O P I N I O N
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Do snakes shrink?

Thomas Madsen and Richard Shine (correspondence), School of Biological Sciences A08, Univ. of Sydney, NSW 2006, Australia (rics@bio.usyd.edu.au).

Growth in vertebrates is usually assumed to be unidirectional, with organisms progressively increasing in body size as they become older (Andrews 1982). However, a recent study by Wikelski and Thom (2000) has challenged this assumption. These workers reported that Galapagos marine iguanas (*Amblyrhynchus cristatus*) decreased in body size by up to 20% during periods of reduced food availability. This remarkable response resulted in increased survival, leading Wikelski and Thom (2000) to interpret shrinkage as an adaptive response to nutritional stress. Do other reptiles show the same response, perhaps in a more subtle form, with the phenomenon remaining unreported because records of "negative growth" are mistakenly attributed to measurement error?

Our ecological studies on water pythons (*Liasis fuscus*) in the Adelaide River floodplain in northern Australia provide an ideal data set with which to test this idea. First, we have very large sample sizes collected over a long period (>10 yr). Second, the simple external morphology of snakes facilitates unambiguous measures of body size. Third, the system we are studying exhibits massive year-to-year variation in abundance of the snake's primary prey resource (dusky rats, *Rattus colletti*; Redhead 1979, Madsen and Shine 1999). Importantly, this variation in food supply strongly affects the rates of feeding, growth, survival and reproduction of the water pythons (Shine and Madsen 1997, Madsen and Shine 1999). Thus, we are likely to be able to detect snake shrinkage if it indeed occurs in our system.

Do water pythons shrink during "bad" years? We have indeed occasionally recorded cases where a python has apparently decreased in size (body length) between successive recaptures. However, we had always assumed that these cases represented measuring error rather than actual size reduction. The study by Wikelski and Thom (2000) made us reconsider this assumption, and we have therefore re-examined our data on these "shrinking" animals more carefully.

During the period 1991 to 1999 we obtained recapture data for 918 snakes. Of these, 59 individual snakes were recorded as being smaller (lower snout-vent length, = SVL) at the second capture event than at the first. However, even the largest of these apparent "shrinkages" was trivial compared to the size reductions of up to 20% reported for marine iguanas by Wikelski and Thom (2000). Among our "shrinking" water pythons, the mean SVL reduction was 1.07% (range 0.5–2.6%) or in absolute terms, 1.92 cm (range 1–5 cm). Unlike Wikelski and Thom (2000), we did not detect any significant trend for larger snakes to shrink more or less than smaller animals (correlation between reduction in snout vent-length versus initial body length, calculated either as percent or in absolute terms: $R = 0.082$, $p = 0.53$, df = 58; $R = 0.093$, $p = 0.48$, df = 58, respectively).

In the marine iguanas the reduction in body length was caused by dramatic year-to-year reduction in food availability (Wikelski and Thom 2000). Our pythons also experienced years with very low food supply, and individual snakes lost up to 30% of their body mass at such times (Madsen and Shine 1998). Thus, our data show a clear pattern for the pythons to gain mass in years when rats were abundant, and lose mass in years when rats were scarce (Spearman rank correlation: $R = 0.83$, $p = 0.028$, $n = 8$). However, year-to-year changes in rat abundance were not significantly correlated with the degree of reduction in body size (%) among our "shrinking" snakes (Spearman rank correlation $R = 0.054$, $p = 0.89$, $n = 8$). The magnitude of apparent "shrinkage" (decrease in SVL) was not correlated with the magnitude of change in body mass by the same snake ($R = 0.019$, $p = 0.89$, $df = 58$).

These data provide strong evidence that water pythons do not decrease substantially in body length as a response to nutritional stress. Despite the common occurrence of such stressful periods, changes in body length are unidirectional in our pythons. The 59 cases of apparent "shrinkage" are almost certainly due to measurement error, given the difficulties of measuring body length in large pythons. We suspect that bidirectional growth (as seen in Galapagos marine iguanas) will prove to be rare among reptiles, but encourage other workers to assess the possibility from their own mark-recapture data sets.

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