Russian Journal of Herpetology Vol. 16, No. 1, 2009, pp. 35 – 40

A TAXONOMIC RE-EVALUATION OF *Goniurosaurus hainanensis* (SQUAMATA: EUBLEPHARIDAE) FROM HAINAN ISLAND, CHINA

Christopher Blair,[1,2] Nikolai L. Orlov,[3,4] Hai-tao Shi,[4,5] and Robert W. Murphy[1,2,4]

Submitted November 3 2007.

Previous examination of morphological characters for *Goniurosaurus hainanensis* yielded incomplete results due to a relatively small sample size ($n = 4$). Therefore, we re-examined previously used scale counts for the species utilizing a significantly larger sample size of 24 individuals in addition to analyzing morphometric data for the species. Our results yielded significant differences in several scale counts previously described, which we attribute to the high degree of morphological variability of lizards in the genus. No sexual size dimorphism was found for any morphometric character, although males had slightly higher values than females for most characters. Future molecular work is needed if we are to better understand the taxonomy and evolutionary history of the genus.

Keywords: Hainan, gecko, morphology, morphometrics, taxonomy

INTRODUCTION

The eublepharid genus *Goniurosaurus* currently contains 10 recognized species found in isolated tropical and subtropical regions in China, Vietnam, and Japan (Orlov and Darevsky, 1999; Grismer et al., 2002). Little is known regarding the ecology of the genus. However, *Goniurosaurus* are primarily nocturnal lizards associated with rocky/karst topography within primary rainforest, usually adjacent to nearby streams (Orlov and Darevsky, 1999). Grismer et al. (2002) compared distinguishing scale characteristics between 5 species of *Goniurosaurus* using multiple individuals per species. However, their sample size for *G. hainanensis* was relatively small ($n = 4$) and thus rendered incomplete. *Goniurosaurus hainanensis* is a species endemic to Hainan Island China, which occurs allopatrically with *G. bawanglingensis* and *G. luii* (Grismer et al., 2002). Herein we provide a brief redescription as well as a re-evaluation of the scale counts previously reported for *G. hainanensis* (Grismer et al., 2002), utilizing a larger sample size in order to provide a more complete analysis. We also include additional morphometric characters to the description.

MATERIAL AND METHODS

Twenty-four specimens (13 male, 11 female) of *G. hainanensis* were collected by N. Orlov, R. Murphy, and H. Shi from 12 to 22 June 2005 and deposited in the Royal Ontario Museum herpetological collections. Meristic characters used in our description follow those used by (Grismer et al., 2002) and include number of supralabials, infralabials, postmentals, preorbitals, eyelid fringe scales, paravertebral tubercles, granular scales around mid-body, granular scales surrounding tubercles, subdigital lamellae, and preanal pores. The following morphometric measurements were taken with digital calipers to the nearest 0.01 mm: snout-vent length (SVL), tail length (TL), head length (HL), head width (HW), and body width (BW). Head length was measured from snout to posterior of external ear. Head with was measured at the widest area of head, and body width at the largest area of torso between limb insertions. Means, ranges, and standard deviations were calculated for each meristic character. Sexual-size dimorphism (SSD) was determined for each morphometric character via *t*-tests

[1] Deparment of Natural History, Royal Ontario Museum, 100 Queen's Park, Toronto, Ontario M5S 2C6, Canada.

[2] Department of Ecology and Evolutionary Biology, University of Toronto, 25 Willcock's St., Toronto, ON M5S 3B2, Canada.

[3] Zoological Institute, Russian Academy of Sciences, Universitetskaya nab. 1, St. Petersburg, 199034, Russia.

[4] Department of Biology, Hainan Normal University, Haikou, Hainan Province 571158, P. R. China.

[5] Chengdu Institute of Biology, Chinese Academy of Sciences, No. 9, Section 4, Renmin Nan Road, Chengdu, Sichuan Province 610041, P. R. China.

using the Bonferroni correction method employed in SYSTAT (SYSTAT, 1997). One sample t-tests were also used to compare the scutellation means presented in this study to the means previously reported by Grismer et al. (2002).

DESCRIPTION OF TAXA

Family Eublepharidae
Genus *Goniurosaurus*
Goniurosaurus hainanensis Mocquard, 1897

Material examined. *Goniurosaurus hainanensis* — China: Hainan Province; Bao Ting, Haikou, Ling Shui, and Qiong Zhong districts (81 – 765 m; ROM 43140 – 43163).

Redescription of species. Triangular-shaped head longer than wide; eyes relatively large (eye length/head length ratio = 6.31/26.29 mm); pupil vertical; head dorsoventrally compressed; interorbital distance small (approximately 24% of total head width); band behind neck V-shaped; external ear opening directly underneath head band; rostral scale divided; external nares bordered anteriorly by prenasals, posteriorly by postnasals, and dorsally by supranasals; prenasals in direct contact with supralabials; two internasals aligned anterior-posteriorly between supranasals; labial scales mottled; first supra- and infralabial in series square; remaining labial scales rectangular with infralabials wider than supralabials; mental triangular, bordered posteriorly by postmentals and laterally by infralabials; postnasals separated from preorbitals by several granular scales; tubercles on dorsal surface of head smaller and fewer than tubercles on neck and torso regions.

Posterior portion of head narrows through neck, giving way to a more robust trunk region; tubercles on neck in greater numbers than on head; four prominent dorsal bands present including head; all bands white with black borders; dorsum covered by numerous small, granular scales giving way to larger and smoother ventral scales dorsolaterally; tubercles present throughout dorsal and appendicular regions, decreasing in abundance and size towards head and tail; hind limbs larger than forelimbs; fingers and toes relatively small; FV < FI < FIV < FII < < FIII, TI < TV < TII < TIII < TIV; claws protruding from sets of terminal scales on digits; preanal pores only present in males.

Tail thin and streamlined with length up to two-thirds snout-vent length; caudal annuli present in varying quantities; ten specimens with regenerated tails, four broken; no annuli present on regenerated tails; regenerated tails less streamlined and more robust than original; ventral caudal scales larger than dorsal caudals.

There was slight intraspecific variation in both scale and morphometric characters (Tables 1 and 2). How-

TABLE 1. Range, Mean, and Standard Deviation (S.D.) on Scale Counts for 24 Specimens of *Goniurosaurus hainanensis*

Value	SLL	SLR	ILL	ILR	PM	POL	POR	EFL	EFR	PVT	BS	GSST	SL	PP
Mean	8.42	8.38	7.54	7.54	3.74	16.38	16.3	64.08	62.65	27.63	109.13	11.96	19.13	28.08
Range	7 – 10	7 – 10	6 – 9	6 – 9	2 – 5	13 – 20	14 – 19	54 – 77	55 – 70	23 – 32	95 – 125	11 – 15	17 – 21	24 – 31
±1 S.D.	0.83	0.82	0.72	0.72	0.81	1.69	1.26	7.62	4.34	2.41	7.4	0.95	1.2	1.8
t-Test (*P*)	<0.001	<0.001	<0.001	<0.001	0.171	<0.001	<0.001	0.857	0.251	0.217	<0.001	<0.001	<0.001	0.027

Note. *t*-Test refers to comparisons made between these data and those presented in Grismer et al. (2002). SLL, left supralabials; SLR, right supralabials; ILL, left infralabials; ILR, right infralabials; PM, postmentals; POL, left preorbitals; POR, right preorbitals; EFL, left eyelid fringe scales; EFR, right eyelid fringe scales; PVT, paravertebral tubercles; BS, body scales; GSST, granular scales surrounding tubercles; SL, subdigital lamellae; PP, preanal pores.

TABLE 2. Total Mean, Range, and Standard Deviation for All Morphometric Characters Measured for 24 Specimens of *Goniurosaurus hainanensis*

Value	SVL	TL	HL	HW	BW
Mean	80.93	51.57	24.5	15.78	15.77
Range	57.25 – 93.25	36.44 – 65.51	16.86 – 30.14	10.75 – 19.46	8.27 – 22.62
±1 S.D.	11.01	9.49	3.45	2.38	3.56
Male	82.68	52.9	24.74	16.4	15.27
Female	78.87	50.24	24.21	15.04	16.37
t-Test (*P*)	0.419	0.545	0.722	0.169	0.491

Note. Mean values for males and females are also presented separately for each character along with its respective *t*-Test *p*-value. Abbreviations follow those presented in the text.

Fig. 1. *Goniurosaurus araneus* from Cao Bang province, Vietnam.

Fig. 2. *Goniurosaurus bawanglingensis* from Bawangling National Nature Reserve, Hainan province, Hainan Island, China (the type locality).

Fig. 3. *Goniurosaurus hainanensis* from Wuzhi Mountain, Wuzhishan National Nature Reserve, Hainan province, Hainan Island, China (the type locality).

Fig. 4. *Goniurosaurus lichtenfelderi* from Kuinong Chao Quang Ninh Province, Vietnam.

Fig. 5. *Goniurosaurus huuliensis*, from Lang Son province, Vietnam.

Fig. 6. *Goniurosaurus luii* from Guangxi province, China.

ever, no significant sexual size dimorphism was present for any measured morphometric character, although males showed slightly higher averages than females in every character except body width (Table 2). Several of our scale counts were significantly different than those presented in Grismer et al. (2002), although similarities were found in number of postmentals, eyelid fringe scales, and number of paravertebral tubercles (Table 1).

Coloration in preservative. Dorsal surface gray to dark brown; venter cream-colored mottled with darker spots on some individuals; significant intraspecific variation in tail pattern and color; regenerated tails dark brown to a grayish green; dorsal bands white surrounded by darker borders; tubercle color varies from white to dark brown depending on location; cloacal region cream-colored speckled with darker spots.

DISCUSSION

The data presented in this study provide a more comprehensive examination of the scale characteristics previously described for *G. hainanensis* (Grismer et al., 2002). Moreover, some of the results presented in our analysis differ significantly from previous results, illustrating the influence of our larger sample size. For example, Grismer et al. (2002) found *G. hainanensis* to have an average of 9.3 and 8.5 supralabial and infralabial scales, whereas our results showed averages of approximately 8.4 and 7.5, respectively. They also showed slightly higher body scale counts (115.8 vs. 109.13) and found no individuals with two or five postmentals. There was also slight to moderate variation in the remainder of morphological characters (Table 1). Thus, larger data sets may be necessary to ascertain the taxonomic status of species of *Goniurosaurus*.

As it stands now the genus *Goniurosaurus* contains 12 species. Orlov and Darevsky (1999) described an eleventh species, *G. murphyi*, from mainland Vietnam. However, further morphological analysis by Grismer (2000) revealed this species to be synonymous to *G. lichtenfelderi*. *Goniurosaurus lichtenfelderi*, however, was described based solely on the morphological characters of two individuals (personal communication) and is known to exhibit significant overlap with *G. hainanensis* in several morphological characters (Schmidt, 1927). Molecular work may be necessary to determine species designations and population differentiation in this group. To our knowledge this is the first study to examine morphometric data for the species. Previous researchers have shown particular morphometric characters to be useful in distinguishing closely related species of reptiles (Doan and Blair, unpublished data). Large datasets utilizing comparative morphometric analyses in conjunction with morphological and molecular data may provide insight into the taxonomic discrepancies found in *Goniurosaurus* and other eublepharid taxa (Grismer, 1991; Grismer et al., 2002). In addition, comparative ecological studies may provide further data that will aid in species and sub-species designations.

Phylogenetic and Biogeographic Implications. According to the morphological phylogeny proposed by Grismer et al. (2002), the three species inhabiting Hainan Island are not closely related. They suggest *G. hainanensis* to be the sister taxon to the mainland *G. lichtenfelderi*, whereas the clade containing *G. luii* + *G. araneus* is sister to *G. bawanglingensis*. If this hypothesized phylogeny were true it would imply multiple independent invasions from the mainland, with *G. luii* arriving on the island significantly later than *G. bawanglingensis*. Due to the extreme intraspecific variation in scale characteristics, future molecular work is needed for the genus to elucidate the phylogenetic and biogeographic hypotheses proposed in previous morphological studies. Molecular analyses may also ascertain the taxonomic status of the highly variable mainland and island populations of *G. luii* (Grismer et al., 2002).

Acknowledgments. Support for this research was provided by the Royal Ontario Museum (ROM) Board of Governors, the ROM Members Volunteer Committee, and the Natural Sciences and Engineering Research Council (NSERC) of Canada grant No. A3148 to Robert W. Murphy. We also thank the Chinese Academy of Science for providing export permits for this research.

REFERENCES

Grismer L. L. (1991), "Cladistic relationships of the lizard *Eublepharis turcmenicus* (Squamata: Eublepharidae)," *J. Herpetol.*, **25**, 251 – 253.

Grismer L. L., Viets B. E., and Boyle L. J. (1999), "Two new continental species of *Goniurosaurus* (Squamata: Eublepharidae) with a phylogeny and evolutionary classification of the genus," *J. Herpetol.*, **33**, 382 – 393.

Grismer L. L. (2000), "*Goniurosaurus murphyi* Orlov and Darevsky: a junior synonym of *Goniurosaurus lichtenfelderi* Mocquard," *J. Herpetol.*, **34**, 486 – 488.

Grismer L. L., Shi H., Orlov N. L., and Ananjeva N. B. (2002), "A new species of *Goniurosaurus* (Squamata: Eublepharidae) from Hainan Island, China," *J. Herpetol.*, **36**, 217 – 224.

Orlov N. L. and Darevsky I. S. (1999), "Description of a new mainland species of *Goniurosaurus* genus, from the north – eastern Vietnam," *Russ. J. Herpetol.*, **6**(1), 72 – 78.

Schmidt K. P. (1927), "The reptiles of Hainan," *Bull. Am. Mus. Nat. Hist.*, **54**, 395 – 465.

Systat (1997), SYSTAT for Windows. Statistics, Version 7.0. SPSS, Chicago.