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SEXUAL DIMORPHISM IN HEAD SIZE IN THE LITTLE BROWN SKINK (*SCINCELLA LATERALIS*)

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***Abstract.*—Many species of skinks show pronounced sexual dimorphism in that males have larger heads relative to their size than females. This can occur in species in which males have greater body length and show different coloration than females, such as several species of the North American genus *Plestiodon*, but can also occur in species in which males and females have the same body length, or species in which females are larger than males. Another North American skink species, *Scincella lateralis*, does not exhibit obvious sexual dimorphism. However, behavioral data suggest sexual differences in head size might be expected because male *S. lateralis* are more aggressive than females and because these aggressive interactions often involve biting. In this study, we measured snout-to-vent length and head dimensions of 31 male and 35 female *S. lateralis* from northeastern Oklahoma. Females were slightly larger than males, but males had longer, wider, and deeper heads for their size than females. Sexual dimorphism in head size may be the result of sexual selection favoring larger heads in males in male-male contests. However, male *S. lateralis* are also aggressive to females and larger male head size may give males an advantage in contests with females whose body sizes are equal to or larger than theirs.**

Key Words.—head size; *Scincella lateralis;* scincid lizard; sexual dimorphism

INTRODUCTION

Sexual dimorphism refers to differences in size, body shape, or coloration between males and females. It is exhibited in many species of lizard in that adult males are often larger, have larger heads, and/or are more brightly colored than adult females (Vitt and Caldwell 2009). Sexual dimorphism was initially studied in territorial members of the Iguania (Stamps 1983). More recently, sexual dimorphism of species in the generally non-territorial Scleroglossan lineage has received attention and numerous examples have been documented. This is especially true for one of the largest and most widely distributed lizard families: the Scincidae. Some of the earliest work was done on several species in the genus *Plestiodon* (formerly *Eumeces*), found in the southeastern United States. Vitt and Cooper (1985) described extensive sexual dimorphism in *Plestiodon laticeps*, noting males are larger and have larger relative head sizes than females, and that the heads of males are colored bright orange (whereas the heads of females retain the juvenile color pattern of black with light stripes). The same authors also documented sexual dimorphism in two other southeastern USA species, *P. fasciatus* and *P. inexpectatus*, noting again that males had relatively larger heads than females, though male body size was also greater than female body size in *P. inexpectatus* (Vitt and Cooper 1986; see also Griffith 1991). Subsequent studies by authors studying skinks from Africa, Asia, and Australia have shown that, when skinks are sexually dimorphic, male body size and head size are usually greater in males, such as *Niveoscincus microlepidotus* (Olsson et al. 2002), *Acontias meleagris meleagris* (Heideman et al. 2008), *Mabuya multifasciata* (Ji et al. 2006), *Plestiodon* (*Eumeces*) *elegans* and *P. latiscutatus* (Griffith 1991), and the previously noted *P. laticeps* and *P. inexpectatus* (Vitt and Cooper 1985, 1986). However, there are also several sexually dimorphic skink species in which male and female body size are the same, but in which males nevertheless have larger heads: *Eulamprus quoyii* (Schwarzkopf 2005), *Microacontias litoralis* and *Acontias percivali occidentalis* (Heideman et al. 2008), *Egernia coventryi* (Clemann et al. 2004), and *Plestiodon fasciatus* (Vitt and Cooper 1986). Also, *Tiliqua rugosa* (Bull and Pamula 1996) and *Sphenomorphus indicus* (Ji and Du 2000) are sexually dimorphic skink species in which male body size is smaller than female body size but males still have larger heads for their size than females. The common thread is that, regardless of body size differences or lack thereof, when sexual dimorphism occurs in skinks, males have larger heads for their size than females. The most common explanation for head size dimorphism is that sexual selection favors larger male head size for success in aggressive male-male interactions (Vitt and Cooper 1985; Bull and Pamula 1996; Clemann et al. 2004). However, natural selection favoring sexual differences in feeding structures to reduce intraspecific competition for food has also been suggested as a driving force behind head size dimorphism in reptiles (Shine 1989; Anderson and Vitt 1990).

Though sexual dimorphism has been documented and studied in many skink species, there are species in several large genera that have not been carefully studied. One of these is the genus *Scincella*, which occurs in southeastern North America and in India eastward through Southeast Asia, China, Korea, and Japan (Chen et al. 2000). The best known species is *Scincella lateralis* (formerly *Lygosoma laterale*), commonly known as the Little Brown Skink. It occurs from eastern Kansas south to regions near the Rio Grande, then east to the Atlantic coast, and is one of the most abundant reptiles in the southeastern United States (Conant and Collins 1998). *Scincella lateralis* is terrestrial and is most commonly found in deciduous forests with abundant leaf litter and rotting logs. It spends nearly all of its time on the ground, rarely climbing trees or other structures. It preys on small invertebrates, mainly insects and spiders (Lewis 1951; Conant and Collins 1998), and uses both visual and chemical cues when foraging (Nicoletto 1985). *Scincella lateralis* is smaller than other North American skinks: minimum snout-to-vent length (SVL) for adults is about 35 mm (Johnson 1953); typical adult size is 40–50 mm SVL and 1–2 g body mass. Unlike the *Plestiodon* species with which it coexists in the southeastern United States, male and female *S. lateralis* have similar coloration. However, sexual dimorphism in body shape has been documented in that females have longer trunks than males: greater axilla-groin/SVL ratio and number of dorsal scale rows (Johnson 1953). In addition, female SVL tends to be 3–5 mm greater on average than male SVL (Brooks 1967), but the difference is not always statistically significant (Johnson 1953).

There have been no studies comparing the head dimensions of male and female *S. lateralis*, but casual observations (Fig. 1) and behavioral data suggest sexual differences in head size might be expected. Male *S. lateralis* are more aggressive than females in both intra- and inter-sexual contests (Akin 1997) and, because biting is commonly exhibited in aggressive interactions (Akin 1997), males might be expected to have evolved larger head sizes to improve their chances of winning aggressive encounters. In this study, we measured SVL and head dimensions of male and female *S. lateralis* to determine whether significant differences in the head size dimensions exist in this species, as has been found in other species of skinks.

Materials and Methods

We captured 31 adult male and 35 adult female *S. lateralis* in and near Sparrowhawk Primitive Area in Cherokee County, Oklahoma, USA (Lat. 35.9590; Long. -94.9026) from May to August 2009, 2010, and 2011. We measured the SVL of each lizard to the nearest mm and measured head dimensions to the nearest 0.001 mm using digital calipers. We measured head length from the tip of the snout to the anterior edge of the tympanum, head width at the level of the hinge of the jaw, and head depth from the parietal scale at the top of the head to the throat at the level of the hinge of the jaw. We took care to not indent the soft tissues of the head when using the calipers. The same individual (BMB) took all measurements on live lizards before sex was determined (by eversion of hemipenes in males) to avoid bias. Most lizards were used in behavioral experiments and then released within two weeks of being captured.

We compared SVL of males and females using a t-test ($\alpha = 0.05$). Because females were larger than males (see Results), we used Analysis of Covariance (ANCOVA, $\alpha = 0.05$) of log-transformed variables (to meet the assumption of normality) using sex as the factor being tested and the log of SVL as the covariate to evaluate differences in head dimensions between the sexes. We ran ANCOVAs separately for log-transformed head length, head width, and head depth dimensions. We ran all statistics using MYSTAT 12 (Systat Software Inc., Chicago, Illinois, USA) or IBM SPSS Statistics 19 (SPSS, Inc., Armonk, New York, USA).

Results

Female Little Brown Skinks had a significantly greater SVL than males (mean ± SD of SVL: males = 42.3 ± 2.52 mm; females = 45.5 ± 5.09 mm; $t = 3.191$, df = 64, $P = 0.002$). There were no significant differences in the slopes of the lines relating head size dimension to SVL between males and females for any of the three head dimensions (Fig. 2; Table 1). However, intercepts were significantly different for all head dimensions (Table 1), with male heads larger than female heads for all three head dimensions (Fig. 2).

Discussion

This study shows male *Scincella lateralis* have larger (longer, wider, and deeper) heads for their size than females. The sexual dimorphism in head size in *S. lateralis* matches what has been found in other sexually dimorphic skinks (Vitt and Cooper 1985, 1986; Bull and Pamula 1996; Schwarzkopf 2005; Heideman et al. 2008). The pattern of the sexual difference in head length is slightly different from those for head width and head depth. The slope of the line relating head length to SVL for males was steeper than the slope of the line relating head length to SVL for females, though the difference narrowly failed to reach statistical significance (Fig. 2, top). This suggests that, as lizards grow, the length of the head of males has a tendency to grow faster than the length of the head of females, a relationship that is common in skinks of the genus *Plestiodon* (Vitt and Cooper 1986; Griffith 1991). The lack of a similar relationship for head width and head depth (Fig. 2 middle and bottom) seems surprising.

FIGURE 1. *Scincella lateralis* from Cherokee County, Oklahoma, USA. Both the male on the left and the female on the right have a SVL of 44 mm. Note the difference in head size. The scale bar is 10 mm. (Photographed by Mark Paulissen)

However, at least one other skink species, *Mabuya multifasciata*, shows sexual differences in the slopes for head length but no sexual differences in the slopes for head width (Ji et al. 2006). This suggests that relationships identified for one head size parameter cannot be assumed to apply for all parameters and so an effort should be made to analyze as many parameters as possible in any study of sexual dimorphism in head size.

The most frequently given explanation for larger male head size in sexually dimorphic skinks is that larger heads and jaws favor males in aggressive encounters with other males (Vitt and Cooper 1985; Bull and Pamula 1996; Clemann et al. 2004). Several lines of evidence hint that sexual selection may be responsible for larger head size in male *S. lateralis*. Male *S. lateralis* have home ranges that are 3.5 times larger on average than those of females (Brooks 1967; Mather 1970). The home ranges of males overlap the home ranges of several females, but the home ranges of females do not overlap (Brooks 1967). If male *S. lateralis* mate only with females whose home range overlaps with theirs, the mating system would be polygynous (Stamps 1983). This mating system would place strong selective pressure on males to develop traits that will enable them to win contests with other males. In a laboratory study of aggressive behavior of *S. lateralis*, males were very aggressive toward other males, frequently attempting to bite their opponents to establish dominance (Akin 1997). In several species of lizard, greater head size allows a lizard to generate greater bite force (Herrel et al. 2001a, b). If a similar relationship exists for *S. lateralis*, then males

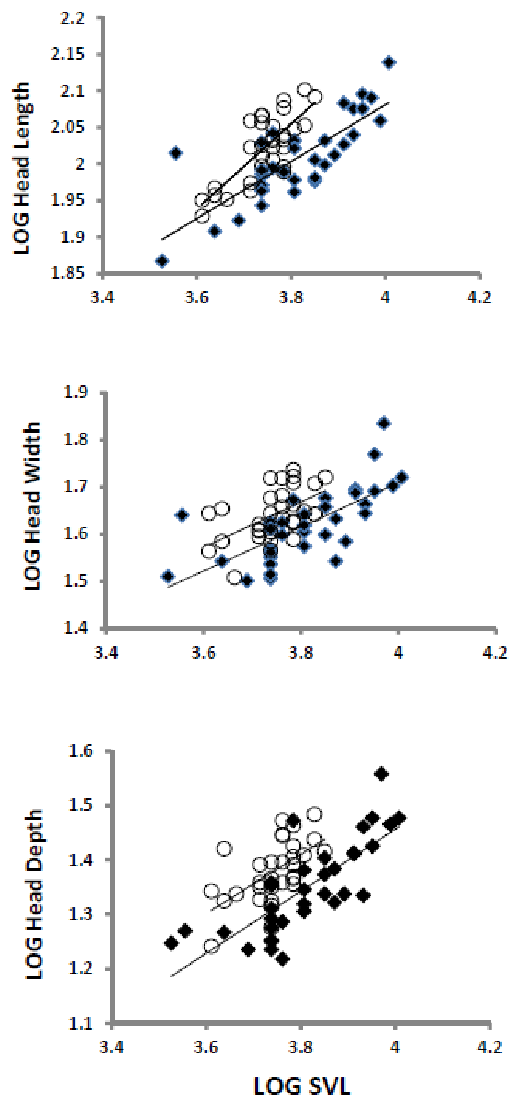

FIGURE 2. Relationship between Log Head Length (top), Log Head Width (middle), and Log Head Depth (bottom) to Log SVL in adult male and female *Scincella lateralis*. Open circles are males, closed diamonds are females. The linear regression lines from males (upper line) and females (lower line) are shown.

with larger heads will have an advantage in male-male contests, enabling them to win these contests and thereby obtaining access to females. If this is true, then sexual selection should strongly favor evolution of larger and stronger heads and jaws in males. Confirmation of this hypothesis requires detailed study of the extent of home range defense by males and the degree to which males are able to secure exclusive access to females as well as study of the relation of male head size to bite force generation.

TABLE 1. Mean ±SD of head measurements of male and female *Scincella lateralis*. The *F* and *P* values are for ANCOVAs using SVL as the covariate comparing slopes and intercepts of males to females for three head dimensions. In all cases, degrees of freedom are 1 and 61. Sample size is given in parentheses.

	Males	**Females**	**slopes**		**intercepts**	
	(n = 31)	**(n = 35)**	***F***	***P***	***F***	***P***
Head Length (mm)	7.56 ± 0.34	7.46 ± 0.42	3.11	0.083	24.66	< 0.001
Head Width (mm)	5.17 ± 0.29	5.09 ± 0.40	0.005	0.945	14.41	< 0.001
Head Depth (mm)	3.98 ± 0.22	3.87 ± 0.34	0.02	0.889	26.44	< 0.001

The study by Akin (1997) suggests an alternative hypothesis for the sexual differences in head size in *S. lateralis*. Males were not aggressive toward males alone; they were also aggressive toward females. Males bit equally sized females significantly more often than females bit males (Akin 1997). This behavior was not related to courtship or reproduction since the study was conducted outside the breeding season. Male aggression toward females did affect food consumption. Females consumed significantly fewer termites when paired with males than in control trials (when paired with a non-living surrogate). There was also a tendency for males to consume more termites when paired with females than in control trials, though this trend narrowly failed to reach statistical significance (Akin 1997). If intersexual aggression involving biting influences access to food in the wild and there is a positive relationship between head size and bite force in males, then there will be strong selection on males to evolve larger heads and jaws. This is because female *S. lateralis* grow larger than males (Johnson 1953; Brooks 1967; this study) so the largest females will have absolute head sizes as large as or larger than those of the largest males (Fig. 2). To compensate, males may evolve larger heads and jaws for their size so they can win intersexual contests with equal sized females by biting their opponents. They would also be at a smaller disadvantage in contests with females that are larger.

Several authors have suggested that differences in diet between males and females may lead to sexual dimorphism in head and jaw size in reptiles (Shine 1989; Anderson and Vitt 1990). Though several studies have documented that *S. lateralis* feeds on small arthropods (Slater 1949; Lewis 1951; Hamilton and Pollack 1961), to our knowledge, there are no studies comparing the diet of males to females so it is not known if sexual differences in diet exist in this species. In a detailed study of *S. lateralis* dentition, Townsend et al. (1999) found a slight, but statistically significant, sexual dimorphism in that the number of premaxillary teeth was negatively correlated with body size in males but not in females. Whether this difference is due to sexual differences in diet or to other factors (such as larger males losing premaxillary teeth by biting opponents in repeated aggressive encounters) is unknown.

This study confirms earlier work that showed that female *S. lateralis* are larger (have larger SVL) than males. The most common hypothesis advanced to explain why female reptiles are larger is fecundity selection that favors larger body size in females to increase clutch size and/or clutch mass (Heideman et al. 2008). The only studies of which we are aware that address this possibility present contradictory results. Johnson (1953) found no relationship between female SVL and either clutch size or egg length. However, Brooks (1963) working with a wider range of female SVLs, found a significant positive correlation between female SVL and clutch size. The question of whether fecundity selection has lead to an increase in female body size in this species remains unanswered.

Herein we document that male *Scincella lateralis* have larger heads for their size than females and therefore add this species to the growing list of skinks for which sexual dimorphism in head size has been demonstrated. Unfortunately, the natural history of *S. lateralis* is less well known than that of many other skinks, so it is not possible to ascertain if the factors driving sexual dimorphism in head size in other skinks account for the sexual dimorphism we described for *S. lateralis*. Detailed study of aggressive and reproductive behaviors, bite force generation, mating systems, and diet, both during and outside of the breeding season, will be required to determine the relative contributions of the several potential forces that shape head size dimorphism in this species.

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