Comparacion de métodos para el estudio y monitore de arrecifes coralinos

Ana M. Palacio-Castro

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Libraries and settings

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Coral cover

Model

```
General.data$T_Coral<- asin(sqrt(General.data$Coral/100))

Coral_Cover_model<-lmer(T_Coral ~ 1 + Zona * Método +
                          (1|Zona:Sitio) + (1|Buzo), data = General.data )

 # summary(Coral_Cover_model)
  anova(Coral_Cover_model)
```

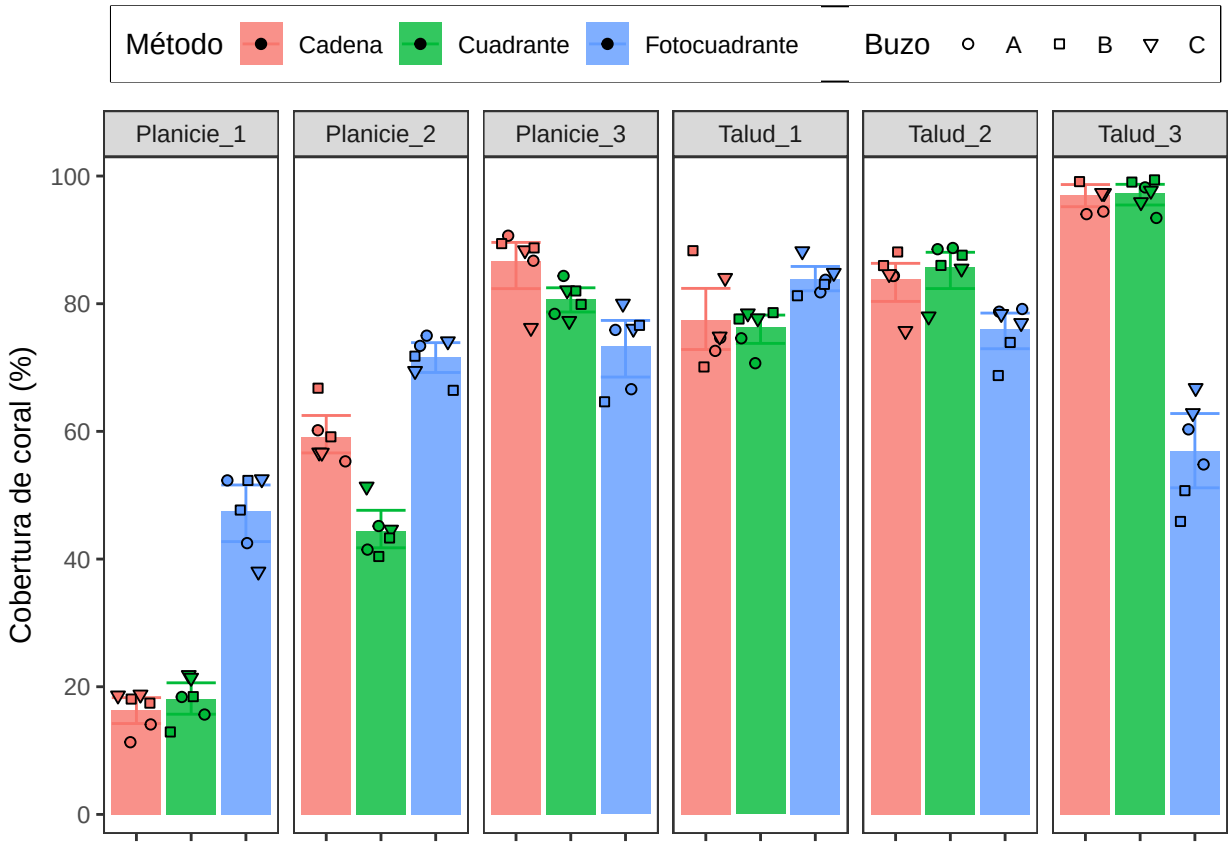
```
## Type III Analysis of Variance Table with Satterthwaite's method
##              Sum Sq Mean Sq NumDF DenDF F value    Pr(>F)
## Zona        0.05748 0.05748     1     4  3.3168    0.1427
## Método      0.04220 0.02110     2    98  1.2174    0.3004
## Zona:Método 0.69236 0.34618     2    98 19.9761 5.289e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
  ranova(Coral_Cover_model)
```

```
## ANOVA-like table for random-effects: Single term deletions
##
## Model:
## T_Coral ~ Zona + Método + (1 | Zona:Sitio) + (1 | Buzo) + Zona:Método
##                   npar logLik     AIC   LRT Df Pr(>Chisq)
## <none>               9 45.758 -73.517
## (1 | Zona:Sitio)     8  1.498  13.004 88.52  1     <2e-16 ***
## (1 | Buzo)           8 45.758 -75.517  0.00  1          1
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Plot

```
Coral_Cover<- ggplot(General.data) + facet_grid(~Transecto)+
  MyTheme+ scale_shape_manual(values=c(21,22,25))+
  stat_summary(aes(x=Método, y=Coral, fill=Método, group=Método),
                fun.data = "mean_cl_boot", geom = "bar",
                position=position_dodge(width=0.8), alpha=0.8)+
   stat_summary(aes(x=Método, y=Coral, group=Método, color=Método),
                fun.data = "mean_cl_boot", geom = "errorbar",
                position=position_dodge(width=0.8))+
   geom_jitter( aes (x=Método, y=Coral, shape=Buzo, fill=Método, group=Método))+
    scale_y_continuous(limits = c(0,100),
                       expand = c(0.03, 0.03),
                       breaks = seq(0, 100, 20),
                       name=expression("Cobertura de coral (%)"))
Coral_Cover
```



Algae cover

Model

```
General.data$T_Alga<- asin(sqrt((General.data$Alga/100)))

Alga_Cover_model<-lmer(T_Alga~ Zona * Método * Zona:Sitio * Buzo +
                         (1|Zona:Sitio) + (1|Buzo), data = General.data )

  #summary(Alga_Cover_model)
  anova(Alga_Cover_model)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##                          Sum Sq  Mean Sq NumDF DenDF F value    Pr(>F)
## Zona                    0.03282 0.032817     1    54  6.0930  0.016769 *
## Método                  0.05151 0.025754     2    54  4.7816  0.012248 *
## Buzo                    0.08181 0.040905     2    54  7.5946  0.001240 **
## Zona:Método             0.31615 0.158075     2    54 29.3490 2.360e-09 ***
## Zona:Sitio              0.03060 0.007651     4    54  1.4205  0.239666
## Zona:Buzo               0.31373 0.156867     2    54 29.1248 2.628e-09 ***
## Método:Buzo             0.16991 0.042476     4    54  7.8864 4.415e-05 ***
## Zona:Método:Sitio       0.62401 0.078001     8    54 14.4822 4.946e-11 ***
## Zona:Método:Buzo        0.01401 0.003502     4    54  0.6502  0.629202
## Zona:Sitio:Buzo         0.36148 0.045184     8    54  8.3892 2.545e-07 ***
## Zona:Método:Sitio:Buzo 0.22680 0.014175    16    54  2.6318  0.004136 **
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
  ranova(Alga_Cover_model)
```

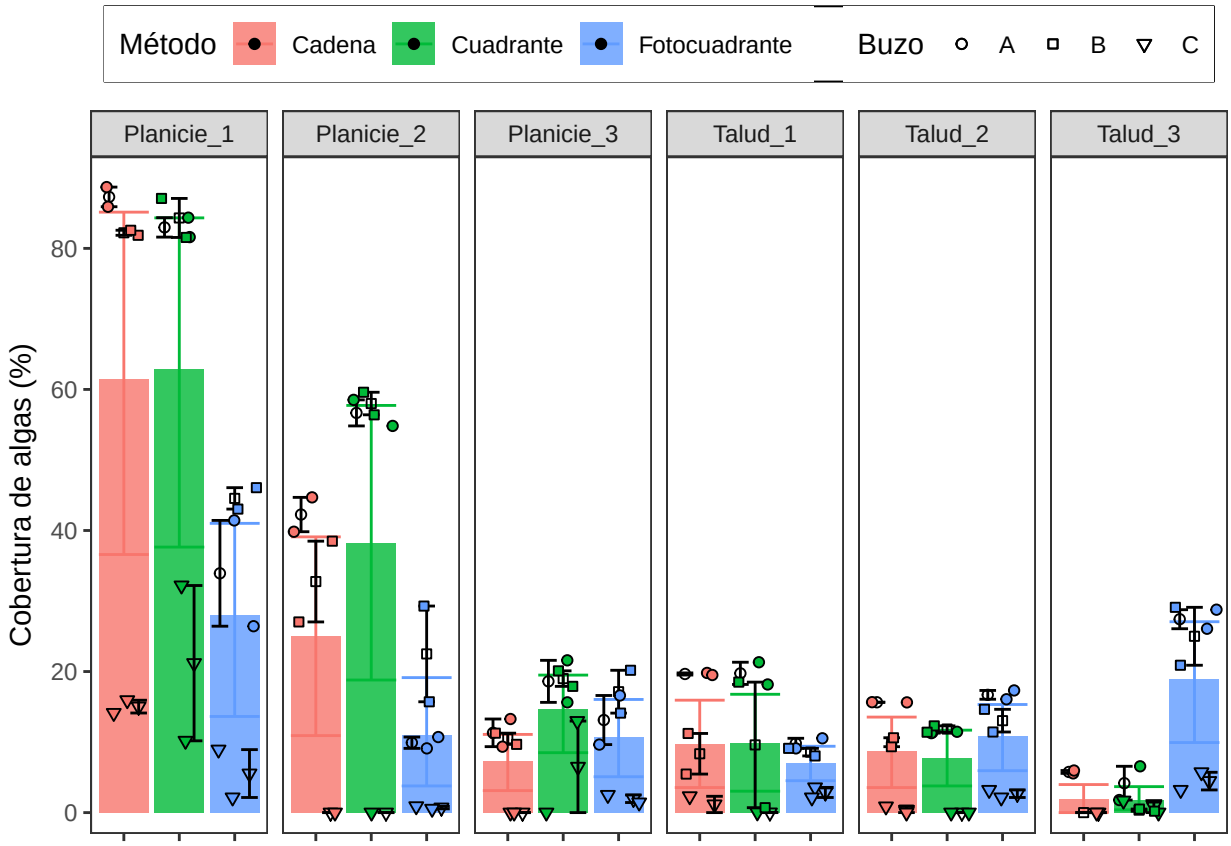
```
## ANOVA-like table for random-effects: Single term deletions
##
## Model:
## T_Alga ~ Zona + Método + Buzo + (1 | Zona:Sitio) + (1 | Buzo) +
##     Zona:Método + Zona:Sitio + Zona:Buzo + Método:Buzo + Zona:Método:Sitio +
##     Zona:Método:Buzo + Zona:Sitio:Buzo + Zona:Método:Sitio:Buzo
##                   npar logLik    AIC        LRT Df Pr(>Chisq)
## <none>              57 45.709 22.582
## (1 | Zona:Sitio)    56 45.709 20.582 3.9790e-13  1          1
## (1 | Buzo)          56 45.709 20.582 4.2633e-13  1          1
```

Plot

```
Algae_Cover<- ggplot(General.data) + facet_grid(~Transecto)+
  MyTheme+ scale_shape_manual(values=c(21,22,25))+
  stat_summary(aes(x=Método, y=Alga, fill=Método),
                fun.data = "mean_cl_boot", geom = "bar",
                position=position_dodge(width=0.8), alpha=0.8)+

  stat_summary(aes(x=Método, y=Alga, colour=Método),
                fun.data = "mean_cl_boot", geom = "errorbar",
                position=position_dodge(width=0.8))+

  stat_summary(aes(x=Método, y=Alga, group=Buzo),
                fun.data = "mean_cl_boot", geom = "errorbar",
                position=position_dodge(width=0.8))+
  stat_summary(aes(x=Método, y=Alga, shape=Buzo),
                fun.data = "mean_cl_boot", geom = "point",
                position=position_dodge(width=0.8))+
  geom_jitter( aes (x=Método, y=Alga, shape=Buzo, fill=Método, group=Buzo))+
  scale_y_continuous(limits = c(0, 90),
                     expand = c(0.03, 0.3),
                     breaks = seq(0, 100, 20),
                     name=expression("Cobertura de algas (%)"))
Algae_Cover
```



Substrate cover

Model

```
General.data$T_Sustrato<- acos(General.data$Sustrato /100)

Sus_Cover_model<-lmer(T_Sustrato~ Zona * Método * Zona:Sitio * Buzo +
                        (1|Zona:Sitio) + (1|Buzo), data = General.data )

  #summary(Sus_Cover_model)
  anova(Sus_Cover_model)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##                          Sum Sq  Mean Sq NumDF DenDF  F value    Pr(>F)
## Zona                    0.00936 0.009362     1    54   4.1311 0.0470313 *
## Método                  0.10197 0.050984     2    54  22.4967 7.821e-08 ***
## Buzo                    0.04152 0.020762     2    54   9.1612 0.0003752 ***
## Zona:Método             0.01395 0.006973     2    54   3.0769 0.0542682 .
## Zona:Sitio              0.01629 0.004073     4    54   1.7971 0.1428660
## Zona:Buzo               0.50465 0.252326     2    54 111.3399 < 2.2e-16 ***
## Método:Buzo             0.09418 0.023545     4    54  10.3892 2.587e-06 ***
## Zona:Método:Sitio       0.18726 0.023408     8    54  10.3288 1.256e-08 ***
## Zona:Método:Buzo        0.02490 0.006225     4    54   2.7467 0.0374815 *
## Zona:Sitio:Buzo         0.43564 0.054455     8    54  24.0283 3.219e-15 ***
## Zona:Método:Sitio:Buzo 0.07348 0.004592    16    54   2.0264 0.0277144 *
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
  ranova(Sus_Cover_model)
```

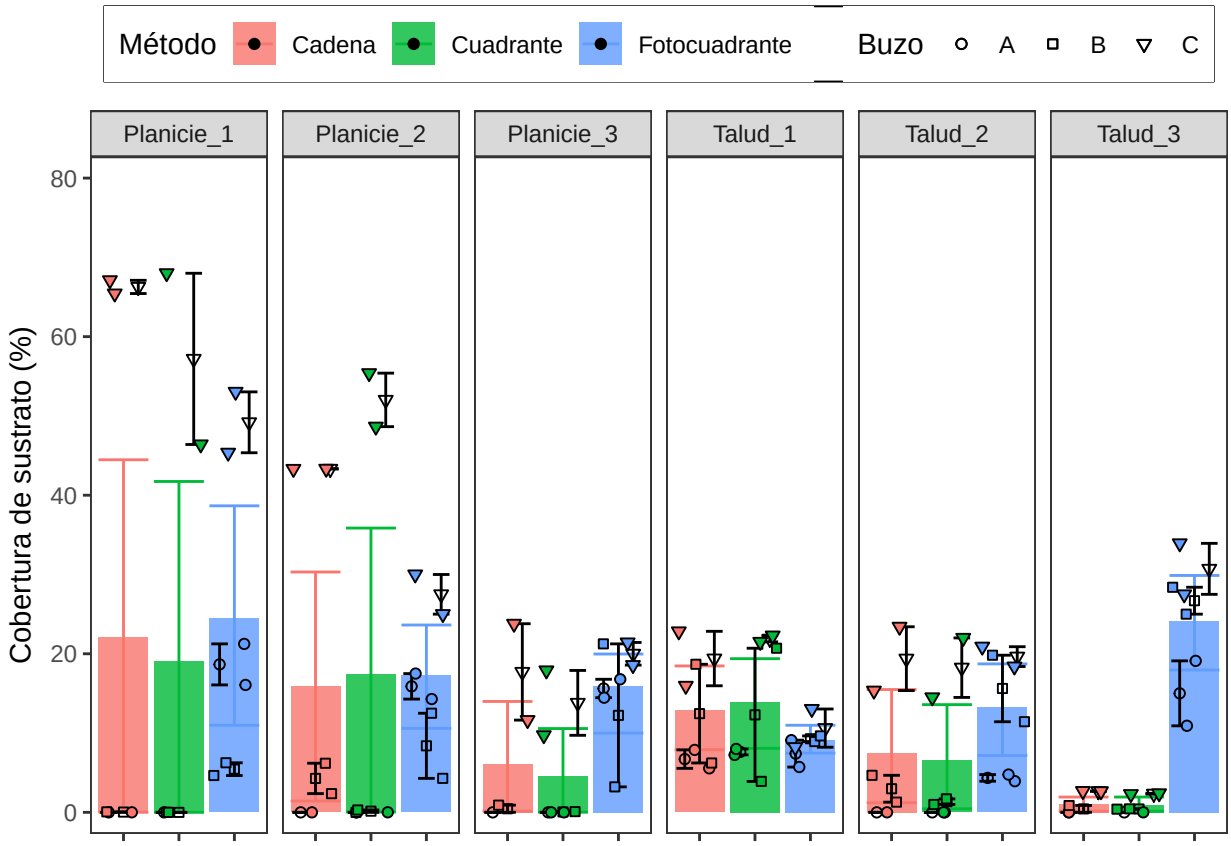
```
## ANOVA-like table for random-effects: Single term deletions
##
## Model:
## T_Sustrato ~ Zona + Método + Buzo + (1 | Zona:Sitio) + (1 |
##     Buzo) + Zona:Método + Zona:Sitio + Zona:Buzo + Método:Buzo +
##     Zona:Método:Sitio + Zona:Método:Buzo + Zona:Sitio:Buzo +
##     Zona:Método:Sitio:Buzo
##                   npar logLik     AIC        LRT Df Pr(>Chisq)
## <none>              57 69.082 -24.164
## (1 | Zona:Sitio)    56 69.082 -26.164 1.7053e-13  1          1
## (1 | Buzo)          56 69.082 -26.164 2.5580e-13  1          1
```

Plot

```
Substrate_Cover<- ggplot(General.data) + facet_grid(~Transecto)+
  MyTheme+ scale_shape_manual(values=c(21,22,25))+
  stat_summary(aes(x=Método, y=Sustrato, fill=Método),
                fun.data = "mean_cl_boot", geom = "bar",
                position=position_dodge(width=0.8), alpha=0.8)+

  stat_summary(aes(x=Método, y=Sustrato, colour=Método),
                fun.data = "mean_cl_boot", geom = "errorbar",
                position=position_dodge(width=0.8))+

  stat_summary(aes(x=Método, y=Sustrato, group=Buzo),
                fun.data = "mean_cl_boot", geom = "errorbar",
                position=position_dodge(width=0.8))+
  stat_summary(aes(x=Método, y=Sustrato, shape=Buzo),
                fun.data = "mean_cl_boot", geom = "point",
                position=position_dodge(width=0.8))+
  geom_jitter( aes (x=Método, y=Sustrato, shape=Buzo, fill=Método, group=Buzo))+
  scale_y_continuous(limits = c(0,80),
                     expand = c(0.03, 0.3),
                     breaks = seq(0, 100, 20),
                     name=expression("Cobertura de sustrato (%)"))
Substrate_Cover
```



Coral richness

Model

```
Richness_model<-lmer(Riqueza_Media ~ Zona * Método  +  (1|Zona:Sitio) + (1|Buzo), data = Index.data )

 # summary(Richness_model)
  anova(Richness_model)
```

```
## Type III Analysis of Variance Table with Satterthwaite's method
##              Sum Sq Mean Sq NumDF DenDF F value   Pr(>F)
## Zona         0.0026  0.0026     1     4  0.0091   0.9286
## Método      21.7315 10.8657     2    42 37.9131 3.91e-10 ***
## Zona:Método  1.1944  0.5972     2    42  2.0838   0.1371
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

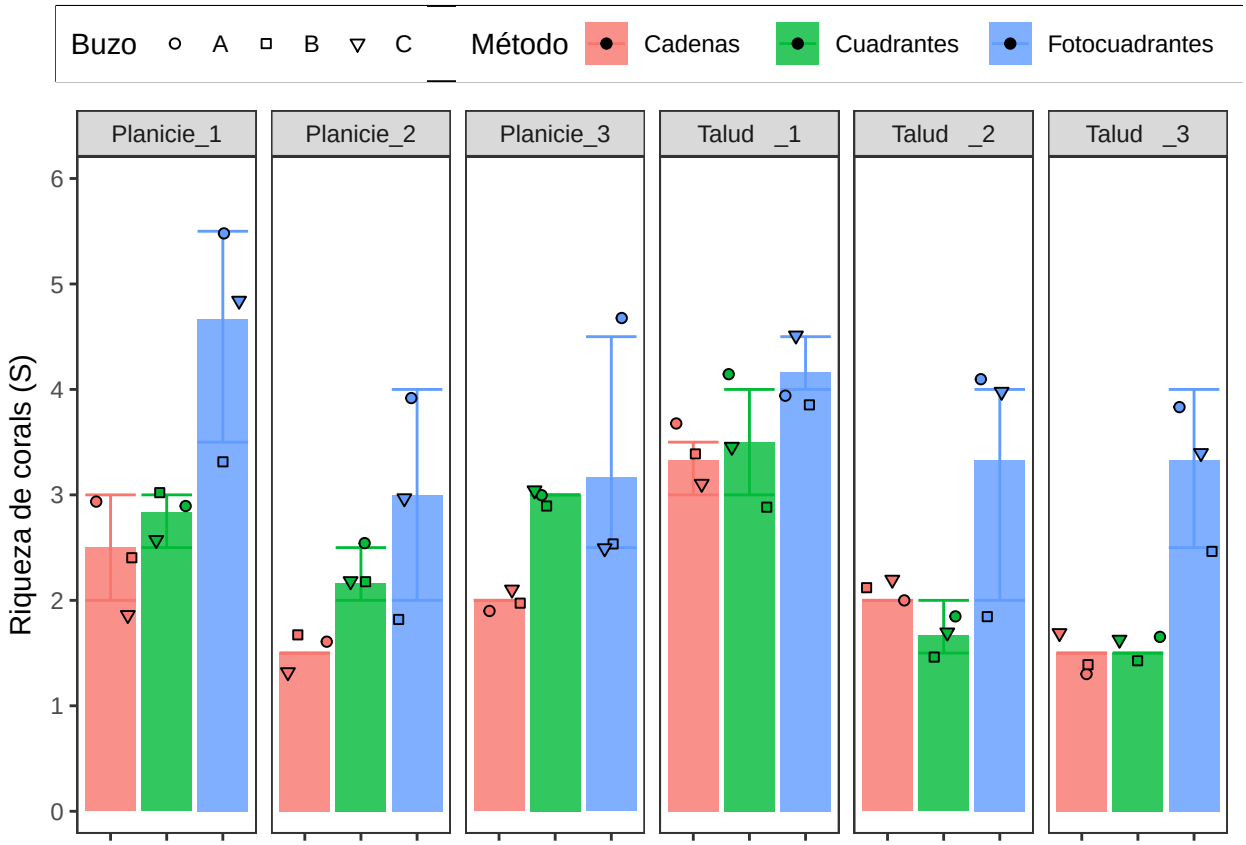
```
  ranova(Richness_model)
```

```
## ANOVA-like table for random-effects: Single term deletions
##
## Model:
## Riqueza_Media ~ Zona + Método + (1 | Zona:Sitio) + (1 | Buzo) +
##     Zona:Método
##                    npar  logLik    AIC     LRT Df Pr(>Chisq)
## <none>                9 -52.203 122.41
## (1 | Zona:Sitio)      8 -65.840 147.68 27.2749  1  1.765e-07 ***
```

```
## (1 | Buzo)          8 -55.590 127.18  6.7747  1   0.009246 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Plot

```
Coral_Richness<- ggplot(Index.data) + facet_grid(~Transecto)+
  MyTheme+ scale_shape_manual(values=c(21,22,25))+
  stat_summary(aes(x=Método, y=Riqueza_Media, fill=Método, group=Método),
                fun.data = "mean_cl_boot", geom = "bar",
                position=position_dodge(width=0.8), alpha=0.8)+
   stat_summary(aes(x=Método, y=Riqueza_Media, group=Método, color=Método),
                fun.data = "mean_cl_boot", geom = "errorbar",
                position=position_dodge(width=0.8))+
   geom_jitter( aes (x=Método, y=Riqueza_Media, shape=Buzo, fill=Método, group=Método))+
    scale_y_continuous(limits = c(0,6),
                       expand = c(0.03, 0.03),
                       breaks = seq(0, 6, 1),
                       name=expression("Riqueza de corals (S)"))
Coral_Richness
```



Chapter figure