# Preliminary Results on the Influence of Feeding Regime on Growth and Body Size in the Boa (*Boa imperator)*

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## Abstract

Because snakes are gape-limited predators, much emphasis has been placed on the role of prey size in inducing plastic changes to trophic morphology. In contrast, few studies have researched the effect of feeding frequency on growth and body size, even though many snakes experience long fasting periods between meals. We conducted an experimental, multiple year study of growth in Boas, (*Boa imperator*) that experienced different feeding regimes. Three liters of full siblings were randomly assigned into two groups. One group received a meal equal to 5% of their body mass every 7 days and the other group received a meal equal to 25% body mass in food every 35 days. Using x-ray radiographs, we measured body size and a several skeletal morphological variables before the feeding regimes began and annually thereafter. We observed that those boas fed frequently grew larger in body mass and exhibited greater robustness, whereas boas feed infrequently had lower body mass and were laterally compressed. Our results suggest that phenotypic plasticity resulting from feeding frequency may play a role in morphological diversity. Further, the changes we observed mirrored the evolutionary changes of mainland and island populations boas from Central America.

## Introduction

Because snakes a gape limited predators, much emphasis has been placed on the role of prey size in the physiology and evolutionary implications of different sized prey. This contrasts with the observation that snakes commonly do not eliminate small prey items from their diet as they age, and that prey availability can vary seasonally. These two factors play a significant role in island populations of Boas, which are known to consume relatively small meals (<10% body mass) that is seasonally available during the spring and fall bird migrations (Boback 2005). Further, boas on islands exhibit a smaller body size, and narrower head, interpreted to be adaptations to feeding on birds in the wild.

Our study focused on growth as a result of feeding frequency, rather than prey size.

## Methods

- The test subjects were three consecutive, full sibling litters of *Boa imperator.*
- Three liters of full siblings (44 snakes) were used and randomly assigned to one of two groups.
- Immediately after birth, some boas began feeding earlier than others. All boas were fed 10% meals weekly until all siblings were feeding regularly and all boas had consumed the same number of meals.
- At 4-6 months, boas were initially X-rayed and assigned to a treatment group.
- Frequent feeder group: 5% of body mass every 7 days (one mouse measuring 5% body mass)
- Infrequent feeder group: 25% of body mass every 35 days (5 mice of 5% body mass).
  - All meals +/- 1% body mass
- Meals consisted of similar sized mice between groups (within 10 grams) to reduce confounding effects of nutrient density at different ages.
- To prevent damage to growth plates from standard straight line body measurements, X-ray radiographs were used to measure body size and other skeletal morphological measurements.
- X-rays were conducted and collected at Hill-Dale Veterinary Hospital, in Baraboo, WI.
- Boas were placed in a squeeze box while x-rays were performed, sedation was not used.
- Body mass was taken using an OHAUS Scout Pro 200g balance with a 0.01g readout accuracy.

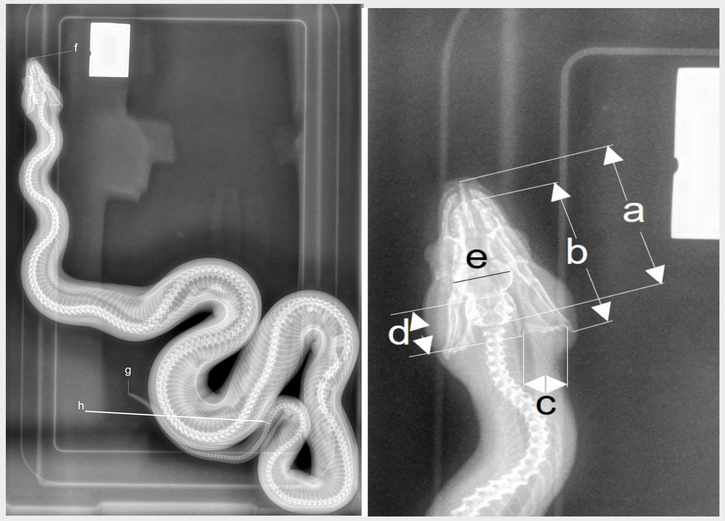


**Image 1. (left)** X-ray radiograph of boa body length measurement (figures 3 & 4) used in this study is from point f to point g.
**Image 2. (right)** X-ray radiograph of boa head length measurement (figures 5 & 6) used in this study is length a.

## Results

**Image 3. (left)** Comparison of two sibling boas on different feeding schedules for 2 years. **Left:** Male boa fed on the infrequent feeding schedule. **Right:** Male boa fed on the frequent feeding schedule (weekly). Both are full siblings born in late 2017 and have been on different feeding schedules since March 2018. Note overall difference in substance between two snakes despite being fed the same relative mass of food. White arrows on the right boa point to skin folds as a result of fat deposits. Snakes in the infrequently fed group lack these same folds, regardless of how tight their body coils are.

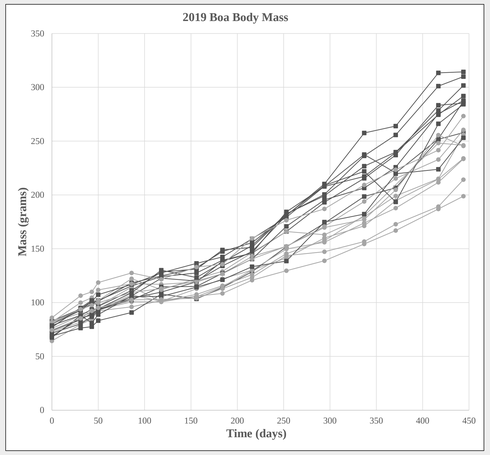


**Figure 1.** Body mass growth of 2019 boas over 444 days. Light grey circles are infrequent feeders. Black boxes are frequent feeders.

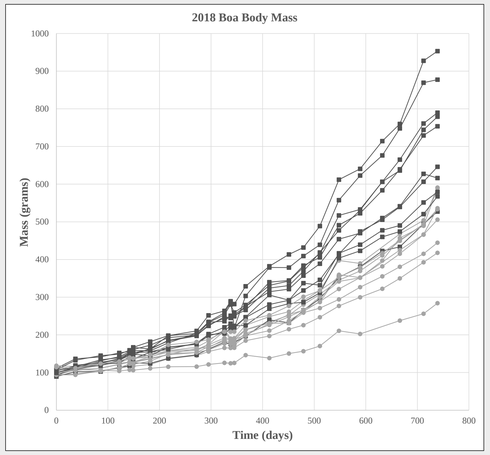


**Figure 2.** Body mass growth of 2018 boas over 739 days. Light grey circles are infrequent feeders. Black boxes are frequent feeders.

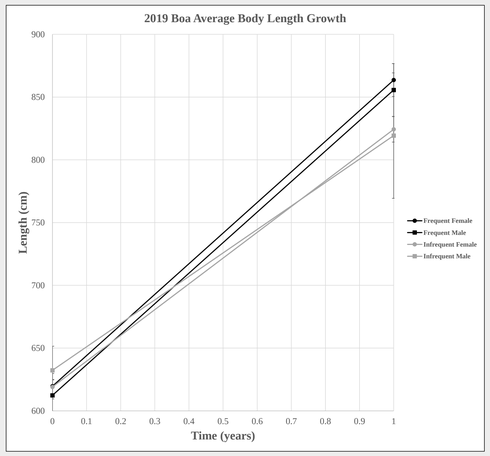


**Figure 3.** Average body length growth for 2019 boas over 1 year. Light grey is infrequent feeders and black is frequent feeders. Females are shown as circles and males are shown as squares. Standard error is displayed.

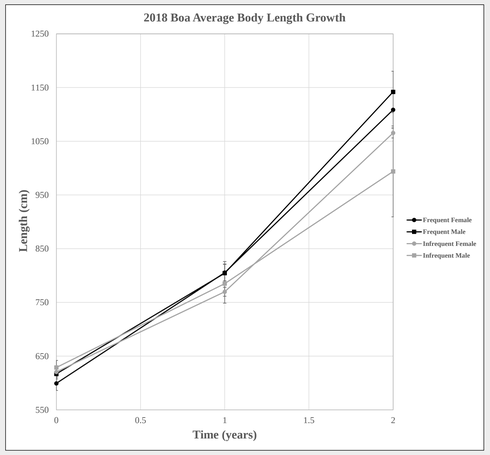


**Figure 4.** Average body length growth for 2018 boas over 2 years. Light grey is infrequent feeders and black is frequent feeders. Females are shown as circles and males are shown as squares. Standard error is displayed.

## Acknowledgements

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## Literature Cited

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Card, D.C. et al. 2019. Genomic Basis of Convergent Island Phenotypes in Boa Constrictors. Genome Biol. Evol. 11(11):3123–3143.
Hill, R.L. et al. 2018. Growth rates of juvenile Boa constrictor under two feeding regimes. Zoo Biology. 2018;1–5.

## Results and Discussion

**Body Shape and Mass**

- One of the key findings of this study was that body mass appears to be different among the feeding treatments, which is consistent with other studies of boa growth. The difference between the groups is larger body mass in those fed frequently and smaller body mass in those fed infrequently.
- While we do not know the exact tissue causing this difference in mass (e.g., fat vs muscle), much appears to be subcutaneous (e.g., adipose).
- From visual inspection, the cross section of the two different groups appears to be different, with boas fed frequently becoming much wider than infrequently fed boas that appear narrower with less overall musculature.

**Body Length & Head Size**

- Currently, it appears that there are modest differences in body length between groups, but interpretation will require statistical analysis.
- Preliminarily, in average body length, the frequently fed group seems to grow at a faster rate than the infrequently fed group, but statistical analysis needs to be performed to confirm this.
- At present, there does not appear to be any relationship between feeding frequency and head length.

**Significance**

- Prior studies of boa growth have demonstrated that differences in body size between mainland and island boas are the result of genetic differences: presumably, the result of natural selection (Card et al. 2019).
- While we have not finished statistical analysis, it appears that changes to body mass and shape, can be the result of phenotypic plasticity.

**Future Directions**

- Future studies could focus on the consequences of these different growth trajectories.
- Are these changes simply the result of energetic consequences of the cost of digestion, or are these adaptive changes due to environmental variation?

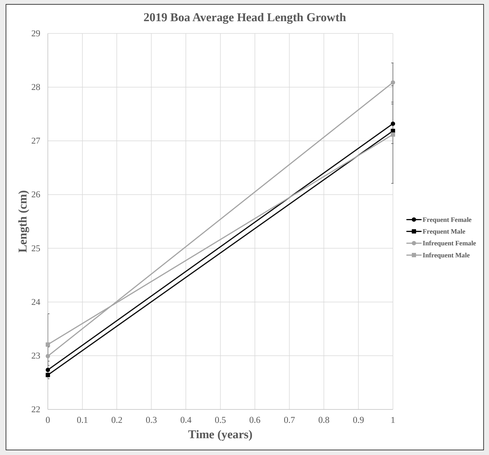


**Figure 5.** Average head length growth for 2019 boas over 1 year. Light grey is infrequent feeders and black is frequent feeders. Females are shown as circles and males are shown as squares. Standard error is displayed.

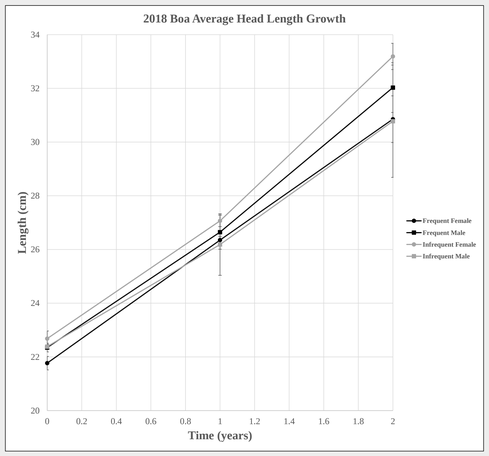


**Figure 6.** Average head length growth for 2018 boas over 2 years. Light grey is infrequent feeders and black is frequent feeders. Females are shown as circles and males are shown as squares. Standard error is displayed.