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At the lower size limit in snakes: two new species of threadsnakes (Squamata: Leptotyphlopidae: *Leptotyphlops*) from the Lesser Antilles

S. BLAIR HEDGES
Department of Biology, Pennsylvania State University, 208 Mueller Laboratory, University Park, PA 16802-5301 USA.
E-mail:sbh1@psu.edu

Abstract

Islands are viewed as natural evolutionary laboratories for terrestrial organisms because they have boundaries that limit dispersal and often reveal evolutionary patterns and mechanisms. One such pattern is that the smallest and largest species of different types of tetrapod animals are frequently found on islands. Here I describe two new diminutive species of snakes of the genus *Leptotyphlops* from the Lesser Antilles: one from Saint Lucia and the other from Barbados. The one from Barbados is the smallest species of snake and has a total adult length of approximately 100 mm. Limited evidence indicates a clutch size of one and a greatly elongated egg shape (length /width). Comparison of egg shapes in snakes indicates that the shape is a packaging phenomenon, related primarily to the shape of the available body cavity and clutch size. For a clutch size of one, expected egg shape is eight whereas expected egg shape drops to two at a clutch size of ten. The body shape of snakes, defined as snout-to-vent length divided by width, also varies and influences the shape of snake eggs. The smallest snakes are typically stout-bodied with shapes of 30–35 whereas the longest snakes usually are more elongate, with shapes of 45–50. The allometry of organ size also affects clutch size and shape, because the smallest snakes have the smallest proportion of body cavity space available for reproduction. The best explanation for the observation of body size extremes on islands is that colonizing species have adapted to open ecological niches that would otherwise be occupied on the mainland. Island colonists encounter novel environments and reduced interspecific competition, allowing species to evolve physical traits, including extremes in size, not normally seen on continents. However, the lower limit of adult size appears to be constrained by the allometry of morphology, physiology, and reproduction. The smallest tetrapods have small clutches, usually one egg or young, and offspring that are relatively large. In the smallest snakes, offspring are one-half of the length of adults, compared with 10% adult length in the case of large species of snakes. Thus the evolutionary tradeoff between number and size of offspring appears to have reached a size boundary in these species, limiting the evolution of yet smaller species.

Key words: adaptive radiation; allometry; body shape; egg shape; evolutionary constraint; extremophile; Lesser Antilles; miniaturization; speciation; West Indies

Introduction

Size is the best-studied trait of an organism, primarily because it is correlated with evolutionary fitness traits and is easy to measure (Blanckenhorn, 2000). Nonetheless, the evolutionary limits of size are not well understood. In some cases there are physical and physiological limitations. For example, there must be sufficient space for critical cellular molecules (e.g., DNA, RNA) placing a lower limit on the size of a prokaryote (National Research Council, 1999; Morris *et al.*, 2002). Also, atmospheric oxygen levels may bear on the upper limits of body size in animals (Falkowski *et al.*, 2005). In other cases, organisms at size extremes show major changes in morphology suggesting possible design limitations of a given body form (Hanken & Wake, 1993). However, it is usually difficult to determine whether physical or biological constraints play a part in the extremes in size that we observe among organisms. The fact that some of the smallest and largest animals are

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