Potential role of soil calcium and phosphorus on Galápagos tortoise growth

Russell Yost¹, Rodolfo Martinez², James Gibbs³, and Stephen Blake⁴
¹Department of Tropical Plant and Soil Sciences, University of Hawai’i at Manoa, Honolulu, Hawai’i 96822;
²Charles Darwin Foundation, ³Department of Forest and Environmental Biology, State University of New York
⁴Max Planck Institute of Ornithology, Radolfzell, Germany

1. Introduction

One of the most recognized symbols of the Galápagos is the tortoise. Their size and diversity are probably unrivaled. Indeed they served as one of the outstanding examples in the development of Darwin’s Theory of Evolution. It is interesting to note that the vice-governor of the Galápagos once said that he could identify the island from which a tortoise came by its appearance. The purpose of this paper is to pursue this idea and to propose a different perspective or interpretation of the existing data.

2. Objectives of the Poster

1. Review previous research and observations
2. Specify on several issues related to tortoise size in relation to conditions of the various Galápagos Islands
3. Examine the relationships among the tortoises, the geology, the soils and the vegetation of the Galápagos Islands.

Figure 1. Galápagos tortoises. Photo Courtesy (Galápagos Online: http://www.galapagos-online.com/animals/tortoise.htm)

3. Evidence – Calcium Requirements of the Tortoise

3.1. Calcium availability and reproduction in animals

Bone

- Eggshell defects reported in birds (Graveland, 1995).
- 75% (Parsa major) egg on poor soils in Sweden had defects (Carcasson, 1991).
- Reproduction of passerines was limited due to calcium (Greenlaw and Brent, 1997).
- Birds adapt by reducing the size and number of eggs, according to the above authors.
- In response to decrease in calcium, birds may increase their search for Ca rich plants (Greenlaw and Berends, 1997).

Tips

- Desert tortoises (Gopherus agassizii) in California located and consumed soil from “mines” that contained significantly higher levels of calcium than surrounding soil by 3-5 fold (Greenlaw and Tolstikov, 1982) – “geophagy”
- Tortoises require Ca supplements to maintain normal growth and health (Pritchard, 1979).

4. Evidence – Soils of Galápagos

4.1 Approximate elevation of the Islands

4.2 Existence of red soils

- “Red soils” are found in several of the older, eastern islands such as Española and Baltra.
- “Red soils” are typically the result of extensive chemical weathering i.e. chemical weathering of soils (Buol et al., 1989). Such intensive weathering results in reddish colors resulting from crystalline iron oxides remaining after weathering.
- “Red soils” are usually found on the more and islands, while domed tortoises occur on islands with very high human activities.
- “Red soils” are found on several of the older, eastern islands such as Baltra, Española and Pinta.
- Given: Small saddle-backed tortoises have marked sexual dimorphism and are found on the islands with great human activities.

5. Tortoises of the Galápagos

5.1. Galápagos tortoises show marked variation in ecology and morphology across the archipelago.

A multivariate assessment of soil Ca levels and tortoise traits in Galápagos (Kaiser et al., 1982).

Figure 2: Tortoise daily pattern of movement (Marlow and Tollestrup, 1982).

6. Speculation:

- Given: calcium and phosphorus influence tortoise growth, morphology and movement patterns.
- Given: tortoises require large amounts of usable calcium for growth, and, in particular, shell and egg formation.
- Given: Small saddle-backed tortoises have marked sexual dimorphism and are found on the islands with great human activities.
- Given: small saddle-backed tortoises require marked sexual dimorphism and are found on islands with very high human activities

7. Hypothesis: Nuts such as calcium and phosphorus limit tortoise growth

8. Testing the hypothesis?

1. Measures of soil calcium, magnesium and other bases needed of tortoise habitat.
2. A multivariate assessment of soil Ca levels and tortoise traits in Galápagos (Kaiser et al., 1982). The tortoises are genetically very similar, thus reducing genetic adaptability as a possible source of growth differences.

Literature cited

Carlsson, H., L. Carlsson, C. Wallin, and N. Wallin. 1991. Growth of the Baja California landbird species in California located and consumed soil from “mines” that contained significantly higher levels of calcium than surrounding soil by 3-5 fold (Greenlaw and Berends, 1997).
Graveland J. and J. Brent 1997. Timing of the calcium uptake and effect of calcium deficiency on behavior and egg laying in captive great tits (Parus major). Physiological Zoology 74:
Inventario de las recursos naturales geomorfologicos, vegetation, historial, y tortoisas de los islas Galápagos, Ecuador, Orstom.
(1)http://www.galapagosonline.com/natural/ wildlife/animals/tortoise.htm

Acknowledgments

This presentation was made possible by funding through the Darwin Foundation and the ASU Chapman Conference Series.