

# pi\_curves\_nls

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```
## install packages if you dont already have them in your library
if ("devtools" %in% rownames(installed.packages()) == 'FALSE') install.packages('devtools')
if ("segmented" %in% rownames(installed.packages()) == 'FALSE') install.packages('segmented')
if ("plotrix" %in% rownames(installed.packages()) == 'FALSE') install.packages('plotrix')
if ("gridExtra" %in% rownames(installed.packages()) == 'FALSE') install.packages('gridExtra')
if ("LoLinR" %in% rownames(installed.packages()) == 'FALSE') install_github('colin-olito/LoLinR')
if ("lubridate" %in% rownames(installed.packages()) == 'FALSE') install.packages('lubridate')
if ("chron" %in% rownames(installed.packages()) == 'FALSE') install.packages('chron')
if ("plyr" %in% rownames(installed.packages()) == 'FALSE') install.packages('plyr')
if ("dplyr" %in% rownames(installed.packages()) == 'FALSE') install.packages('dplyr')
if ("phytotools" %in% rownames(installed.packages()) == 'FALSE') install.packages('phytotools')
if ("tidyverse" %in% rownames(installed.packages()) == 'FALSE') install.packages('tidyverse')
if ("broom" %in% rownames(installed.packages()) == 'FALSE') install.packages('broom')

#Read in required libraries

library("devtools")
library("ggplot2")
library("segmented")
library("plotrix")
library("gridExtra")
library("LoLinR")
library("lubridate")
library("chron")
library('plyr')
library('dplyr')
library('phytotools')
library("tidyverse")
library("broom")
```

## Import data

```
Data <- read.csv(file = 'output/3_pi_curve_rates.csv')
#Data <- Data[1:40,]
```

## Define data

```
#specify data
Data$PAR <- as.numeric(Data$Light_Value)
Data$Pc <- as.numeric(Data$micromol.cm2.h)
Data<-Data%>%
  filter(!Pc=="NA")
```

## Define PI curve function as a nonlinear Least Squares regression of a quadratic fit, test nls fit

Aquatic Photosynthesis, Falkowski

Pmax = max photosynthesis (AKA Am from Bayesian script)

alpha = quantum yield (AKA AQY from Bayesian script)

I/E = irradiance (AKA PAR from Bayesian script)

Rd = dark respiration

Run models

Using fixed initial values (not used, kept for reference):

```
#nls_data <- Data %>%
  #filter(Pc>-2)%>% #remove low outliers
  #group_by(colony_id) %>%
  #nest(-colony_id) %>%
  #mutate(model1 = map(data, ~
    #nls(Pc ~ (Am*((AQY*PAR)/(sqrt(Am^2 + (AQY*PAR)^2)))-Rd), data=., start=list(Am=
    #tidy %>%
    #dplyr::select(term, estimate) %>%
    #spread(term, estimate))) %>%
  #unnest(model1) %>%
  #unnest(data) %>%
  #group_by(colony_id)%>%
  #summarise(Am=mean(Am), AQY=mean(AQY), Rd=mean(Rd))%>%
  #mutate(timepoint="timepoint2")%>%
  #write_csv(., "output/2_pi_curve_pars_NLS.csv")
```

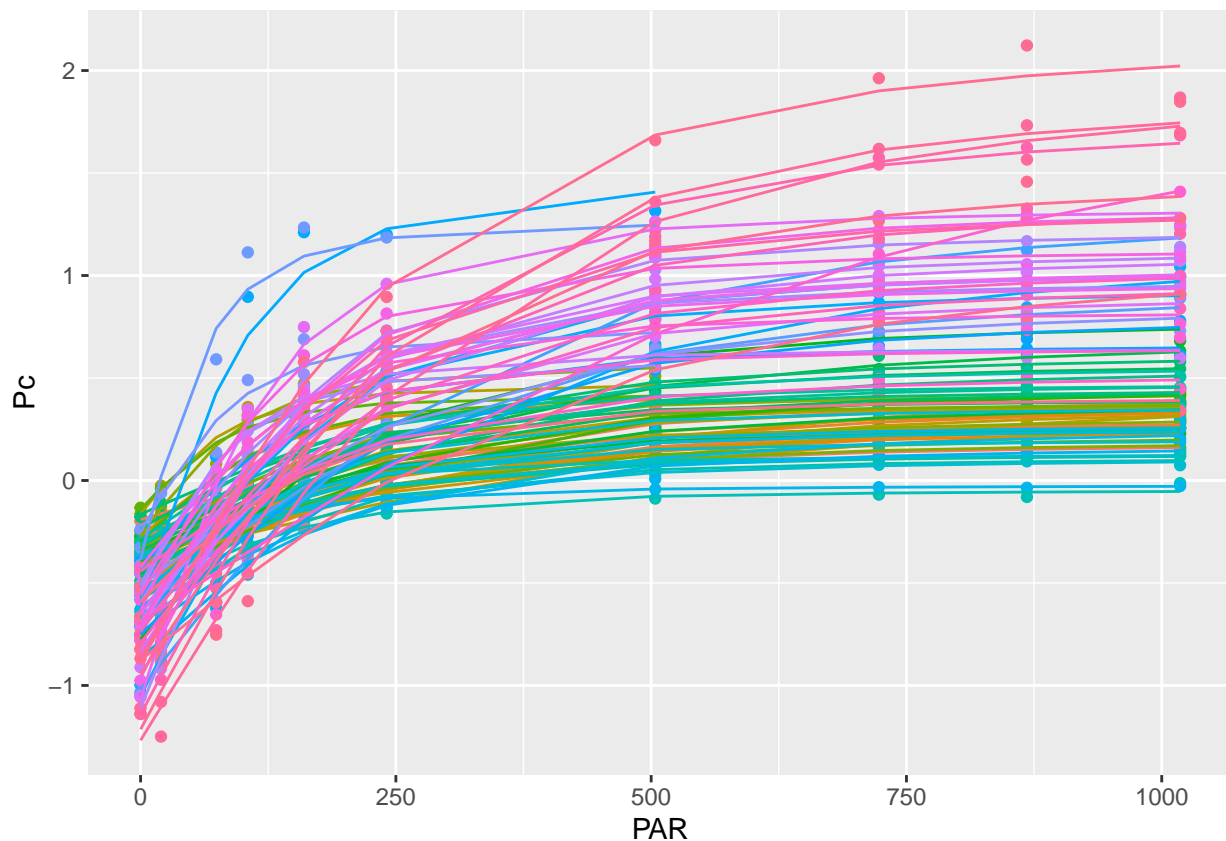
Using flexible initial values based on input data:

```
nls_data <- Data %>%
  group_by(colony_id) %>%
  nest(-colony_id) %>%
  mutate(model1 = map(data, ~
    nls(Pc ~ (Am*((AQY*PAR)/(sqrt(Am^2 + (AQY*PAR)^2)))-Rd), data=., start=list(Am=
    tidy %>%
    dplyr::select(term, estimate) %>%
    spread(term, estimate))) %>%
  unnest(model1) %>%
  unnest(data) %>%
  group_by(colony_id)%>%
  summarise(Am=mean(Am), AQY=mean(AQY), Rd=mean(Rd))%>%
  mutate(timepoint="timepoint3")%>%
  write_csv(., "output/3_pi_curve_pars_nls.csv")
```

Plot curve over data points.

```
augmented <- Data %>%
  nest(-colony_id) %>%
  mutate(
    fit = map(data, ~ nls(Pc ~ (Am*((AQY*PAR)/(sqrt(Am^2 + (AQY*PAR)^2)))-Rd), data=., start=list(Am=0.1, Rd=0.1)),
    augmented = map(fit, augment),
  ) %>%
  unnest(augmented)

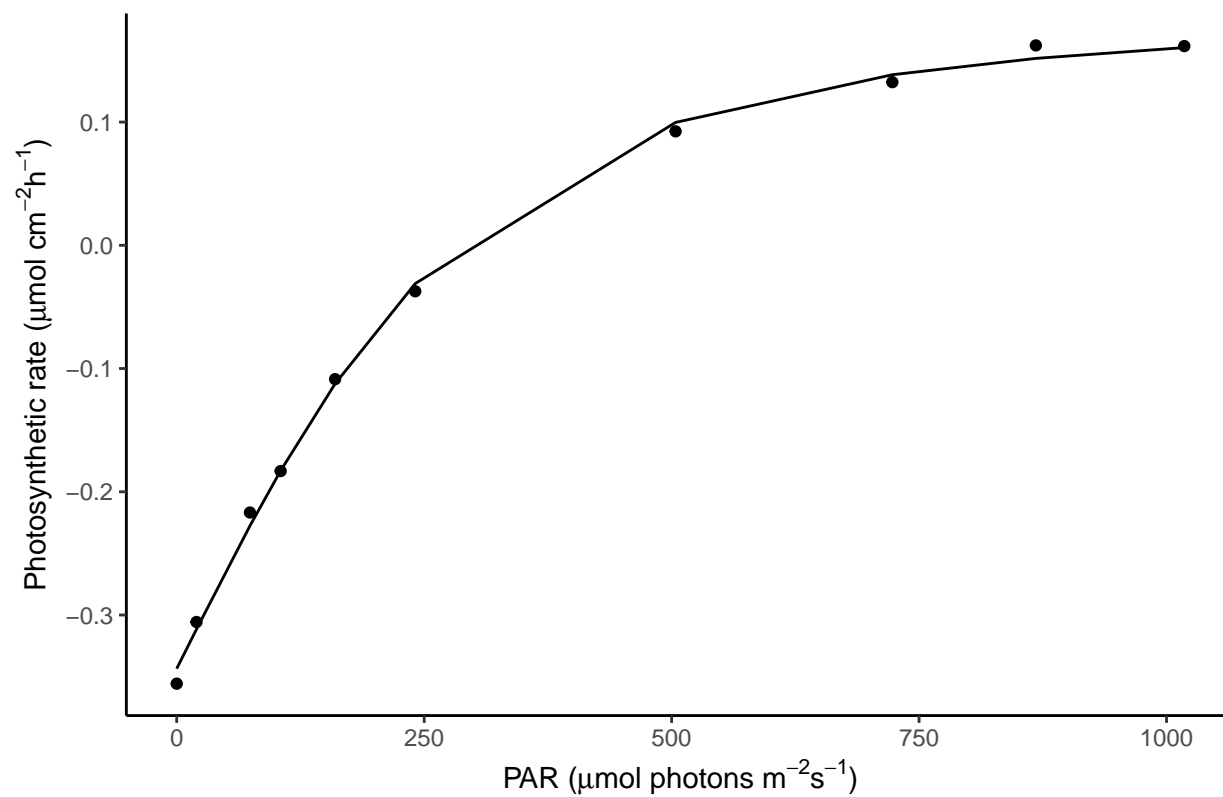
#all colonies together
augmented %>%
  group_by(colony_id)%>%
  qplot(PAR, Pc, data = ., geom = 'point', colour = colony_id) +
  geom_line(aes(y=.fitted))+
  theme(legend.position="none")
```



```
#view individual plots
by(augmented, augmented$colony_id, function(i) {
  ggplot(i) +
    geom_point(aes(PAR, Pc, group=colony_id)) +
    geom_line(aes(y=.fitted, x=PAR)) +
    theme_classic()+
    labs(x = expression(paste('PAR (', mu, "mol photons m"^-2, 's'^-1,")')),
         y = expression(paste('Photosynthetic rate (', mu, "mol cm"^-2, 'h'^-1,")')),
         title = paste0("1_", augmented$colony_id))
})
```

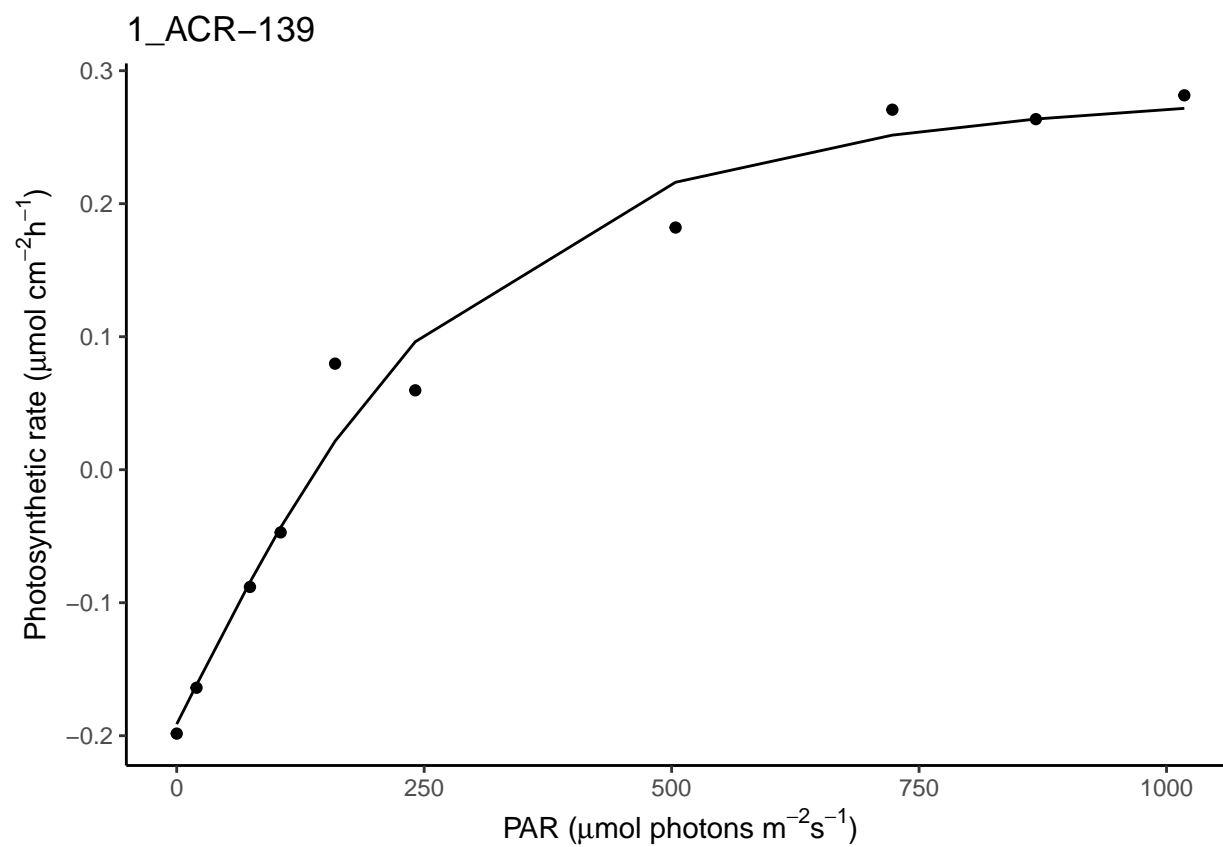
```
## augmented$colony_id: ACR-139
```

1\_ACR-139

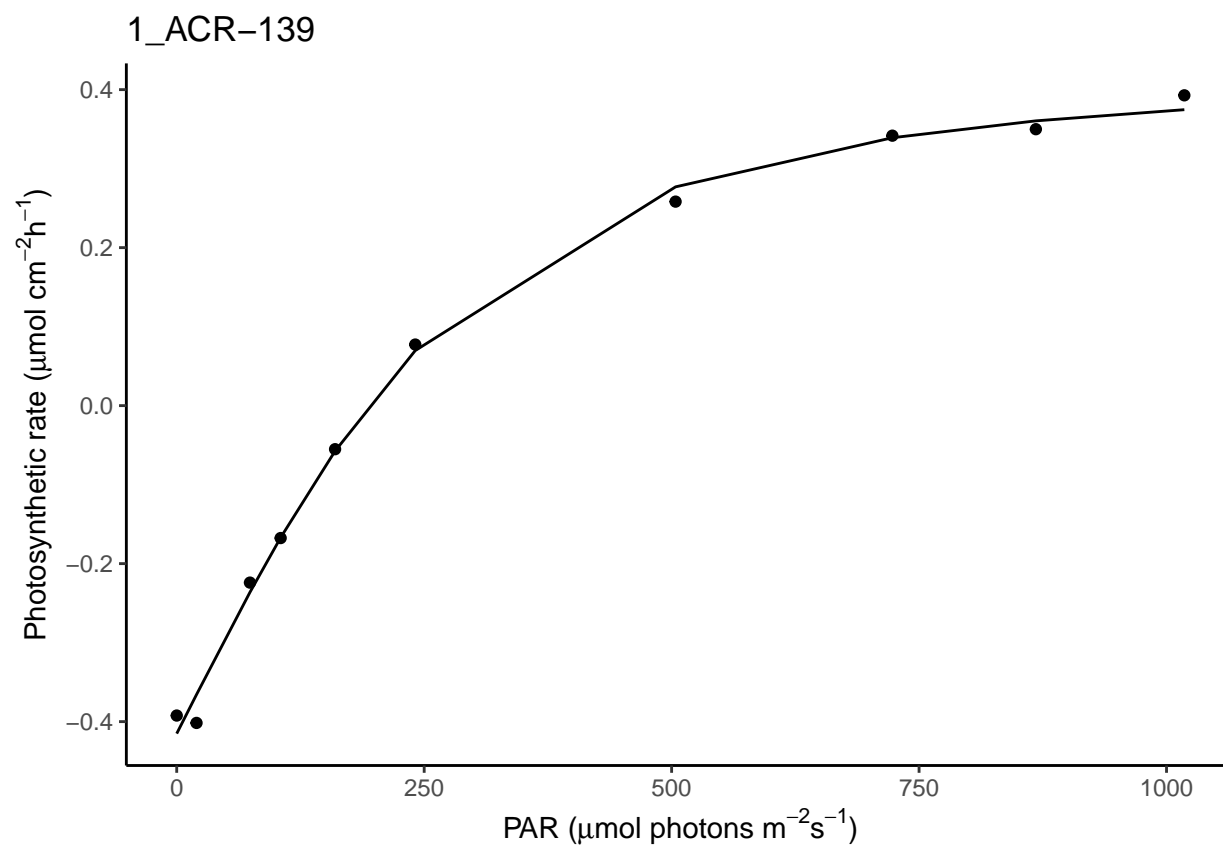


```
## -----
```

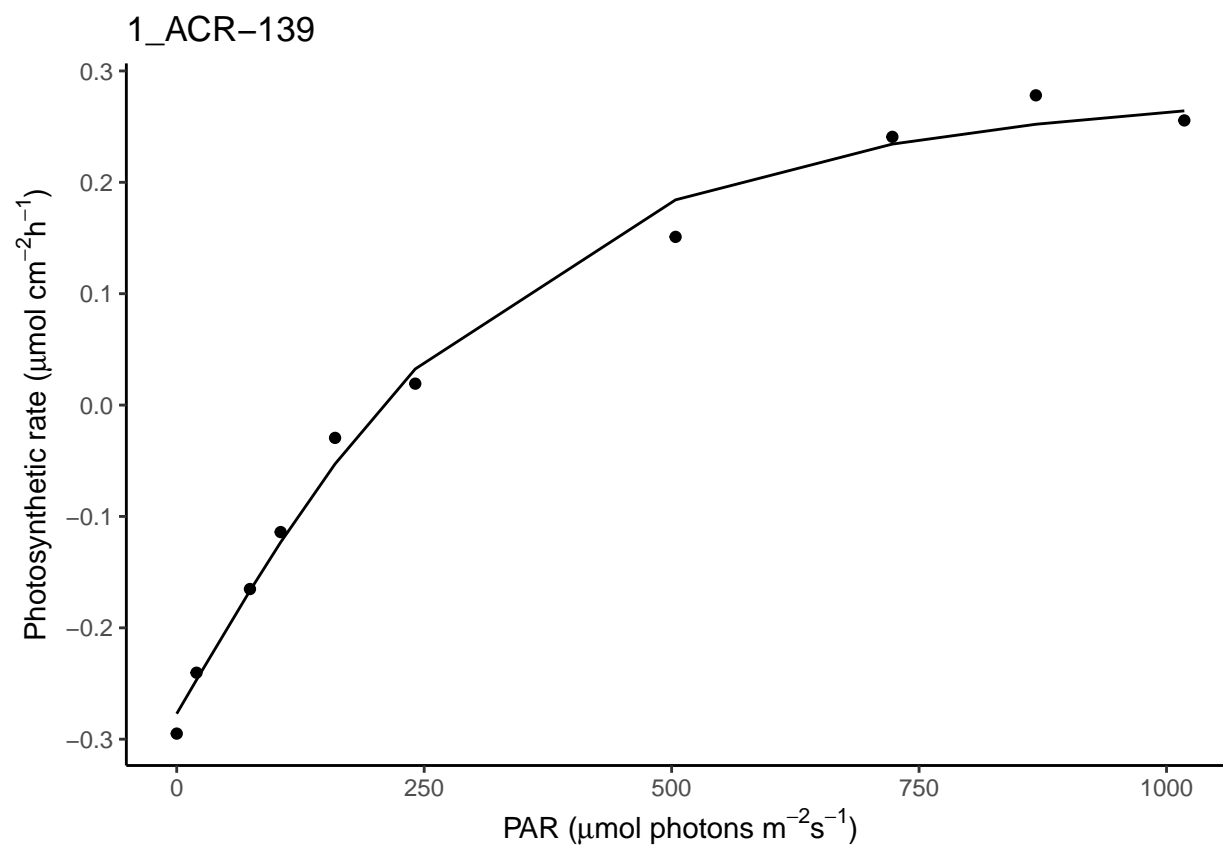
```
## augmented$colony_id: ACR-140
```



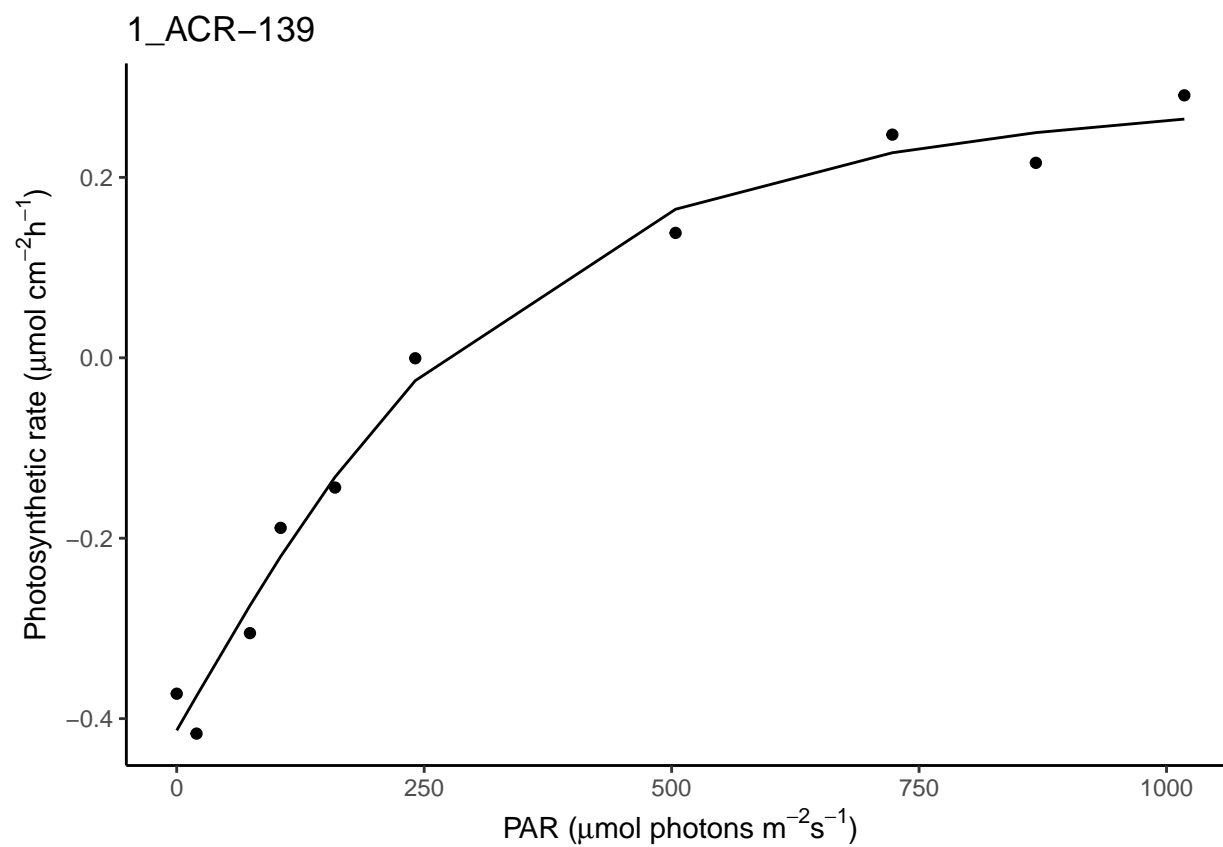
```
## -----  
## augmented$colony_id: ACR-143  
## NULL  
## -----  
## augmented$colony_id: ACR-150
```



## -----  
## augmented\$colony\_id: ACR-173

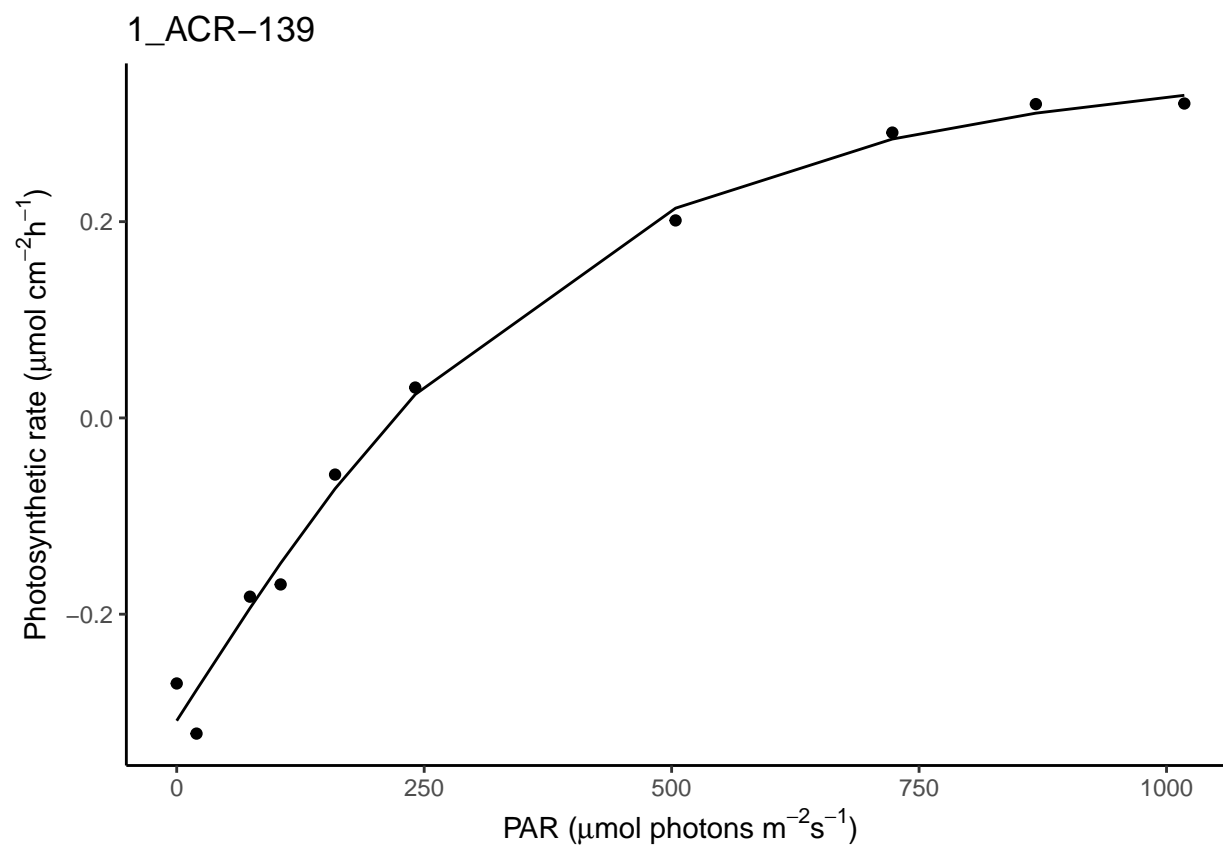


## -----  
## augmented\$colony\_id: ACR-175

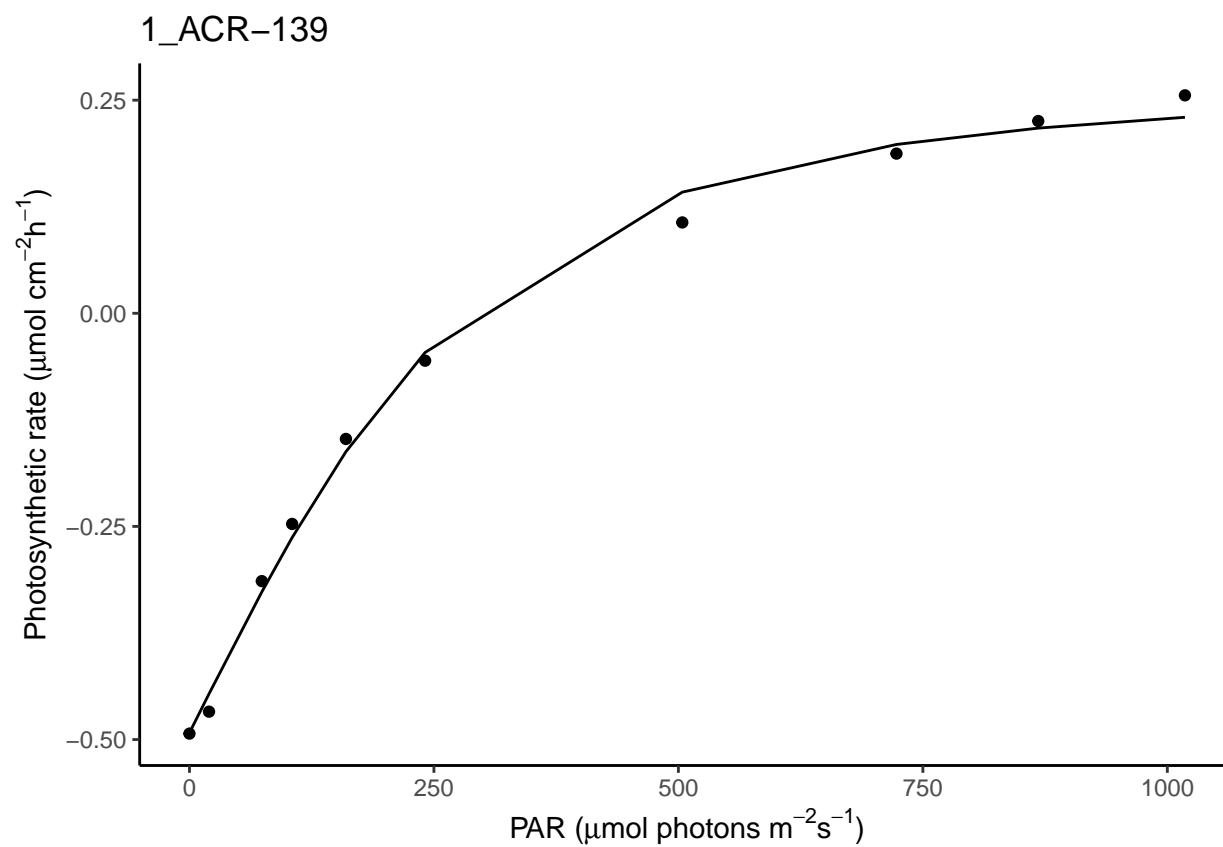


## -----  
## augmented\$colony\_id: ACR-178

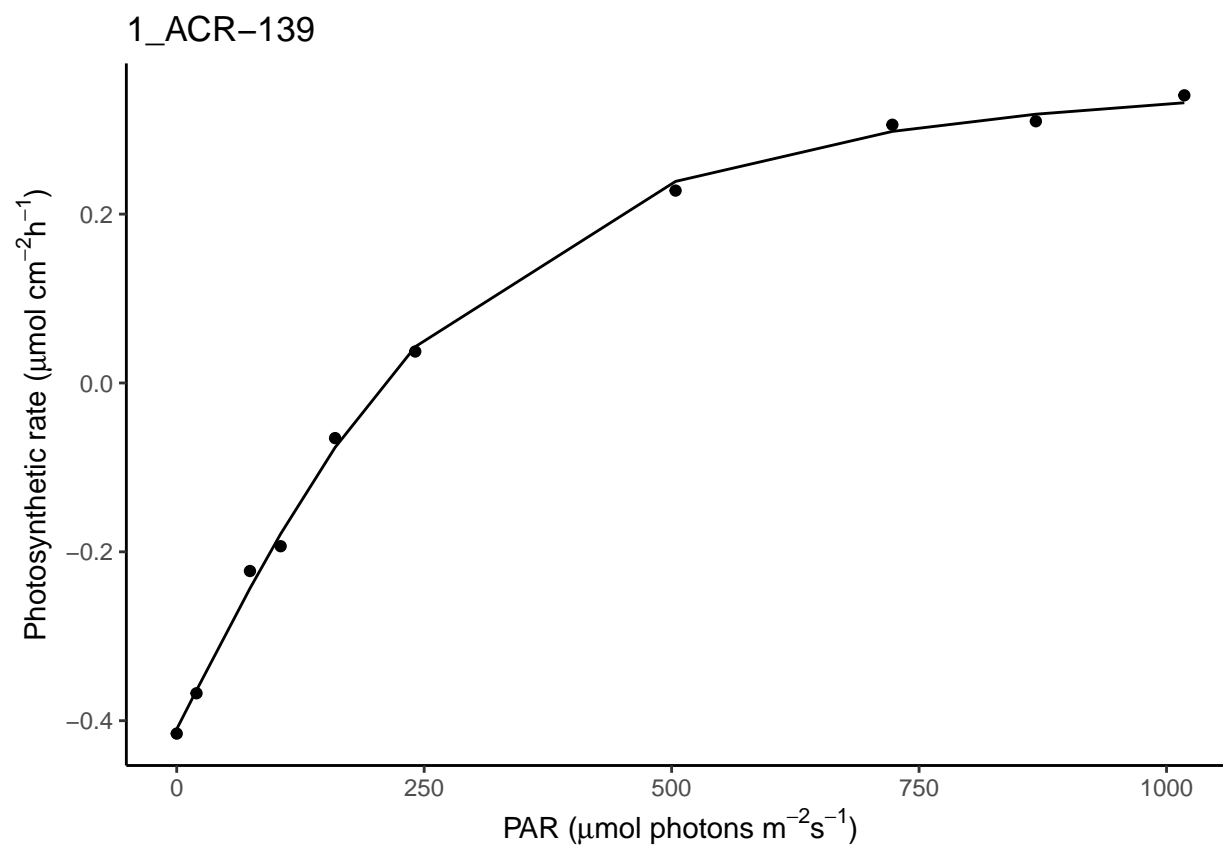




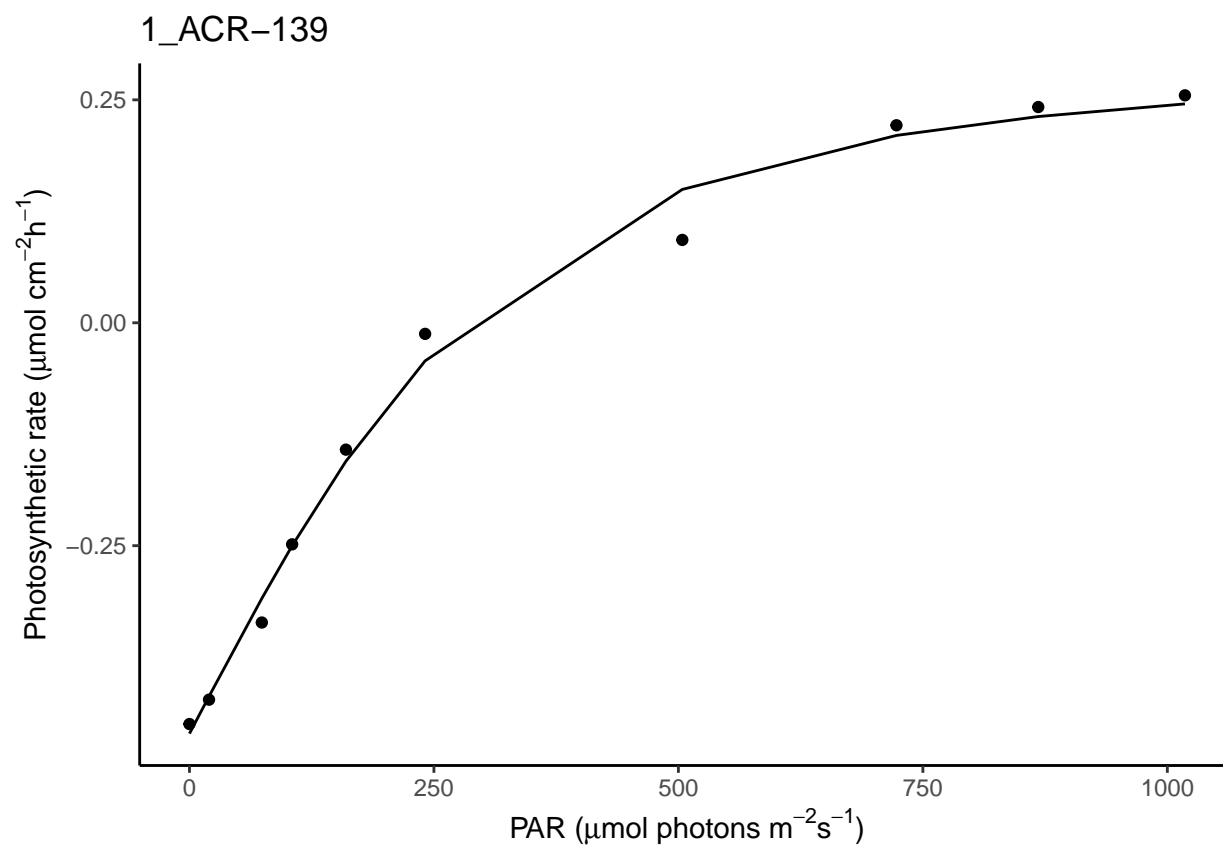
## -----  
## augmented\$colony\_id: ACR-186



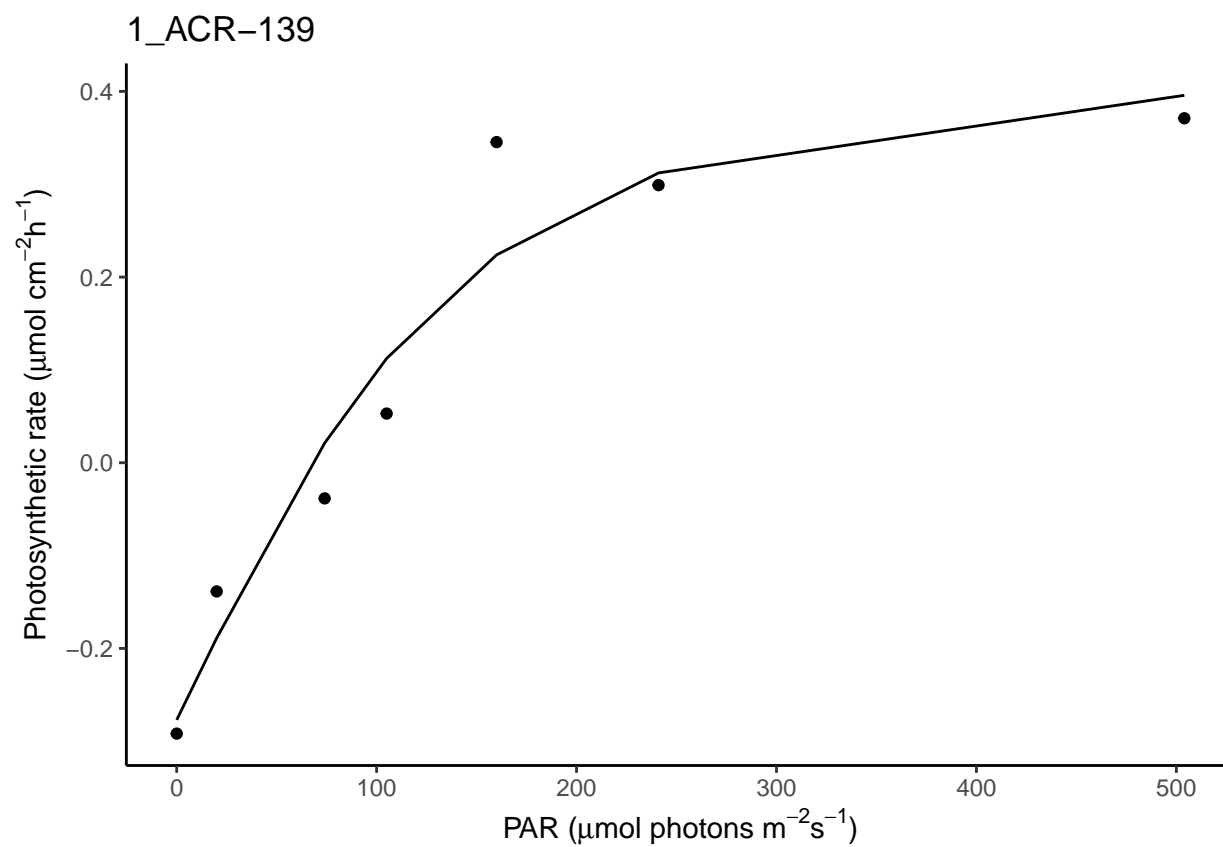
```
## -----  
## augmented$colony_id: ACR-190
```



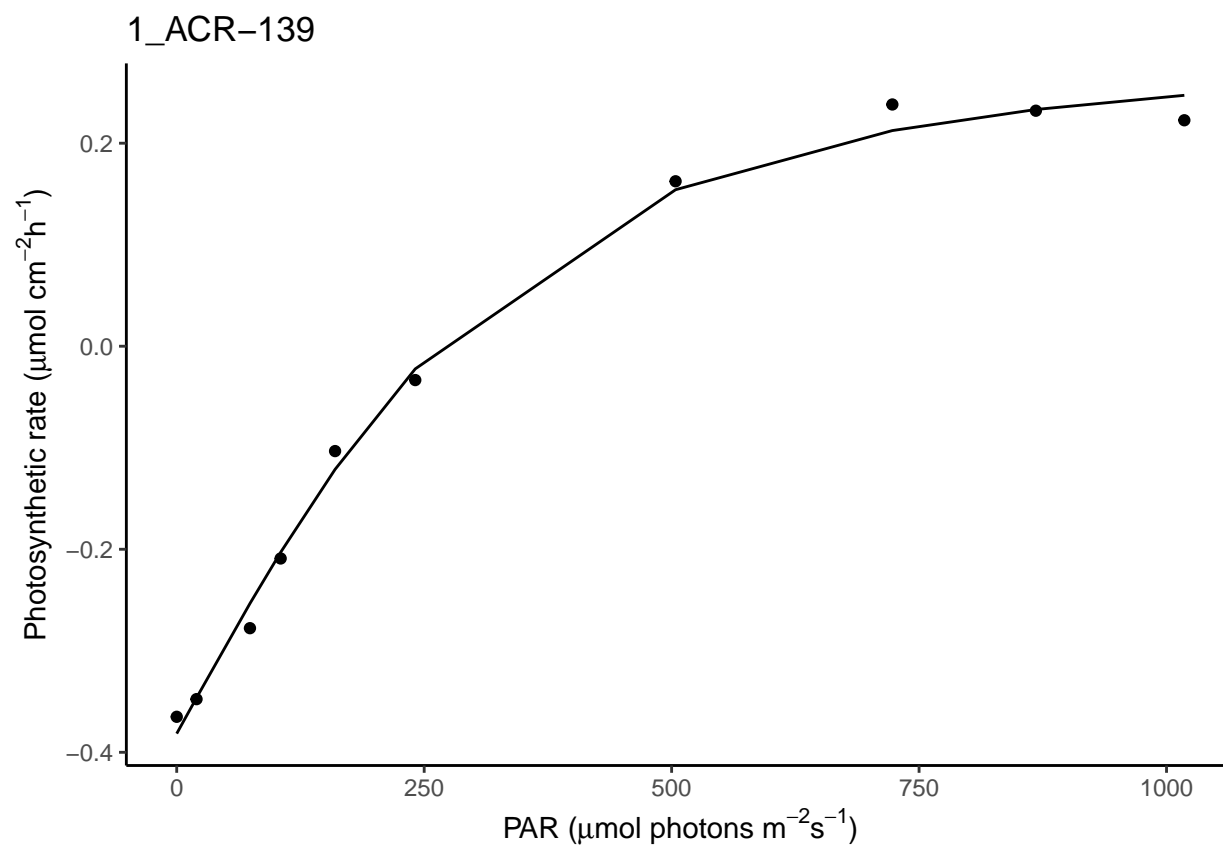
```
## -----  
## augmented$colony_id: ACR-210
```



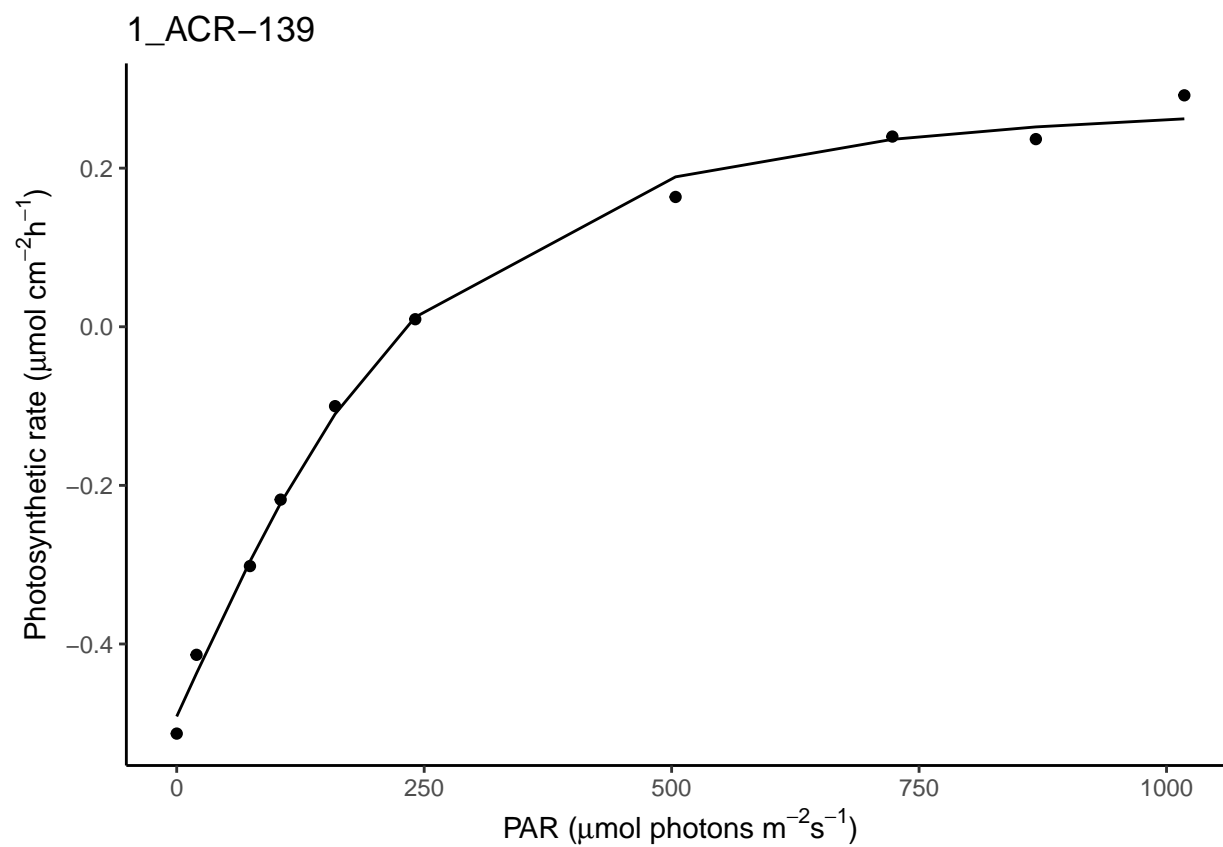
```
## -----  
## augmented$colony_id: ACR-213
```



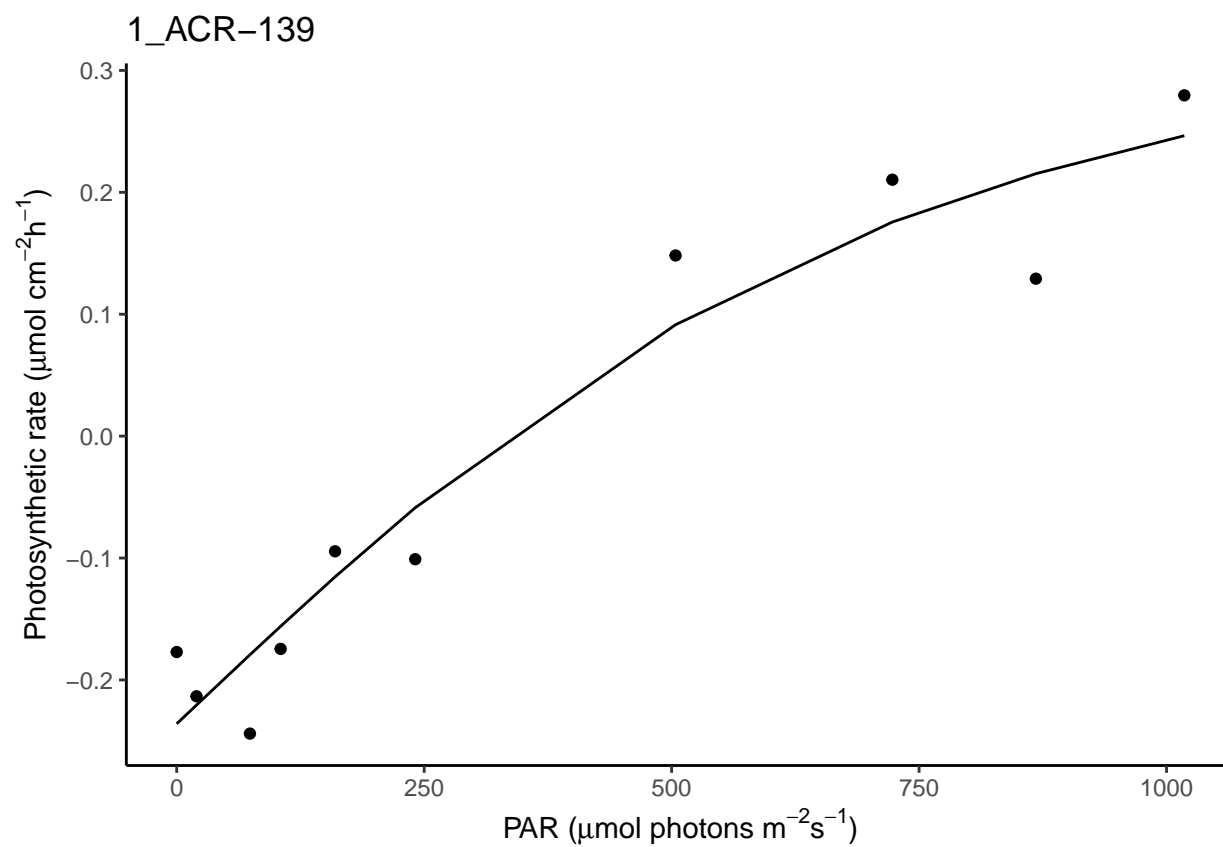
```
## -----  
## augmented$colony_id: ACR-218
```



```
## -----  
## augmented$colony_id: ACR-220
```

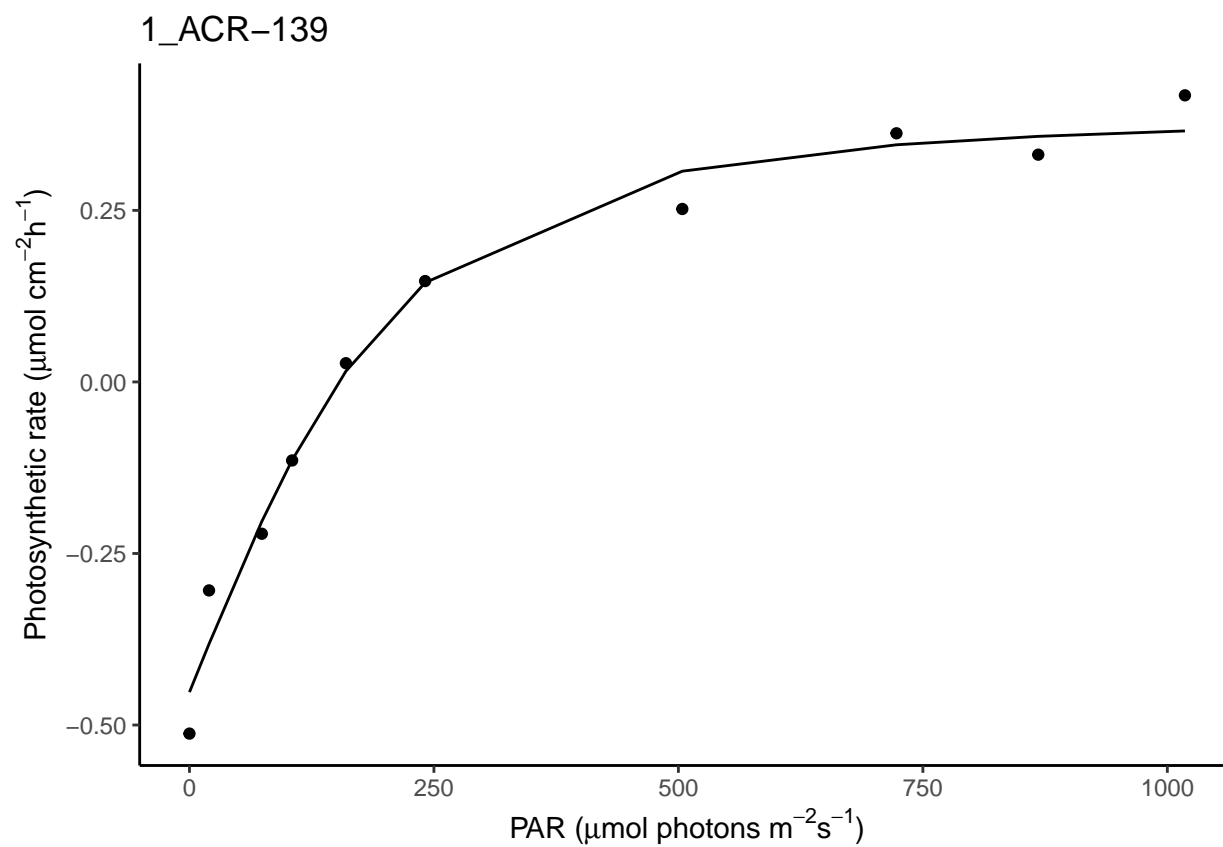


```
## -----  
## augmented$colony_id: ACR-225
```

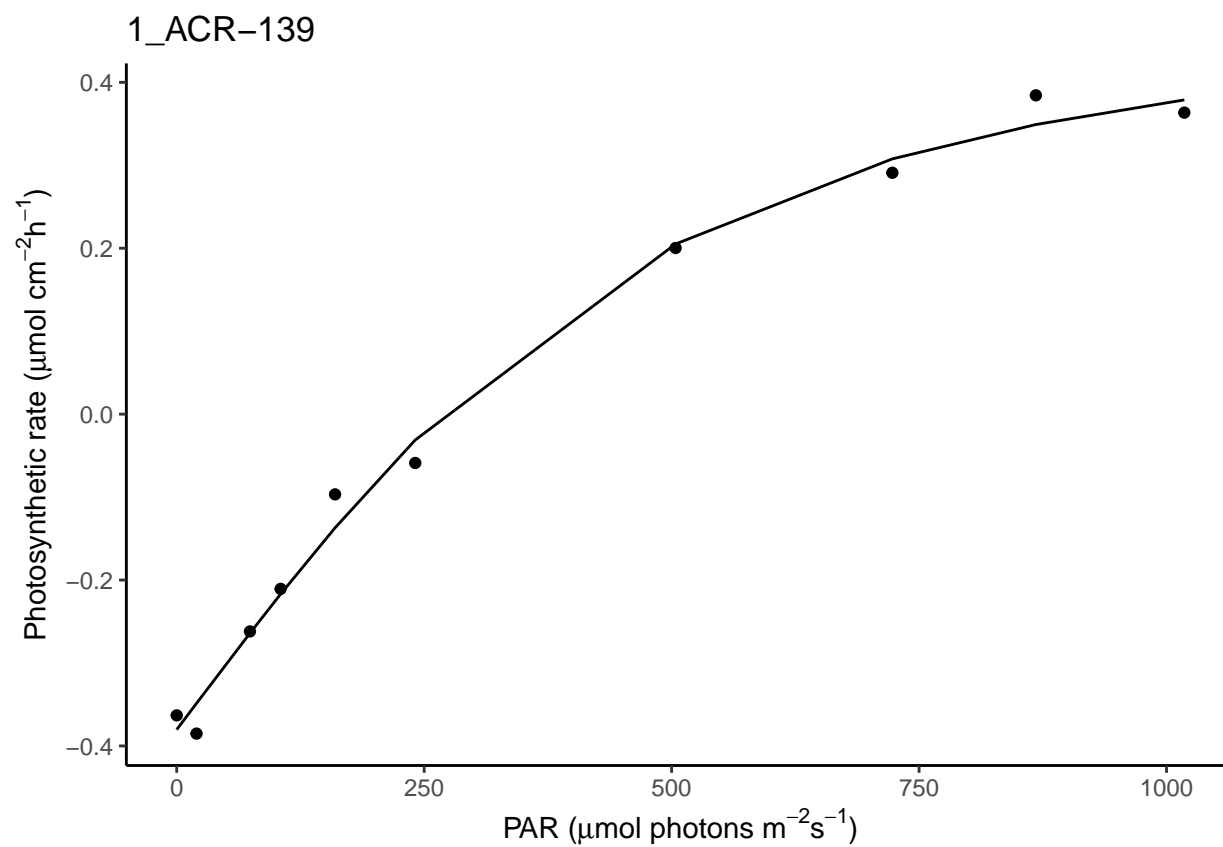


```
## -----  
## augmented$colony_id: ACR-229
```

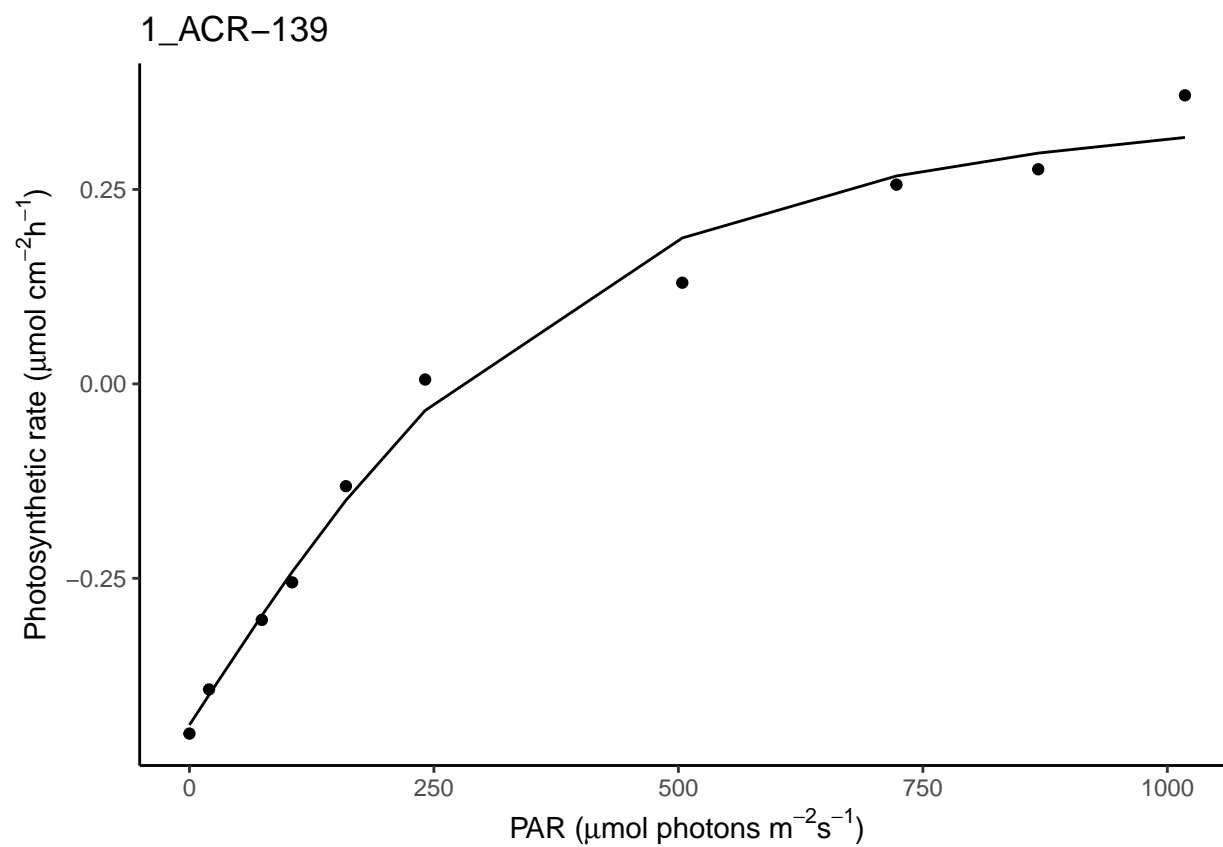




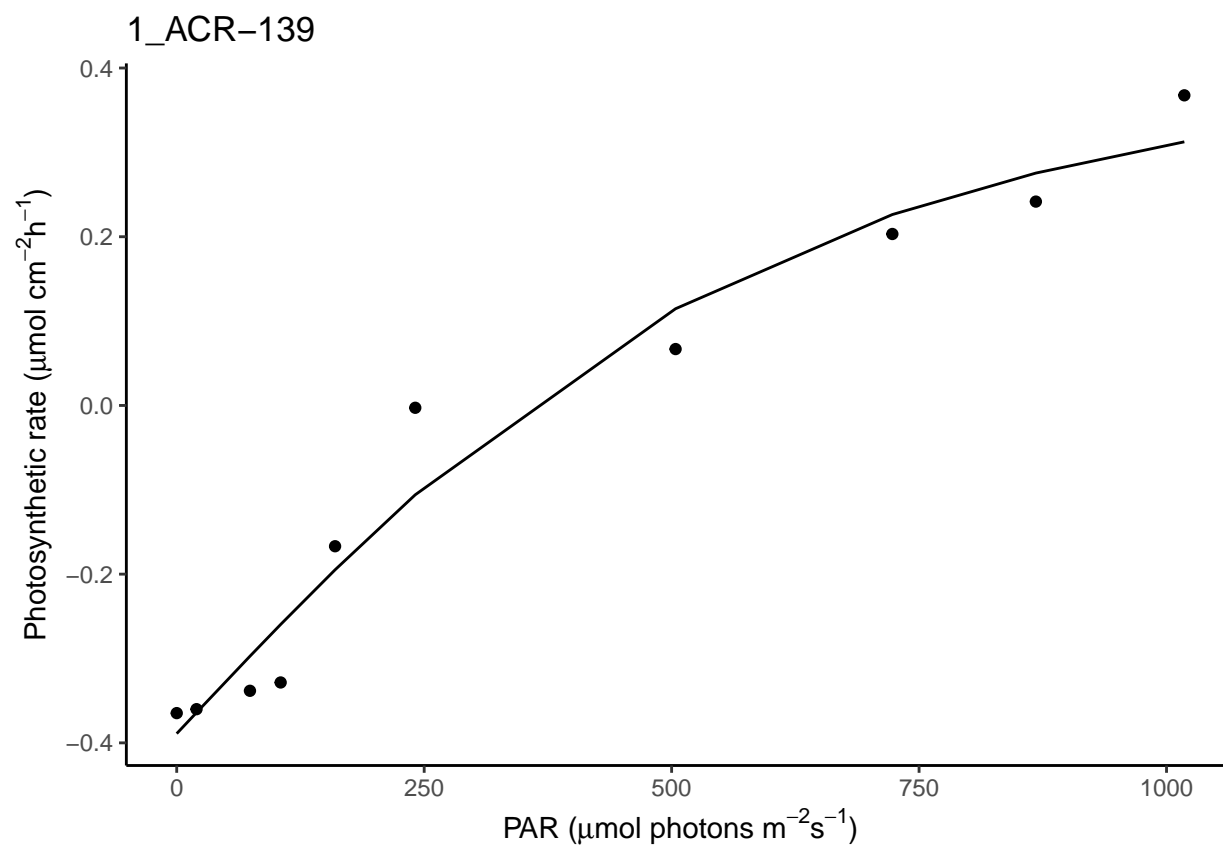
## -----  
## augmented\$colony\_id: ACR-237



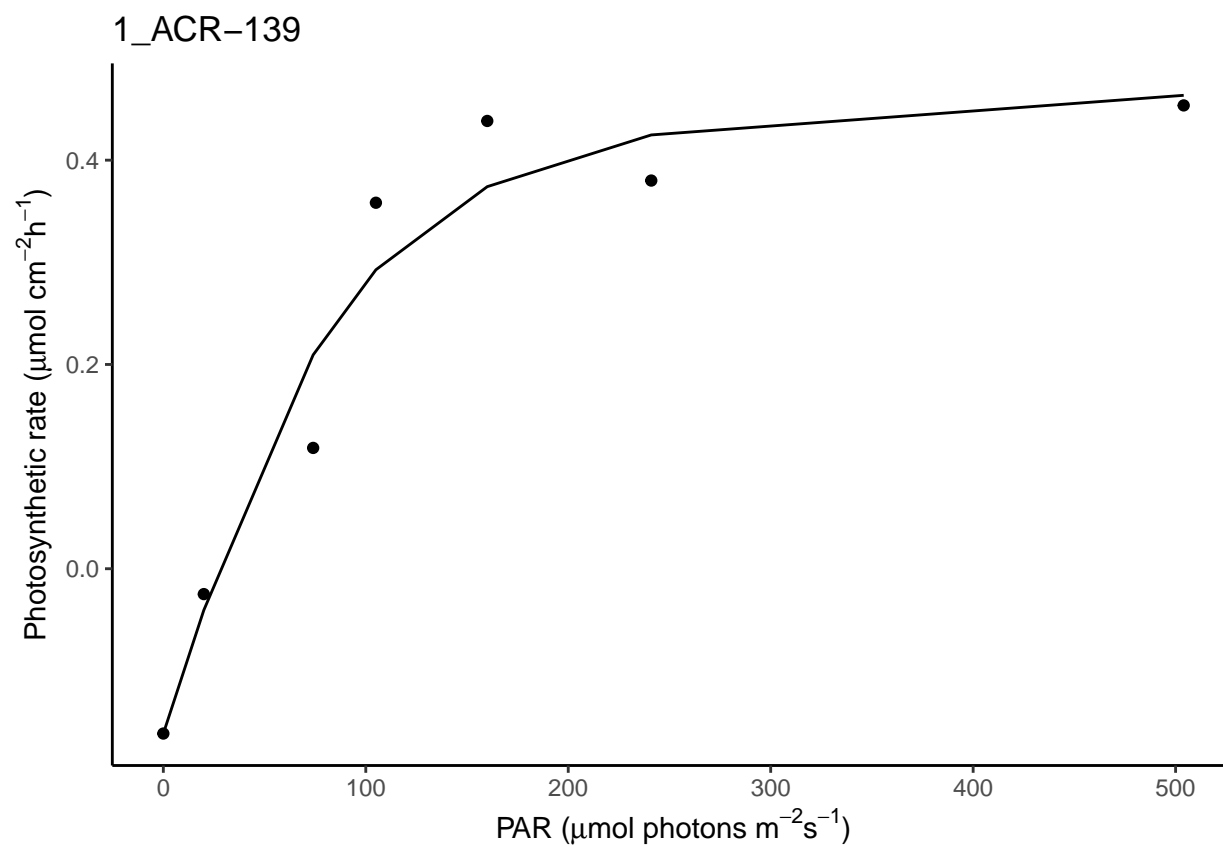
## -----  
## augmented\$colony\_id: ACR-241



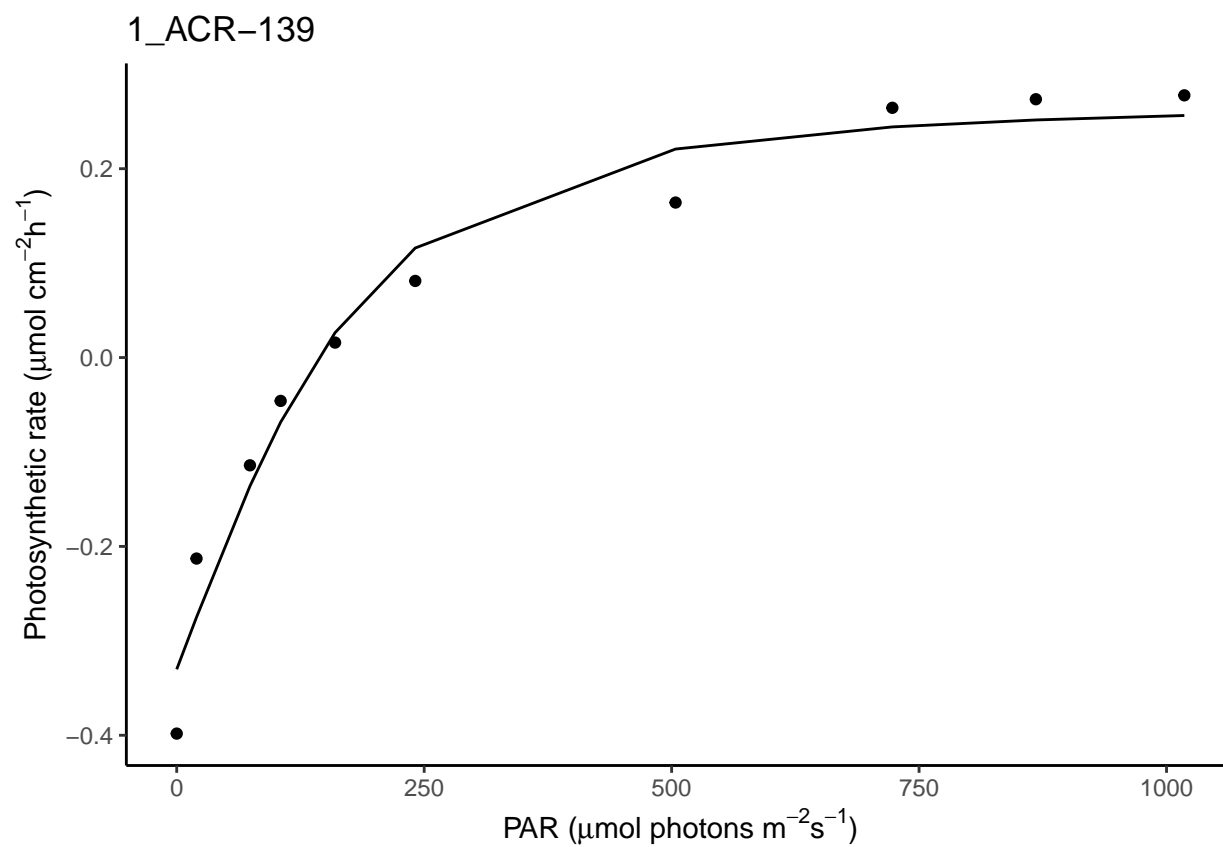
## -----  
## augmented\$colony\_id: ACR-244



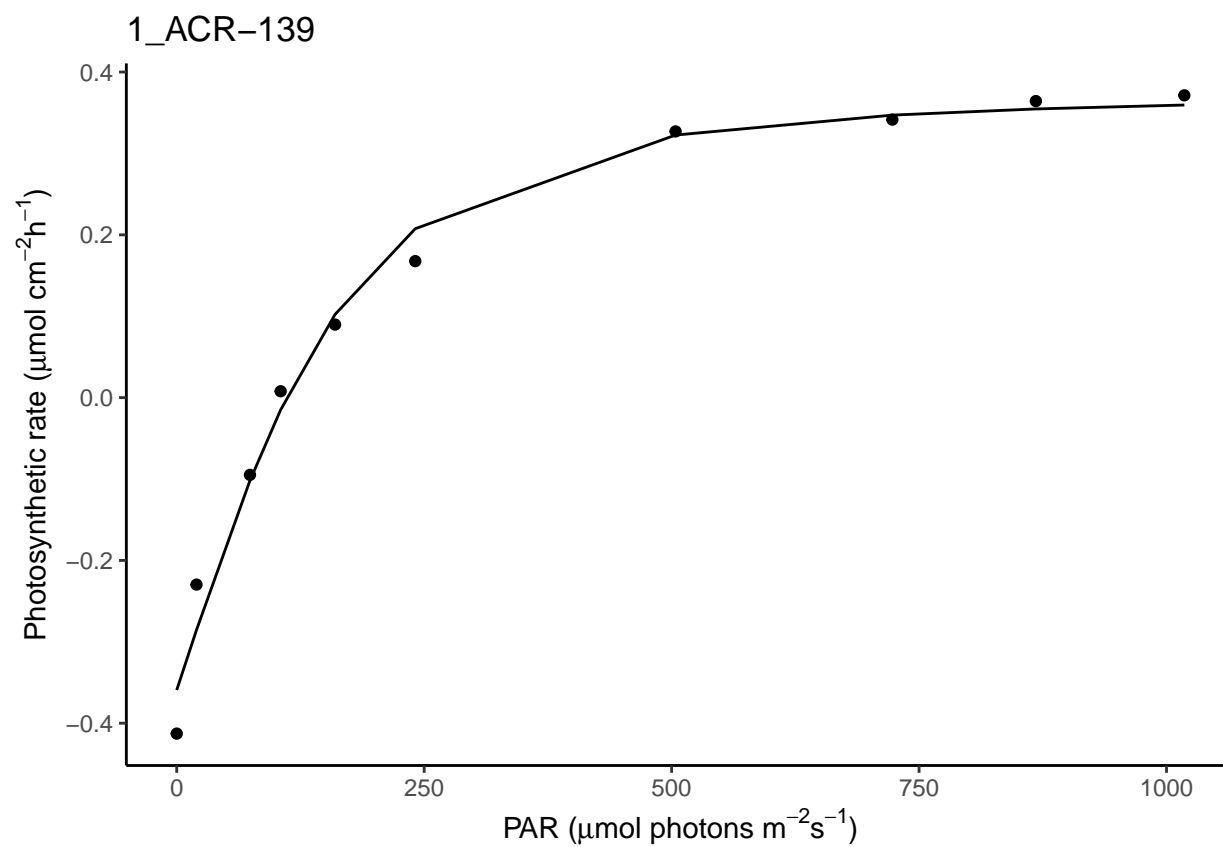
```
## -----  
## augmented$colony_id: ACR-265
```



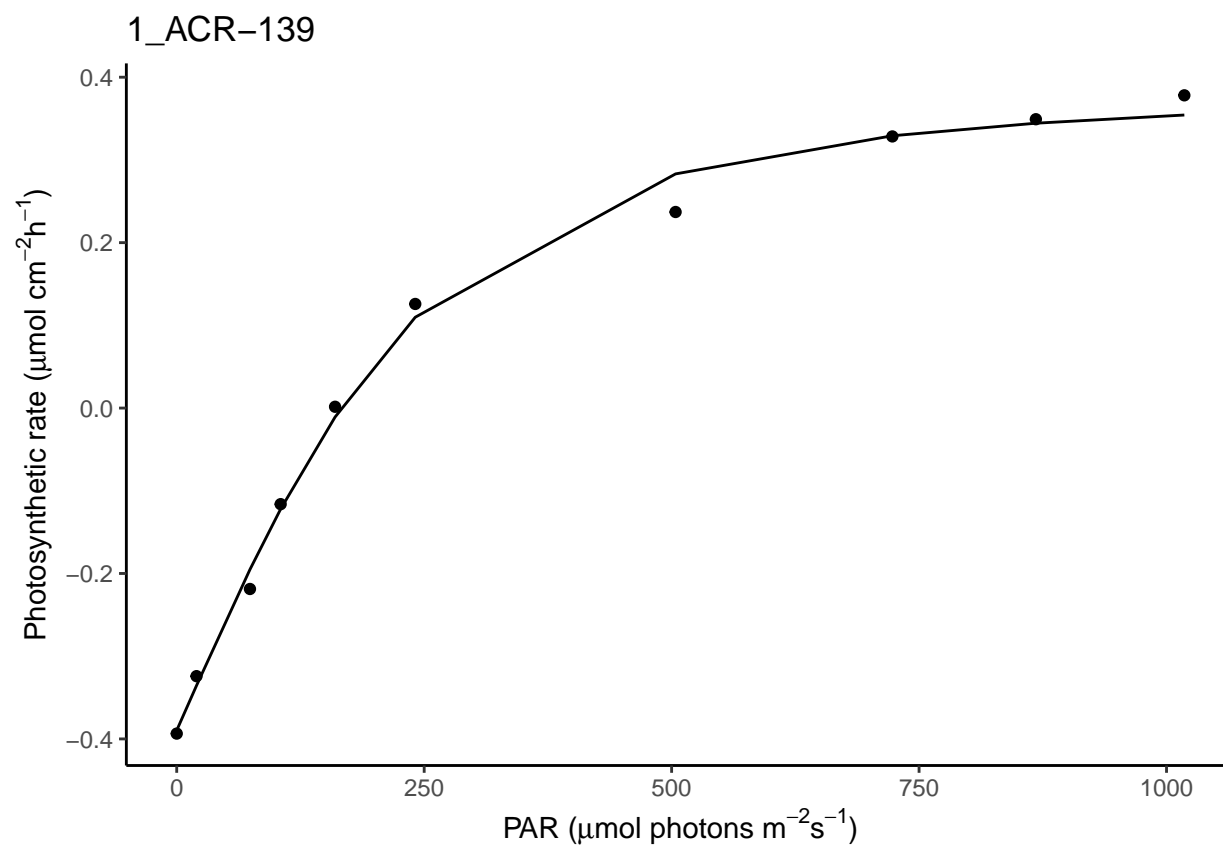
```
## -----  
## augmented$colony_id: ACR-343
```



## -----  
## augmented\$colony\_id: ACR-364

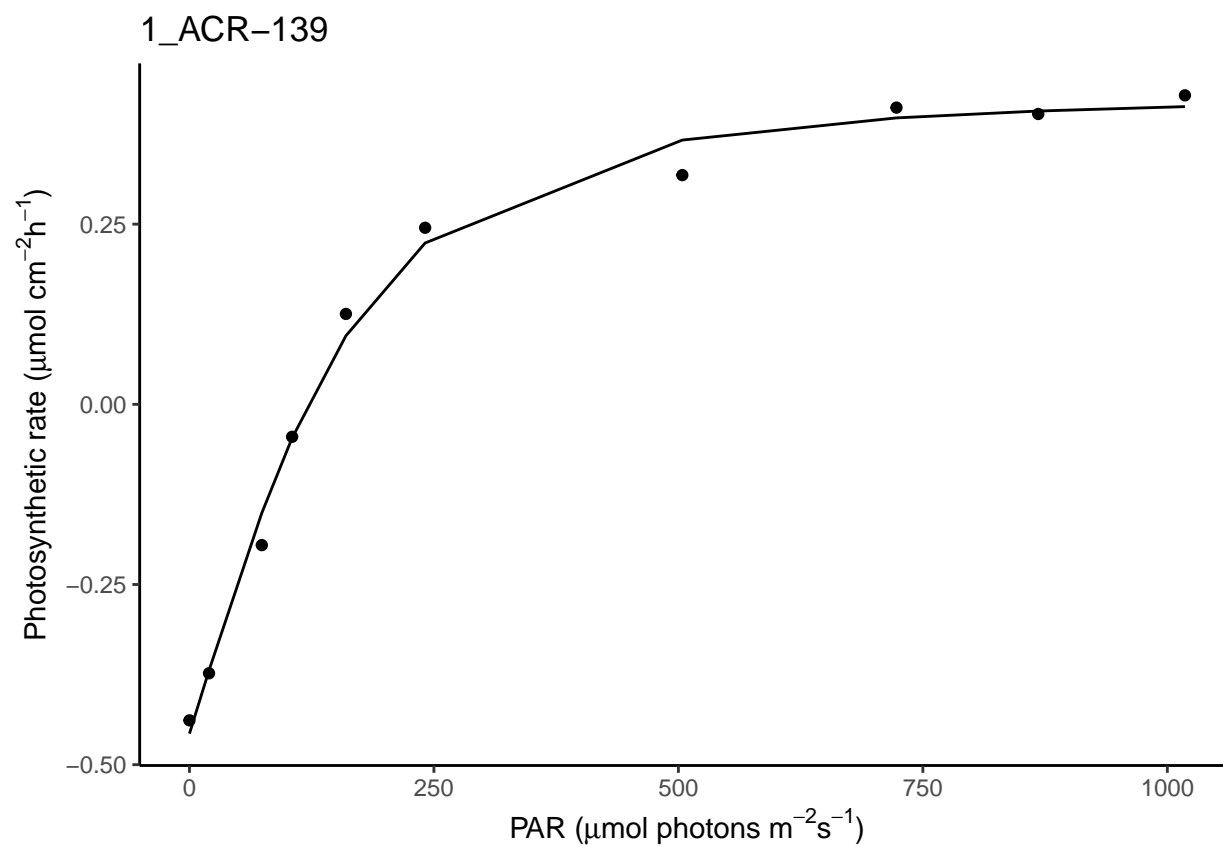


## -----  
## augmented\$colony\_id: POC-200

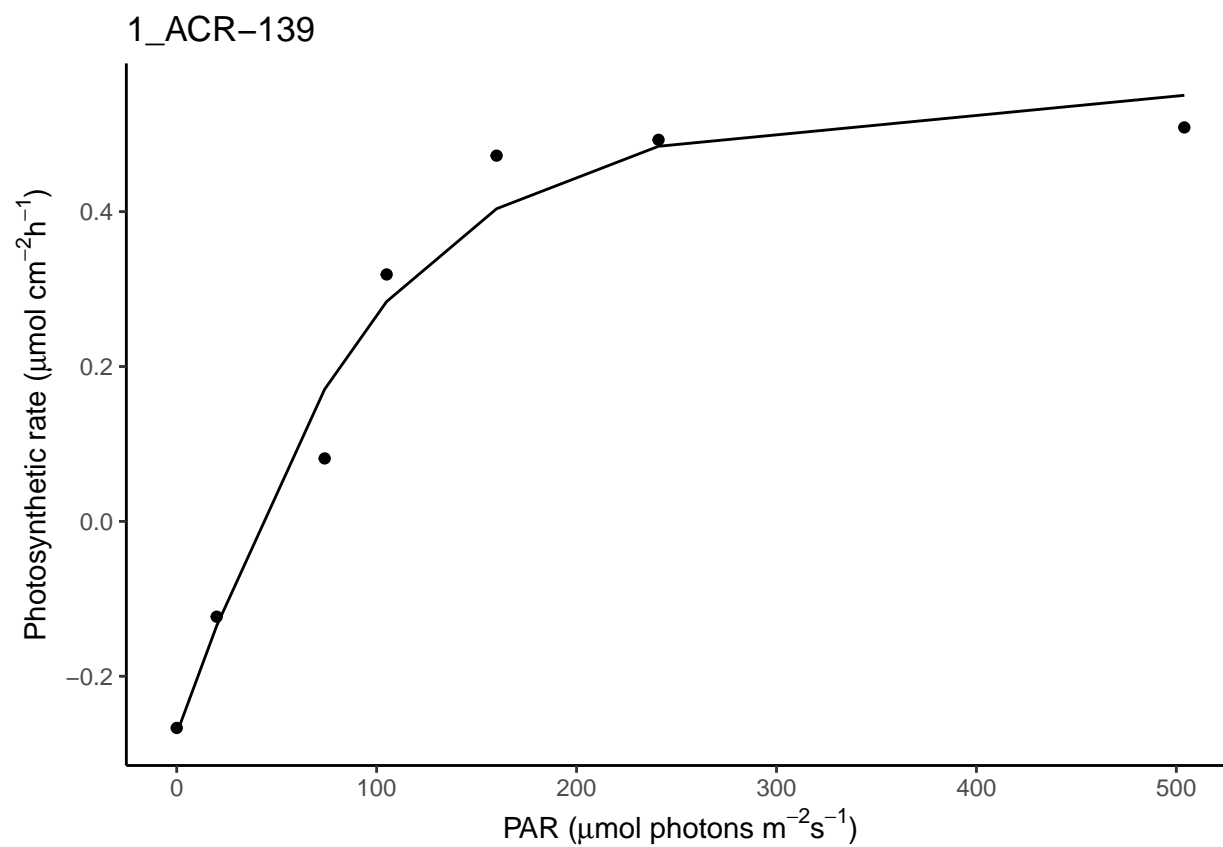


## -----  
## augmented\$colony\_id: POC-201

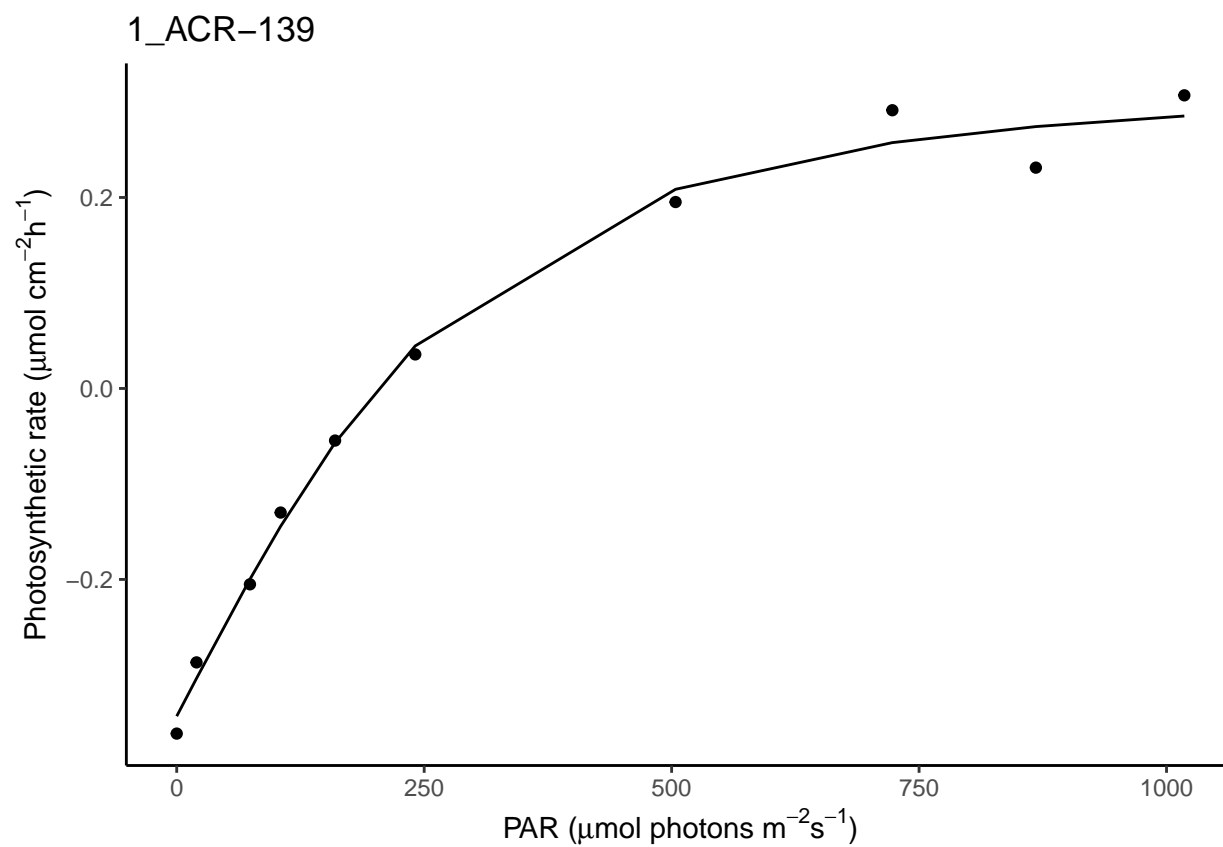




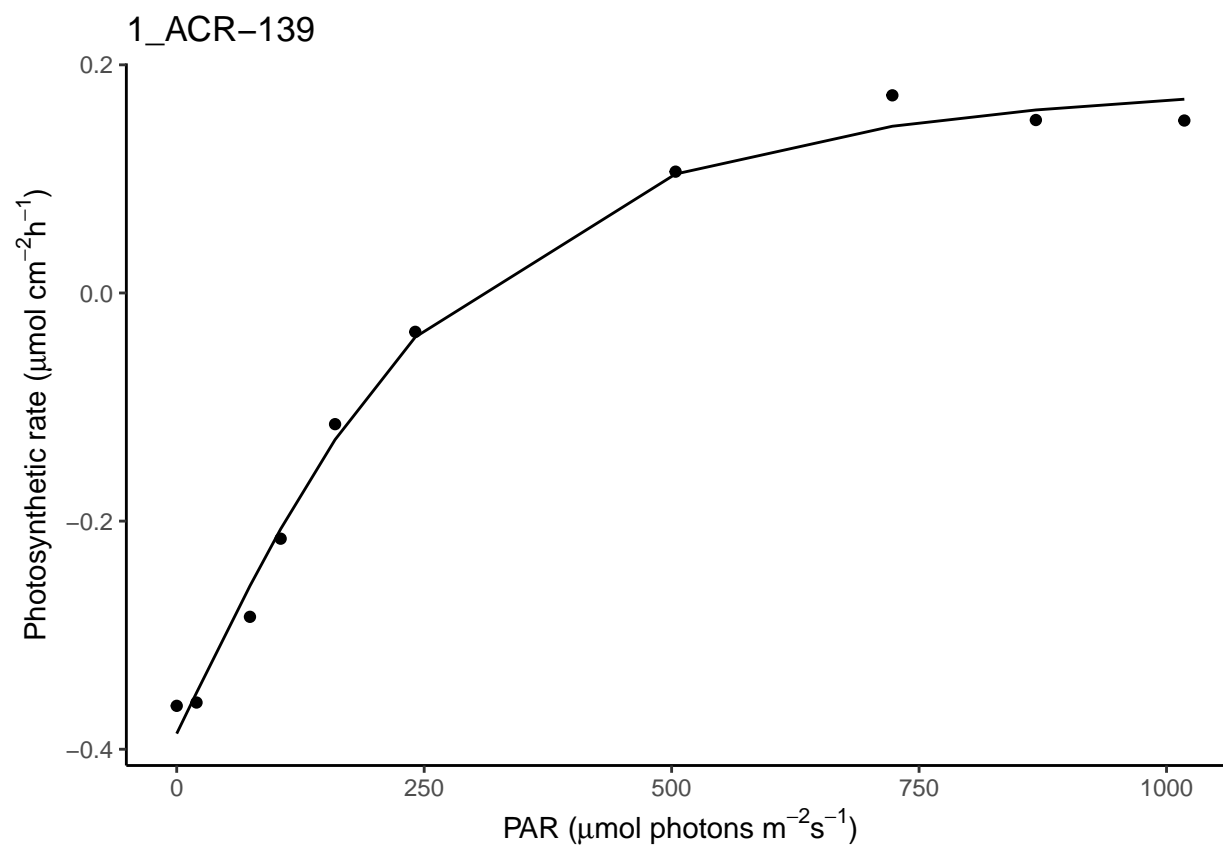
## -----  
## augmented\$colony\_id: POC-205



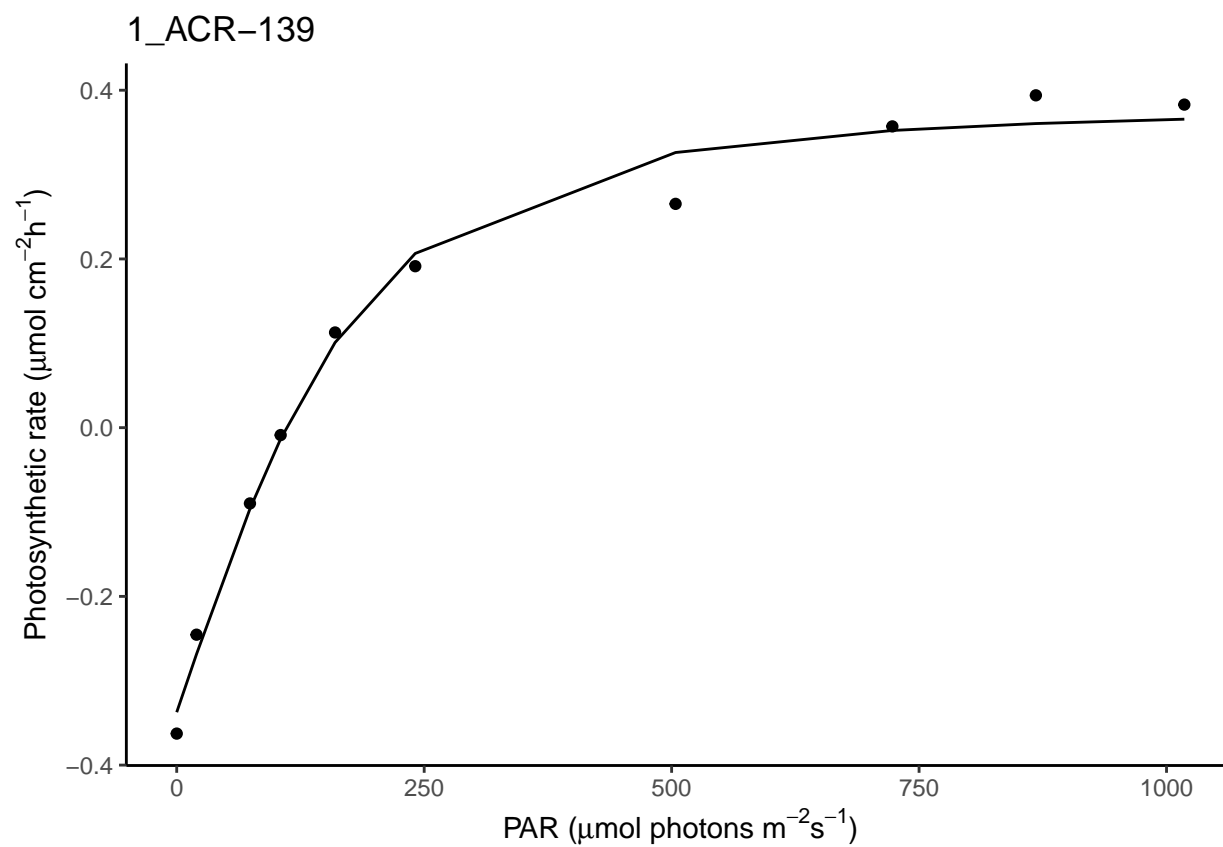
## -----  
## augmented\$colony\_id: POC-207



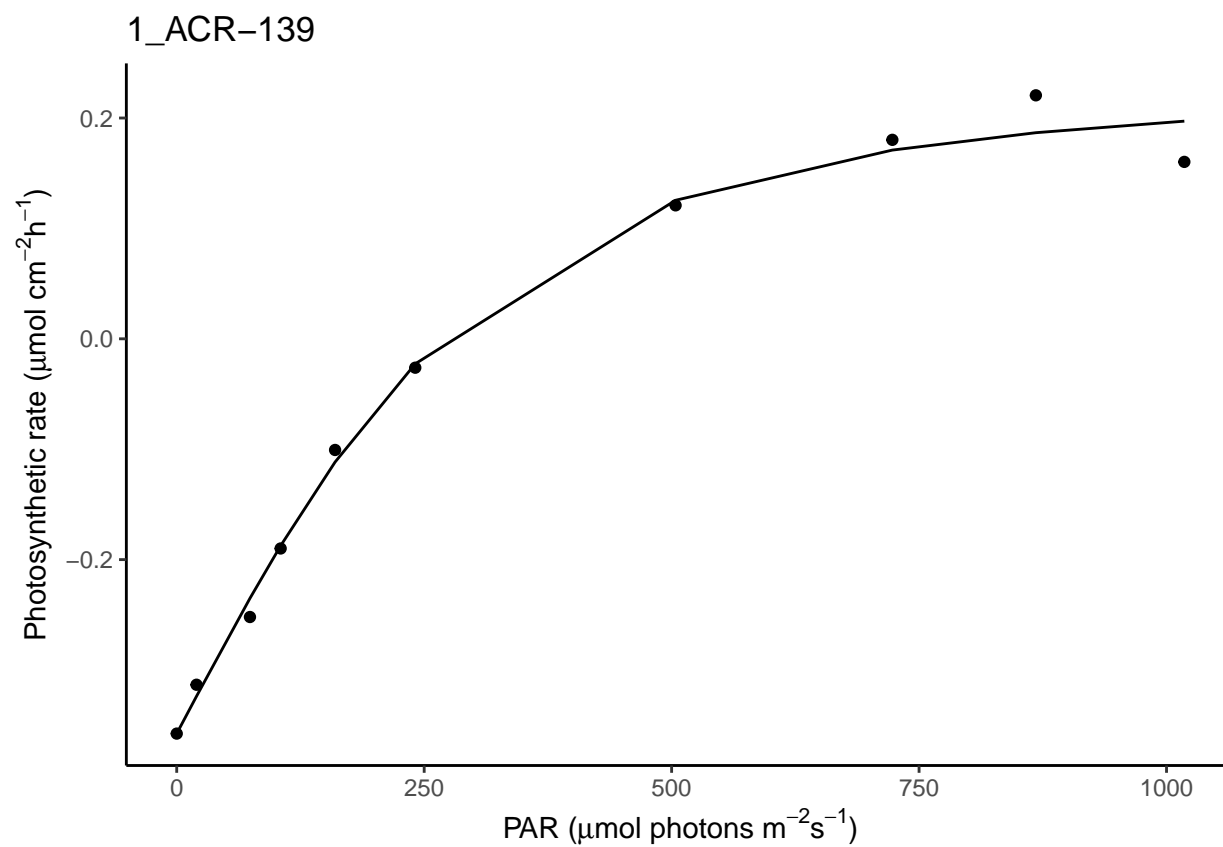
```
## -----  
## augmented$colony_id: POC-219
```



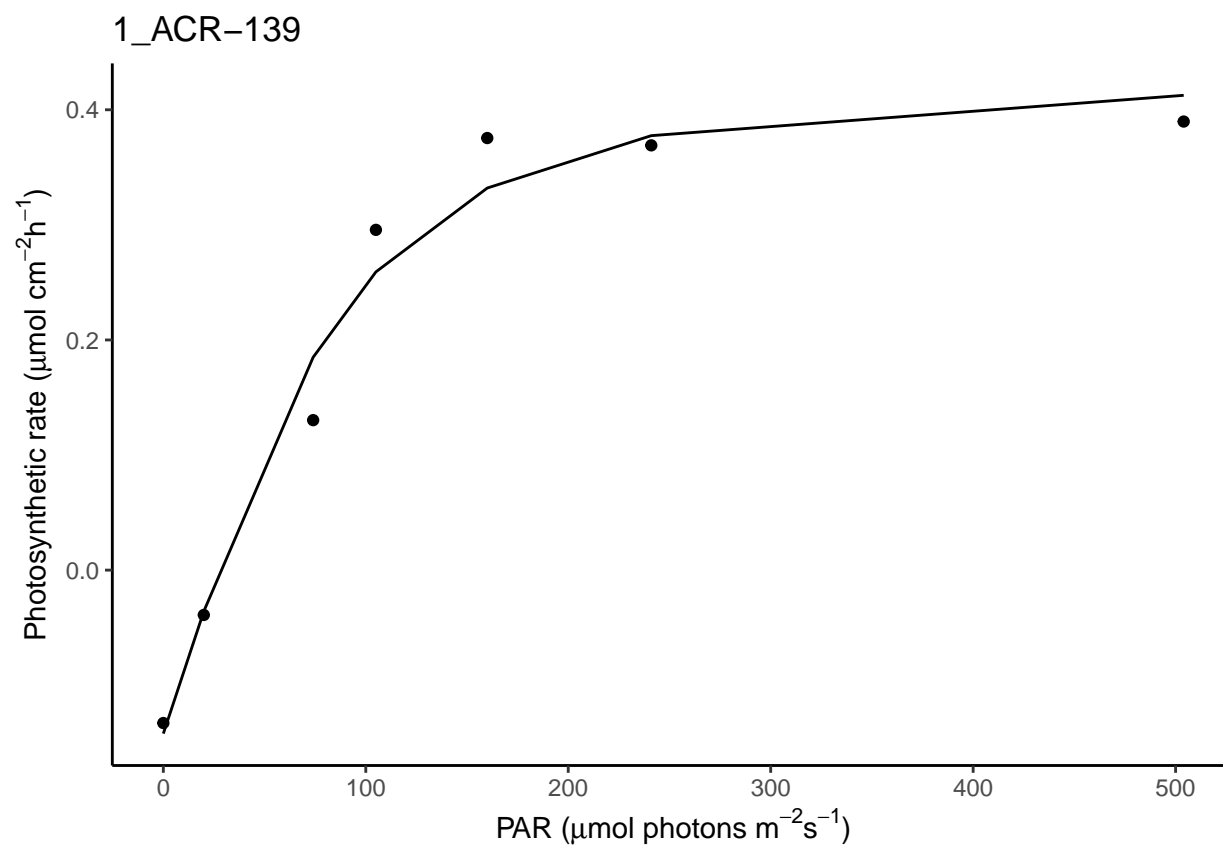
```
## -----  
## augmented$colony_id: P0C-222
```



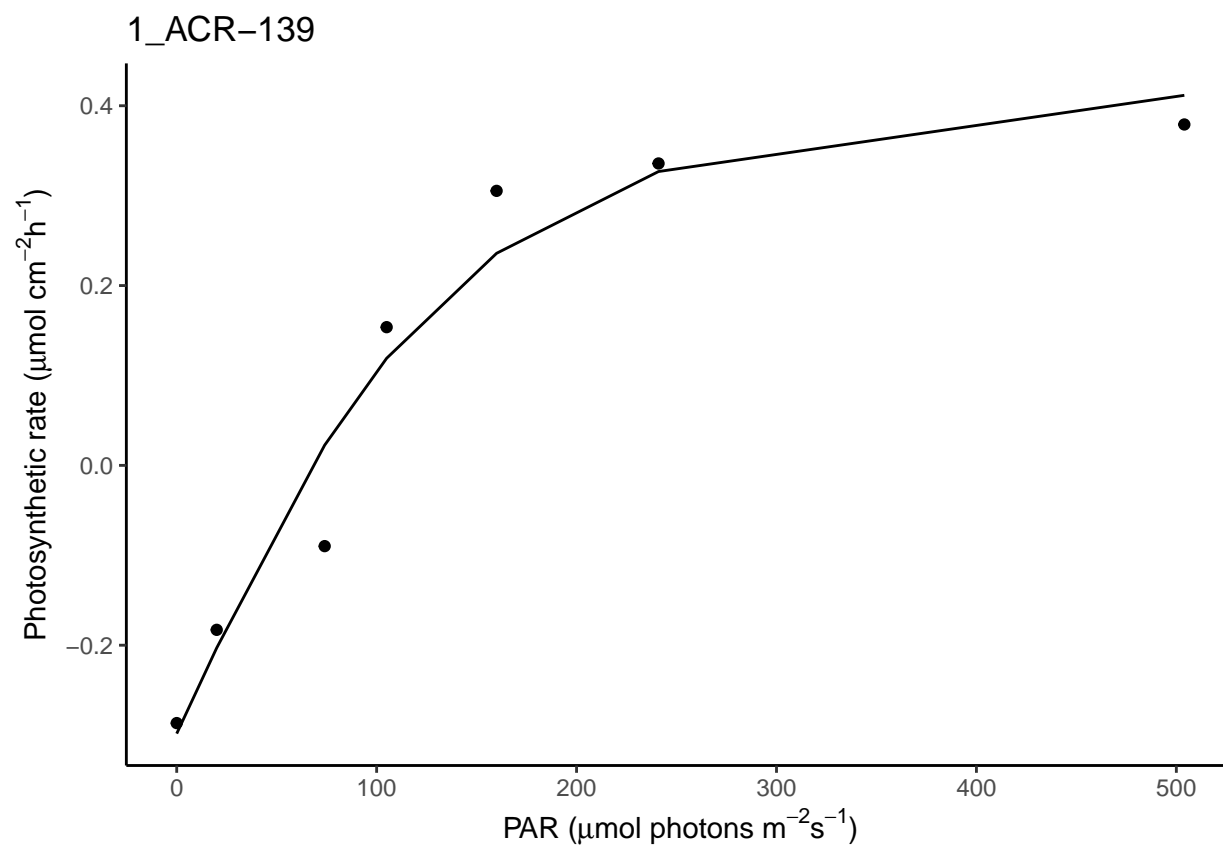
## -----  
## augmented\$colony\_id: POC-238



```
## -----  
## augmented$colony_id: P0C-239
```

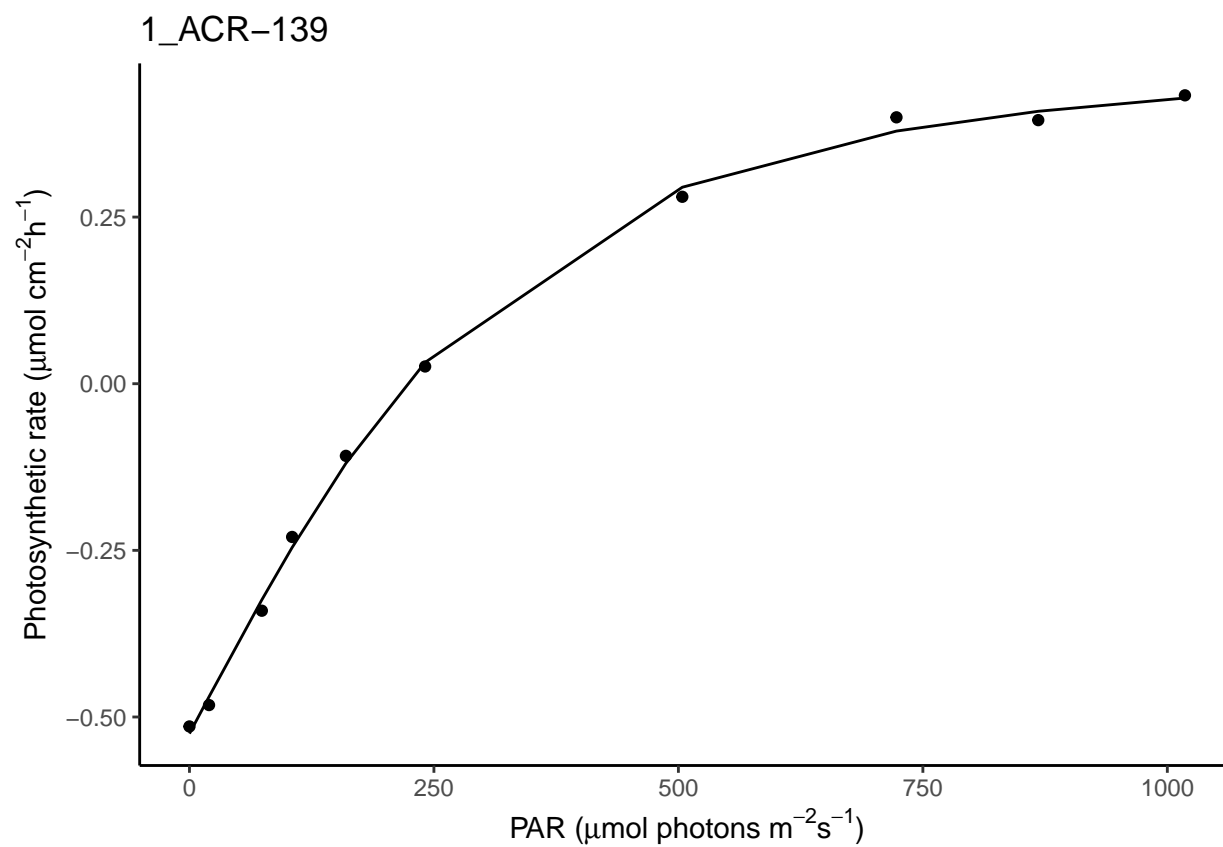


## -----  
## augmented\$colony\_id: POC-248

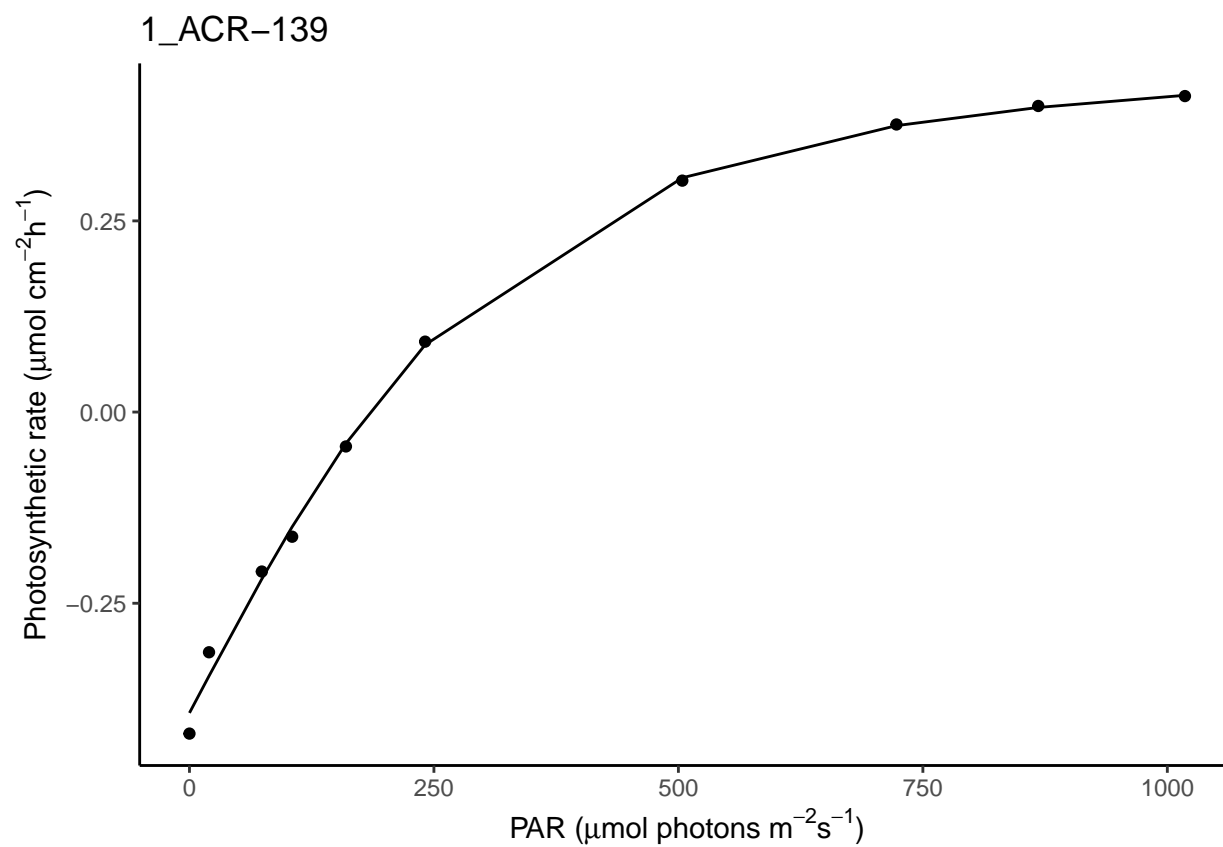


## -----  
## augmented\$colony\_id: POC-254

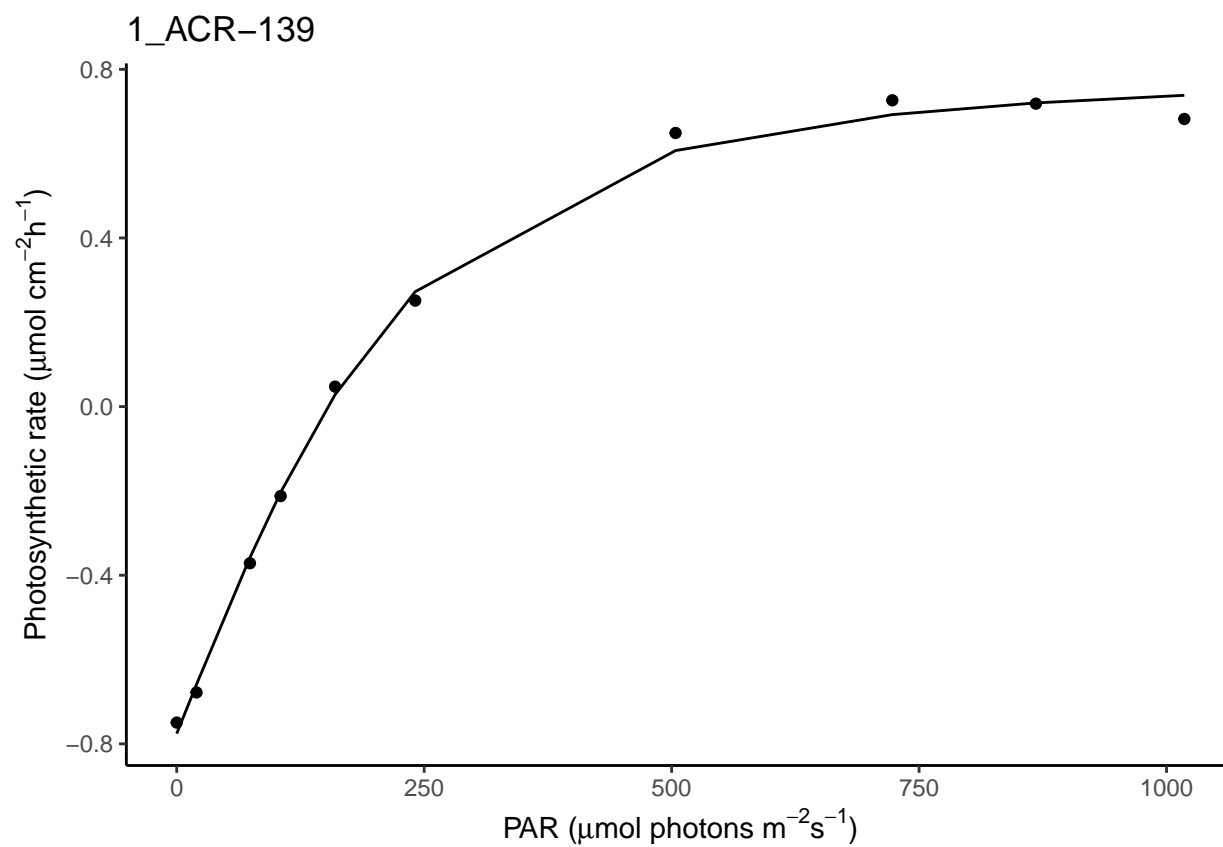




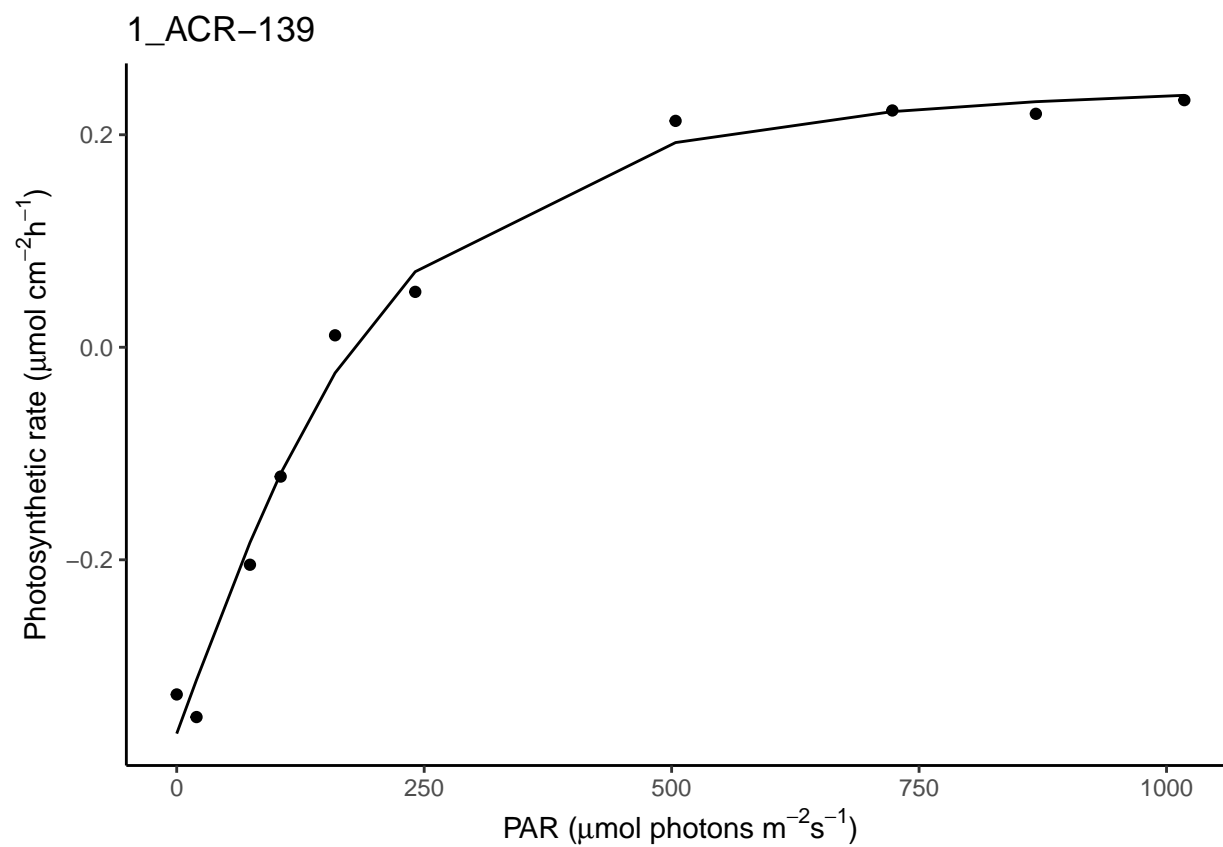
## -----  
## augmented\$colony\_id: POC-255



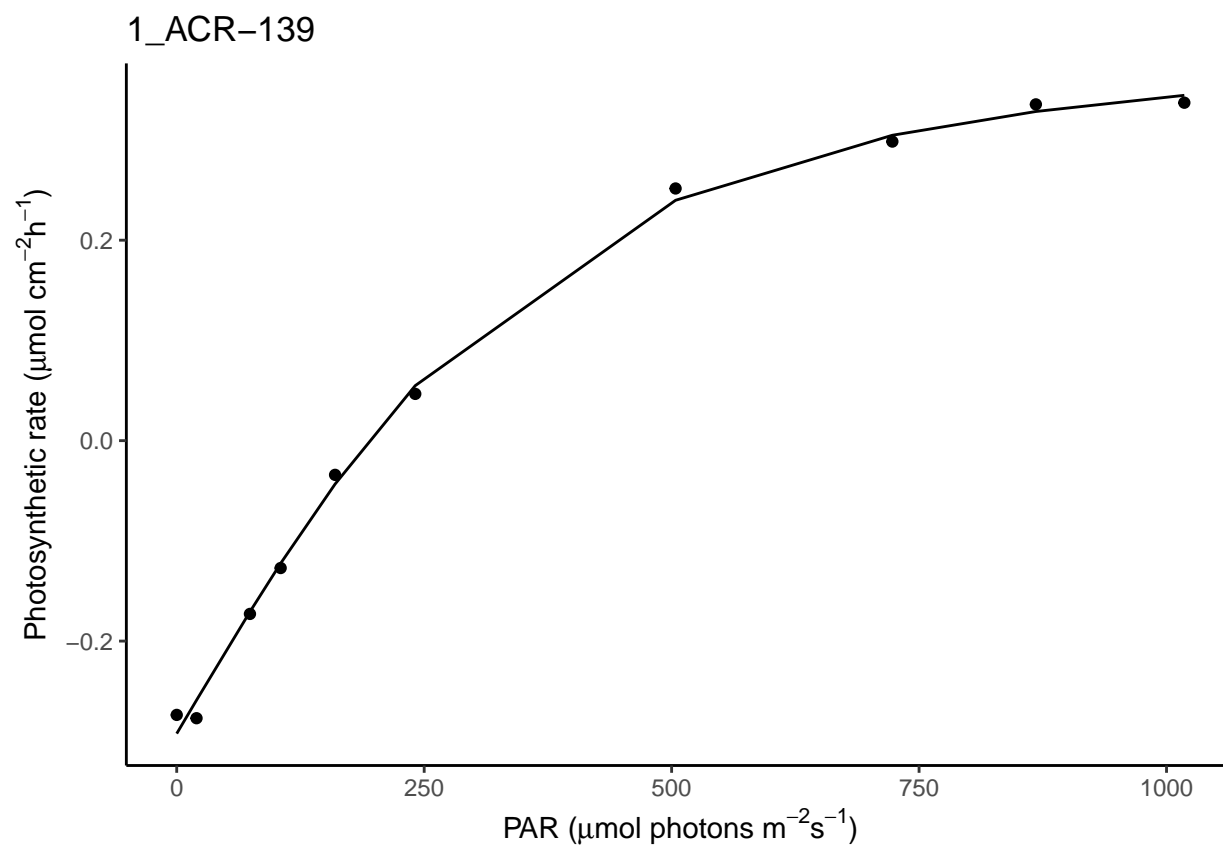
## -----  
## augmented\$colony\_id: POC-257



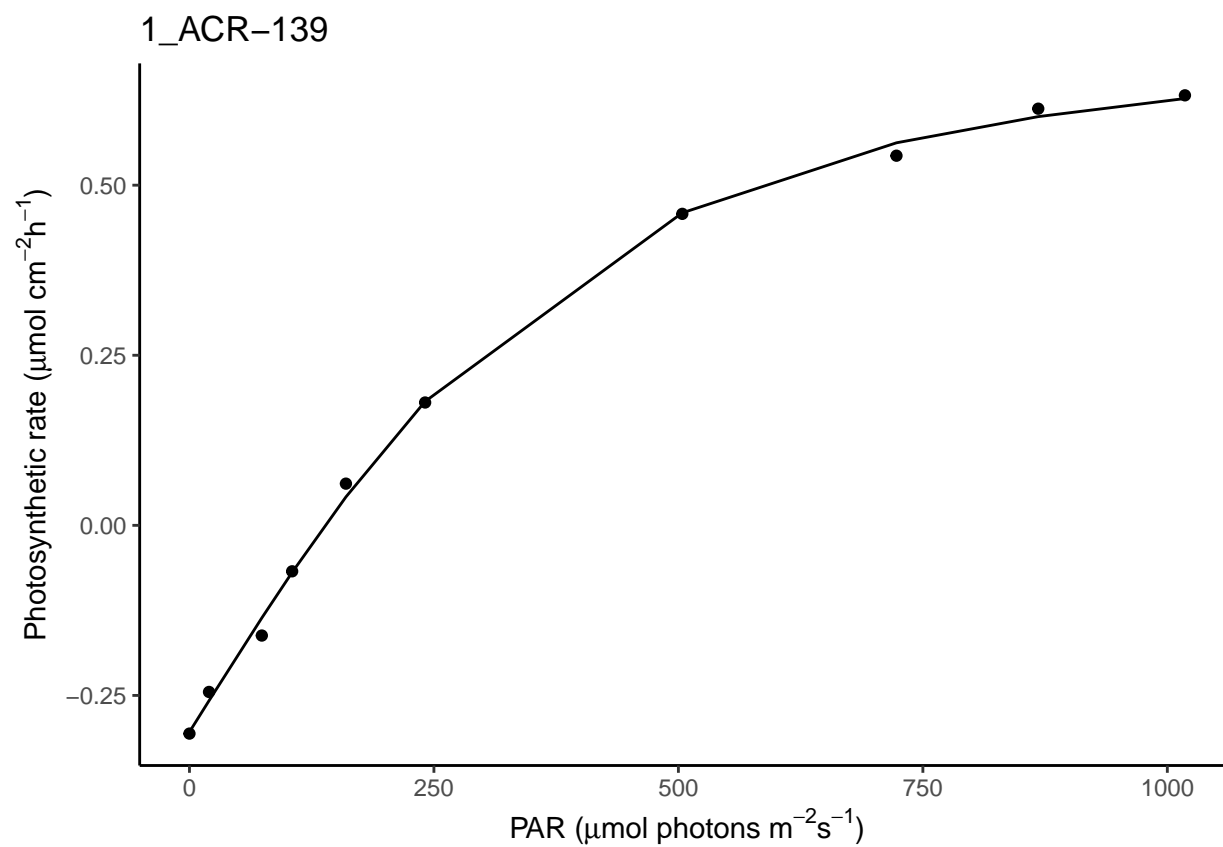
## -----  
## augmented\$colony\_id: POC-259



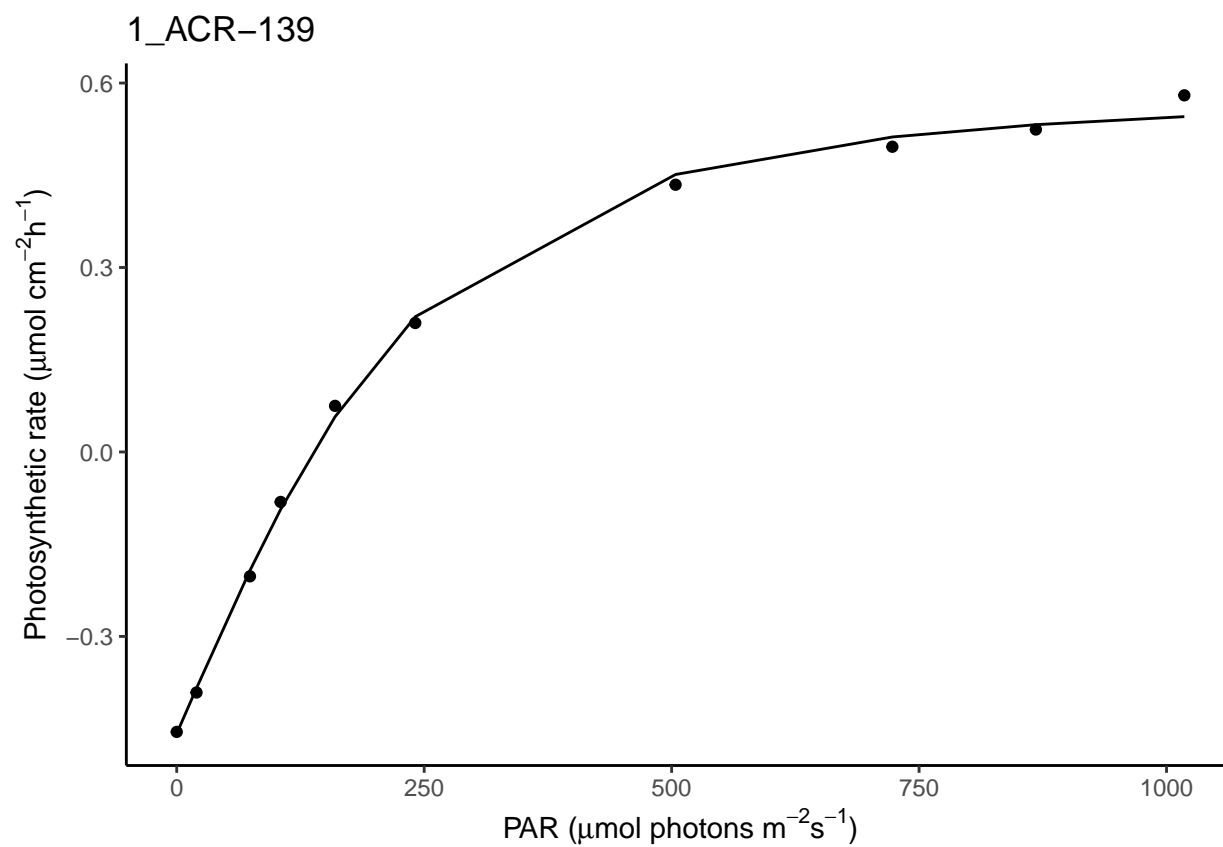
## -----  
## augmented\$colony\_id: POC-358



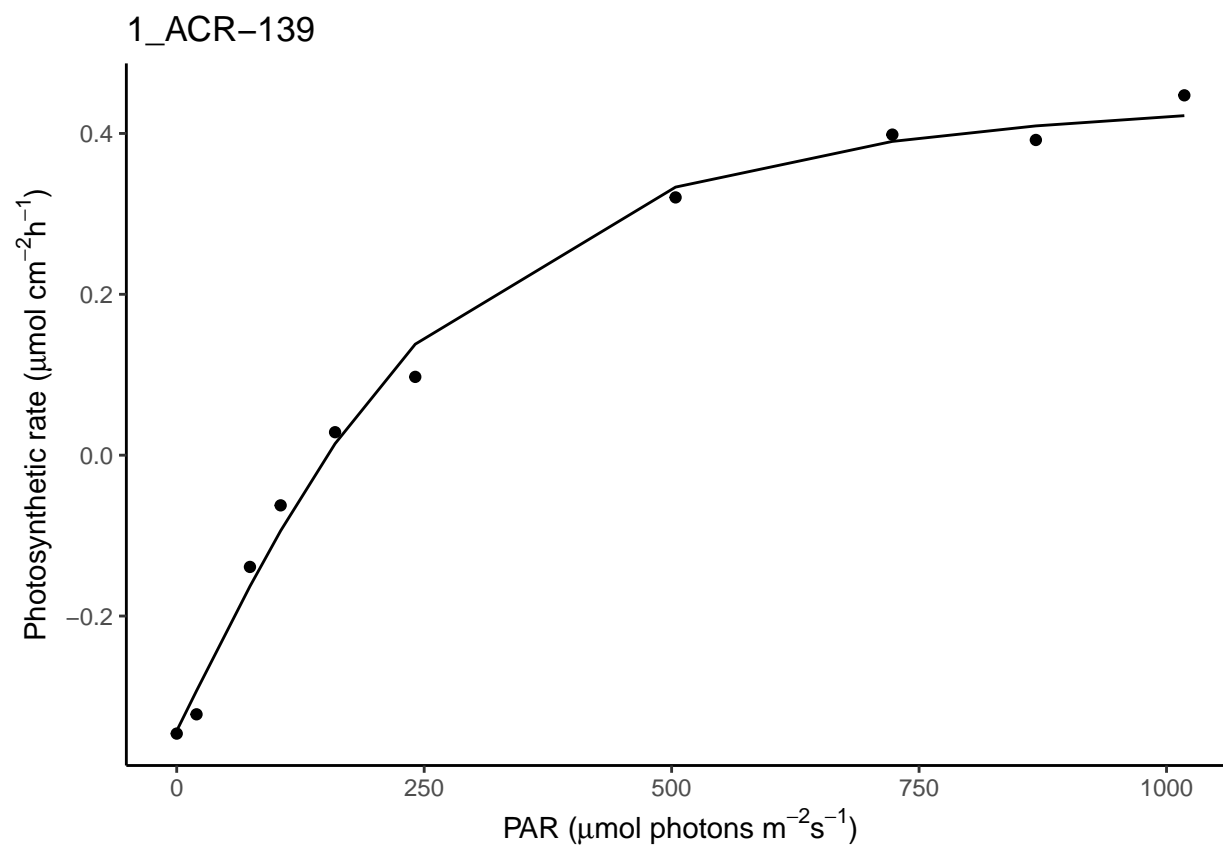
## -----  
## augmented\$colony\_id: POC-359



```
## -----  
## augmented$colony_id: P0C-366
```

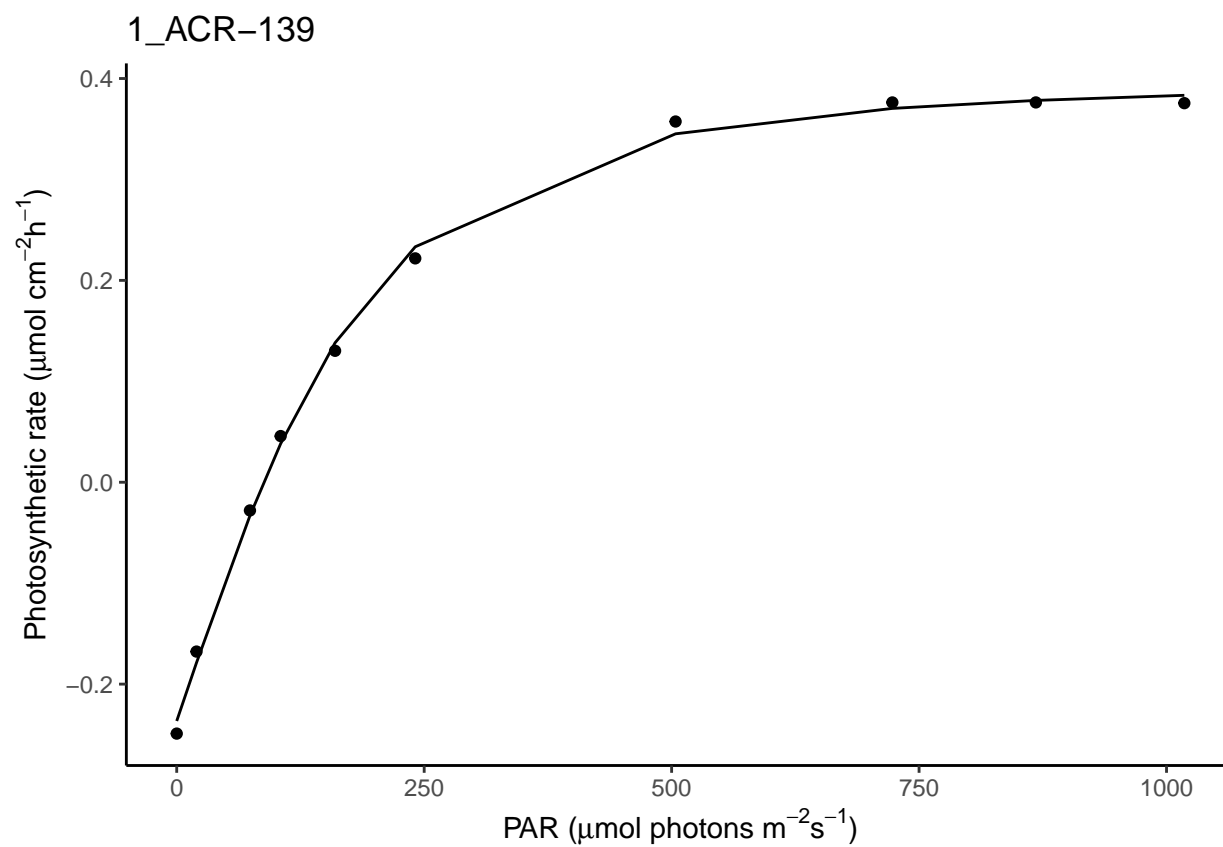


## -----  
## augmented\$colony\_id: POC-369

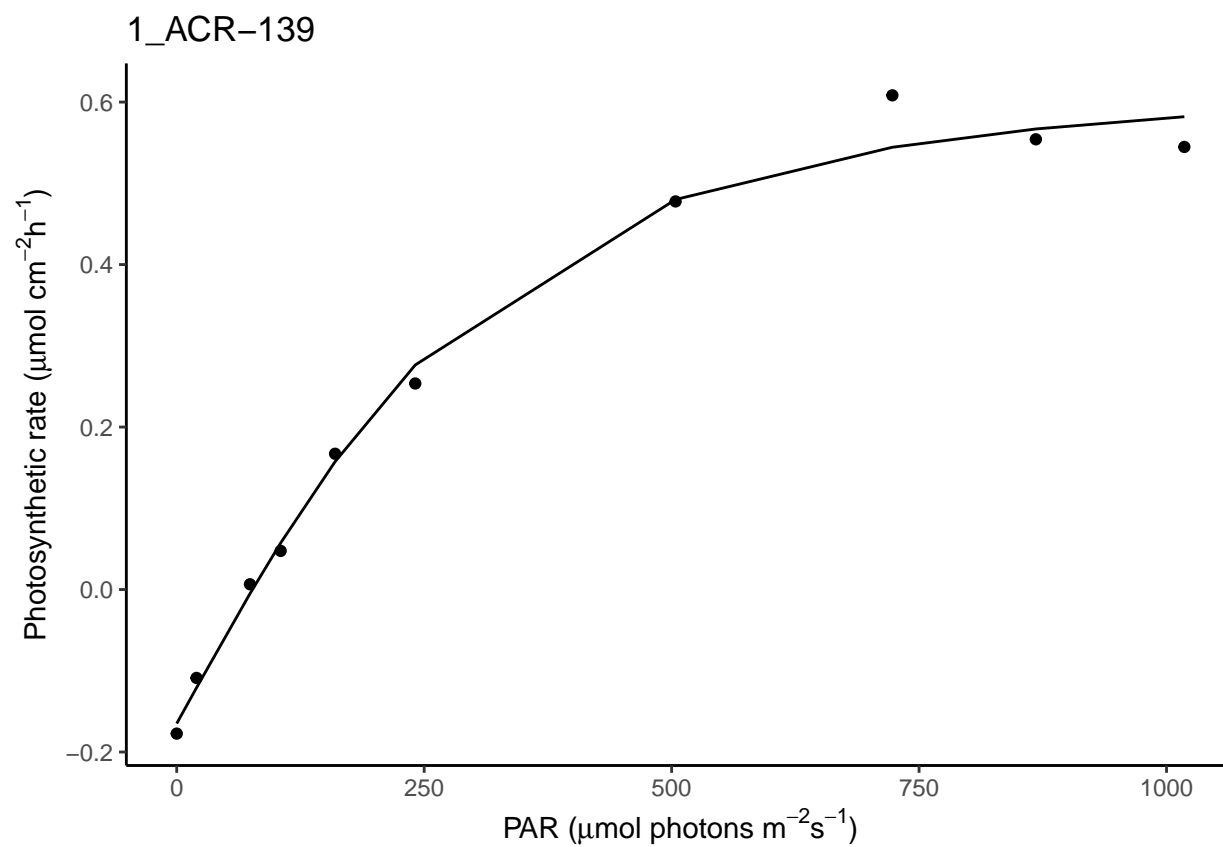


```
## -----  
## augmented$colony_id: P0C-371
```

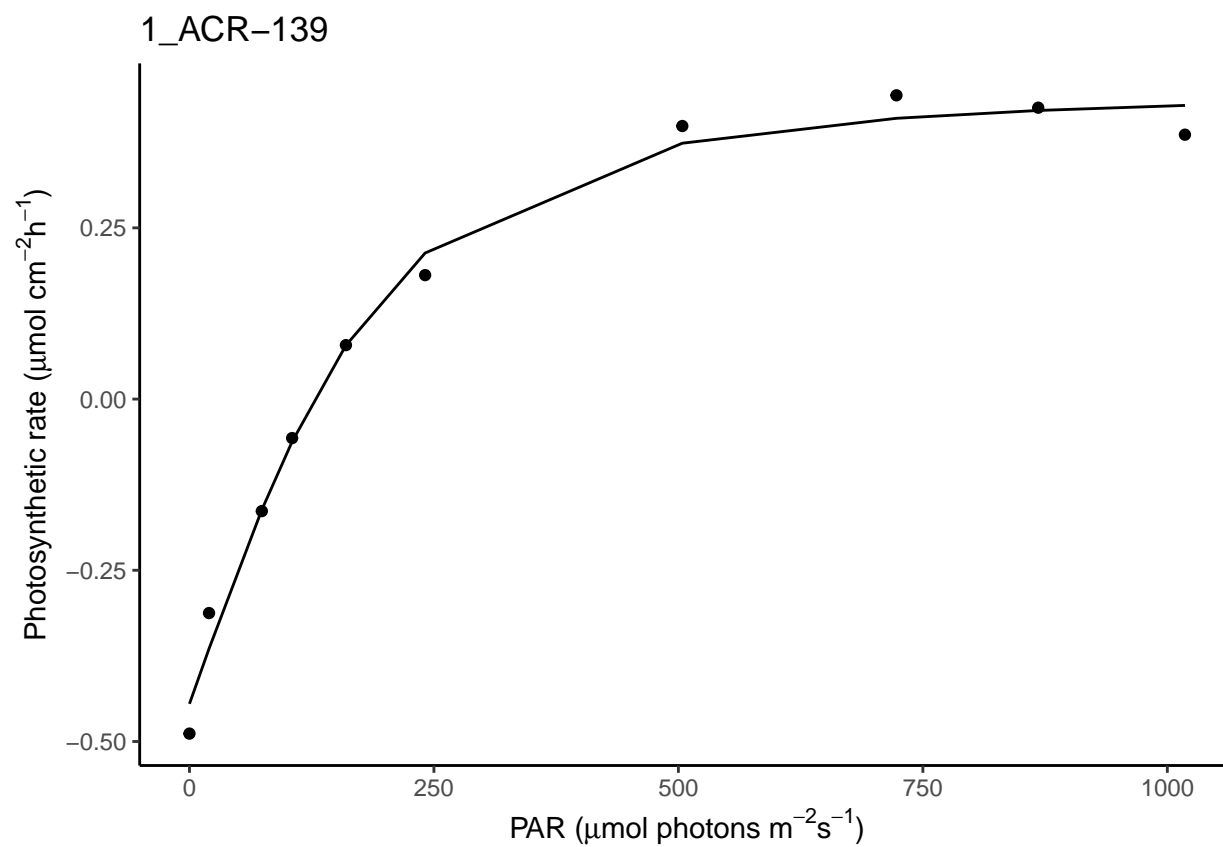




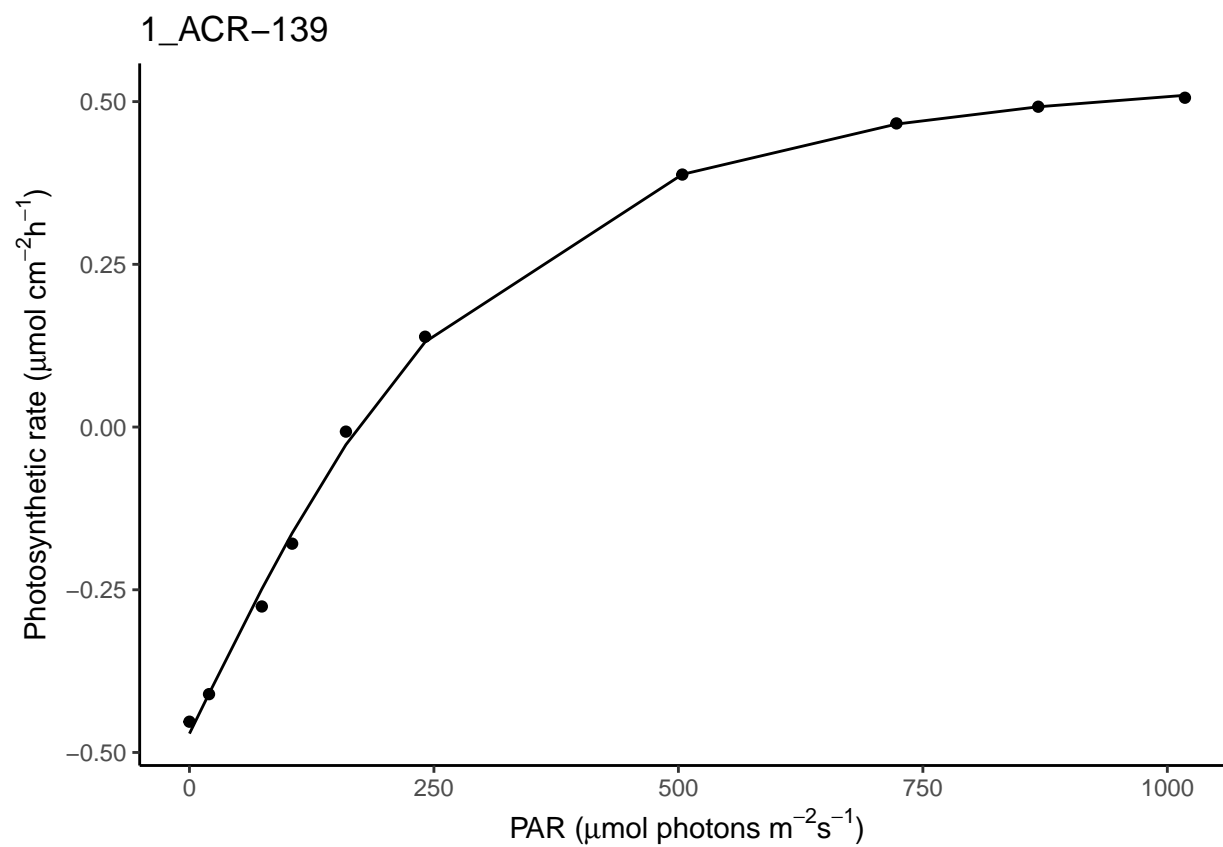
```
## -----  
## augmented$colony_id: POC-372
```



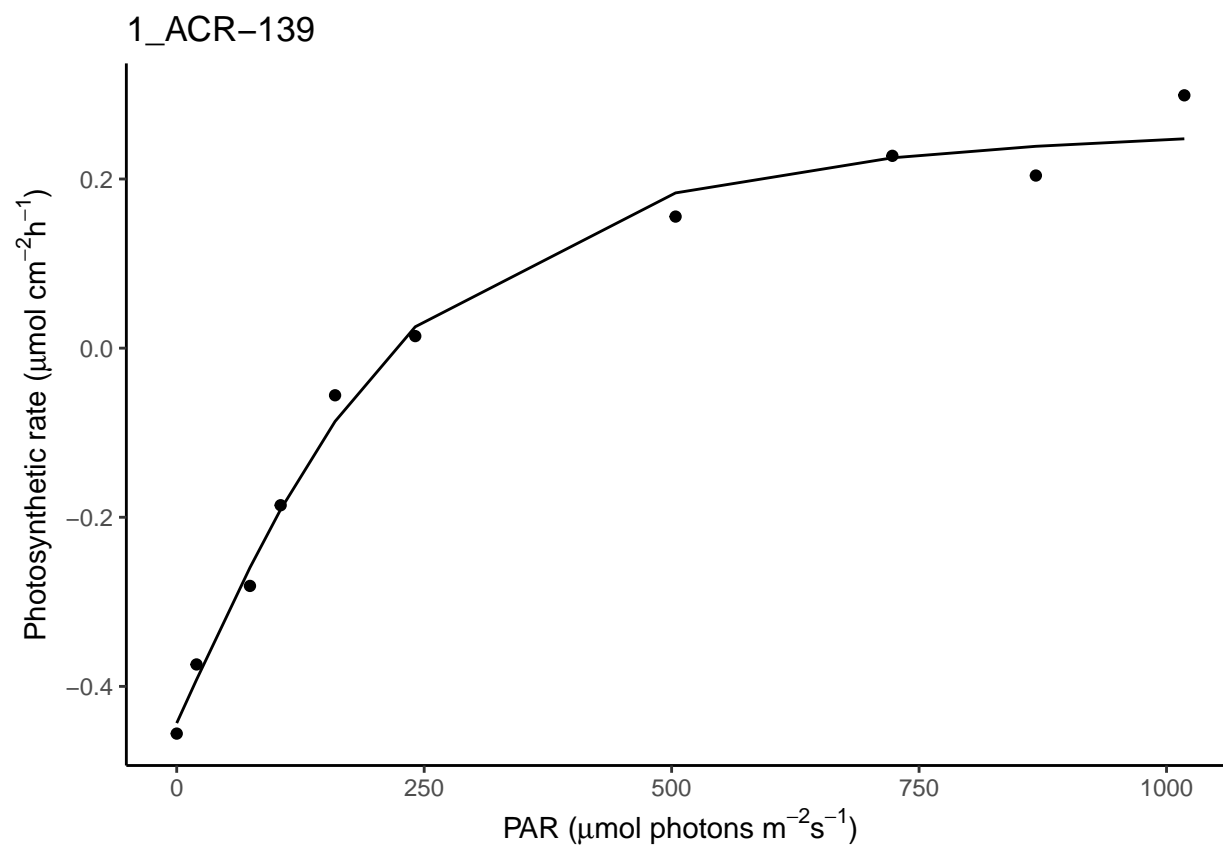
## -----  
## augmented\$colony\_id: P0C-373



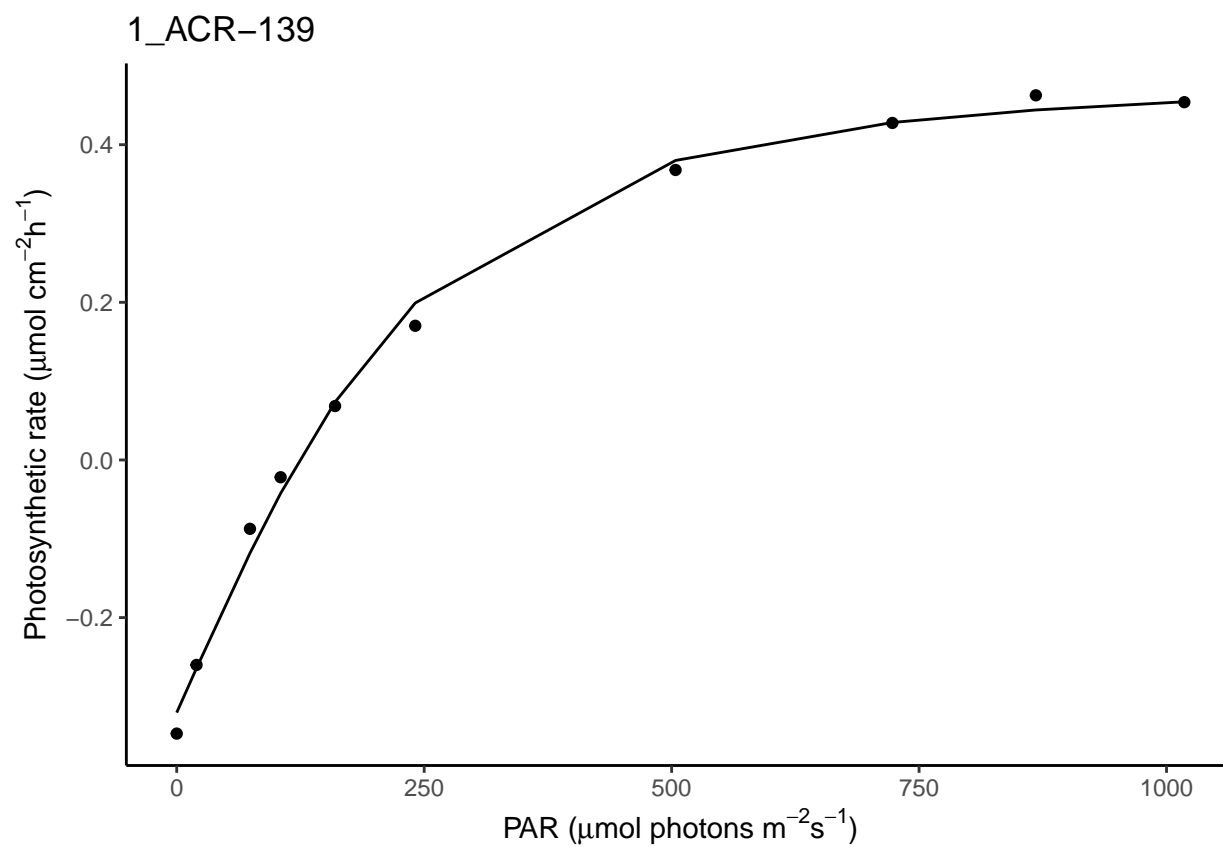
```
## -----  
## augmented$colony_id: P0C-375
```



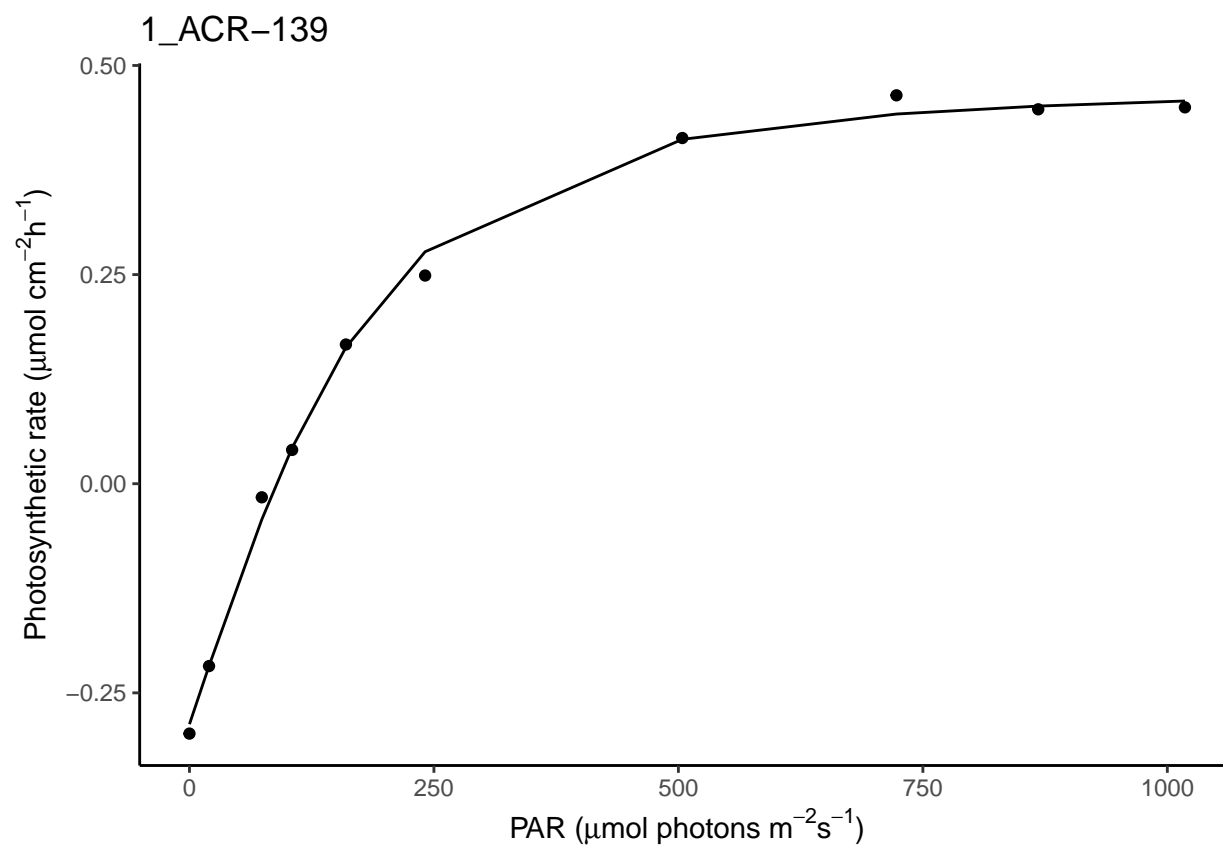
## -----  
## augmented\$colony\_id: POC-377



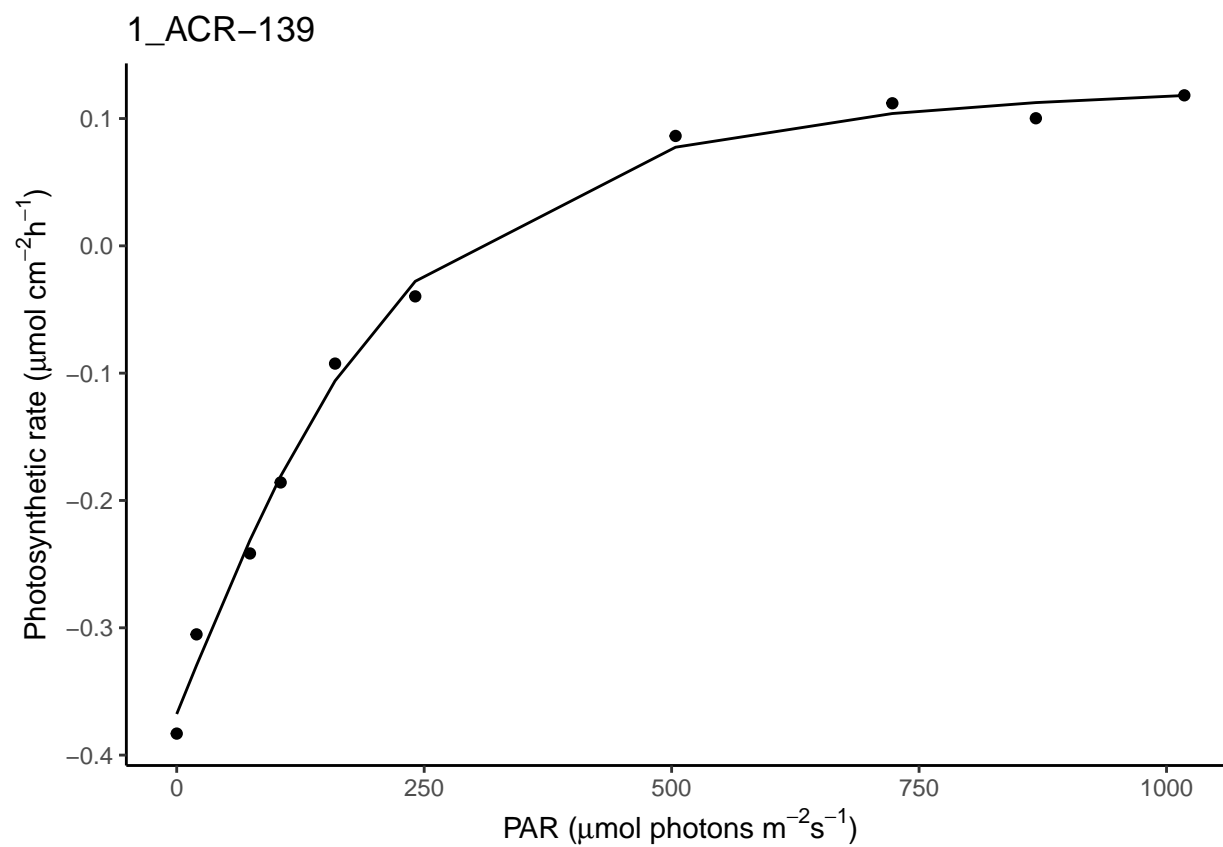
## -----  
## augmented\$colony\_id: POC-378



## -----  
## augmented\$colony\_id: P0C-386

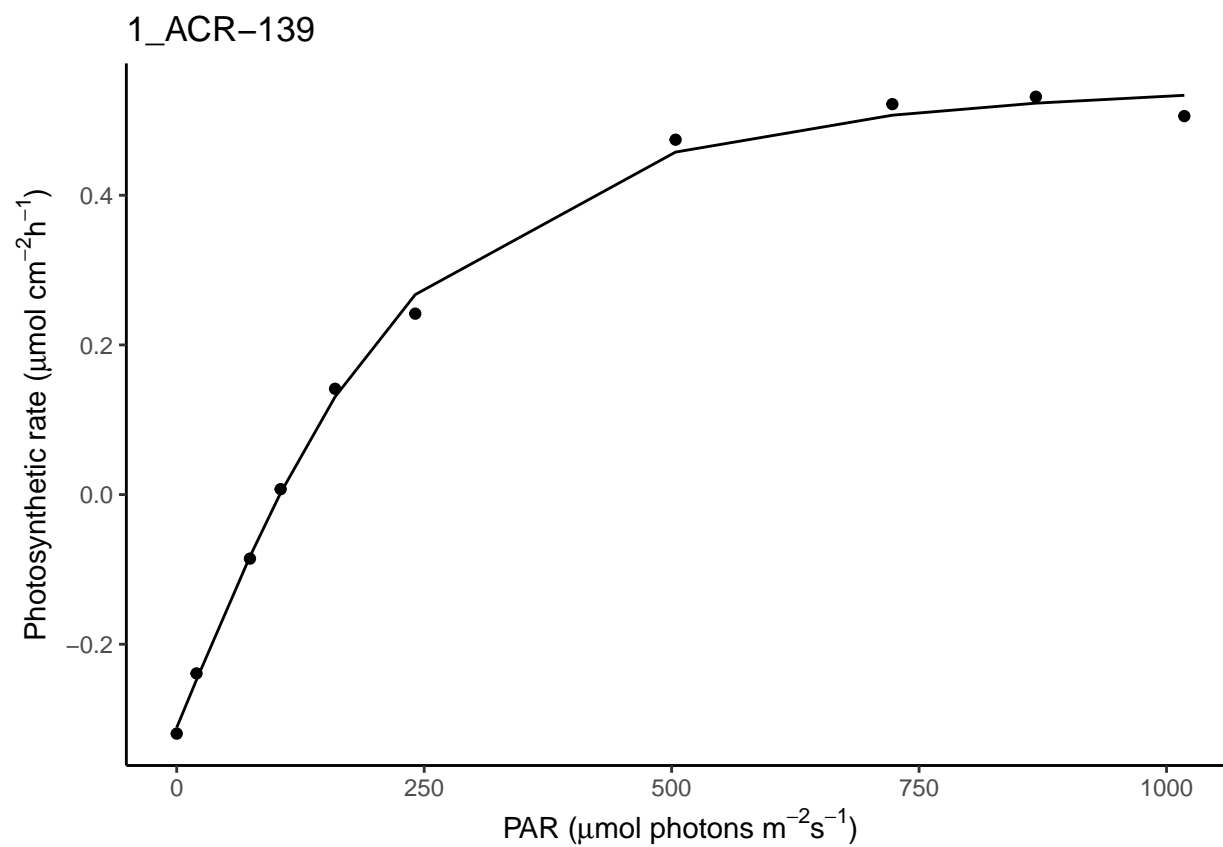


```
## -----  
## augmented$colony_id: POC-391
```

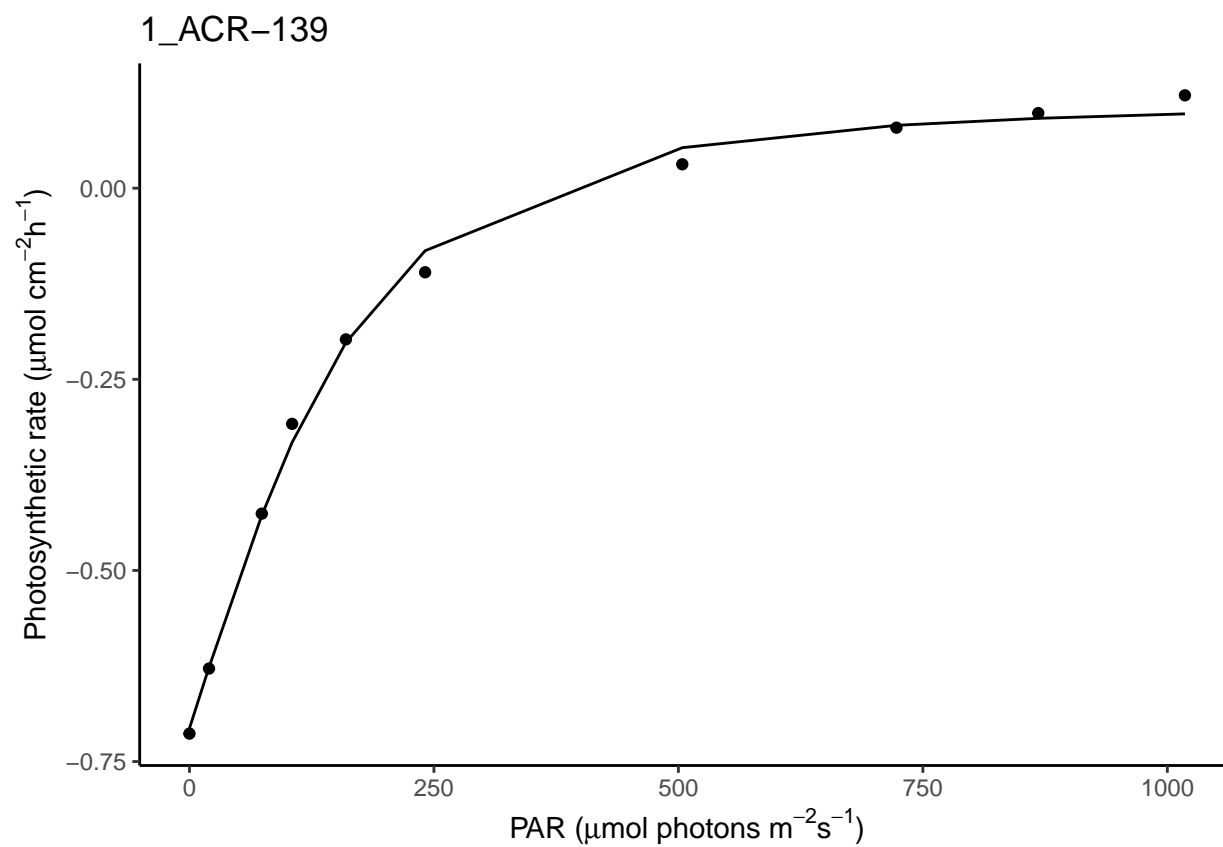


## -----  
## augmented\$colony\_id: P0C-395

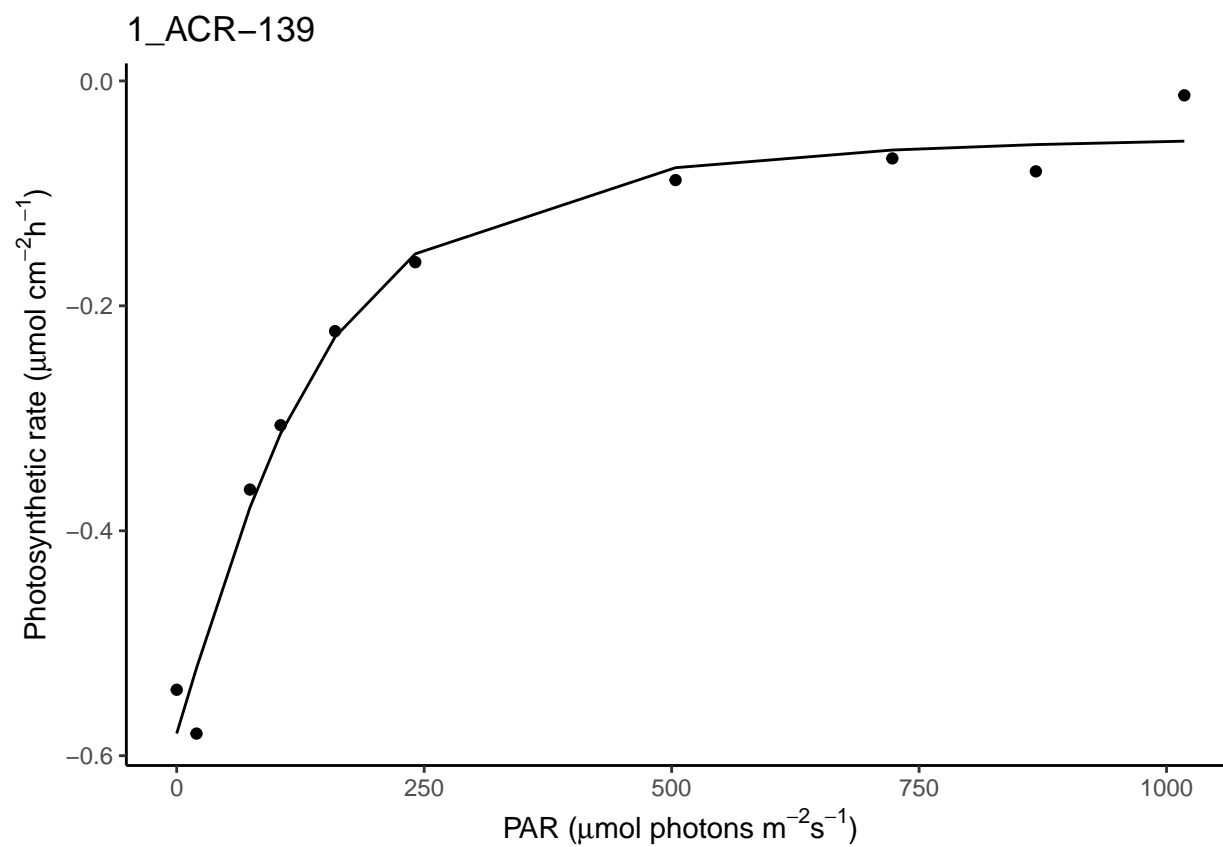




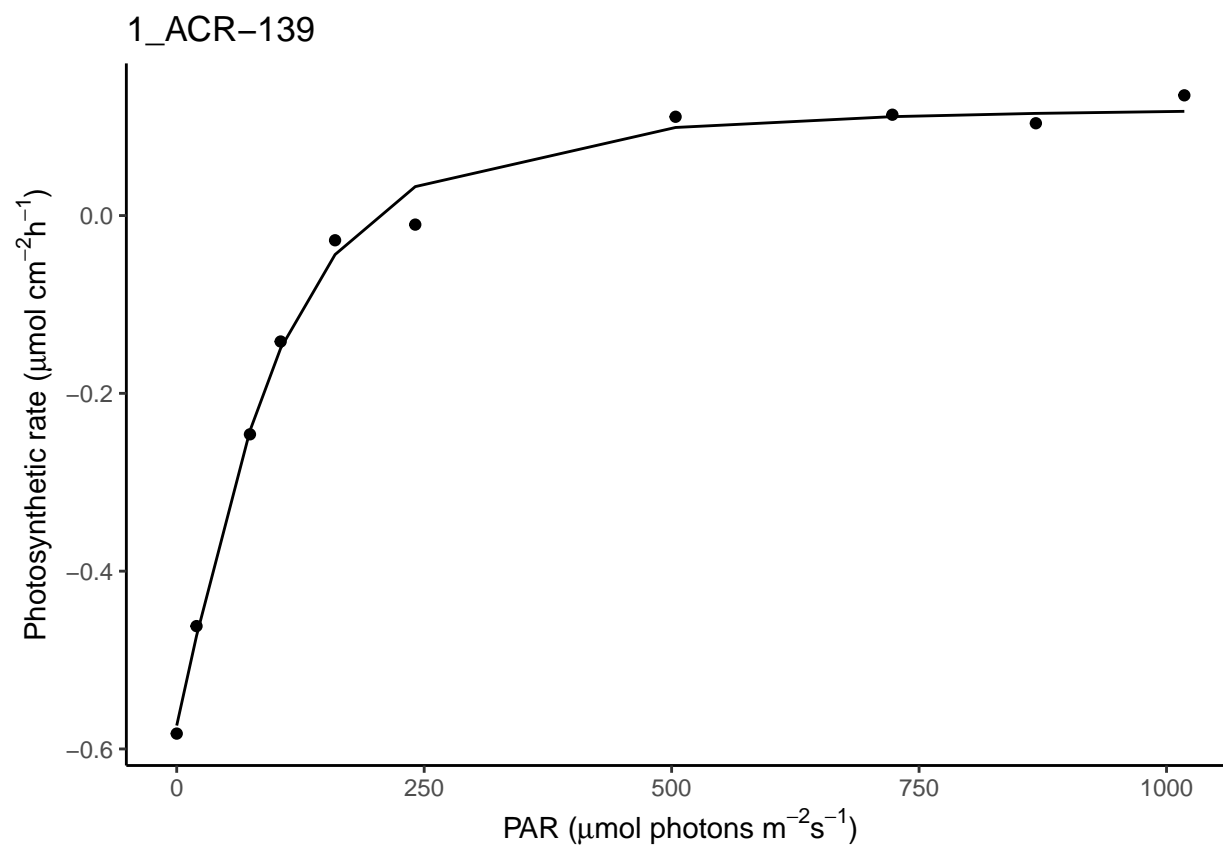
## -----  
## augmented\$colony\_id: POC-40



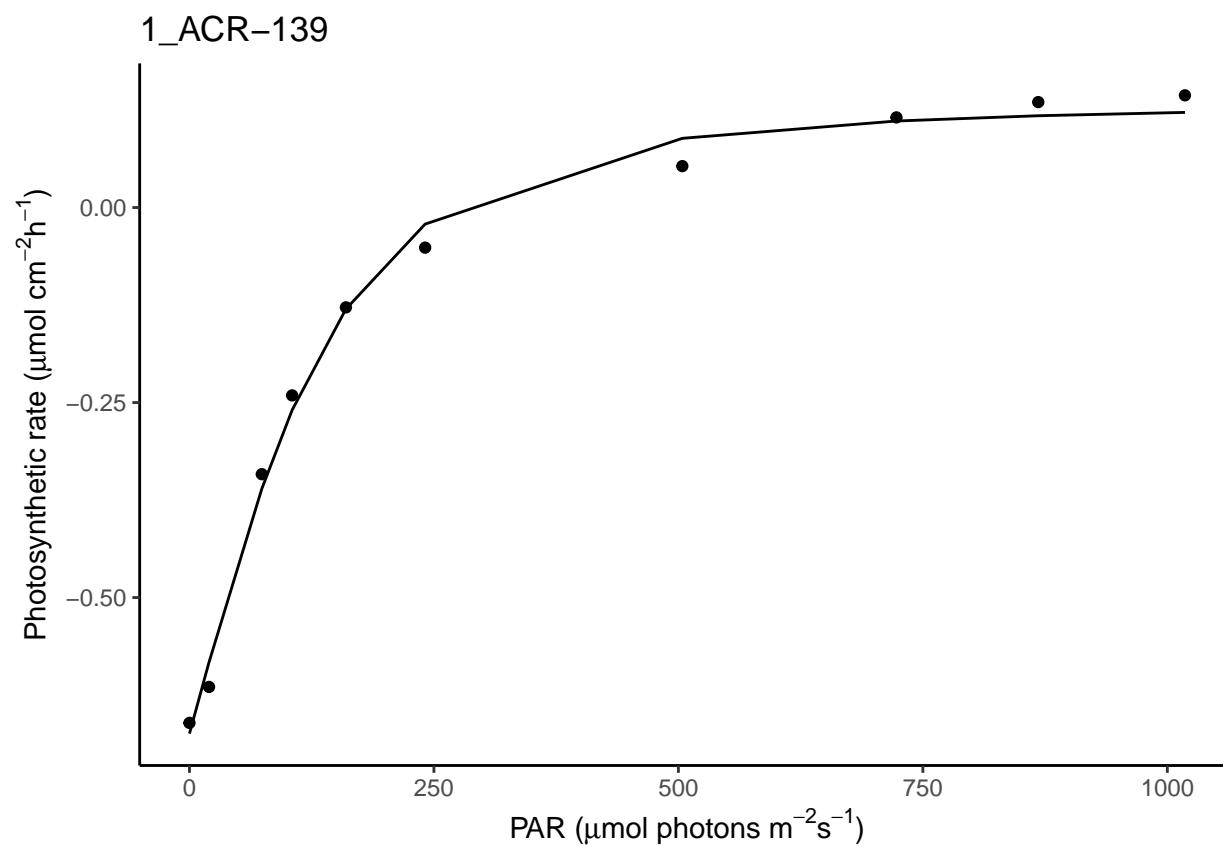
## -----  
## augmented\$colony\_id: POC-42



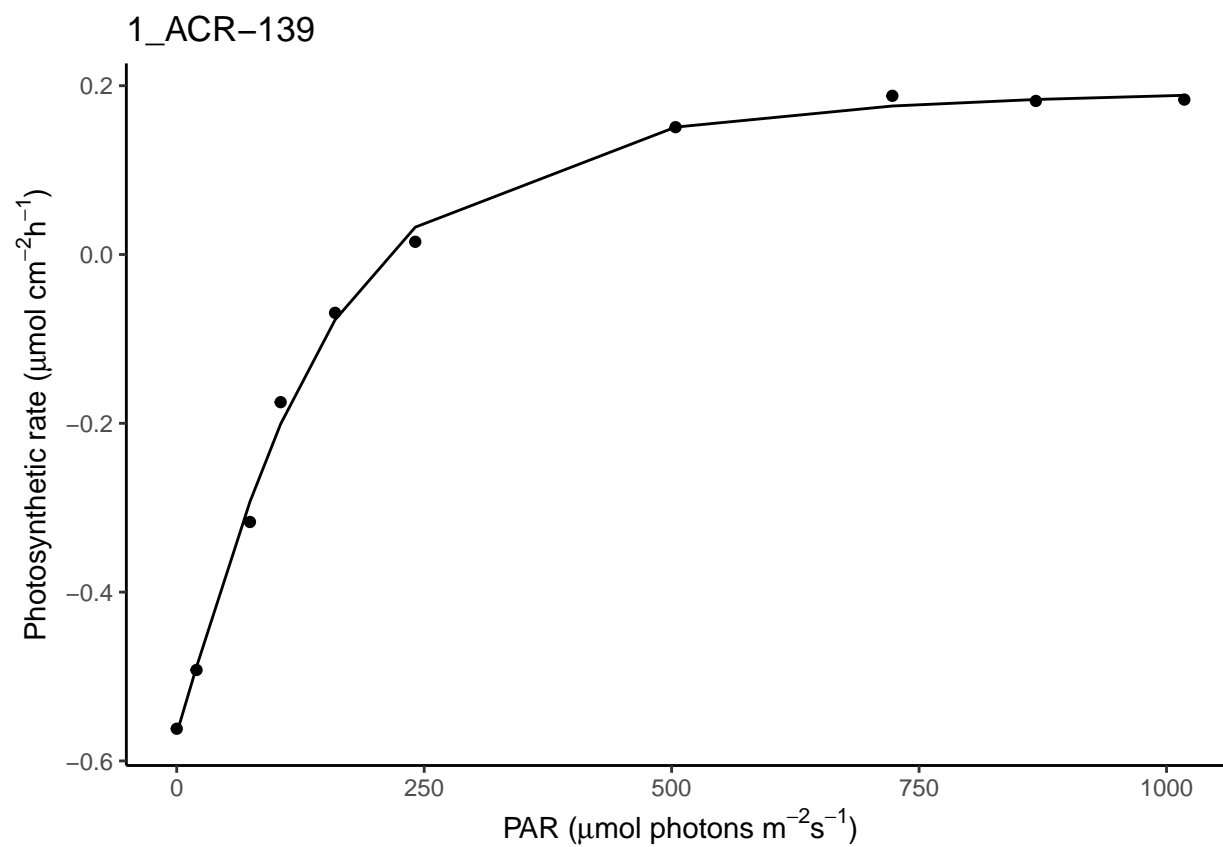
## -----  
## augmented\$colony\_id: POC-43



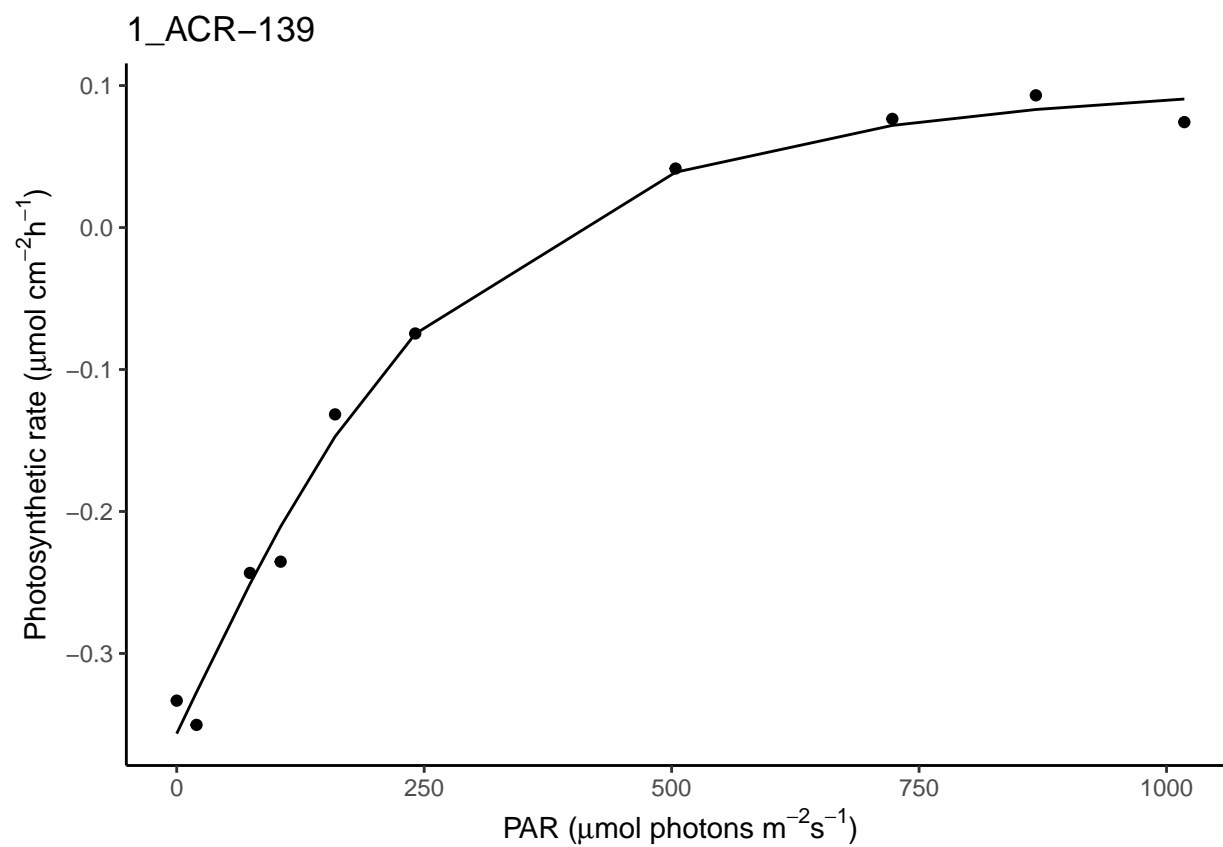
## -----  
## augmented\$colony\_id: POC-44



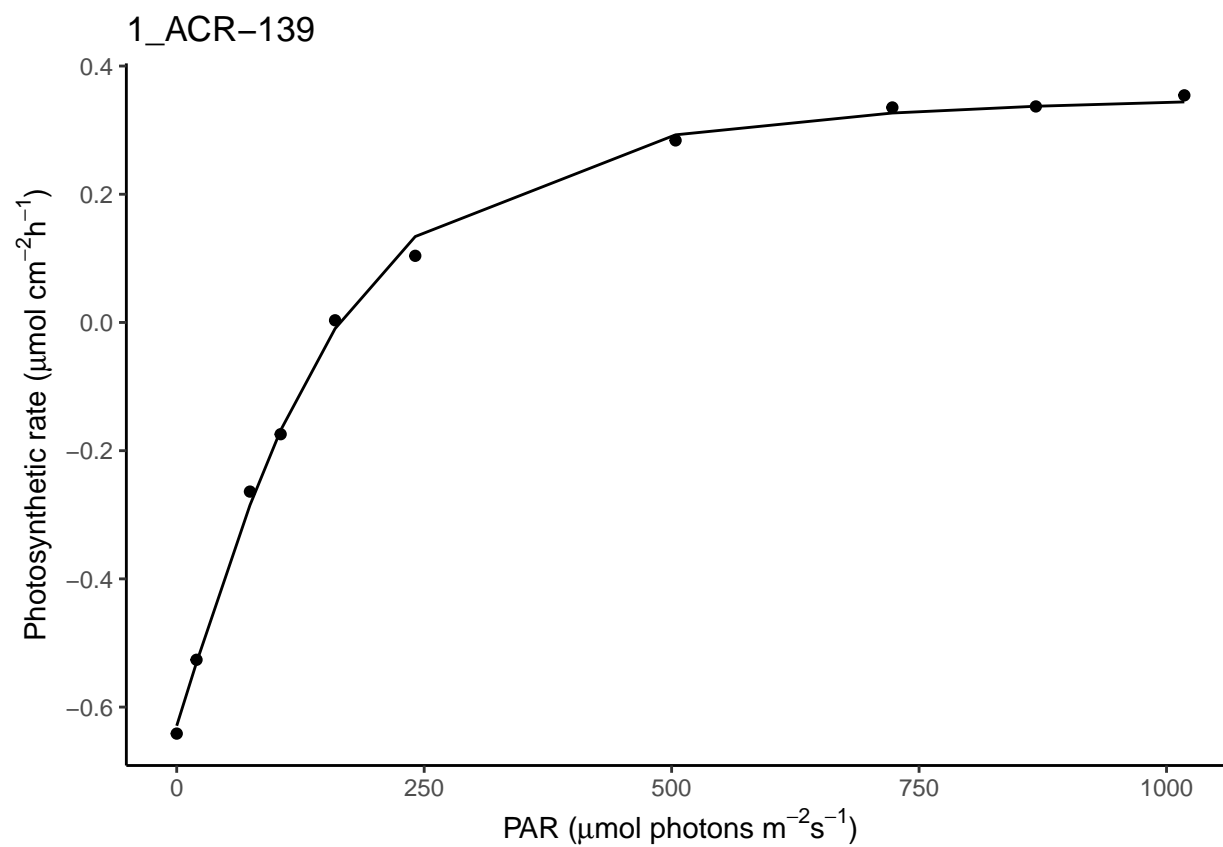
```
## -----  
## augmented$colony_id: POC-45
```



## -----  
## augmented\$colony\_id: POC-47

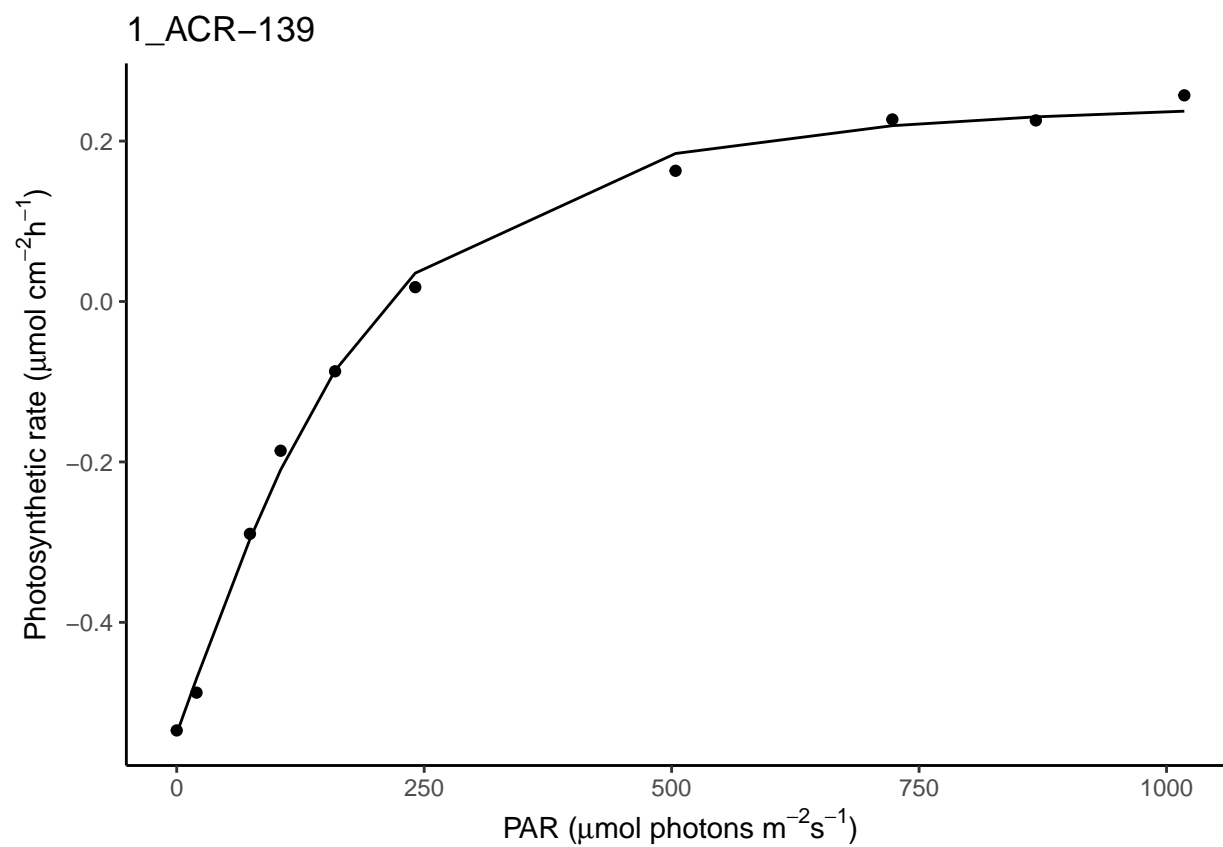


## -----  
## augmented\$colony\_id: POC-48

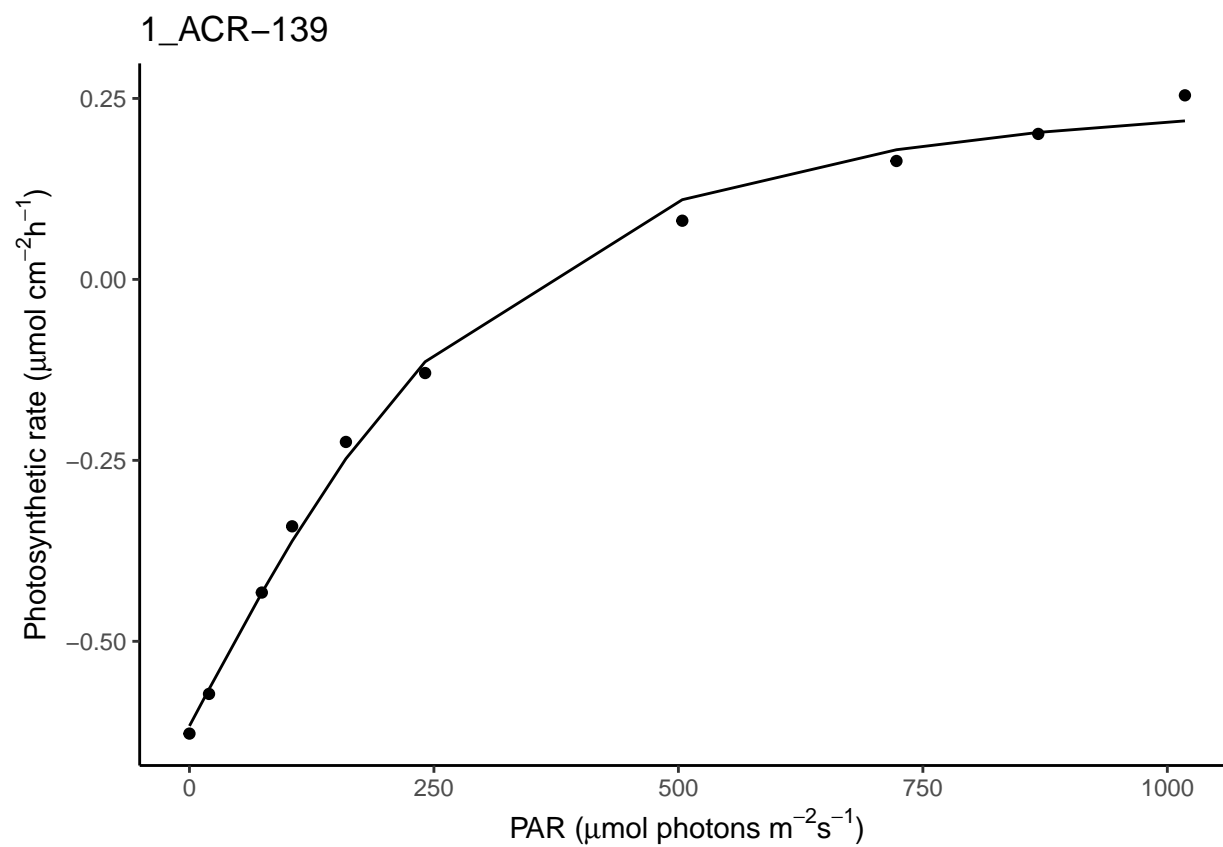


## -----  
## augmented\$colony\_id: POC-52

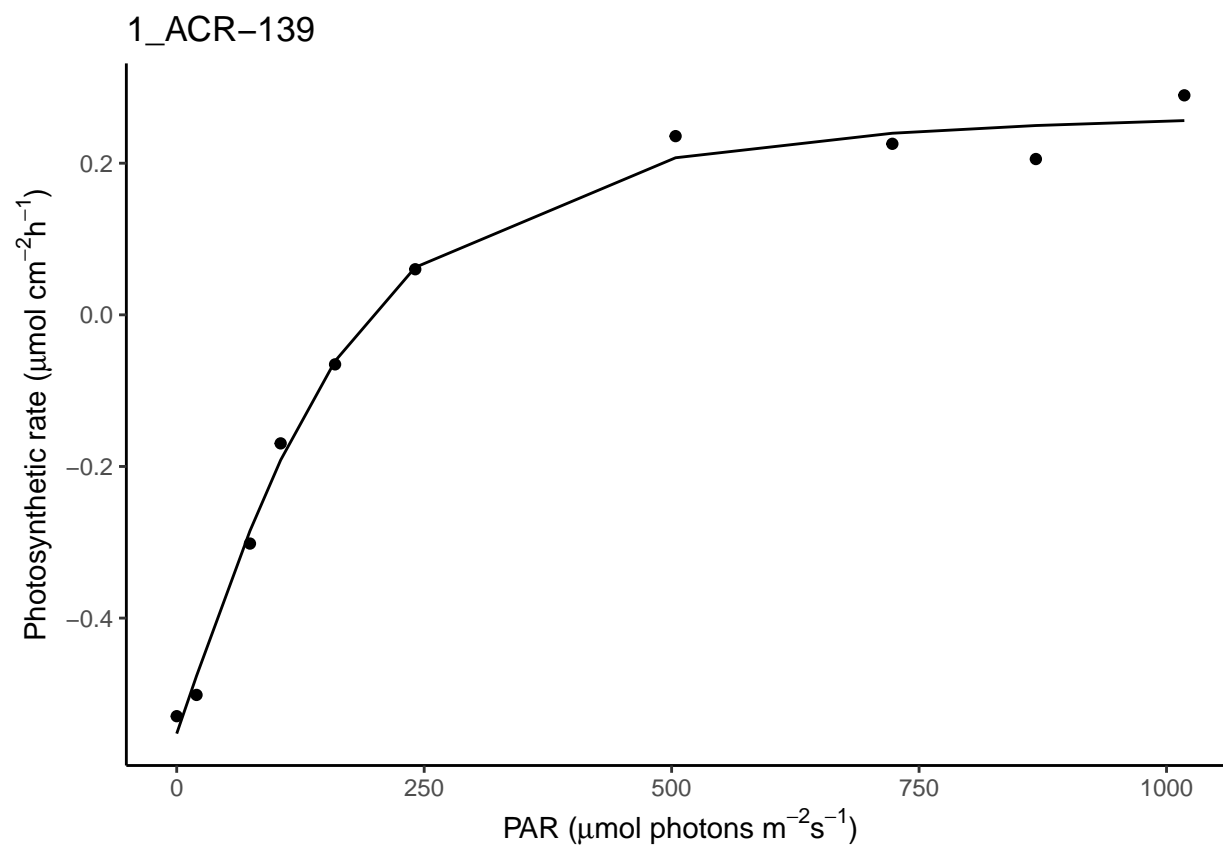




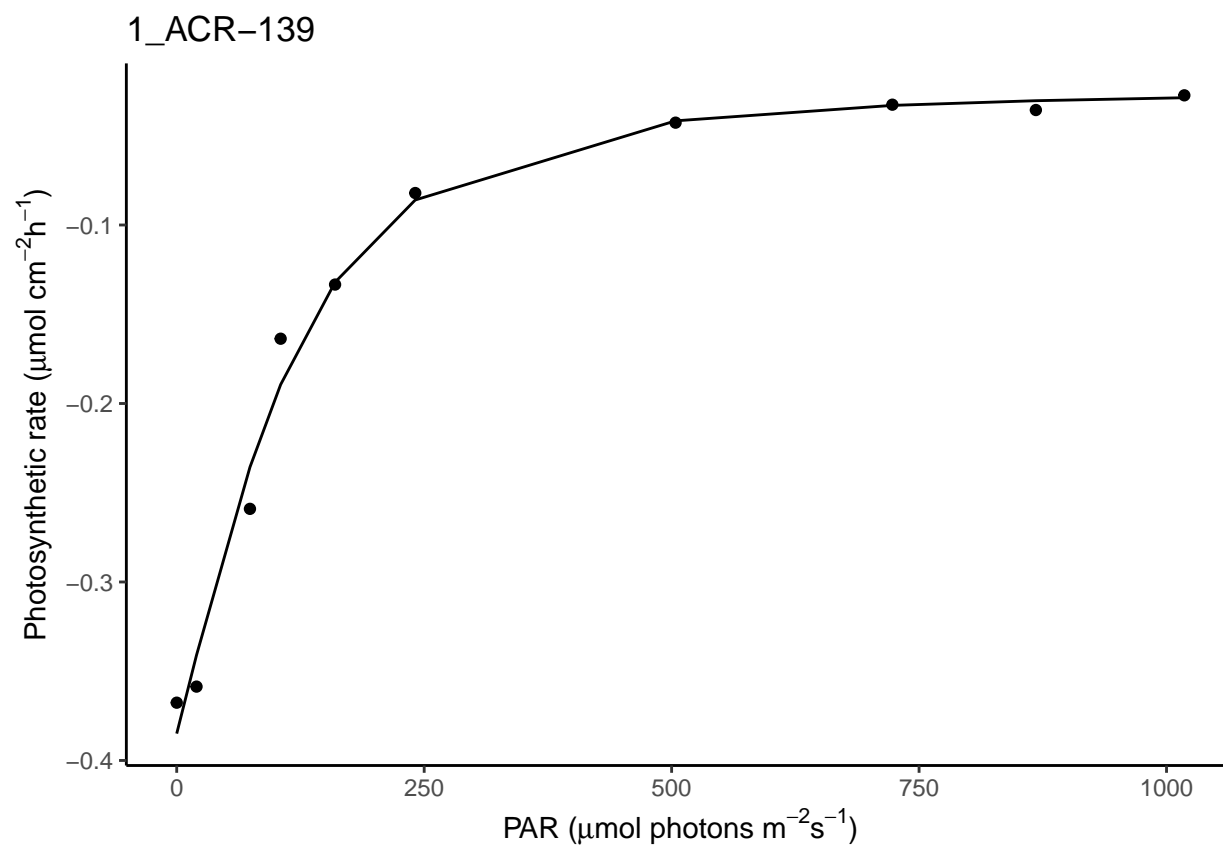
## -----  
## augmented\$colony\_id: POC-53



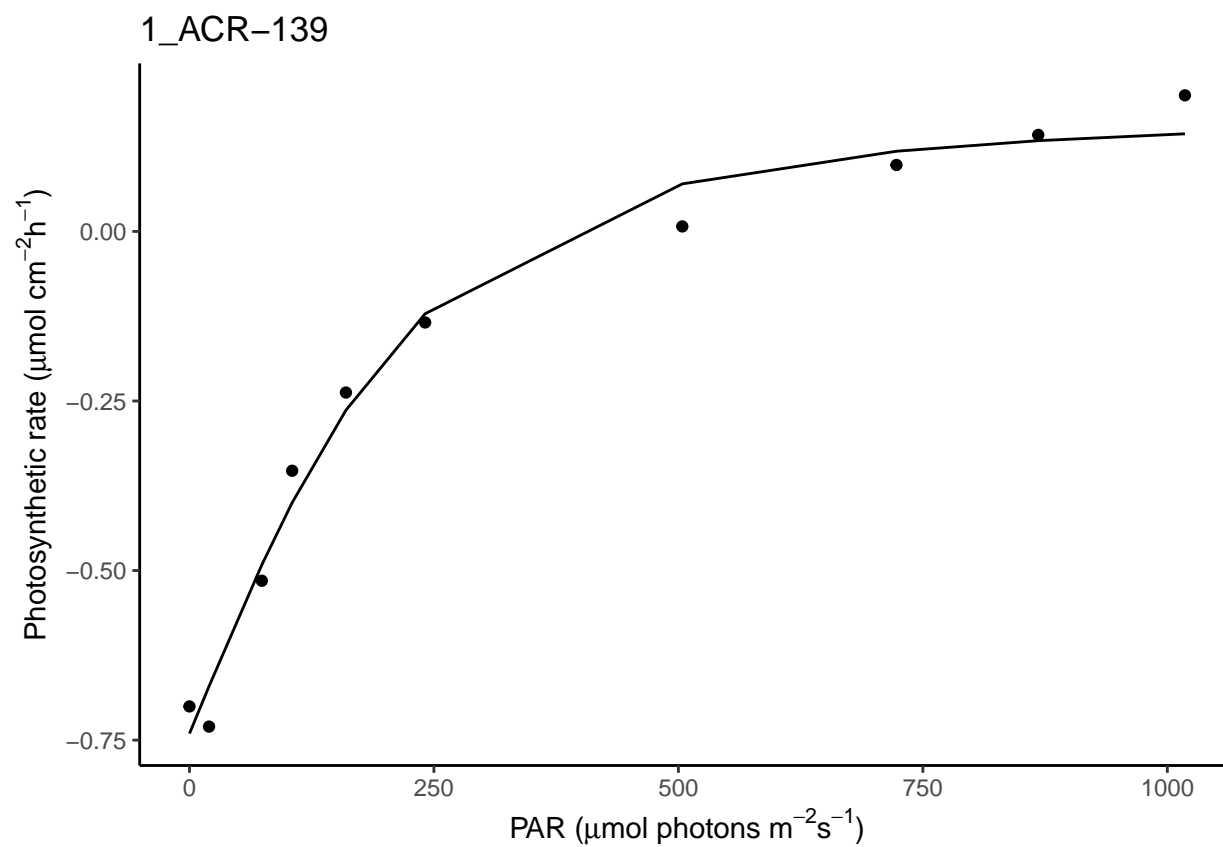
## -----  
## augmented\$colony\_id: P0C-55



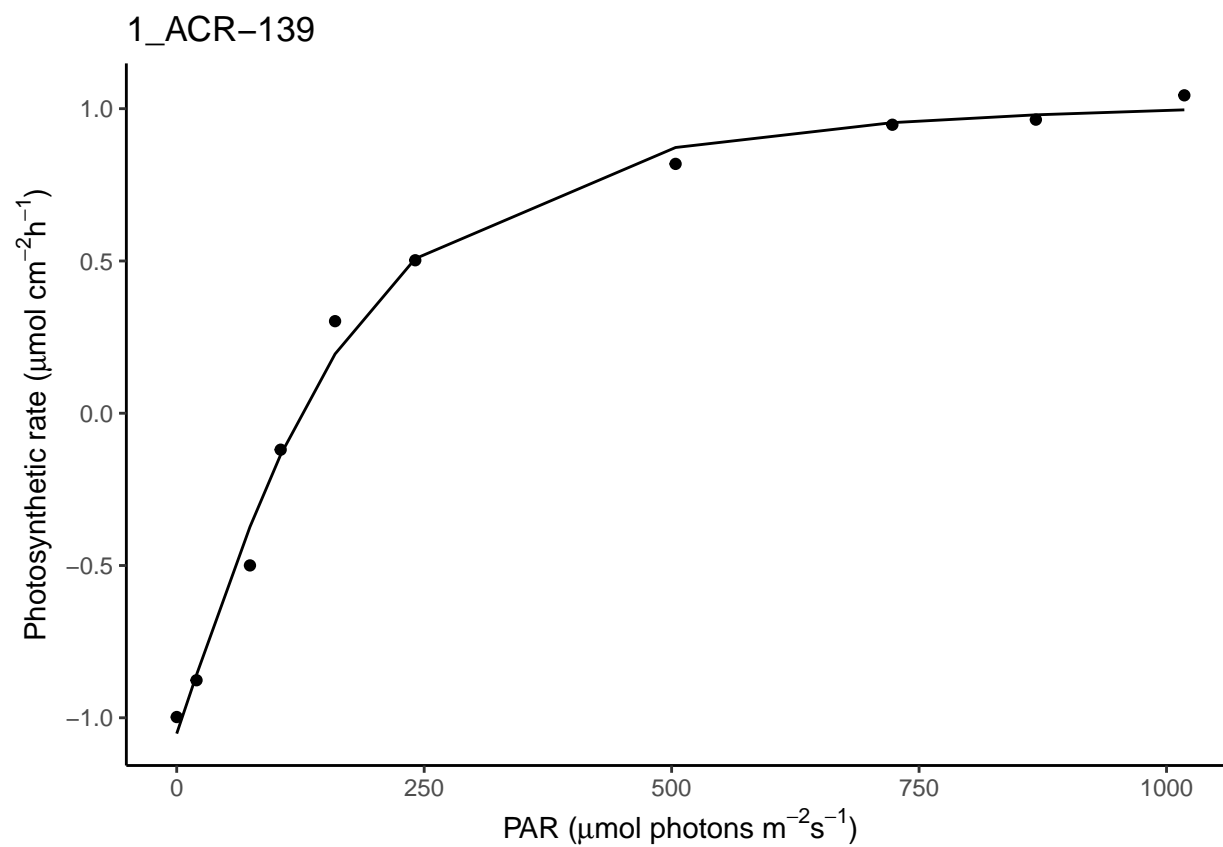
## -----  
## augmented\$colony\_id: POC-57



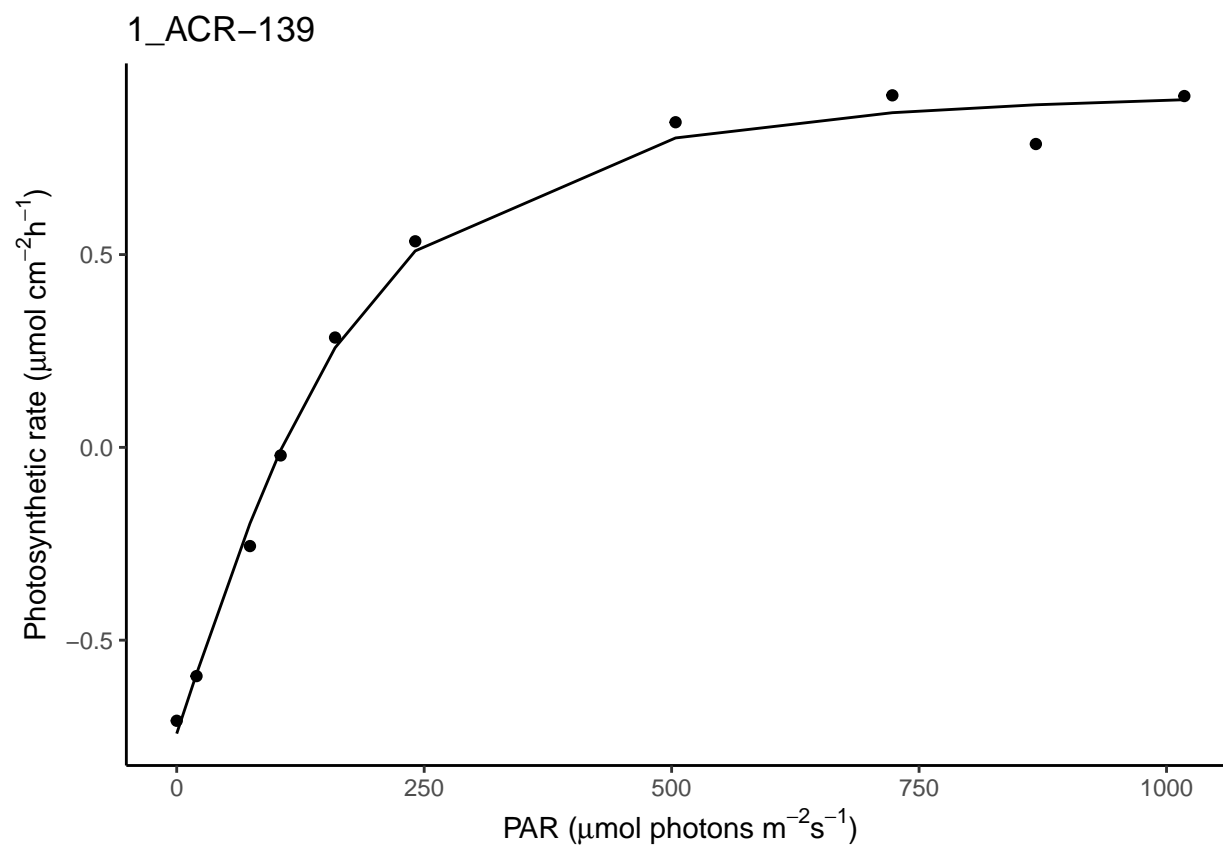
## -----  
## augmented\$colony\_id: POC-68



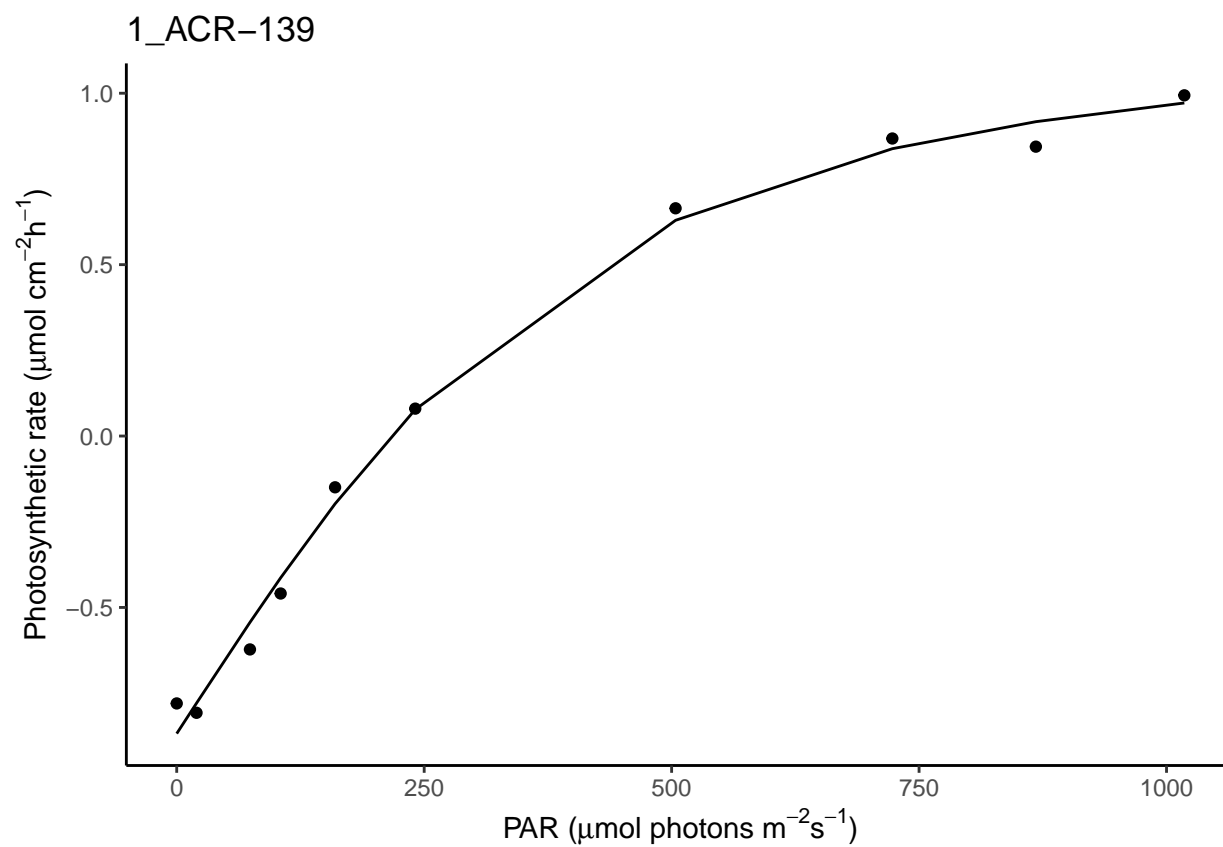
## -----  
## augmented\$colony\_id: POR-209



## -----  
## augmented\$colony\_id: POR-214

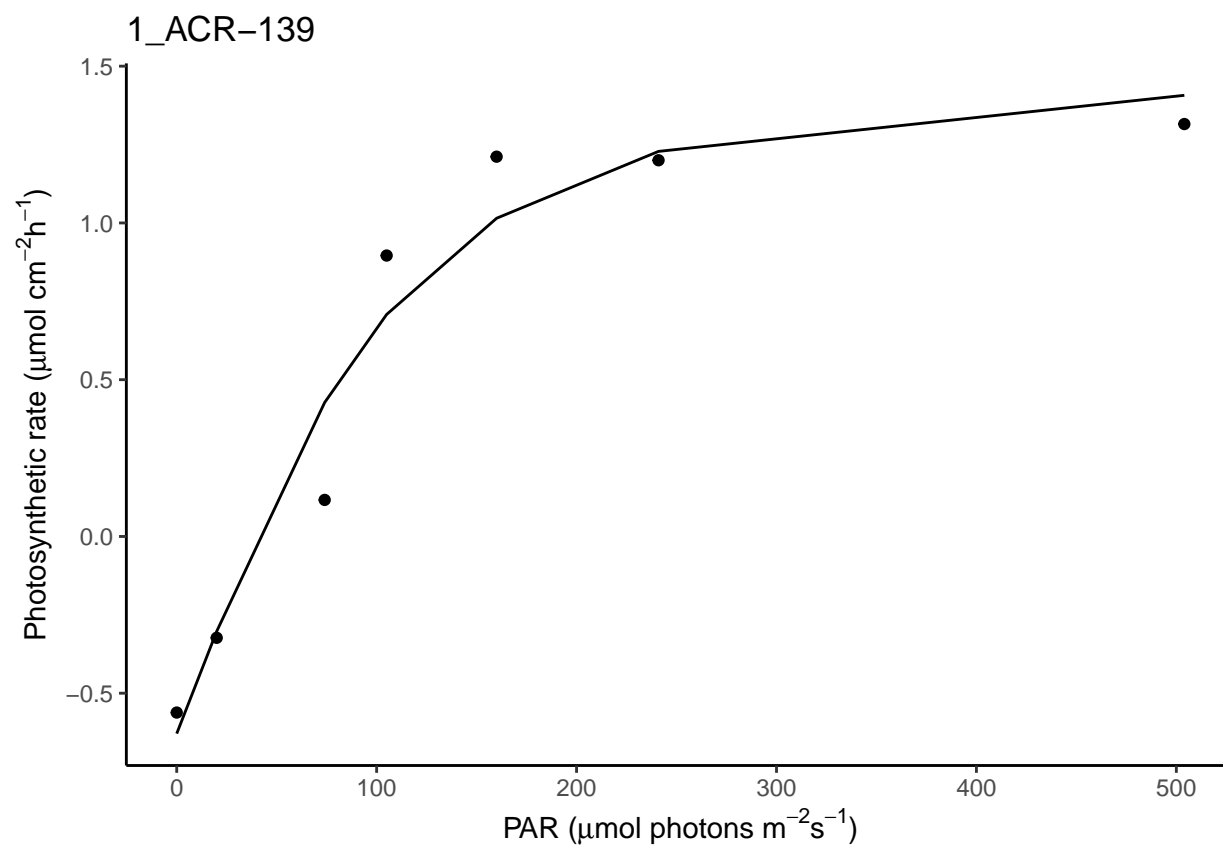


```
## -----  
## augmented$colony_id: POR-216
```

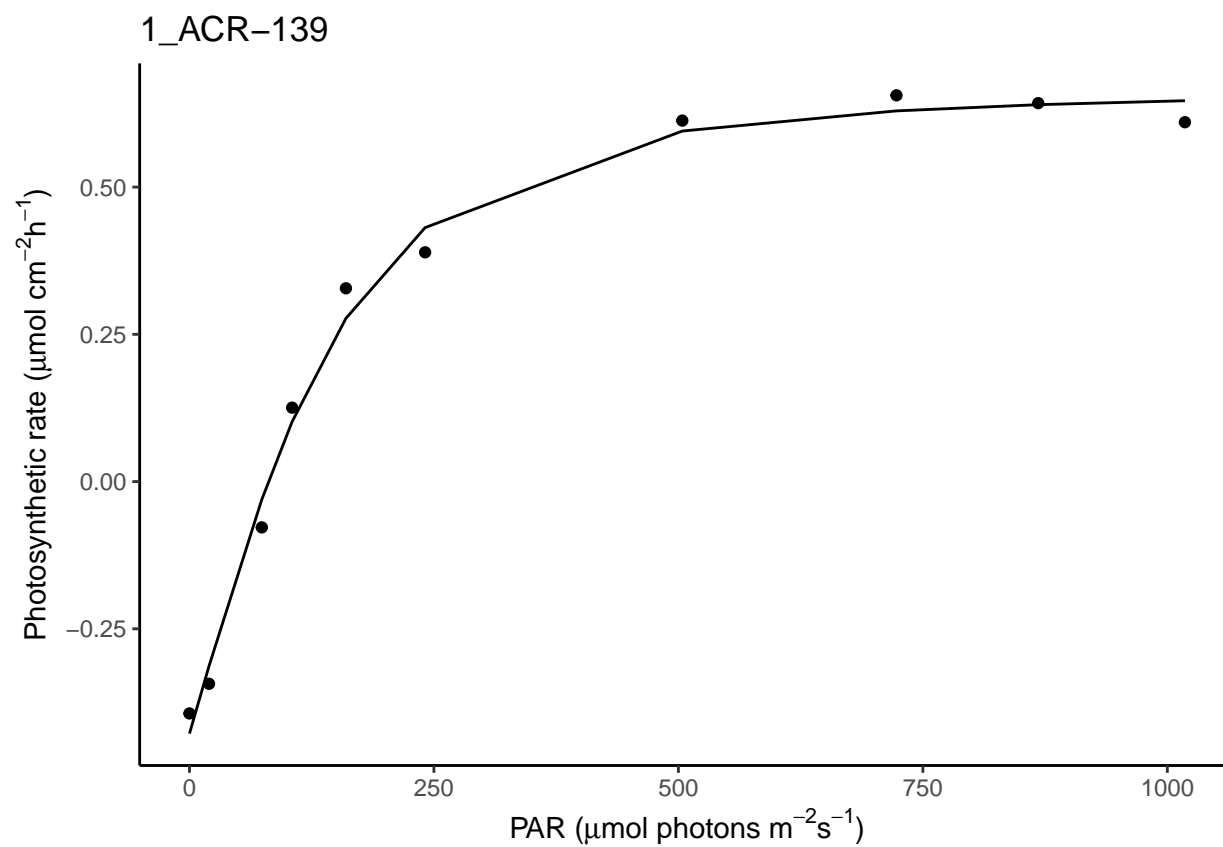


## -----  
## augmented\$colony\_id: POR-221

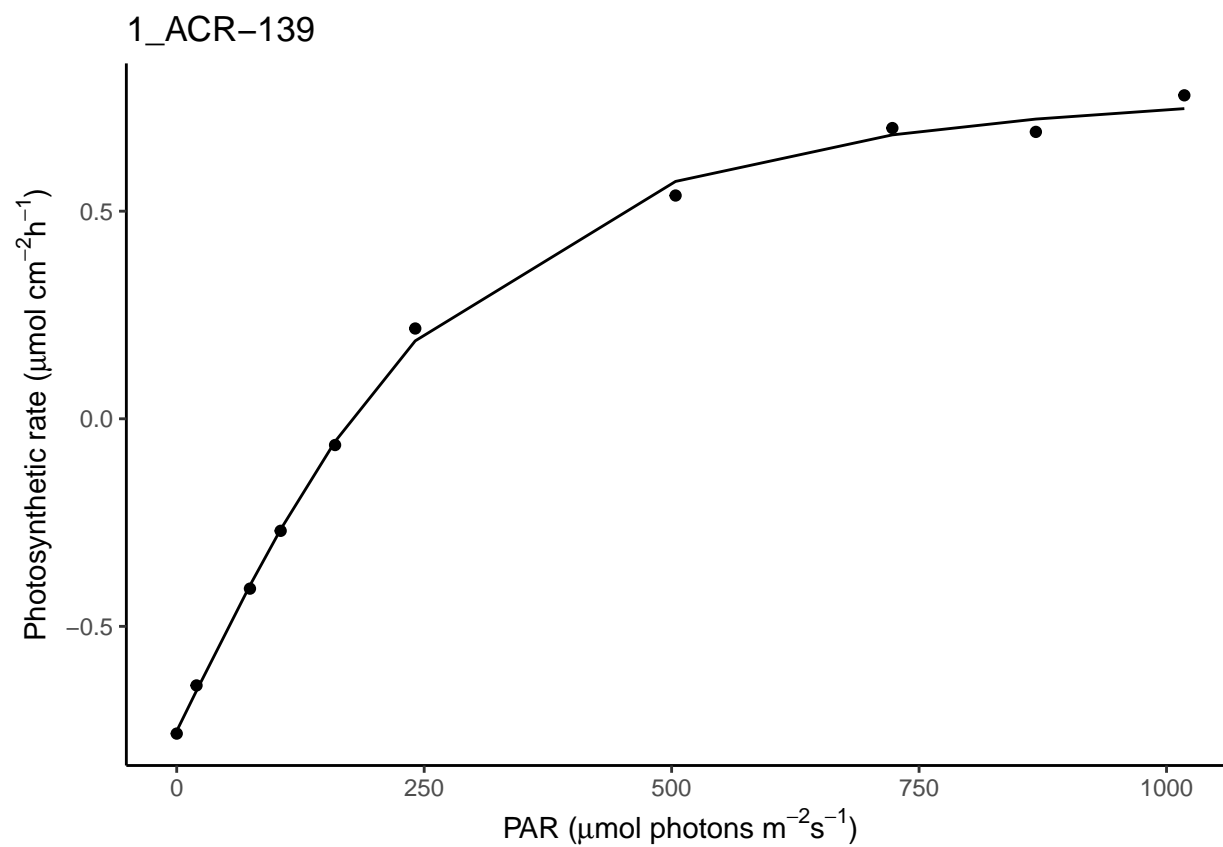




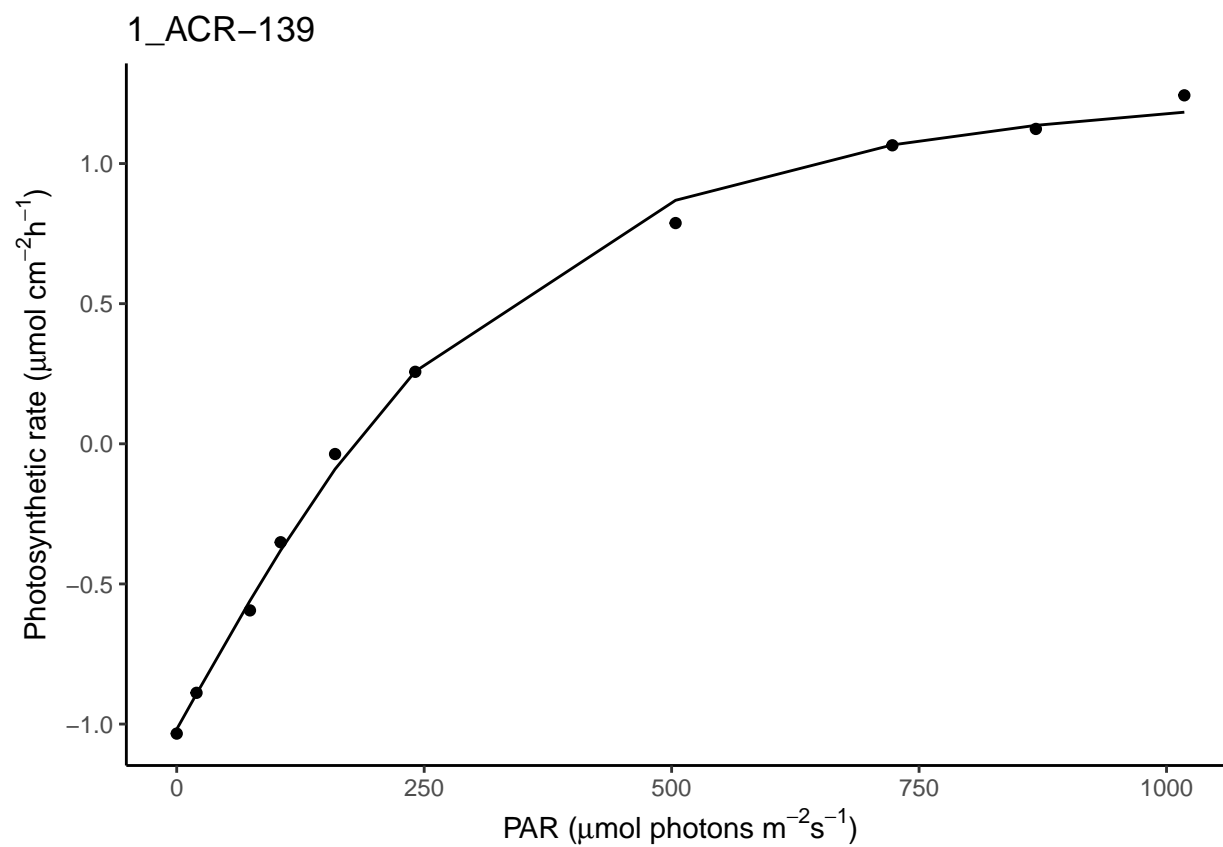
```
## -----  
## augmented$colony_id: POR-224
```



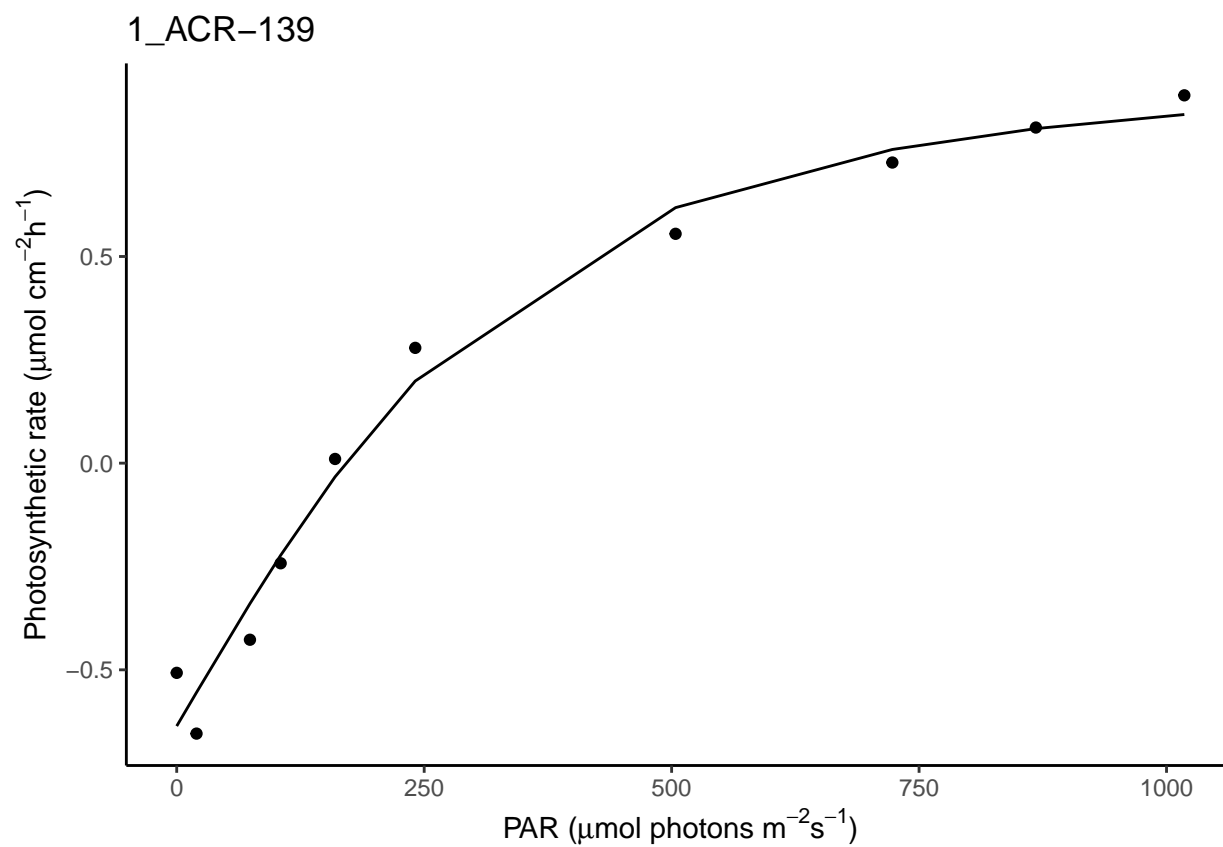
## -----  
## augmented\$colony\_id: POR-240



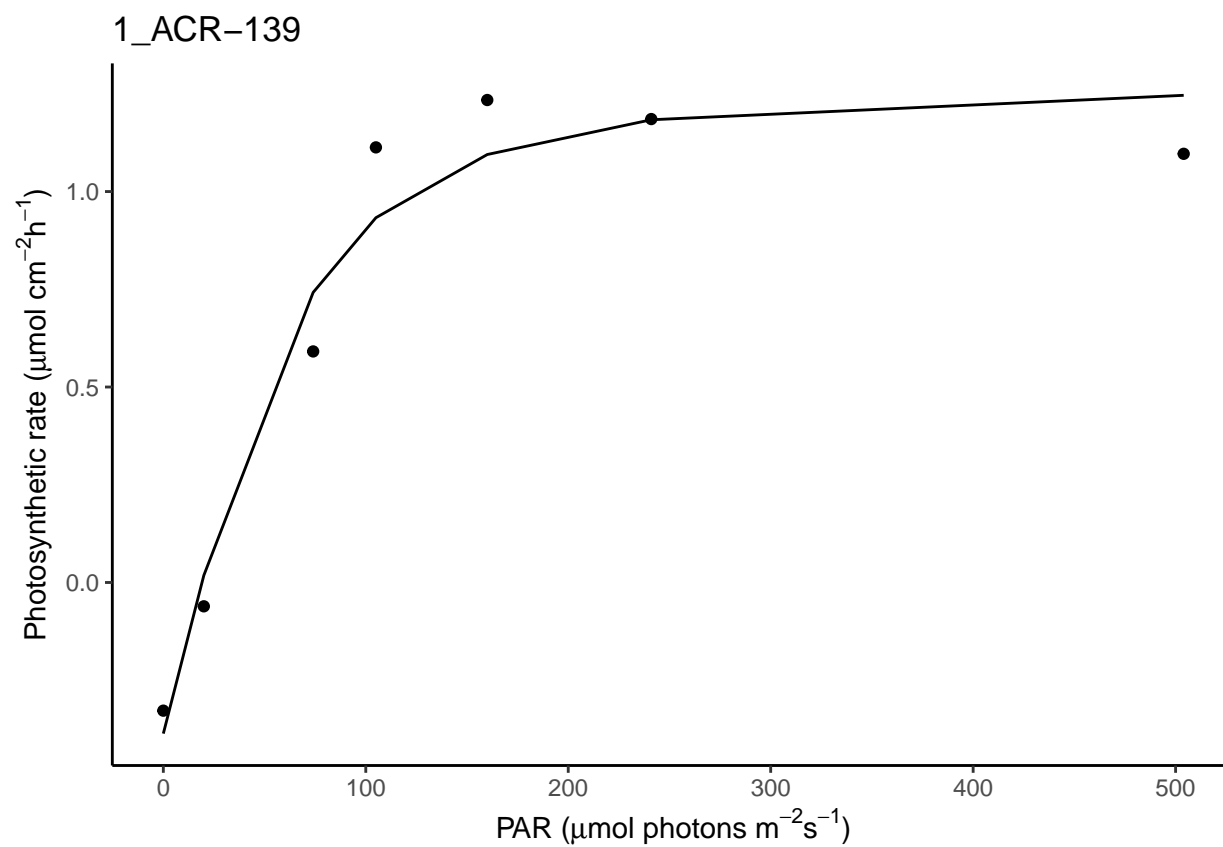
## -----  
## augmented\$colony\_id: POR-242



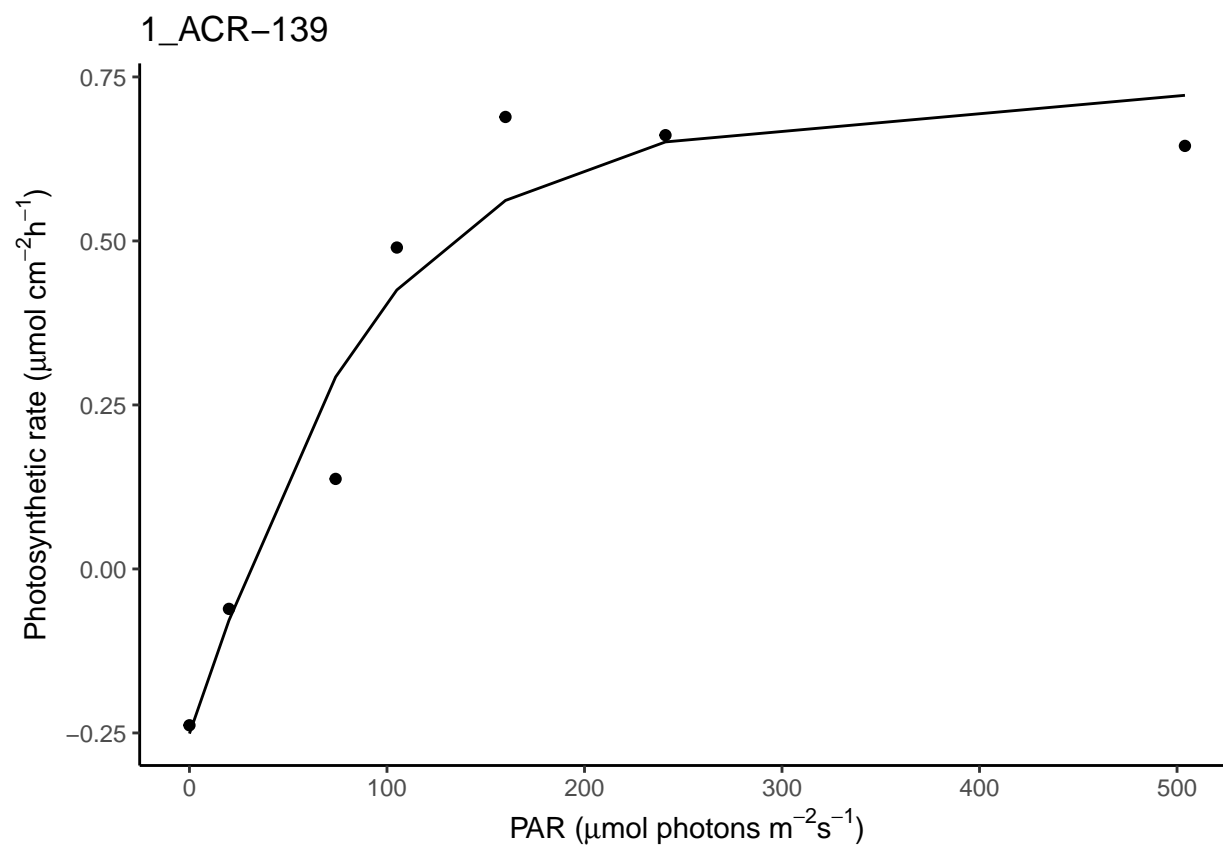
## -----  
## augmented\$colony\_id: POR-245



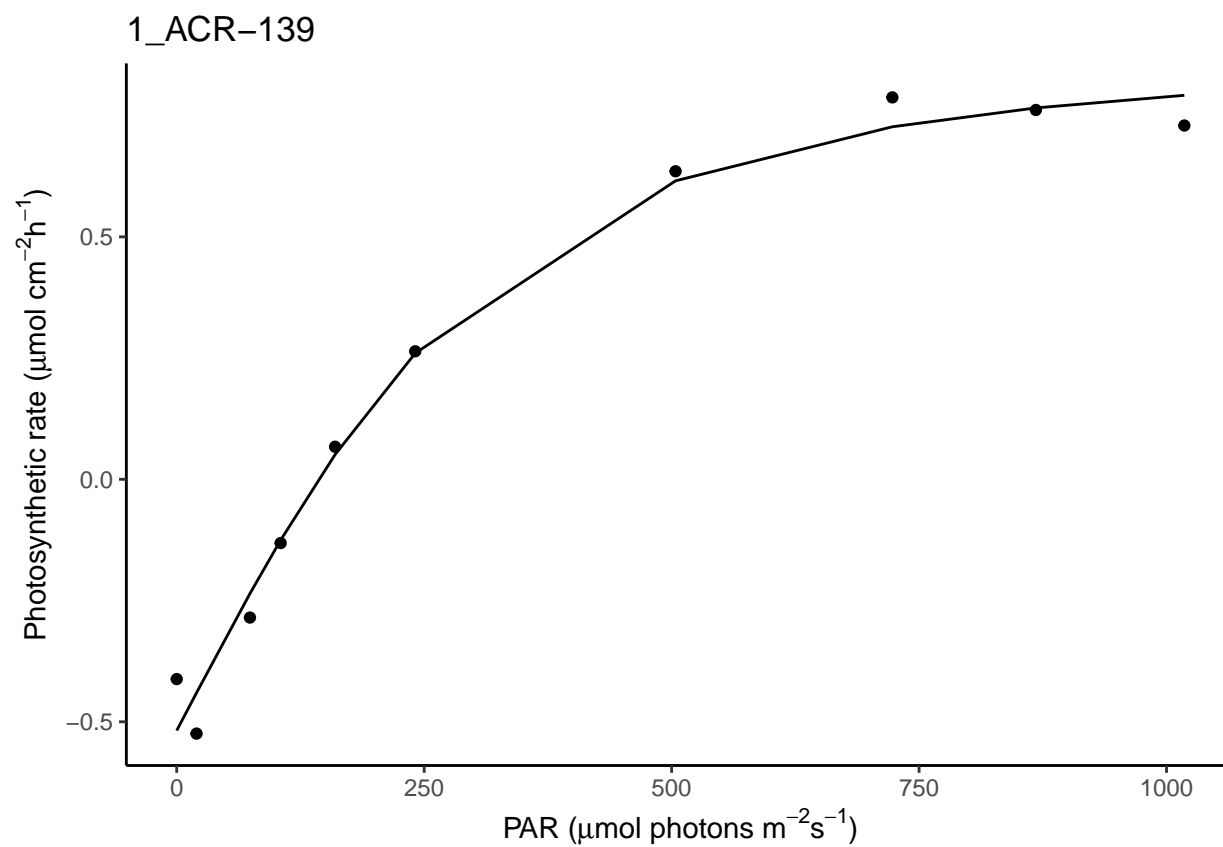
## -----  
## augmented\$colony\_id: POR-251



## -----  
## augmented\$colony\_id: POR-253

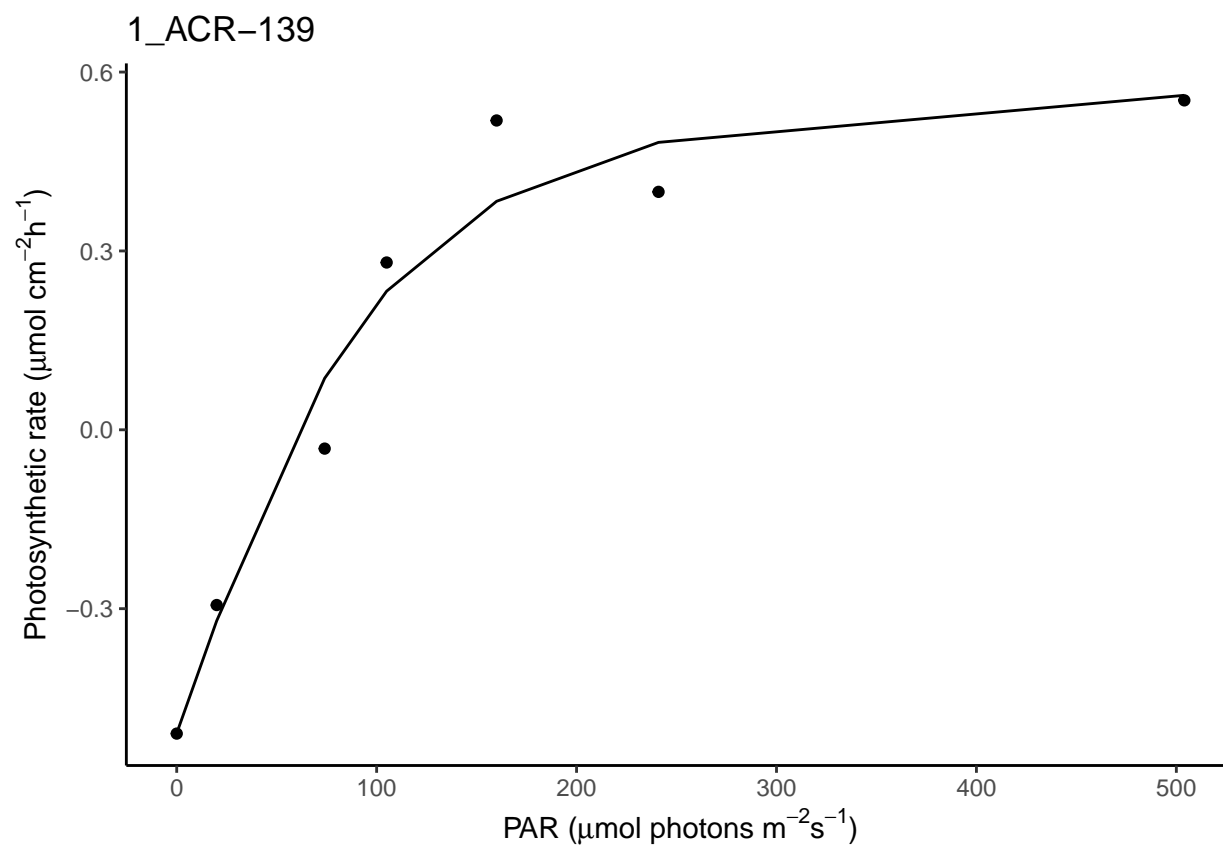


## -----  
## augmented\$colony\_id: POR-260

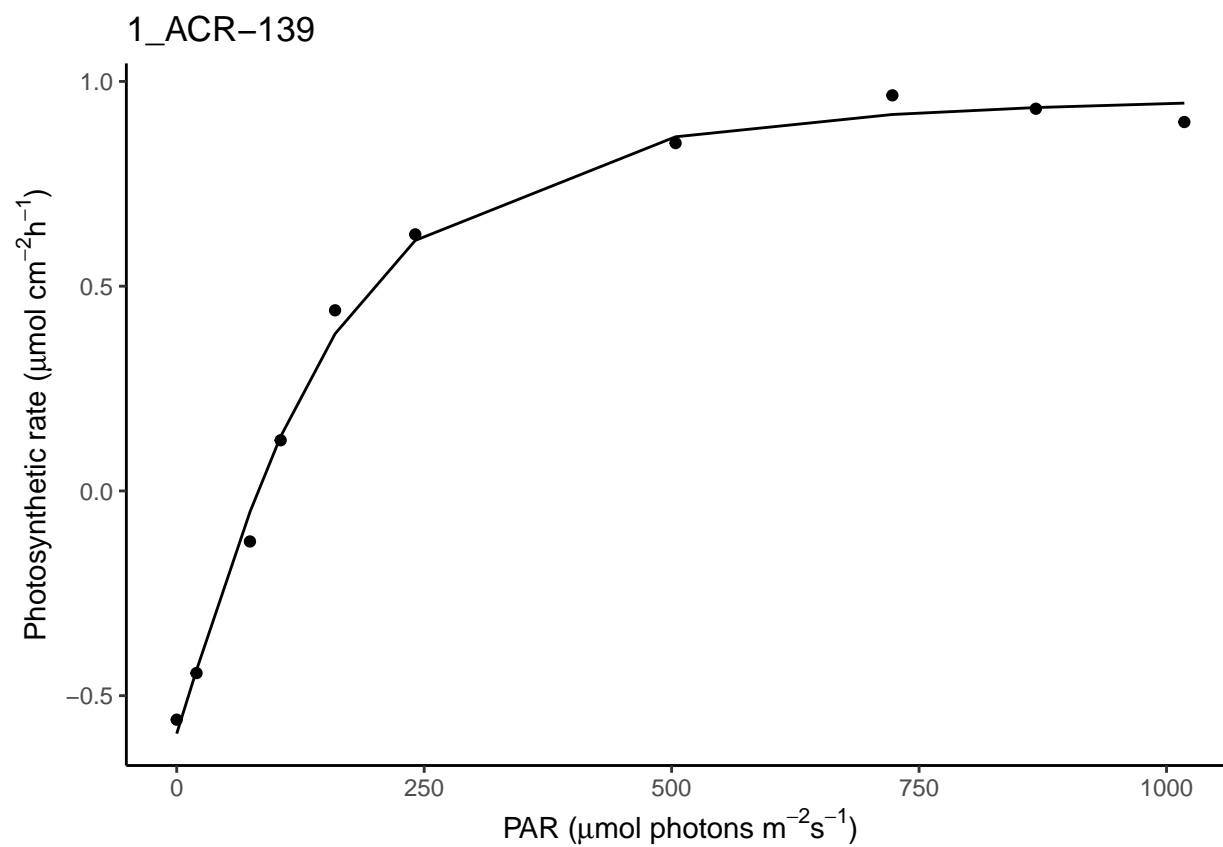


## -----  
## augmented\$colony\_id: POR-262

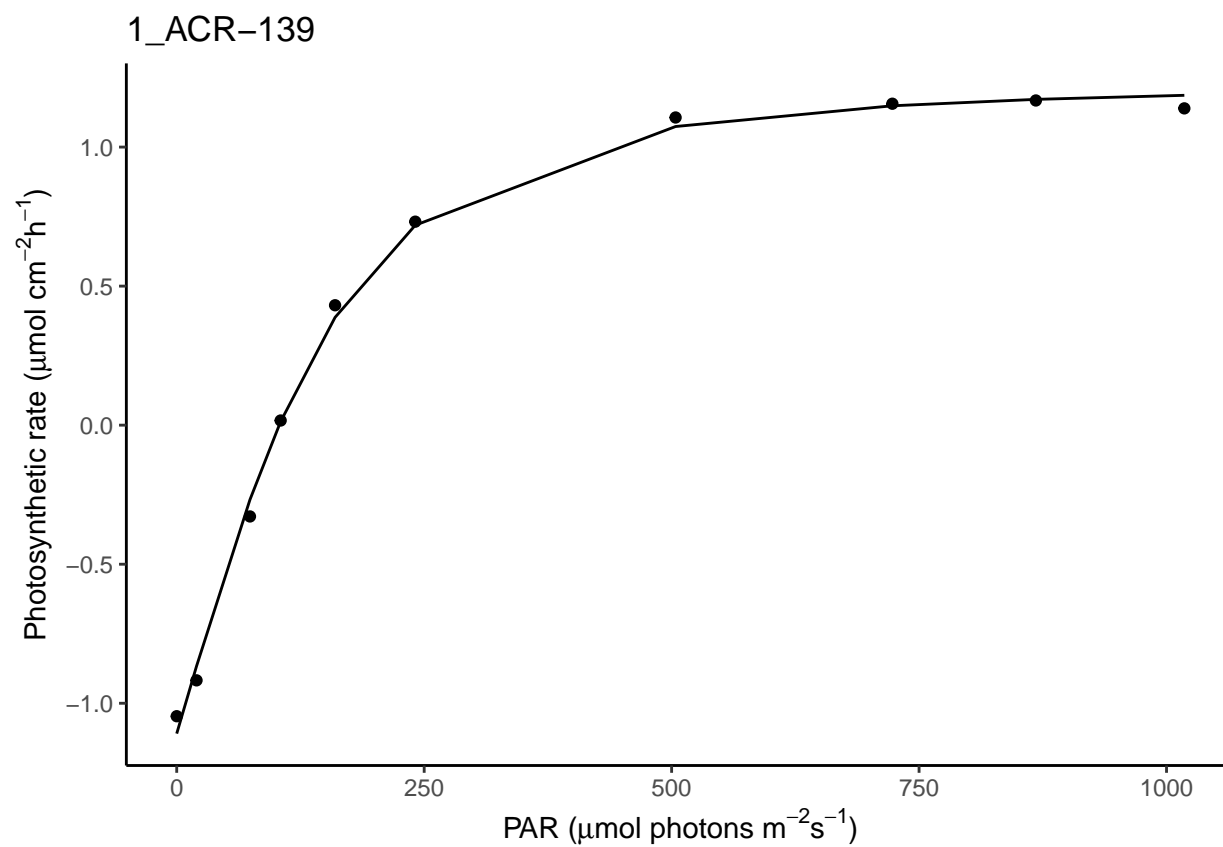




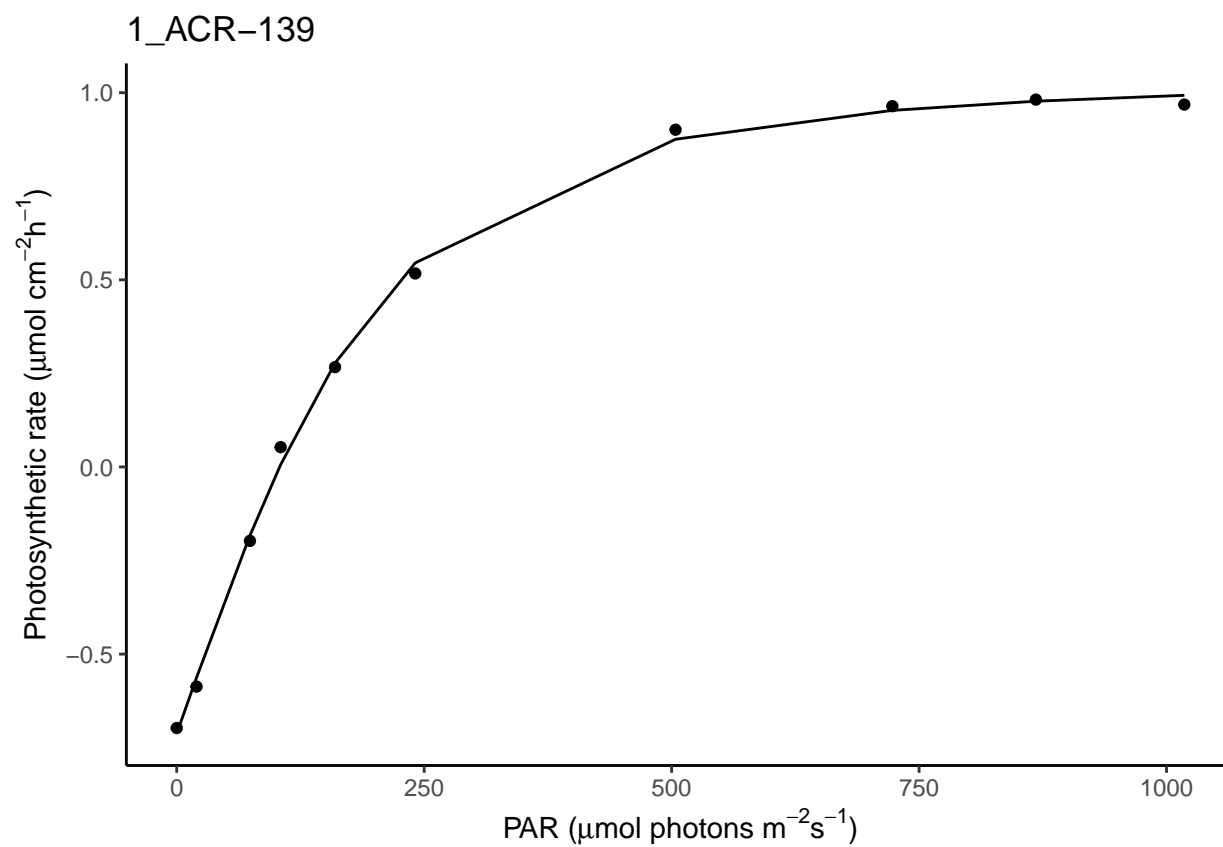
## -----  
## augmented\$colony\_id: POR-338



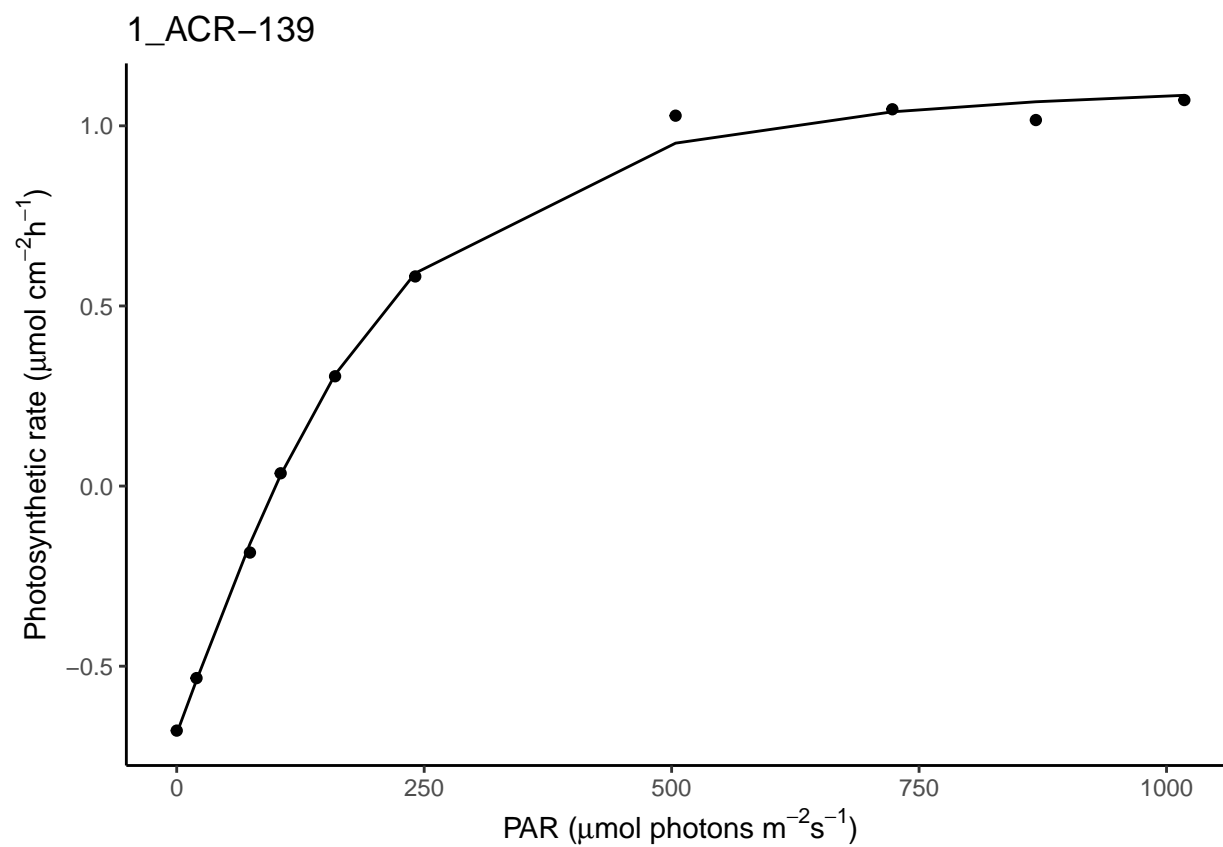
## -----  
## augmented\$colony\_id: POR-340



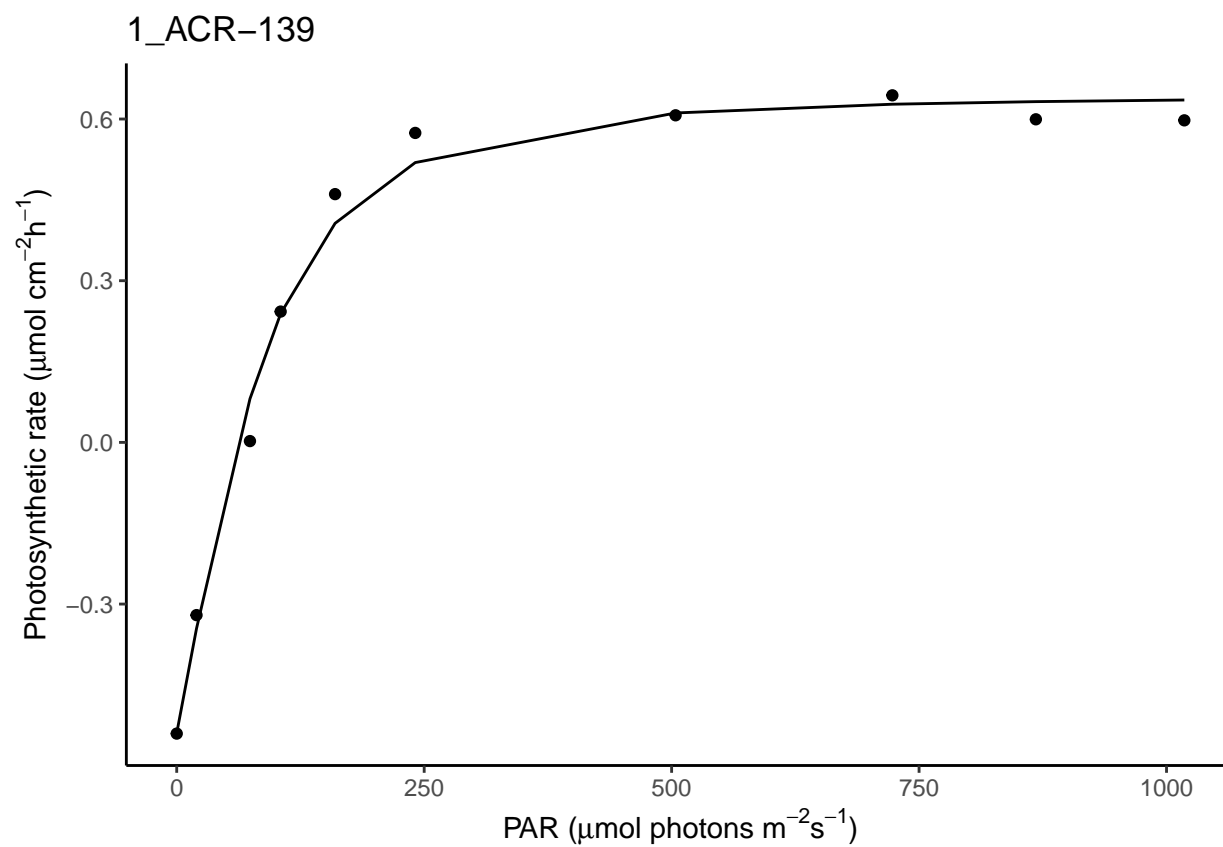
## -----  
## augmented\$colony\_id: POR-341



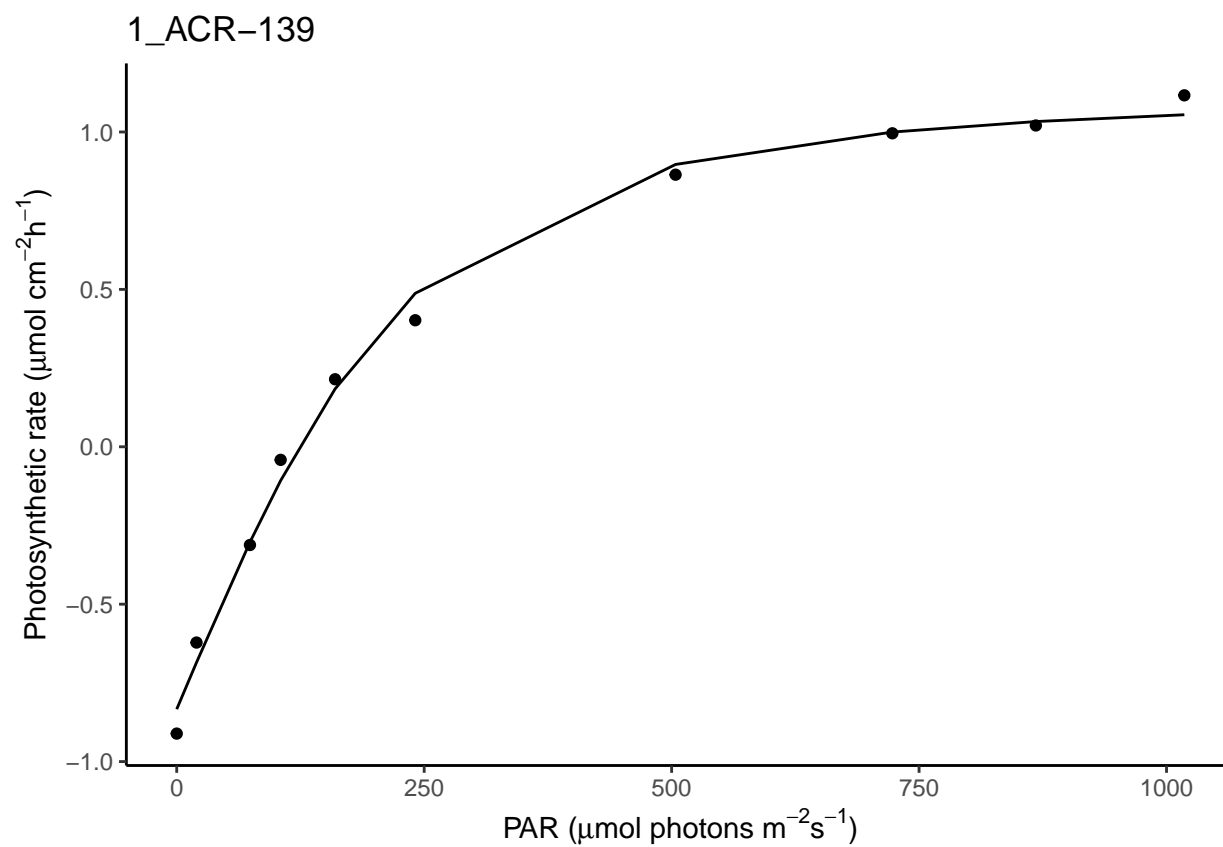
## -----  
## augmented\$colony\_id: POR-349



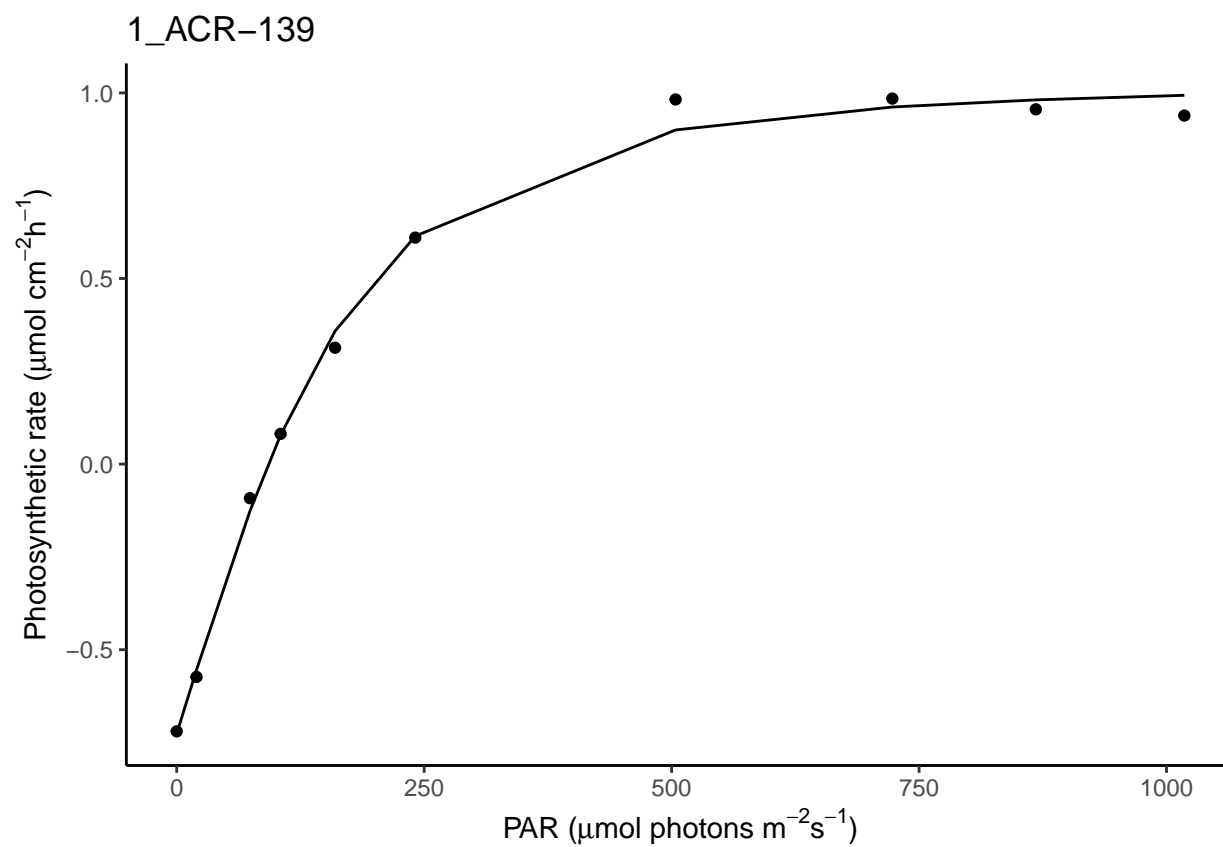
## -----  
## augmented\$colony\_id: POR-353



## -----  
## augmented\$colony\_id: POR-354

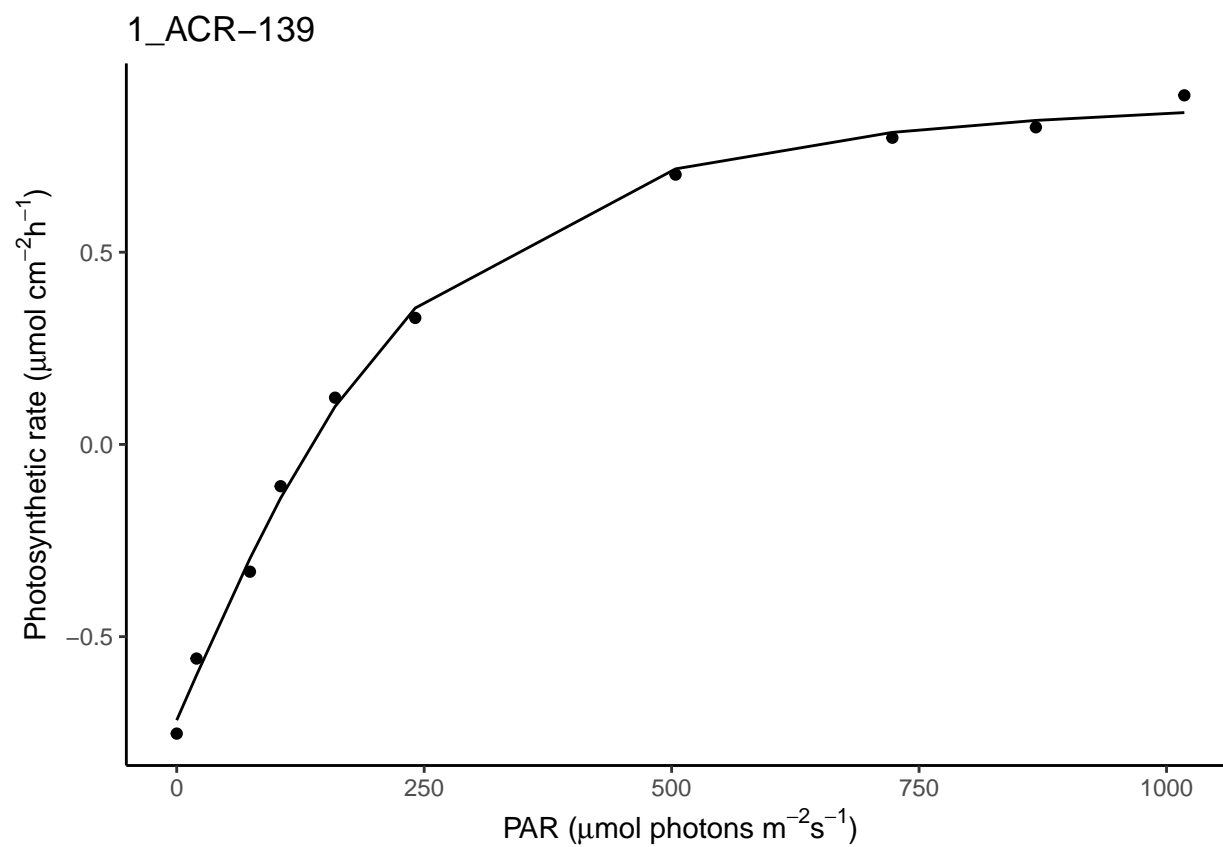


## -----  
## augmented\$colony\_id: POR-355

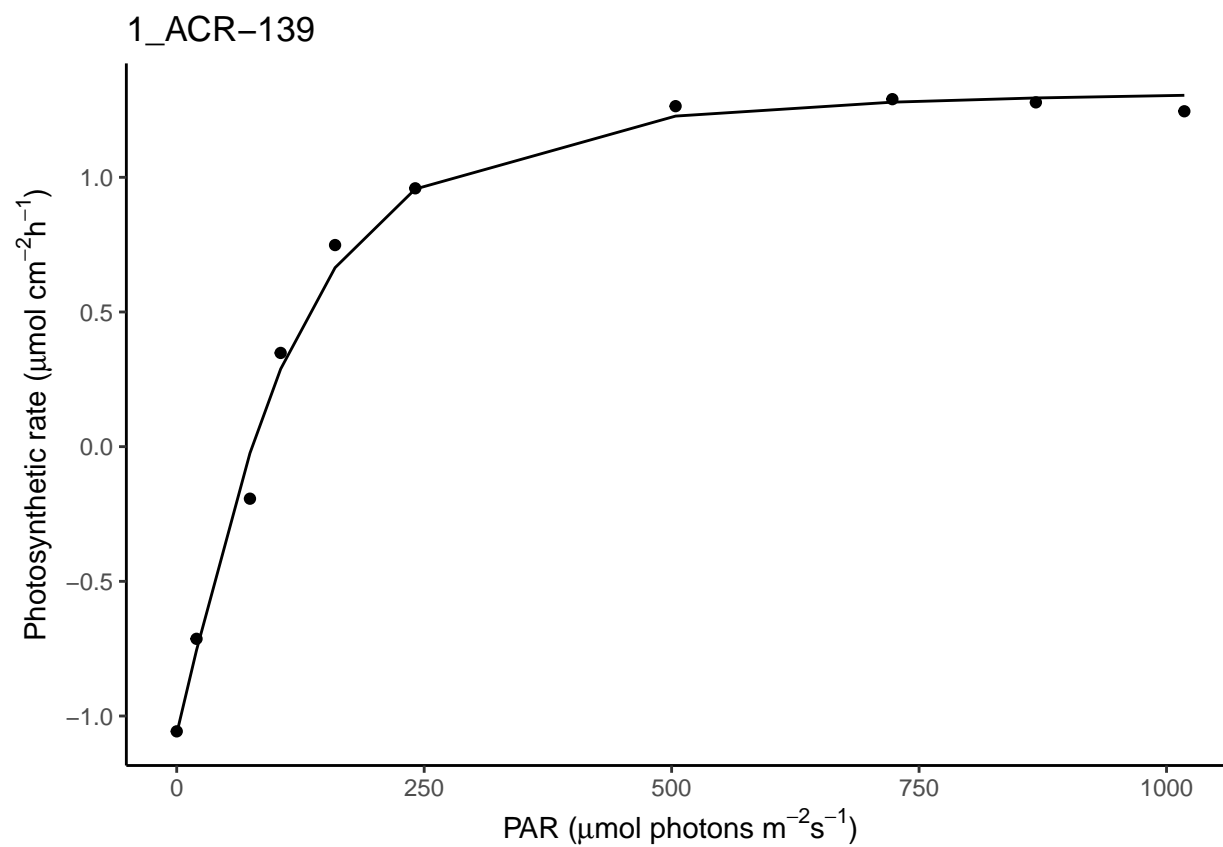


## -----  
## augmented\$colony\_id: POR-357

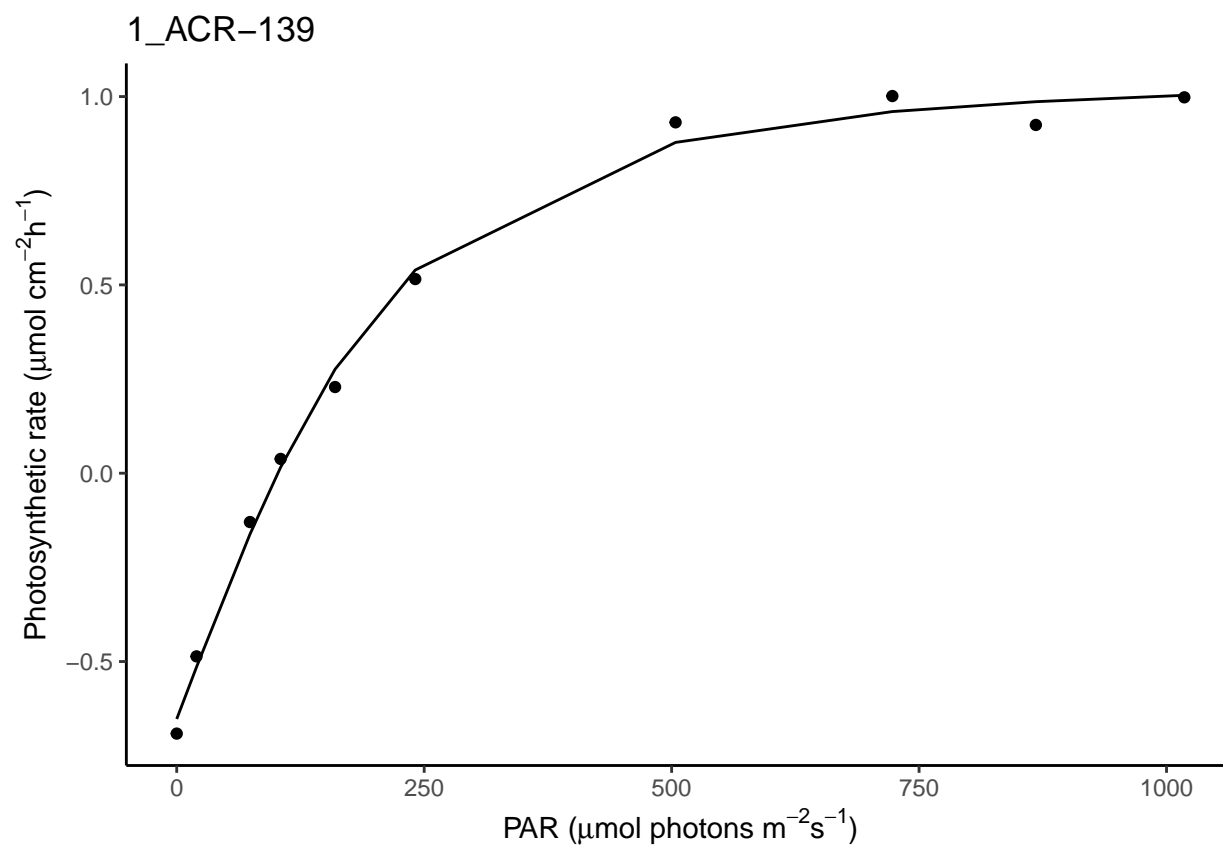




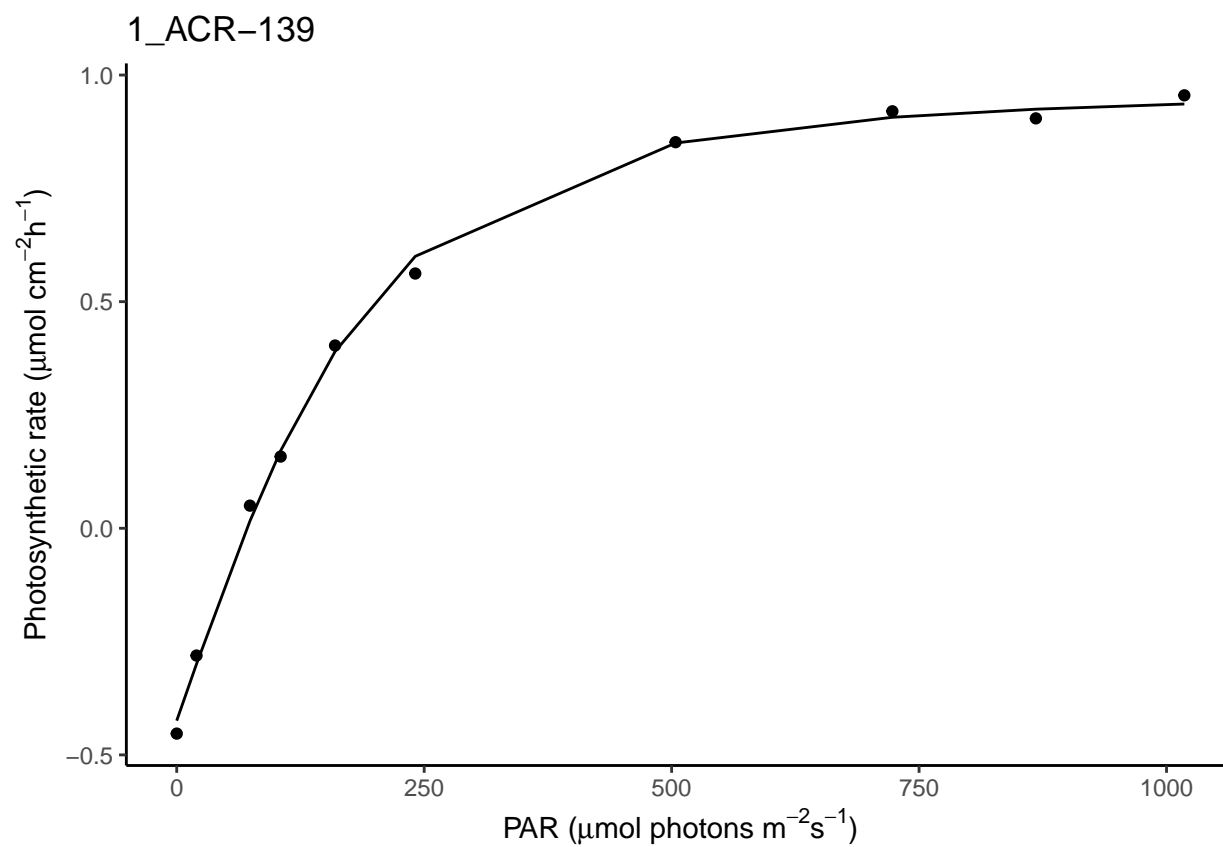
## -----  
## augmented\$colony\_id: POR-362



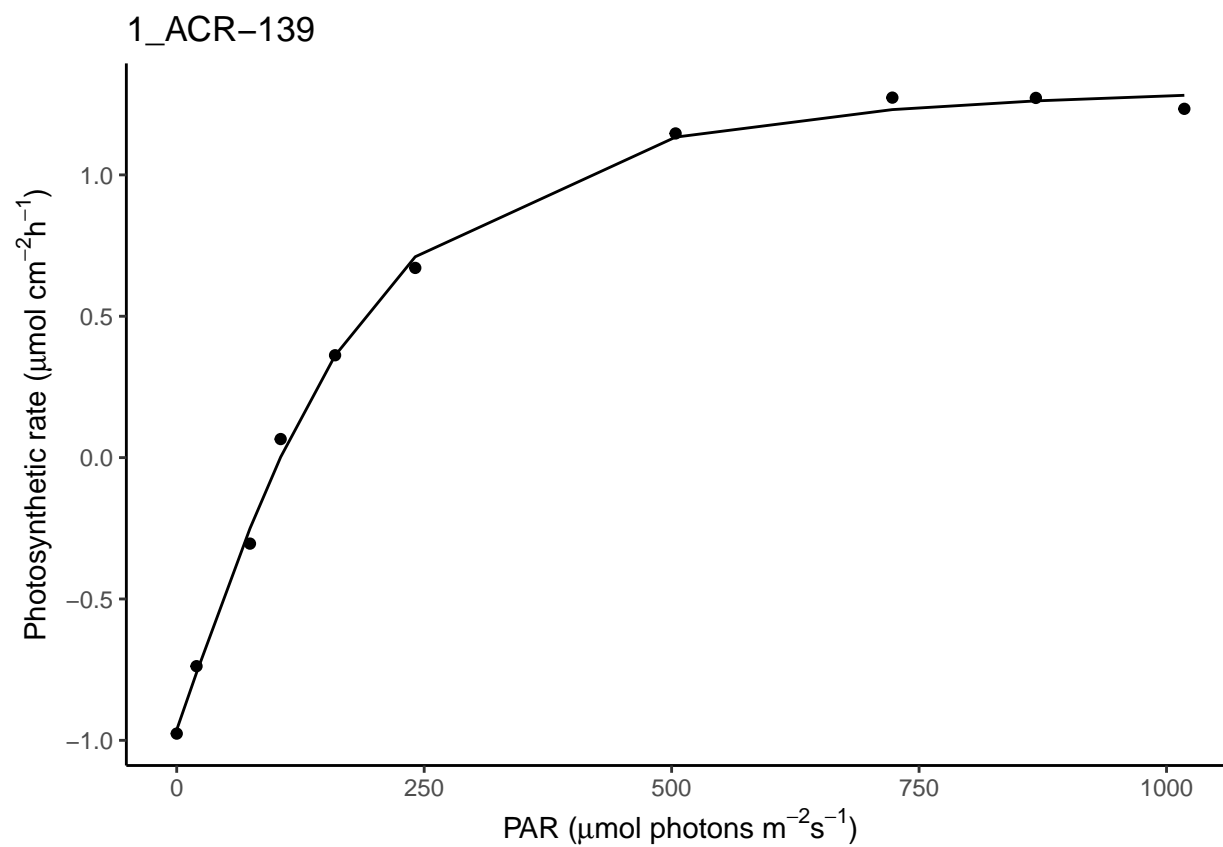
## -----  
## augmented\$colony\_id: POR-365



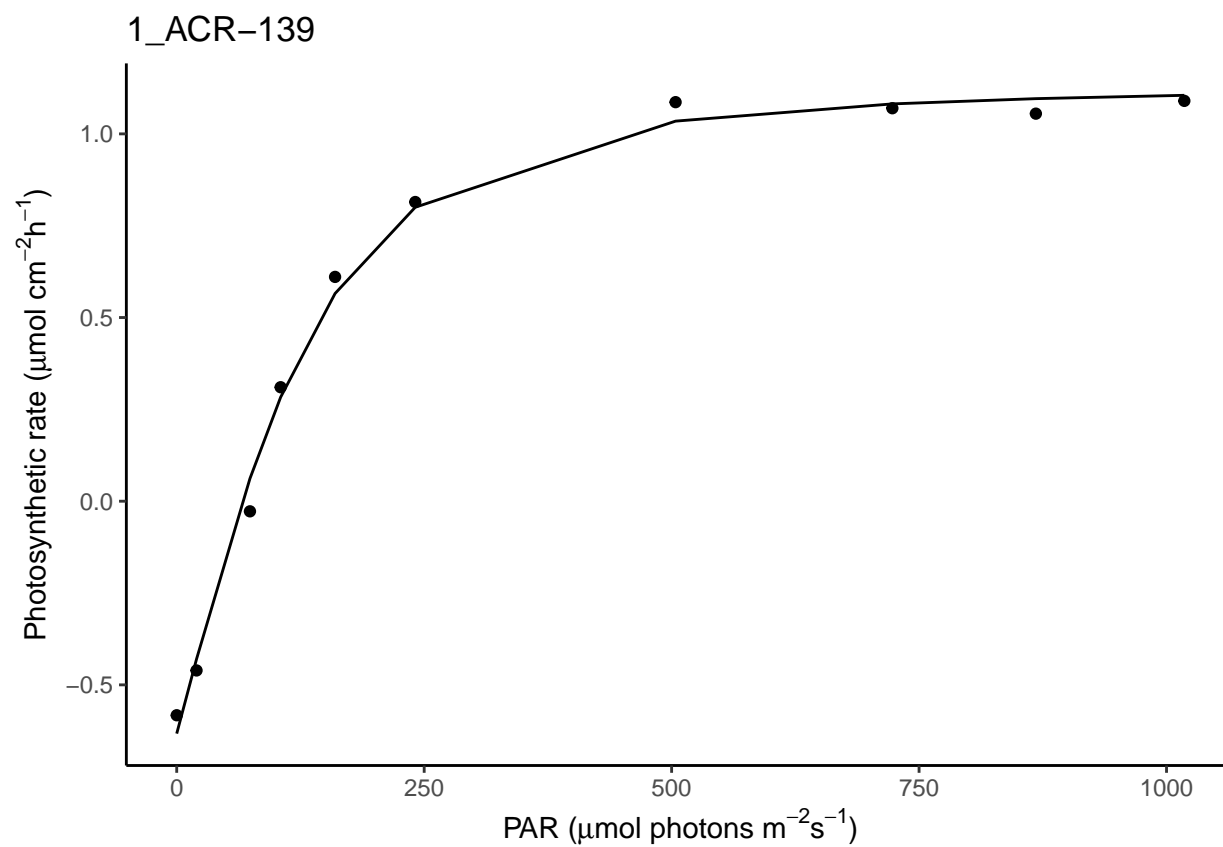
## -----  
## augmented\$colony\_id: POR-367



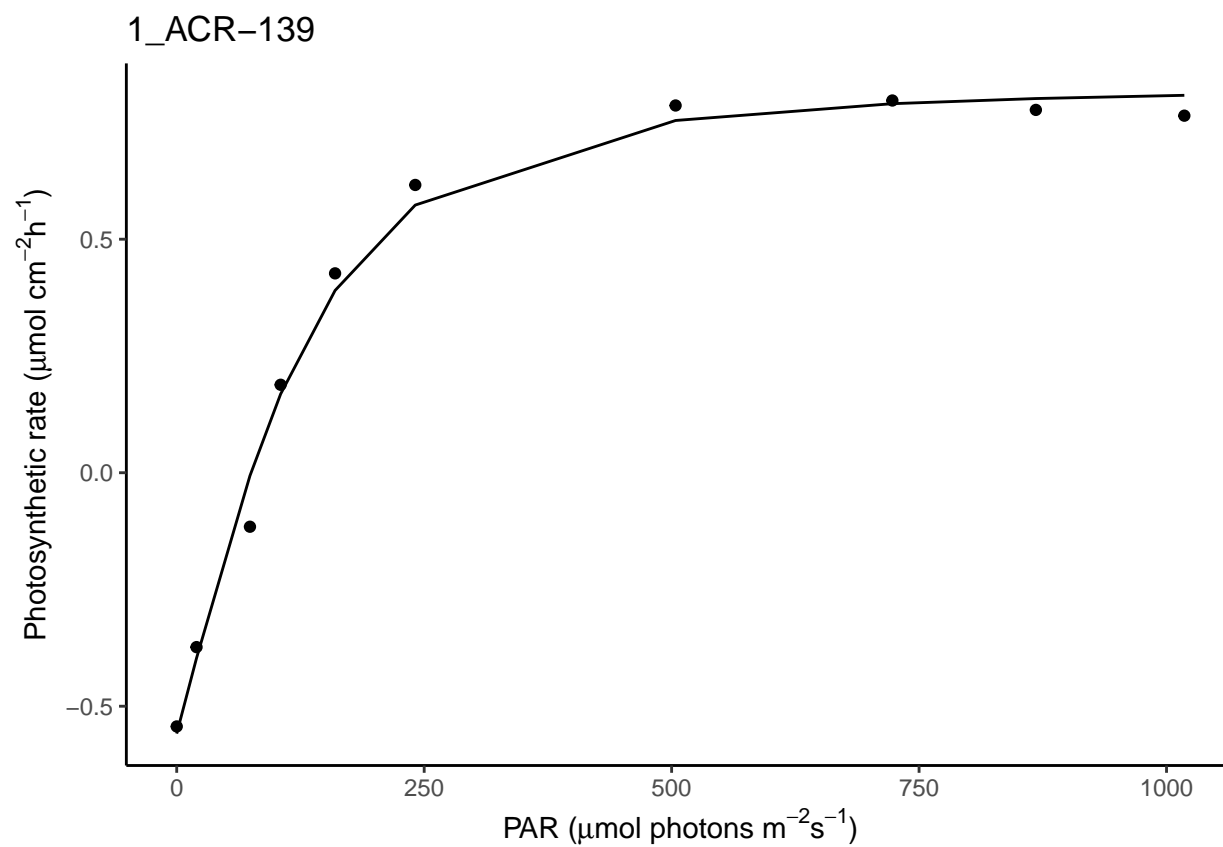
## -----  
## augmented\$colony\_id: POR-381



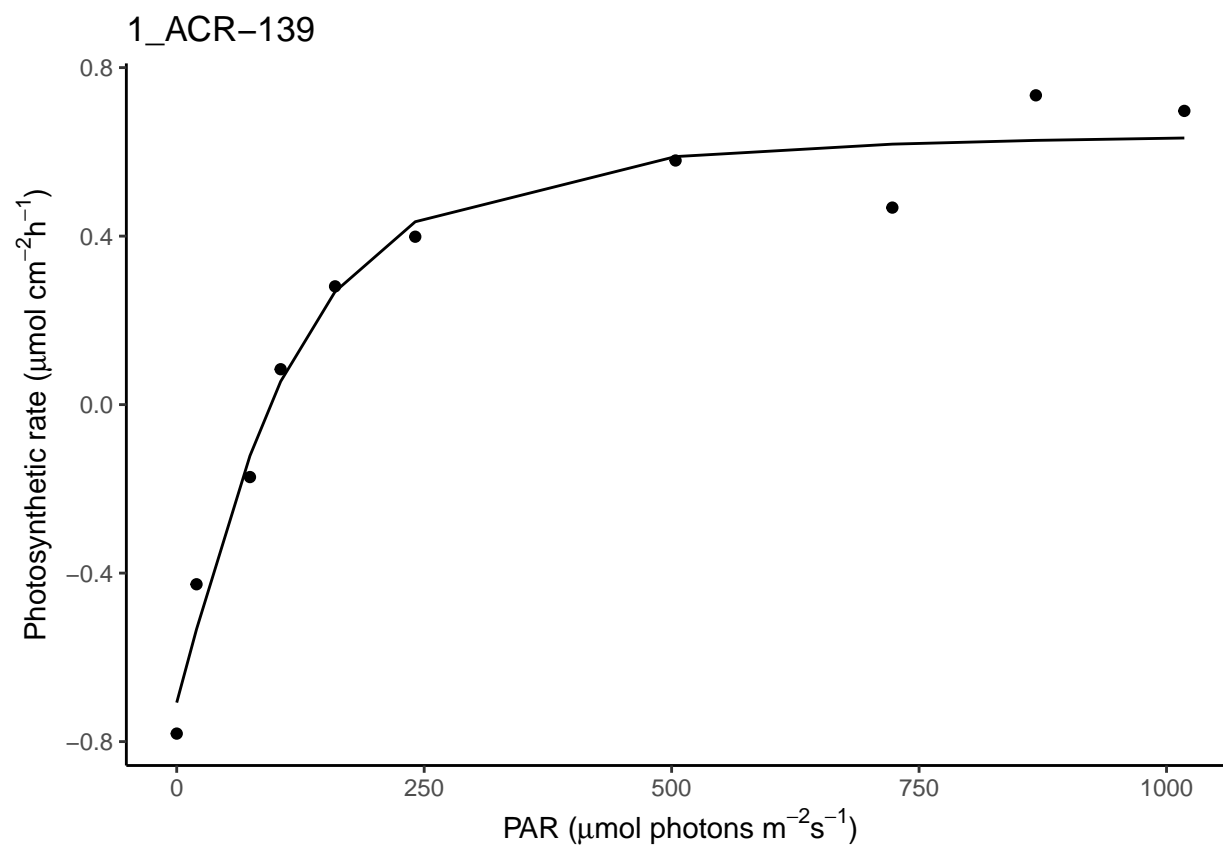
## -----  
## augmented\$colony\_id: POR-383



## -----  
## augmented\$colony\_id: POR-384

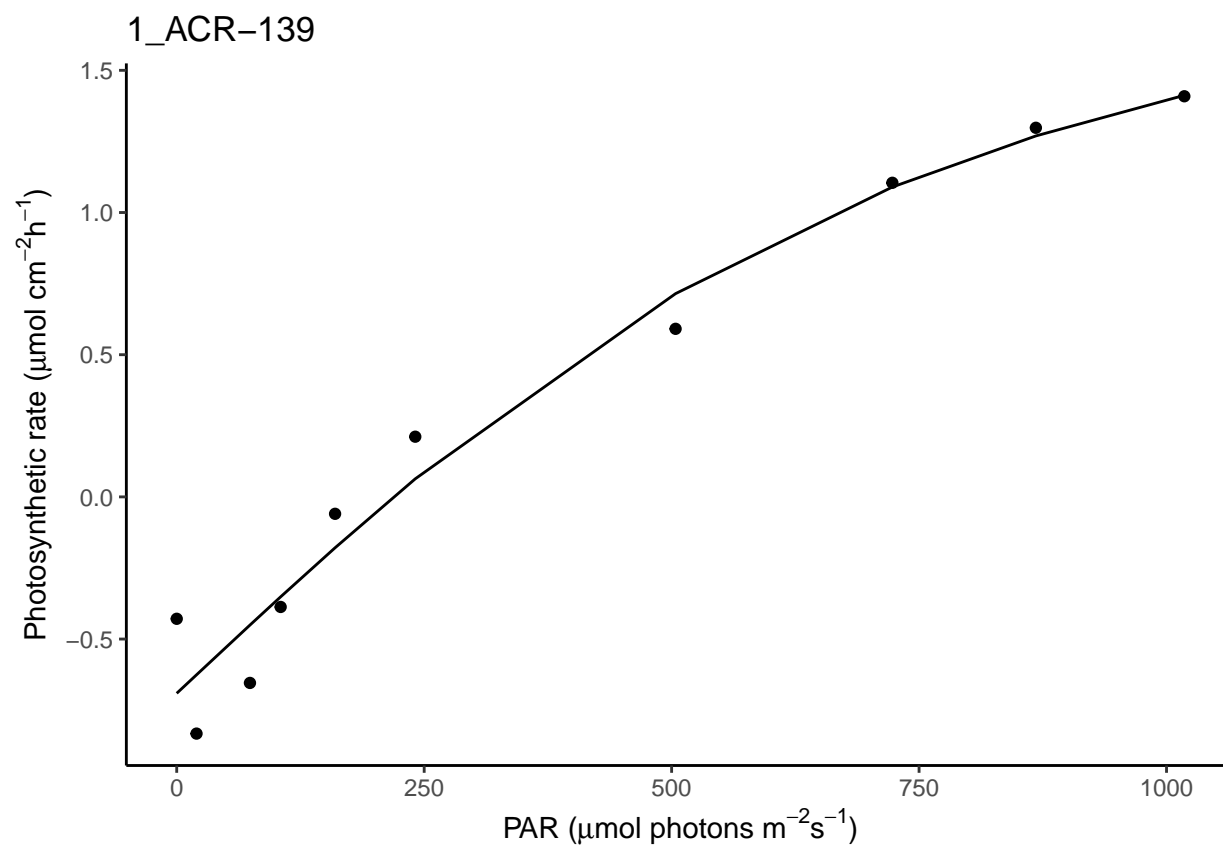


## -----  
## augmented\$colony\_id: POR-387

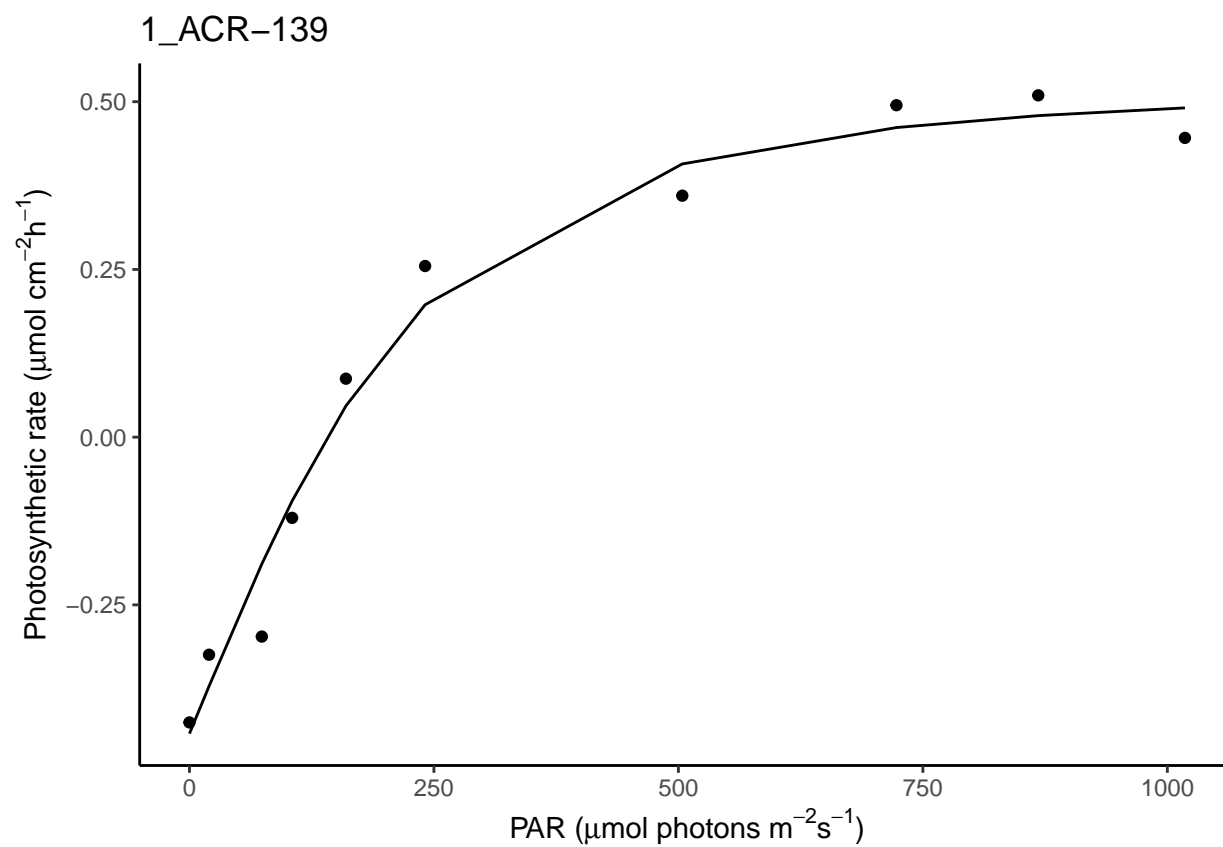


## -----  
## augmented\$colony\_id: POR-69

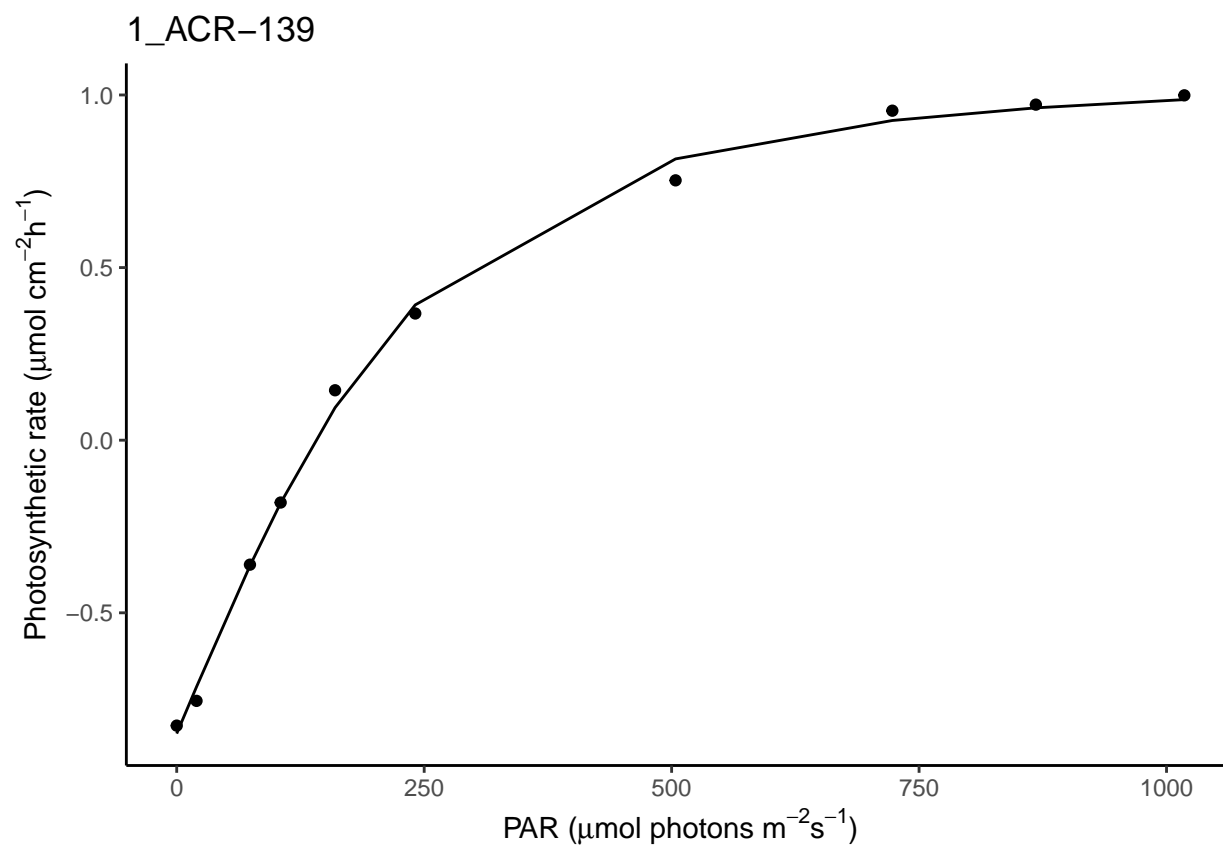




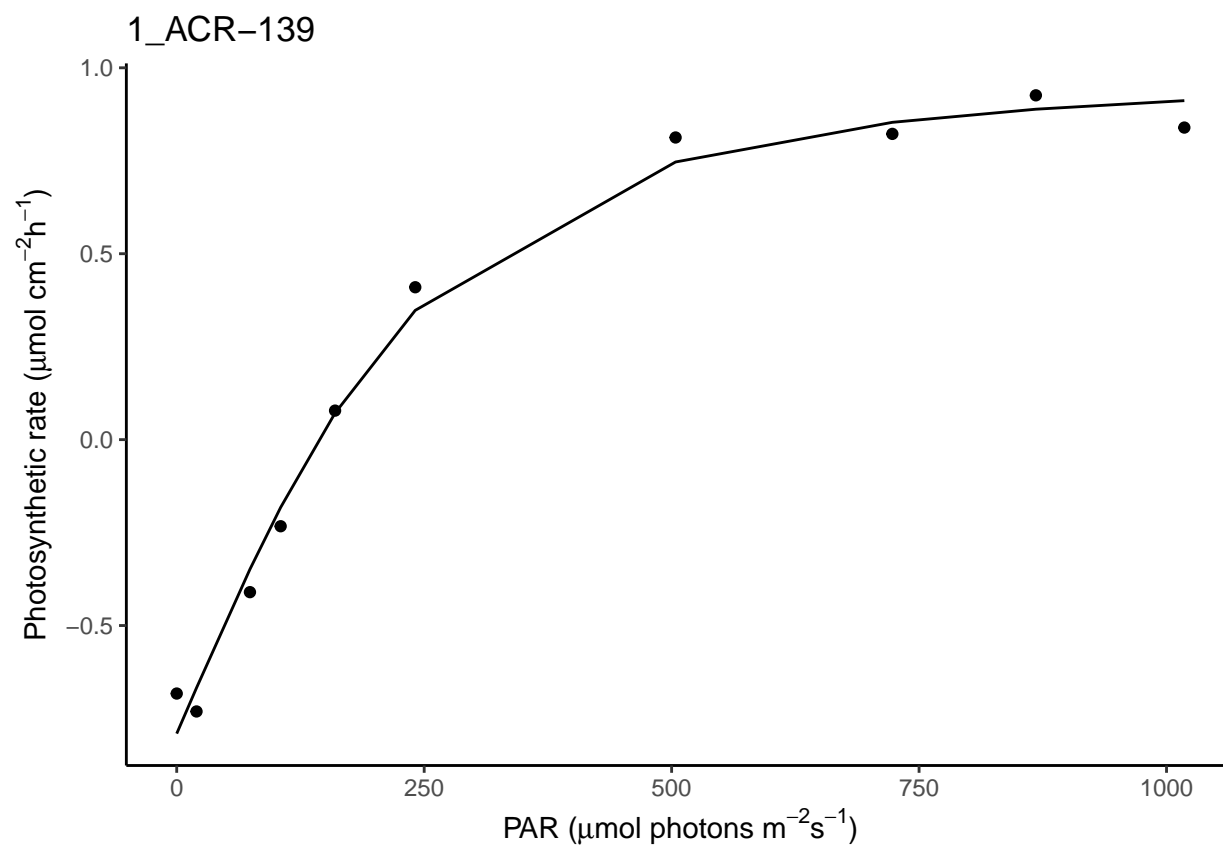
```
## -----  
## augmented$colony_id: POR-70
```



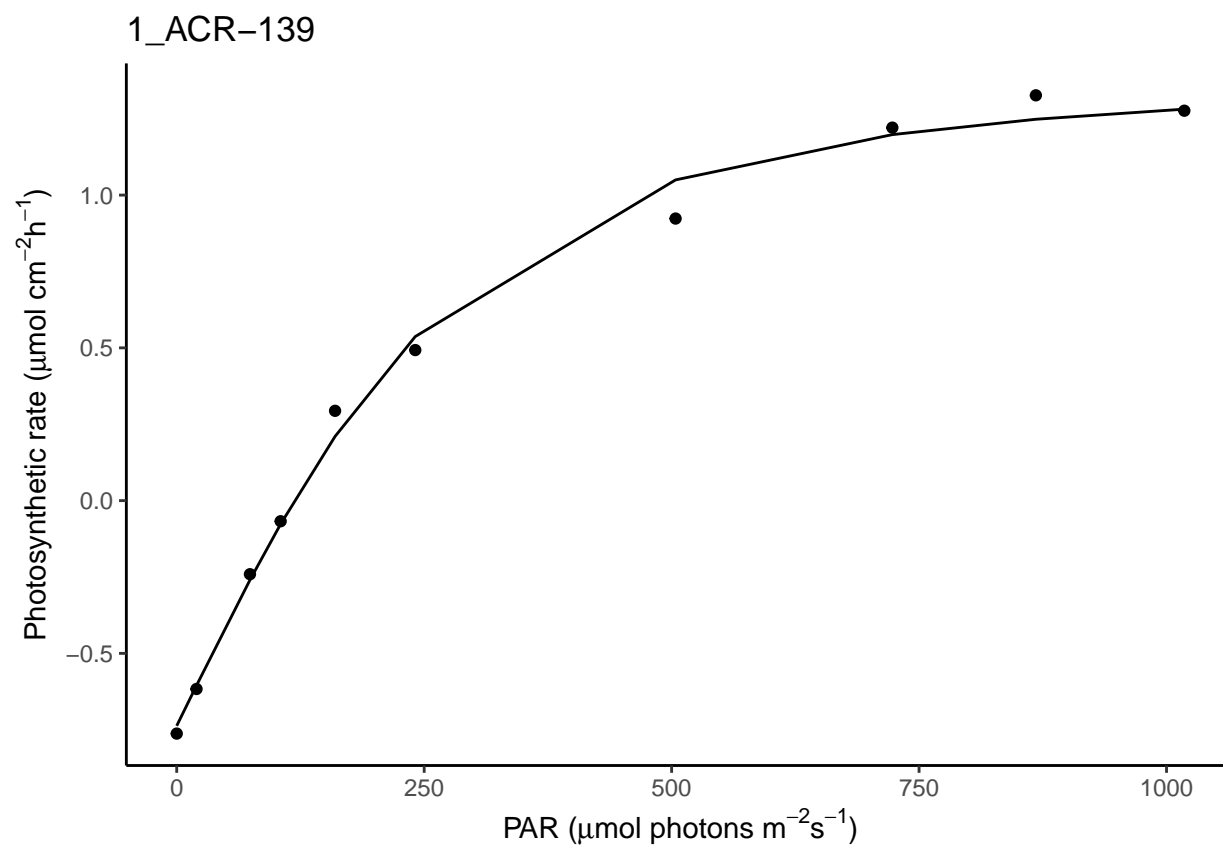
## -----  
## augmented\$colony\_id: POR-71



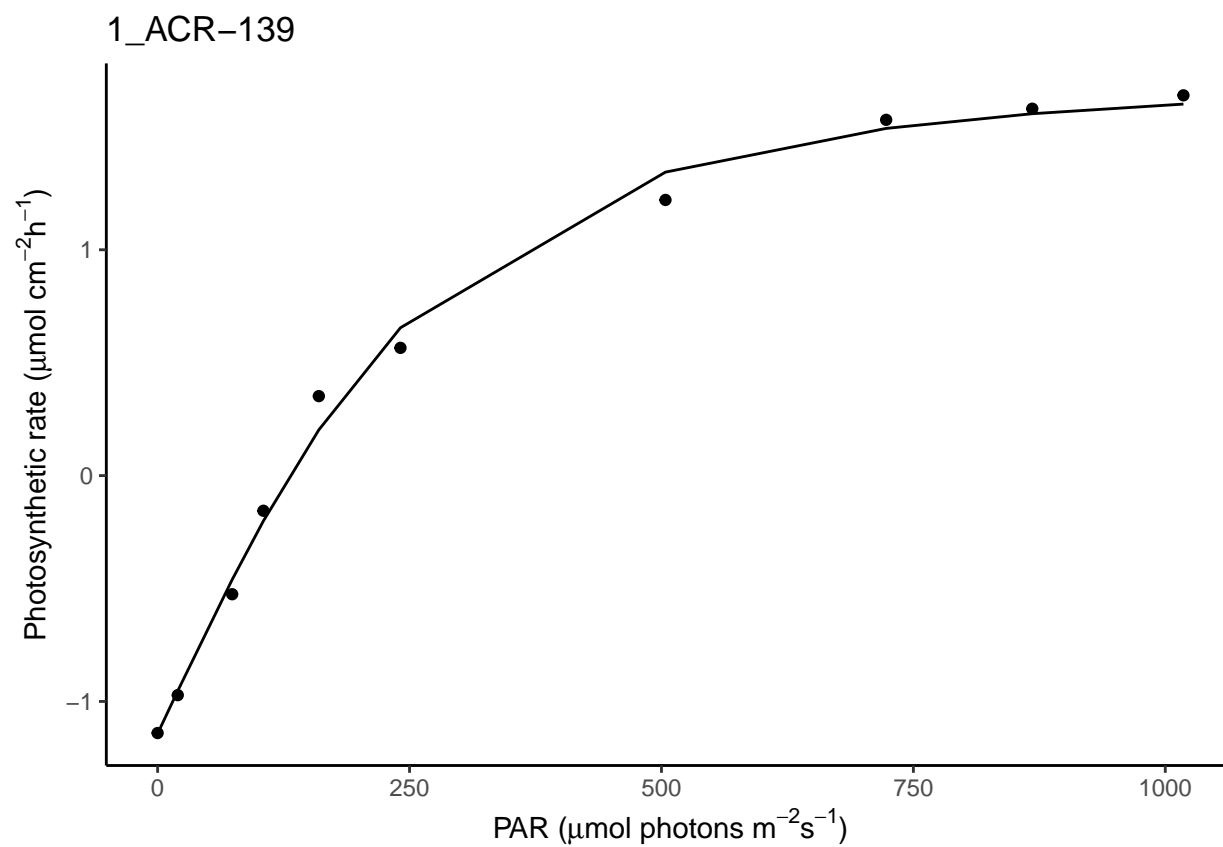
## -----  
## augmented\$colony\_id: POR-72



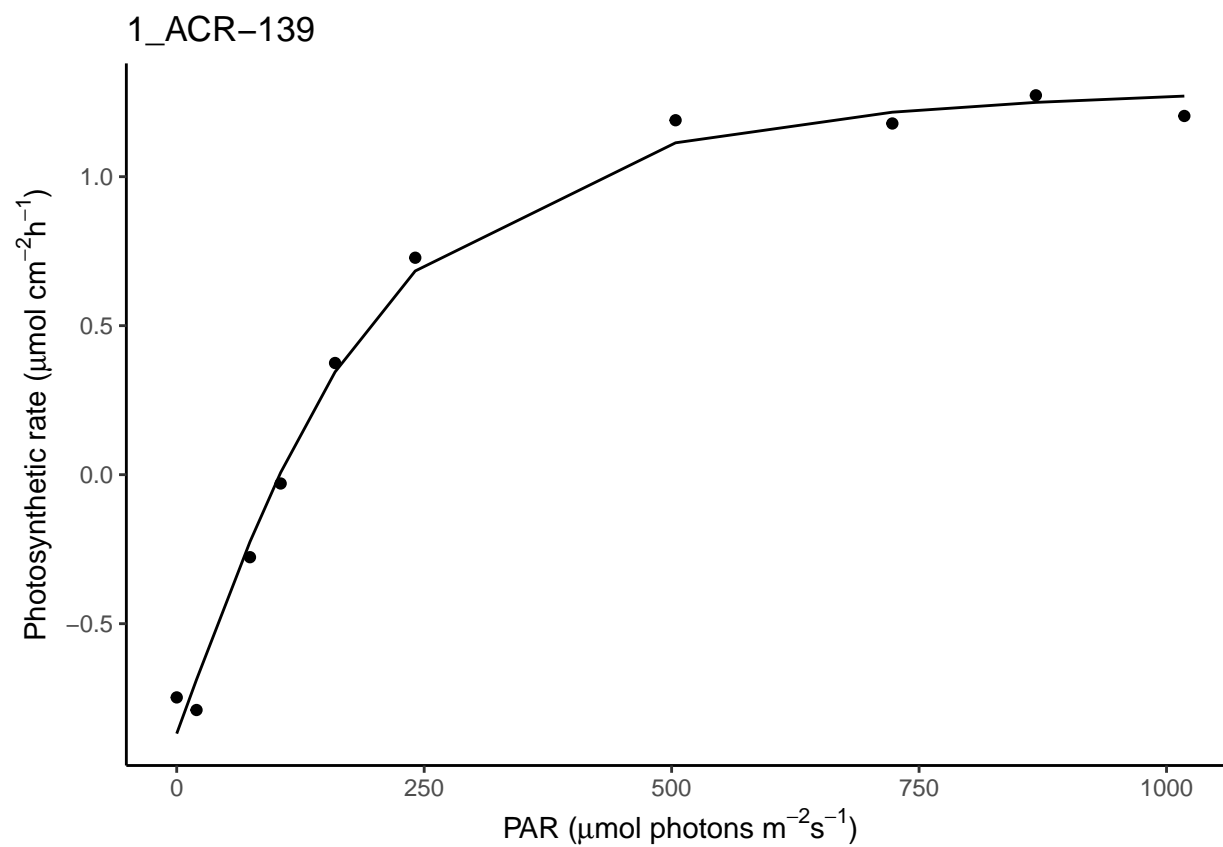
```
## -----  
## augmented$colony_id: POR-73
```



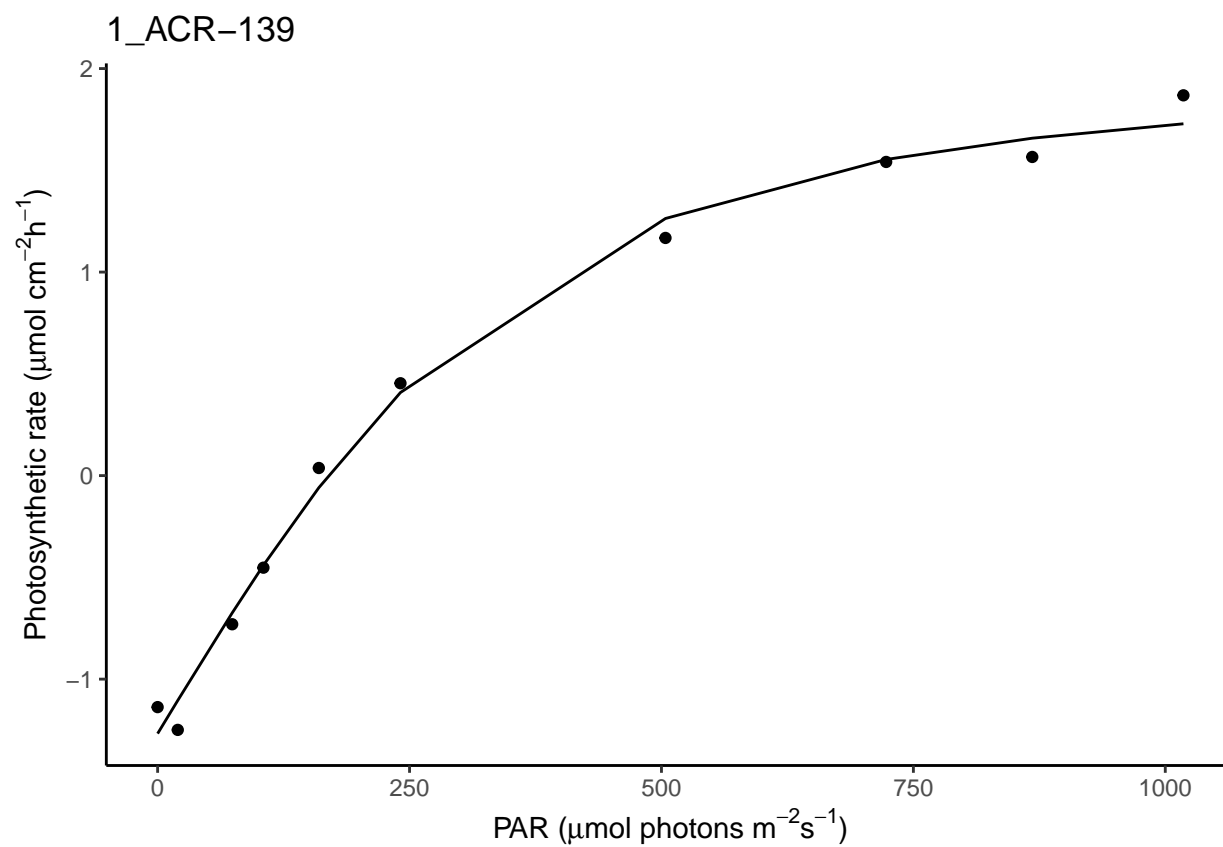
## -----  
## augmented\$colony\_id: POR-74



## -----  
## augmented\$colony\_id: POR-75

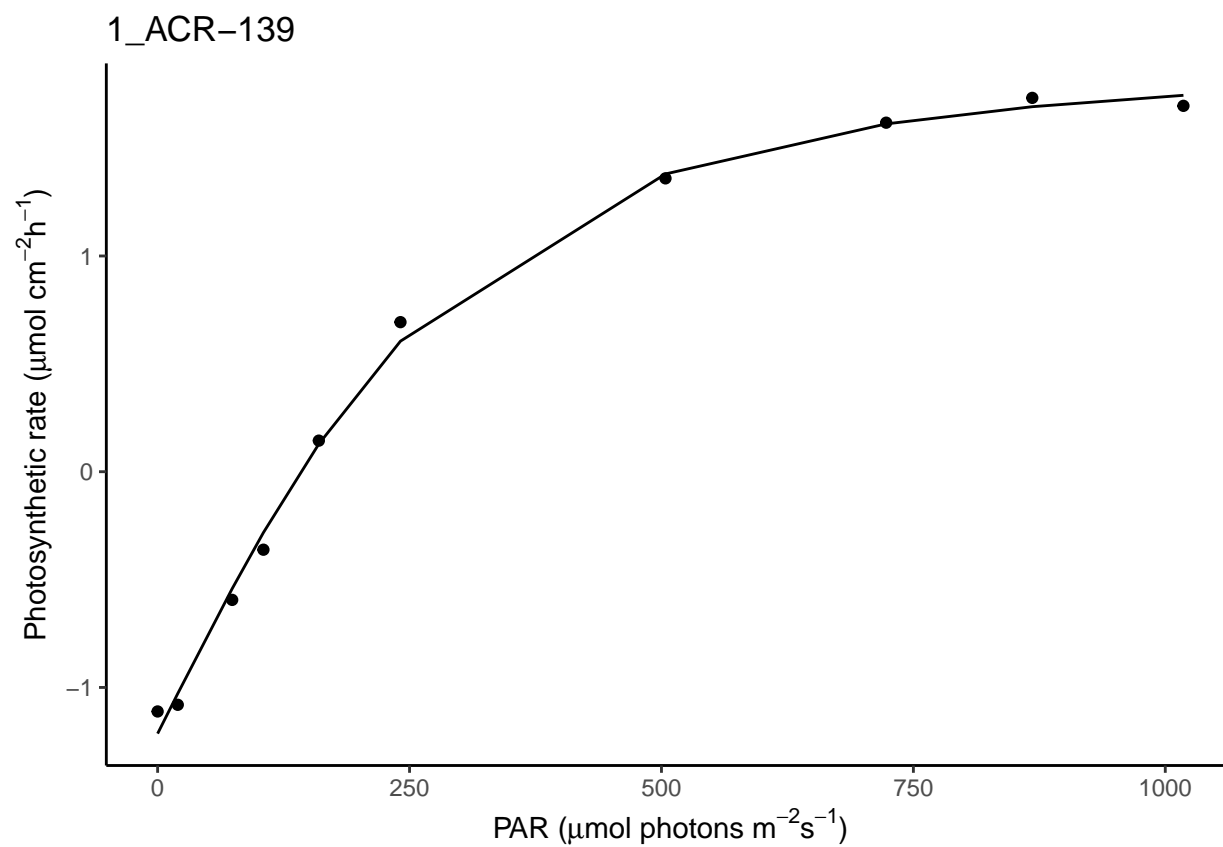


## -----  
## augmented\$colony\_id: POR-76

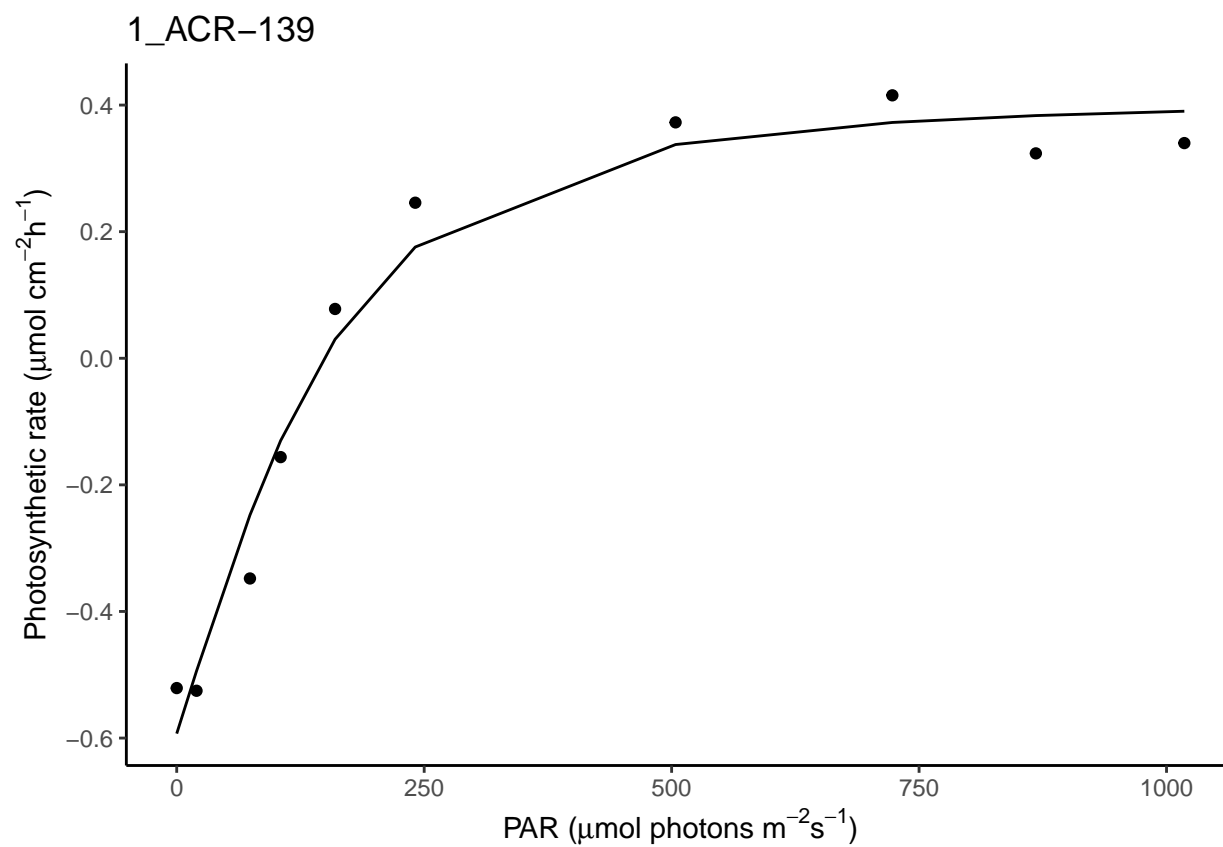


## -----  
## augmented\$colony\_id: POR-79

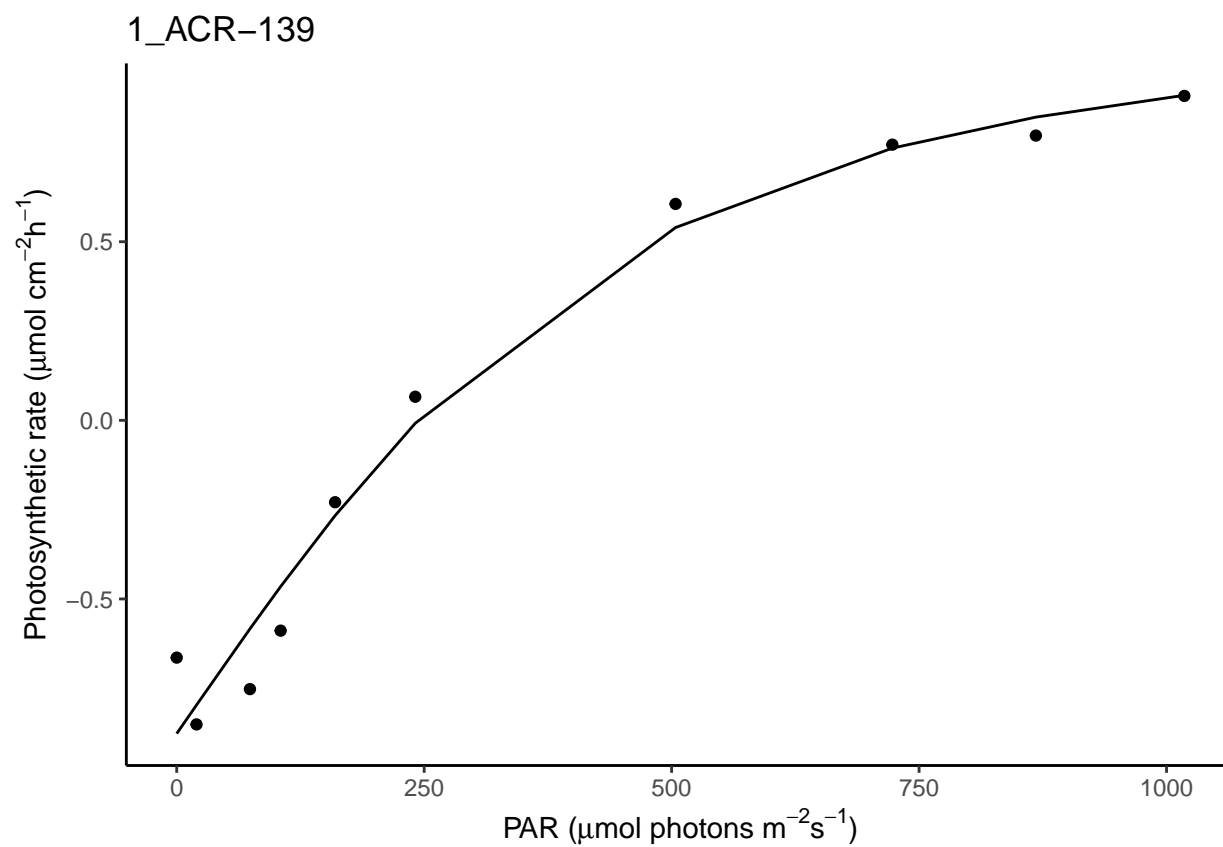




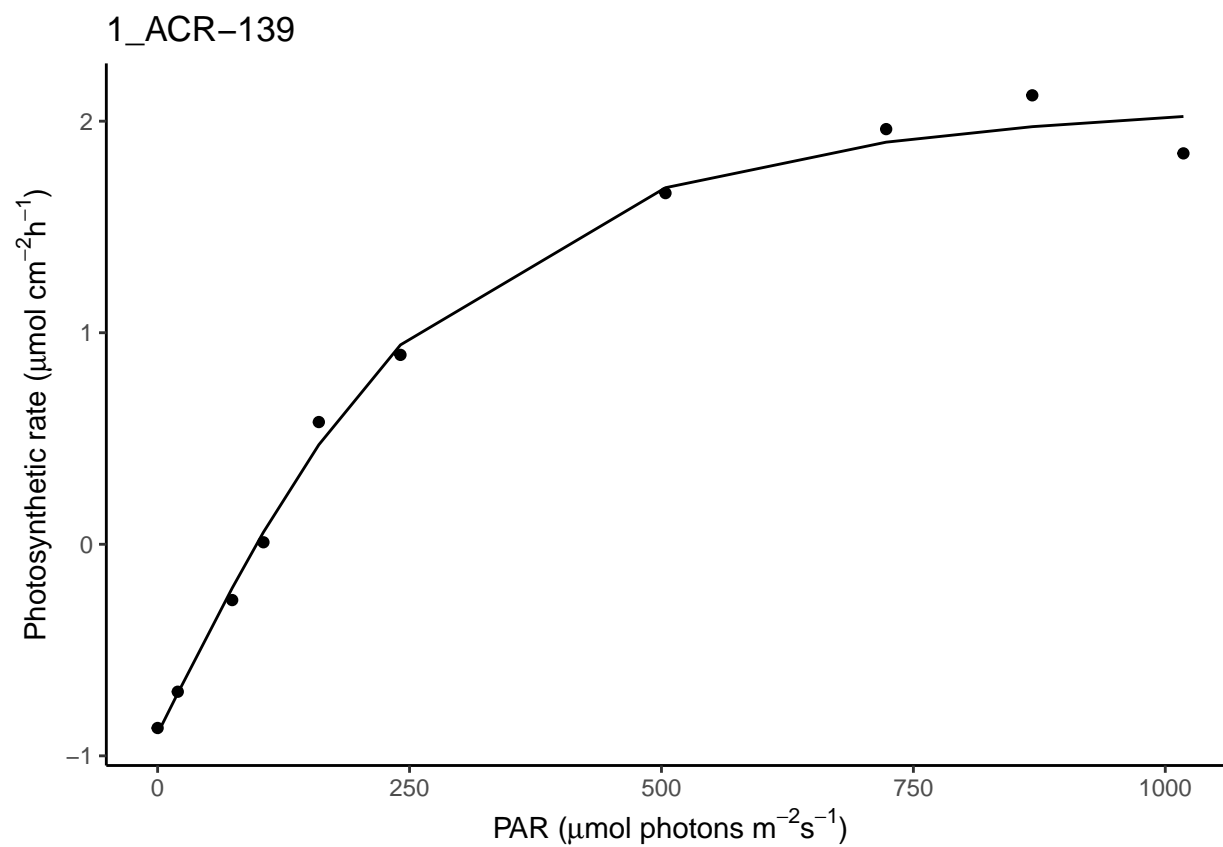
## -----  
## augmented\$colony\_id: POR-80



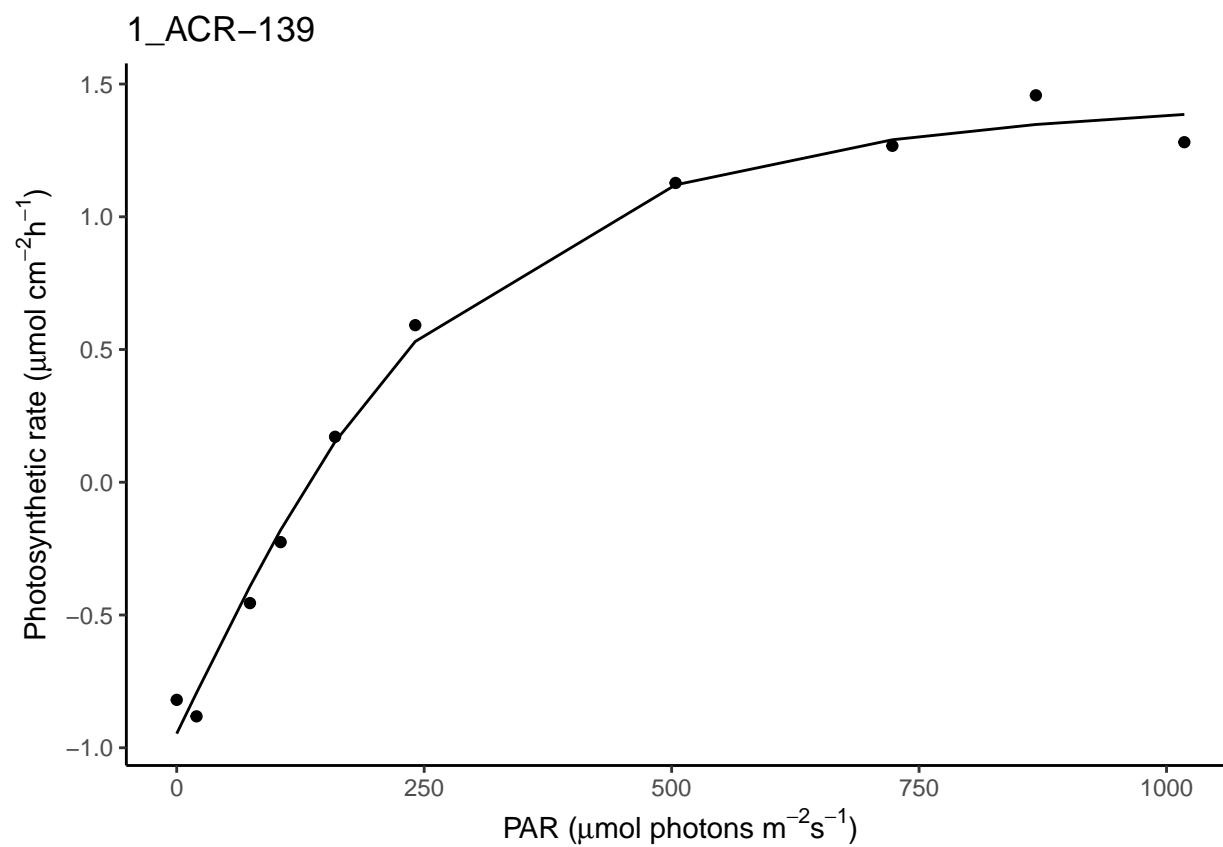
## -----  
## augmented\$colony\_id: POR-81



## -----  
## augmented\$colony\_id: POR-82



## -----  
## augmented\$colony\_id: POR-83



#NEED TO FIND A WAY TO SAVE INDIVIDUALS