ISSN 2349-7823

International Journal of Recent Research in Life Sciences (IJRRLS)
Vol. 9, Issue 2, pp: (92-100), Month: April - June 2022, Available at: www.paperpublications.org

FAVOURABLE RESULT OF A COMPLEX MODEL TO ACCOUNT FOR THE IRIDESCENT COLOURS IN WOODHOOPOE FEATHERS THROUGH GRADIENTS WITH CLIMATE

M. IAN. COOPER[1]

[1]University of South Africa, South Africa

DOI: https://doi.org/10.5281/zenodo.6670229

Published Date: 20-June-2022

Abstract: **Thirteen gradients were predicted with microscopic differences in green and violet woodhoopoe iridosome diameters of mantle feathers. Outer iridophore diameters from Green Woodhoopoe *P. p. purpureus* barbules (0.22±0.03µm, n=244) recorded at Morgan Bay were smaller than those from violet barbules (0.28±0.04µm, n=248) recorded in Namibia (Hobatere and Omaruru). Precipitation (r=-0.99, Z score=-4.48, n=6, p<0.01), month with the highest relative humidity (r=-0.99, Z score=-4.28, n=6, p<0.01), month with the lowest relative humidity (r=-0.998, Z score=-6.03, n=6, p=0), month with the lowest number of rainy days (r=1, Z score=-31.82, n=6, p=0), driest month (r=-1, Z score=inf, n=6, p=0), warmest month (r=0.99, Z score=4.87, n=6, p<0.01), lowest average temperate (r=0.98, Z score=3.96, n=6, p<0.01), month with the most daily hours of sunshine (average) (r=0.996, Z score=5.39, n=6, p<0.01) (total) (r=0.996, Z score=5.43, n=6, p<0.01), month with the fewest daily hours of sunshine (average) (r=0.998, Z score=6.00, n=6, p=0) (r=0.998, Z score=6.03, n=6, p=0) (total), hours of sunshine throughout the year (r=0.999, Z score=6.53, n=6, p=0), and hours of sunshine per month (average) (r=0.998, Z score=6.15, n=6, p=0) were correlated with outer iridosome diameters. This study examined how woodhoopoes mantles may have consequences for energy expenditures.**

Keywords: **climate, feathers, gradient, weather, woodhoopoe.**

I. INTRODUCTION

There is an ecogeographical rule that states within a species of endotherms, more heavily pigmented forms are found in more humid environments near the equator [8]. It was first remarked upon this phenomenon in 1833 in a review of covariation of climate and avian plumage color. The Namibian Violet Woodhoopoe *Phoenicluus d. damarensis* is an arid near-endemic with a somewhat resolved status [2, 3, 4, 11]. It is closely related to the Green Woodhoopoe *P. purpureus* yet differs in mass and mantle feather coloration [1, 2, 6, 9]. Here I provide further resolution to the ecogeographical status of the Violet Woodhoopoe *P. damarensis* in comparison with the Green Woodhoopoe *P. purpureus*, using microscopic details of mantle feathers across precipitation, the month with the highest relative humidity, the month with the lowest relative humidity, the month with the lowest number of rainy days, the driest month, warmest month, lowest average temperate, the month with the most daily hours of sunshine (average) and (total), the month with the fewest daily hours of sunshine (average) and (total), hours of sunshine throughout the year, and hours of sunshine per month gradients.

ISSN 2349-7823

International Journal of Recent Research in Life Sciences (IJRRLS)
Vol. 9, Issue 2, pp: (92-100), Month: April - June 2022, Available at: www.paperpublications.org

II. MATERIALS AND METHODS

Mantle feathers were sampled from netted live Violet (Namibia: Hobatere and Omaruru; n = 9) and a dead Green Woodhoopoe (Morgan Bay; n = 1) in 1999. Mantle feathers were soaked for 30 min in 0.25M NaOH, followed by 2 hours in formic acid: EtOH (2:3 v/v) and 3 days in 15% (v/v) Spurr's resin in propylene oxide. They were then embedded in Spurr's resin. Both transverse and longitudinal sections of the barbules were cut, revealing that the iridophores of both species were hollow prolate cylinders. Iridophore cylinder widths were measured and correlated with precipitation, the month with the highest relative humidity, the month with the lowest relative humidity, the month with the lowest number of rainy days, the driest month, the warmest month, lowest average temperate, the month with the most daily hours of sunshine (average) and (total), the month with the fewest daily hours of sunshine (average) and (total), hours of sunshine throughout the year, and hours of sunshine per month gradients using the Pearson Correlation Coefficient Calculator (http://www.gigacalculator.com/calculators/correlation-coefficient-calculator.php). Measurements of the outer iridosome diameter of Green feathers from the Morgan Bay bird were compared with those from a Hobatere bird and an Omaruru bird to produce a correlation of mean outer iridosome diameters against the 13 climatic or weather factors (https://en.climate-data.org). Localities inputted were Kamanjab in for Hobatere, Omaruru, and Kei Road in for Mogan's Bay.

III. RESULTS

Mantle feathers and iridophores from Namibian Violet Woodhoopoe *P. damarensis* and Green Woodhoopoe *P. purpureus* predictably vary according to:

Precipitation (rainfall)

r=-0.98874052, Z score=-4.48085553, n=6, p=0.00000372

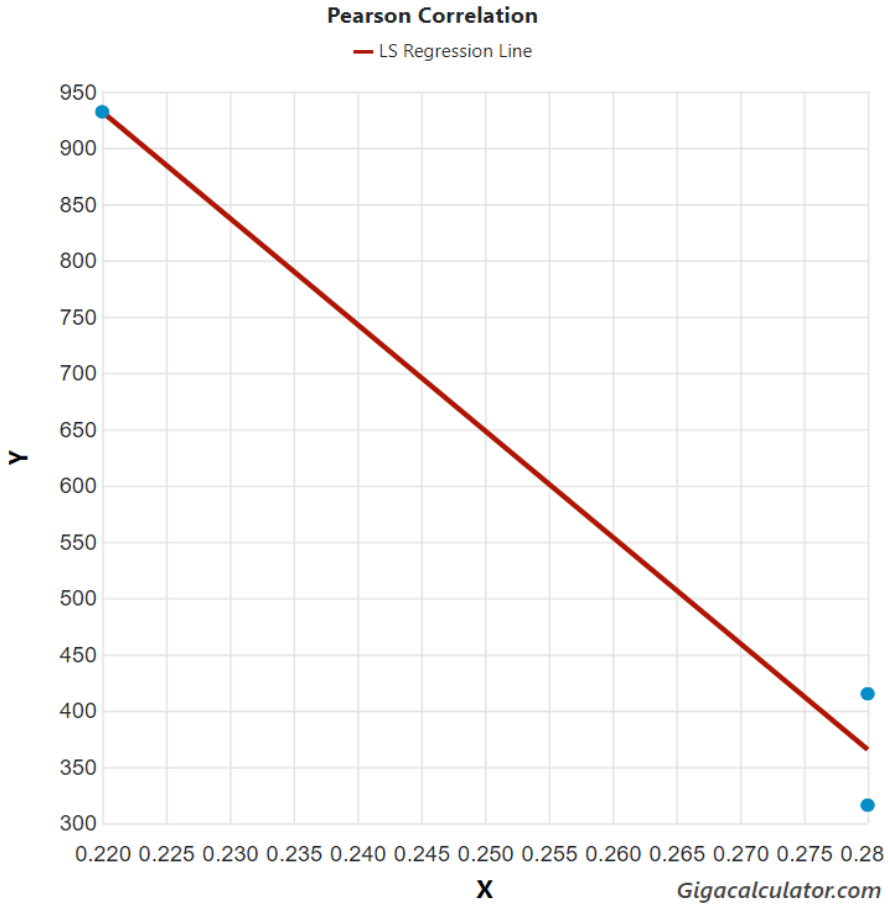

Figure 1. Predicted relationship between iridosome diameter (x) and rainfall (y).

ISSN 2349-7823

International Journal of Recent Research in Life Sciences (IJRRLS)
Vol. 9, Issue 2, pp: (92-100), Month: April - June 2022, Available at: www.paperpublications.org

Month with the highest relative humidity

r=-0.98582930, Z score=-4.28043080, n=6, p=0.00000933

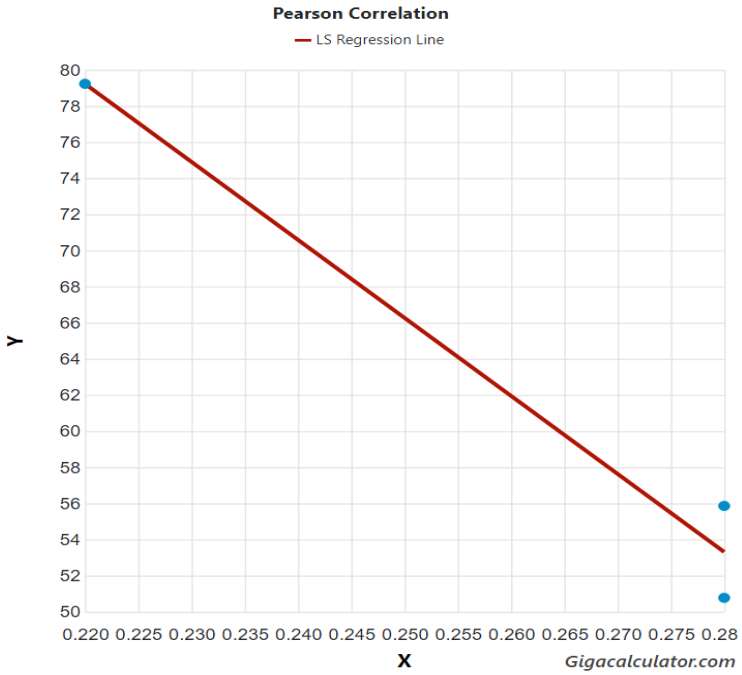

Figure 2. Predicted relationship between iridosome diameter (x) and month with the highest relative humidity (y).

Month with the lowest relative humidity

r=-0.99810253, Z score=-6.02704683, n=6, p=0

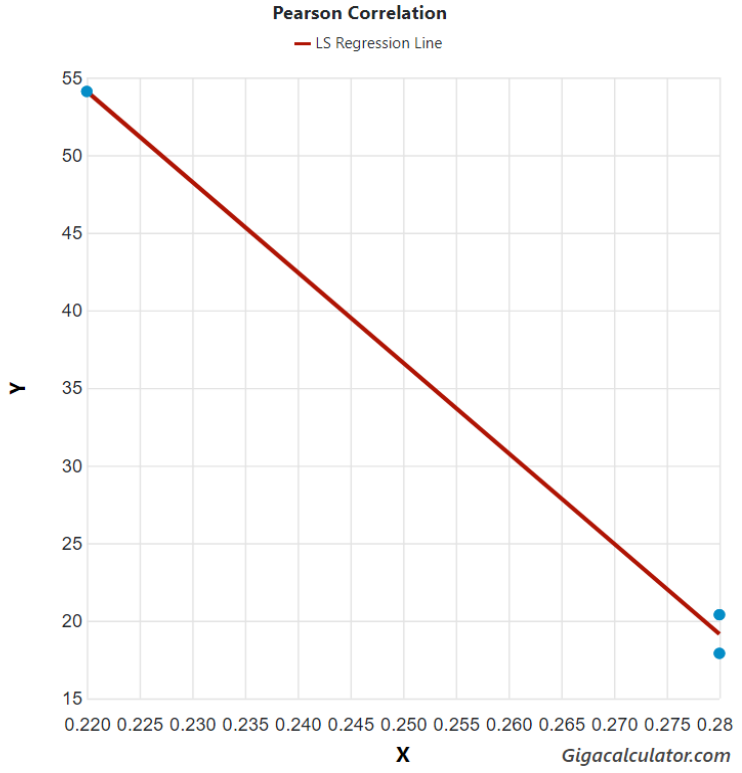

Figure 3. Predicted relationship between iridosome diameter (x) and month with the lowest relative humidity (y).

ISSN 2349-7823

International Journal of Recent Research in Life Sciences (IJRRLS)
Vol. 9, Issue 2, pp: (92-100), Month: April - June 2022, Available at: www.paperpublications.org

Month with the lowest number of rainy days

r=1, Z score=-31.81500255, n=6, p=0

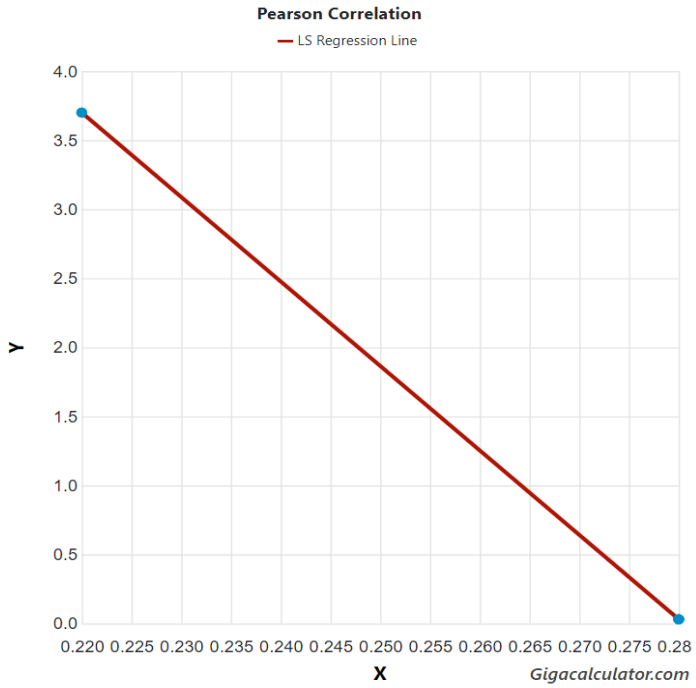

Figure 4. Predicted relationship between iridosome diameter (x) and month with the lowest number of rainy days (y).

Driest month

r=-1, Z score=inf, n=6, p=0

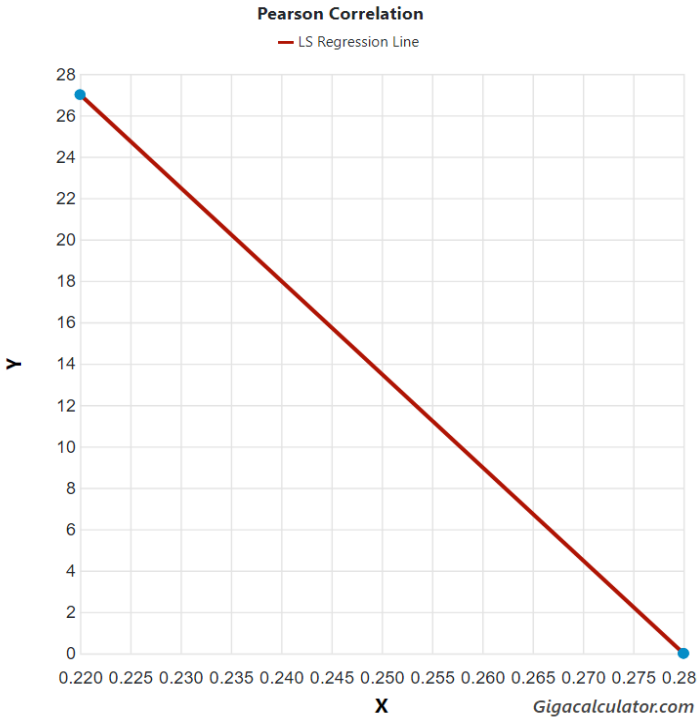

Figure 5. Predicted relationship between iridosome diameter (x) and driest month (y).

ISSN 2349-7823

International Journal of Recent Research in Life Sciences (IJRRLS)
Vol. 9, Issue 2, pp: (92-100), Month: April - June 2022, Available at: www.paperpublications.org

Warmest month

r=0.99277776, Z score=4.86716610, n=6, p=0.00000057

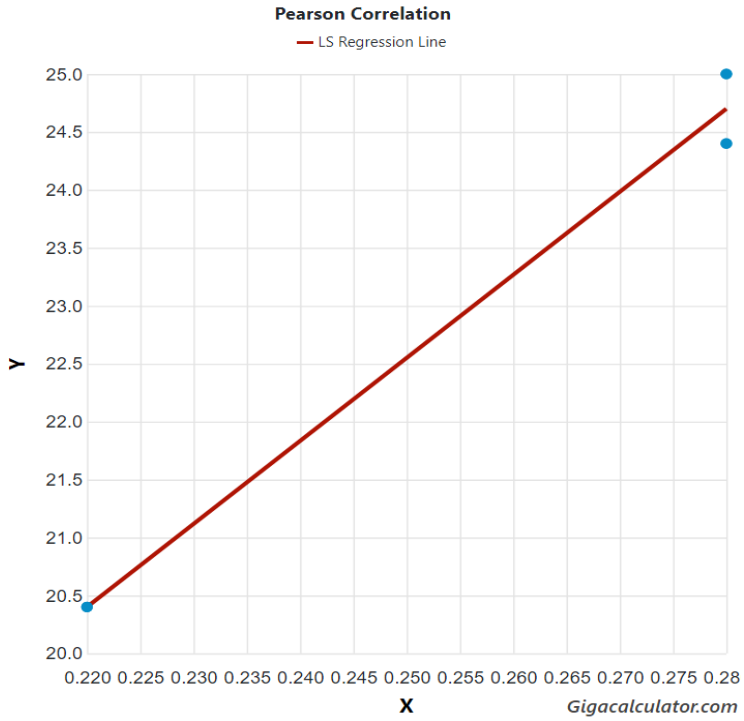

Figure 6. Predicted relationship between iridosome diameter (x) and warmest month (y).

Lowest average temperature

r=0.97965319, Z score=3.96445023, n=6, p=0.00003680

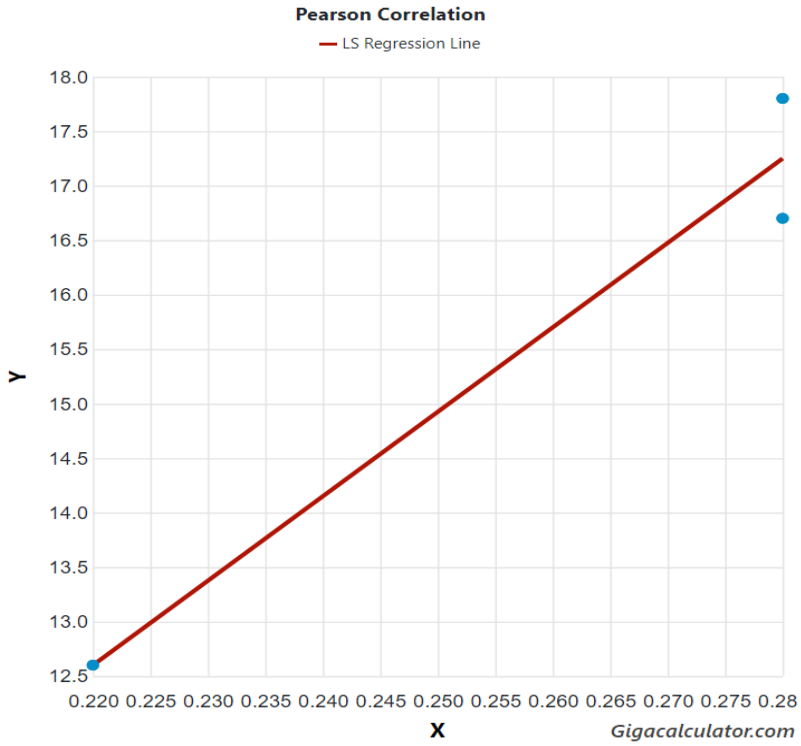

Figure 7. Predicted relationship between iridosome diameter (x) and lowest average temperature (y).

ISSN 2349-7823

International Journal of Recent Research in Life Sciences (IJRRLS)
Vol. 9, Issue 2, pp: (92-100), Month: April - June 2022, Available at: www.paperpublications.org

Month with the most daily hours of sunshine (average)

r=0.99604666, Z score=5.39045605, n=6, p=0.00000004

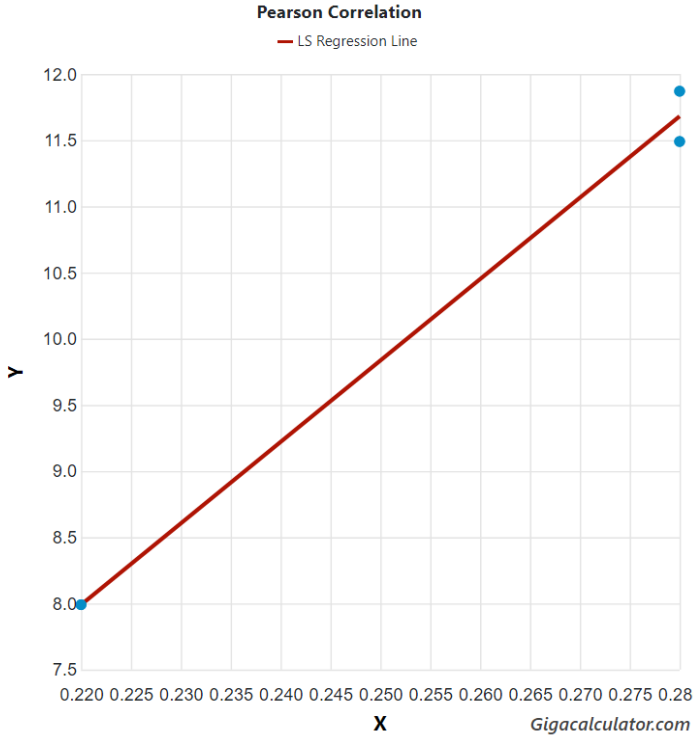

Figure 8. Predicted relationship between iridosome diameter (x) and month with the most daily hours of sunshine (y).

Month with the most daily hours of sunshine (total)

r=0.99620915, Z score=5.42687515, n=6, p=0.00000003

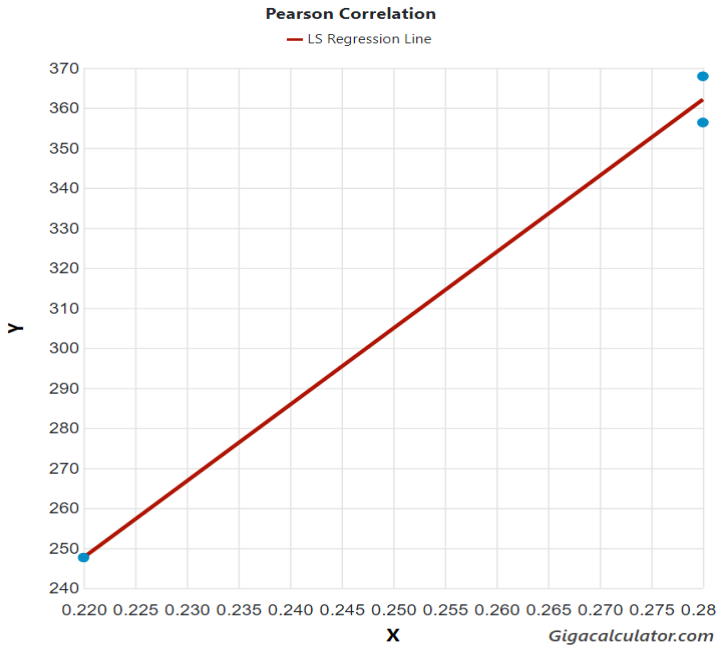

Figure 9. Predicted relationship between iridosome diameter (x) and month with month with the most daily hours of sunshine (total) (y).

ISSN 2349-7823

International Journal of Recent Research in Life Sciences (IJRRLS)
Vol. 9, Issue 2, pp: (92-100), Month: April - June 2022, Available at: www.paperpublications.org

Month with the fewest daily hours of sunshine (average)

r=0.99803368, Z score=5.99614920, n=6, p=0

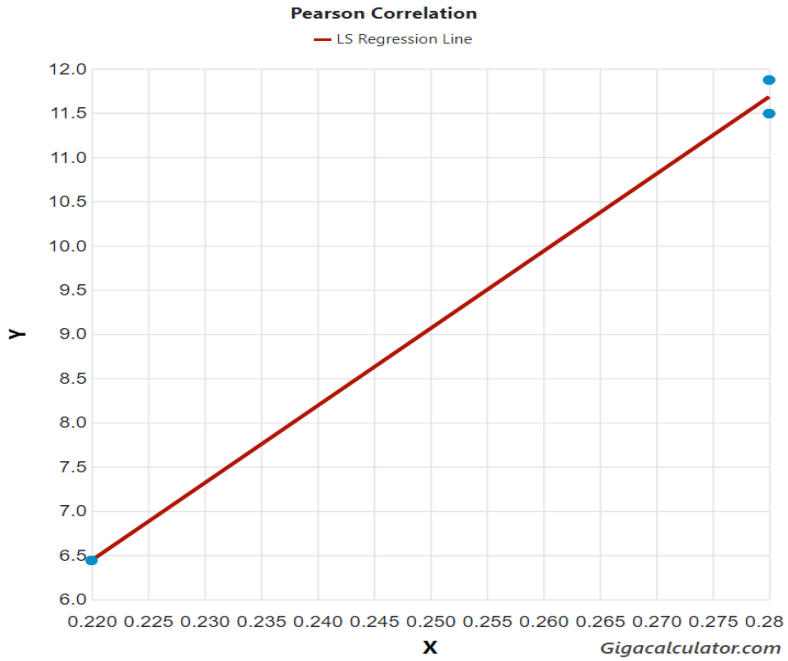

Figure 10. Predicted relationship between iridosome diameter (x) and month with month with the fewest daily hours of sunshine (average) (y).

Month with the fewest daily hours of sunshine (total)

r=0.99811392, Z score=6.03226495, n=6, p=0

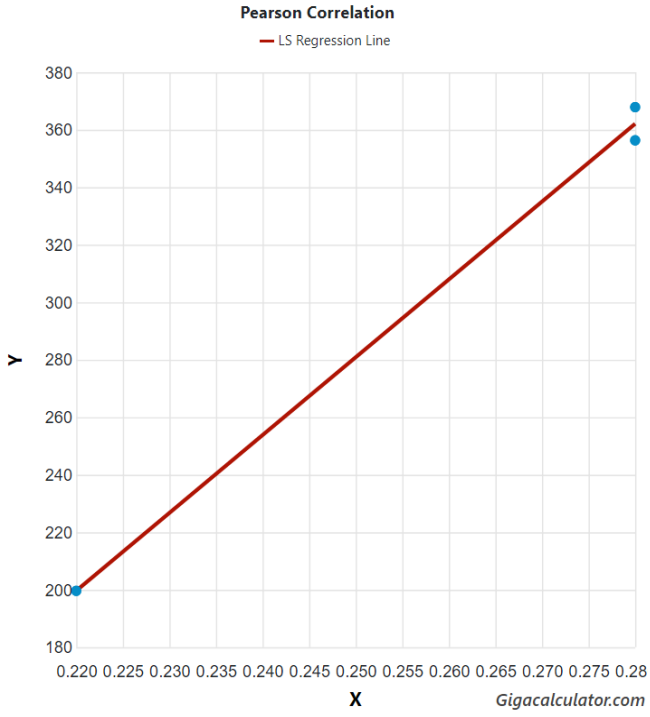

Figure 11. Predicted relationship between iridosome diameter (x) and month with month with the fewest daily hours of sunshine (total) (y).

ISSN 2349-7823

International Journal of Recent Research in Life Sciences (IJRRLS)
Vol. 9, Issue 2, pp: (92-100), Month: April - June 2022, Available at: www.paperpublications.org

Hours of sunshine throughout the year

r=0.998935, Z score=6.52757706, n=6, p=0

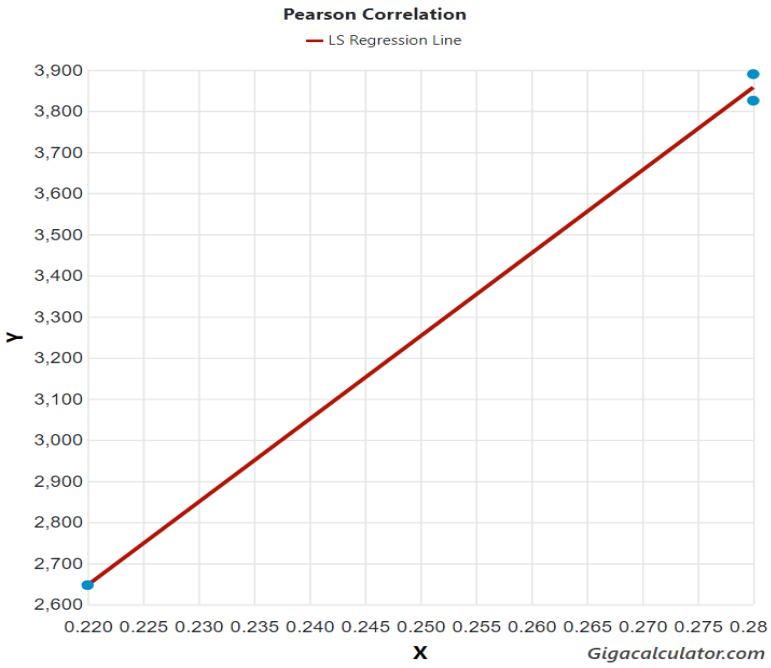

Figure 12. Predicted relationship between iridosome diameter (x) and month with month with the daily hours of sunshine throughout the year (y).

Hours of sunshine per month (average)

r=0.99835739, Z score=6.15206428, n=6, p=0

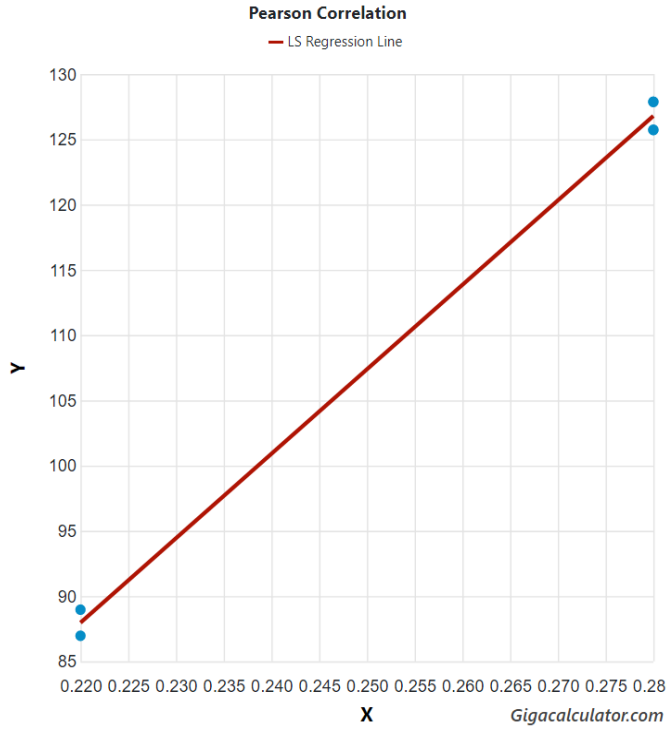

Figure 13. Predicted relationship between iridosome diameter (x) and month with hours of sunshine throughout the month (y).

IV. DISCUSSION

Examination of mantle feathers from woodhoopoes predict a clinal variation with the 13 climatic or weather factors [1]. A complex model of climatic and weather gradients may account for differences between iridophore diameters, differences that are enough to discern green from violet woodhoopoes. This study reveals how woodhoopoes mantles may have consequences on energy expenditure [6]. The results support a complex version of the biological rule [8, 10]. This is similar to the results found in Australasian songbird clades [7]. Closer examination of rainfall and temperature and comparison among woodhoopoes from different climates under different weather help to reconcile the complex and simple biological rules [1, 5, 10]. A critical examination showed all factors differ wiith outer iridosome diameter as predicted in this rule [8].

V. CONCLUSION

Examination of mantle feathers from woodhoopoes suggests a clinal variation of the outer iridosome diameters consistent with the biological rule are complex; correlated and figured.

REFERENCES

[1] M. I. Cooper, M. Cunningham, M. I. Cherry, "Taxonomic status of the Namibian Violet Woodhoopoe *Phoeniculus damarensis* as determined by mitochondrial DNA," Ibis, vol. 143, no. 3, pp. 572-579, 2001.

[2] M. I. Cooper, B. T. Sewell, M. A. Jaffer, "Differences between Violet and Green Woodhoopoe mantle feathers," Biodiversity Observations, vol. 8.46, pp. 1-2, 2017.

[3] M. I. Cooper, "PHENOTYPIC STATUS OF THE NAMIBIAN VIOLET WOODHOOPOE PHOENICULUS DAMARENSIS AS DETERMINED BY MASS," Universe International Journal of Interdisciplinary Research, vol. 2, no. 9, pp. 7-8, 2022.

[4] M. Cunningham, M. I. Cherry, "Seeing the woodhoopoe for the trees: a response to Simmons et al. (2005)," Ibis, vol. 147, no. 1, pp. 225–227, 2005.

[5] K. Delhey, J. Dale, M. Valcu, B. Kempenaers, "Reconciling ecogeographical rules: rainfall and temperature predict global colour variation in the largest bird radiation," Ecology Letters, vol. 22, pp. 726–736, 2019.

[6] M. A. DuPlessis, J. B. Williams, "Communal cavity roosting in green woodhoopoes: consequences for energy expenditure and the seasonal pattern of mortality," The Auk, vol. 111, no. 2, pp. 292-299, 1994.

[7] N. R. Friedman, V. Remeš, "Ecogeographical gradients in plumage coloration among Australasian songbird clades," Global Ecology and Biogeography, vol. 26, pp. 261-274, 2017.

[8] C. W. L. Gloger, "§. 5. Abänderungsweise der einzelnen, einer Veränderung durch das Klima unterworfenen Farben," Das Abändern der Vögel durch Einfluss des Klimas [The Evolution of Birds Through the Impact of Climate] (in German). Breslau: August Schulz, pp. 11–24, 1833.

[9] J. D. Ligon, G. M. Kirwan, "Violet Woodhoopoe (*Phoeniculus damarensis*), version 1.0, In del Hoyo, J., Elliott, A., Sargatal, J., Christie, D. A. & de Juana, E. (eds) Birds of the World," Cornell Lab of Ornithology, Ithaca, NY, USA, 2020.

[10] R. Marcondes, "Testing the simple and complex versions of Gloger's rule in the Variable Antshrike (*Thamnophilus caerulescens*, Thamnophilidae)," Dryad, Dataset, 2021.

[11] R. E. Simmons, M. A. du Plessis, T. A. J. Hedderson, "Seeing the woodhoopoe for the trees: should we abandon Namibia's Violet Woodhoopoe *Phoeniculus damarensis* as a species?" Ibis, vol. 147, no. 1, pp. 222-224, 2005.