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WHAT IS THE LENGTH OF A SNAKE?

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INTRODUCTION

The way that herpetologists have traditionally measured live snakes is by stretching them on a ruler and recording the total length (TL). However, due to the thin constitution of the snake, the large number of intervertebral joints, and slim muscular mass of most snakes, it is easier to stretch a snake than it is to stretch any other vertebrate. The result of this is that the length of a snake recorded is influenced by how much the animal is stretched. Stretching it as much as possible is perhaps a precise way to measure the length of the specimen but it might not correspond to the actual length of a live animal. Furthermore, it may seriously injure a live snake. Another method involves placing the snake in a clear plexiglass box and pressing it with a soft material such as rubber foam against a clear surface. Measuring the length of the snake may be done by outlining its body with a string (Fitch 1987; Frye 1991). However, this method is restricted to small animals that can be placed in a box, and in addition, no indications of accuracy of the technique are given. Measuring the snakes with a flexible tape has also been reported (Blouin-Demers 2003) but when dealing with a large animals the way the tape is positioned can produce great variance on the final outcome. In this contribution we revise alternative ways to measuring a snake and propose a method that offers repeatable results. We further analyze the precision of this method by using a sample of measurements taken from wild populations of green anacondas (*Eunectes murinus*) with a large range of sizes.

METHODS

To record the natural measure of the length of the animal we muzzled the snake with a sock and tape (Rivas et al. 1995). Next, we followed an imaginary midline of the body from head to tail (not necessarily the spine, depending on the position of the snake) with a string and then measured the length of the string by laying it loosely on a ruler (Figure 1). This allowed us to record the actual length of the animal regardless of its position and without having to stretch it. A total of 82 newborn and 42 stillborn snakes from 14 wild captured pregnant females were measured for this study. Three measurements of each animal were taken; and these were slightly different due to errors caused by the snake struggling and moving from under the string, as well as from inaccuracies in the placement of the string. The average of the three measures was then calculated. We also recorded the TL of each neonate in the sample using the conventional method of stretching it on a ruler and used a sign test to compare both measurements of each animal. We divided the measurements obtained with the stretching method by the measurements obtained with the string method in order to calculate a relationship between the two. In order to analyze the changes of this relationship in respect to size, we used the mass as an independent measure of the size of the animal. We performed a Spearman correlation test between the variables. The use of stillborn snakes in this study was to remove the error introduced by the struggle of live animals, allowing a determination of the "actual" TL of the animals as close as possible.

A different sample of 68 animals from a wild population (ranging from 84.7 cm to 494.7 cm TL) was measured independently by three people. Each snake was measured by one of two researchers who had three years of experience performing the procedure, and by two people well instructed in the technique but without much previous experience. Thirteen of the animals were measured by the two researchers (MDCM and JAR) that had previous experience.

We calculated the coefficient of variation (CV) on the three measurements collected on animals from the wild to study the changes in the precision of the measurement of snakes of different sizes. The CV was calculated by dividing the mean by the standard deviation (see formula in Sokal and Braumanm 1980) and provided a measurement of the variance in units of the mean, so it was not dependent on the absolute value of the variable measured. This is especially important when dealing with variables that vary in a wide range of values. All statistical analysis was made using the program SSPS 8.0.

RESULTS AND DISCUSSION

The string technique described here is comparable to the squeeze box except that it can be used on larger animals that cannot fit in a box; or on animals that cannot be pinned and restrained allowing broader applicability. Measurements taken with the string were consistently shorter than measurements with the ruler (Z= 6.82; p < 0.000; Table 1). The quotient among the measurements is smaller in larger animals (r = –0.362; p< 0.001; Figure 2) which suggests that smaller animals are being significantly stretched when measured on a ruler.

All the measurements estimate a unique parameter: “the size of the neonate”. However, measurements from the two methods using stillborn snakes were more disparate than measurements on live individuals (Table 1). Measurements of stillborn snakes with the ruler were the largest of all and the measurements of stillborn snakes with the string were the shortest of all (Table 1). An ANOVA test shows a significant difference between the measurements of all the groups (F = 70.47; df = 3; p<0.0001). We used only stillborn animals that were completely formed and whose cause of death was most likely due to dystocia of the female or other problems at the end of the gestation (Ross and Marzec 1990). We believe that the size of the stillborns was not significantly different than the size of live neonates, which is supported by the fact that there was no significant difference in mass (t= 1.252; df = 120; p = 0.21; Table 1). Thus the difference in the measurements of the live snakes and the stillborns are most likely due to inaccuracies resulting from the struggling of live animals.

If we assume that the “real” length of the animal is the length when it is relaxed, and not struggling or being over-stretched (as is usually the case when most other vertebrates are measured), then the length of the stillborn measured with the string should be a more realistic estimate of true length. However, the data suggest that even this method is not error-free either.

Repeated measurements collected with the string on the same wild-caught animals showed a relatively high variance. The average variance in animals around 80 cm was 0.514 cm and the maximum was up to 2.35 cm. It was clear that while processing calmer animals the repeated measurements on them were more similar than the measurements were for more active animals. In animals that struggled a lot, the first measurement tended to be the most different. After the snake had been measured once, it tended to calm down.

The struggle of the animal during the measuring can potentially influence the repeatability of the measure. The data collected by the experienced versus the inexperienced researchers were significantly different (Z= -3.13; p< 0.002); where inexperienced researchers consistently obtained shorter measurements than experienced ones. The data collected by the two experienced researchers were consistent with each other and were not significantly different in a Wilcoxon sign test (z= -0.27; p< 0.79).

The variance of the measurements changed with the size of the animal being measured (Figure 2). Between snake size of 2 to 3 meters the variance was particularly high, mostly due to a few animals that had a very high CV. This might be a consequence of the higher level of struggling found in some smaller animals. The smallest animals can be easily subdued during the process and the measurements are more consistent with each other (but see below). Beyond a certain size the snakes are stronger and some of them are able to put up more of a struggle, which decreases the precision of the measurements. Larger animals are calmer and although they could make the measuring much harder they tended to be easier to measure consistently (Figure 4). However, the CV was high in all the smaller sizes and decreased after three meters. Thus, the lower variance found in Figure 2 for smaller sizes is probably an artifact of smaller values. The first measurement of each animal tended to be more different than the following two; this was especially true in medium-sized animals. Larger animals are only females and the medium-sized ones are mostly males so some differences in the behavior of each sex could be involved in this trend. However, the effects of size versus sex could not be tested because adult males are always smaller and females are typically larger (Rivas 2000; Rivas and Burghardt 2001).

Stretching a snake apparently has a considerable effect on the measurements collected for the length of the snake. Smaller animals seem to provide less resistance to being stretched than larger ones, thus studies involving measuring animals among several size classes must

Figure 1. Measuring technique of stretching the string over the back of the anaconda to assess its length.

Table 1. Total length of neonate green anacondas measured by stretching them on a ruler and by following their midbody line with a string. Lengths are the mean of three independent measurements of each snake given in centimeters. Mass is recorded in grams.

	Length Ruler	Length String	Mass	N
Live	79.72	77.57	228.11	82
Stillborn	85.12	76.0	225.54	42

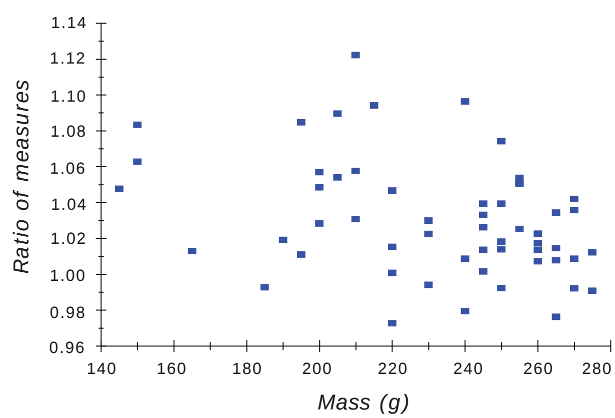

Figure 2. Scatter plot of ontogenetic change of the quotient between the measurements of neonate anacondas obtained by stretching them on a ruler and follwing the midline of the body with a string. Notice how the relationship between the two measurements changes with the size (r = –0.362 p< 0.001; n= 124).

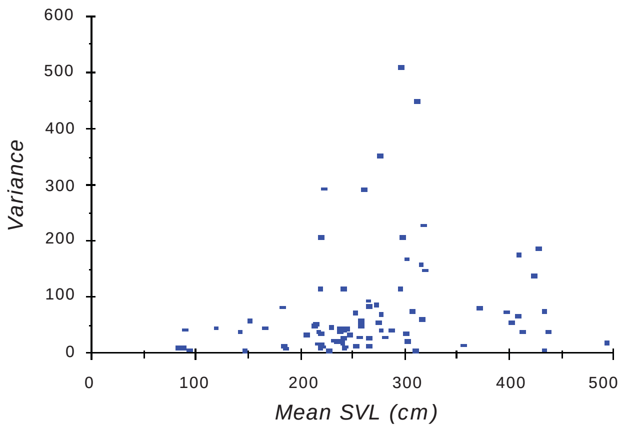

Figure 3. Size related change of variance of three measurements of SVL obtained from each wild-caught anaconda using a string to follow the mid-line of the body.

consider this issue. This method is not different in theory from the method of the squeeze box (Fitch 1987; Frye 1991) but it has a much broader application to snakes of larger sizes. The squeeze box method is most often used to measure animals that are difficult to handle such as venomous snakes or very small animals. Here we suggest that measuring the snake with a string is the best way to obtain accurate measurements of the length of a snake and should be used in a more generalized manner. We also recommend that animals be measured several times to account for errors in the measurements that are always present. We do not believe that using a tape (as done by Blouin-Demers 2003) is a good idea since the tape is not as malleable as the string and it may make it more difficult to track the middle of the snake. Furthermore, when the measure is done with a tape the different measures are not truly independent since the first measure may influence how measurer places the tape in the later ones.

The size of newborn anacondas is within the size range of what is considered a relatively small snake. Herpetologists have traditionally known that measuring large snakes is problematic, but measuring animals smaller than, say, 1.3 meters has not been perceived as a problem. We have shown that this is not the case. Stretching the animal on a ruler is less time consuming and in

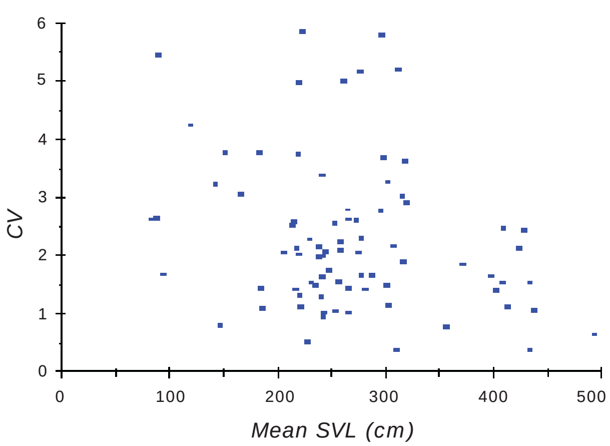

Figure 4 Relationship of the coefficient of variation from three measurements on the same individual wild-caught anaconda measured with a string. Note the decrease in the larger sizes.

some situations it might seem appropriate. However, the degree that the animal is stretched can be influenced by the size and behavior of the animal, or even by the mood of the researcher!

There are many records and claims of large sizes in snakes and what the record is for the longest snake seems to still be a question that many herpetologists debate. Here we introduce more fuel to that discussion, and perhaps rendering it pointless, since the measured length of the animal can vary wildly depending on the temperament of the snake and skills of the researcher. Our data show significant difference between data collected by skilled and unskilled collectors even when they use the same technique. An error of two or three feet does not seem to be out of the question when measuring a snake that measures, say, more than 20 feet in length. Anecdotally, we may point out that in 2003 an anaconda was measured by a well-known herpetologist to be 5.5 meters long in the llanos of Venezuela. However, the following week we had the opportunity to measure the same snake, and it proved to be only 4.3 meters long!!

Measuring the animals with a clean, unmarked, non-elastic string is a more reliable method especially if it is done by people properly trained in the technique. We discourage the use of a measuring tape since its consistency and shape compromises the ability to track accurately the middle line of the snake. In addition, it has the potential to bias consecutive measurements that the researcher takes. Research involving mark and recapture, or growth studies must give special attention to these issues.

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