

Pseudomonas Epiphytic Growth and Virulence Analysis

2024 Summer

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Load Libraries

```
pacman::p_load(ggplot2, readxl, RColorBrewer, paletteer, viridis, wesanderson, ggbeeswarm,
  dplyr, tidyverse, devtools, emmeans, cowplot, knitr, survival, here, tibble,
  survminer, lubridate, formatR, gridExtra, ggsurvfit, gtsummary, tidycmprsk, install = FALSE)

# Load strain colors Define your strains
strains <- c("194", "200", "204", "205", "215", "216", "220", "221", "227", "228",
  "B728a", "Cit7", "Control", "pisi")

# Generate colors using the 'grDevices::Set 2' palette
set2_colors <- as.character(paletteer_c("grDevices::Dark 3", length(strains)))

# Create a named vector for strain colors, with 'Control' as black
strain_colors <- setNames(c(set2_colors), strains)

species_colors <- c(`P. fluorescens` = "dodgerblue2", `P. syringae` = "springgreen3",
  `P. paralactis` = "sienna4")
```

```
pseud_epi_growth_2024summer_R <- read_excel("data/pseud_epi_growth_2024summer_R.xlsx")
aphid_virulence_data <- read_csv("data/virulence_new_all.csv")
```

```
## Rows: 4973 Columns: 6
## -- Column specification -----
## Delimiter: ","
## chr (3): date, treatment, replicate
## dbl (3): individual, censored, time
##
## i Use 'spec()' to retrieve the full column specification for this data.
## i Specify the column types or set 'show_col_types = FALSE' to quiet this message.
```

Goals

- Create Kaplan-Meier curve for Pseud. virulence data
- Use stats (Wilcox?) to determine statistical significance of each strain
- Compare virulence data with epiphytic growth ability

Virulence Analysis

Note: *In order to help me with this analysis, I am using the following sites - Survival Analysis in R and Hazard Ratio: Interpretation & Definition.*

Calculate survival probabilities for each strain and create dataframe

```
# Fit the survival model
km_fit <- survfit(Surv(time, censored) ~ treatment, data = aphid_virulence_data)

# Extract survival probabilities at specific time points
time_points <- c(24, 48, 72)
km_summary <- summary(km_fit, times = time_points)

# Initialize empty lists to store the results
times_list <- list()
treatment_list <- list()
surv_prob_list <- list()

# Loop over each treatment group and extract survival probabilities at
# specified time points
for (i in 1:length(km_fit$strata)) {
  treatment_name <- names(km_fit$strata)[i]
  for (t in time_points) {
    idx <- which(km_summary$time == t & km_summary$strata == treatment_name)
    if (length(idx) > 0) {
      times_list <- c(times_list, t)
      treatment_list <- c(treatment_list, treatment_name)
      surv_prob_list <- c(surv_prob_list, km_summary$surv[idx])
    }
  }
}
```

```

    } else {
      times_list <- c(times_list, t)
      treatment_list <- c(treatment_list, treatment_name)
      surv_prob_list <- c(surv_prob_list, NA)
    }
  }
}

# Create the data frame
surv_probs <- data.frame(time = unlist(times_list), treatment = unlist(treatment_list),
  surv_prob = unlist(surv_prob_list))

# Replace 'treatment=' with an empty string
surv_probs$treatment <- gsub("treatment=", "", surv_probs$treatment)

# Print the data frame
print(surv_probs)

```

```

##      time treatment  surv_prob
## 1     24         194 0.77891156
## 2     48         194 0.18707483
## 3     72         194 0.12244898
## 4     24         200 0.53159851
## 5     48         200 0.05576208
## 6     72         200 0.02230483
## 7     24         204 0.54929577
## 8     48         204 0.08450704
## 9     72         204 0.05281690
## 10    24         205 0.56949153
## 11    48         205 0.11525424
## 12    72         205 0.07118644
## 13    24         215 0.79513889
## 14    48         215 0.44791667
## 15    72         215 0.22222222
## 16    24         216 0.56250000
## 17    48         216 0.27430556
## 18    72         216 0.15625000
## 19    24         220 0.35135135
## 20    48         220 0.19256757
## 21    72         220 0.17229730
## 22    24         221 0.65543071
## 23    48         221 0.21722846
## 24    72         221 0.09363296
## 25    24         227 0.40000000
## 26    48         227 0.22033898
## 27    72         227 0.16949153
## 28    24         228 0.65671642
## 29    48         228 0.15298507
## 30    72         228 0.10447761
## 31    24       B728a 0.68041237
## 32    48       B728a 0.40549828
## 33    72       B728a 0.10996564
## 34    24        Cit7 0.75609756

```

```
## 35 48 Cit7 0.37630662
## 36 72 Cit7 0.17073171
## 37 24 Control 0.94777397
## 38 48 Control 0.87243151
## 39 72 Control 0.81678082
## 40 24 pisi 0.88250653
## 41 48 pisi 0.79634465
## 42 72 pisi 0.74151436
```

```
# subset data by time
surv_probs_72 <- surv_probs %>%
  filter(time == 72)

# If you need to save it to a file, you can use the following command
# write.csv(surv_probs, 'survival_probabilities.csv', row.names = FALSE)
```

Post-hoc test for survival

```
# Perform pairwise log-rank tests between treatment groups and the control
# group
pairwise_tests <- pairwise_survdif(Surv(time, censored) ~ treatment, data = aphid_virulence_data)

# Print the pairwise tests
print(pairwise_tests)
```

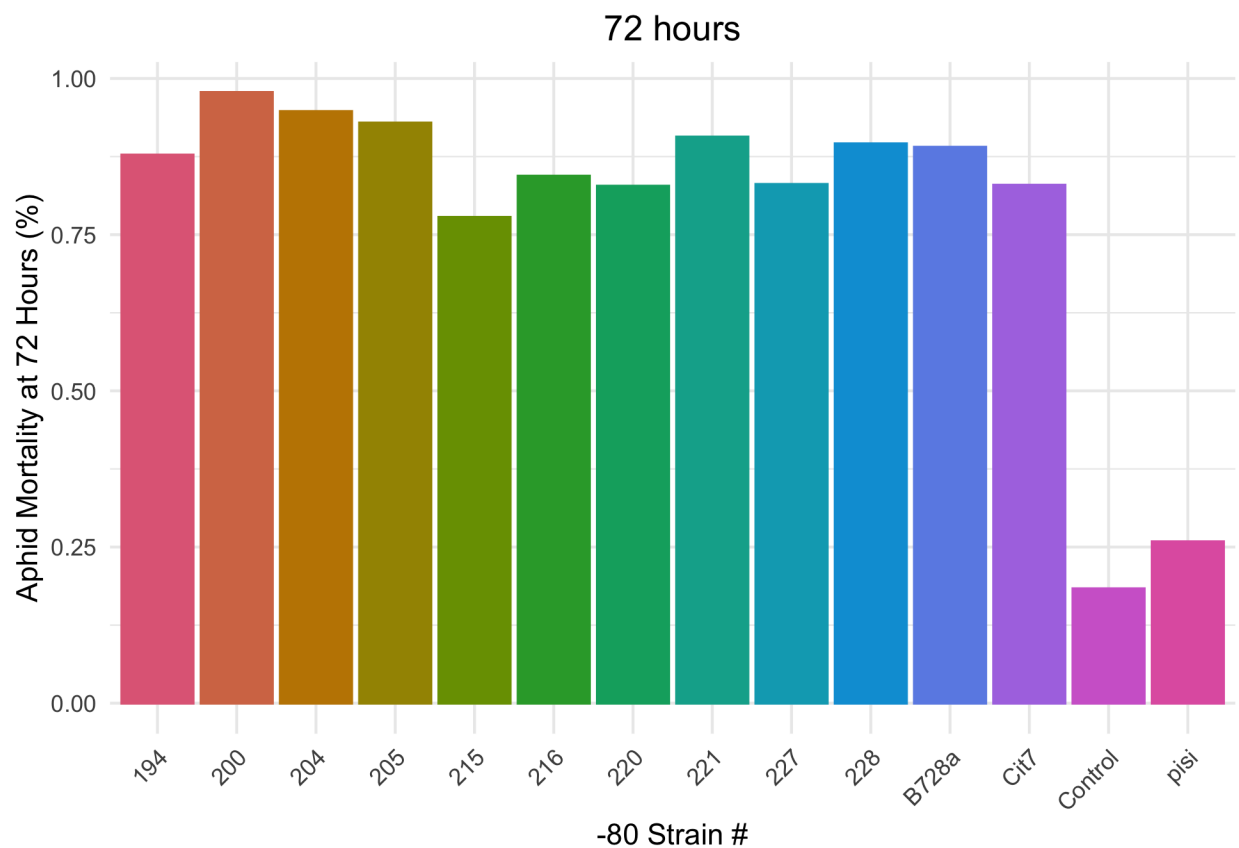
```
##
## Pairwise comparisons using Log-Rank test
##
## data: aphid_virulence_data and treatment
##
##      194      200      204      205      215      216      220      221      227
## 200 2.3e-12 -          -          -          -          -          -          -
## 204 1.6e-08 0.26489 -          -          -          -          -          -
## 205 3.7e-06 0.04009 0.38289 -          -          -          -          -
## 215 4.6e-05 < 2e-16 < 2e-16 7.8e-16 -          -          -          -
## 216 0.20589 3.0e-06 0.00054 0.00915 1.3e-05 -          -          -
## 220 1.2e-05 0.34987 0.95899 0.61067 7.5e-10 0.04787 -          -
## 221 0.06597 1.7e-06 0.00063 0.01560 3.0e-08 0.57084 0.05899 -          -
## 227 0.00048 0.05275 0.34910 0.75895 1.7e-08 0.14997 0.65606 0.23547 -
## 228 0.02457 2.3e-05 0.00265 0.03730 5.6e-09 0.52684 0.02668 0.75895 0.15756
## B728a 0.30241 3.8e-15 2.0e-10 1.5e-07 0.00193 0.15635 0.00089 0.00913 0.00558
## Cit7 0.97833 6.8e-10 1.0e-06 8.4e-05 0.00044 0.38289 0.00217 0.11439 0.01459
## Control < 2e-16 < 2e-16 < 2e-16 < 2e-16 < 2e-16 < 2e-16 < 2e-16 < 2e-16
## pisi < 2e-16 < 2e-16 < 2e-16 < 2e-16 < 2e-16 < 2e-16 < 2e-16 < 2e-16
##      228      B728a      Cit7      Control
## 200 -          -          -          -
## 204 -          -          -          -
## 205 -          -          -          -
## 215 -          -          -          -
## 216 -          -          -          -
## 220 -          -          -          -
```

```
## 221      -      -      -      -
## 227      -      -      -      -
## 228      -      -      -      -
## B728a    0.00265 -      -      -
## Cit7     0.05646 0.46912 -      -
## Control  < 2e-16 < 2e-16 < 2e-16 -
## pisi     < 2e-16 < 2e-16 < 2e-16 0.00042
##
## P value adjustment method: BH
```

Plot Survival Dataframe at different times

```
surv_plot_72 <- ggplot(data = surv_probs_72, aes(x = treatment, y = (1 - surv_prob),
  color = treatment, fill = treatment)) + geom_col() + labs(title = "72 hours",
  x = "-80 Strain #", y = "Aphid Mortality at 72 Hours (%)") + theme_minimal() +
  scale_fill_manual(values = strain_colors) + scale_color_manual(values = strain_colors) +
  theme(plot.title = element_text(hjust = 0.5), axis.text.x = element_text(angle = 45,
    hjust = 1), legend.position = "none")
```

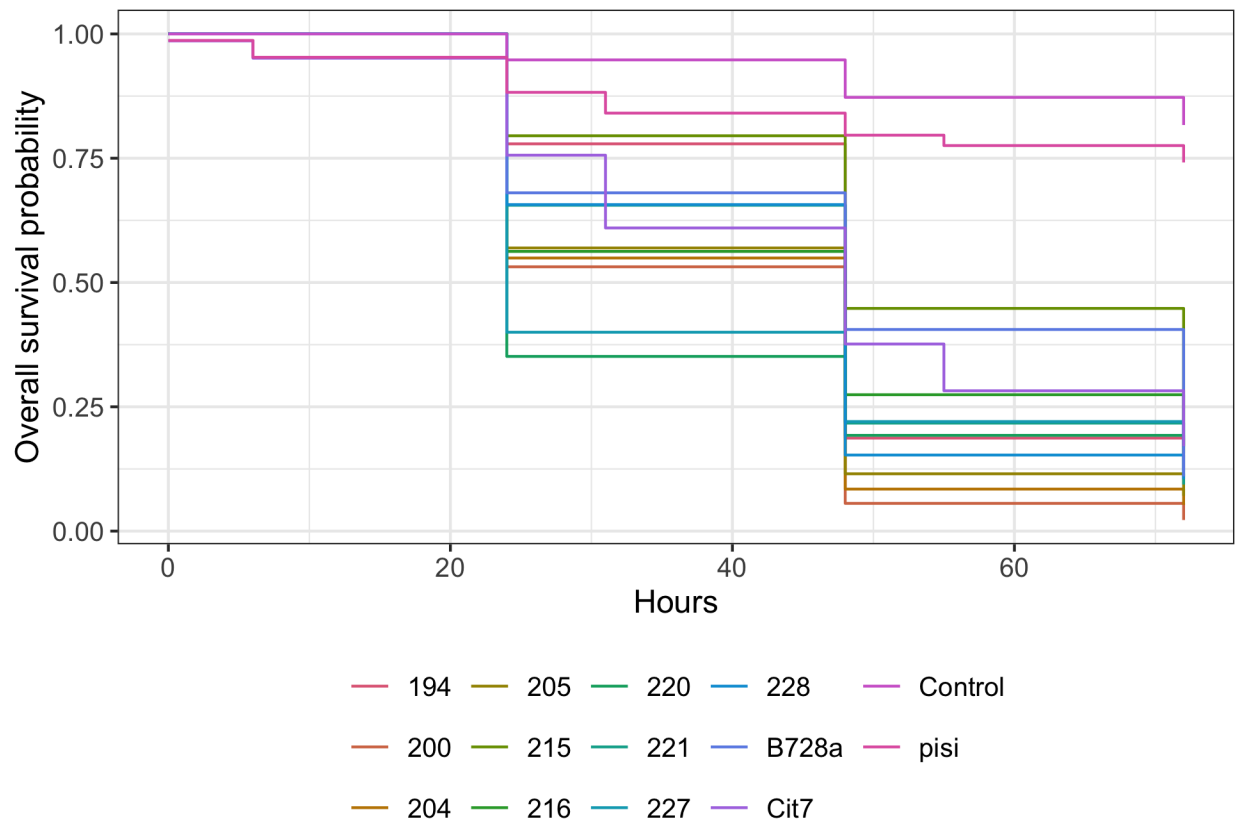
surv_plot_72



Make Kaplan-Meier Plot

Cohort Survival Curve

```
survfit2(Surv(time, censored) ~ treatment, data = aphid_virulence_data) %>%
  ggsurvfit() + labs(x = "Hours", y = "Overall survival probability") + scale_color_manual(values = s
```



Epiphytic Growth Analysis

Calculate mean/variance epiphytic growth ability

```
# Replace NA with a lower value or remove them for visualization Remove rows
# with NA in CFU_per_10_leafdiscs
epi_growth_clean <- pseud_epi_growth_2024summer_R %>%
  filter(!is.na(CFU_per_10_leafdiscs))

# Convert CFU_per_10_leafdiscs to numeric, handling scientific notation
epi_growth_clean$CFU_per_10_leafdiscs <- as.numeric(gsub("<", "", epi_growth_clean$CFU_per_10_leafdiscs))

## Warning: NAs introduced by coercion
```

```

# Subset data to remove unfinished strains and extract the letter part from the
# 'plant_rep' column
epi_growth_clean <- epi_growth_clean %>%
  filter(!strain %in% c("pisi", "215")) %>%
  mutate(plant_rep_letter = substr(plant_rep, 1, 1))

# Calculate the mean and SD CFU per strain for each plant rep letter and retain
# the specified columns
epi_growth_mean_per_rep <- epi_growth_clean %>%
  group_by(strain, plant_rep_letter) %>%
  summarise(mean_CFU_per_10_leafdiscs = mean(CFU_per_10_leafdiscs, na.rm = TRUE),
            sd_CFU = sd(CFU_per_10_leafdiscs, na.rm = TRUE), sample = first(sample),
            person = first(person), block = first(block), species = first(species), plant_rep = first(plant_rep),
            .groups = "drop")

# Calculate the mean and SD CFU per strain for each plant rep letter and retain
# the specified columns
epi_growth_mean_per_strain <- epi_growth_clean %>%
  group_by(strain) %>%
  summarise(mean_CFU_per_10_leafdiscs = mean(CFU_per_10_leafdiscs, na.rm = TRUE),
            sd_CFU = sd(CFU_per_10_leafdiscs, na.rm = TRUE), sample = first(sample),
            person = first(person), block = first(block), species = first(species), plant_rep = first(plant_rep),
            .groups = "drop")

epi_growth_mean_per_strain

```

```

## # A tibble: 11 x 8
##   strain mean_CFU_per_10_leafdiscs sd_CFU sample person block species plant_rep
##   <chr>           <dbl>    <dbl> <chr>  <chr>  <chr> <chr>    <chr>
## 1 194             156472.  1.43e5 194-A1 Havi   2-1   P. par~ A1
## 2 200             261214.  1.81e5 200-A1 Havi   2-6   P. flu~ A1
## 3 204             186888.  1.89e5 204-A1 Havi   2-3   P. flu~ A1
## 4 205             207750.  2.40e5 205-A1 Sara    3     P. flu~ A1
## 5 216              6788.  7.61e3 216-A1 Sara    3     P. flu~ A1
## 6 220             172543.  1.89e5 220-A1 Sara    5     P. par~ A1
## 7 221             259556.  1.93e5 221-A1 Havi   2-7   P. flu~ A1
## 8 227              82872.  1.53e5 227-A1 Sara    5     P. flu~ A1
## 9 228              22875.  2.37e4 228-A1 Sara    5     P. flu~ A1
## 10 B728a          71144.  1.36e5 B728a~ Sara    4     P. syr~ A1
## 11 Cit7           61906.  1.17e5 Cit7~~ Havi   2-3   P. syr~ A1

```

Plot Epiphytic Growth

```

epi_growth_strain <- ggplot(data = epi_growth_mean_per_rep, aes(x = strain, y = mean_CFU_per_10_leafdiscs)) +
  geom_boxplot(outlier.shape = NA, alpha = 0.3) +
  geom_beeswarm(stroke = 0.5, size = 0.8, alpha = 0.8) +
  labs(title = "CFU per 10 Leaf Discs Across Samples",
       x = "-80 Strain #",
       y = "CFU per 10 Leaf Discs") +
  theme_minimal() +
  scale_fill_manual(values = strain_colors) +

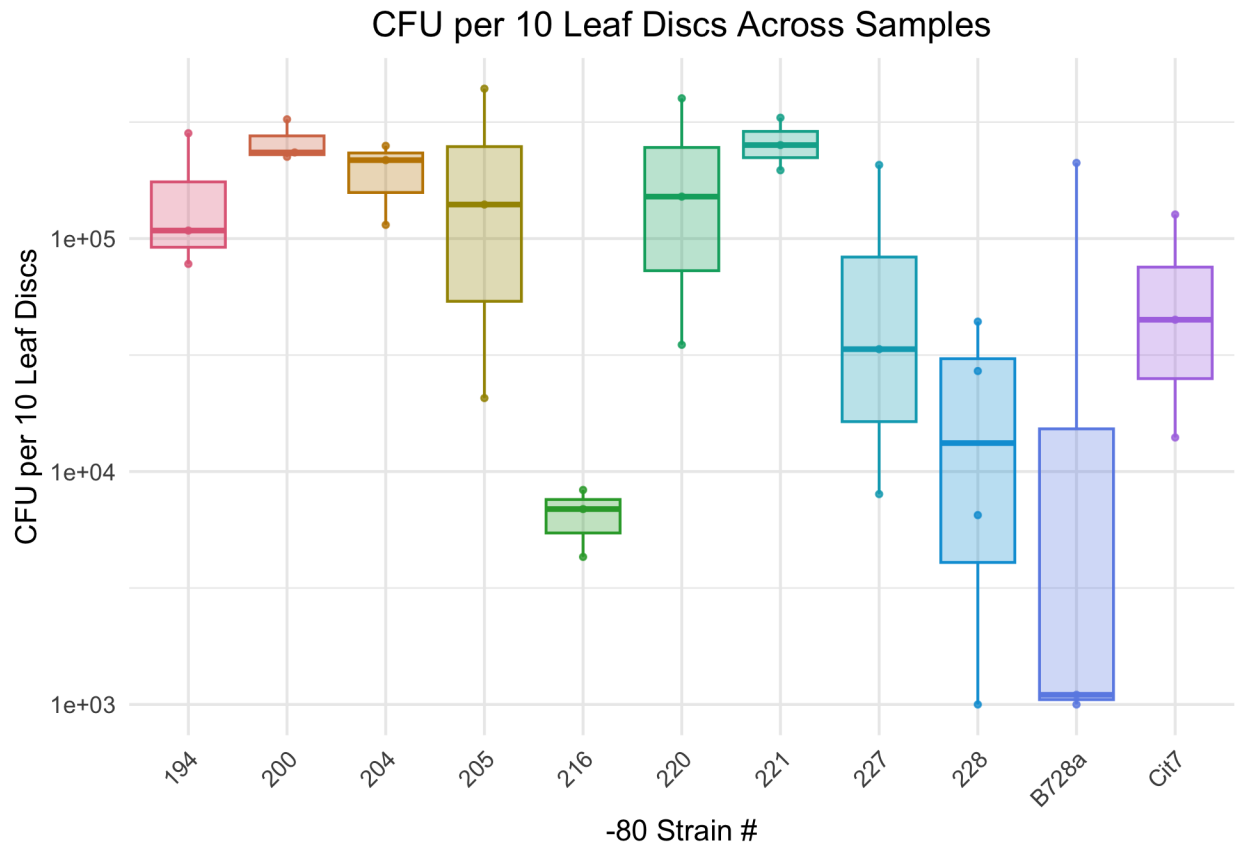
```

```

scale_color_manual(values = strain_colors) +
scale_y_log10() + # Apply log transformation to y-axis
theme(plot.title = element_text(hjust = 0.5),
      axis.text.x = element_text(angle = 45, hjust = 1), legend.position = "none")

```

epi_growth_strain

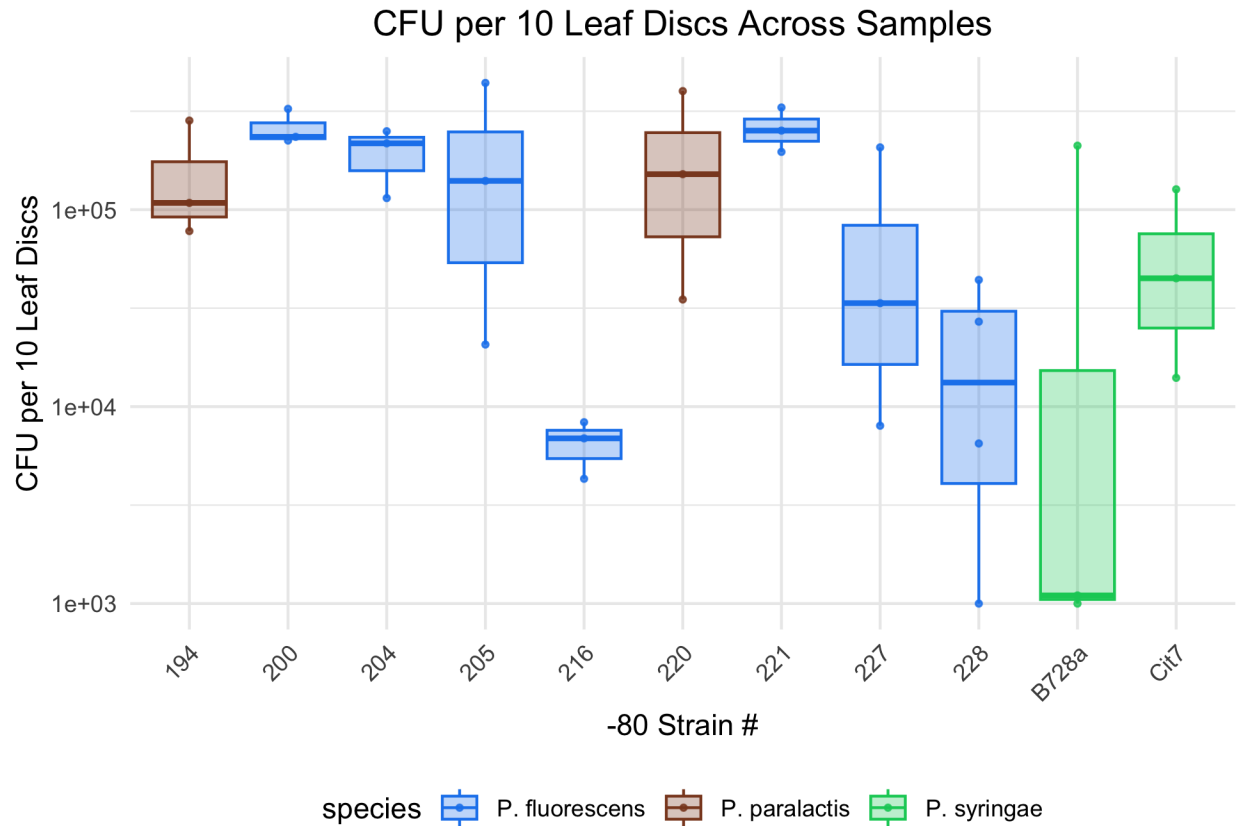


```

epi_growth_species <- ggplot(data = epi_growth_mean_per_rep, aes(x = strain, y = mean_CFU_per_10_leafdiscs)) +
  geom_boxplot(outlier.shape = NA, alpha = 0.3) +
  geom_beeswarm(stroke = 0.5, size = 0.8, alpha = 0.8) +
  labs(title = "CFU per 10 Leaf Discs Across Samples",
       x = "-80 Strain #",
       y = "CFU per 10 Leaf Discs") +
  theme_minimal() +
  scale_fill_manual(values = species_colors) +
  scale_color_manual(values = species_colors) +
  scale_y_log10() + # Apply log transformation to y-axis
  theme(plot.title = element_text(hjust = 0.5),
        axis.text.x = element_text(angle = 45, hjust = 1), legend.position = "bottom")

```

epi_growth_species



Combine epiphytic and virulence data

```
# Assuming strain_stats has a column 'strain' and surv_probs has a column
# 'treatment' Rename columns if necessary to match the key for joining
epi_growth_mean_per_strain <- epi_growth_mean_per_strain %>%
  rename(treatment = strain)

# Combine strain_stats and surv_probs using left_join
epi_virulence_data <- left_join(epi_growth_mean_per_strain, surv_probs, by = "treatment")

# Print the combined data
print(epi_virulence_data)
```

```
## # A tibble: 33 x 10
##   treatment mean_CFU_per_10_leaf~1 sd_CFU sample person block species plant_rep
##   <chr>          <dbl>    <dbl> <chr>  <chr>  <chr> <chr>    <chr>
## 1 194          156472.  1.43e5 194-A1 Havi   2-1   P. par~ A1
## 2 194          156472.  1.43e5 194-A1 Havi   2-1   P. par~ A1
## 3 194          156472.  1.43e5 194-A1 Havi   2-1   P. par~ A1
## 4 200          261214.  1.81e5 200-A1 Havi   2-6   P. flu~ A1
## 5 200          261214.  1.81e5 200-A1 Havi   2-6   P. flu~ A1
## 6 200          261214.  1.81e5 200-A1 Havi   2-6   P. flu~ A1
## 7 204          186888.  1.89e5 204-A1 Havi   2-3   P. flu~ A1
```

```
## 8 204 186888. 1.89e5 204-A1 Havi 2-3 P. flu~ A1
## 9 204 186888. 1.89e5 204-A1 Havi 2-3 P. flu~ A1
## 10 205 207750 2.40e5 205-A1 Sara 3 P. flu~ A1
## # i 23 more rows
## # i abbreviated name: 1: mean_CFU_per_10_leafdiscs
## # i 2 more variables: time <dbl>, surv_prob <dbl>
```

```
subset_data_72 <- epi_virulence_data %>%
  filter(time == 72)

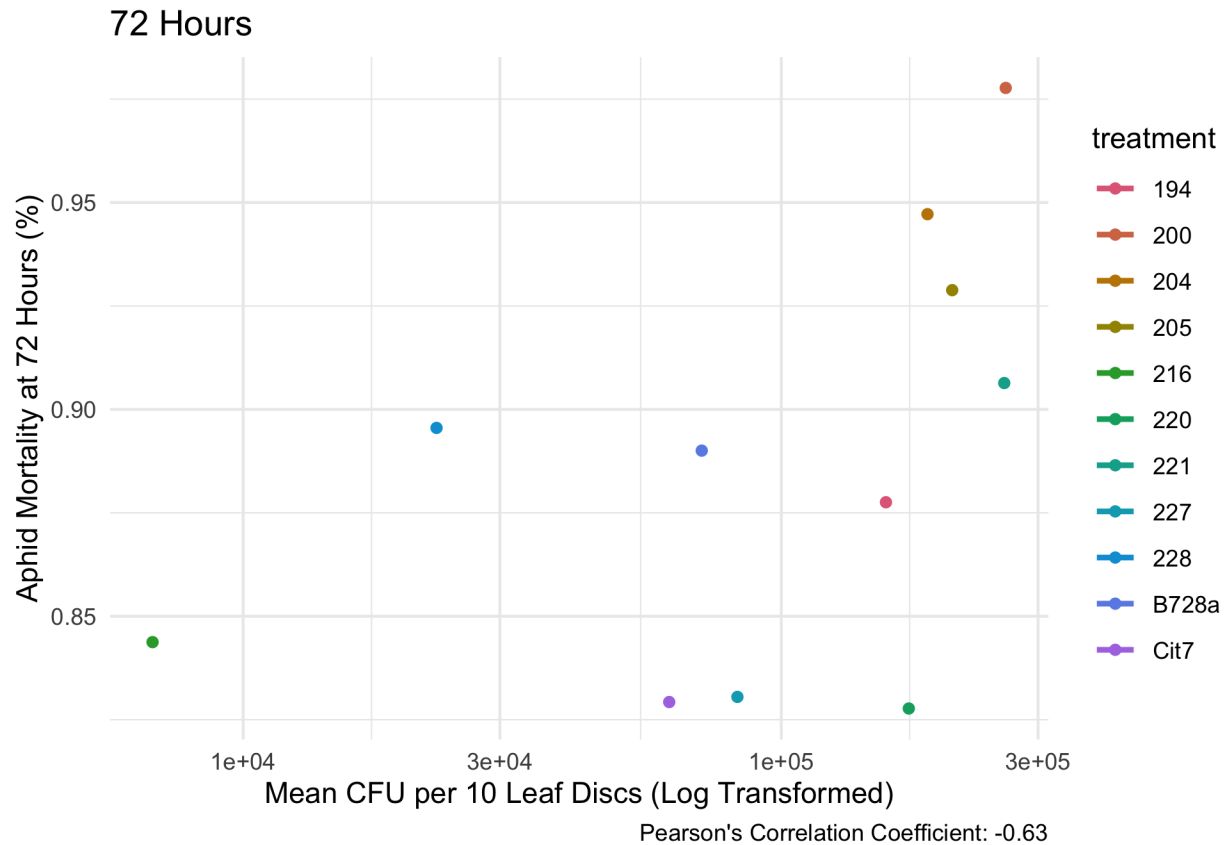
# Calculate correlation coefficient between survival probability and epiphytic
# growth ability
correlation_72 <- cor(subset_data_72$surv_prob, subset_data_72$mean_CFU_per_10_leafdiscs,
  method = "pearson")
```

Plot it for different times

```
# Create scatter plot for 72 hours
epi_virulence_plot_strains <- ggplot(subset_data_72, aes(x = mean_CFU_per_10_leafdiscs, y = (1-surv_prob))) +
  geom_point() +
  geom_smooth(data = subset_data_72, method = "lm", se = FALSE) +
  labs(title = "72 Hours",
    x = "Mean CFU per 10 Leaf Discs (Log Transformed)",
    y = "Aphid Mortality at 72 Hours (%)",
    caption = paste("Pearson's Correlation Coefficient:", round(correlation_72, 2))) +
  scale_x_continuous(trans = "log10") + # Apply log transformation to x-axis
  scale_color_manual(values = strain_colors) +
  theme_minimal()

epi_virulence_plot_strains
```

```
## 'geom_smooth()' using formula = 'y ~ x'
```

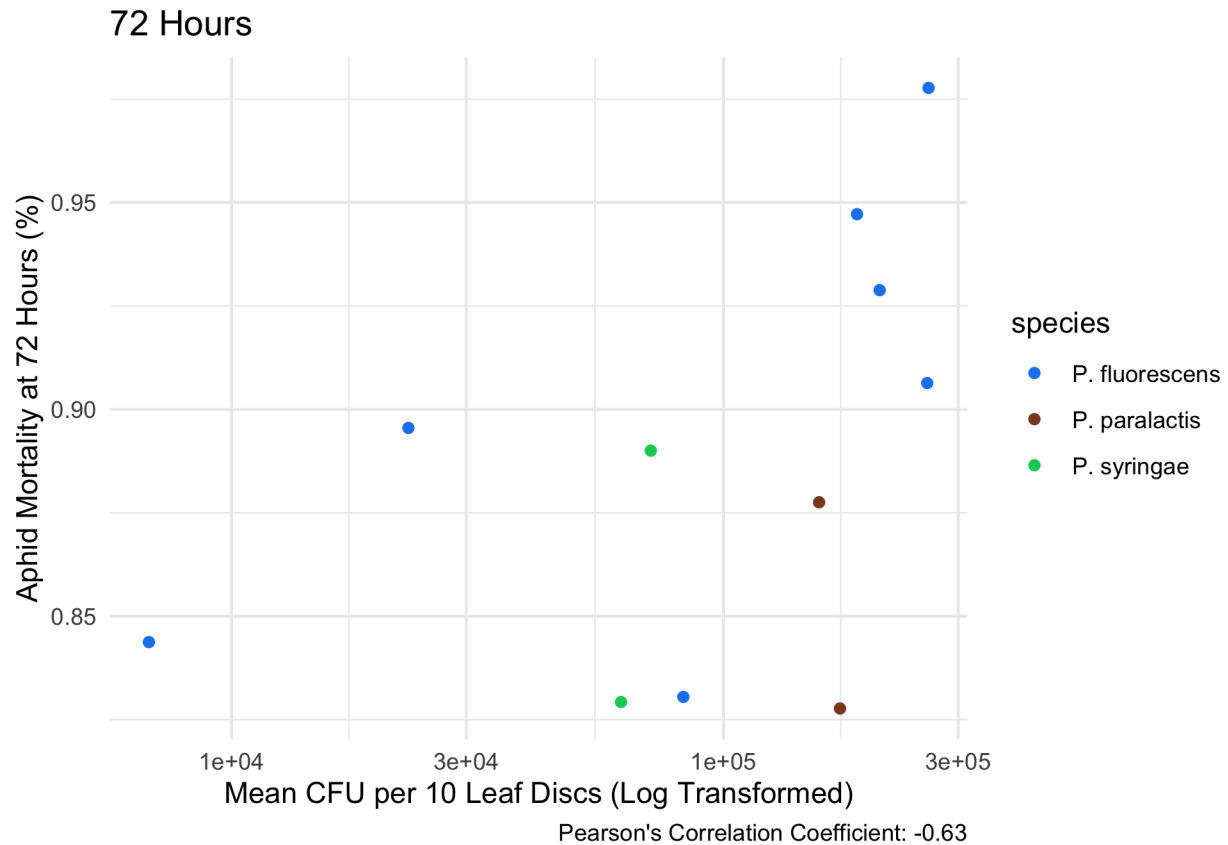


```

epi_virulence_plot_species <- ggplot(subset_data_72, aes(x = mean_CFU_per_10_leafdiscs, y = (1-surv_prob))) +
  geom_point() +
  #geom_smooth(method = "lm", se = FALSE) +
  labs(title = "72 Hours",
        x = "Mean CFU per 10 Leaf Discs (Log Transformed)",
        y = "Aphid Mortality at 72 Hours (%)",
        caption = paste("Pearson's Correlation Coefficient:", round(correlation_72, 2))) +
  scale_color_manual(values = species_colors) +
  scale_x_continuous(trans = "log10") + # Apply log transformation to x-axis
  theme_minimal()

```

epi_virulence_plot_species



Session Information

```
devtools::session_info()
```

```
## - Session info -----
## setting value
## version R version 4.4.0 (2024-04-24)
## os      macOS Ventura 13.4
## system  x86_64, darwin20
## ui      X11
## language (EN)
## collate en_US.UTF-8
## ctype   en_US.UTF-8
## tz      America/New_York
## date    2024-06-16
## pandoc  3.1.11 @ /Applications/RStudio.app/Contents/Resources/app/quarto/bin/tools/x86_64/ (via rm
##
## - Packages -----
## ! package      * version date (UTC) lib source
## P abind         1.4-5   2016-07-21 [?] RSPM
```

##	P backports	1.4.1	2021-12-13	[?]	CRAN	(R 4.4.0)
##	P beeswarm	0.4.0	2021-06-01	[?]	CRAN	(R 4.4.0)
##	P bit	4.0.5	2022-11-15	[?]	CRAN	(R 4.4.0)
##	P bit64	4.0.5	2020-08-30	[?]	CRAN	(R 4.4.0)
##	P broom	1.0.6	2024-05-17	[?]	CRAN	(R 4.4.0)
##	P broom.helpers	1.15.0	2024-04-05	[?]	CRAN	(R 4.4.0)
##	P cachem	1.0.8	2023-05-01	[?]	CRAN	(R 4.4.0)
##	P car	3.1-2	2023-03-30	[?]	RSPM	
##	P carData	3.0-5	2022-01-06	[?]	RSPM	
##	P cellranger	1.1.0	2016-07-27	[?]	CRAN	(R 4.4.0)
##	P cli	3.6.2	2023-12-11	[?]	CRAN	(R 4.4.0)
##	P colorspace	2.1-0	2023-01-23	[?]	CRAN	(R 4.4.0)
##	P cowplot	* 1.1.3	2024-01-22	[?]	CRAN	(R 4.4.0)
##	P crayon	1.5.2	2022-09-29	[?]	CRAN	(R 4.4.0)
##	P data.table	1.15.4	2024-03-30	[?]	CRAN	(R 4.4.0)
##	P devtools	* 2.4.5	2022-10-11	[?]	RSPM	
##	P digest	0.6.35	2024-03-11	[?]	CRAN	(R 4.4.0)
##	P dplyr	* 1.1.4	2023-11-17	[?]	CRAN	(R 4.4.0)
##	P ellipsis	0.3.2	2021-04-29	[?]	RSPM	
##	P emmeans	* 1.10.2	2024-05-20	[?]	RSPM	
##	P estimability	1.5.1	2024-05-12	[?]	RSPM	
##	P evaluate	0.23	2023-11-01	[?]	CRAN	(R 4.4.0)
##	P fansi	1.0.6	2023-12-08	[?]	CRAN	(R 4.4.0)
##	P farver	2.1.2	2024-05-13	[?]	CRAN	(R 4.4.0)
##	P fastmap	1.1.1	2023-02-24	[?]	CRAN	(R 4.4.0)
##	P forcats	* 1.0.0	2023-01-29	[?]	CRAN	(R 4.4.0)
##	P formatR	* 1.14	2023-01-17	[?]	RSPM	
##	P fs	1.6.4	2024-04-25	[?]	CRAN	(R 4.4.0)
##	P generics	0.1.3	2022-07-05	[?]	CRAN	(R 4.4.0)
##	P ggbeeswarm	* 0.7.2	2023-04-29	[?]	CRAN	(R 4.4.0)
##	P ggplot2	* 3.5.1	2024-04-23	[?]	CRAN	(R 4.4.0)
##	P ggpubr	* 0.6.0	2023-02-10	[?]	RSPM	
##	P ggsignif	0.6.4	2022-10-13	[?]	RSPM	
##	P ggsvrfit	* 1.1.0	2024-05-08	[?]	CRAN	(R 4.4.0)
##	P glue	1.7.0	2024-01-09	[?]	CRAN	(R 4.4.0)
##	P gridExtra	* 2.3	2017-09-09	[?]	RSPM	
##	P gt	0.10.1	2024-01-17	[?]	CRAN	(R 4.4.0)
##	P gtable	0.3.5	2024-04-22	[?]	CRAN	(R 4.4.0)
##	P gtsummary	* 1.7.2	2023-07-15	[?]	CRAN	(R 4.4.0)
##	P here	* 1.0.1	2020-12-13	[?]	CRAN	(R 4.4.0)
##	P hms	1.1.3	2023-03-21	[?]	CRAN	(R 4.4.0)
##	P htmltools	0.5.8.1	2024-04-04	[?]	CRAN	(R 4.4.0)
##	P htmlwidgets	1.6.4	2023-12-06	[?]	CRAN	(R 4.4.0)
##	P httpuv	1.6.15	2024-03-26	[?]	RSPM	
##	P km.ci	0.5-6	2022-04-06	[?]	RSPM	
##	P KMsurv	0.1-5	2012-12-03	[?]	RSPM	
##	P knitr	* 1.46	2024-04-06	[?]	CRAN	(R 4.4.0)
##	P labeling	0.4.3	2023-08-29	[?]	CRAN	(R 4.4.0)
##	P later	1.3.2	2023-12-06	[?]	RSPM	
##	P lattice	0.22-6	2024-03-20	[?]	CRAN	(R 4.4.0)
##	P lifecycle	1.0.4	2023-11-07	[?]	CRAN	(R 4.4.0)
##	P lubridate	* 1.9.3	2023-09-27	[?]	CRAN	(R 4.4.0)
##	P magrittr	2.0.3	2022-03-30	[?]	CRAN	(R 4.4.0)
##	P Matrix	1.7-0	2024-03-22	[?]	CRAN	(R 4.4.0)

##	P memoise	2.0.1	2021-11-26	[?]	CRAN	(R 4.4.0)
##	P mime	0.12	2021-09-28	[?]	CRAN	(R 4.4.0)
##	P miniUI	0.1.1.1	2018-05-18	[?]	RSPM	
##	P munsell	0.5.1	2024-04-01	[?]	CRAN	(R 4.4.0)
##	P mvtnorm	1.2-5	2024-05-21	[?]	RSPM	
##	P pacman	0.5.1	2019-03-11	[?]	CRAN	(R 4.4.0)
##	P paletteer	* 1.6.0	2024-01-21	[?]	RSPM	
##	P pillar	1.9.0	2023-03-22	[?]	CRAN	(R 4.4.0)
##	P pkgbuild	1.4.4	2024-03-17	[?]	RSPM	
##	P pkgconfig	2.0.3	2019-09-22	[?]	CRAN	(R 4.4.0)
##	P pkgload	1.3.4	2024-01-16	[?]	RSPM	
##	P prismatic	1.1.2	2024-04-10	[?]	RSPM	
##	P profvis	0.3.8	2023-05-02	[?]	RSPM	
##	P promises	1.3.0	2024-04-05	[?]	RSPM	
##	P purrr	* 1.0.2	2023-08-10	[?]	CRAN	(R 4.4.0)
##	P R6	2.5.1	2021-08-19	[?]	CRAN	(R 4.4.0)
##	P RColorBrewer	* 1.1-3	2022-04-03	[?]	CRAN	(R 4.4.0)
##	P Rcpp	1.0.12	2024-01-09	[?]	CRAN	(R 4.4.0)
##	P readr	* 2.1.5	2024-01-10	[?]	CRAN	(R 4.4.0)
##	P readxl	* 1.4.3	2023-07-06	[?]	CRAN	(R 4.4.0)
##	P rematch2	2.1.2	2020-05-01	[?]	CRAN	(R 4.4.0)
##	P remotes	2.5.0	2024-03-17	[?]	CRAN	(R 4.4.0)
##	P renv	1.0.7	2024-04-11	[1]	CRAN	(R 4.4.0)
##	P rlang	1.1.3	2024-01-10	[?]	CRAN	(R 4.4.0)
##	P rmarkdown	2.26	2024-03-05	[?]	CRAN	(R 4.4.0)
##	P rprojroot	2.0.4	2023-11-05	[?]	CRAN	(R 4.4.0)
##	P rstatix	0.7.2	2023-02-01	[?]	RSPM	
##	P rstudioapi	0.16.0	2024-03-24	[?]	CRAN	(R 4.4.0)
##	P scales	1.3.0	2023-11-28	[?]	CRAN	(R 4.4.0)
##	P sessioninfo	1.2.2	2021-12-06	[?]	RSPM	
##	P shiny	1.8.1.1	2024-04-02	[?]	RSPM	
##	P stringi	1.8.3	2023-12-11	[?]	CRAN	(R 4.4.0)
##	P stringr	* 1.5.1	2023-11-14	[?]	CRAN	(R 4.4.0)
##	P survival	* 3.6-4	2024-04-24	[?]	CRAN	(R 4.4.0)
##	P survminer	* 0.4.9	2021-03-09	[?]	RSPM	
##	P survMisc	0.5.6	2022-04-07	[?]	RSPM	
##	P tibble	* 3.2.1	2023-03-20	[?]	CRAN	(R 4.4.0)
##	P tidycmprsk	* 1.0.0	2023-10-30	[?]	CRAN	(R 4.4.0)
##	P tidyr	* 1.3.1	2024-01-24	[?]	CRAN	(R 4.4.0)
##	P tidyselect	1.2.1	2024-03-11	[?]	CRAN	(R 4.4.0)
##	P tidyverse	* 2.0.0	2023-02-22	[?]	CRAN	(R 4.4.0)
##	P timechange	0.3.0	2024-01-18	[?]	CRAN	(R 4.4.0)
##	P tzdb	0.4.0	2023-05-12	[?]	CRAN	(R 4.4.0)
##	P urlchecker	1.0.1	2021-11-30	[?]	RSPM	
##	P usethis	* 2.2.3	2024-02-19	[?]	RSPM	
##	P utf8	1.2.4	2023-10-22	[?]	CRAN	(R 4.4.0)
##	P vctrs	0.6.5	2023-12-01	[?]	CRAN	(R 4.4.0)
##	P vipor	0.4.7	2023-12-18	[?]	CRAN	(R 4.4.0)
##	P viridis	* 0.6.5	2024-01-29	[?]	RSPM	
##	P viridisLite	* 0.4.2	2023-05-02	[?]	CRAN	(R 4.4.0)
##	P vroom	1.6.5	2023-12-05	[?]	CRAN	(R 4.4.0)
##	P wesanderson	* 0.3.7	2023-10-31	[?]	RSPM	
##	P withr	3.0.0	2024-01-16	[?]	CRAN	(R 4.4.0)
##	P xfun	0.43	2024-03-25	[?]	CRAN	(R 4.4.0)

```

## P xml2          1.3.6    2023-12-04 [?] CRAN (R 4.4.0)
## P xtable        1.8-4    2019-04-21 [?] RSPM
## P yaml          2.3.8    2023-12-11 [?] CRAN (R 4.4.0)
## P zoo           1.8-12   2023-04-13 [?] RSPM
##
## [1] /Users/zahavahrojer/Desktop/Cornell/Hendry Lab/pseud-epi-growth/renv/library/macos/R-4.4/x86_64
## [2] /Users/zahavahrojer/Library/Caches/org.R-project.R/R/renv/sandbox/macos/R-4.4/x86_64-apple-darw
##
## P -- Loaded and on-disk path mismatch.
##
## -----

```