

## A New Species of *Gonatodes* (Squamata: Gekkonidae) from the West Indies

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**ABSTRACT.**—We describe a new species of *Gonatodes* from remnant dry forest on Union Island, St. Vincent and the Grenadines. The new species is distinguished from all congeners by its small size, large body scales (39-44 around midbody; >70 in all congeners), a bright red-orange iris, and a unique pattern of three pairs of prominent dorsolateral ocelli on the body. We discuss the biogeographical implications of the new species' Lesser Antillean distribution and its conservation status.

**KEYWORDS.**—*Gonatodes daudini* new species, West Indies, Grenadines, Union Island, systematics, taxonomy

### INTRODUCTION

The genus *Gonatodes* (Squamata: Gekkonidae) contains about 20 species in Central America and central and northern South America (Avila-Pires 1995; Warren et al. 2005). These small lizards also occur on many continental islands (e.g., Trinidad, Tobago, Aruba, Curaçao, Tortuga, Orchila, Gorgona). In the West Indies, *G. albugularis fuscus* occurs on Cuba and *G. a. notatus* is found on Hispaniola (including Île-à-Cabrit and Île de la Gonâve), Jamaica, and Grand Cayman (Schwartz and Henderson 1991); the latter subspecies is endemic to the West Indies. No previously known species of *Gonatodes* is endemic to the West Indies or known to occur in the Lesser Antilles.

While conducting a botanical survey in dry upland forest on Union Island, southernmost of the St. Vincent Grenadines (Fig. 1), Fr. Mark de Silva encountered a small gekkonid, which he brought to our attention. Because a species of *Sphaerodactylus* had recently been discovered on the Grenada Bank (Lazell 1994), which includes all of the Grenadine Islands, our initial thought was that the diminutive lizard

was a *Sphaerodactylus*. Closer inspection, however, showed it to be a new species of *Gonatodes*.

### MATERIALS AND METHODS

All measurements were made to the nearest 0.1 mm with dial calipers under a dissecting microscope. The formula for the sequence of transversely enlarged scales on the underside of the tail is illustrated and explained in Avila-Pires (1995: Fig. 2). Abbreviations used are SVL (snout-vent length), HL (head length), HW (head width), and TL (tail length). We used the descriptions of *Gonatodes* in Avila-Pires (1995) as the template for the description that follows.

### RESULTS

*Gonatodes daudini* sp. nov.

*Holotype.*—University of Kansas Natural History Museum (KU) 275717 (original number: Milwaukee Public Museum Field Herpetology, MPM-FH 2307; Figs. 2, 3), male, 9 May 2005, Water Rock Reserve on the northern slope of Mt. Taboi above Chatham Bay (elev. ~120 m), Union Island (12°35'N, 61°25'W), St. Vincent and the

ms. received June 28, 2005; accepted August 19, 2005.

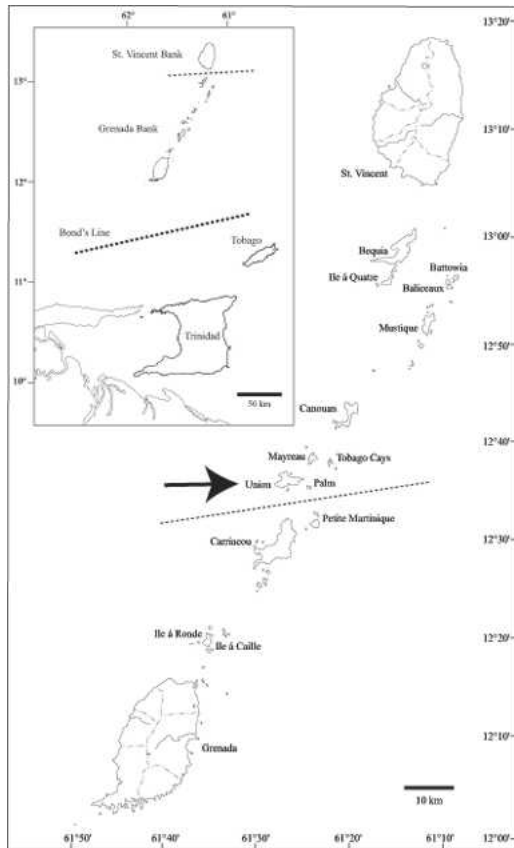


FIG. 1. Location of Union Island (arrow), the southernmost of the St. Vincent Grenadines. The dotted line immediately below Union Island represents the political boundary between St. Vincent and the Grenadines to the north and Grenada to the south. Also note that all of the Grenadines, regardless of political affiliation, are on the Grenada Bank (see inserted map). The narrow dotted line indicates the boundary between the St. Vincent and Grenada banks, whereas the bold dotted line represents Bond's Line, which separates the Lesser Antilles (and West Indies) from South America and its continental islands (e.g., Trinidad and Tobago). The proximity of the South American mainland and Trinidad and Tobago, all of which support species of *Gonatodes*, to the Grenada Bank suggests that the ancestors of *G. daudini* may have originated in South America and reached the bank via overwater dispersal.

Grenadines, collected by Mark de Silva and Matthew Harvey.

*Paratypes*.—All from the immediate vicinity of the type locality: MPM 33975 (original number: MPM-FH 2304) and MPM 33977 (MPM-FH 2308), males, 18

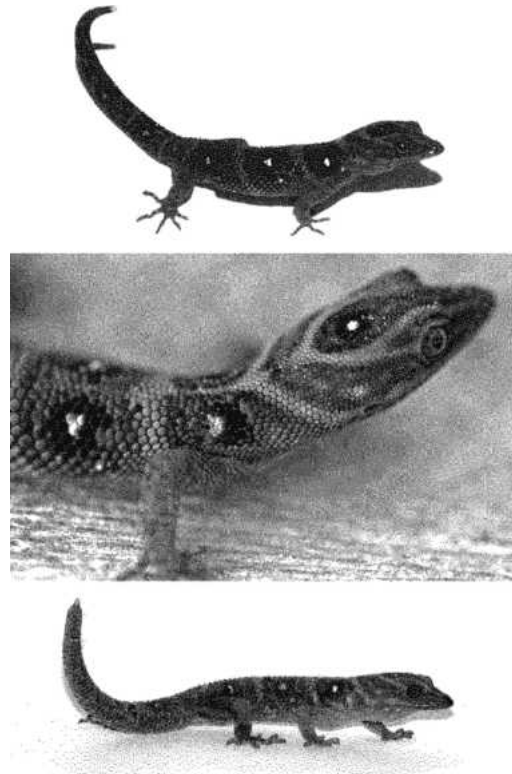


FIG. 2. Photograph of the holotype (KU 275717; top) and two paratypes (MPM 33975, middle; MPM 33977; bottom) illustrating variation in intensity and distinctiveness of pattern elements.

May 2005, collected by Mark de Silva and Matthew Harvey, and KU 275718 (MPM-FH 2305) and MPM 33976 (MPM-FH 2306), males, 7 June 2005, collected by Robert W. Henderson, Robert Powell, and Matthew Harvey.

*Diagnosis*.—A very small *Gonatodes* with a pointed snout, a bright red-orange iris, and 39-44 scales around midbody (>70 in all congeners). Scales along mid-ventral line between anterior margin of the forelimbs and vent 34-38. Proximal subdigital lamellae as wide as digits, in total 18-22 under fourth toe. Two lateral rows of scales on distal portions of fingers and toes. Tail ventrally with two enlarged single mid-ventral scales, each in contact with one latero-distal scale per side, followed by a divided mid-ventral in contact with two latero-distal scales per side. Males with

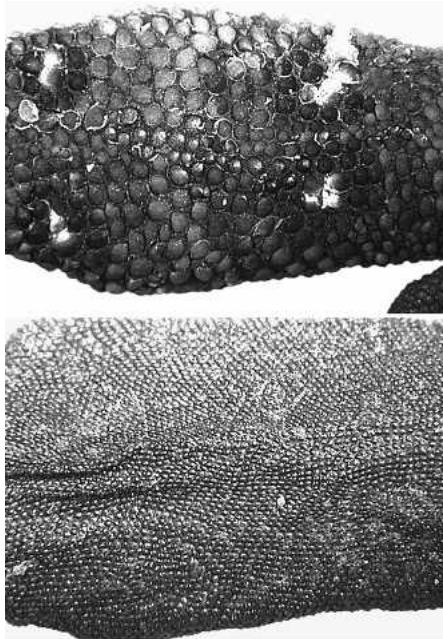


FIG. 3. Dorsum of *Gonatodes daudini* (MPM 33977; top), showing large body scales (except the 1-2 irregular rows of small middorsal scales), and dorsum of *G. humeralis* (MPM 10232; SVL = 38 mm) from Perú (Loreto: Yanamono) showing small scales of essentially uniform size.

three conspicuous pairs of dorsolateral white spots surrounded concentrically first by black and then by red. No other species of *Gonatodes* has comparably large body scales, small SVL, bright red-orange iris, or a body pattern consisting of three prominent dorsolateral pairs of ocelli.

*Description of holotype*.—Adult male; 29.9 mm SVL; HL 8.0 mm (0.27 times SVL); HW 4.8 mm (0.16 times SVL); head 1.67 times as long as wide; body dorsoventrally compressed; TL 25.5 mm (0.85 times SVL); limbs well-developed.

Snout narrow and rounded from above, moderately elongate, sloping gradually toward top of head; rostral large, clearly visible from above with a median cleft extending from the posterior margin, 6 postrostrals including 1<sup>st</sup> supralabial; scales on snout and loreal region round to polygonal and moderately conical; scales on top of head between eyes smaller than on snout, then increasing in size toward nape and onto dorsum of body; scales of supra-

orbital region similar to those on top of head; supraciliary flap with 4 enlarged, prominent scales on upper margin suggesting small spines over the eye; supralabials 5, decreasing in size posteriorly, with 3 to below center of eye; scales of temporal region small, granular; ear opening oval, much smaller than eye; mental large, more or less rhomboidal, bordered by infralabials and 2 postmentals; scales on anterior chin polygonal, decreasing in size from postmentals; infralabials 6, with 3 to below center of eye; scales on nape more or less round, conical; scales on side of neck ovoid and moderately conical; throat scales small and granular, merging posteriorly into those that are smooth, imbricate with a rounded posterior margin; pupil round.

Dorsal scales large, juxtaposed, not as rugose as those on nape; 1-2 rows of much smaller middorsal scales; scales on flanks large, but decreasing in size ventrolaterally; ventrals large, smooth, imbricate, in oblique rows with rounded free edge; 36 scales along midventral line between anterior margin of forelimbs and vent; scales around midbody 40; scales on preanal plate similar to ventrals, but those bordering vent very small.

Scales on anterolateral surface of forelimb smooth, rhomboidal, imbricate; scales on posterior surface of upper forelimb small, rugose, imbricate; scales on anterodorsal surface of upper hindlimb smooth, variable in shape, imbricate; scales on undersurface of hindlimb similar to those on belly; scales on posterior surface of thigh reduced in size, smooth, imbricate; fingers and toes with 2 rows of lateral scales distally; 3rd finger lamellae 15; 4th toe lamellae 19; lamellae at the base of toes as wide as toes; claws exposed, non-retractile, between four basal scales.

Scales on dorsal surface of tail variable in shape (round, oblong, ovoid), imbricate; laterally scales become larger and more homogeneous in shape; midventral scales large, smooth, imbricate, free edge rounded with scales lateral to midventral scales in sequence of 1' 1' 2"; escutcheon absent.

In life, ground color on head olive-gray with scattered black scales; 2 bright olive green lines from nares to above and behind

eyes onto occipital area; bright olive-green bands extend from behind the eyes and converge on nape; occipital area with a bright white spot surrounded by a black circle surrounded by pale red circle surrounded by brown ground color; dorsum with 3 pairs of dorsolateral ocelli, each a bright white blotch (2-3 scales) surrounded concentrically by black (1-2 scales wide), then red (1-2 scales wide); the red becoming less intense on the more posterior ocelli; between pairs of ocelli bright gray-green crossbands interspersed with gray and brown (3-4 scales wide); chin with overall greenish hue; thorax pale lavender; belly pale gray with fine brown stippling; legs gray-green with variable amounts of brown flecks; digits alternately banded gray-green and brown; dorsum of tail pale charcoal ground color with two pairs of white spots surrounded by black, the pairs separated by light gray-green crossbands; tip of tail white; subcaudals gray; iris red-orange.

In alcohol, color faded quickly (7 days) to pale gray with only the ocelli maintaining distinctive white, black, and pale red.

*Variation.*—All males. Scale characters are very similar for the entire type series

(N = 5; Table 1), although the continuity of the 1-2 rows of small middorsal scales varies (Figs. 2, 3). Number of scales around midbody (mean  $\pm$  SE =  $41.8 \pm 1.0$ ; range 39-44) indicative of the large body scales in this species. Pattern elements essentially similar in the entire series, although intensity of colors, distinctiveness of pattern elements, and number of rows of scales involved varied (Table 1, Fig. 2), with those on one of the larger individuals (MPM 33977) and both of the smaller individuals (KU 275718 and MPM 33976) duller and less distinct, respectively. For example, the most posterior of the three prominent dorsolateral pairs of ocelli is faint in these three lizards and the red associated with those ocelli was barely discernible. Also variable was the presence of light dorsolateral spots on the tail; two of the larger individuals possessed at least one pair of such spots, whereas none were evident on the other three lizards.

*Distribution and ecology.*—Union Island has an area of 8.1 km<sup>2</sup> and has the highest peak in the Grenadines (305 m); rainfall is about 1025 mm annually (Daudin 2003). Howard (1952) described the area in which

TABLE 1. Variation in *Gonatodes daudini* for selected characters. Measurements for SVL, HL, and HW are in mm. Dashes represent values missing because of damage to that specimen.

Character	MPM 33975	KU 275718	MPM 33976	KU 275717	MPM 33977
SVL	27.9	19.3	19.9	29.9	29.9
HL	7.4	5.5	6.1	8.0	7.5
HW	4.5	3.2	3.5	4.8	5.1
HL/SVL	0.27	0.28	0.31	0.27	0.25
HW/SVL	0.16	0.17	0.18	0.16	0.17
HL/HW	1.6	1.7	1.7	1.7	1.5
Supralabials	6	5	6	5	6
Supralabials to center of eye	4	3	4	3	3
Infralabials	6	6	6	6	7
Infralabials to center of eye	3	3	3	3	3
Rows of small middorsal scales	1-2	1-2	1-2	1-2	1-2
Scales around midbody	42	44	44	40	39
Ventrals at midbody*	35	—	38	36	34
Lamellae on 3 <sup>rd</sup> finger	15	17	16	15	14
Lamellae on 4 <sup>th</sup> toe	18	22	—	19	19
Scales in white spots	3-9	2-3	1-2	2-3	1-3
Width of black rings**	1-3	2-3	1-4	1-2	1-2
Width of red rings**	1-4	1-3	1-2	1-2	1-3
Width of green bands**	2-4	2-3	3-4	3-4	3-4

\*Between anterior margin of forelimbs and vent.

\*\*Expressed in numbers of scales.

*Gonatodes daudini* was collected as "secondary woodland existing on dry shallow soil and having a thin open aspect, with the plants 15 to 30 feet tall." Fiard (2003) described the Water Rock forest as "surprisingly healthy for such a dry island." The canopy reaches 15-18 m, and dominant tree species are *Bursera simaruba*, *Pisonia fragrans*, *Longhocarpus violaceus*, *Albizia caribea*, and *Spondias mombin* (Fiard 2003).

The new species appears to be restricted to mature dry upland forest, and all specimens were associated with rotting logs and loose soil, often interspersed with small stones and rocks. Three animals (KU 275717, MPM 33975, 33977) were collected late in the day near dusk. Two (KU 275718 and MPM 33976) were collected at 1100 h in rotten wood on shallow (1.0 cm) leaf litter and bedded in loose soil with small rocks and stones (Fig. 4). The sky was overcast, air temperature was 27.3 °C, and litter temperature was 26.3 °C. Although about 750 m of habitat along a historic trail were

sampled, all five specimens were collected within one 50-m stretch.

*Etymology.*—The specific epithet is a patronym honoring Jacques Daudin. "Jack," now 80 years old, arrived on Union 27 years ago and has been documenting its natural history ever since. An ardent conservationist, he has fought many battles in order to protect the island's natural resources, and he recently compiled and edited "A Natural History Monograph of Union Island" (Daudin 2003).

#### DISCUSSION

The herpetofauna of the Grenada Bank is of South American origin (Murphy 1996). At the generic level, all frogs and reptiles known to occur on the Grenada Bank are represented on nearby Trinidad and Tobago and on the South American mainland. However, the bank does harbor several endemic species in addition to *Sphaerodactylus kirbyi* (*Eleutherodactylus euphronides*, *Typh-*



FIG. 4. Habitat at the type locality where two animals (KU 275718 and MPM 33976) were collected in rotten wood on shallow (1.0 cm) leaf litter and bedded in loose soil with small rocks and stones.

*lops tasymicris*, *Corallus grenadensis*). The discovery of *Gonatodes* on the bank is surprising only because the sphaerodactyline niche has been explosively filled elsewhere in the West Indies by *Sphaerodactylus* (85 species) and *S. kirbyi* has been described recently from Bequia (Lazell 1994). *Gonatodes daudini* is a very small species similar to many species of *Sphaerodactylus* in size and habitat use and may fill the sphaerodactyline niche on the southern portion of the Grenada Bank. Its presence there may explain, at least in part, the apparent absence of *Sphaerodactylus* from the southern islands of the Bank, including the major island of Grenada.

In most of northeastern South America, relatively small to medium-sized *Gonatodes humeralis* appears to occur alone in many habitats. Where it is sympatric with a congener, those species (*G. annularis*, *G. caeciliae*, *G. concinnatus*, *G. tapajonicus*, or *G. hasemani*) are invariably larger (Avila-Pires 1995; Hoogmoed 1973, in litt., 5.VIII.2005; Rivero-Blanco 1979). The situation on Trinidad and part of adjacent Venezuela is a bit different because three species can occur in sympatry: small *G. vittatus*, medium-sized *G. humeralis*, and large *G. caeciliae*. On Tobago, only large *G. ocellatus* is known, which is unusual. The situation on Union also is unusual in having only one diminutive ground-dwelling species of *Gonatodes*.

Species of *Gonatodes* generally are arboricolous, with larger forms frequently found closer to the base of trees, where they may forage in the leaf litter. The apparent terrestrial proclivities of *G. daudini* thus are unusual for the genus, particularly in light of its small size.

The relationship of *Gonatodes daudini* to congeners is not immediately evident, and elucidation of this species' place within the genus will require a more extensive systematic study involving consideration of genetic material. However, comparisons with published descriptions and photographs of species of *Gonatodes* from Aruba, Bonaire, and Curaçao (van Buurt 2001, 2005), Trinidad and Tobago (Murphy 1997), northeastern South America (Avila-Pires 1995; Hoogmoed 1973), and those in the review of the genus by Rivero-Blanco (1979)

preclude any confusion regarding the distinctiveness of *G. daudini*. The diminutive size, large body scales, bright red-orange iris, and the dorsal pattern of *G. daudini* are unique, although the body pattern is faintly reminiscent of *G. ocellatus* from Tobago. The latter has a single pair of ocelli above the insertion of the forelimbs and at least some individuals show evidence of a vague second pair on the flank. Male *G. ocellatus*, however, are much larger than male *G. daudini*, and the former possess the very small dorsal scales that are characteristic of species in this genus other than *G. daudini*.

The apparently restricted range suggests that this is a relictual population, the survival of which is intimately tied to the presence of mature dry upland forest. Because such forests have been destroyed at least once on all of the Grenadines and on nearly all of Grenada, the historical distribution of *G. daudini* may once have included much of the Grenada Bank.

The very limited distribution and the vulnerability of the forest habitat on Union speak to a need for implementation of conservation measures. The species certainly qualifies for red-listing as "critically endangered" according to IUCN criteria ([http://www.redlist.org/info/categories\\_criteria.html](http://www.redlist.org/info/categories_criteria.html)): the species is in imminent danger of extinction in the wild due to an extent of occurrence less than 10 km<sup>2</sup>, known to exist at only a single location, and the area and quality of habitat is threatened by potential development. Also, because efforts to collect specimens inevitably destroy the microhabitat, additional collection of individuals should be discouraged and monitoring efforts should focus on suitable habitat rather than actual observations of individuals.

*Acknowledgments.*—Fr. Mark de Silva discovered these diminutive lizards and immediately recognized them as new. He brought them to our attention, facilitated our subsequent visit to Union Island, helped us describe the vegetation at the type locality, provided the photograph of MPM 33975 (Fig. 2), and humbly declined our invitation to be a co-describer. On Union, Matthew Harvey was a knowledge-

able and enthusiastic guide and companion as we searched for the new *Gonatodes*, and, despite not being in the best of health, Jacques Daudin welcomed us upon our arrival at the Union airport and was there to say good-bye as we departed. Brian Johnson, FitzGerald Providence, Cornelius Richards, and FitzRoy Springer of the Department of Forestry, St. Vincent and the Grenadines were generous with their time and enthusiasm for our work. They provided the necessary permits for collecting and exporting specimens. FitzGerald Providence went above and beyond the call of duty by helping us find lodging and a jeep we could afford to rent. John S. Parmelee, Jr. provided the map and Rose Henderson provided the photographs of dorsal scales. S. Blair Hedges, Marinus Hoogmoed, William W. Lamar, and James (Skip) Lazell reviewed this manuscript and provided valuable insights. Fieldwork was funded by NSF grant DBI-0242589 to R. Powell.

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