HW#7

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```
library(ggplot2)
```

1. In the absence of distinct treatment groups for my project, the data frame was created predicated on the assumption that species within the genus *Micrathena* colonized the Caribbean from South America via the GAARlandia land bridge, which connected northern South America (Colombia) with the Greater Antilles, or more recently from Florida via overwater dispersal .If the GAARlandia route occurred, we should see an increased number of speciation events (branching) between ancestral South American taxa and new Caribbean taxa at the time of the bridge (30-35 mya) in modern Caribbean clades. Therefore, the mean in this model represents the mean divergence time (in millions of years) between these two taxon groups, and also represents the peak area of GAARlandia, at 30 with a s.d. of 5 to represent the time span where the bridge might have also been emergent. The sample size I have set is 150 individuals, representing an adequate sampling of S.A. and C.A. taxa that may present this distinct phylogeographic pattern. Conversely, species that colonized the Caribbean from North America would have a wildly variable colonization history, probably with a mean divergence time closer to present @ about 10 mya [from FL], with a s.d of 3 mya- sample size will be the same.

```
n_group <- 2
n_Name <- c("GAArlandia","NorthAmerica")
GAArlandia <- rnorm(n=150,mean=30,sd=5)
NorthAmerica <- rnorm(n=150,mean=10,sd=3)
n_size <- c(150,150)

id <- 1:sum(n_size)
ColonizationTime <- c(GAArlandia, NorthAmerica)
Origin <- rep(n_Name,n_size)
ano_data <- data.frame(id, Origin,ColonizationTime)
str(ano_data)
```

```
## 'data.frame':    300 obs. of  3 variables:
##  $ id              : int  1 2 3 4 5 6 7 8 9 10 ...
##  $ Origin          : Factor w/ 2 levels "GAArlandia","NorthAmerica": 1 1 1 1 1 1 1 1 1 1 ...
##  $ ColonizationTime: num  39.8 23 25.9 26.7 25.5 ...
```

```
ano_data
```

```
##      id       Origin ColonizationTime
## 1     1   GAArlandia        39.767886
## 2     2   GAArlandia        22.961147
## 3     3   GAArlandia        25.934934
## 4     4   GAArlandia        26.687888
```

```
## 5     5   GAArlandia       25.497995
## 6     6   GAArlandia       32.769424
## 7     7   GAArlandia       25.869001
## 8     8   GAArlandia       26.051537
## 9     9   GAArlandia       31.995135
## 10   10   GAArlandia       26.388317
## 11   11   GAArlandia       24.617060
## 12   12   GAArlandia       33.729457
## 13   13   GAArlandia       31.242688
## 14   14   GAArlandia       29.755125
## 15   15   GAArlandia       27.962582
## 16   16   GAArlandia       23.690086
## 17   17   GAArlandia       37.274460
## 18   18   GAArlandia       32.530071
## 19   19   GAArlandia       33.507158
## 20   20   GAArlandia       29.714951
## 21   21   GAArlandia       29.786182
## 22   22   GAArlandia       36.385508
## 23   23   GAArlandia       32.649943
## 24   24   GAArlandia       27.035197
## 25   25   GAArlandia       28.398761
## 26   26   GAArlandia       22.010957
## 27   27   GAArlandia       37.663866
## 28   28   GAArlandia       27.250026
## 29   29   GAArlandia       24.999815
## 30   30   GAArlandia       32.787393
## 31   31   GAArlandia       31.814282
## 32   32   GAArlandia       36.085196
## 33   33   GAArlandia       33.378807
## 34   34   GAArlandia       37.357490
## 35   35   GAArlandia       25.173093
## 36   36   GAArlandia       29.674017
## 37   37   GAArlandia       35.124621
## 38   38   GAArlandia       23.580356
## 39   39   GAArlandia       23.290572
## 40   40   GAArlandia       30.863352
## 41   41   GAArlandia       29.434911
## 42   42   GAArlandia       32.010854
## 43   43   GAArlandia       27.810530
## 44   44   GAArlandia       33.894602
## 45   45   GAArlandia       34.450793
## 46   46   GAArlandia       27.171915
## 47   47   GAArlandia       30.602655
## 48   48   GAArlandia       33.865584
## 49   49   GAArlandia       35.517218
## 50   50   GAArlandia       27.280560
## 51   51   GAArlandia       21.565699
## 52   52   GAArlandia       31.322075
## 53   53   GAArlandia       30.802180
## 54   54   GAArlandia       23.152009
## 55   55   GAArlandia       23.014287
## 56   56   GAArlandia       24.131442
## 57   57   GAArlandia       25.389083
## 58   58   GAArlandia       42.288927
```

```
## 59   59   GAArlandia       26.714144
## 60   60   GAArlandia       28.416615
## 61   61   GAArlandia       22.692968
## 62   62   GAArlandia       30.008266
## 63   63   GAArlandia       31.078855
## 64   64   GAArlandia       30.516887
## 65   65   GAArlandia       27.170455
## 66   66   GAArlandia       32.066721
## 67   67   GAArlandia       39.563929
## 68   68   GAArlandia       21.716538
## 69   69   GAArlandia       28.424518
## 70   70   GAArlandia       35.404489
## 71   71   GAArlandia       34.946875
## 72   72   GAArlandia       29.538874
## 73   73   GAArlandia       27.607692
## 74   74   GAArlandia       31.232740
## 75   75   GAArlandia       24.300117
## 76   76   GAArlandia       39.961182
## 77   77   GAArlandia       33.570529
## 78   78   GAArlandia       29.795664
## 79   79   GAArlandia       28.699432
## 80   80   GAArlandia       25.549617
## 81   81   GAArlandia       28.797514
## 82   82   GAArlandia       37.660359
## 83   83   GAArlandia       24.826671
## 84   84   GAArlandia       30.643144
## 85   85   GAArlandia       26.984092
## 86   86   GAArlandia       31.885093
## 87   87   GAArlandia       33.294904
## 88   88   GAArlandia       30.970761
## 89   89   GAArlandia       32.461894
## 90   90   GAArlandia       36.629848
## 91   91   GAArlandia       39.746484
## 92   92   GAArlandia       27.274939
## 93   93   GAArlandia       39.273785
## 94   94   GAArlandia       27.780094
## 95   95   GAArlandia       31.439468
## 96   96   GAArlandia       29.324815
## 97   97   GAArlandia       27.616189
## 98   98   GAArlandia       35.400022
## 99   99   GAArlandia       29.601547
## 100 100   GAArlandia       33.967965
## 101 101   GAArlandia       33.846368
## 102 102   GAArlandia       25.193540
## 103 103   GAArlandia       34.963986
## 104 104   GAArlandia       30.914731
## 105 105   GAArlandia       28.116642
## 106 106   GAArlandia       31.632988
## 107 107   GAArlandia       30.875202
## 108 108   GAArlandia       30.918702
## 109 109   GAArlandia       32.468307
## 110 110   GAArlandia       39.924094
## 111 111   GAArlandia       32.961958
## 112 112   GAArlandia       34.046234
```

```
## 113 113   GAArlandia        30.864615
## 114 114   GAArlandia        32.761069
## 115 115   GAArlandia        32.394788
## 116 116   GAArlandia        40.389672
## 117 117   GAArlandia        29.936592
## 118 118   GAArlandia        34.397126
## 119 119   GAArlandia        35.141339
## 120 120   GAArlandia        33.502727
## 121 121   GAArlandia        27.830976
## 122 122   GAArlandia        31.087014
## 123 123   GAArlandia        21.725471
## 124 124   GAArlandia        30.413042
## 125 125   GAArlandia        32.966299
## 126 126   GAArlandia        21.166687
## 127 127   GAArlandia        29.566869
## 128 128   GAArlandia        29.120375
## 129 129   GAArlandia        28.029701
## 130 130   GAArlandia        37.944452
## 131 131   GAArlandia        31.796953
## 132 132   GAArlandia        34.257595
## 133 133   GAArlandia        34.121701
## 134 134   GAArlandia        29.705279
## 135 135   GAArlandia        39.753701
## 136 136   GAArlandia        33.165426
## 137 137   GAArlandia        27.360100
## 138 138   GAArlandia        33.584094
## 139 139   GAArlandia        23.768437
## 140 140   GAArlandia        23.790816
## 141 141   GAArlandia        31.126635
## 142 142   GAArlandia        29.010050
## 143 143   GAArlandia        41.330793
## 144 144   GAArlandia        19.077808
## 145 145   GAArlandia        34.941782
## 146 146   GAArlandia        31.751514
## 147 147   GAArlandia        29.133618
## 148 148   GAArlandia        32.304633
## 149 149   GAArlandia        24.735595
## 150 150   GAArlandia        29.415346
## 151 151 NorthAmerica         5.732029
## 152 152 NorthAmerica        14.606369
## 153 153 NorthAmerica        11.317256
## 154 154 NorthAmerica         7.941740
## 155 155 NorthAmerica         9.939239
## 156 156 NorthAmerica        12.410139
## 157 157 NorthAmerica         5.382379
## 158 158 NorthAmerica        10.304695
## 159 159 NorthAmerica        11.199373
## 160 160 NorthAmerica         9.401605
## 161 161 NorthAmerica         8.996039
## 162 162 NorthAmerica        16.061680
## 163 163 NorthAmerica         9.931680
## 164 164 NorthAmerica         2.921997
## 165 165 NorthAmerica        10.277584
## 166 166 NorthAmerica        15.001097
```

```
## 167 167 NorthAmerica        12.580021
## 168 168 NorthAmerica         8.784675
## 169 169 NorthAmerica        10.200620
## 170 170 NorthAmerica        13.574523
## 171 171 NorthAmerica        12.141151
## 172 172 NorthAmerica        10.239441
## 173 173 NorthAmerica         9.311486
## 174 174 NorthAmerica         4.540976
## 175 175 NorthAmerica        12.935168
## 176 176 NorthAmerica        12.811839
## 177 177 NorthAmerica         7.923187
## 178 178 NorthAmerica         6.594231
## 179 179 NorthAmerica         7.803203
## 180 180 NorthAmerica        14.279067
## 181 181 NorthAmerica        18.032019
## 182 182 NorthAmerica        12.141993
## 183 183 NorthAmerica         9.206212
## 184 184 NorthAmerica        12.181561
## 185 185 NorthAmerica         3.942923
## 186 186 NorthAmerica         4.855081
## 187 187 NorthAmerica        13.339453
## 188 188 NorthAmerica         6.615060
## 189 189 NorthAmerica         7.633331
## 190 190 NorthAmerica        12.378389
## 191 191 NorthAmerica         9.368125
## 192 192 NorthAmerica        11.431722
## 193 193 NorthAmerica         8.384085
## 194 194 NorthAmerica         8.815817
## 195 195 NorthAmerica        10.253909
## 196 196 NorthAmerica        11.254227
## 197 197 NorthAmerica         9.998293
## 198 198 NorthAmerica         8.377482
## 199 199 NorthAmerica         7.400653
## 200 200 NorthAmerica        12.338501
## 201 201 NorthAmerica        13.594325
## 202 202 NorthAmerica        11.721289
## 203 203 NorthAmerica         9.833807
## 204 204 NorthAmerica         8.764555
## 205 205 NorthAmerica         7.774646
## 206 206 NorthAmerica         5.950056
## 207 207 NorthAmerica         8.673901
## 208 208 NorthAmerica         7.427801
## 209 209 NorthAmerica        13.585774
## 210 210 NorthAmerica         9.902837
## 211 211 NorthAmerica         9.318875
## 212 212 NorthAmerica         9.917223
## 213 213 NorthAmerica         9.218944
## 214 214 NorthAmerica         7.996143
## 215 215 NorthAmerica        12.545364
## 216 216 NorthAmerica         8.036051
## 217 217 NorthAmerica        10.302940
## 218 218 NorthAmerica        11.501020
## 219 219 NorthAmerica         8.187445
## 220 220 NorthAmerica         9.557591
```

```
## 221 221 NorthAmerica        10.906726
## 222 222 NorthAmerica        12.408474
## 223 223 NorthAmerica        11.483082
## 224 224 NorthAmerica        11.037256
## 225 225 NorthAmerica         8.313601
## 226 226 NorthAmerica         9.927716
## 227 227 NorthAmerica        11.012503
## 228 228 NorthAmerica        10.828437
## 229 229 NorthAmerica         5.320138
## 230 230 NorthAmerica         9.842938
## 231 231 NorthAmerica         8.315961
## 232 232 NorthAmerica        12.682402
## 233 233 NorthAmerica         7.533188
## 234 234 NorthAmerica        15.104020
## 235 235 NorthAmerica         8.989866
## 236 236 NorthAmerica         7.660039
## 237 237 NorthAmerica        11.541160
## 238 238 NorthAmerica         7.056089
## 239 239 NorthAmerica         6.092002
## 240 240 NorthAmerica        12.895183
## 241 241 NorthAmerica         9.646290
## 242 242 NorthAmerica         6.386721
## 243 243 NorthAmerica         4.753650
## 244 244 NorthAmerica        14.784419
## 245 245 NorthAmerica        13.016126
## 246 246 NorthAmerica         9.018656
## 247 247 NorthAmerica         8.585859
## 248 248 NorthAmerica        10.820299
## 249 249 NorthAmerica        11.412260
## 250 250 NorthAmerica         9.862359
## 251 251 NorthAmerica         7.612941
## 252 252 NorthAmerica        10.877894
## 253 253 NorthAmerica        11.904785
## 254 254 NorthAmerica        12.493540
## 255 255 NorthAmerica        14.648561
## 256 256 NorthAmerica        11.258636
## 257 257 NorthAmerica        10.210643
## 258 258 NorthAmerica         9.889938
## 259 259 NorthAmerica         6.894864
## 260 260 NorthAmerica        11.210803
## 261 261 NorthAmerica         7.488728
## 262 262 NorthAmerica        10.335022
## 263 263 NorthAmerica        11.204954
## 264 264 NorthAmerica         8.555192
## 265 265 NorthAmerica        10.074777
## 266 266 NorthAmerica         7.515542
## 267 267 NorthAmerica        14.236930
## 268 268 NorthAmerica         4.206324
## 269 269 NorthAmerica         9.217299
## 270 270 NorthAmerica         7.928145
## 271 271 NorthAmerica         3.897171
## 272 272 NorthAmerica        13.788084
## 273 273 NorthAmerica         6.162205
## 274 274 NorthAmerica        11.135541
```

```
## 275 275 NorthAmerica         9.670002
## 276 276 NorthAmerica        10.409881
## 277 277 NorthAmerica        11.189178
## 278 278 NorthAmerica         7.056169
## 279 279 NorthAmerica         9.961331
## 280 280 NorthAmerica         8.484778
## 281 281 NorthAmerica        14.019570
## 282 282 NorthAmerica        10.491123
## 283 283 NorthAmerica         9.546206
## 284 284 NorthAmerica         8.867659
## 285 285 NorthAmerica         5.750497
## 286 286 NorthAmerica         6.353198
## 287 287 NorthAmerica        17.411606
## 288 288 NorthAmerica        12.532942
## 289 289 NorthAmerica        13.508094
## 290 290 NorthAmerica         5.425773
## 291 291 NorthAmerica         9.464479
## 292 292 NorthAmerica        10.034400
## 293 293 NorthAmerica        10.998105
## 294 294 NorthAmerica         5.874334
## 295 295 NorthAmerica        10.636585
## 296 296 NorthAmerica         8.557769
## 297 297 NorthAmerica         5.557457
## 298 298 NorthAmerica         8.813620
## 299 299 NorthAmerica        11.518104
## 300 300 NorthAmerica        10.712544
```

ANOVA of colonization data:

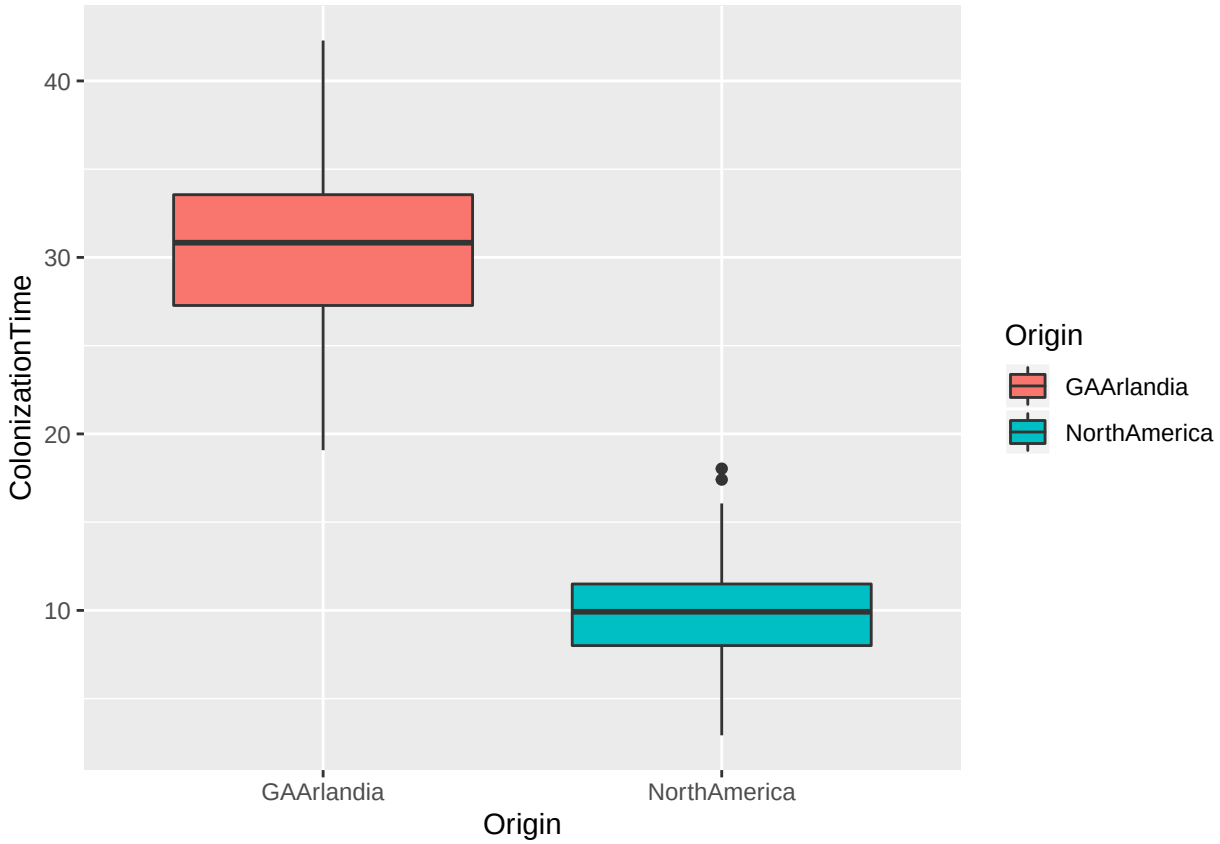
```
ANOmodel <- aov(ColonizationTime~Origin,data=ano_data)
print(ANOmodel)
```

```
## Call:
##    aov(formula = ColonizationTime ~ Origin, data = ano_data)
##
## Terms:
##                    Origin Residuals
## Sum of Squares  32054.35   4515.71
## Deg. of Freedom        1       298
##
## Residual standard error: 3.892737
## Estimated effects may be unbalanced
```

```
print(summary(ANOmodel))
```

```
##              Df Sum Sq Mean Sq F value Pr(>F)
## Origin        1  32054   32054    2115 <2e-16 ***
## Residuals   298   4516      15
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
ANOPlot <- ggplot(data=ano_data, aes(x=Origin, y=ColonizationTime, fill=Origin)) + geom_boxplot()
print(ANOPlot)
```



Manipulating Means of the two groups: The smallest possible effect size where the correlation between origin and colonization time is still significant rests at around a difference of 1.5 (million years). If the mean GAARlandia time is set at 11.5 and the mean time variable for North America is set at 10, the ANOVA analysis returns a significant value generally slightly under 0.05. Decreasing the effect size more than this results in the erasure of a significant pattern between the two variables.

Manipulating Sample Size: Sample sizes set to 2 still indicate a significant relationship between origin and colonization time, which is somewhat staggering! Lowering the sample size to 0