Supplement

Mihaljevic & Páez

```
# Source functions and static objects
source("supp_funcs.R")
```

In this supplement, we will show alternative simulations of the host-pathogen and host-demography models with different assumptions.

First, we will generates the same temperature regime as used in the main text, which will be used throughout this supplement for consistency and to remove any effect of the specific temperature regime.

```
set.seed(5)

# Create a realistic temperature sequence:
time_seq = c(1:90)
T_temp = 40 * exp(-0.5 * (time_seq + 10 - 55)^2 / 800) + rnorm(length(time_seq), 0, 2.5)
# plot(T_temp ~ time_seq, type = "l")

# Fit a piece-wise constant (regression tree)
piece_mod = rpart(T_temp ~ time_seq,
                  control=rpart.control(maxdepth=5, cp=.0001))

# Quick check on results:
T_piece = predict(piece_mod, data.frame(time_seq = time_seq))
```

1 Positive relationship between CV and temperature

We will briefly explore an reciprocal effect of temperature on CV compared to the main text. Specifically, we will show how a positive relationship between CV and temperature can impact long-term dynamics of the host population density.

1.1 Simulate the CV-temp relationship

Here, we generate a figure summarizing the effect of temperature on CV during the annual epizootic, which draws upon the piece-wise pattern of temperature over time. Note that we parameterized the effect so that we maintain an average CV=0.5, to be consistent with the simulation in the main text.

```
# Smooth temperature sequence:
T_seq = seq(0, 45, by = 0.1)

# CV Gaussian function parameters
```

```r
a_CV = 1.1
b_CV = 44.5
c_CV = 12

# Gaussian functional relationship (smooth)
CV_t = a_CV * exp( -0.5 * ((T_seq - b_CV)/c_CV)^2 )

# plot(CV_t ~ T_seq, type = "l",
#      xlab = "Temp (C)", ylab = expression("C"["(T)"]))

# Gaussian functional relationship (based on piece-wise temperature)
CV_piece = a_CV * exp( -0.5 * ((T_piece - b_CV)/c_CV)^2 )
mean_CV = round(mean(CV_piece),2)
print(paste0("mean of CV_piece = ", mean_CV))
```

```
[1] "mean of CV_piece = 0.51"
```

```r
plot_S1.1 = CV_plot_func(CV_t, CV_piece, T_seq)

grid.arrange(plot_S1.1)
```

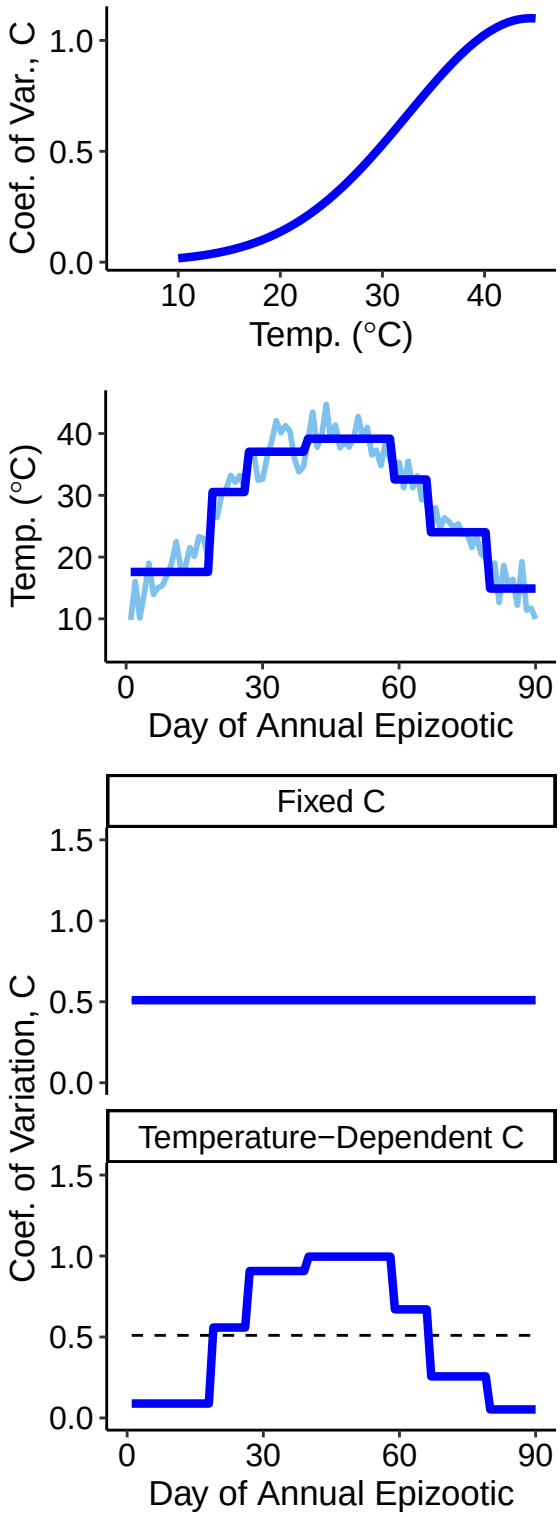

Figure S1: Positive relationship between CV and temperature during the annual epizootic

1.2 Run the multi-generational simulations

```
set.seed(seed = NULL)
cv_positive_sims = run_full_sim(time_seq)
str(cv_positive_sims)
```

```
num [1:51, 1:2, 1:2] 18.1 82.06 3.12 17.15 82.39 ...
- attr(*, "dimnames")=List of 3
 ..$ Gen  : chr [1:51] "1" "2" "3" "4" ...
 ..$ Class: chr [1:2] "S" "P"
 ..$ CV   : chr [1:2] "Fixed C" "Temperature-Dependent C"
```

```
# Returns an array
## Gen == generation (i.e., year)
## Class == Susceptible (S), Pathogen (P)
## CV == whether CV was fixed or temp-dependent
```

Plot the output:

```
plot_S1.2 = multi_gen_plot(cv_positive_sims)
grid.arrange(plot_S1.2)
```

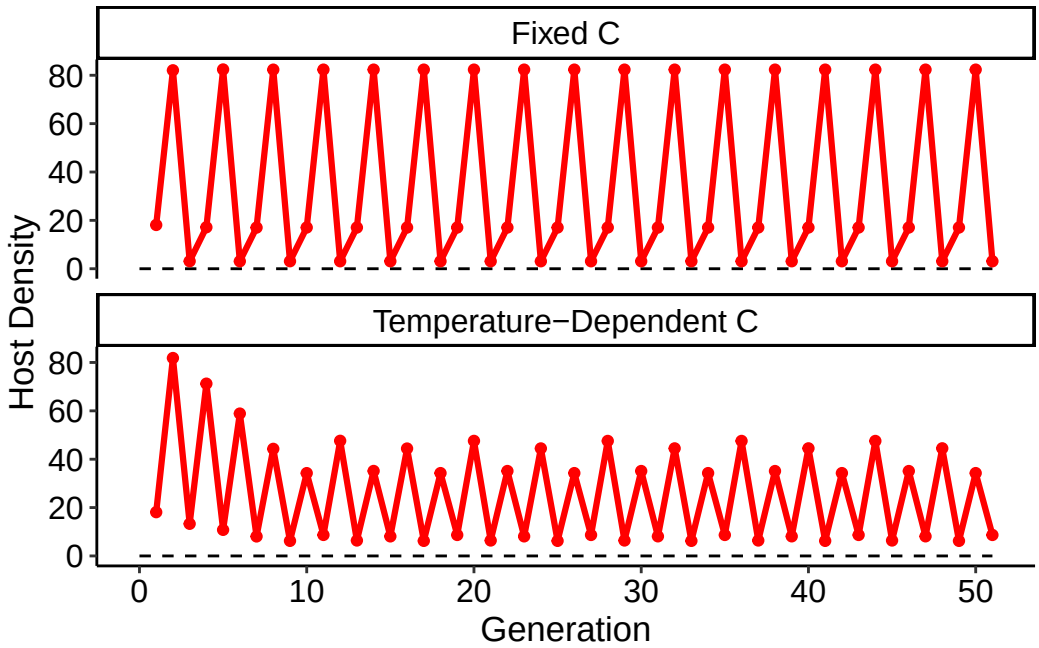

Figure S2: Comparing multi-generational effects of fixed CV versus a positive relationship between CV and temperature during the annual epizootic.

1.3 Slightly change the shape of the positive relationship

We can show that, even if we maintain the mean CV across the epizootic, if we change the pattern of CV over time, this leads to distinct long-term dynamics of host population density.

For example, below we slightly alter the CV-temperature relationship. In this case, the average CV is still 0.5, as in Figure S1 and Figure S2. However, the max CV is slightly lower (0.9), and the CV at low and high temperatures is a bit higher.

```
# Smooth temperature sequence:
T_seq = seq(0, 45, by = 0.1)

# CV Gaussian function parameters
a_CV = 0.9
b_CV = 44.5
c_CV = 15

# Gaussian functional relationship (smooth)
CV_t = a_CV * exp( -0.5 * ((T_seq - b_CV)/c_CV)^2 )

# plot(CV_t ~ T_seq, type = "l",
#      xlab = "Temp (C)", ylab = expression("C"["(T)"]))

# Gaussian functional relationship (based on piece-wise temperature)
CV_piece = a_CV * exp( -0.5 * ((T_piece - b_CV)/c_CV)^2 )
mean_CV = round(mean(CV_piece),2)
print(paste0("mean of CV_piece = ", mean_CV))
```

```
[1] "mean of CV_piece = 0.51"
```

```
plot_S1.3 = CV_plot_func(CV_t, CV_piece, T_seq)

grid.arrange(plot_S1.3)
```

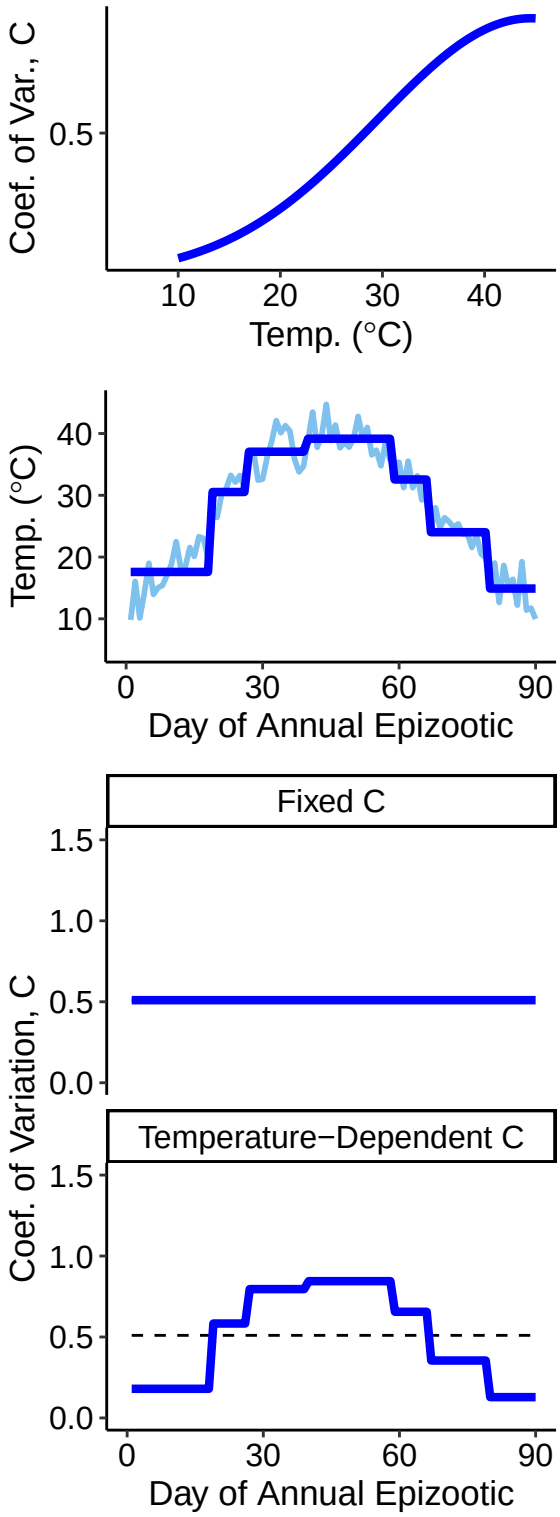

Figure S3: Positive relationship between CV and temperature during the annual epizootic

```
cv_positive_sims2 = run_full_sim(time_seq)
```

```
plot_S1.4 = multi_gen_plot(cv_positive_sims2)
grid.arrange(plot_S1.4)
```

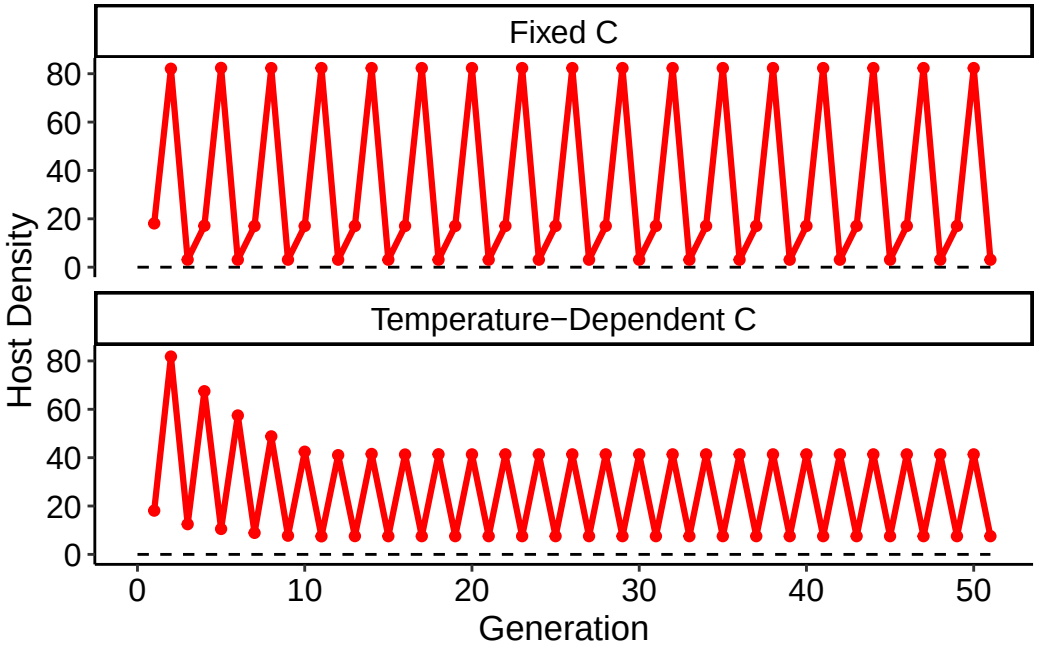

Figure S4: Comparing multi-generational effects of fixed CV versus a positive relationship between CV and temperature during the annual epizootic.

```
[1] "Mean host density, Fixed C = 17.048"
```

```
[1] "Mean host density, Temp-Dependent C = 18.1"
```