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FACTORS RELATED TO PRECIPITATION IN FOREST RED MILLIPEDES *CENTROBOLUS* COOK, 1897

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***Abstract*- Precipitation was tested for a correlation with ten factors in red millipedes *Centrobolus*. Precipitation was correlated with temperature (r= 0.5369, r^2=0.2883, n=22, p=0.009967), longitude (r=0.7355, r^2=0.541, n=22, p=0.00101), latitude (r=0.6515, r^2=0.4245, n=22, p=0.001009), highest ocean water temperature (r=0.6812, r^2=0.484, n=9, p=0.04335), minimum ocean water temperature (r=0.92942823, Z score=4.05188315, n=9, p=0.00002542), month with the highest number of rainy days (r=- 0.4627, r^2=0.2141, n=22, p=0.03001), maximum temperature (r=0.5809, r^2=0.3374, n=22, p=0.004575), minimum temperature (r=0.6467, r^2=0.4182, n=22, p=0.001163), lowest relative humidity (r=- 0.4795, r^2=0.2299, n=22, p=0.023771) and mean ocean water temperature (r=0.91556939, Z score=4.12980631, n=10, p=0.00001816). Ten factors were tested for a correlation with minimum precipitation in the same red millipedes *Centrobolus*. Highest relative humidity (r= 0.4651, r^2=0.2163, n=22, p=0.029215), possibly abundance (r=0.63046242, Z score=1.65957221, n=8, p=0.04850025), mean ocean water temperature (r=0.90328257, Z score=3.94156315, n=10, p=0.00004049), average temperature (r= 0.5939, r^2=0.3527, n=22, p=0.003559), altitude (r=-0.5623, r^2=0.3162, n=22, p=0.006452), highest ocean water temperature (r=0.70020301, Z score=2.29571497, n=10, p=0.01084606), lowest relative humidity (r= 0.4651, r^2=0.2163, n=22, p=0.029215), highest duration of sunshine (r=- 0.4421, r^2=0.1955, n=22, p=0.039386), minimum ocean water temperature (r=0.91774928, Z score=3.85688746, n=9, p=0.00005744), moments of inertia (r=0.63011750, Z score=1.96211827, n=10, p=0.02487429), and species volume (r=0.6843, r^2=0.4683, n=22, p=0.000448) were correlated to minimum precipitation.**

***Keywords*: precipitation, Red Millipedes.**

I. INTRODUCTION

Red millipedes are found in the southern African subregion with northern limits on the east coast being about -17° latitude S and southern limits being -35° latitude S. They are well represented in the littoral forests of the eastern half of the subcontinent [1-297]. It consists of taxonomically important species with 12 species considered threatened and includes nine vulnerable and three endangered species [226]. It occurs in all the forests of the coastal belt from the Cape Peninsula to Beira in Mocambique [225]. These worm-like millipedes have female-biased sexual size dimorphism [57].
Here, the precipitation was tested for a correlation with ten factors and minimum precipitation with eleven factors in *Centrobolus* Cook, 1897.

II. MATERIALS AND METHODS

Horizontal tergite width measurements for 22 species of southern African *Centrobolus* were obtained from published material [57]. These were halved to get radii (r). The surface areas (mm^2) were calculated based on the equation $2 \cdot \pi \cdot r \cdot (r + h)$ for males and females. A correlation between precipitation with ten factors and minimum preciptation with eleven factors were generated at https://www.socscistatistics.com/tests/pearson/default2.aspx (Appendix 1-23).

III. RESULTS

Precipitation was correlated with temperature (Fig. 1: r=0.5369, r^2=0.2883, n=22, p=0.009967).

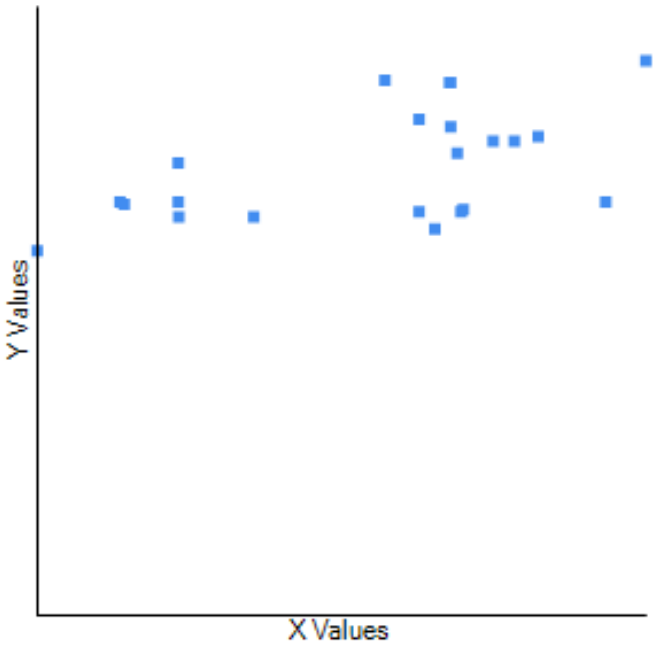

Fig. 1. Correlation between precipitation (x) and temperature (y) across therange of *Centrobolus* Cook, 1897.

Precipitation was related to longitude (Fig. 2: r=0.7355, r^2=0.541, n=22, p=0.00101).

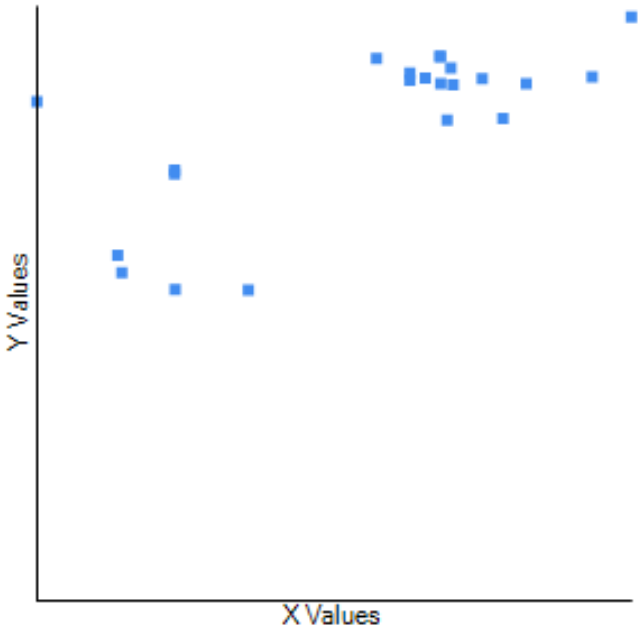

Fig. 2. Correlation between precipitation (mm) and longitude across therange of *Centrobolus* Cook, 1897.

Precipitation was related to latitude (Fig. 3: r=0.6515, r^2=0.4245, n=22, p=0.001009).

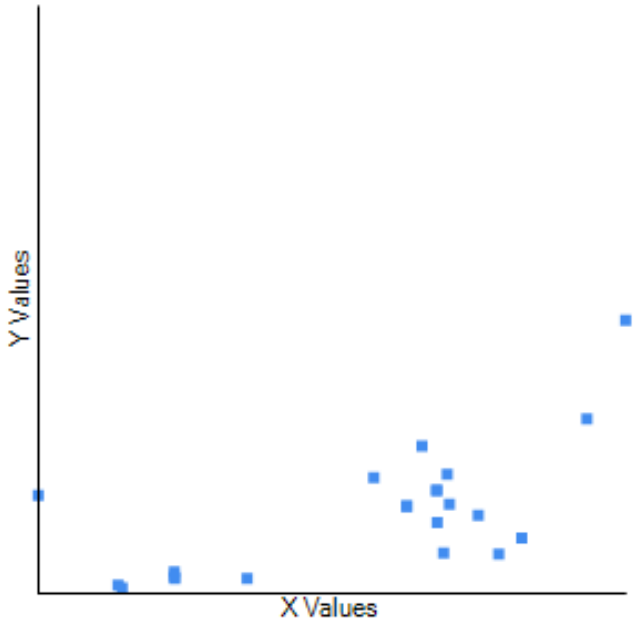

Fig. 3. Correlation between precipitation (mm) and latitude across therange of *Centrobolus* Cook, 1897.

Highest ocean water temperature was related to precipitation (Fig. 4: r=0.6812, r^2=0.484, n=9, p=0.04335).

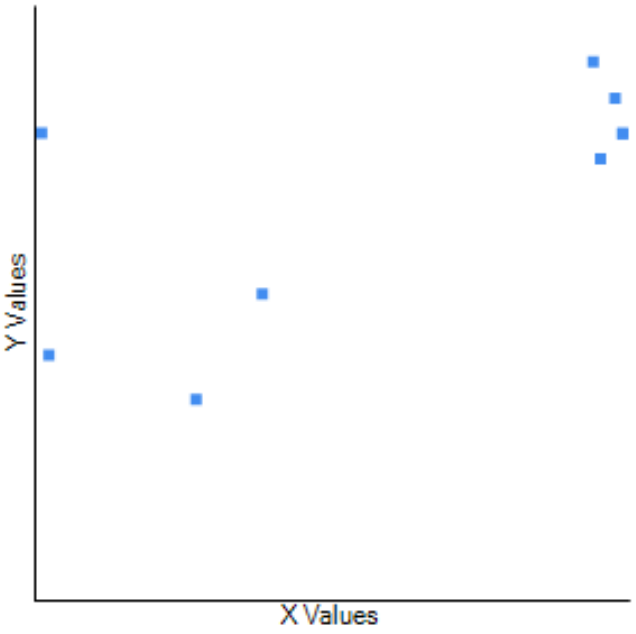

Fig. 4. Correlation between highest ocean water temperature and precipitation in *Centrobolus* Cook, 1897.

Minimum ocean water temperature was related to precipitation (Fig. 5: r=0.92942823, Z score=4.05188315, n=9, p=0.00002542).

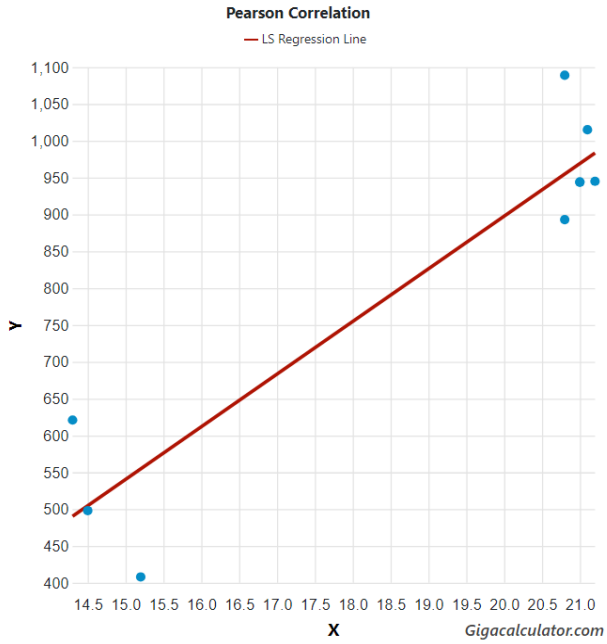

Fig. 5. Correlation between minimum ocean water temperature and precipitation in *Centrobolus* Cook, 1897.

Month with the highest number of rainy days was related to precipitation (Fig. 6: r=- 0.4627, r^2=0.2141, n=22, p=0.03001).

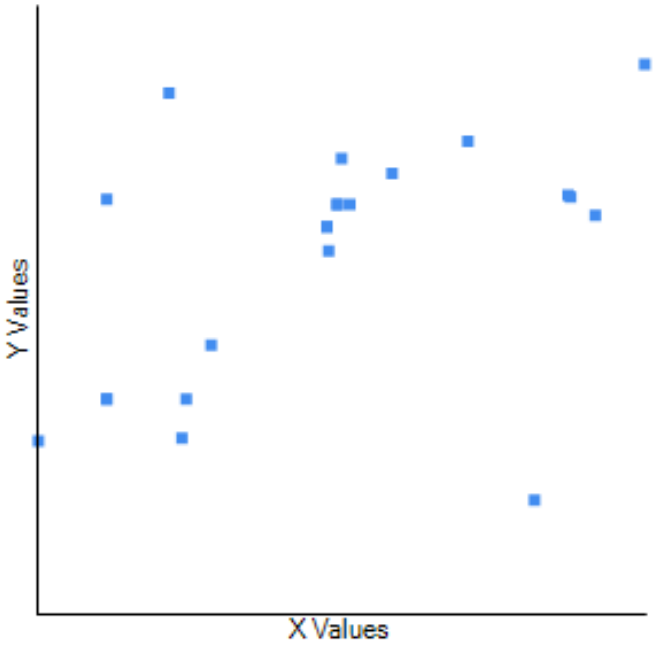

Fig. 6. Correlation between month with the highest number of rainy days and precipitation across therange of *Centrobolus* Cook, 1897.

Precipitation was tested for a correlation with maximum temperature in red millipedes *Centrobolus*. Precipitation was related to minimum temperature (Fig. 7: r=0.5809, r^2=0.3374, n=22, p=0.004575).

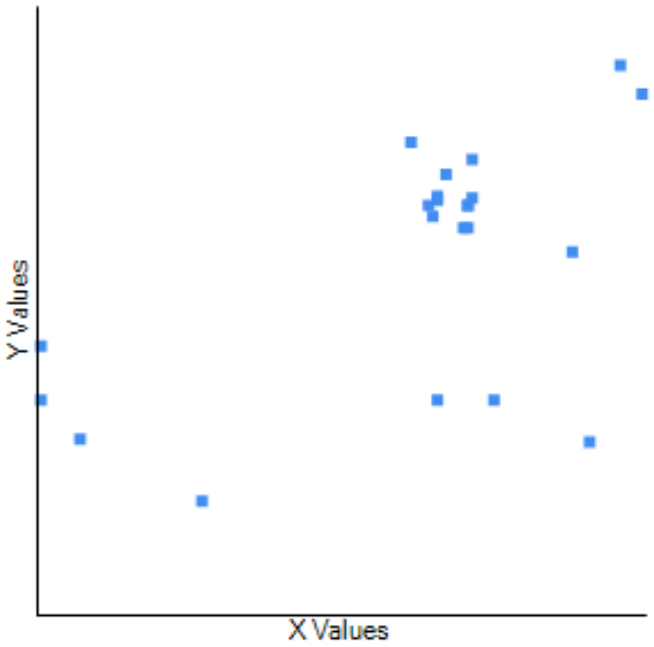

Fig. 7. Correlation between precipitation and maximum temperature across the range of *Centrobolus* Cook, 1897.

Precipitation was tested for a correlation with minimum temperature in red millipedes *Centrobolus*. Precipitation was related to minimum temperature (Fig. 8: r=0.6467, r^2=0.4182, n=22, p=0.001163).

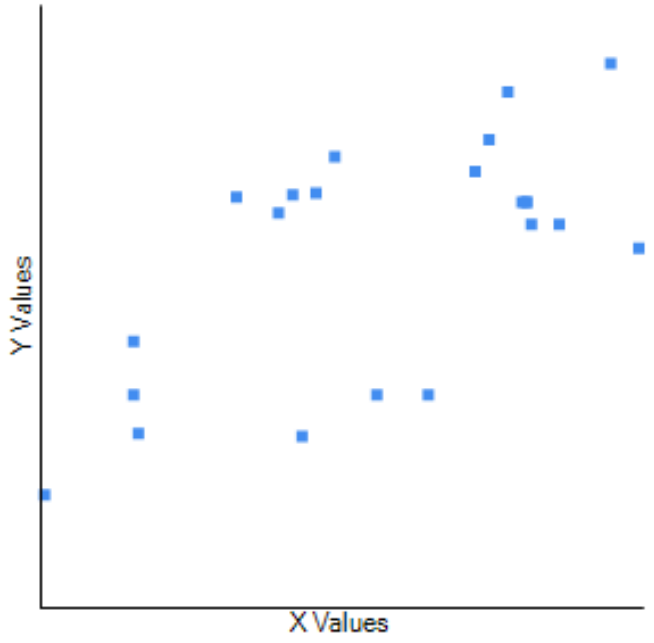

Fig. 8. Correlation between precipitation and minimum temperature across the range of *Centrobolus* Cook, 1897.

Lowest relative humidity was related to precipitation (Fig. 9: r=-0.4795, r^2=0.2299, n=22, p=0.023771).

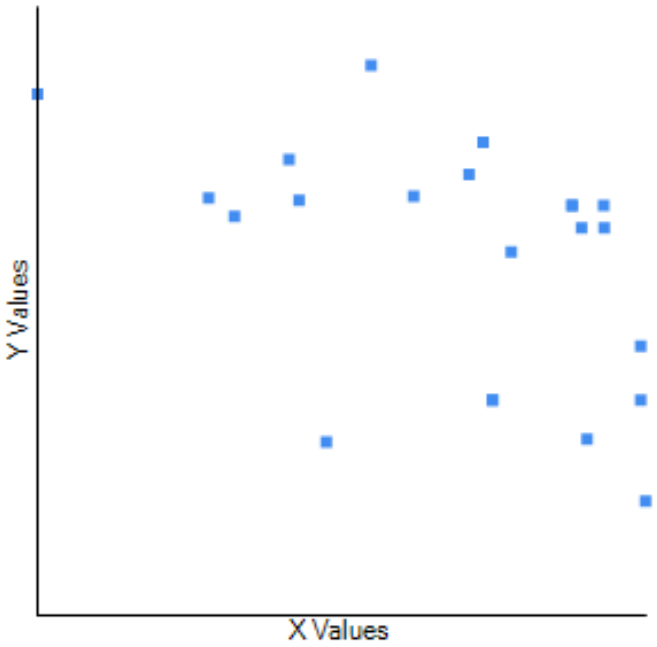

Fig. 9. Correlation between lowest relative humidity (%) and precipitation across therange of *Centrobolus* Cook, 1897.

Mean ocean water temperature was related to precipitation (Fig. 10: r=0.91556939, Z score=4.12980631, n=10, p=0.00001816).

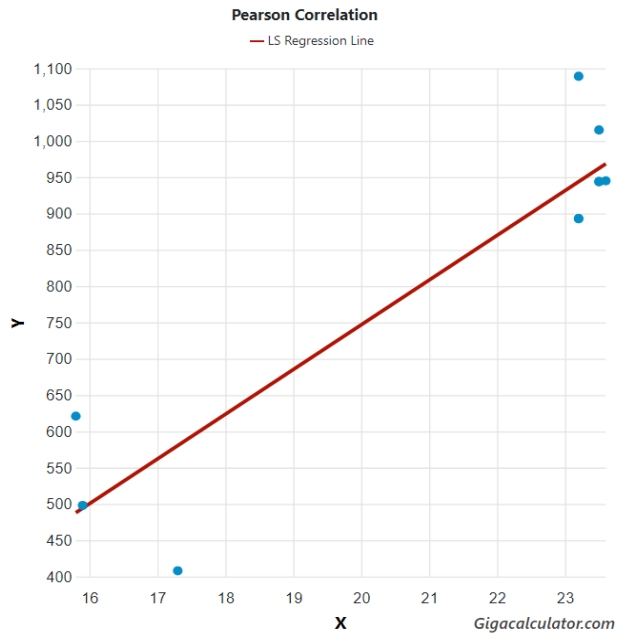

Fig. 10. Correlation between mean ocean water temperature and precipitation in *Centrobolus* Cook, 1897.

Highest relative humidity was related to minimum precipitation (Fig. 11: r= 0.4651, r^2=0.2163, n=22, p=0.029215).

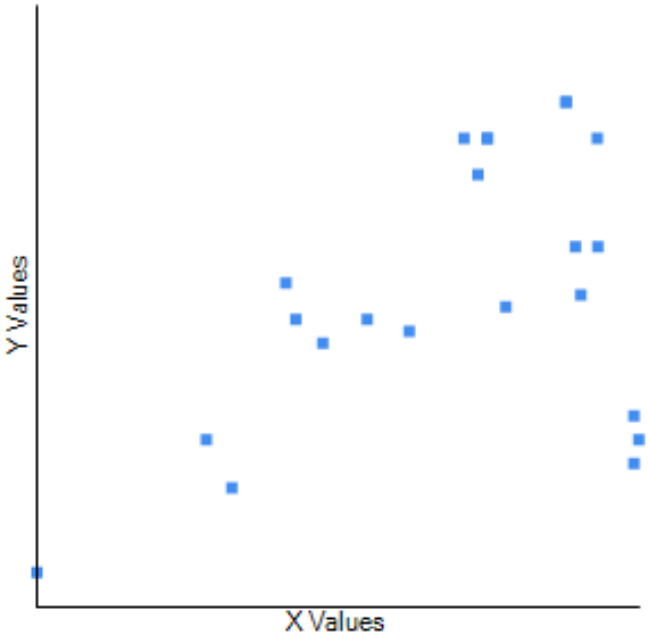

Fig. 11. Correlation between highest relative humidity (%) and minimum precipitation (mm) across therange of *Centrobolus* Cook, 1897.

Abundance was related to minimum precipitation (Fig. 12: r=0.63046242, Z score=1.65957221, n=8, p=0.04850025).

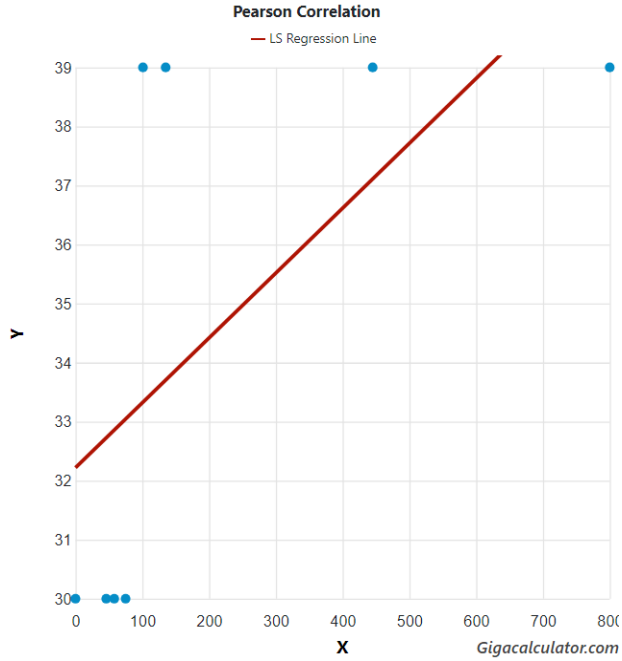

Fig. 12. Correlation between abundance and minimum precipitation across therange of *Centrobolus* Cook, 1897.

The mean ocean water temperature was correlated with minimum precipitation (Fig. 13: r=0.90328257, Z score=3.94156315, n=10, p=0.00004049).

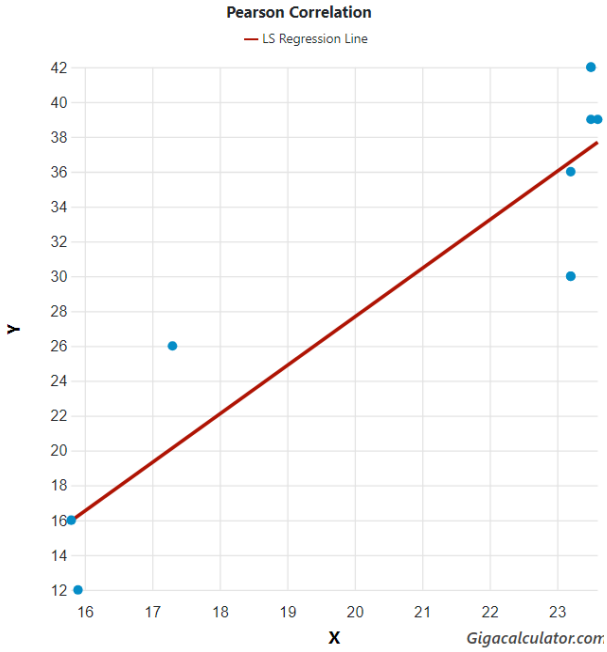

Fig. 13. Correlation between the mean ocean water temperature (X) and minimum precipitation (Y) across therange of *Centrobolus* Cook, 1897.

The temperature was correlated with minimum precipitation (Fig. 14: r= 0.5939, r^2=0.3527, n=22, p=0.003559).

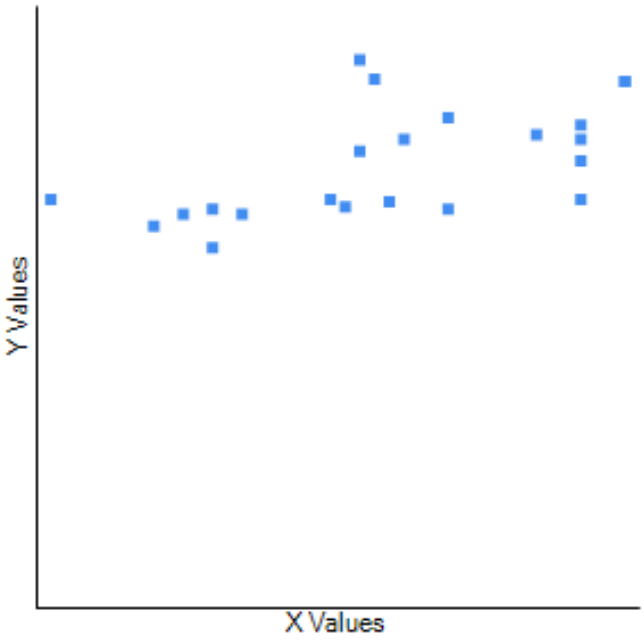

Fig. 14. Correlation between temperature (Y) and minimum precipitation (X) across therange of *Centrobolus* Cook, 1897.

Altitude was related to minimum precipitation (Fig. 15: r=-0.5623, r^2=0.3162, n=22, p=0.006452).

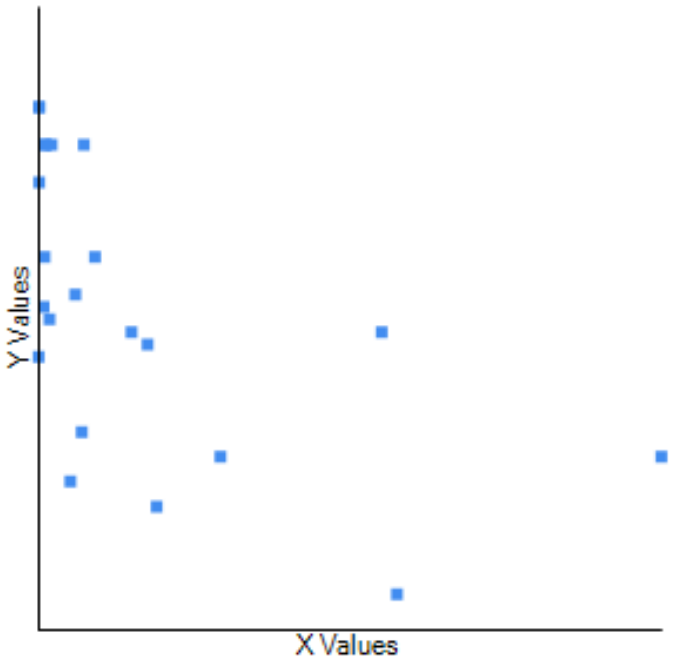

Fig. 15. Correlation between altitude (m) and minimum precipitation across therange of *Centrobolus* Cook, 1897.

Highest ocean water temperature was related to minimum precipitation (Fig. 16: r=0.70020301, Z score=2.29571497, n=10, p=0.01084606).

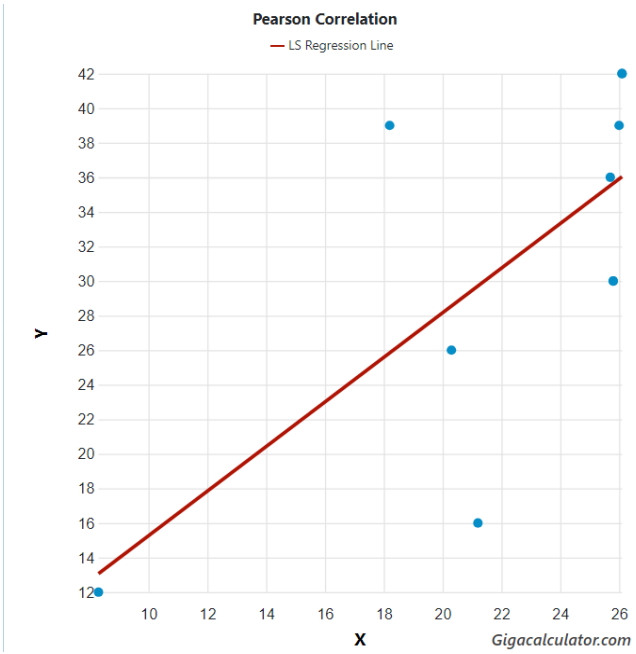

Fig. 16. Correlation between highest ocean water temperature and minimum precipitation in *Centrobolus* Cook, 1897.

Lowest relative humidity was related to minimum precipitation (Fig. 17: r= 0.4651, r^2=0.2163, n=22, p=0.029215).

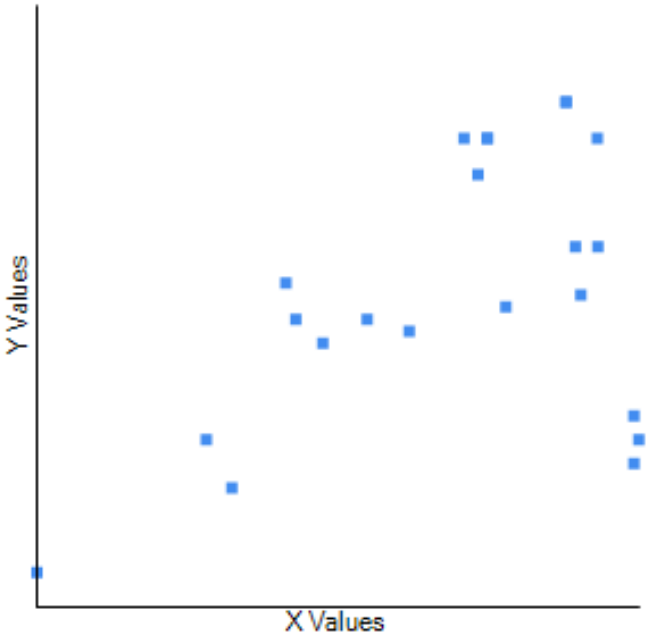

Fig. 17. Correlation between lowest relative humidity (%) and minimum precipitation (mm) across therange of *Centrobolus* Cook, 1897.

The highest duration of sunshine was correlated with minimum precipitation (Fig. 18: r=- 0.4421, r^2=0.1955, n=22, p=0.039386).

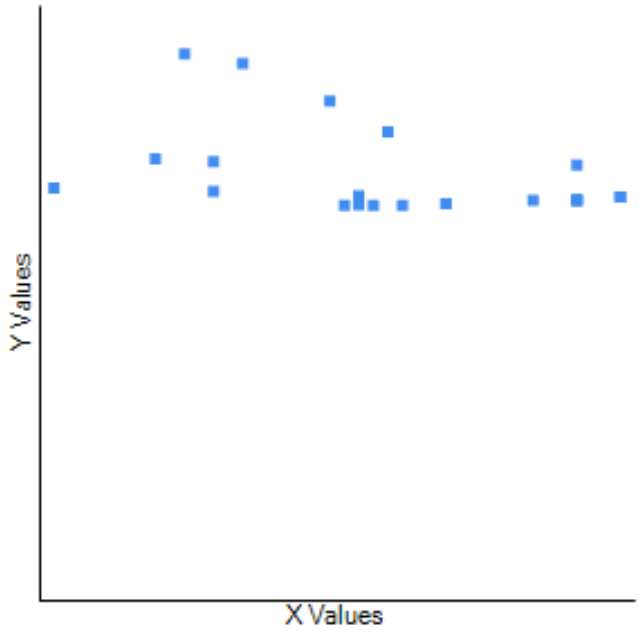

Fig. 18. Correlation between highest duration of sunshine (Y) and minimum precipitation (X) across therange of *Centrobolus* Cook, 1897.

Minimum ocean water temperature was related to minimum precipitation (Fig. 19: r=0.91774928, Z score=3.85688746, n=9, p=0.00005744).

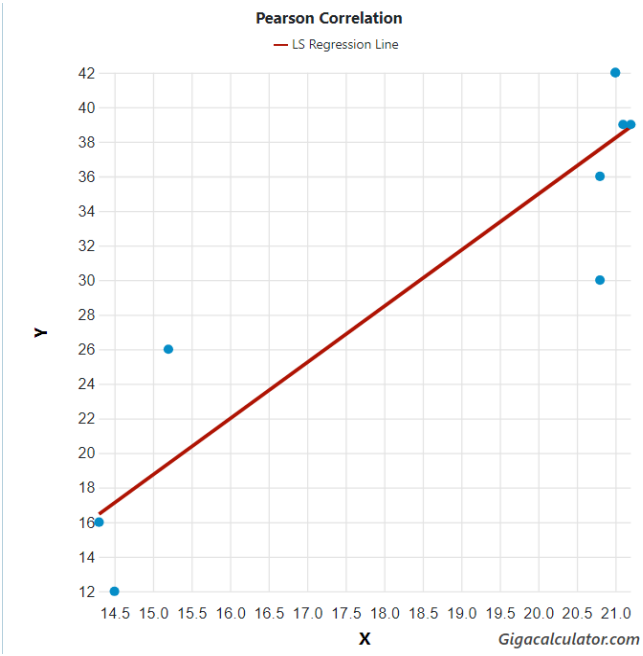

Fig. 19. Correlation between minimum ocean water temperature and minimum precipitation in *Centrobolus* Cook, 1897.

The moments of inertia were correlated with minimum precipitaiton (Fig. 20: r=0.63011750, Z score=1.96211827, n=10, p=0.02487429).

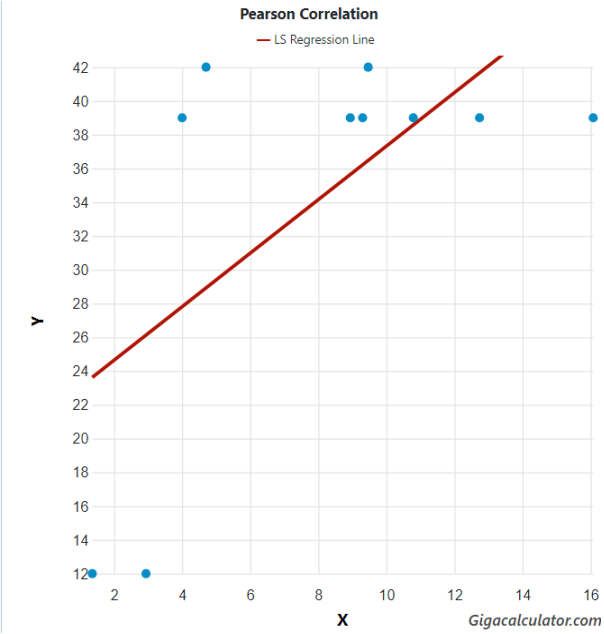

Fig. 20. Correlation between moments of inertia (Y) and minimum precipitation (X) across therange of *Centrobolus* Cook, 1897.

The species volume was correlated with minimum precipitation (Fig. 21: r= 0.6843, r^2=0.4683, n=22, p=0.000448).

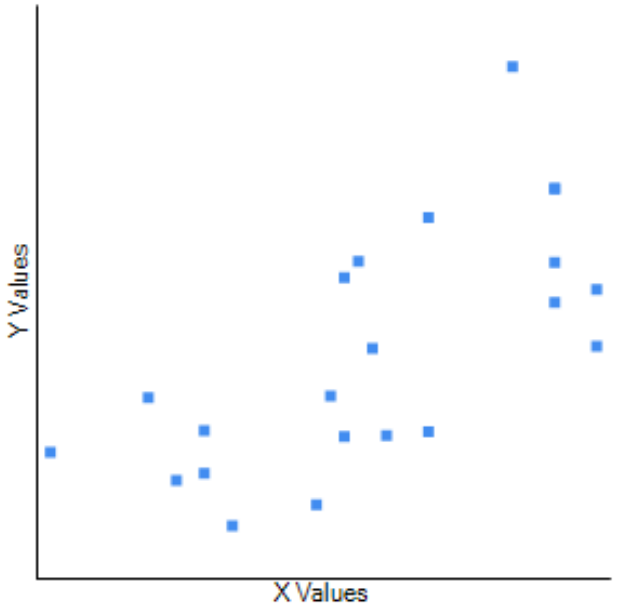

Fig. 21. Correlation between species volume (Y) and minimum preciptation (X) across therange of *Centrobolus* Cook, 1897.

IV. DISCUSSION

There is a correlation between precipitation with ten factors and minimum precipitation with eleven factors in *Centrobolus* .

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APPENDIX 1. Precipitation (mm) in *Centrobolus* Cook, 1897.

919
893
962
498
408
944
1266
1015
893
966
497
621
1050
944
945
837
497
956
401
1200
265
1089

APPENDIX 2. Temperature (degrees Celsius) in *Centrobolus* Cook, 1897.

15.9
20.4
16.6
16.4
16.9
21.9
22.8
19.5
16.6
16.7
17.0
16.4
19.5
21.9
20.1
22.0
18.6
19.0
17.0
17.0
15.0
19.7

APPENDIX 3. Longitude across the range of *Centrobolus* Cook, 1897.

30.786
31.084
31.400
18.357
19.350
32.049
34.394
30.754
30.666
30.393
25.173
18.348
28.433
32.078
30.456
31.952
25.396
28.317
20.383
30.867
29.418
30.451

APPENDIX 4. Latitude across the range of *Centrobolus* Cook, 1897.

-26.1502
-29.7462
-27.8403
-34.0477
-34.5849
-28.7784
-18.6866
-30.2805
-29.7080
-29.6301
-33.9322
-34.0164
-32.5717
-28.7784
-30.7157
-28.0246
-33.6367
-32.5064
-34.4142
-24.5392
-29.0939
-31.6334

APPENDIX 5. Highest ocean temperature (degrees Celsius) followed by precipitation (mm) in *Centrobolus* Cook, 1897.
25.80
18.30
20.30
26.10
26.00
21.20
26.10
18.20
25.70
893
498
408
944
1015
621
944
945
1089

APPENDIX 6. Minimum ocean temperature (degrees Celsius) followed by precipitation (mm) in *Centrobolus* Cook, 1897.
20.80, 893
14.50, 498
15.20, 408
21.00, 944
21.10, 1015
14.30, 621
21.00, 944
21.20, 945
20.80, 1089

APPENDIX 7. Month with the highest number of rainy days across the range of *Centrobolus* Cook, 1897.
24.7
19.90
13.73
19.33
10.50
10.40
13.97
21.03
15.23
13.73
19.27
8.67
11.07
14.07

13.97
14.26
13.77
8.67
8.67
7.10
10.10
18.50
16.97

APPENDIX 8. Maximum temperature (degrees Celsius) across the range of *Centrobolus* Cook, 1897.

24.7
25.4
25.6
15.7
16.6
25.5
29.0
25.0
25.5
24.8
24.8
15.7
25.6
25.5
24.6
27.9
26.1
24.8
28.3
29.5
19.4
24.2

APPENDIX 9. Minimum temperature (degrees Celsius) across the range of *Centrobolus* Cook, 1897.

14.5
19.9
14.8
11.4
11.5
19.8
21.6
18.7
20.5
15.3
17.7
11.4
15.7

19.8
19.7
22.2
16.6
13.6
15.0
19.4
9.5
19.0

APPENDIX 10. Lowest relative humidity across the range of *Centrobolus* Cook, 1897.24.7

51.38
68.65
50.09
71.60
68.93
68.18
58.18
63.06
69.79
60.29
64.23
71.60
54.10
68.18
69.75
65.15
64.23
54.60
55.95
41.57
71.84
63.75

APPENDIX 11. Mean ocean temperature (degrees Celsius) followed by precipitation (mm) in *Centrobolus* Cook, 1897.

23.20, 893
15.90, 498
17.30, 408
23.50, 944
23.50, 1015
23.20, 893
15.80, 621
23.50, 944
23.60, 945
23.20, 1089

APPENDIX 12. Highest relative humidity across the range of *Centrobolus* Cook, 1897.24.7

51.38

68.65
50.09
71.60
68.93
68.18
58.18
63.06
69.79
60.29
64.23
71.60
54.10
68.18
69.75
65.15
64.23
54.60
55.95
41.57
71.84
63.75

APPENDIX 13. Minimum precipitation (mm) across the range of *Centrobolus* Cook, 1897.

10
30
14
12
26
42
24
39
30
23
39
16
27
42
39
25
39
24
22
3
14
36

APPENDIX 14. Abundance across two species of *Centrobolus* followed by minimum precipitaion (mm).

101, 39

445, 39
800, 39
135, 39
46, 30
58, 30
75, 30
0, 30

APPENDIX 15. Mean ocean water temperature (degrees Celsius) followed by minimum precipitation (mm) across the range of *Centrobolus* Cook, 1897.

23.20, 30
15.90, 12
17.30, 26
23.50, 42
23.50, 39
23.20, 30
15.80, 16
23.50, 42
23.60, 39
23.20, 36

APPENDIX 16. The average temperature across *Centrobolus* Cook, 1897.

15.9
20.4
16.6
16.4
16.9
21.9
22.8
19.5
16.6
16.7
17.0
16.4
19.5
21.9
20.1
22.0
18.6
19.0
17.0
17.0
15.0
19.7

APPENDIX 17. Altitude across the range of *Centrobolus* Cook, 1897.

646
38
990

178
34
9
1863
48
312
596
252
240
206
9
38
65
76
509
6
1947
3377
9

APPENDIX 18. Highest ocean temperature (degrees Celsius) followed by minimum precipitation (mm) in *Centrobolus* Cook, 1897.

25.80, 30
8.30, 12
20.30, 26
26.10, 42
26.00, 39
21.20, 16
26.10, 42
18.20, 39
25.70, 36
25.80, 30

APPENDIX 19. Lowest relative humidity across the range of *Centrobolus* Cook, 1897.24.7

51.38
68.65
50.09
71.60
68.93
68.18
58.18
63.06
69.79
60.29
64.23
71.60
54.10

68.18
69.75
65.15
64.23
54.60
55.95
41.57
71.84
63.75

APPENDIX 20. The highest duration of sunshine in a day (h) across *Centrobolus* Cook, 1897.

8.93
8.03
8.28
11.04
9.47
8.16
8.00
8.09
8.03
7.99
8.81
10.85
7.99
8.16
8.11
7.99
8.09
8.18
10.1
8.34
8.87
8.09

APPENDIX 21. Minimum ocean temperature (degrees Celsius) followed by minimum precipitation (mm) in *Centrobolus* Cook, 1897.

20.80, 30
14.50, 12
15.20, 26
21.00, 42
21.10, 39
14.30, 16
21.00, 42
21.20, 39

20.80, 36

APPENDIX 22. The moments of inertia followed by minimum precipitaiton (mm) in four species of *Centrobolus* Cook, 1897.

10.791, 39
4.7021, 42
4.00, 39
1.36, 12
8.9401, 39
12.738, 39
9.4659, 42
9.3025, 39
2.9376, 12
16.078, 39

APPENDIX 23. The species volume in *Centrobolus* Cook, 1897.
952
1894
557
522
1210
1518
1580
2043
775
962
2046
284
756
1221
1451
1666
1659
749
393
669
781
2683