Report: Testing hybrid vigor in the lab in response to Eimeria

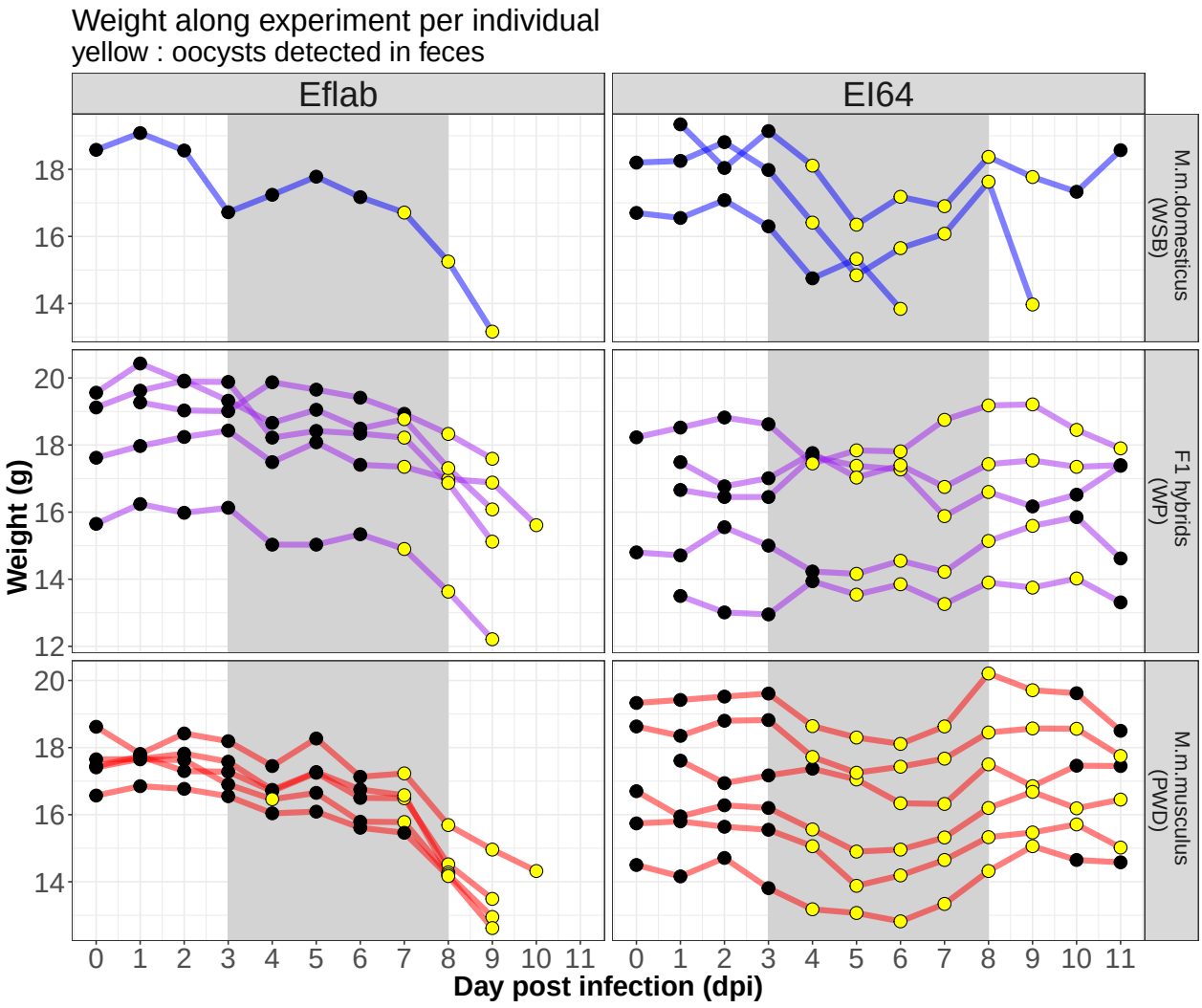
Alice

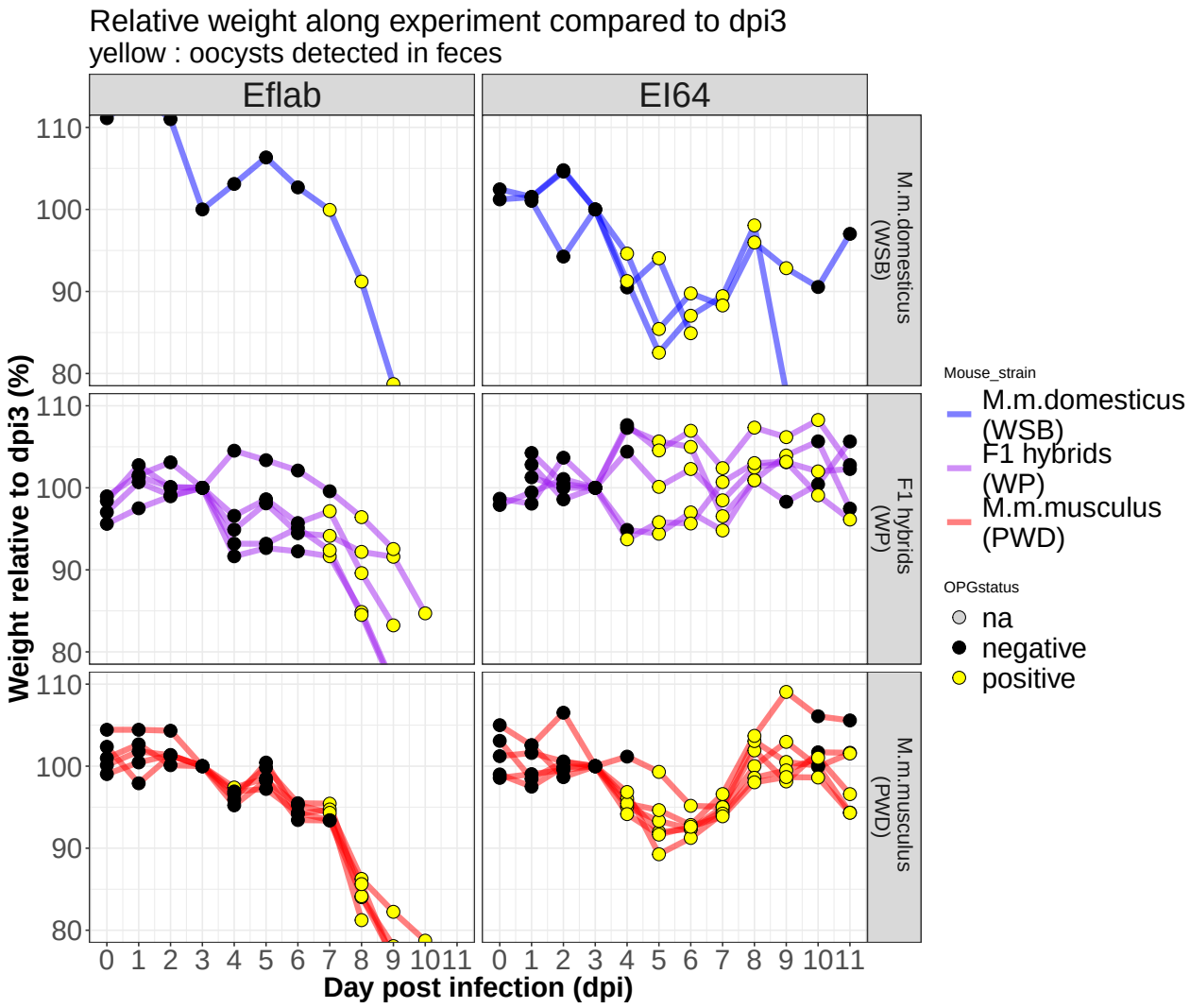
23 January 2019

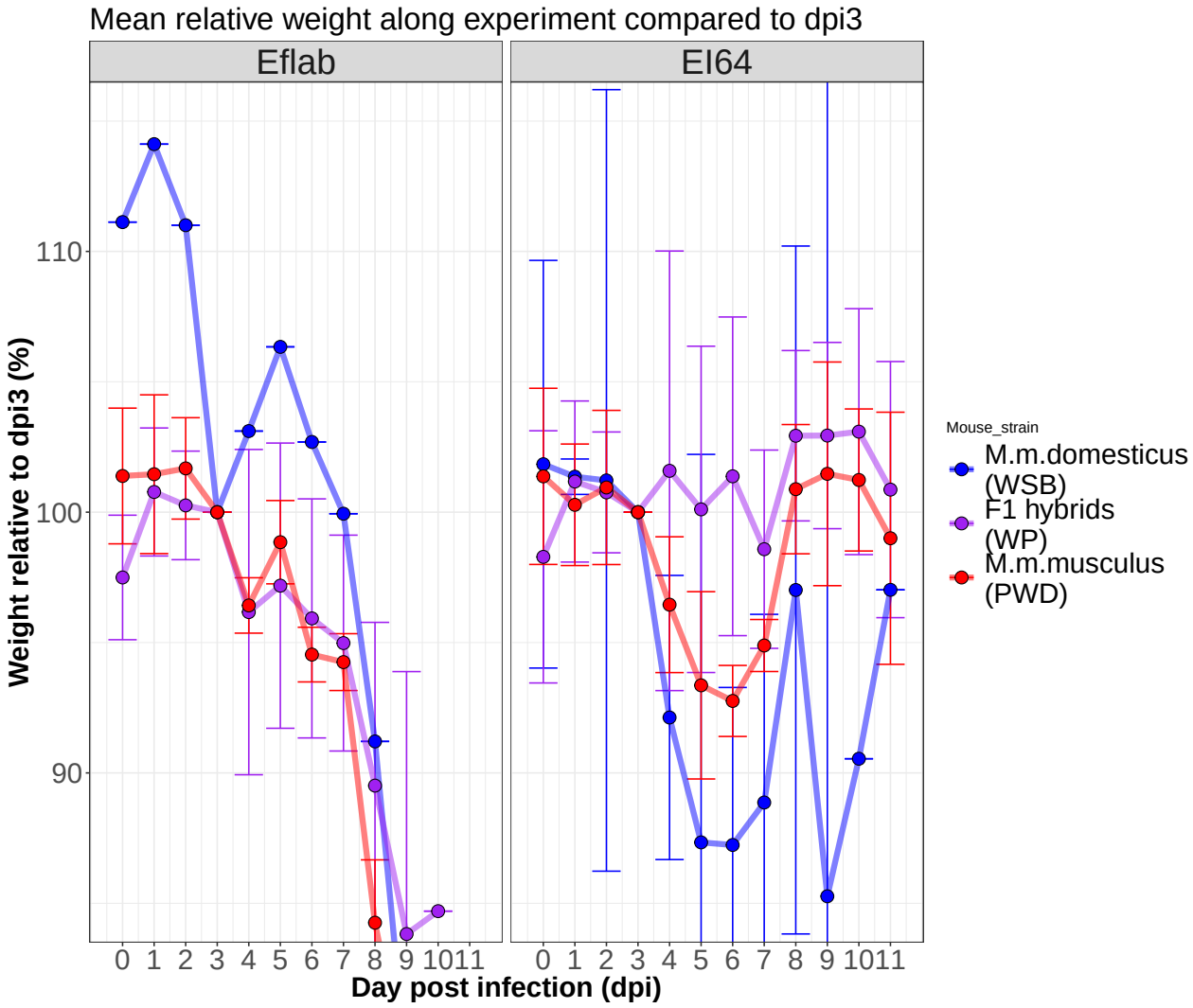
Contents

Expe_001, March 2017, Francisca's experiment. infection with E64 and Eflab

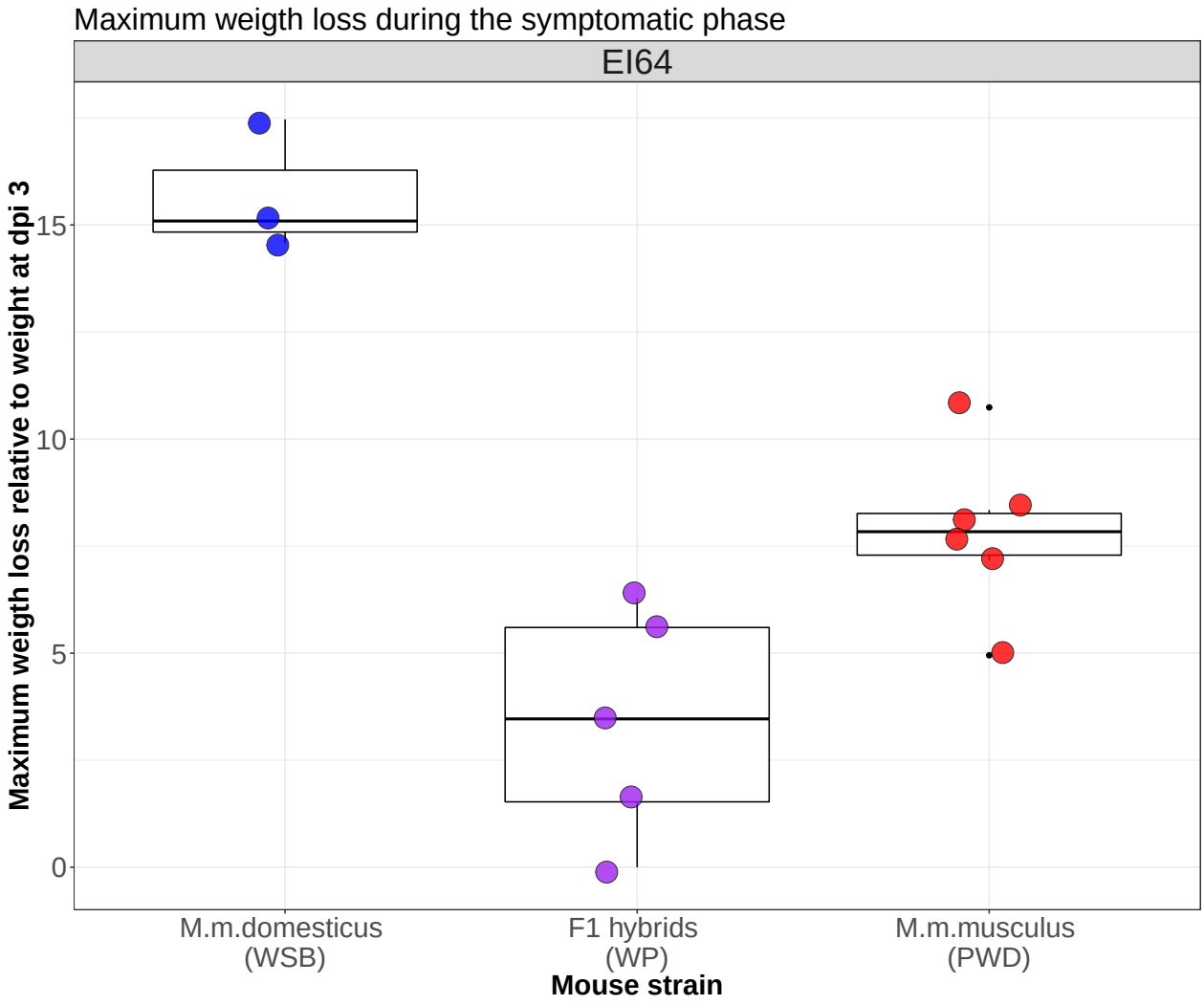
1. Weight loss




Relative weight along experiment compared to dpi3
yellow : oocysts detected in feces
Eflab
EI64
M.m.domesticus (WSB)
F1 hybrids (WP)
M.m.musculus (PWD)
Weight relative to dpi3 (%)
Day post infection (dpi)
Mouse_strain
M.m.domesticus (WSB)
F1 hybrids (WP)
M.m.musculus (PWD)
OPGstatus
na
negative
positive



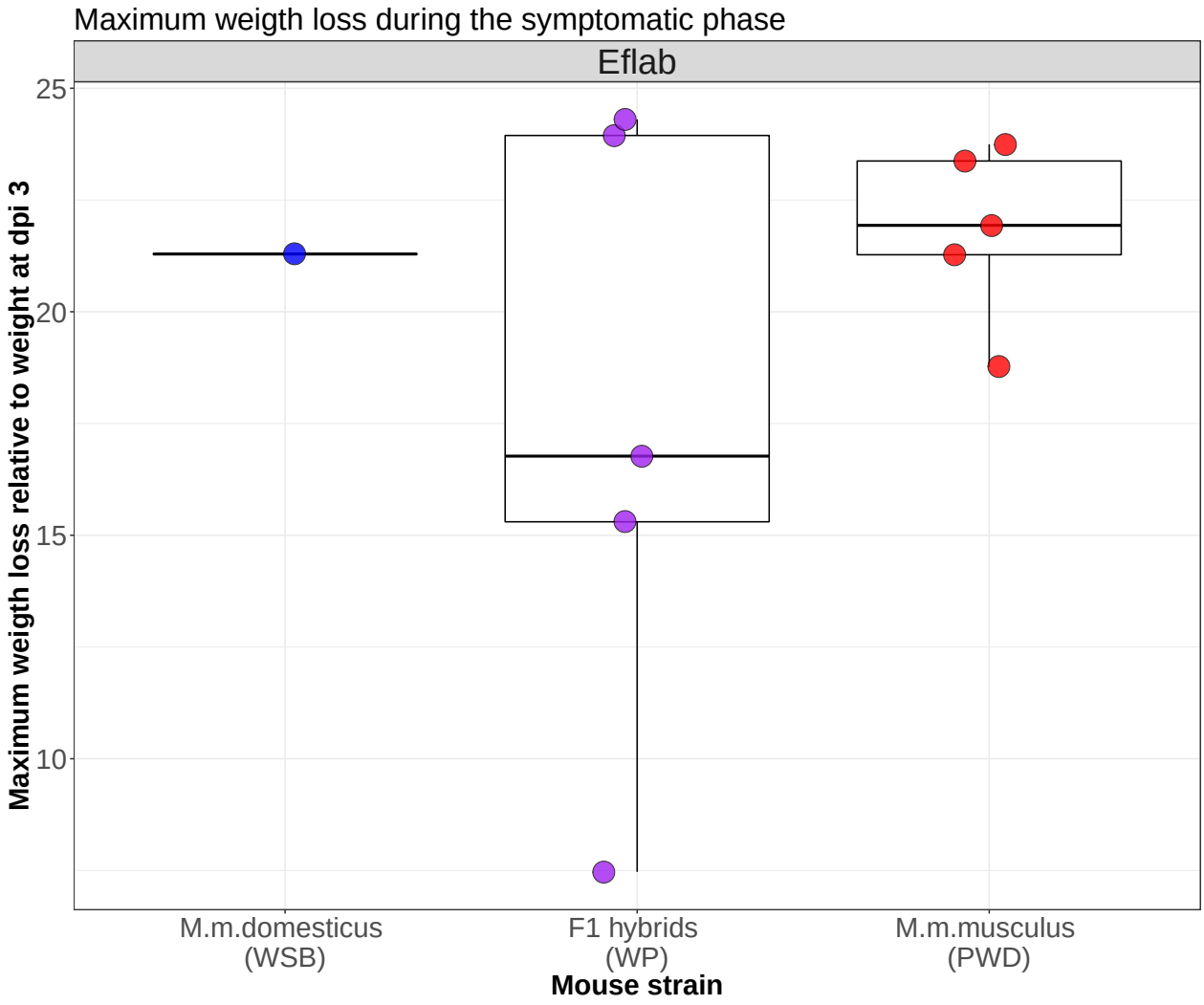
For statistical analysis, we compare the maximum relative weight loss between the different groups. We limit our analysis to the period : dpi3 to dpi8 (symptomatic period for E64 strain).




```
##
##  Kruskal-Wallis rank sum test
##
## data:  relativeWeight by Mouse_strain
## Kruskal-Wallis chi-squared = 10.141, df = 2, p-value = 0.006279
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test
##
## data:  max.loss_001_64$relativeWeight and max.loss_001_64$Mouse_strain
##
##                         F1 hybrids \n(WP) M.m.domesticus \n(WSB)
## M.m.domesticus \n(WSB) 0.036             -
## M.m.musculus \n(PWD)   0.036             0.036
##
## P value adjustment method: BH
```

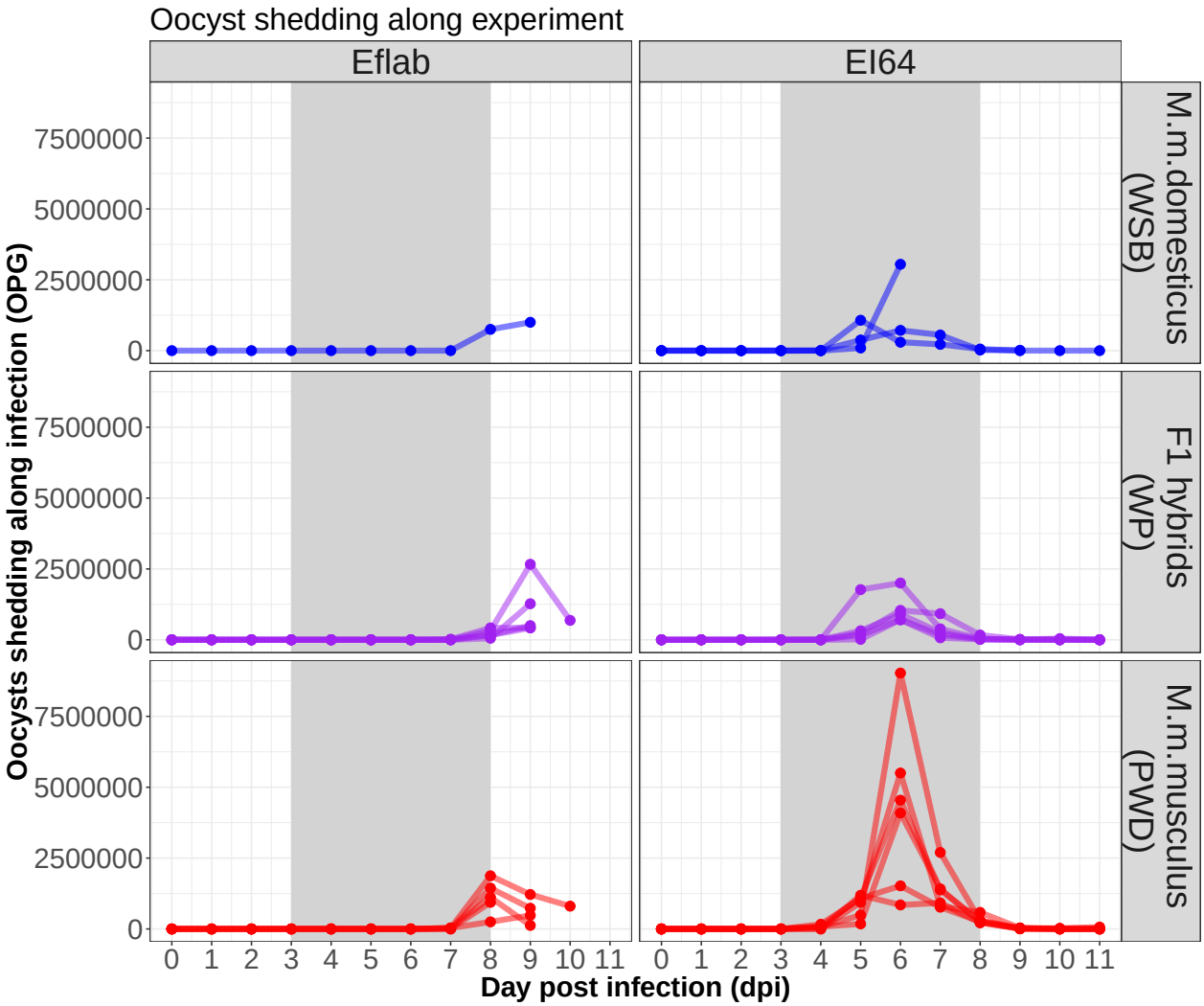
For statistical analysis, we compare the maximum relative weight loss between the different groups. We limit our analysis to the period : dpi7 to dpi11 (symptomatic period for E88 strain).

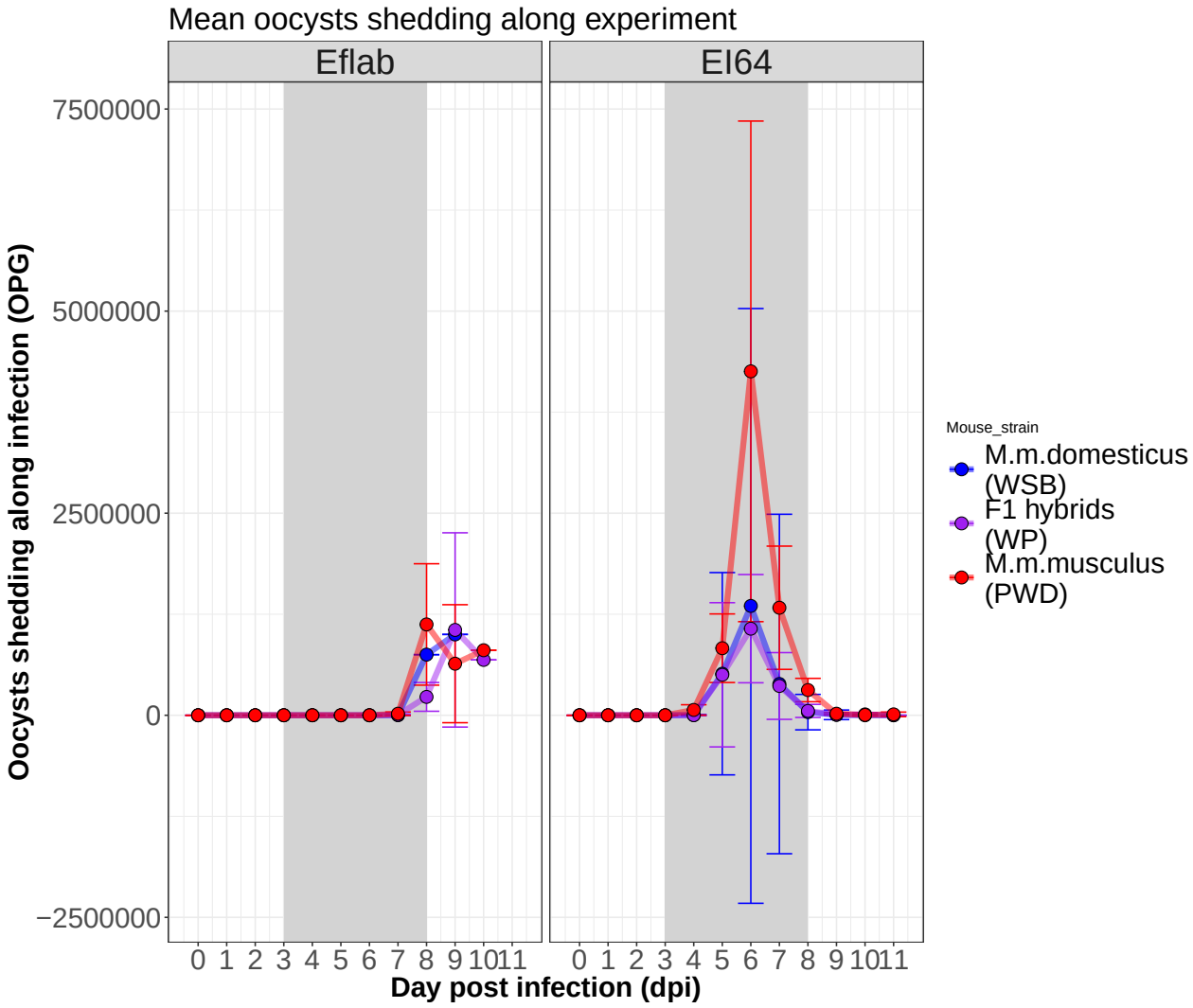


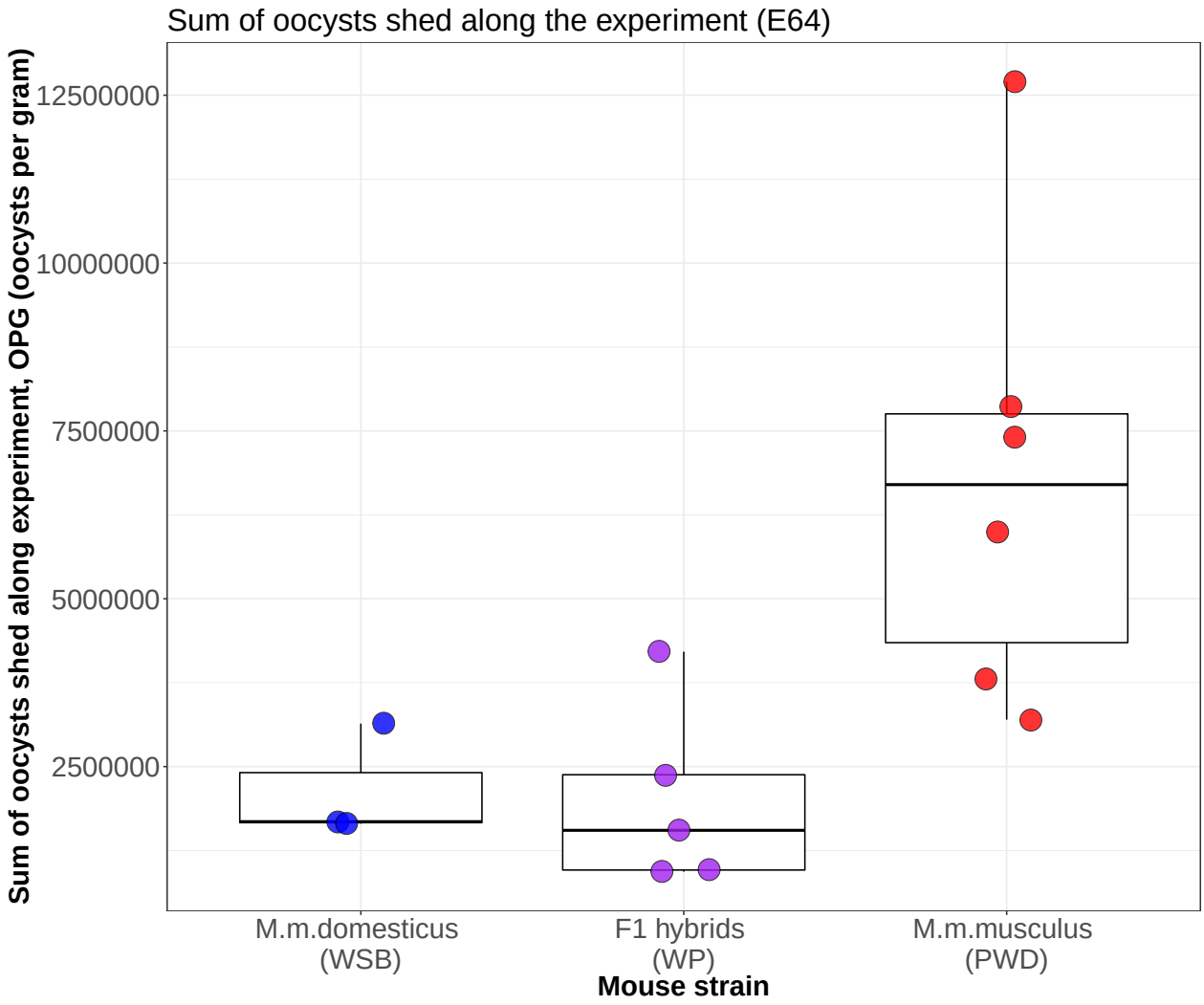

```
##
##  Kruskal-Wallis rank sum test
##
## data:  relativeWeight by Mouse_strain
## Kruskal-Wallis chi-squared = 0.32727, df = 2, p-value = 0.8491
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test
##
## data:  max.loss_001_88$relativeWeight and max.loss_001_88$Mouse_strain
##
##                         F1 hybrids \n(WP) M.m.domesticus \n(WSB)
## M.m.domesticus \n(WSB) 1                 -
## M.m.musculus \n(PWD)   1                 1
##
## P value adjustment method: BH
```

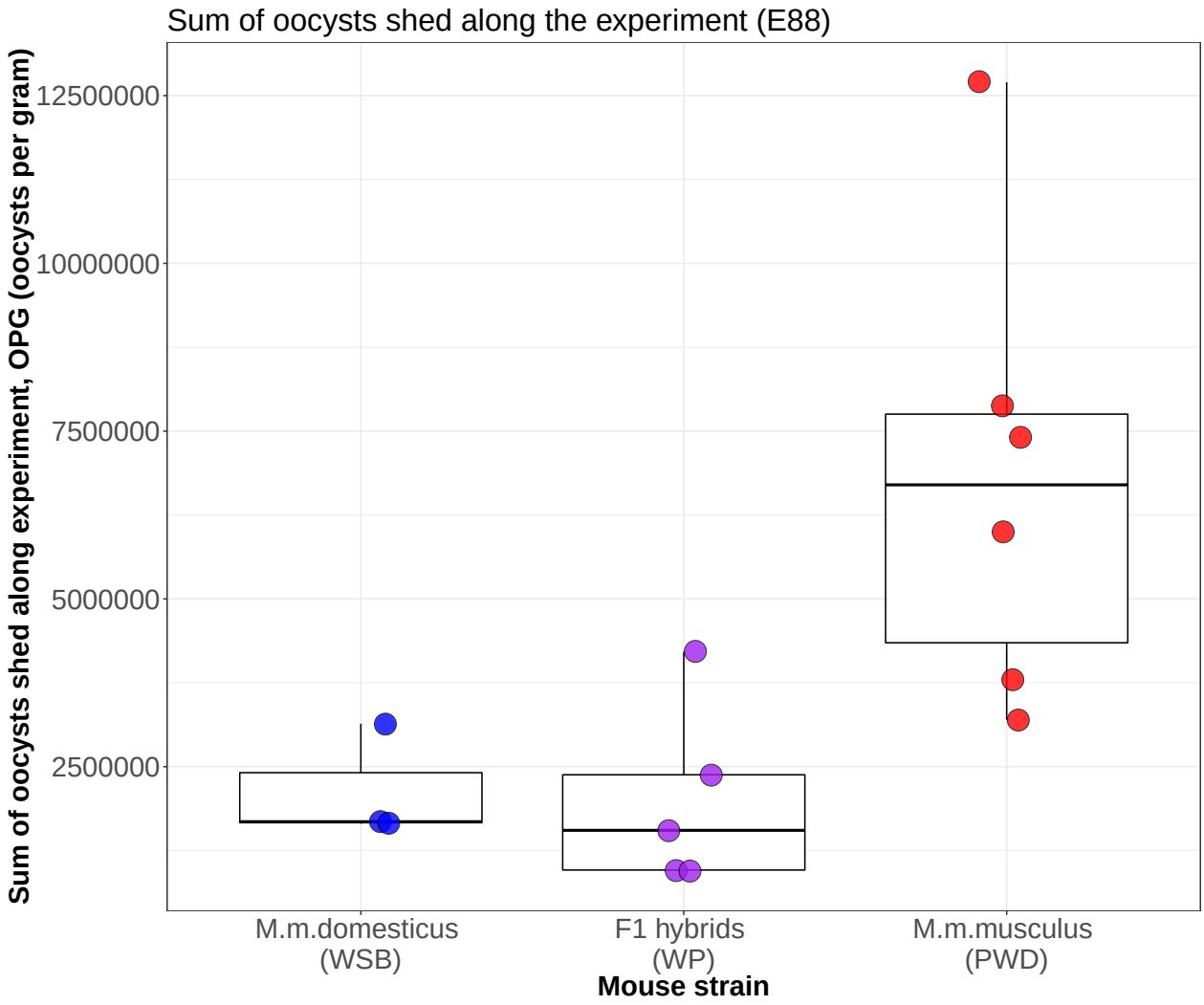
2. Parasite shedding




Mean oocysts shedding along experiment
Eflab
EI64
7500000
5000000
2500000
0
−2500000
Oocysts shedding along infection (OPG)
0 1 2 3 4 5 6 7 8 9 10 11
Day post infection (dpi)
Mouse_strain
M.m.domesticus (WSB)
F1 hybrids (WP)
M.m.musculus (PWD)




```
##
##  Kruskal-Wallis rank sum test
##
## data:  sum.oo by Mouse_strain
## Kruskal-Wallis chi-squared = 8.16, df = 2, p-value = 0.01691

##
##  Pairwise comparisons using Wilcoxon rank sum test
##
## data:  sum.oocysts_001_64$sum.oo and sum.oocysts_001_64$Mouse_strain
##
##                         F1 hybrids \n(WP) M.m.domesticus \n(WSB)
## M.m.domesticus \n(WSB) 0.571             -
## M.m.musculus \n(PWD)   0.036             0.036
##
## P value adjustment method: BH
```




```
##
##  Kruskal-Wallis rank sum test
##
## data:  sum.oo by Mouse_strain
## Kruskal-Wallis chi-squared = 8.16, df = 2, p-value = 0.01691

##
##  Pairwise comparisons using Wilcoxon rank sum test
##
## data:  sum.oocysts_001_88$sum.oo and sum.oocysts_001_88$Mouse_strain
##
##                         F1 hybrids \n(WP) M.m.domesticus \n(WSB)
## M.m.domesticus \n(WSB) 0.571             -
## M.m.musculus \n(PWD)   0.036             0.036
##
## P value adjustment method: BH
```

3. Comparison host/parasite proxy

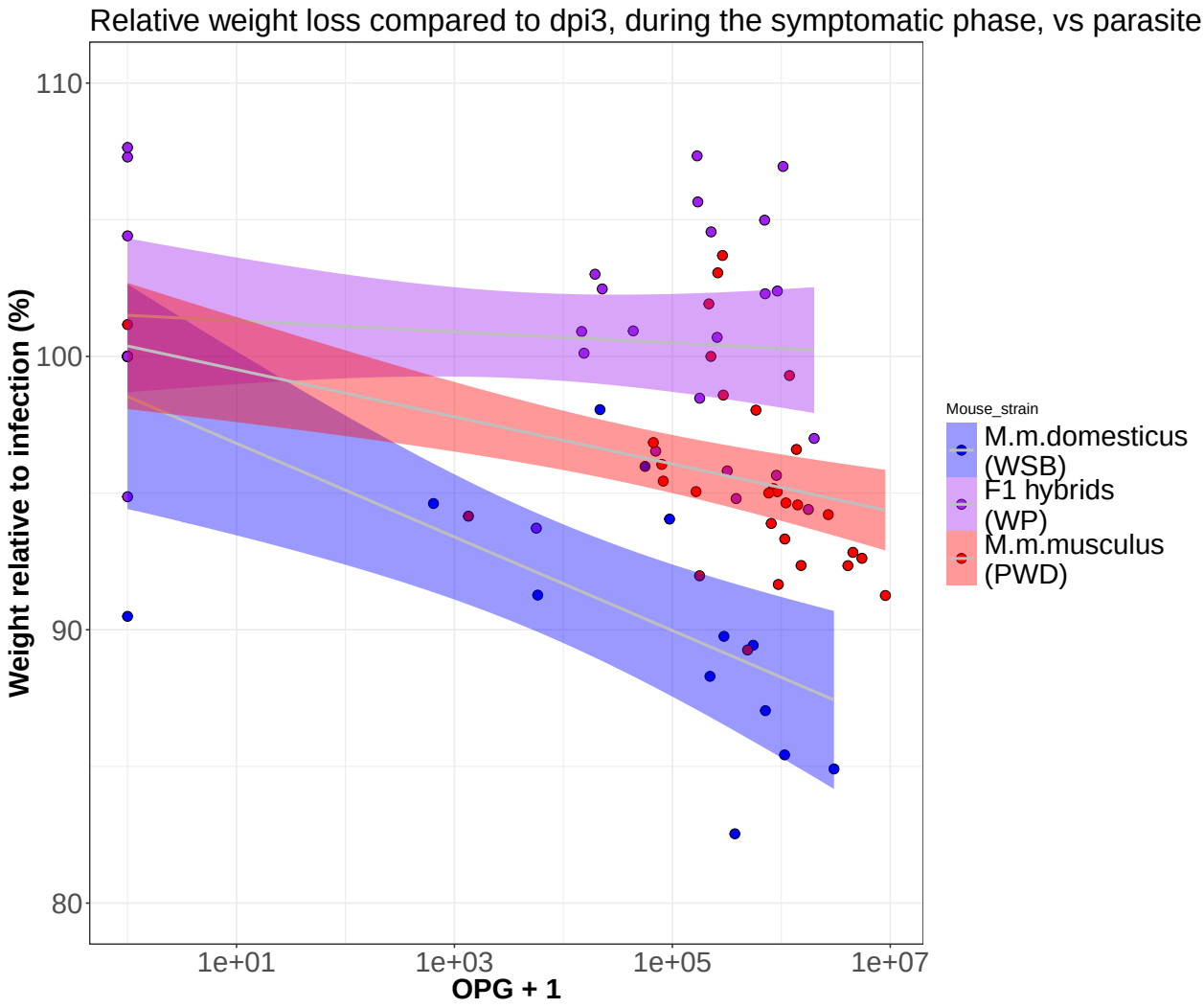


Figure 1: Weight as a function of OPG

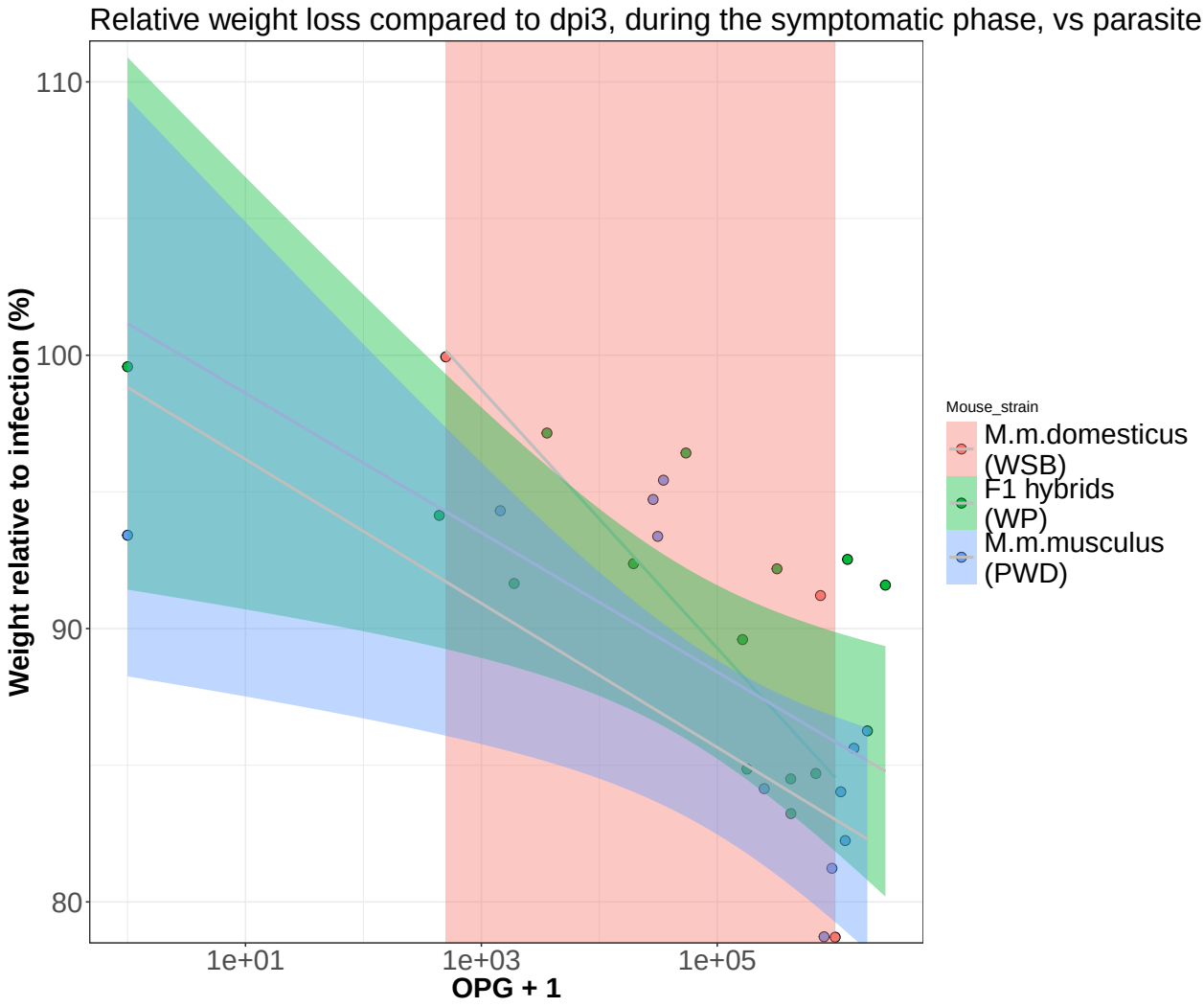
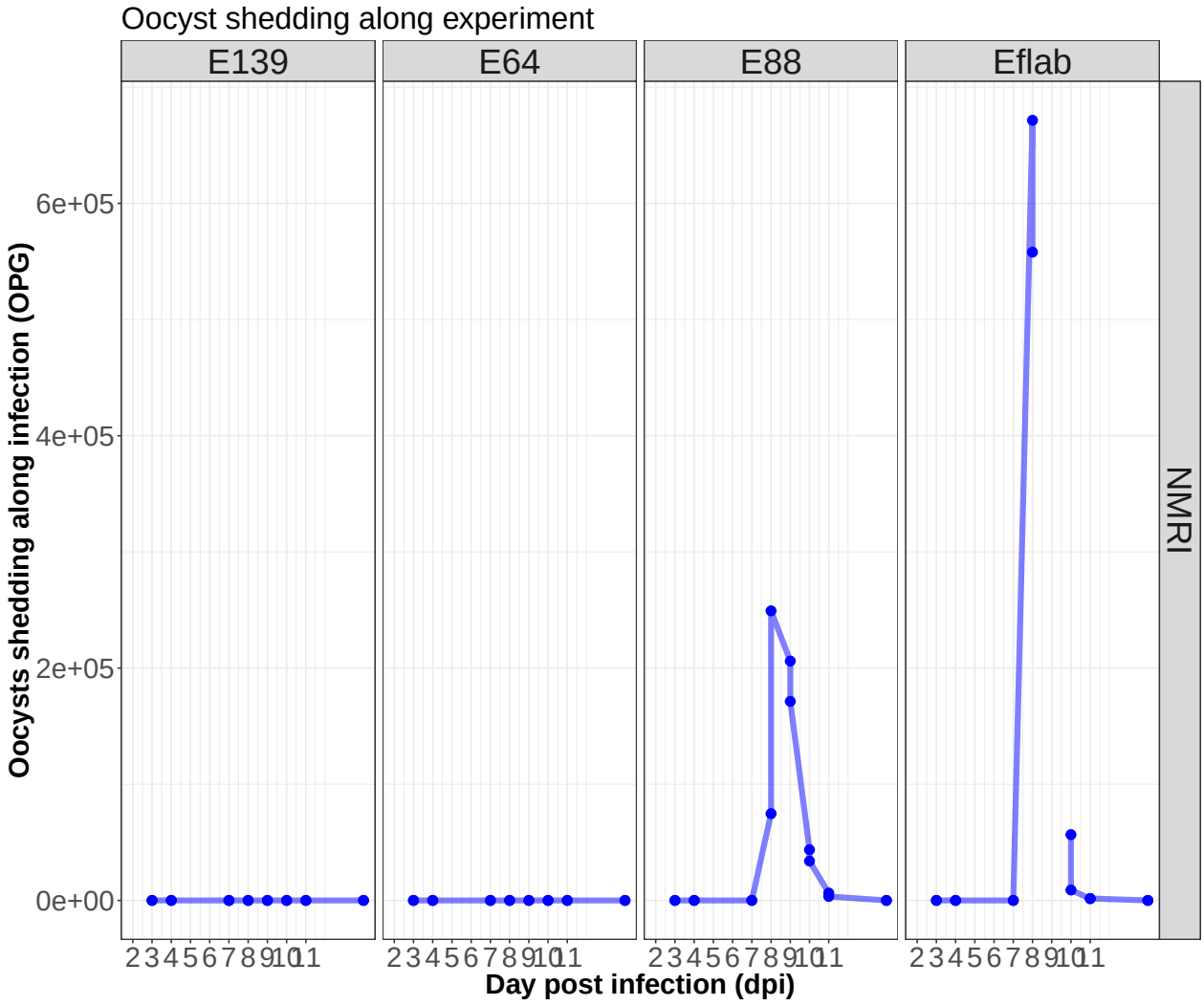


Figure 2: Weight as a function of OPG

Pass001: Nov 2017, passaging 4 isolates (some missing data)

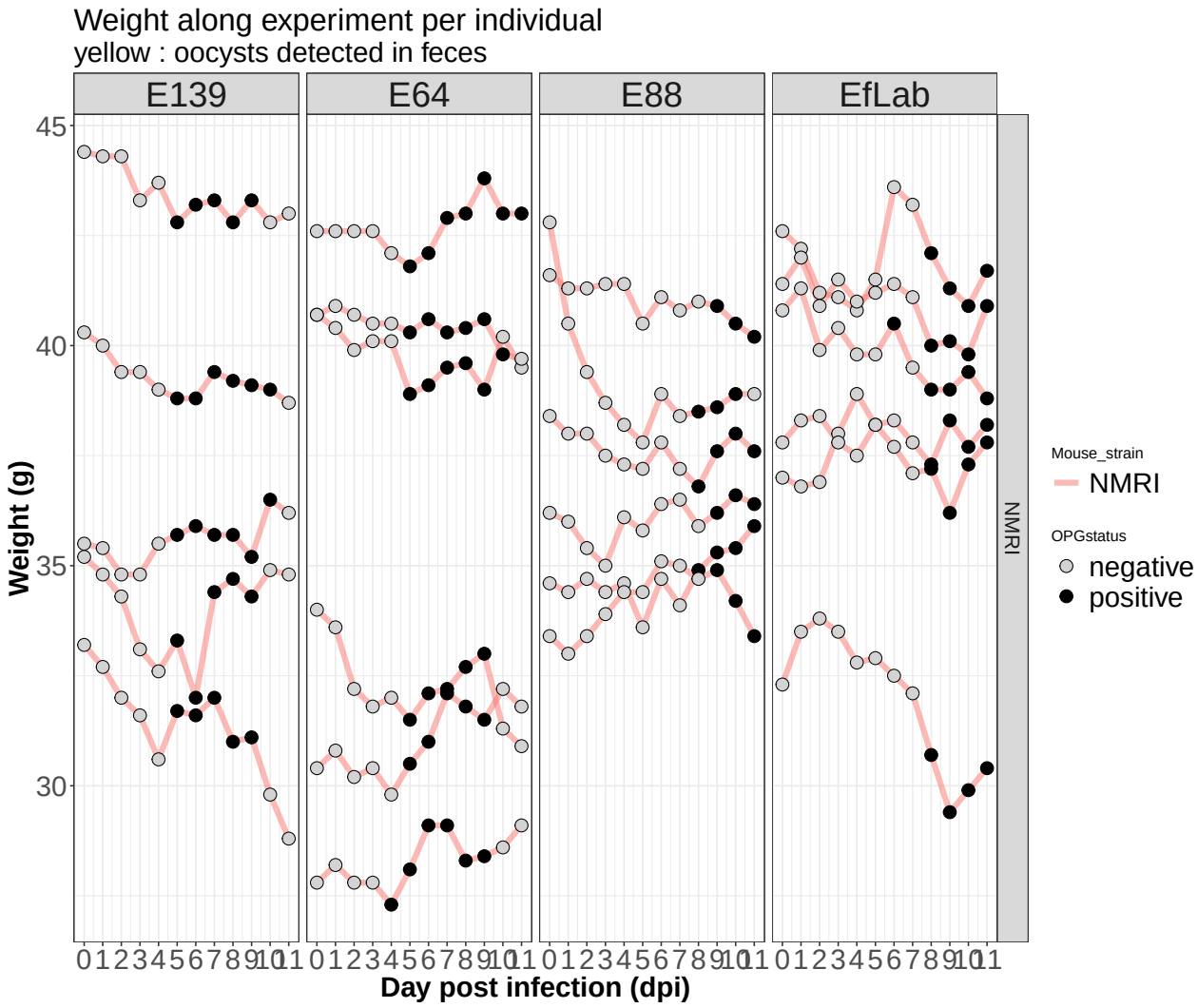
(Eflab, E88, E139, E64) in NMRI. 2 mice per cage. Only OPG recorded

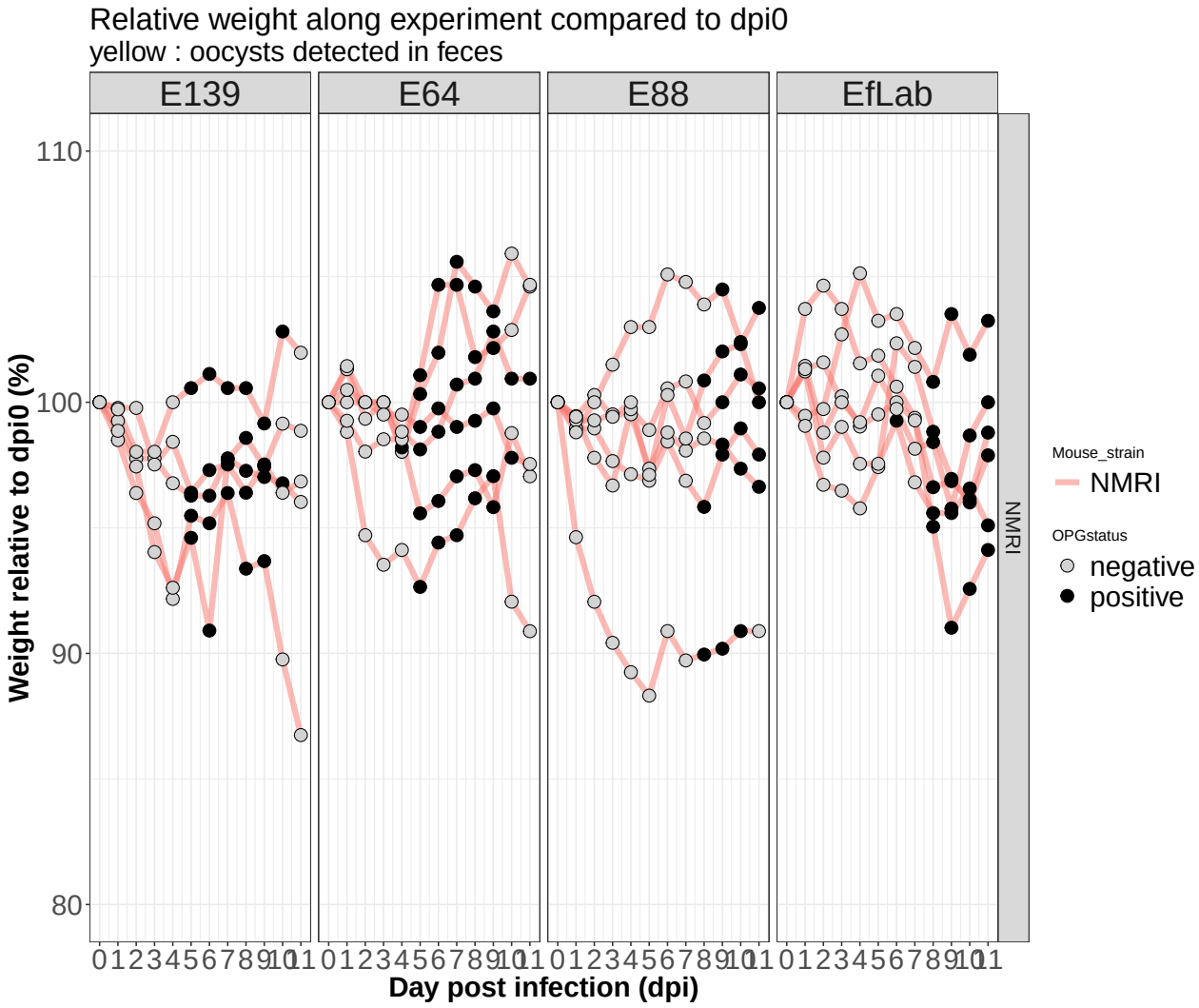
Parasite shedding

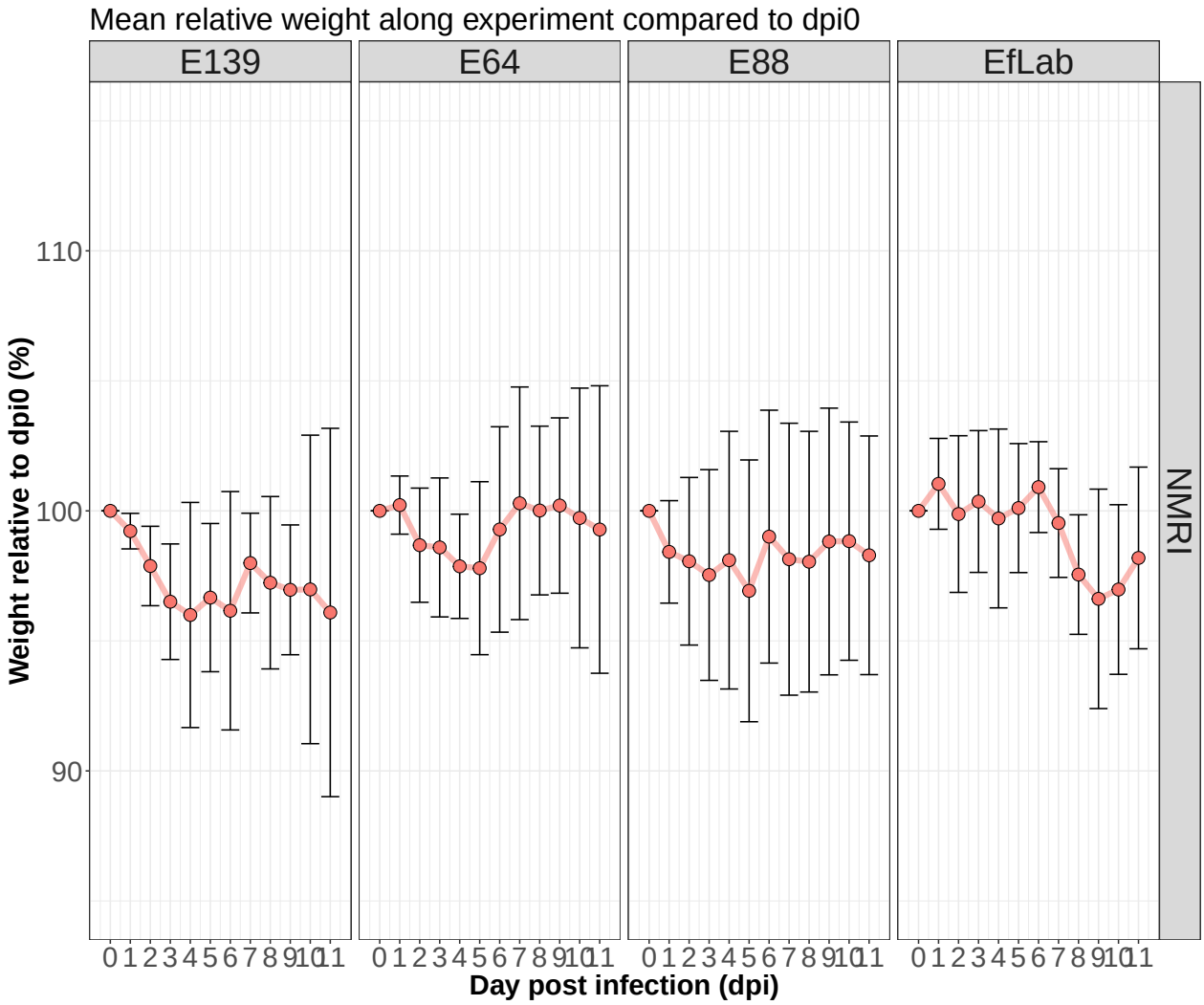


Expe_002: March 2018, NMRI mice infected with 4 *Eimeria* strains (Eflab, E88, E139, E64)

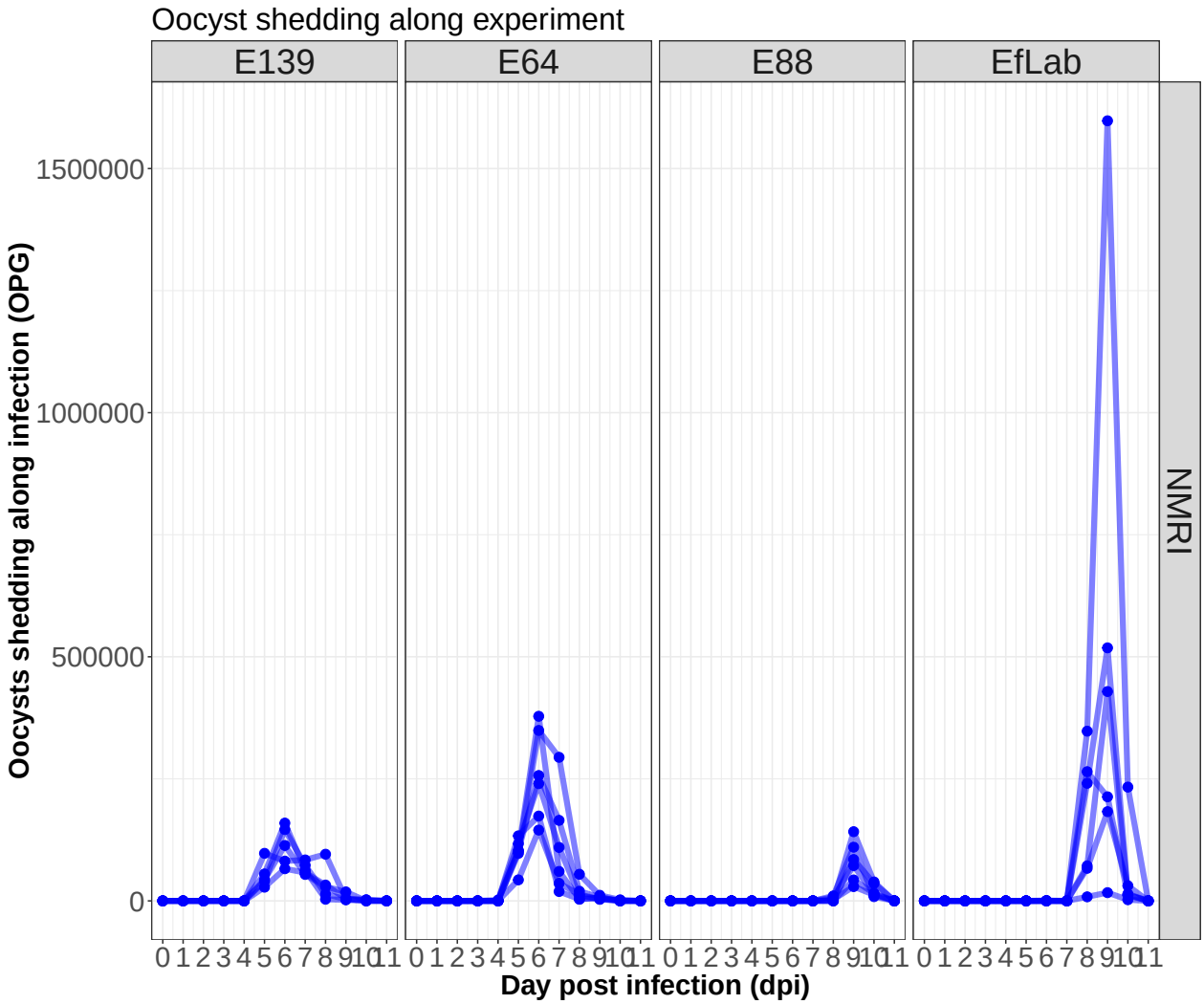
1. Weight loss

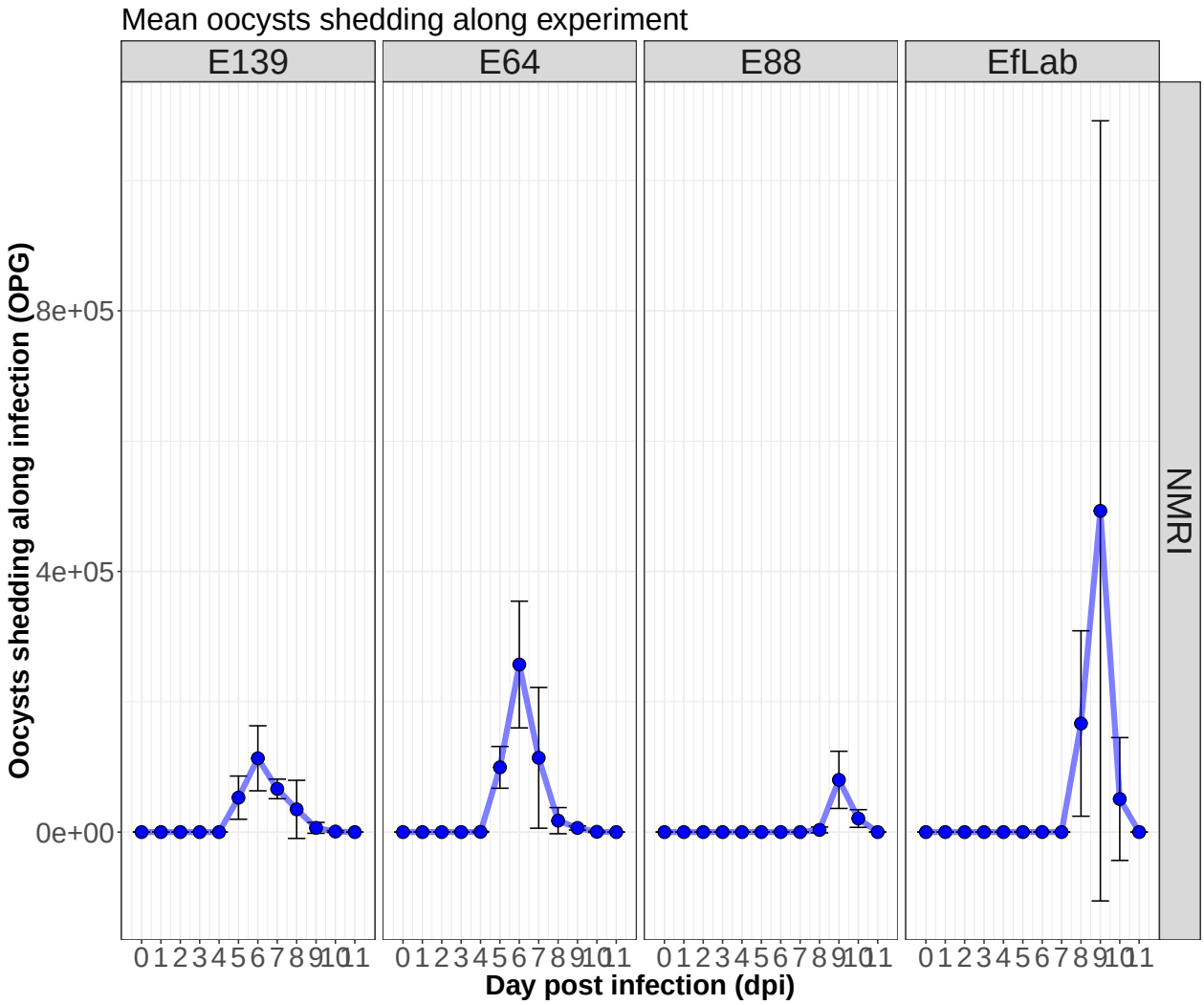



Relative weight along experiment compared to dpi0
yellow : oocysts detected in feces
E139
E64
E88
EfLab
NMRI
Weight relative to dpi0 (%)
110
100
90
80
0 1 2 3 4 5 6 7 8 9 10 11
Day post infection (dpi)
Mouse_strain
NMRI
OPGstatus
negative
positive


Mean relative weight along experiment compared to dpi0
E139
E64
E88
EfLab
NMRI
Weight relative to dpi0 (%)
110
100
90
0 1 2 3 4 5 6 7 8 9 10 11
Day post infection (dpi)

2. Parasite shedding




Mean oocysts shedding along experiment
E139
E64
E88
EfLab
NMRI
Oocysts shedding along infection (OPG)
8e+05
4e+05
0e+00
0 1 2 3 4 5 6 7 8 9 10 11
Day post infection (dpi)

3. Comparison host/parasite proxy

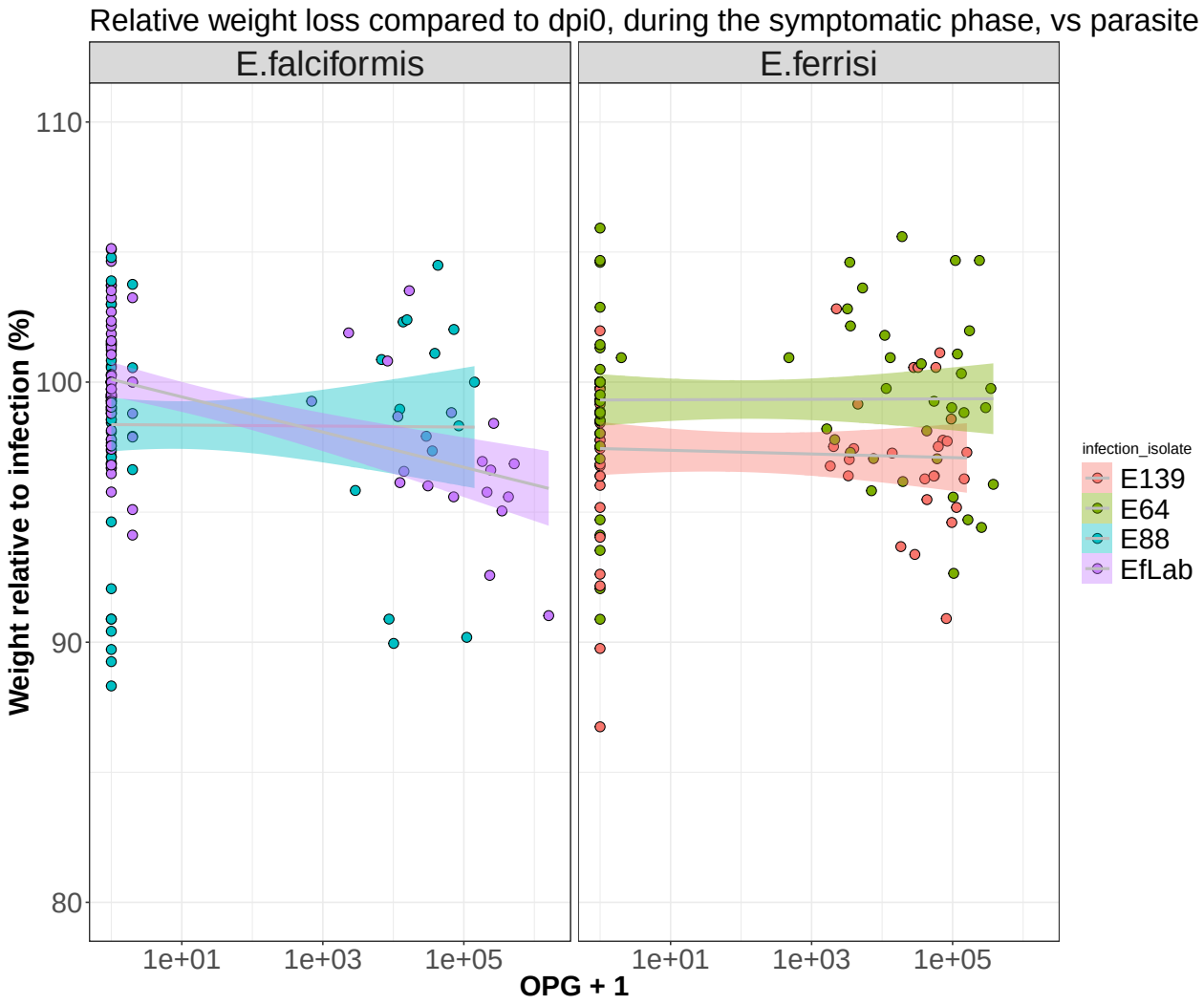
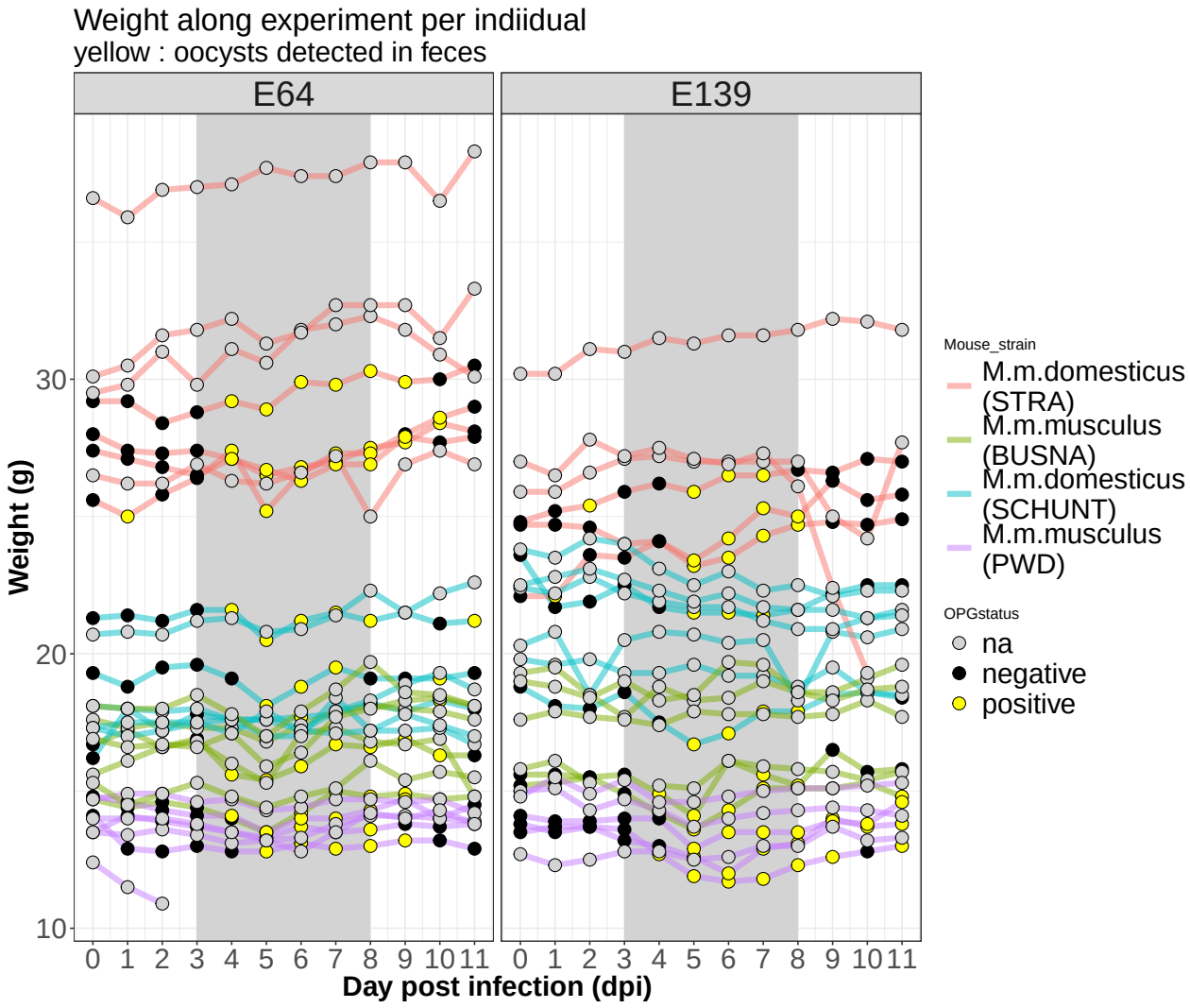
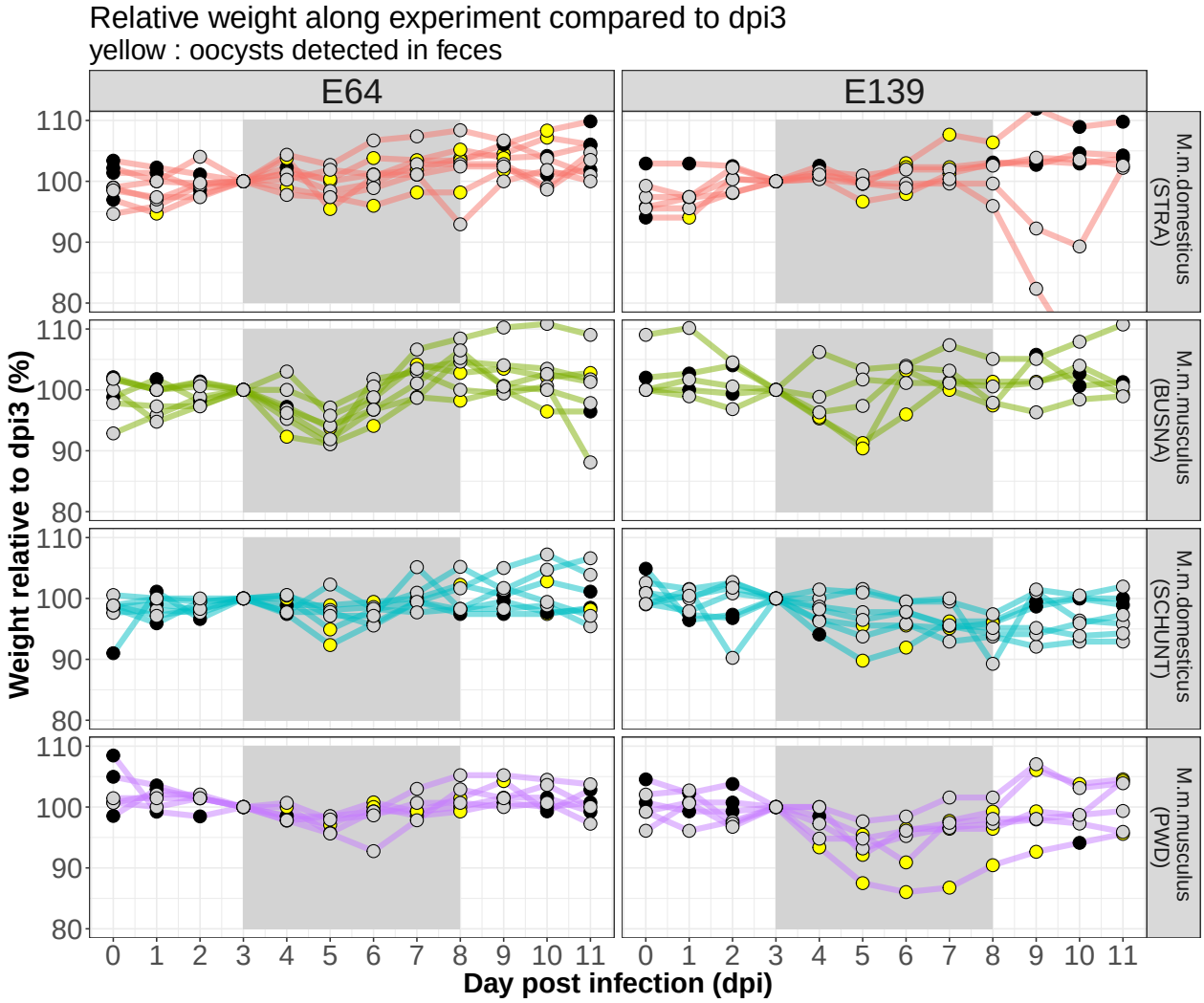


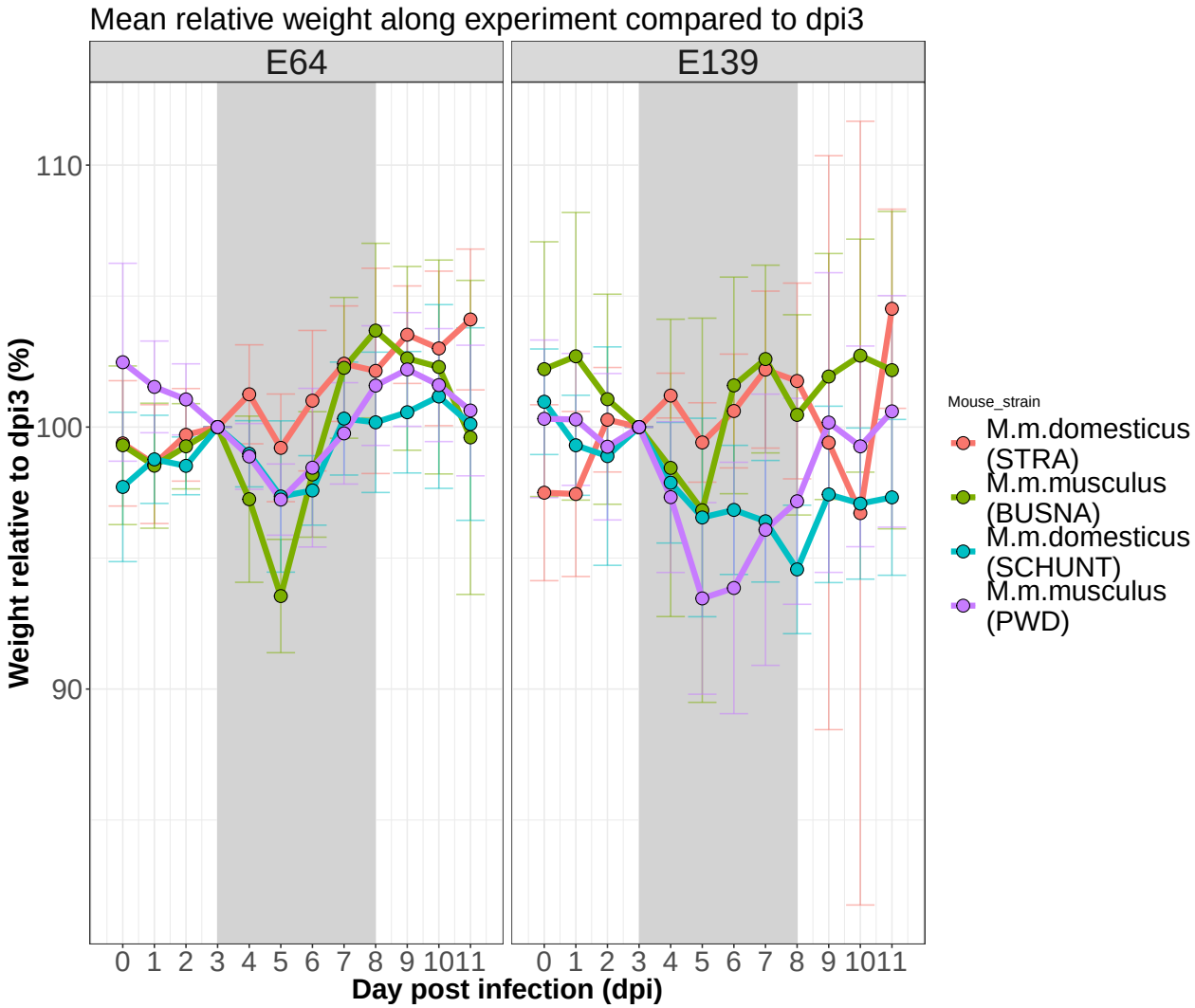
Figure 3: Weight as a function of OPG

Expe_003 & Expe_004, April-May 2018, first batch Parental strains (F0) BUSNA, STRA, SCHUNT, PWD, infection with Eferrisi (E64 and E139) [2 batches]

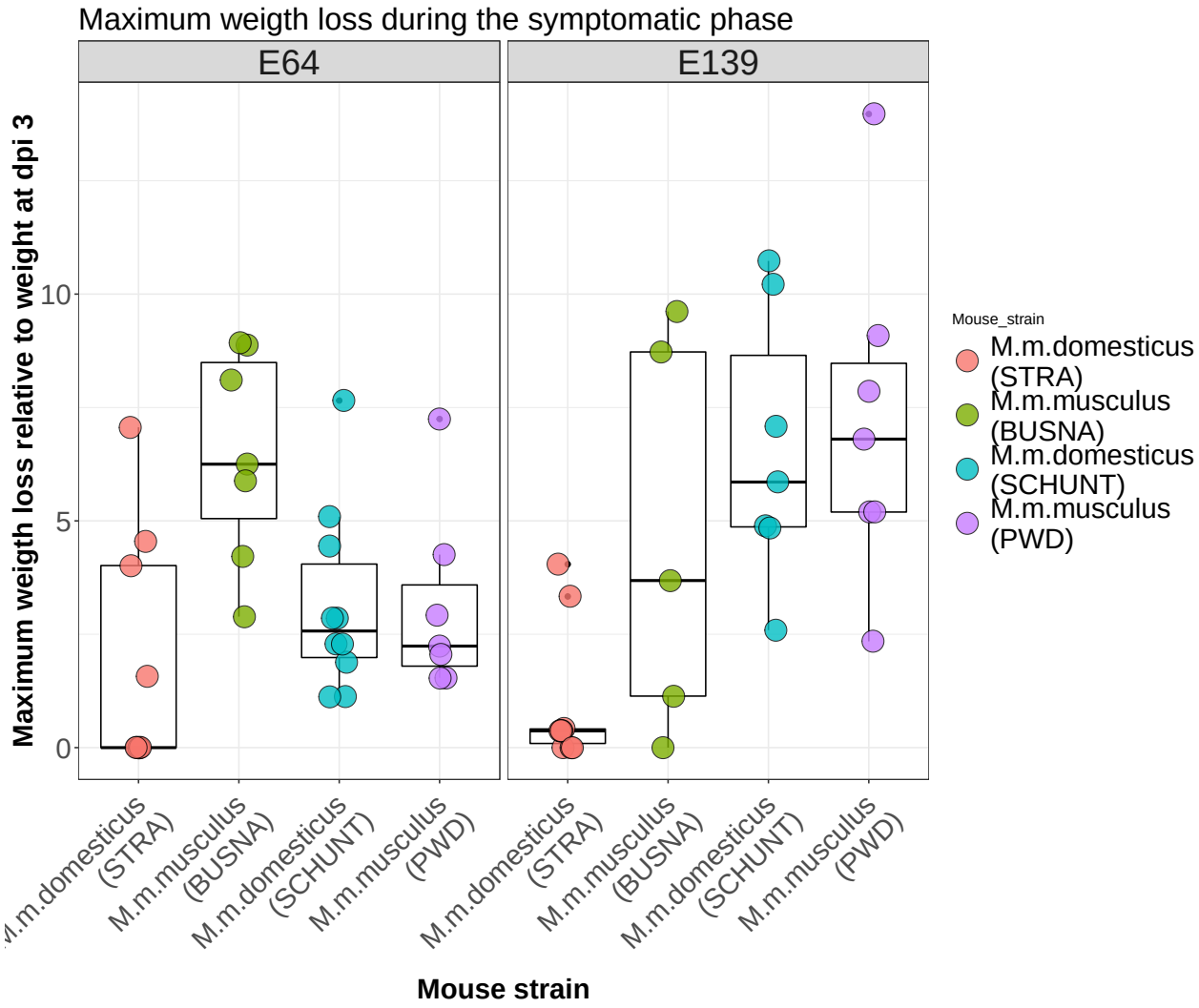
1. Weight loss




Relative weight along experiment compared to dpi3
yellow : oocysts detected in feces
E64
E139
M.m.domesticus (STRA)
M.m.musculus (BUSNA)
M.m.domesticus (SCHUNT)
M.m.musculus (PWD)
Weight relative to dpi3 (%)
110
100
90
80
0 1 2 3 4 5 6 7 8 9 10 11
Day post infection (dpi)



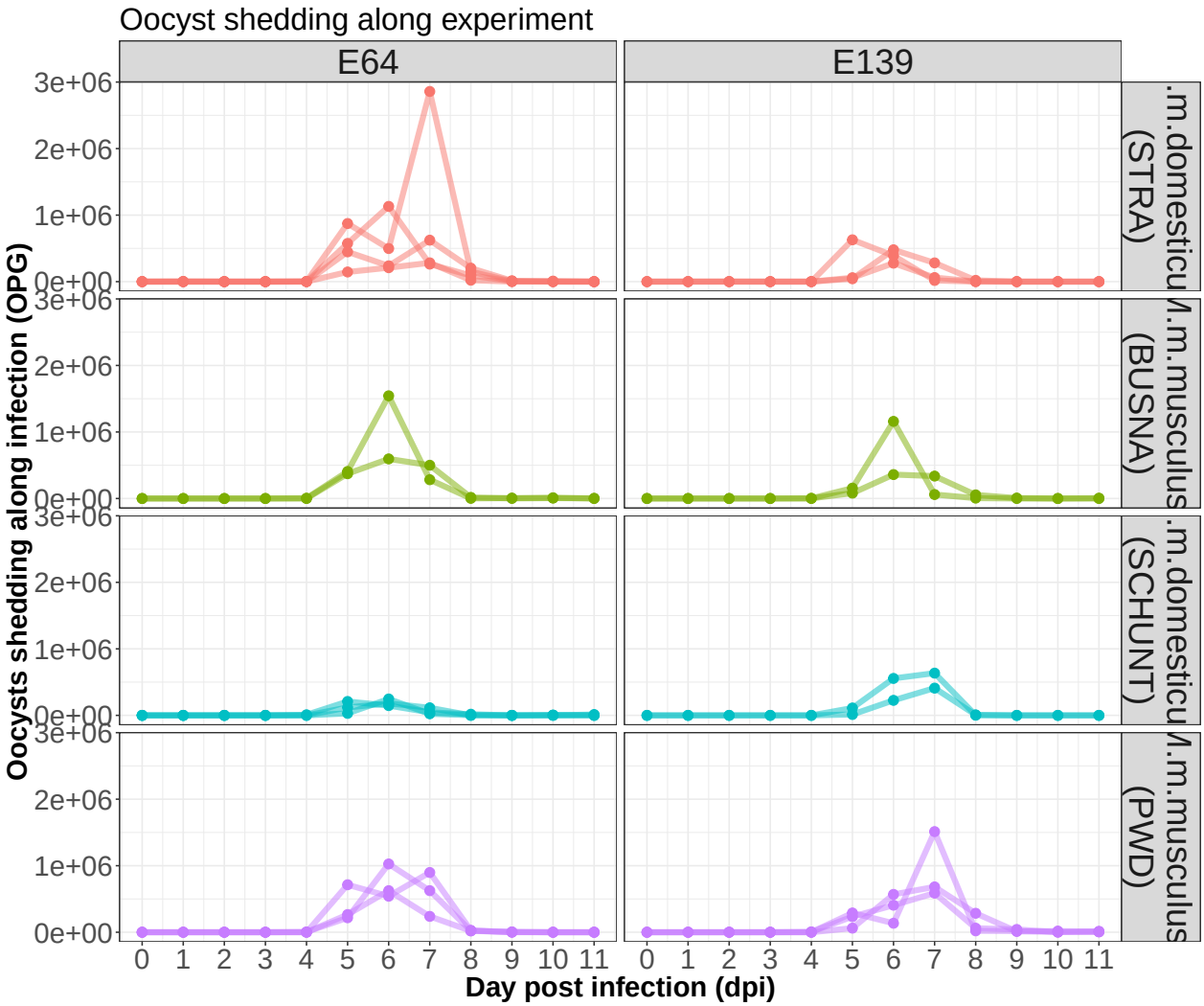
For statistical analysis, we compare the maximum relative weight loss between the different groups. We limit our analysis to the period : dpi3 to dpi8 (symptomatic period for E64 strain).

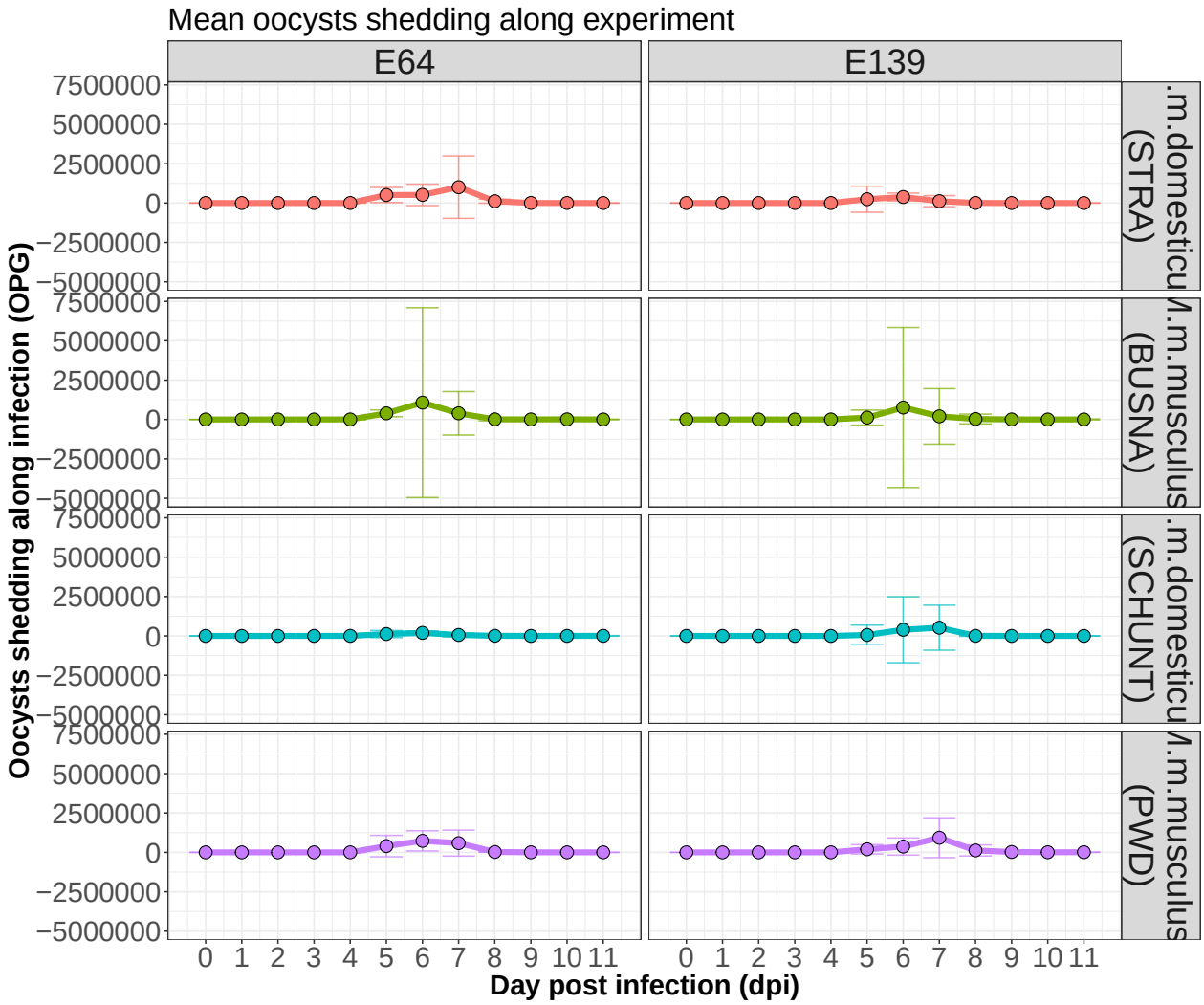


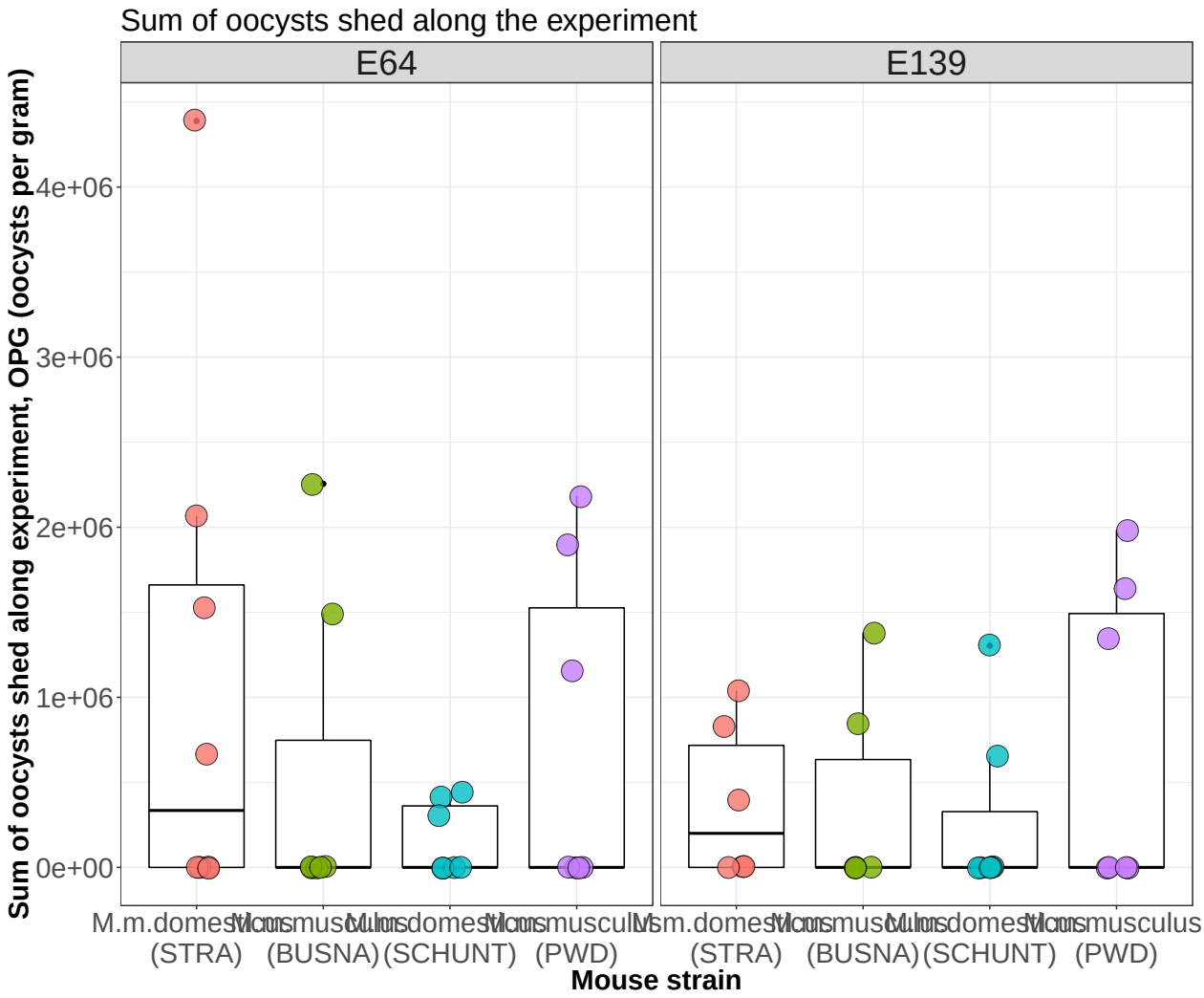

```
##
##  Kruskal-Wallis rank sum test
##
## data:  relativeWeight by Mouse_strain
## Kruskal-Wallis chi-squared = 20.177, df = 3, p-value = 0.000156
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test
##
## data:  max.loss_003_4$relativeWeight and max.loss_003_4$Mouse_strain
##
##                           M.m.domesticus \n(STRA) M.m.musculus \n(BUSNA)
## M.m.musculus \n(BUSNA)    0.0022                  -
## M.m.domesticus \n(SCHUNT) 0.0014                  0.4167
## M.m.musculus \n(PWD)      0.0014                  0.6649
##                           M.m.domesticus \n(SCHUNT)
## M.m.musculus \n(BUSNA)    -
## M.m.domesticus \n(SCHUNT) -
## M.m.musculus \n(PWD)      0.7060
##
## P value adjustment method: BH
```

2. Parasite shedding




Mean oocysts shedding along experiment
E64
E139
M.m.domesticus (STRA)
M.m.musculus (BUSNA)
M.m.domesticus (SCHUNT)
M.m.musculus (PWD)
Oocysts shedding along infection (OPG)
7500000
5000000
2500000
0
−2500000
−5000000
0 1 2 3 4 5 6 7 8 9 10 11
Day post infection (dpi)

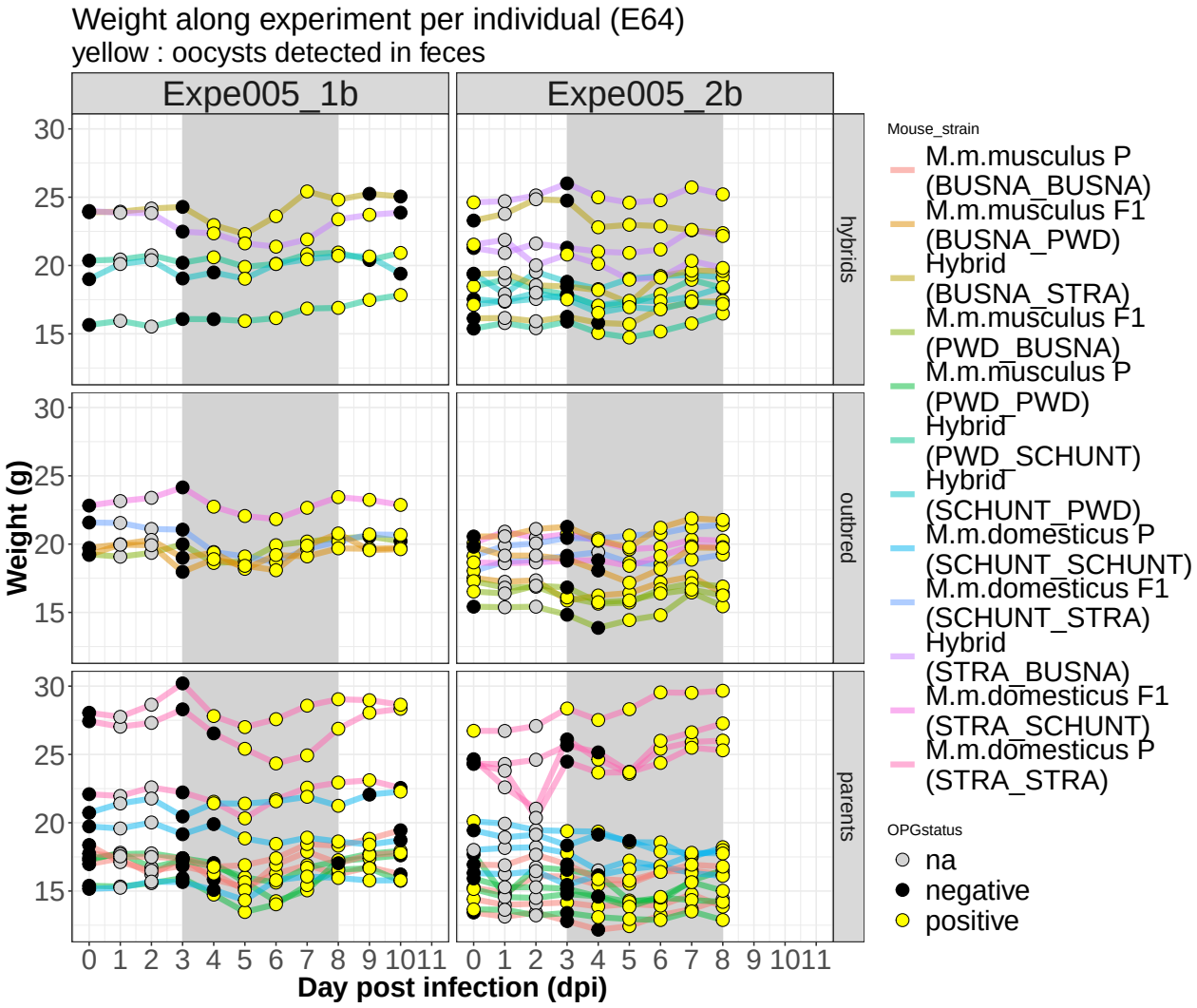


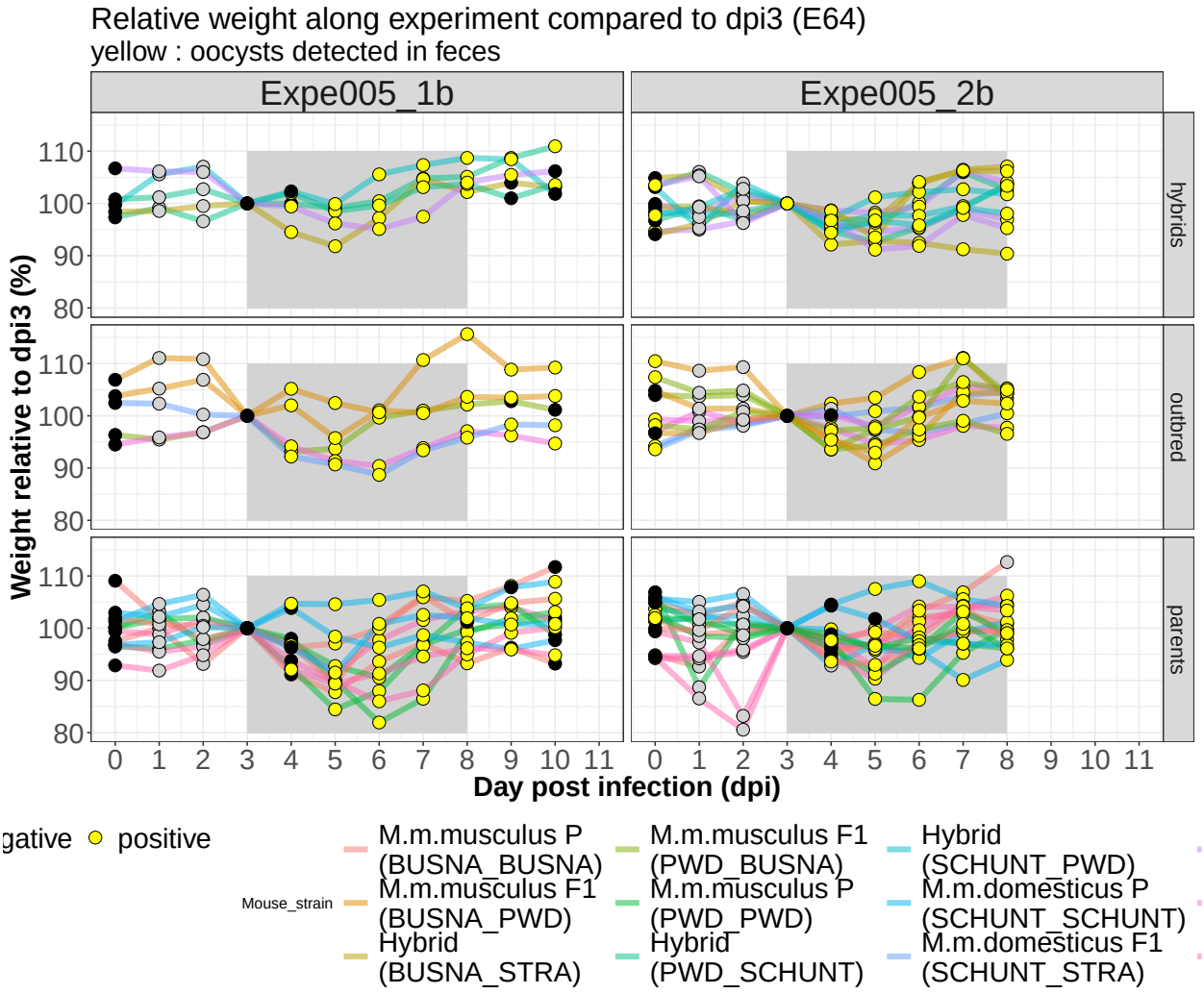

```
##
##  Kruskal-Wallis rank sum test
##
## data:  sum.oo by Mouse_strain
## Kruskal-Wallis chi-squared = 2.0367, df = 3, p-value = 0.5648

##
##  Pairwise comparisons using Wilcoxon rank sum test
##
## data:  sum.oocysts_003_4$sum.oo and sum.oocysts_003_4$Mouse_strain
##
##                           M.m.domesticus \n(STRA) M.m.musculus \n(BUSNA)
## M.m.musculus \n(BUSNA)    0.73                    -
## M.m.domesticus \n(SCHUNT) 0.73                    0.98
## M.m.musculus \n(PWD)      0.98                    0.73
##                           M.m.domesticus \n(SCHUNT)
## M.m.musculus \n(BUSNA)    -
## M.m.domesticus \n(SCHUNT) -
## M.m.musculus \n(PWD)      0.73
##
## P value adjustment method: BH
```

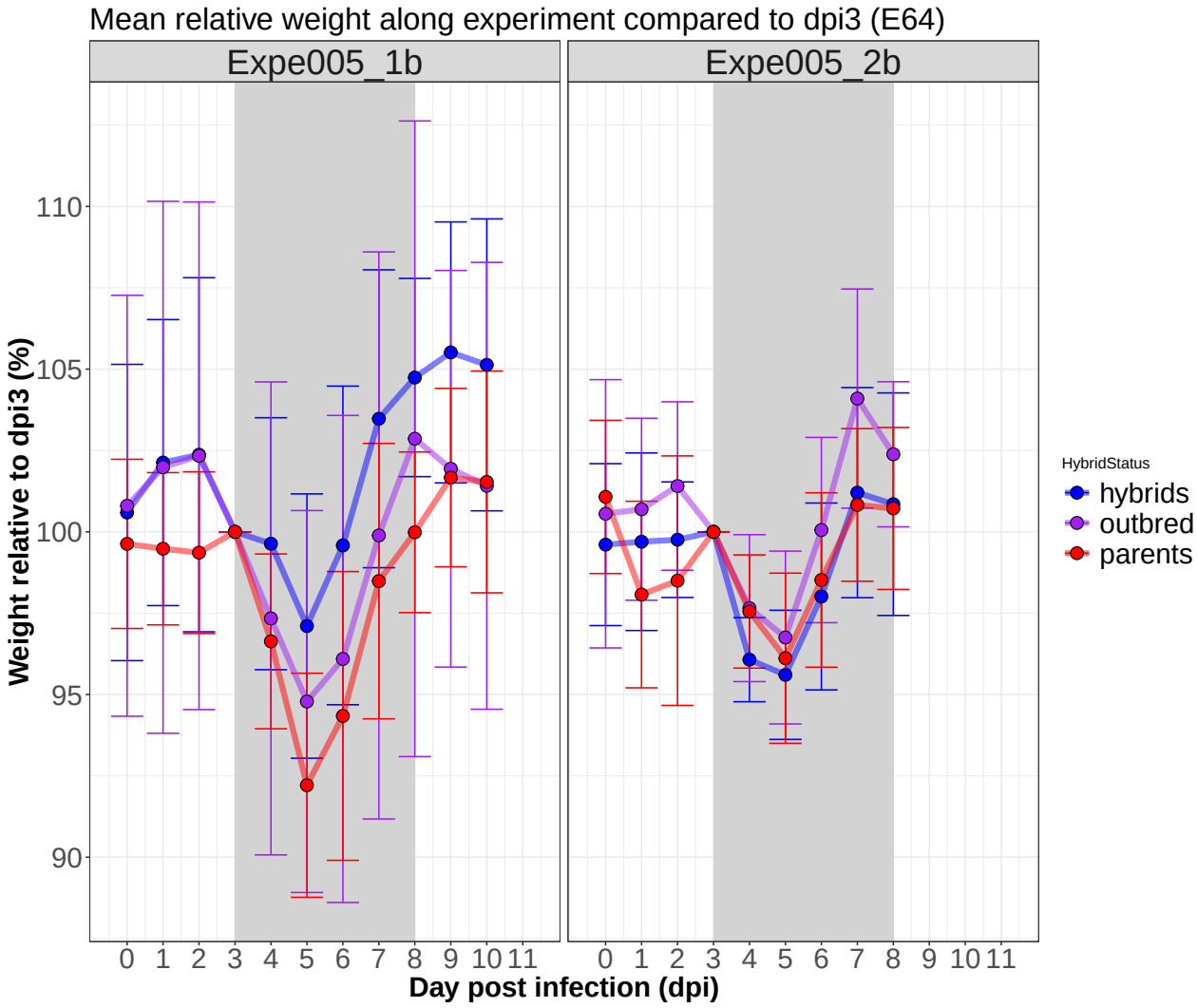
Expe_005, July 2018, FULL experiment (parents, intra specific and inter species hybrids) BUSNA, STRA, SCHUNT, PWD, infection with Eferrisi and Efalciformis (E64 and E88)

1. Weight loss

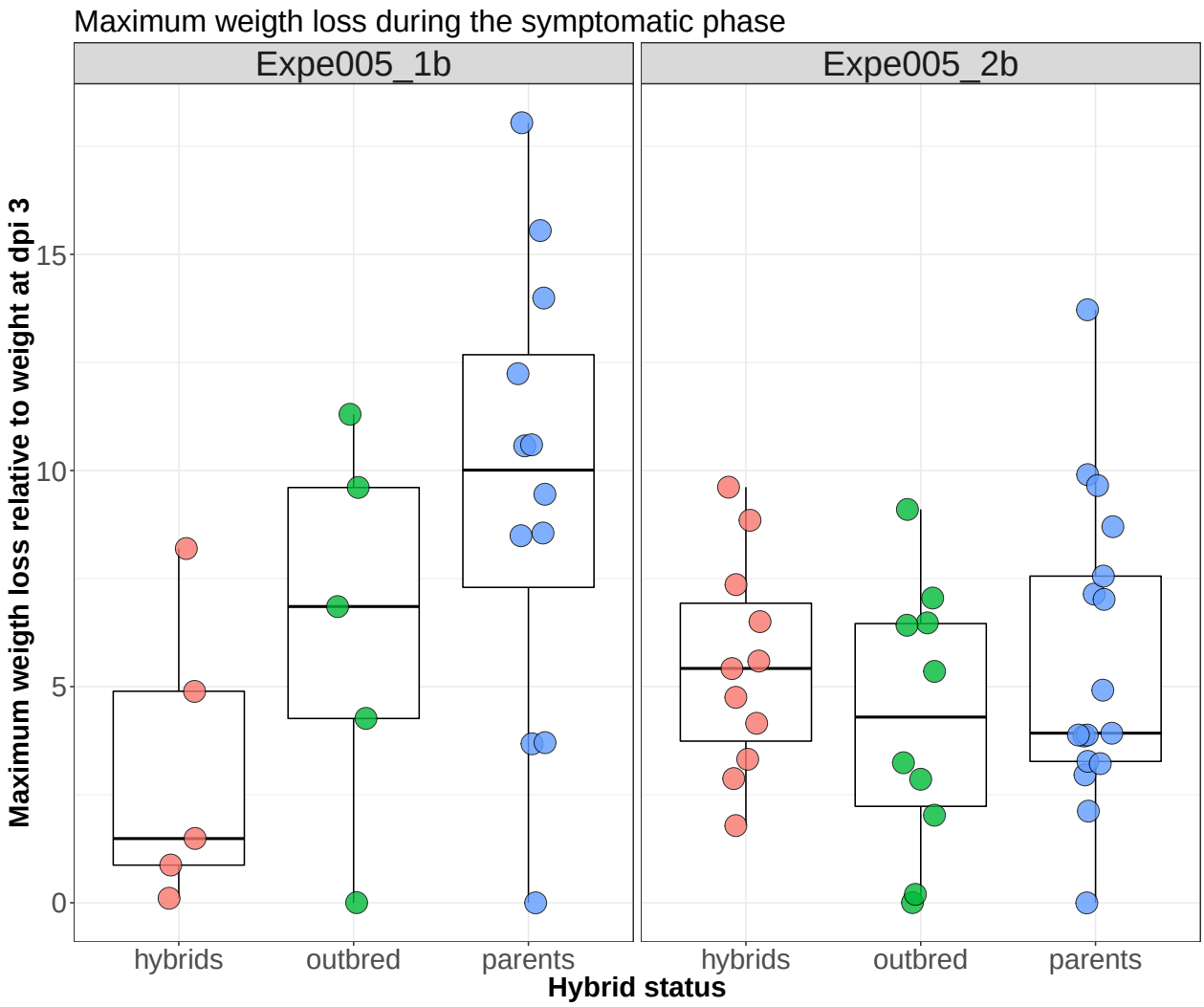
Eimeria ferrisi




Relative weight along experiment compared to dpi3 (E64)
yellow : oocysts detected in feces
Expe005_1b
Expe005_2b
hybrids
outbred
parents
Weight relative to dpi3 (%)
Day post infection (dpi)
gative
positive
Mouse_strain
M.m.musculus P (BUSNA_BUSNA)
M.m.musculus F1 (BUSNA_PWD)
Hybrid (BUSNA_STRA)
M.m.musculus F1 (PWD_BUSNA)
M.m.musculus P (PWD_PWD)
Hybrid (PWD_SCHUNT)
Hybrid (SCHUNT_PWD)
M.m.domesticus P (SCHUNT_SCHUNT)
M.m.domesticus F1 (SCHUNT_STRA)



For statistical analysis, we compare the maximum relative weight loss between the different groups. We limit our analysis to the period : dpi3 to dpi8 (symptomatic period for E64 strain).




```
## [1] "first batch"
```

```
##
##  Kruskal-Wallis rank sum test
##
## data:  relativeWeight by HybridStatus
## Kruskal-Wallis chi-squared = 5.0441, df = 2, p-value = 0.0803
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test
##
## data:  maxloss_E64B1$relativeWeight and maxloss_E64B1$HybridStatus
##
##         hybrids outbred
## outbred 0.42    -
## parents 0.08    0.42
##
## P value adjustment method: BH
```

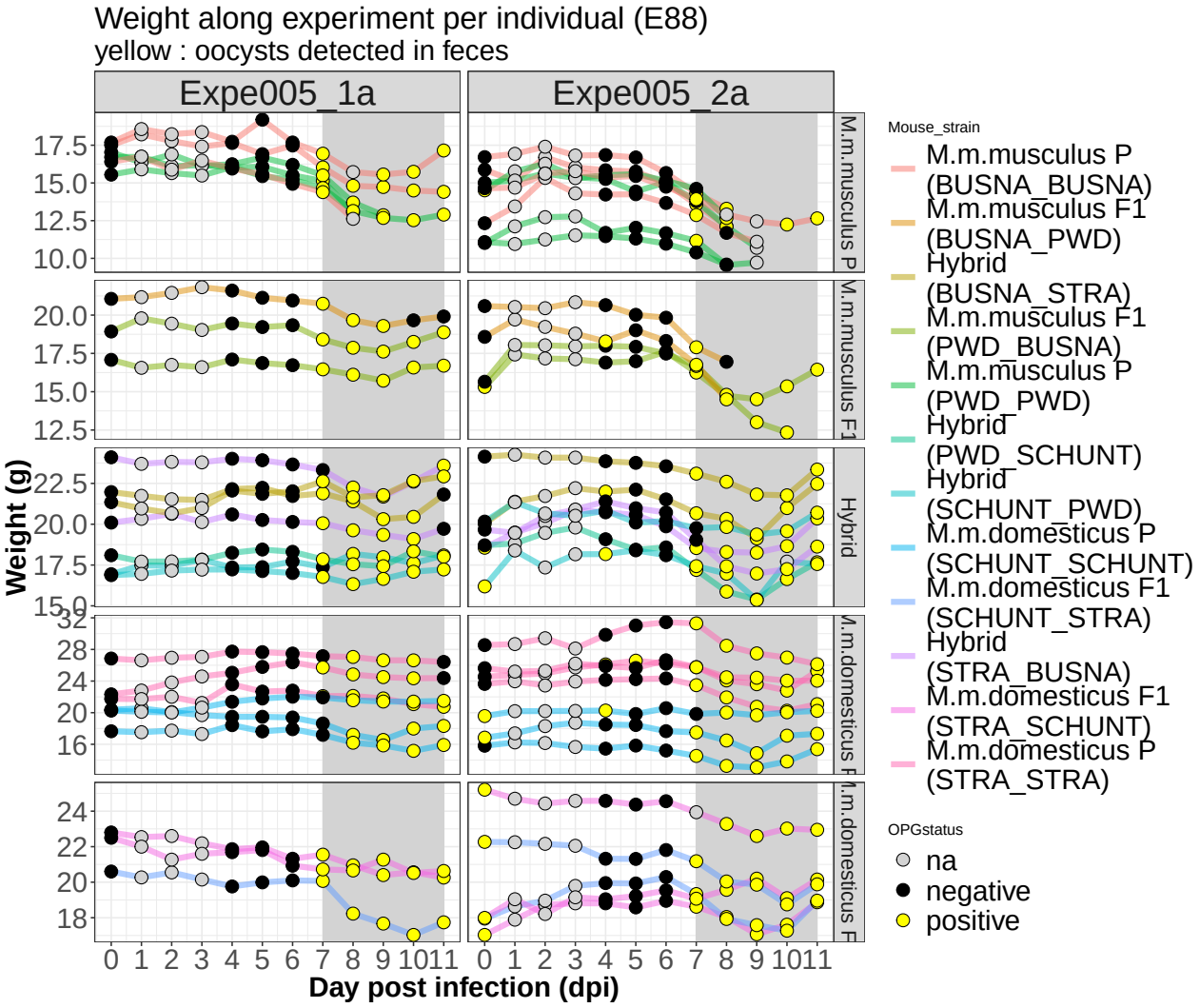
```
## [1] "second batch"
```

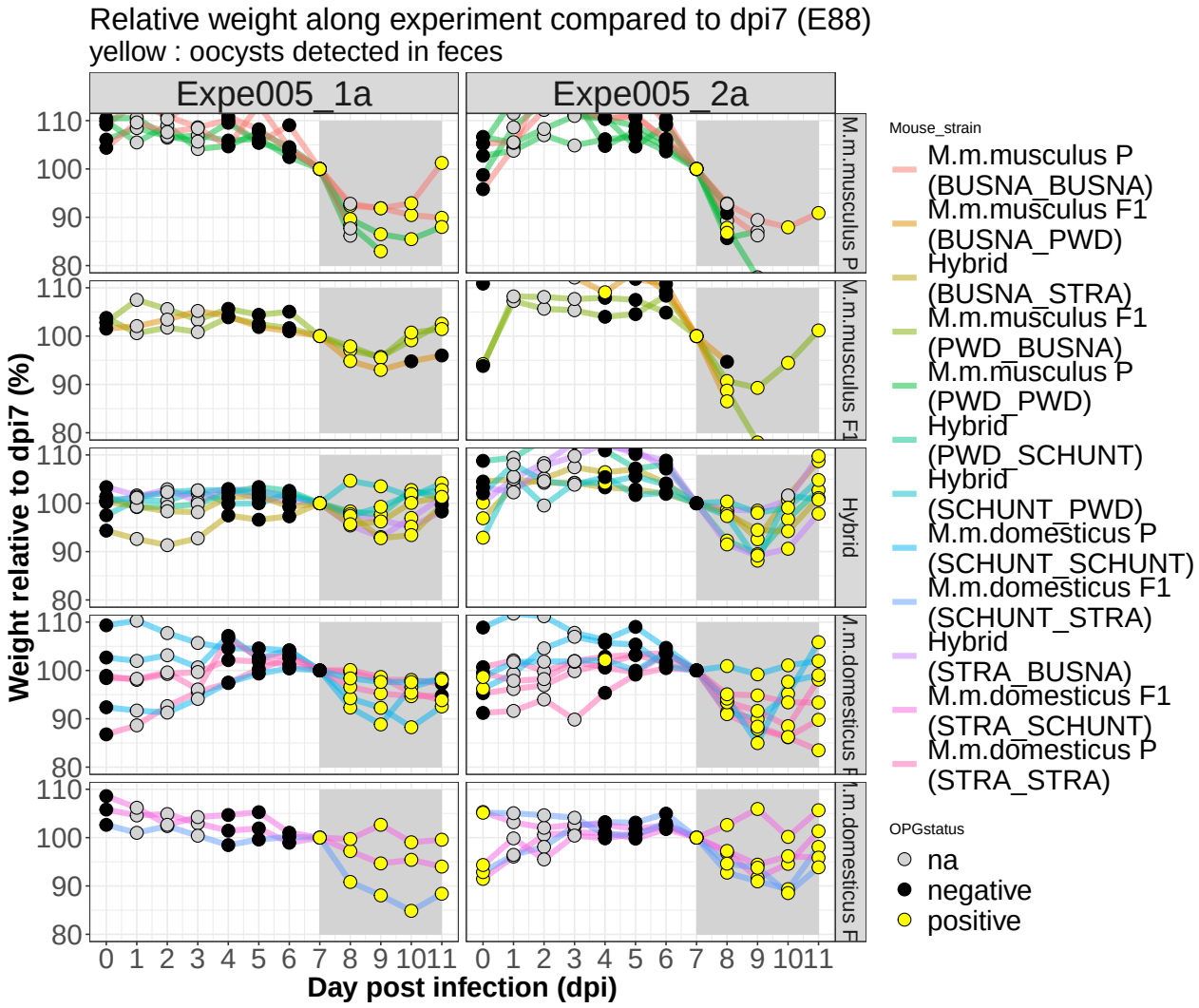
```
##
##  Kruskal-Wallis rank sum test
```

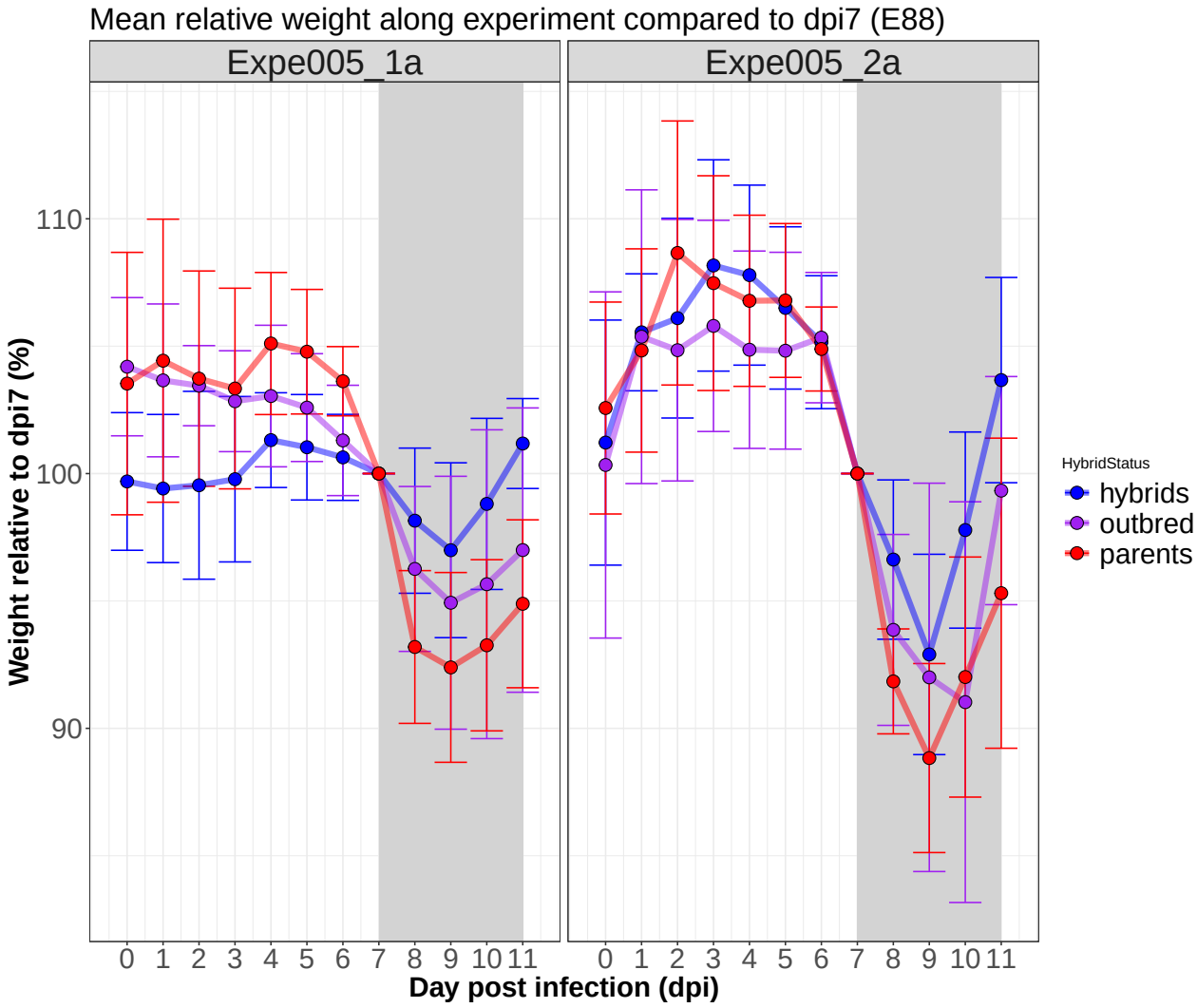
```
##
## data:  relativeWeight by HybridStatus
## Kruskal-Wallis chi-squared = 1.3931, df = 2, p-value = 0.4983
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test
##
## data:  maxloss_E64B2$relativeWeight and maxloss_E64B2$HybridStatus
##
##         hybrids outbred
## outbred 0.52    -
## parents 0.93    0.52
##
## P value adjustment method: BH
```

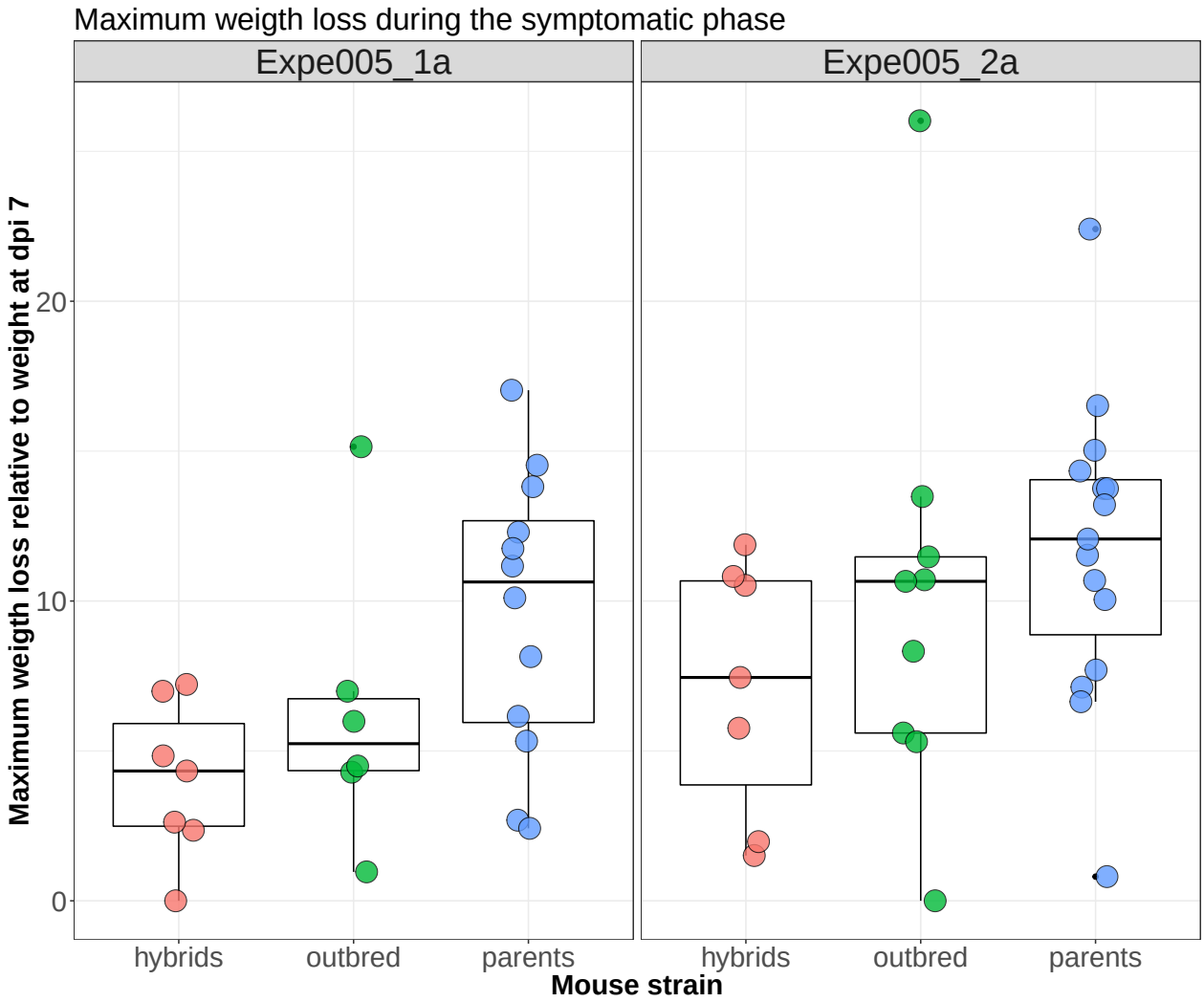
Eimeria falciformis




Relative weight along experiment compared to dpi7 (E88)
yellow : oocysts detected in feces
Expe005_1a
Expe005_2a
M.m.musculus P
M.m.musculus F1
Hybrid
M.m.domesticus P
M.m.domesticus F1
Weight relative to dpi7 (%)
110
100
90
80
0 1 2 3 4 5 6 7 8 9 10 11
Day post infection (dpi)
Mouse_strain
M.m.musculus P (BUSNA_BUSNA)
M.m.musculus F1 (BUSNA_PWD)
Hybrid (BUSNA_STRA)
M.m.musculus F1 (PWD_BUSNA)
M.m.musculus P (PWD_PWD)
Hybrid (PWD_SCHUNT)
Hybrid (SCHUNT_PWD)
M.m.domesticus P (SCHUNT_SCHUNT)
M.m.domesticus F1 (SCHUNT_STRA)
Hybrid (STRA_BUSNA)
M.m.domesticus F1 (STRA_SCHUNT)
M.m.domesticus P (STRA_STRA)
OPGstatus
na
negative
positive



For statistical analysis, we compare the maximum relative weight loss between the different groups. We limit our analysis to the period : dpi7 to dpi11 (symptomatic period for E88 strain).




```
## [1] "first batch"
```

```
##
##  Kruskal-Wallis rank sum test
##
## data:  relativeWeight by HybridStatus
## Kruskal-Wallis chi-squared = 6.1426, df = 2, p-value = 0.04636
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test
##
## data:  maxloss_E88B1$relativeWeight and maxloss_E88B1$HybridStatus
##
##         hybrids outbred
## outbred 0.534   -
## parents 0.039   0.319
##
## P value adjustment method: BH
```

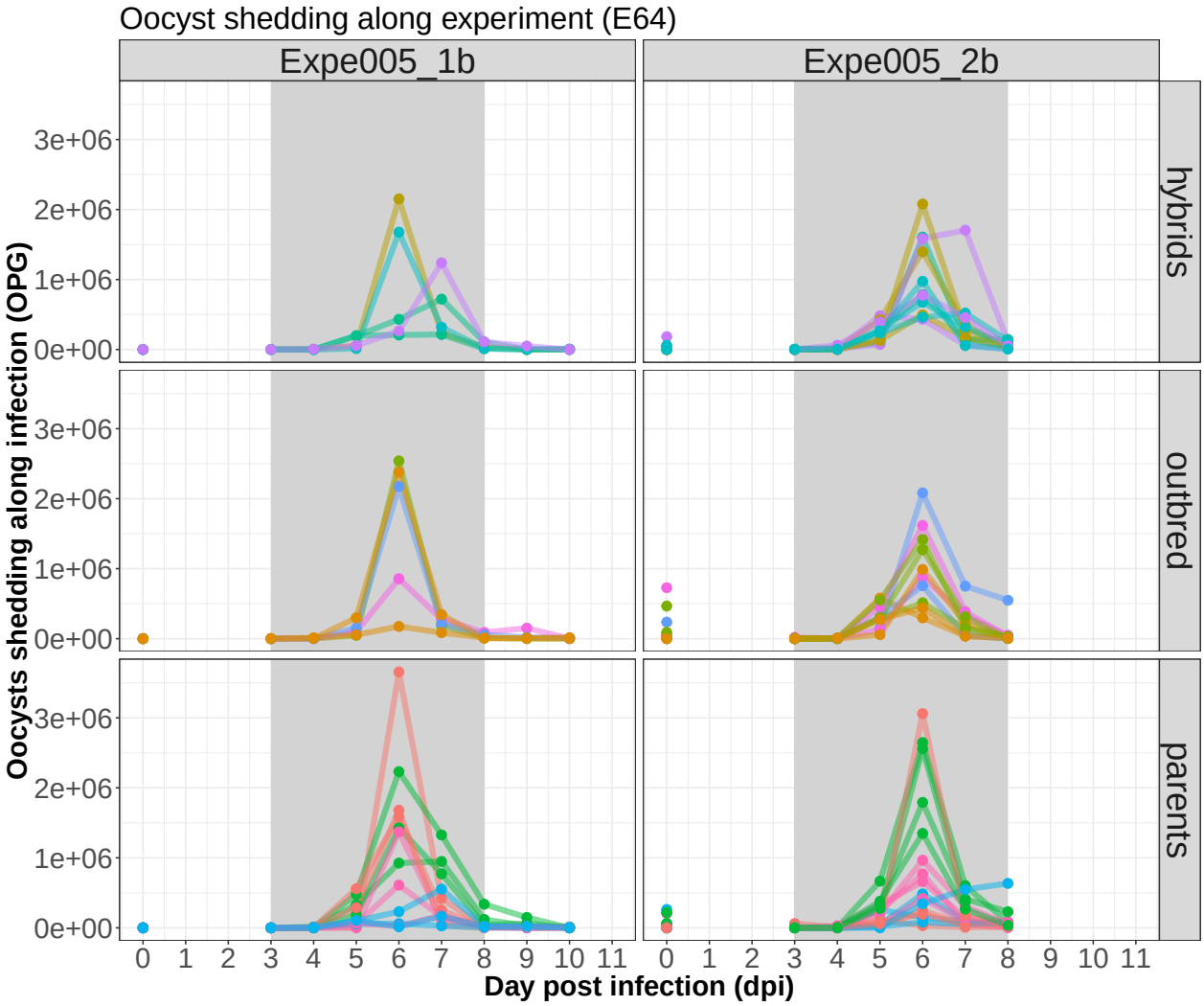
```
## [1] "second batch"
```

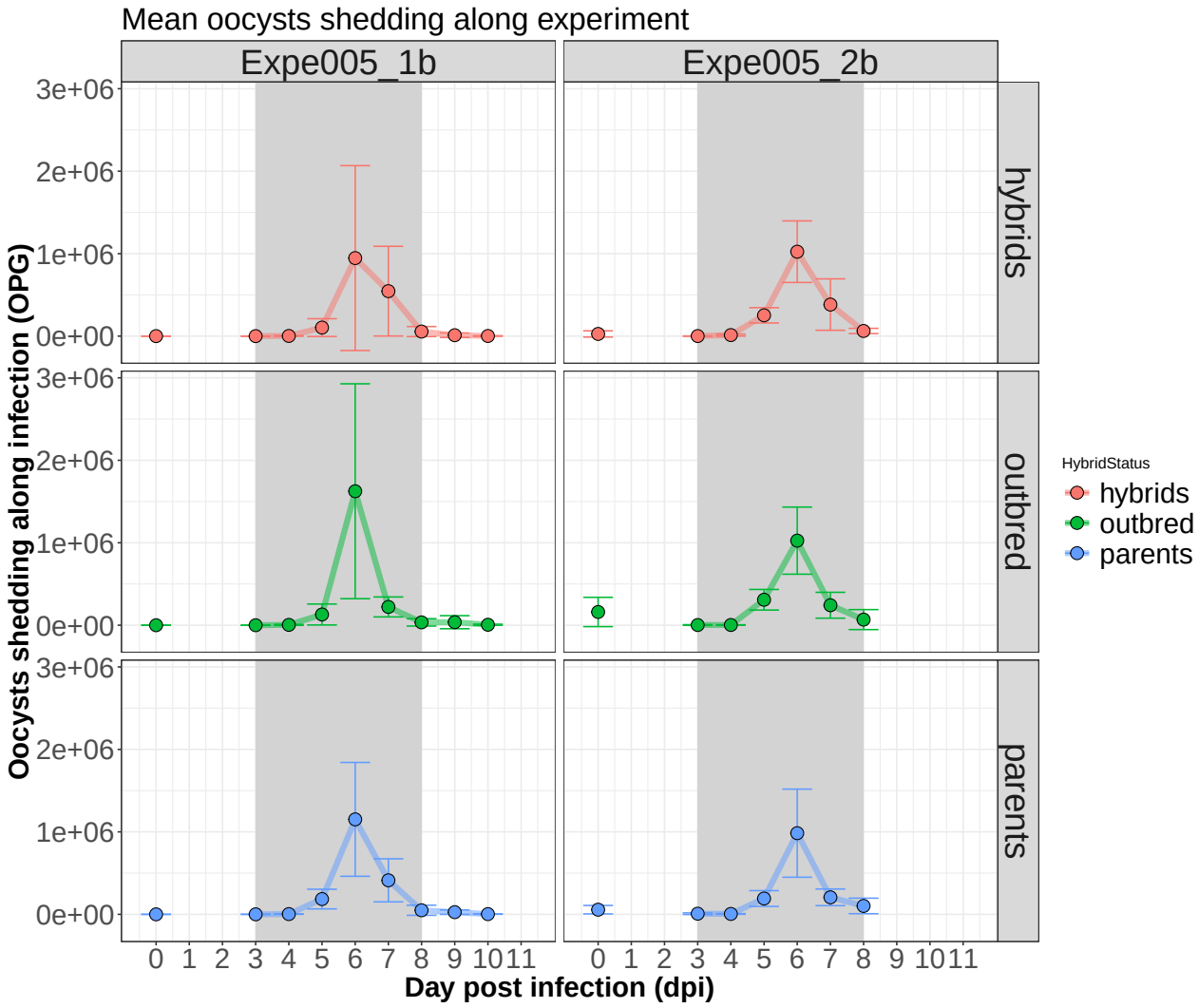
```
##
##  Kruskal-Wallis rank sum test
```

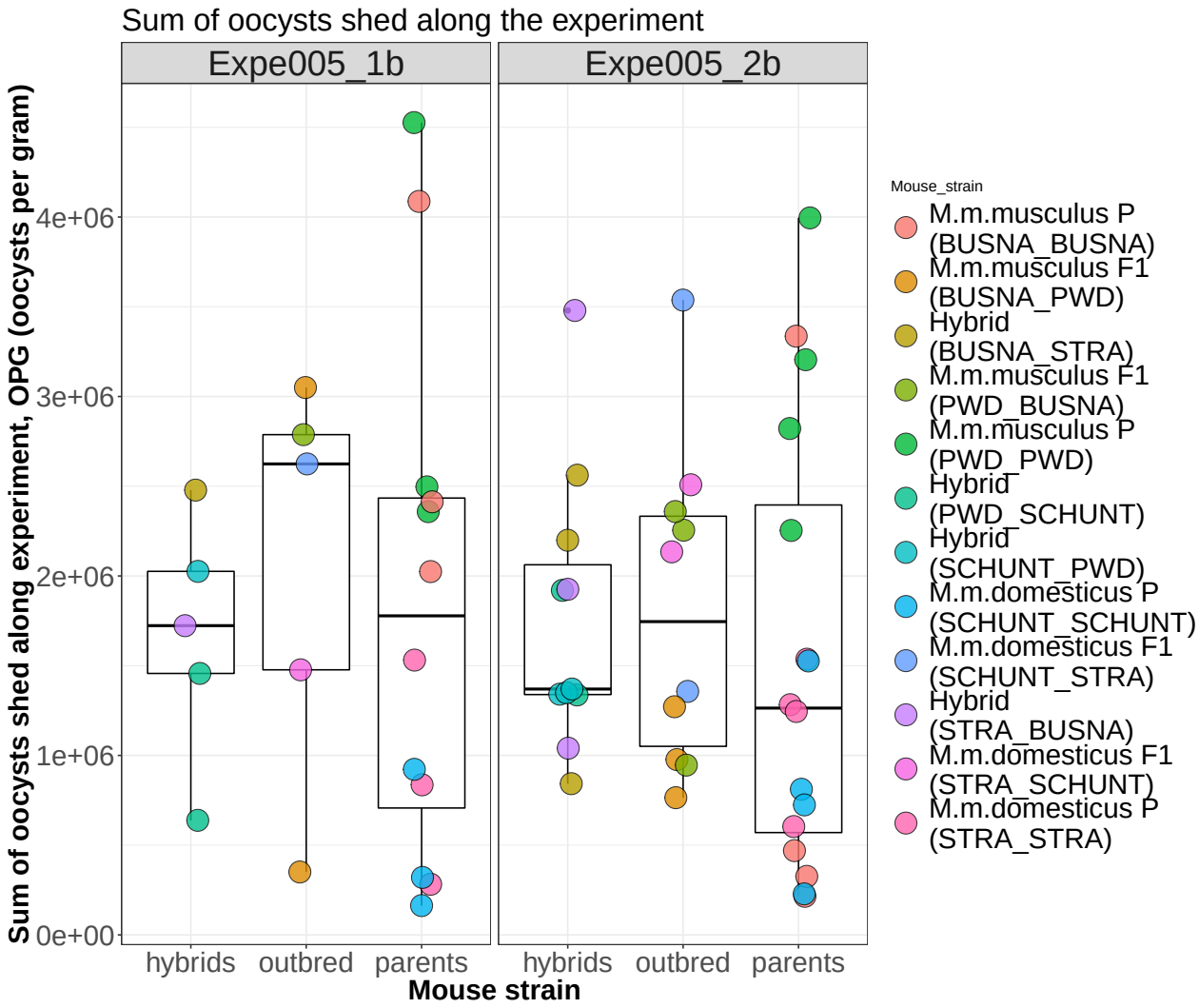
```
##
## data:  relativeWeight by HybridStatus
## Kruskal-Wallis chi-squared = 4.3167, df = 2, p-value = 0.1155
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test
##
## data:  maxloss_E88B2$relativeWeight and maxloss_E88B2$HybridStatus
##
##          hybrids outbred
## outbred 0.54    -
## parents 0.14    0.36
##
## P value adjustment method: BH
```

2. Parasite shedding



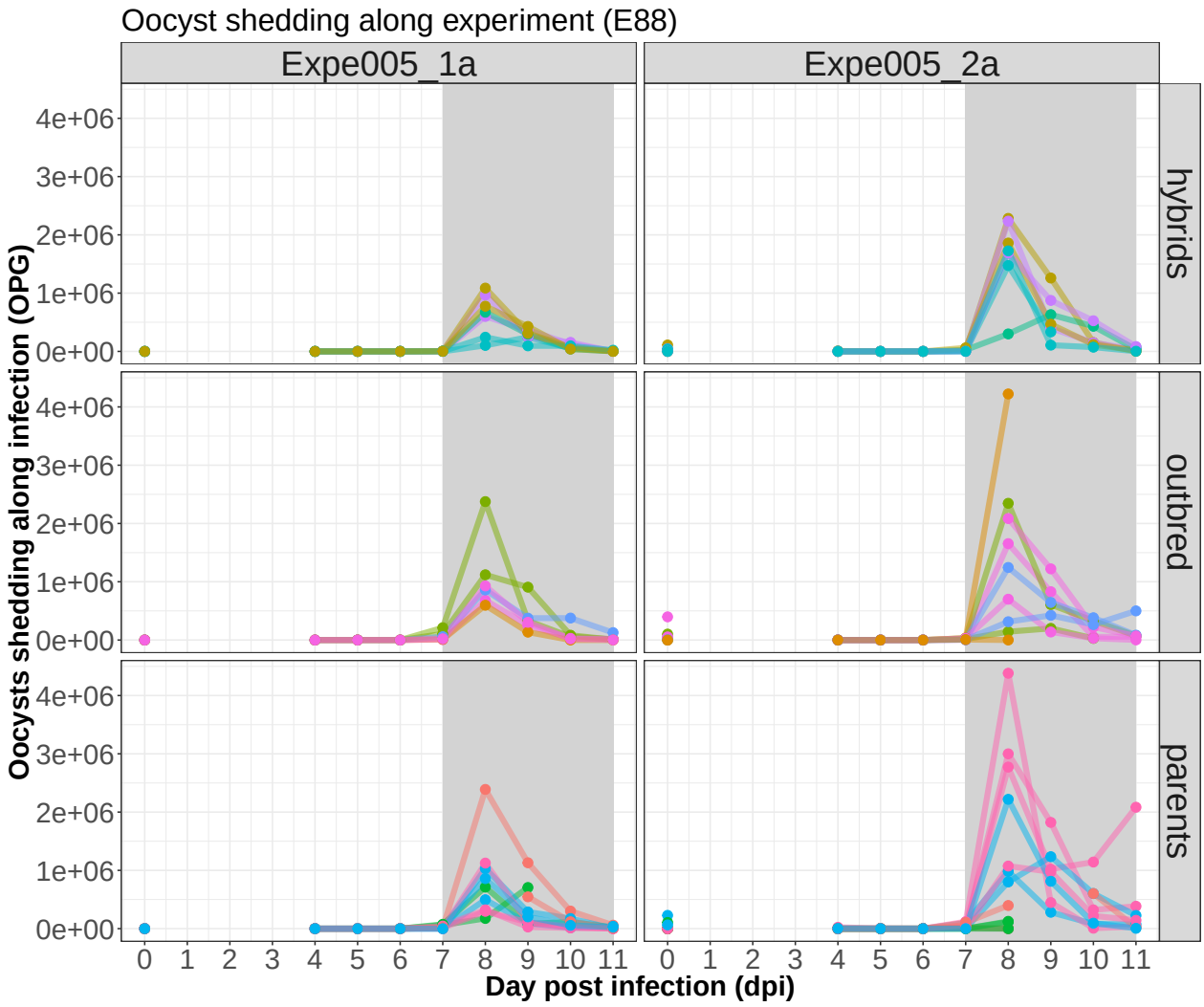

Mean oocysts shedding along experiment
Expe005_1b
Expe005_2b
hybrids
outbred
parents
Oocysts shedding along infection (OPG)
3e+06
2e+06
1e+06
0e+00
0 1 2 3 4 5 6 7 8 9 10 11
Day post infection (dpi)
HybridStatus
hybrids
outbred
parents

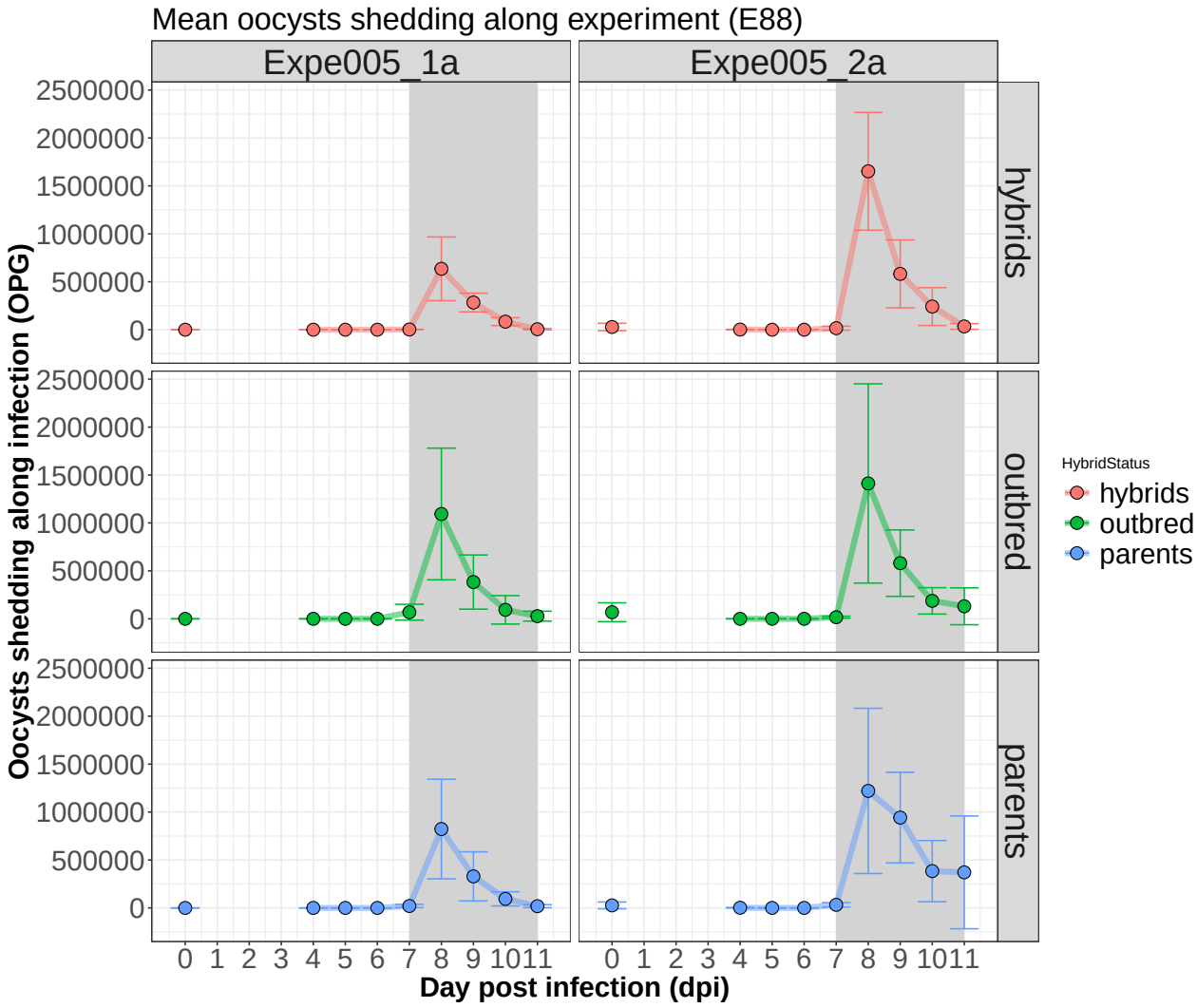


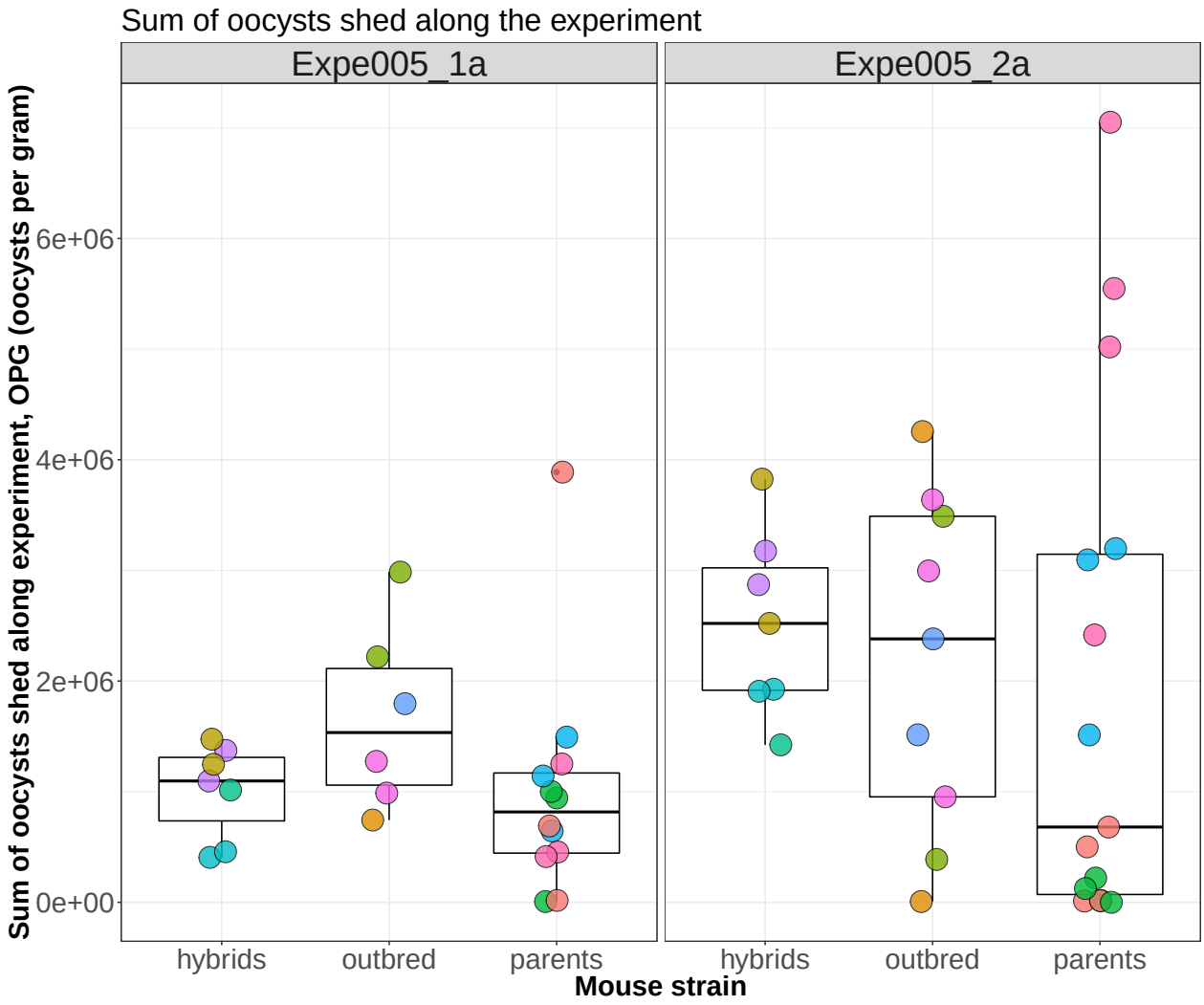

```
##
##  Kruskal-Wallis rank sum test
##
## data:  sum.oo by HybridStatus
## Kruskal-Wallis chi-squared = 1.4151, df = 2, p-value = 0.4929
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test
##
## data:  sum.oocysts_005_64$sum.oo and sum.oocysts_005_64$HybridStatus
##
##         hybrids outbred
## outbred 0.57    -
## parents 0.57    0.57
##
## P value adjustment method: BH
```

Eimeria falciformis


Oocyst shedding along experiment (E88)
Expe005_1a
Expe005_2a
hybrids
outbred
parents
Oocysts shedding along infection (OPG)
0e+00
1e+06
2e+06
3e+06
4e+06
0 1 2 3 4 5 6 7 8 9 10 11
Day post infection (dpi)


Mean oocysts shedding along experiment (E88)
Expe005_1a
Expe005_2a
hybrids
outbred
parents
Oocysts shedding along infection (OPG)
2500000
2000000
1500000
1000000
500000
0
0 1 2 3 4 5 6 7 8 9 10 11
Day post infection (dpi)
HybridStatus
hybrids
outbred
parents




```
##
##  Kruskal-Wallis rank sum test
##
## data:  sum.oo by HybridStatus
## Kruskal-Wallis chi-squared = 3.918, df = 2, p-value = 0.141
```

```
##
##  Pairwise comparisons using Wilcoxon rank sum test
##
## data:  sum.oocysts_005_88$sum.oo and sum.oocysts_005_88$HybridStatus
##
##         hybrids outbred
## outbred 0.81    -
## parents 0.16    0.16
##
## P value adjustment method: BH
```

Ideas:

- Add variable for each 4 parents and test the linear relationships for each of these variables set to 0 (copy of DNA), 1 (copy of DNA) (2 we can remove as we want outbred vs hybrids) + another variable HybridStatus : hybrid or outbred. + mixed effect (1|EH_ID, 1|Expe)

- Depend on the angle, but could be really interesting to quantify this for each mouse strain (outbreeding effet + hybrid effect) and show that it is highly strain specific. The focus on the article could be on that.
- Internal collaborators: Alice Balard, Vivian Mittné, Francisca Böhning, Emanuel Heitlinger
- External collaborators: Stuart J. Baird, Jaroslav Piálek, Ľudovít Ďureje, Joëlle Goüy de Bellocq, Milos Macholán.
- Aknowledgements: Victor Jarquin, Jenny Jost, Deborah Dymke, Lubomír Bednář, Parnika Mukherjee, Julia Murata, Clément Vollet, Tabea Roth von Szepesbéla, Yasmin Schickel, Gordon Mählis