

Problem 29, page 203: Male Displays

Black wheatears, *Oenanthe leucura*, are small birds of Spain and Morocco. Males of the species demonstrate an exaggerated sexual display by carrying many heavy stones to nesting cavities. This 35-gram bird transports, on average, 3.1 kg of stones per nesting season! Different males carry somewhat different sized stones, prompting a study of whether larger stones may be a signal of a higher health status. M. Soler *et al.* ("Weight lifting and health status in the black wheatear," *Behavioral Ecology* 10(3) (1999): 281-86) calculated the average stone mass (g) carried by each of 21 male black wheatears, along with T-cell response measurements reflecting their immune systems' strengths. Analyze the data and write a statistical report summarizing the evidence supporting whether health--as measured by Tt-cell response--is associated with stone mass, and quantifying the association.

Some useful R code

```
> bw=read.table("...\\BlackWheatears.txt",header=TRUE)
> attach(bw)
> bw
  Mass Tcell
1  3.33 0.252
2  4.62 0.263
3  5.43 0.251
4  5.73 0.251
5  6.12 0.183
6  6.29 0.213
7  6.45 0.332
8  6.51 0.203
9  6.65 0.252
10 6.75 0.342
11 6.81 0.471
12 7.56 0.431
13 7.83 0.312
14 8.02 0.304
15 8.06 0.370
16 8.18 0.381
17 9.08 0.430
18 9.15 0.430
19 9.35 0.213
20 9.42 0.508
21 9.95 0.411
```

```
>summary(Mass)
```

```
Min. 1st Qu. Median Mean 3rd Qu. Max.  
3.330 6.290 6.810 7.204 8.180 9.950
```

```
> sd(Mass)
```

```
[1] 1.702441
```

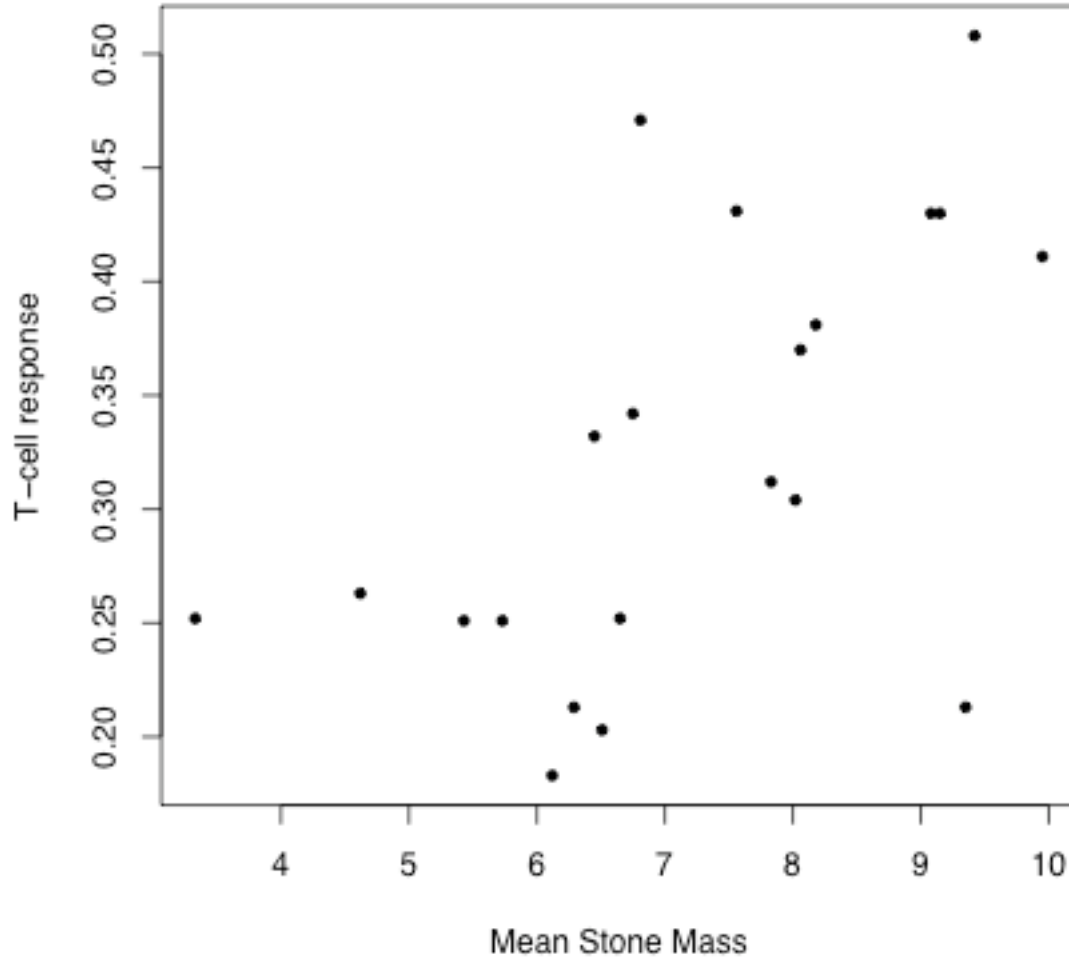
```
>summary(Tcell)
```

```
Min. 1st Qu. Median Mean 3rd Qu. Max.  
0.183 0.251 0.312 0.324 0.411 0.508
```

```
> sd(Tcell)
```

```
[1] 0.09673752
```

```
>plot(Mass,Tcell,pch=20,xlab="Mean Stone Mass",ylab="T-cell response")
```



```
>cor(Mass,Tcell)
```

```
[1] 0.577611
```

```
>SLR=lm(Tcell~Mass)
```

```
> SLR
```

```
Call:
```

```
lm(formula = Tcell ~ Mass)
```

```
Coefficients:
```

```
(Intercept)    Mass  
  0.08750      0.03282
```

```
> summary(SLR)
```

```
Call:
```

```
lm(formula = Tcell ~ Mass)
```

```
Residuals:
```

```
   Min     1Q  Median     3Q    Max  
-0.18138 -0.04673  0.01796  0.04219  0.15999
```

```
Coefficients:
```

```
            Estimate Std. Error t value Pr(>|t|)  
(Intercept) 0.08750   0.07868   1.112  0.2800  
Mass         0.03282   0.01064   3.084  0.0061 **
```

```
---
```

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

```
Residual standard error: 0.08102 on 19 degrees of freedom
```

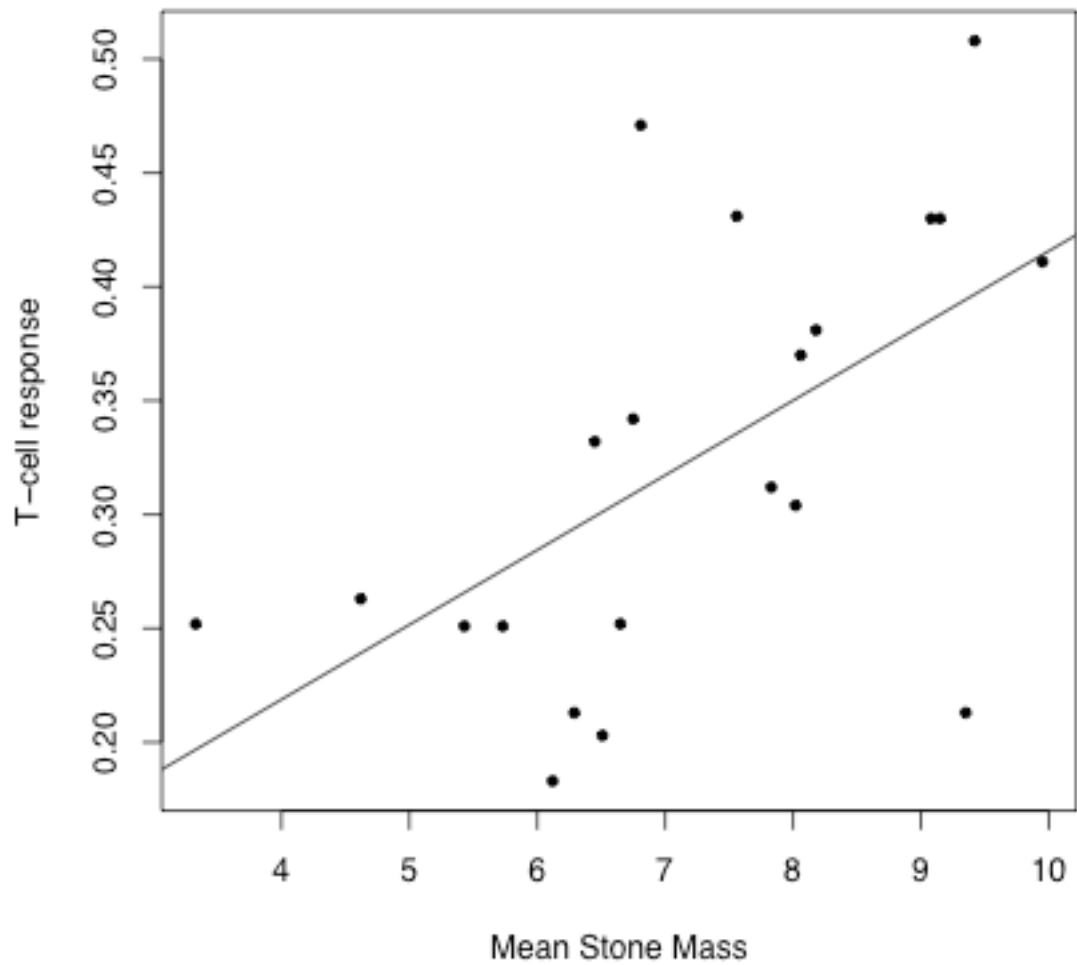
```
Multiple R-Squared: 0.3336,    Adjusted R-squared: 0.2986
```

```
F-statistic: 9.513 on 1 and 19 DF, p-value: 0.006105
```

```
> SLR$coefficients
```

```
(Intercept)    Mass  
0.08749698  0.03282149
```

```
>plot(Mass,Tcell,pch=20,xlab="Mean Stone Mass",ylab="T-cell response")  
>abline(SLR$coefficients)
```



> names(SLR)

```
[1] "coefficients" "residuals" "effects" "rank"  
[5] "fitted.values" "assign" "qr" "df.residual"  
[9] "xlevels" "call" "terms" "model"
```

> SLR\$fitted

```
 1      2      3      4      5      6      7  
0.1967925 0.2391323 0.2657177 0.2755641 0.2883645 0.2939442 0.2991956  
 8      9     10     11     12     13     14  
0.3011649 0.3057599 0.3090420 0.3110113 0.3356275 0.3444893 0.3507253  
15     16     17     18     19     20     21  
0.3520382 0.3559768 0.3855161 0.3878136 0.3943779 0.3966754 0.4140708
```

> SLR\$residuals

```
 1      2      3      4      5  
0.055207452 0.023867729 -0.014717679 -0.024564126 -0.105364507  
 6      7      8      9     10  
-0.080944161 0.032804401 -0.098164889 -0.053759897 0.032957953  
11     12     13     14     15  
0.159988664 0.095372546 -0.032489257 -0.046725340 0.017961801  
16     17     18     19     20  
0.025023222 0.044483880 0.042186376 -0.181377923 0.111324573  
21  
-0.003070817
```

```
> plot(SLR$fitted,SLR$residuals,xlab="Fitted Values",ylab="Residuals")
```

