

## Humidity and Pyramiding on the Sulcata tortoise

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Those of you with tortoises and turtles are perhaps familiar with the problem of pyramidal growth in the carapaces of young captive tortoises. Many factors have been incriminated --- dietary protein, calcium, vitamin D, Ca:P, low UVB, rapid growth from high calorie diets --- but to date our information has been strictly observational and anecdotal. One paper published 15 years ago suggested environmental humidity may play a role in pyramidal growth (Weser, 1988, Zur Hockerbildung bei Schildkroten. Sauria 10:23-25). No controlled trials have been done, until now.

A paper has just been published by nutritionists at the University of Veterinary Medicine in Vienna (Austria). Fifty hatchling *Geochelone sulcata* (siblings and half-siblings from the same farm) were placed in one of five groups that differed in dietary protein and environmental humidity. Protein levels were 14, 19 and 30% crude protein on a dry matter (DM) bases; the diet form was soaked pellets mixed with endive. Extra calcium was provided each group. Humidity groups were arid (24-58%), medium (31-75%) and high (45-99%). Lighting was by three different lights, including UVB-emitting Reptisun 5.0 by ZooMed.

Pyramid humps were quantified by means of measuring the depth and side-lengths of the second and third, and third and fourth central plates on the carapace. Ratios were calculated and termed the H-value (H=hump). Statistical tests included appropriate non-parametric Kruskal-Wallis test and Mann-Whitney U-test.

The study lasted 5 months. The researchers found that growth rates differed significantly with dietary protein level. Hematocrit and serum levels of calcium and phosphorus did not differ between groups. They found that dietary protein had little effect on pyramidal growth.

However the researchers found that environmental humidity had a significant effect on pyramidal growth. Sulcata kept in the drier conditions had significantly greater pyramidal growth, and those kept in the highest humidity level had smooth carapaces. Photos accompany the data and statistical analyses.

The authors suggest that under natural conditions, the faster growing hatchlings would be in the humid areas under growing grasses. In contrast, those naturally in dry areas would have no growing grass because of food scarcity, hence have lower food intakes. During food scarcity, there is little growth and probably little bone growth.

Thus the combination of arid conditions and abundant food is abnormal for young tortoises, yet is commonly found in captivity. However, correction of the problem is not through food (calories, protein) restriction, which can secondarily lead to immune suppression, stunting, debilitation from multiple nutrient deficiencies, and shortened lifespan, but through increasing humidity. When humidity was high, then high food intake, and high dietary protein, did not lead to pyramidal growth.

The authors hypothesize that during dry conditions, dehydration reduces both intra- and inter-cellular pressures on soft cartilage at the areas of bone growth, which could lead to collapse of the soft tissue and subsequent ossification in the collapsed position. The authors conclude the paper by recommending hide areas of 100% humidity be available to tortoises at all times.

Further work is needed to replicate these results, determine mineral balance (acid-base balance) under dry and humid conditions, and examine the carapacial tissue histologically.

For details: Wiesner CS, Iben C. 2003. Influence of environmental humidity and dietary protein on pyramidal growth of carapaces in African spurred tortoises (*Geochelone sulcata*). *J Anim Physiol a Anim. Nutr* 87:66-74.

Influence Of Environmental Humidity And Dietary Protein On Pyramidal Growth Of Carapaces In African Spurred Tortoises (*Geochelone Sulcata*).  
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The carapaces of captive-raised tortoises (terrestrial chelonians of the zoological family Testudinidae, often develop pyramidal-shaped osseous growth centrally within the horny plates. With very few exceptions (e.g. *Geochelone elegans*, *Psammobates* sp.), this conical growth pattern is considered to be pathologic. This very common defect is believed to be an important indicator of

the quality of captive tortoise management. This study was designed to examine the effect of dietary protein level and environmental humidity on the degree of pyramidal growth in the carapaces. Fifty recently hatched African spurred tortoises (*G. sulcata*) were raised for 5 months under artificial conditions of varying environmental humidity and dietary protein content (14% vs. 19% vs. 30% crude protein in dry matter). Humps of the carapaces that developed and

blood values of calcium, phosphorus and haematocrit were measured and compared among groups. Dry environmental conditions (24.3-57.8% and 30.6! -74.8% relative humidity) produced taller humps than humid conditions (45-99% relative humidity). Hump formation differed significantly ( $p < 0.001$ ) between these three groups kept under different humidity conditions.

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dietary protein had a minor, positive impact on this pathological formation of humps (pyramidal growth syndrome, PGS). Analysis of blood (calcium, phosphorus and haematocrit) offered no further explanation as to the development of the humps.

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