



SULCATA STATION

What Causes Pyramiding in Tortoises?

SUMMARY

Pyramiding in tortoises appears to be primarily related to humidity and hydration status, with other factors contributing to the problem. This finding seems to be supported by some recent research into tortoise nutrition and hydration.

We recommend (based on our own experiences and what limited research is being done on this problem) that you provide areas of high humidity where your hatchling or juvenile tortoise can hide and/or sleep in overnight. This can be accomplished in different ways; a few suggestions would include:

- For small (hatchling to 3-inch-long) tortoises: Attach a cellulose sponge (or two) to the inside of an appropriately-sized plastic hide box and keep the sponge moist; **AND ALSO** pile a well-dampened substrate (Bed-A-Beast® or topsoil) deeply in the corners of your tortoise enclosure so that your tortoise can dig in for the night. Make sure you keep these areas moist!
- For larger tortoises: Cut an easily-accessible hole in the side of a Rubbermaid® or similar large container with lid, fill the container with several inches of dampened Bed-A-Beast® or ground-up coconut fiber substrate, and put the container in your tortoise's enclosure for it to use as a hide box when desired. Make sure you keep the substrate inside the container moist!

Supporting Research

The Tortoise Trust USA published the following article in its Summer 2000 Newsletter:

Causes of Pyramiding in Tortoises
Tortoise Trust Newsletter, Summer 2000
Darrell Senneke
Director - World Chelonian Trust (WCT)

I have come to see pyramiding as being the end result of any one or usually a combination of these six things. In my examples I will use various tortoises as some are more prone to pyramiding than others. The following is a melding of recent discussions by Joe (Chiro), Chris Tabaka, myself and several others on this subject.

- Too much food
- Inaccessible calcium
- Too much protein
- Low fiber foods
- Lack of exercise
- Hydration status

SULCATA STATION

Page Title: What Causes Pyramiding in Tortoises:

Page Location: www.sulcata-station.org/pdf/pyramiding.pdf

Page 2 of 4

Too much food is a real problem. Especially with *sulcata*, *hermanni* and *horsfieldii* -- they literally eat themselves into trouble. This is the type of pyramiding that seems to be exhibited by the conical scutes. Tortoise keepers -- especially in the north -- see this a lot, regardless of how much calcium they supplement. My feeling is that the body is much better at removing protein from the food than calcium -- the calcium passes through and the protein is converted to keratin resulting in the "stacked" look. Regardless of how low in protein the diet is, too much food results in this to varying amounts. In groups of redfoots and leopards where most are perfect, I have seen one or two that showed light pyramiding -- usually they are the heaviest eaters.

Inaccessible calcium or low calcium seems to present itself more as a flattened appearance with collapsed vertebral scutes. Tortoises seem to preferentially put the available calcium in the plastron. This is a result of poor food or a steady diet of high-oxalate foods. I have seen this in *radiata*, leopards, *hermanni* and recently a Russian tortoise. Lack of UV exposure for vitamin D conversion is another co-factor for this problem.

Too much protein (plant or animal) also gives this "stacked" look. There are documented cases of wild tortoises that exhibit pyramiding -- they live near soybean fields (Highfield). High protein diets are also physically stressful and are believed to damage the kidneys in addition to contributing to the stacked look.

Low fiber in the diet: In my opinion, low fiber foods give the same result as too much food because they are too digestible. A look at the droppings of grass-fed tortoises shows them to be fibrous and still containing a lot of vegetative integrity. Looking at store produce droppings shows them to be watery. EVERY leopard tortoise owner I know in the north has trouble with this in the winter when grass (or grass hay) is not available. Interestingly, feeding alfalfa -- even though it is high in protein -- seems to not result in much pyramiding; I assume because of the fiber.

Physical activity levels in proper protein/calcium metabolism is necessary for a sound skeletal frame. If you look at people's pens for their tortoises -- even the best setup does not give them as much room as in the wild. It is known that high levels of physical activity leads to more calcium being deposited in bone. (at least in human studies)

Hydration status has also been suggested as another important co-factor. This is an interesting subject in itself. While I would not suggest this to anyone (*do NOT try this at home, folks!*), as an experiment in South America, a veterinarian is feeding 20 Redfoot Tortoises diets intentionally very high in protein (using high-protein pelleted fish food). He is also maintaining the animals in very shallow water. At this point the animals are over 4 inches long and show absolutely no pyramiding. The jury is out on kidney and liver functions and time will tell on that, but externally at least he is forcing very rapid growth with high protein and achieving very smooth shells at the same time. The thought is that the very high water throughput is flushing the system sufficiently to avoid pyramiding. (David Fabius -- pers. comm.)

In closing, another example -- I have a friend who owns an Aldabra tortoise. It has developed semi-severe pyramiding, yet I know that this animal gets the lowest protein "best" foods available. I think that the pyramiding in this case is a result of too much food and almost no exercise.

So in brief, I strongly suggest avoiding protein but **all** of these other matters should be taken into account as well.

[Sulcata Station thanks Darrell Senneke for granting permission to reproduce his article here.]

SULCATA STATION

Page Title: What Causes Pyramiding in Tortoises:

Page Location: www.sulcata-station.org/pdf/pyramiding.pdf

Page 3 of 4

Another interesting research project was described by Dr. Susan Donoghue, DVM, in the now-defunct HerpNutrition YahooGroup. The research found that hydration is crucial to preventing pyramiding:

SUMMARY: Researchers using *Geochelone Sulcata* hatchlings with controlled humidity settings and controlled dietary protein levels found that providing adequate hydration was much more crucial in preventing pyramiding than reducing dietary protein.

To: herpnutrition@yahoogroups.com

From: walkaboutf@aol.com

Date: Sun, 28 Sep 2003 19:50:43 EDT

Subject: [HerpNutrition] New Research on Pyramidal Growth in Tortoises. 28Sep03

Hello All

Regarding our emailings on this list, we've had several requests for reprinting in hard copy and also for forwarding to other lists. Both are fine and permitted as long as credit is given to our HerpNutrition list and Walkabout Farm. Our goal is simply the dissemination of knowledge in order to advance the science of herpetoculture, so it's great to see the information out there in other venues.

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 ratios, 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) basis; 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.

SULCATA STATION

Page Title: What Causes Pyramiding in Tortoises:

Page Location: www.sulcata-station.org/pdf/pyramiding.pdf

Page 4 of 4

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.

cheers,

Sue

Susan Donoghue, VMD, DACVN

Owner, Nutrition Support Services, Inc.

HerpNutrition at Walkabout Farm

www.HerpNutrition.com