Group B — FD indices and trait–environment links

Master FBE · 90 min · Realms: Palearctic + Ethiopian

You will compute functional diversity indices for Palearctic and Ethiopian freshwater fish and test whether environmental gradients (temperature, discharge) predict trait composition.

Deliverable: 5-slide PPT presented to the class in 8 minutes.

```
library(FD); library(ggplot2); library(dplyr)

traits <- read.csv("fish_traits.csv", row.names=1)
env    <- read.csv("env_data.csv",    row.names=1)
comm   <- read.csv("fish_communities.csv", row.names=1)

my_realms <- c("Palearctic","Ethiopian")
sites     <- rownames(env[env$Realm %in% my_realms,])
```

Step 1 — Community-weighted mean (25 min)

1a. Align species between the community matrix and trait data. Compute CWM for all traits across your basins.

```
sp_shared  <- intersect(colnames(comm[sites,]), rownames(traits))
comm_sub   <- comm[sites, sp_shared]
tr_sub     <- traits[sp_shared, 2:8]          # numeric traits only

cwm <- functcomp(as.matrix(tr_sub), as.matrix(comm_sub))
cwm$Realm <- env[rownames(cwm),"Realm"]
cwm$temp  <- env[rownames(cwm),"temp_mean"]
```

1b. Does mean temperature predict CWM body length? Plot the relationship and fit a linear model. Is Bergmann's rule (larger body at lower temperature) supported?

```
ggplot(cwm,aes(temp,BL_mean,colour=Realm))+
  geom_point(size=2.5)+geom_smooth(method="lm",colour="black",linetype=2)+
  labs(x="Mean temperature (°C)",y="CWM body length (cm)")+theme_bw()

m <- lm(BL_mean~temp,data=cwm)
summary(m)
```

Step 2 — FD indices (30 min)

2a. Compute FRic, FEve, FDiv, FDis and RaoQ using dbFD().

```
set.seed(42)
fd <- dbFD(x=tr_sub, a=as.matrix(comm_sub),
           m=3, calc.FRic=TRUE, calc.CWM=FALSE, print.pco=FALSE)

fd_df <- data.frame(
  basin=rownames(comm_sub),
  S    =specnumber(comm_sub),
```

```
  FRic =fd$FRic, FEve=fd$FEve,
  FDiv =fd$FDiv, FDis=fd$FDis, RaoQ=fd$RaoQ,
  Realm=env[rownames(comm_sub),"Realm"],
  temp =env[rownames(comm_sub),"temp_mean"]
)
```

2b. Is FRic correlated with species richness S? Plot the relationship. Why is this a problem when comparing basins?

```
cor.test(fd_df$S,fd_df$FRic,method="spearman")
ggplot(fd_df,aes(S,FRic,colour=Realm))+
  geom_point(size=2.5)+geom_smooth(method="lm",colour="black",linetype=2)+theme_bw()
```

2c. Compare FRic between realms with a boxplot. Which realm is functionally richer? Does FEve differ between realms?

```
library(tidyr)
fd_long <- pivot_longer(fd_df,cols=c(FRic,FEve,FDiv,FDis),
                        names_to="index",values_to="value")
ggplot(fd_long,aes(Realm,value,fill=Realm))+
  geom_boxplot(alpha=0.7)+facet_wrap(~index,scales="free_y")+
  theme_bw()+theme(legend.position="none")
```

Step 3 — Trait–environment relationship (15 min)

3a. Does temperature predict FDis? A higher FDis in warm basins would suggest that warm environments support more diverse strategies.

```
ggplot(fd_df,aes(temp,FDis,colour=Realm))+
  geom_point(size=2.5)+geom_smooth(method="lm")+
  labs(x="Mean temp (°C)",y="FDis")+theme_bw()
cor.test(fd_df$temp,fd_df$FDis,method="spearman")
```

Slide template (5 slides, 8 min)

Slide	Content	~Time
1 — Intro	Context: Palearctic vs Ethiopian fish. What is CWM?	30 sec
2 — CWM figure	Body length CWM vs temperature. Bergmann's rule?	2 min
3 — FD indices	FRic / FDis boxplot by realm. Key numbers.	2 min
4 — Interpretation	Do warmer basins have more diverse strategies?	2 min
5 — Limitation	FRic–richness confound: how to deal with it?	1 min