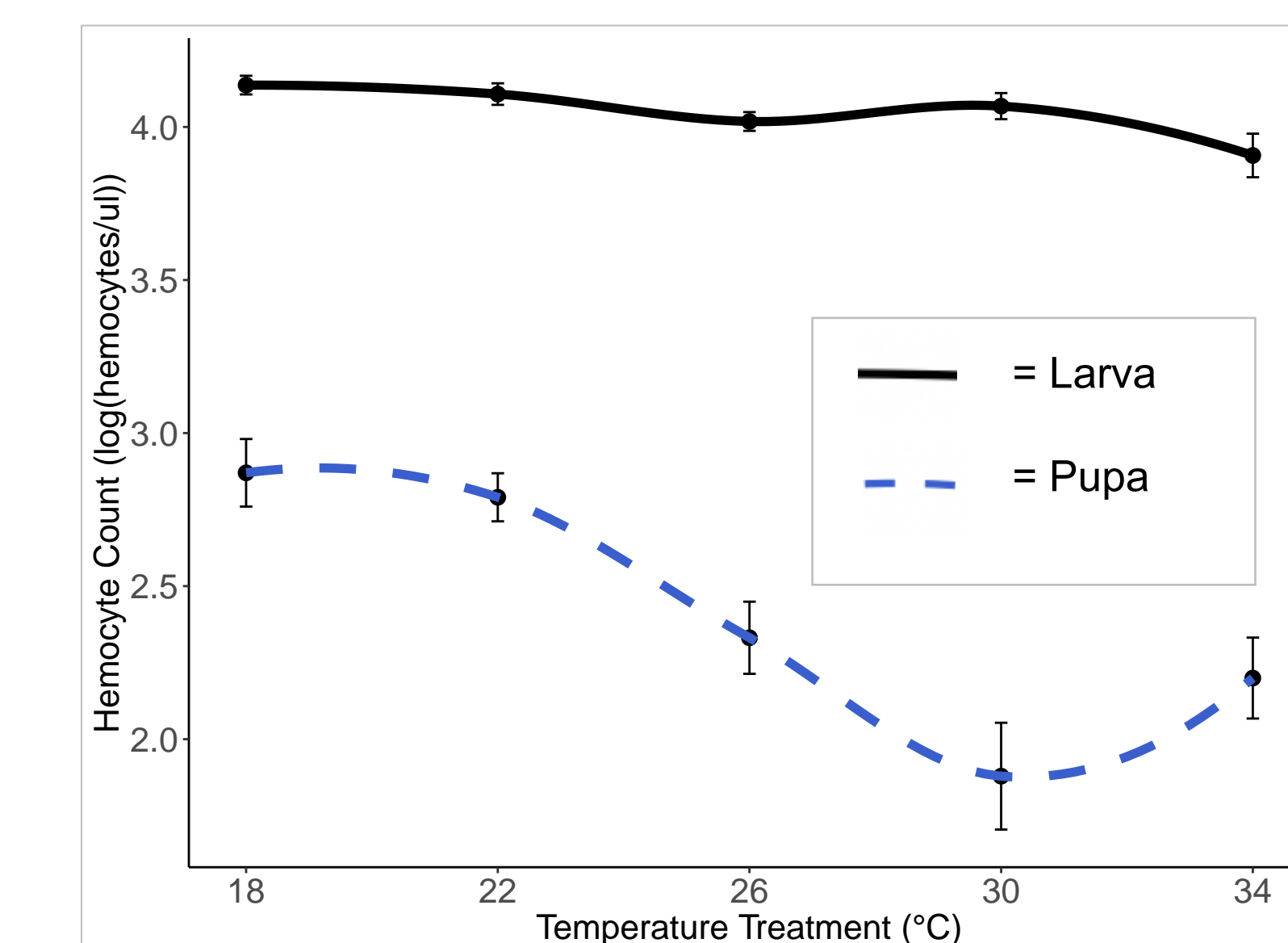
Larval bleed sample showing hemocytes (the immune cells of insects)



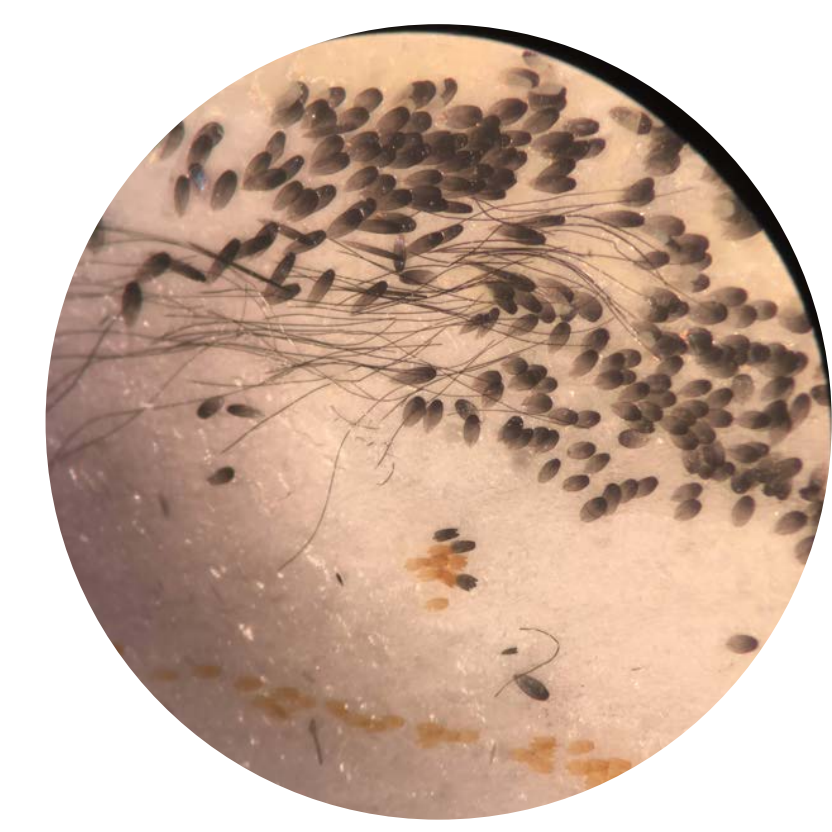
Pupal bleed sample showing merozoites (a stage of the parasite)

Pupal mass is drastically lower in 34°C. Monarch development time decreases non-linearly with increasing temperature

Figure 4. Larva & pupa hemocyte counts



Fully formed OE spores

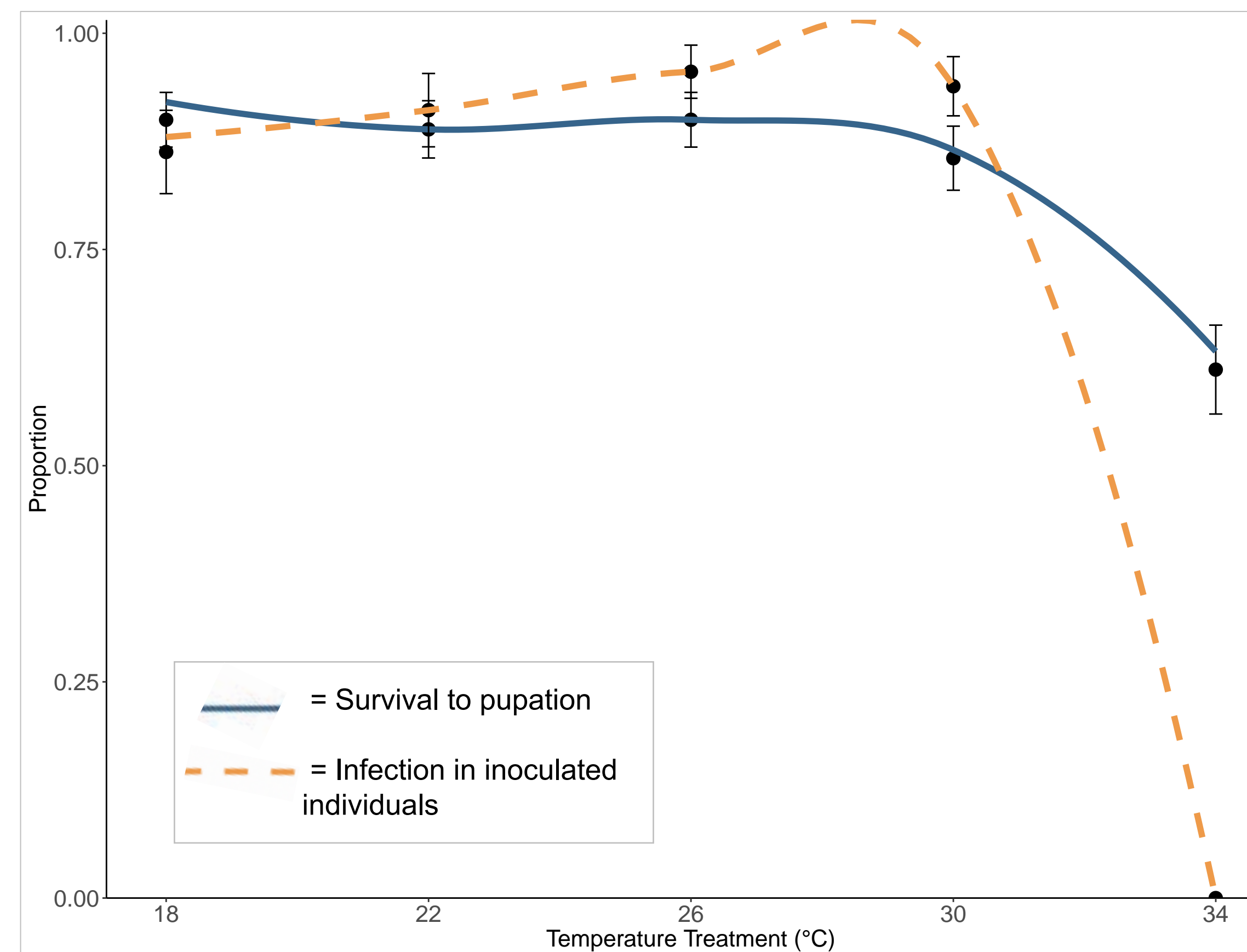


Infection score tape showing monarch scales

There is little variation in larval hemocyte counts while pupal hemocyte counts appear to decline with temperature.

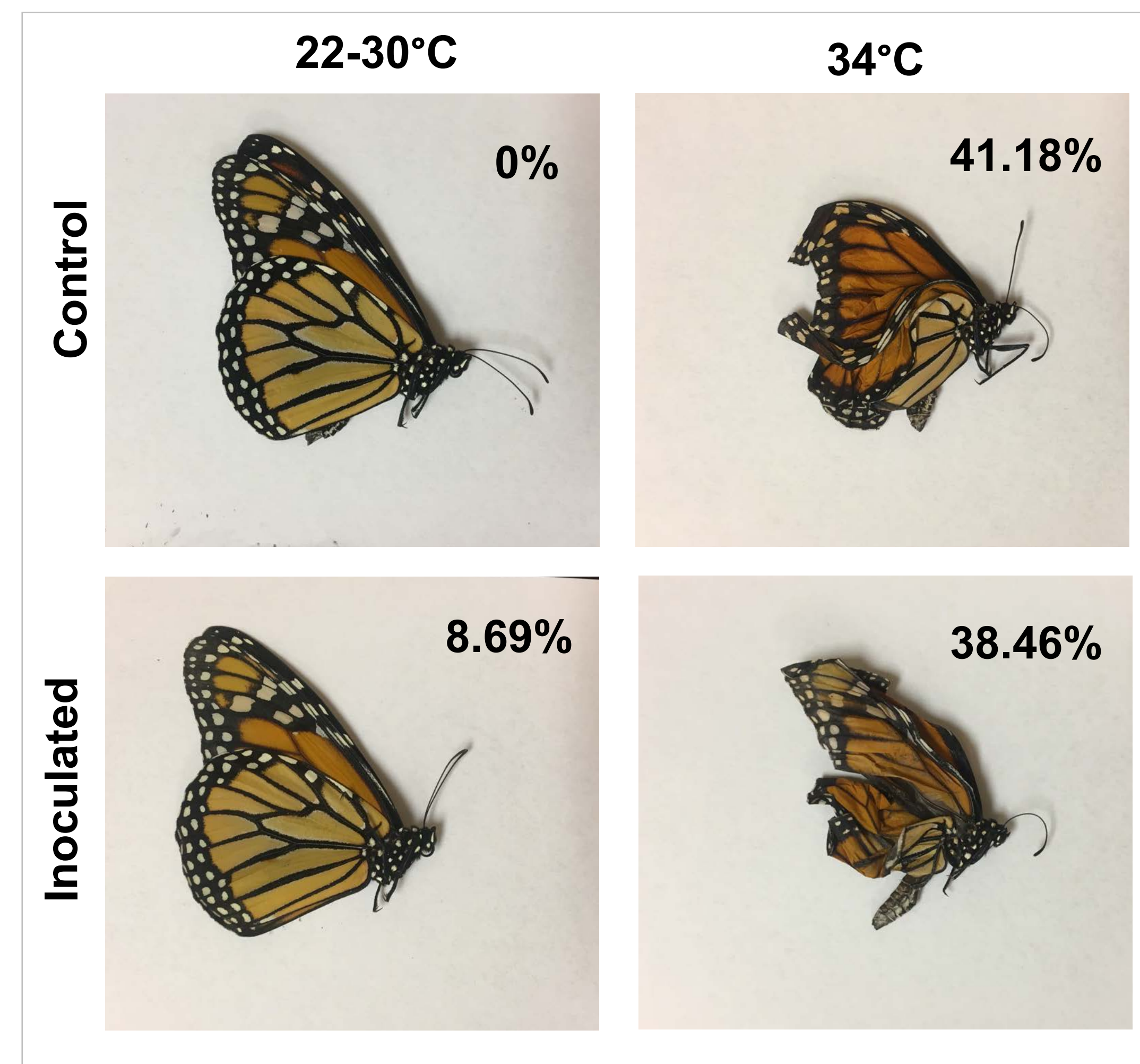
Overall, lower infection in 34°C monarchs is not due to greater cellular immunity

Figure 1. Survival and infection success



Survival and infection success drop at 34°C

Figure 3. Percent wing deformities across treatments



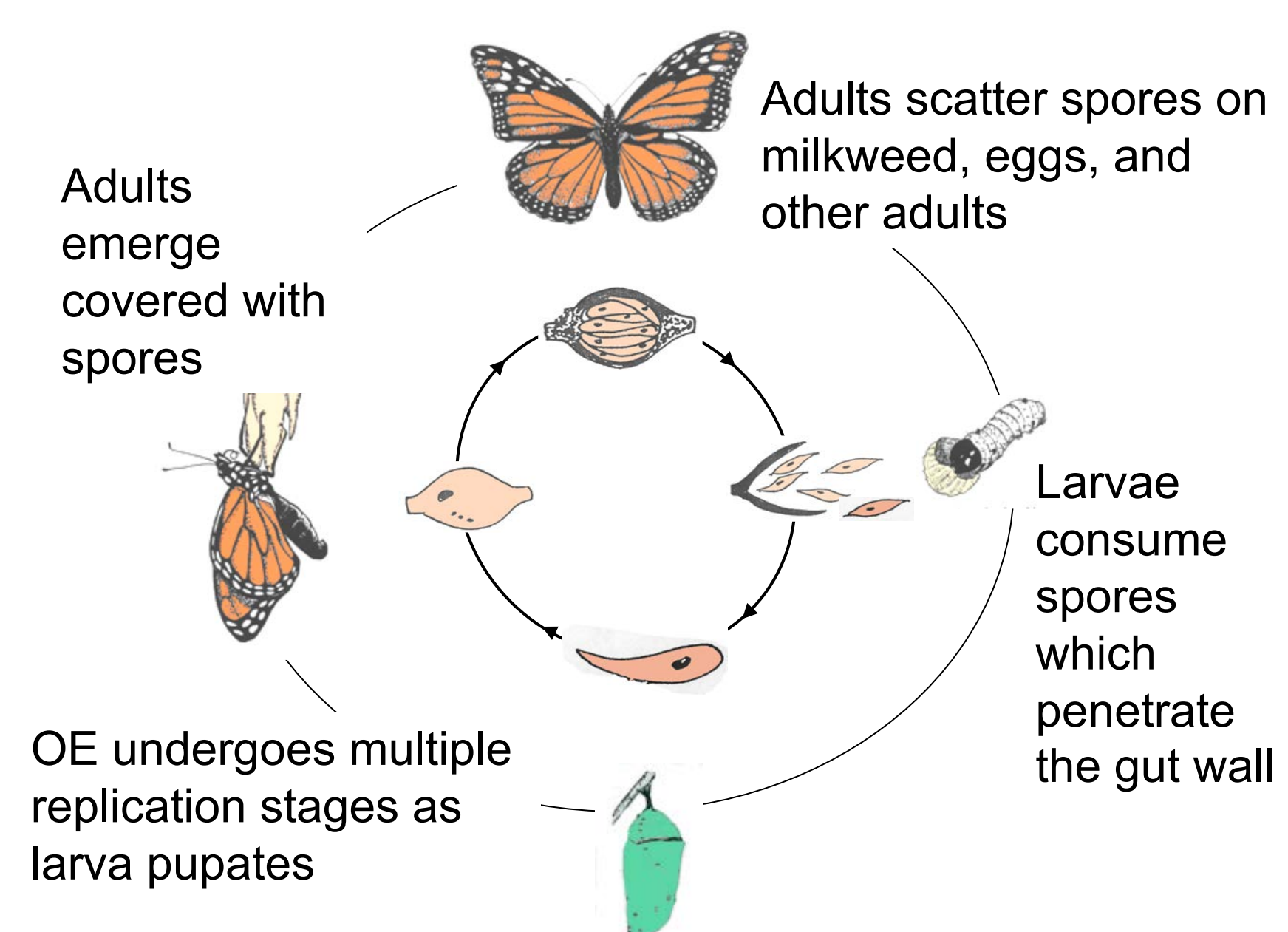
At intermediate temperatures, only inoculated monarchs had wing deformities.

At the hottest temperature, control & inoculated monarchs both suffered high rates of wing deformity.

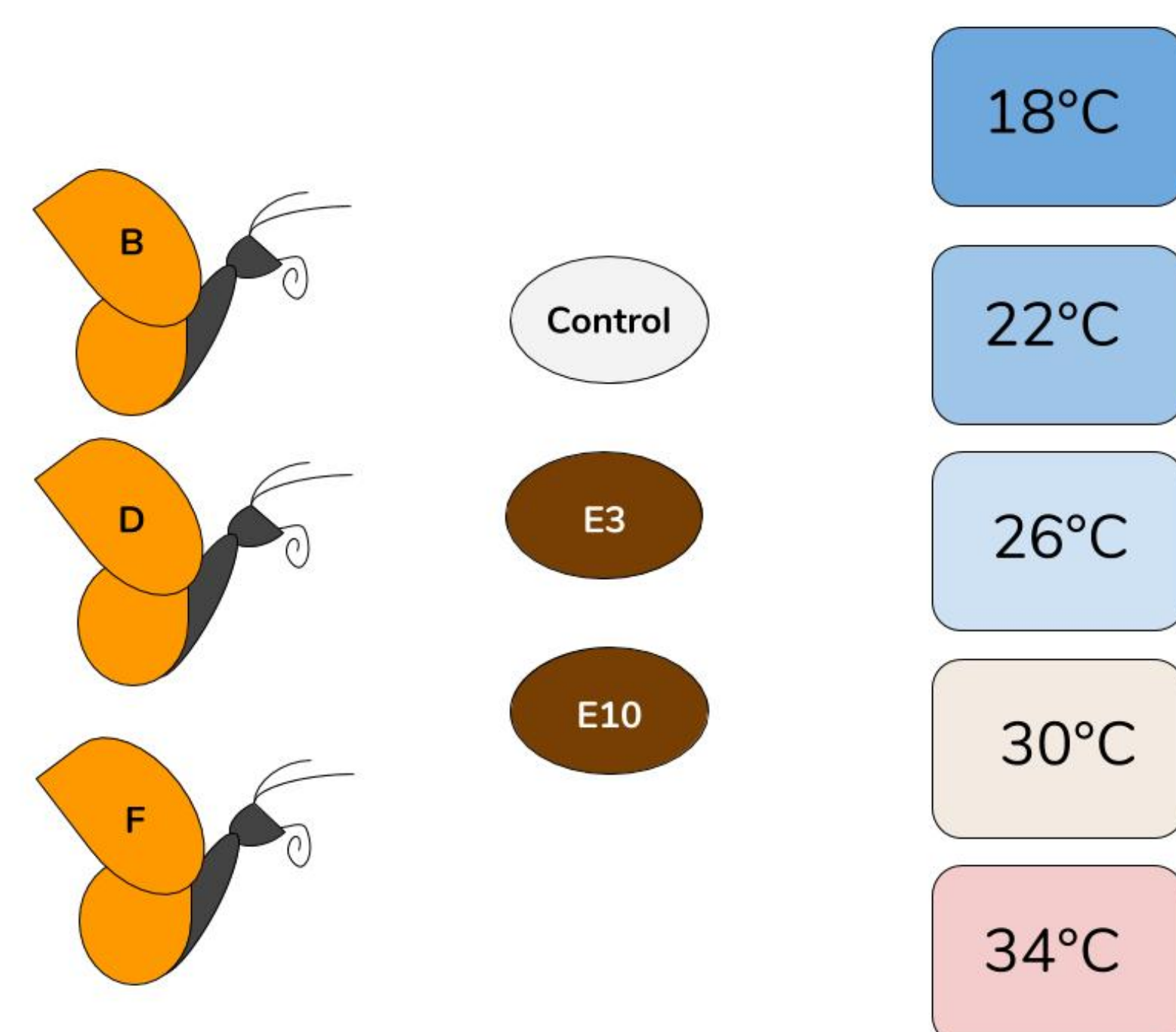
Background

- Environmental temperature affects insect development, survival, physiology, and distribution
- Insects are important pollinators and vectors of disease; it is vital to understand how climate warming affects insect-parasite interactions
- A debilitating protozoan parasite, *Ophryocystis elektroscirrha* (OE) is present in all Monarch (*Danaus plexippus*) populations.
- Temperature's effect on within-host OE development or Monarch immune function is not known

The Life Cycle of the OE parasite in Monarch butterflies



Experimental Design



Three lineages of migratory monarchs test genetic effects while 3 spore treatments test spore virulence effects within 5 different temperature treatments.

Methods & Measurements

Monarch Condition:

- Survival (to pupation & emergence)
- Development time ("")
- Mass (pupal & larval)
- Adult longevity

Immune Function:

- Hemocyte counts (larval & pupal bleeds)

Infection Measurement:

- Merozoite counts (pupal bleeds)
- Infection scores (adult taping)

Conclusions

- The study provides new evidence that high environmental temperatures decrease infectivity of a parasite in Monarchs
- Moderate warming is predicted to lead to more monarch generations per season and higher parasite fitness
- More extreme heat events, which are predicted with climate change, will be harsh on both monarchs and their parasite

Future Directions

- Complete and analyze spore load, immune assays, & adult longevity
- Investigate the effects of temperature extremes (30-34°C & <18°C) and fluctuations in temperature on the host-parasite interaction



FIG2 cute caterpillar (noo die)

Acknowledgements

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