

Co-evolution of house mouse and an intracellular parasite, *Eimeria* spp.

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Context

- Parasite model: *Eimeria* spp., obligate intracellular apicomplexan parasite. **Two major clades (A & B)** of *Eimeria* spp. identified (3 markers) in the mice of the hybrid zone
- Host model: *Mus musculus domesticus*, *Mus musculus musculus*, and hybrids

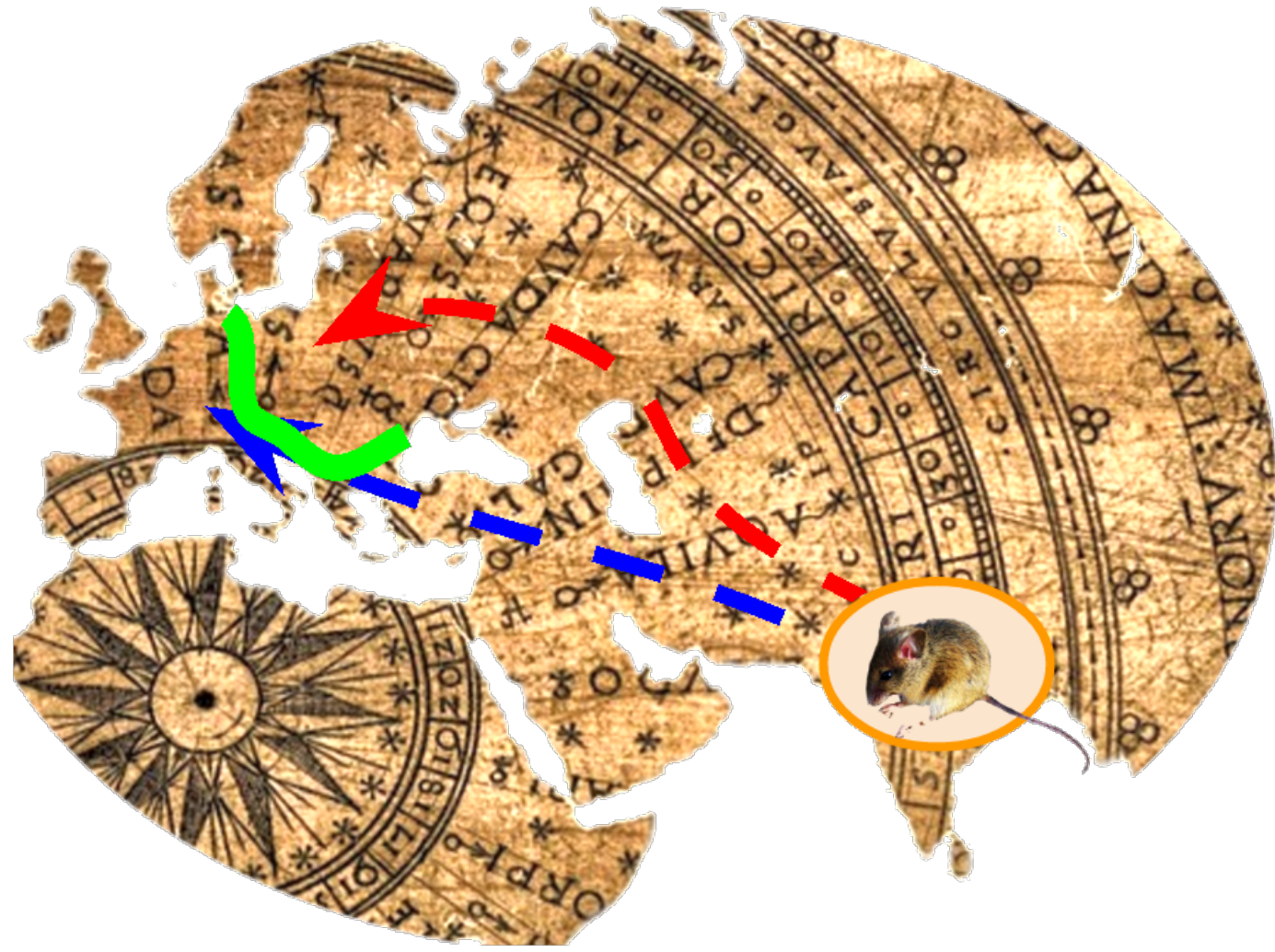


Fig. 1: Migration of sub-species of *Mus musculus* until formation of the House Mouse Hybrid Zone (HMHZ), 20km wide, formed by hybrids of the two sub-species. After 500,000 years in isolation, secondary contact 5000 years ago (Macholán *et al.* 2012)

Aims of the study

- Investigate the **hybrid vigor/resistance** of house mouse to their parasite *Eimeria* spp. using prevalence and intensity data for parasite strains throughout the House Mouse Hybrid Zone
- Test **local adaptation** between the host and its parasite

Material & Methods: Field study

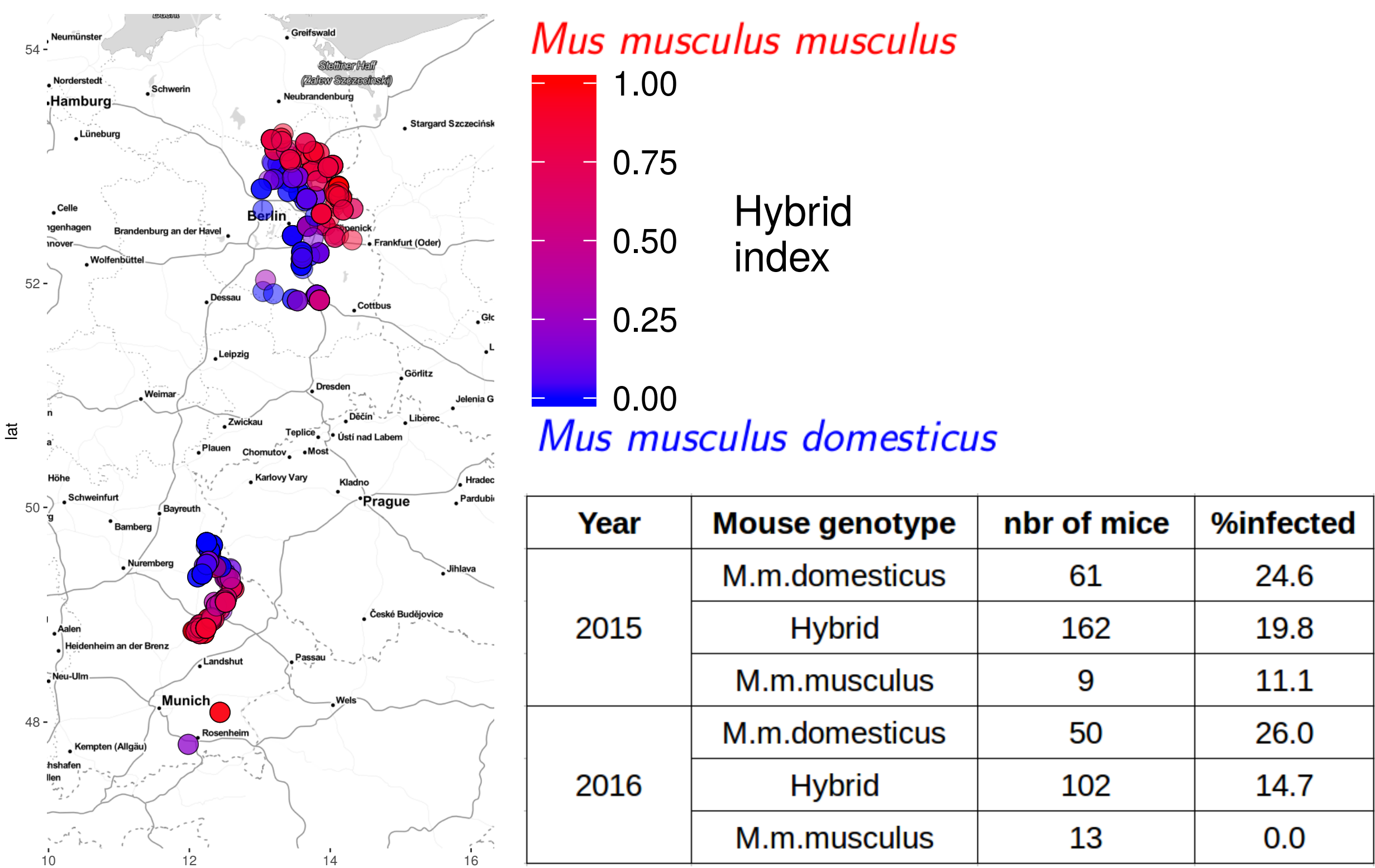


Fig. 2: Annual sampling every September. Oocyst counted in mice feces. Mice assigned to a hybrid index based on *M.m.domesticus*/*M.m.musculus* alleles ratio (Macholán *et al.* (2011))

Material & Methods: Cross infection

- Parasite strains:
 - Eimeria A** laboratory strain *Eimeria falciformis* (Heitlinger *et al.* 2014)
 - Eimeria B** strain isolated in the wild
- Host strains:
 - WSB** Wild-derived inbred strain. Derived from wild *Mus musculus domesticus*
Region of capture: Eastern Shore, Maryland
 - PWD** Wild-derived inbred strain. Derived from wild *Mus musculus musculus*
Region of capture: near Prague, Czech Republic
 - WP** Hybrids between the two previous strains

Exploring hybrid vigor/resistance in the wild

Adaptation of the method of Stuart J.E. Baird (Baird *et al.* 2012):
Maximum likelihood analysis explicitly linking parasite abundance to a gradient along the hybrid index as a proxy of host heterozygosity

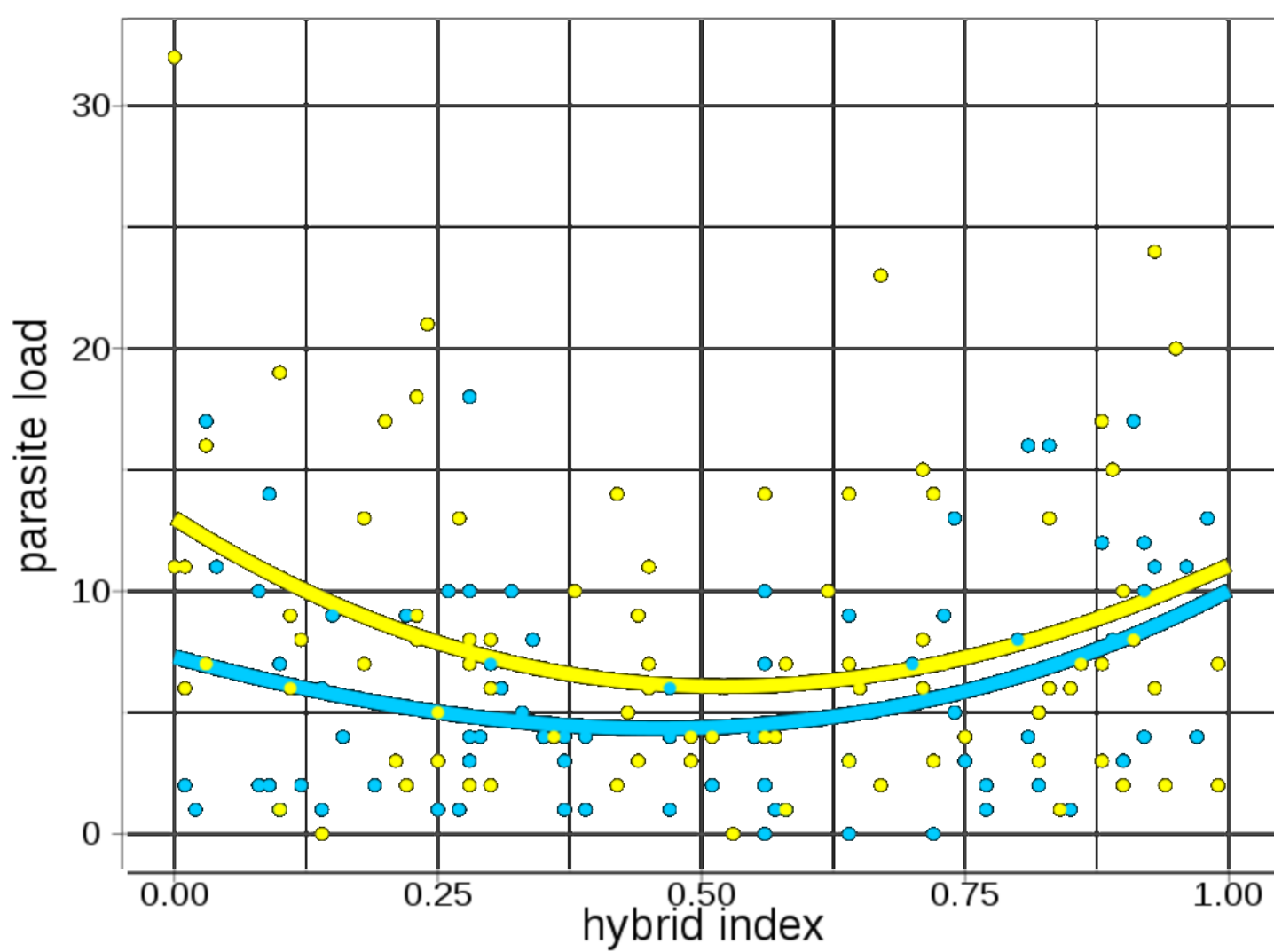


Fig. 3: Generalized linear model with negative binomial distribution: **glm.hybrid** applied to simulated data, two groups both presenting a hybrid vigor

R package under development: https://github.com/alicebalard/Parasite_Load
Goal: using our **glm.hybrid** model to assess the existence of hybrid vigor/resistance, taking into account the parasite strains

$$\text{Parasite load} \sim \text{mouse heterozygosity level} * \text{parasite strain}$$

Results of the infection experiment

- Eimeria* B has **lower parasite shedding** and **lower relative weight retained** in mice strains WSB compared to PWD
- Eimeria* B has **lower parasite shedding** and **lower relative weight retained** in mice hybrids than in the pure strains

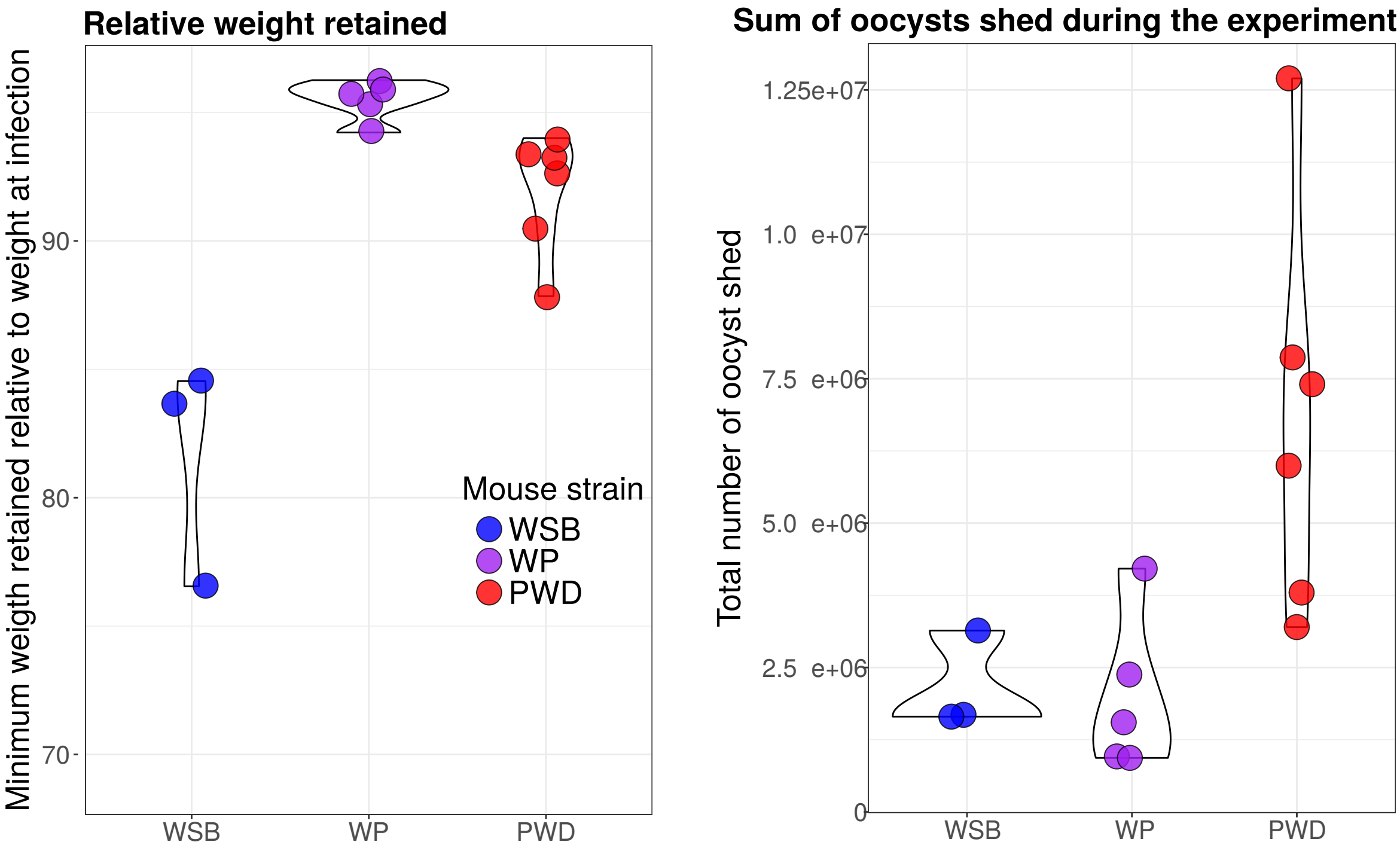


Fig. 4: First indications of **local adaptation** and **hybrid vigor**

Perspective

- Next cross infection experiment:
- Test our hypotheses of hybrid vigor (within subspecies heterosis vs between subspecies)
 - Assess local adaptation in other parasite strains
- Field data:
- Obtain enough data (Sept. 2017) to test our hypotheses of hybrid vigor and local adaptation in the wild

References

Baird *et al.* (2012) Where Are the Wormy Mice? A Reexamination of Hybrid Parasitism in the European House Mouse Hybrid Zone *Evolution* 66 (9): 2757–72
Heitlinger *et al.* (2014) The genome of *Eimeria falciformis*-reduction and specialization in a single host apicomplexan parasite *BMC genomics* 15 (1), 696
Macholán *et al.* (2011) Assessing Multilocus Introgression Patterns: A Case Study on the Mouse X Chromosome in Central Europe *Evolution* 65: 1428–1446
Macholán *et al.* (2012) *Evolution of the House Mouse* Cambridge University Press

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