

Tutorial -

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1 Aim

This tutorial explain how plot growth curves for phytoplankton cultures in different conditions. * Antibiotics treatment : 4 RCC cultures, 8 days, 2 antibiotics, 5 concentrations,

2 Downloads

Install the following software :

- R studio : <https://www.rstudio.com/products/rstudio/download/#download>
- Download and install the following libraries by running under R studio the following lines

```
install.packages("dplyr")      # To manipulate dataframes
install.packages("tidyr")      # To manipulate dataframes

install.packages("stringr")    # To strings

install.packages("ggplot2")    # for high quality graphics
install.packages("gridExtra")  # for grids

install.packages("plotrix" )   # needed for standard error
```

3 Data used

- **cultures antibiotics.txt** contains data obtained by Priscilla Gourvil on antibiotics treatment of RCC strains

4 Tutorial description

4.1 Load the libraries

```
library("ggplot2")
library("gridExtra")
library("plotrix" ) # needed for standard error
library("dplyr")
library("tidyr")
library("stringr")
```

4.2 Antibiotics treatments

4.2.1 Read and reformat the data

Read the data

```
cell<- read.table("cultures_antibiotics.txt", header=TRUE, sep="\t", na.strings="NA", dec=".", strip.whitespace=TRUE)
knitr::kable(head(cell))
```

RCC	Antibio	Well	Concentration	X1	X2	X3	X4	X5	X6	X7
RCC 96	G 418	A01	0.5	35888	17043	3853	593	225	675	591
RCC 96	G 418	A02	0.5	27281	20952	337	450	84	394	562
RCC 96	G 418	A03	0.5	29952	19630	34846	3853	21318	19996	31639
RCC 96	G 418	B01	1.0	33018	17268	6468	337	478	394	253
RCC 96	G 418	B02	1.0	26662	20530	34902	675	22555	8268	14062
RCC 96	G 418	B03	1.0	24946	19040	49011	4725	21599	26746	277217

Change from wide format to long format

```
cell<- gather(cell, X1:X7, key = "day", value = "cell_number")
knitr::kable(head(cell))
```

RCC	Antibio	Well	Concentration	day	cell_number
RCC 96	G 418	A01	0.5	X1	35888
RCC 96	G 418	A02	0.5	X1	27281
RCC 96	G 418	A03	0.5	X1	29952
RCC 96	G 418	B01	1.0	X1	33018
RCC 96	G 418	B02	1.0	X1	26662
RCC 96	G 418	B03	1.0	X1	24946

Reformat day as numeric

```
cell$day<-as.numeric(str_replace(cell$day, "X", ""))
knitr::kable(head(cell))
```

RCC	Antibio	Well	Concentration	day	cell_number
RCC 96	G 418	A01	0.5	1	35888
RCC 96	G 418	A02	0.5	1	27281
RCC 96	G 418	A03	0.5	1	29952

RCC	Antibio	Well	Concentration	day	cell_number
RCC 96	G 418	B01	1.0	1	33018
RCC 96	G 418	B02	1.0	1	26662
RCC 96	G 418	B03	1.0	1	24946

Reformat concentration as character

```
cell$Concentration<-as.character(cell$Concentration)
knitr::kable(head(cell))
```

RCC	Antibio	Well	Concentration	day	cell_number
RCC 96	G 418	A01	0.5	1	35888
RCC 96	G 418	A02	0.5	1	27281
RCC 96	G 418	A03	0.5	1	29952
RCC 96	G 418	B01	1	1	33018
RCC 96	G 418	B02	1	1	26662
RCC 96	G 418	B03	1	1	24946

Compute mean and SD for each RCC, Antibio, Concentration and day using dplyr

```
cell_1<- cell %>% group_by(RCC,Antibio,Concentration, day)%>%
  summarise (cell_mean=mean(cell_number),cell_sd=sd(cell_number), cell_se=std.error(cell_number))
knitr::kable(head(cell_1))
```

RCC	Antibio	Concentration	day	cell_mean	cell_sd	cell_se
RCC 4094	G 418	0.5	1	188562.333	46983.373	27125.863
RCC 4094	G 418	0.5	2	100846.333	48010.521	27718.887
RCC 4094	G 418	0.5	3	4087.667	3401.215	1963.692
RCC 4094	G 418	0.5	4	42195.333	18511.363	10687.541
RCC 4094	G 418	0.5	5	8727.667	14751.465	8516.763
RCC 4094	G 418	0.5	6	3806.000	6105.543	3525.037

4.2.2 Define graphics options

Define the color, line type and symbol shape

```
Concentration_color<-c("0.2"="white","0.5"="white", "0.8"="white", "1"="black", "1.5"="black", "2"="black")
Concentration_linetype<-c("0.2"=1,"0.5"=1, "0.8"=1, "1"=2, "1.5"=2, "2"=2)
Concentration_shape<-c("0.2"=21,"0.5"=22, "0.8"=21, "1"=22, "1.5"=21, "2"=22)
```

Define graphics options

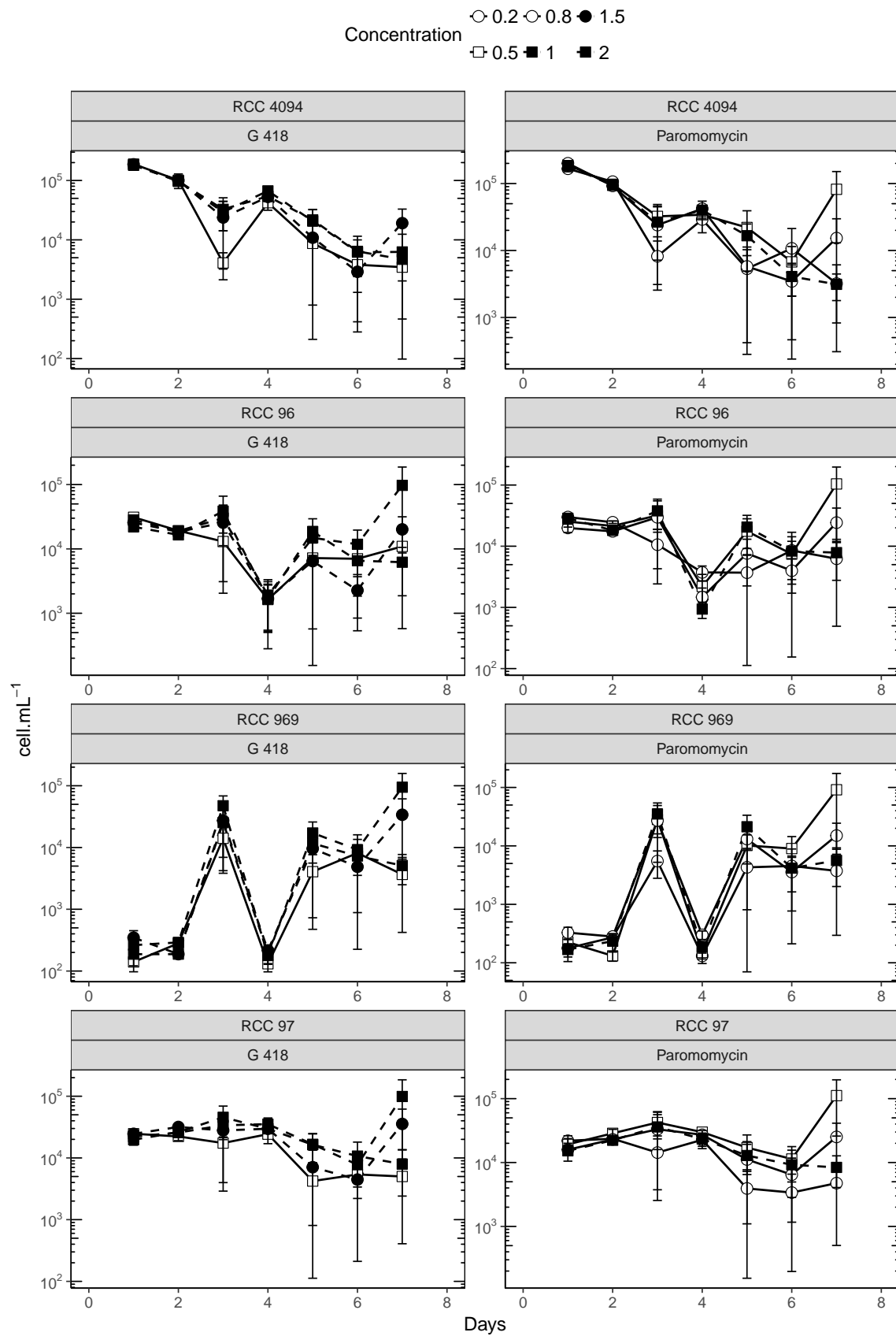
```
scaling_factor=15
cell_label <- expression (paste("cell.",mL^-1))
cell_breaks=c(100,1000,10000,100000,1000000)
x_max=8
x_breaks=c(0, 2,4,6,8)
x_labels=c("0", "2", "4", "6", "8")
```

4.2.3 Plot the data

```
plot1<- ggplot(cell_1, aes(x=day, y=cell_mean, group = Concentration, xmin=0, xmax=x_max,
  shape=Concentration, fill=Concentration, linetype=Concentration)) +
  facet_wrap(~ RCC + Antibio, nrow=4, ncol=2, scales="free") +
  geom_line (size=0.8, colour="black") +
  geom_point(size = 4) +
  geom_errorbar(aes(ymin=cell_mean-cell_se, ymax=cell_mean+cell_se),width=0.2, linetype=1) +
  theme_bw(scaling_factor) +
  theme(panel.border = element_rect(colour = "black"), panel.grid.major = element_blank(),
  axis.line = element_line(colour = "black"),
    legend.title=element_text(size=scaling_factor), legend.key=element_blank(),
    axis.title = element_text(size=scaling_factor),
    legend.text=element_text(size=scaling_factor), legend.key.height = unit(1, "cm"),
    axis.text = element_text(size=0.8*scaling_factor), panel.background = element_rect(fill="white",
  theme(legend.position = "top", legend.box = "horizontal") +
  labs(x = "Days", y = cell_label ) +
  scale_x_continuous(breaks=x_breaks, labels=x_labels) +
  scale_y_log10(breaks = cell_breaks ,labels = scales::trans_format("log10", scales::math_format(x))) +
  annotation_logticks(sides = "lr") +
  scale_fill_manual(values=Concentration_color) +
  scale_shape_manual(values=Concentration_shape) +
  scale_linetype_manual(values=Concentration_linetype)

# Add next line to zoom
# + coord_cartesian(ylim=c(100, 10000000))

plot1
```



```
# Next can be used to save the plot as pdf  
# ggsave(file="Fig 1 version 2.0.pdf", plot=plot1, scale=5, width = 7, height = 10, units = "cm", useD
```