Skeletochronology in the Mezquite Lizard, *Sceloporus grammicus*

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Histological cross sections of femoral bones of a temperate lizard were analyzed to determine if individuals show osseous growth marks and if these marks are useful estimates of age. In a series of 20 individuals of the iguanid lizard *Sceloporus grammicus*, we identified three histological stages each representing an annual period of time. The histological age estimates of individual lizards closely match those inferred from body sizes and the body-size growth curve of the population. The observed osseous growth marks in *S. grammicus* are not the result of periodic absences of activity, but reflect the effects of a seasonal increase in activity combined with a period of low food resources availability.

INTRODUCTION

Sceloporus grammicus Wiegman (Sauria: Iguanidae) is a relatively small lizard (42-74 mm, adult snout-vent length) distributed throughout most of the Republic of México. In spite of its broad distribution and generally high densities, little information exists concerning this species (*1-3*).

The principal goal of this study was to determine if *S. grammicus* shows cyclic growth marks in bones, such as do many other heterothermal species (*4-6*). Also, we tried to estimate the age of individuals through observations of such growth marks (skeletochronology: *7-9*). This method could provide complementary advantages to the classical procedures of statistical analysis of population structure and mark-recapture methods. Both procedures may be used for the demographic analysis of natural populations.

MATERIALS and METHODS

During May 1985, we collected 20 individuals of *Sceloporus grammicus* in the Michilía Biosphere Reserve (the Michilía Biosphere Reserve, in the Mexican State of Durango, is part of the MAB-UNESCO Program). The area has a mean annual temperature range between 17.4 °C and 20 °C, and receives approximately 567 mm of precipitation annually. The vegetation of the zone is typically oak-pine forest, but highly diversified (*10*).

For each collected individual lizard we measured snout-vent length (SVL) and tail length with metal calipers to the nearest 0.1 mm. Specimens were weighed with a balance to the nearest 0.1 g, killed with nembutal, and fixed with 90% alcohol. The left femur of each individual was removed, decalcified with 0.5% nitric acid and transversely sectioned (206 μm) with a freezing microtome. The resulting segments were stained with Ehrlich's hematoxylin (*7,11*) and analyzed with optical microscopy independently by each author.

Sliced bone sections were examined for the degree of vascularization, cellular distribution, the presence of stop of growth lines and the endosteal remnant (*4*).

RESULTS

We recognized three different histological phases, which display the following principal characteristics:

Phase 1 (Fig. 1): The average lizard SVL is 49.57 mm *(N*=12). A peripheral Stop of Growth Line (SGL) is clearly visible; the diameter of the cross section averages 523 μm; the medullar cavity diameter is approximately 314 μm. The femoral cross sections are smaller than those of the other two phases. Toward the interior zone of the SGL, the osseous cells are relatively large, irregularly distributed and the tissue, in general, is densely vascularized.

Phase 2 (Fig. 2): Two SGL's are always present. The average lizard SVL is 57.82 mm *(N*=6). The diameter of the cross section (657 μm) and medullar cavity (442 μm)

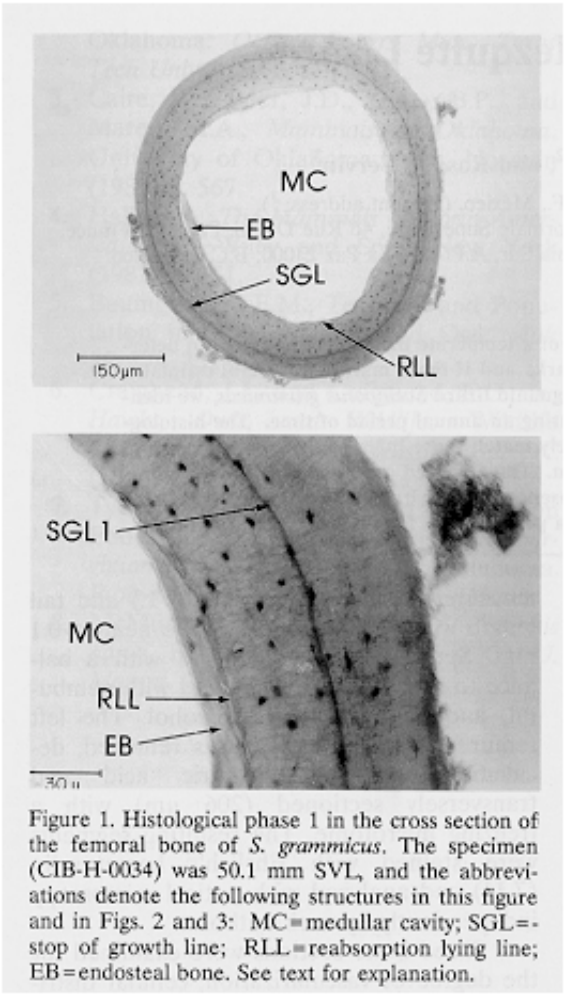

Figure 1. Histological phase 1 in the cross section of the femoral bone of *S. grammicus*. The specimen (CIB-H-0034) was 50.1 mm SVL, and the abbreviations denote the following structures in this figure and in Figs. 2 and 3: MC=medullar cavity; SGL=stop of growth line; RLL=reabsorption lying line; EB=endosteal bone. See text for explanation.

to individuals two years old, with average body sizes (SVL) of 57.82 mm (SD ± 1.31) and which have experienced two periods of growth, albeit with a much reduced rate of growth in the second year. Phase 3 included two 3-year-old individuals, one of them with an SVL of 61.9 mm and the other, 62.3 mm. Phase 3 is characterized by the greatest cross-sectional diameters and three intermittent growth periods.

DISCUSSION

An extensive study of the dynamics and demography of the Michilía population of *S. grammicus*, covering three consecutive years (*12*, pp. 206-210), has shown that the population structure is on average (during May) composed of: 1-year-old individuals, 63%; 2-year-old individuals, 28%; and individuals 3 years or older, 9%.

Females in this population undergo parturition (*S. grammicus* is viviparous) in a

are intermediate to those of the other two phases. Both SGL's are located in the medial portion of the tissue and are close together. Between the two consecutive SGL's the osseous bed is relatively slender and sparsely vascularized, corresponding to the peripheral bed of the previous phase.

Phase 3 (Fig. 3): In this phase (represented by only two individuals with SVL 61.9 and 62.3 mm), we observed 3 SGL's, and the largest cross section (742 μm) and medullar cavity diameters (504 μm) The more internal SGL is not close to the reversion laying bed (RLL), or to the medullar cavity wall.

Exclusively from the cross-section analysis, it is possible to infer that growth is very quick in the first year and abruptly diminishes thereafter.

Phase 1 appears to be confined to individuals one year old, with average body sizes (SVL) of 49.57 mm (SD ± 1.63) in which growth occurs rapidly before stopping completely. Such a pattern would produce the wide and heavily vascularized first osseous bed. The phase 2 pattern seems to correspond

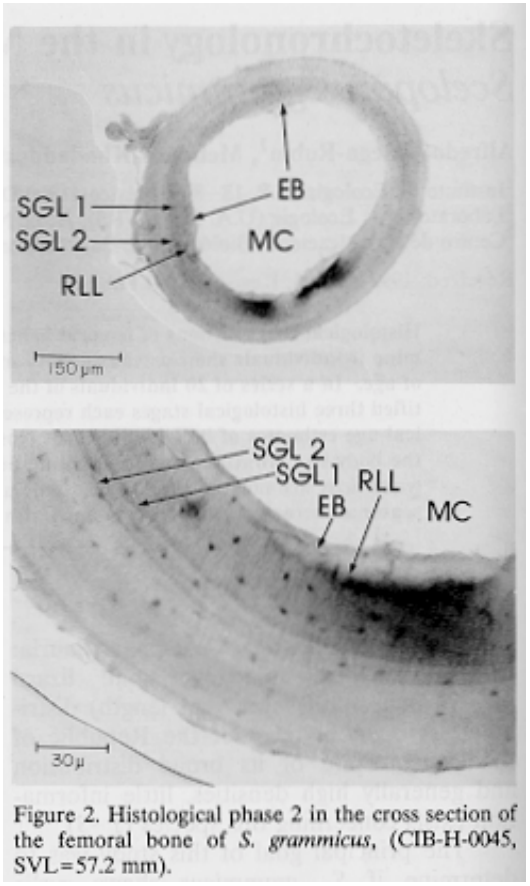

Figure 2. Histological phase 2 in the cross section of the femoral bone of *S. grammicus*, (CIB-H-0045, SVL=57.2 mm).

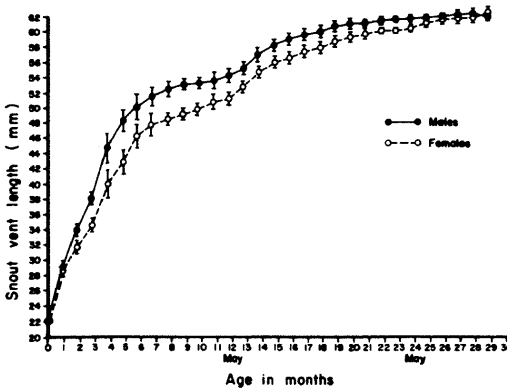

Figure 4. Growth rates (as inferred from snout-vent lengths) of male and female *Sceloporus grammicus* from a single population in Michilía, Durango (taken from Ortega (*12*)). Each point represents the average of at least 20 individuals.

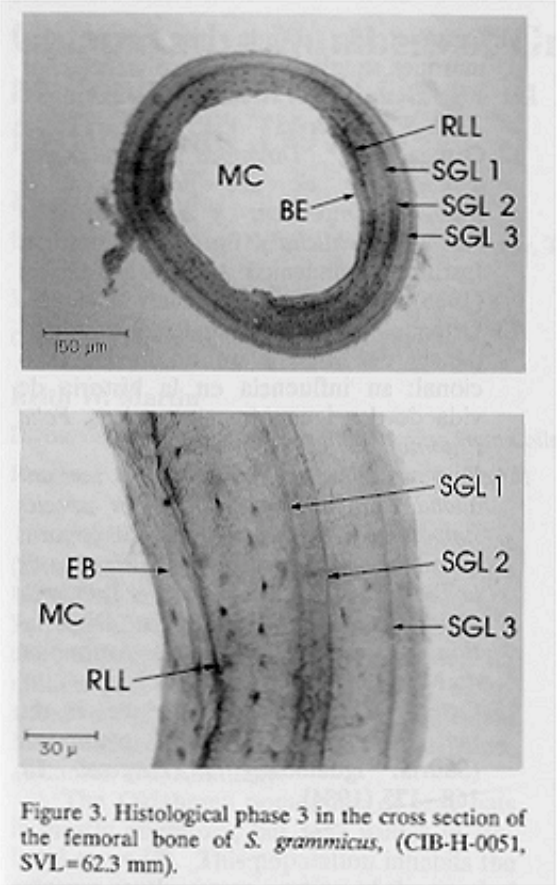

Figure 3. Histological phase 3 in the cross section of the femoral bone of *S. grammicus*, (CIB-H-0051, SVL=62.3 mm).

brief 10-day period during May. Thus, all individuals collected for this study were at least one year old. Individual growth rates are very high for juveniles in this population (0.067 mm/day; *12*, pp. 86-92).

When we compared ages estimated by the histological analysis with ages inferred from snout-vent lengths of each individual by matching sizes with the body-size growth curve of the population (Fig. 4), we observed perfect concordance between the two methods. It could be noted in Fig. 4 that the standard deviation for each point enables us to rely on the accuracy of such method.

Most previous studies show that SGL's appear in the bones of amphibians and reptiles when growth ceases during periods of seasonal inactivity (*4-11*). However, individuals of the Michilía population of *S. grammicus* are active year round, yet still develop pronounced SGL's.

Apparently the SGL's in *S. grammicus* result from the joint effects of the decreased availability of prey in November and December, two months after the end of the rainy season (*13*), and the sudden increase in activity of the individuals during the same period. During November and December courtship and mating takes place (*14*), requiring males to devote much more time and energy to the defense and patrol of territories and to courtship and mating of females.

Females show a significant change in their physiology during this period, allocating a great amount of their energy reserves (stored during the rainy season) from lipid bodies to the production of vitellus in the oviductal eggs (*15*). Thus, it seems likely that the occurrence of SGL's in *S. grammicus* is due to a significant reduction of available energy for body growth, which temporarily stops the production of new bone.

Thus, this is the first work reporting SGL's production, not as the result of seasonal inactivity, but as the result of the combined effects of a sudden *increase* in activity and a simultaneous *decrease* in availability of prey.

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