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New Species of Earless Lizard Genus *Heterodactylus* (Squamata: Gymnophthalmidae) from the Highlands of Chapada Diamantina, State of Bahia, Brazil

MIGUEL TREFAUT RODRIGUES,[1,2] MARCO ANTONIO DE FREITAS,[3] AND THAIS FIGUEIREDO SANTOS SILVA[3]

[1]*Universidade de São Paulo, Instituto de Biociências, Departamento de Zoologia, Caixa Postal 11.461, CEP 05422-970, São Paulo, Brasil; E-mail: mturodri@usp.br*

[3]*Universidade Estadual Santa Cruz, Programa de Pós-Graduação em Zoologia, Rodovia Ilhéus/Itabuna km 16, 45.650-000, Ilhéus, Bahia, Brasil; E-mail: philodryas@hotmail.com*

ABSTRACT.—**A new species of *Heterodactylus* is described based on two specimens obtained in the highlands of Chapada Diamantina, state of Bahia, Brazil. The new lizard is characterized by very elongate body and tail, absence of external ear opening, presence of moveable eyelids, absence of prefrontals and frontoparietals, a vestigial interparietal, 37–39 dorsal and 27–29 ventral transverse scale rows, 23–25 scales around midbody, six gular scale rows, and 10–11 and 14–15 fourth finger and fourth toe infradigital lamellae, respectively. The new species is most similar to *Heterodactylus lundii* from which it differs by the absence of contact between frontal and interparietal, by having wider than long parietals, smooth posterior dorsal scales, posterior ventral scales almost twice longer than wide, a lower number of scales around midbody, last supralabial in contact with the granules of the ear depression, and a more elongate body. The new species occurs about 1,100 km north of the northernmost known record of *H. lundii*. Species of *Heterodactylus* seem to be restricted to areas of cold climates associated with high latitudes and mountainous areas of eastern Brasil.**

RESUMO.—**Uma nova espécie de *Heterodactylus* é descrita com base em dois exemplares obtidos nas terras altas da Chapada Diamantina, estado da Bahia, Brazil. O novo lagarto, caracterizado por apresentar corpo e cauda extremamente alongados, ausência de ouvido externo, pálpebra presente, ausência de prefrontais e frontoparietais, interparietal vestigial, 37–39 fileiras transversais de escamas dorsais, 27–29 fileiras transversais de escamas ventrais, 23–25 escamas ao redor do meio do corpo, 10–11 e 14–15 lamelas infradigitais, respectivamente, no quarto dedo e artelho, e seis fileiras de escamas gulares, assemelha-se mais a *Heterodactylus lundii*, do qual difere pela ausência de contato entre frontal e interparietal, por ter parietais mais largas que longas, dorsais posteriores lisas, ventrais posteriores quase duas vezes mais longas que largas, menor número de escamas à volta do meio do corpo, última supralabial em contato com os grânulos da depressão ótica, e um corpo mais alongado. A nova espécie ocorre cerca de 1100 km ao norte do registro mais ao norte conhecido para *H. lundii*. As espécies de *Heterodactylus* parecem estar restritas a áreas de climas frios associados com altas latitudes e áreas montanhosas no leste do Brasil.**

The genus *Heterodactylus* was erected by Spix in 1825 to allocate *Heterodactylus imbricatus* Spix, 1825, a fossorial limb-reduced and earless lizard with very elongate body and tail obtained in southern Brazil. Later, a second species, *Heterodactylus lundii* Reinhardt and Lutken, 1862, was added to the genus. Both species remain very rare in collections with a total of only 15 museum specimens at the time of the last revision (Dixon, 1973). Thanks to the use of pit fall traps, the collection of new specimens of *Heterodactylus* became more frequent, but they still remain rare, and only a couple of new individuals of *H. lundii* have been obtained in recent years (Rodrigues et al., 2007). For this reason *H. lundii* has been placed on the Brazilian Official List of Species Threatened with Extinction in the IUCN Category Vulnerable (Ibama, 2003; Rodrigues, 2005). *Heterodactylus imbricatus* occurs in the Atlantic Forest of southern Brazil, whereas *H. lundii* is restricted to a few localities in open mountainous areas in the state of Minas Gerais, Brazil (Vanzolini and Ramos, 1977; Rodrigues et al., 2009, in press).

In a recent note, we reported on a specimen of *H. lundii* obtained at Mucugê in the state of Bahia, a range extension of more than 1,000 km north of its known distribution (Freitas et al., 2007). Despite the distance separating these areas, the only important difference we noted between these specimens seemed to be the absence of contact between frontal and interparietal scales in the specimen from Bahia,

[2]Corresponding Author.

whereas in all other specimens, this contact was broad. Based on this apparent lack of significant morphological differences, we identified the specimen from Bahia as *H. lundii*. The recent collection of an additional specimen from the same locality and a more detailed comparison with other specimens of *H. lundii* from southern Brazil reveals that the Mucugê individuals should be recognized as a new species which is herein described.

Materials and Methods

Snout–vent length (SVL) and tail length were measured to the nearest millimeters with a ruler; scale counts were taken with the aid of a Zeiss stereomicroscope. Scale counts and scale nomenclature are according to Dixon (1973). All data were taken from preserved specimens in the MZUSP (Museu de Zoologia, Universidade de São Paulo) collection. Comparative material is listed in Appendix 1.

Heterodactylus septentrionalis sp. nov.
Figures 1–2

Holotype.—MZUSP 98087, adult female from Fazenda Caraibas (13°09′49″S, 41°24′19″W), district of Cascavel, municipality of Mucugê, Serra do Espinhaço (Chapada Diamantina): state of Bahia: Brazil, collected by Marco Antonio de Freitas and Thais Figueiredo Santos Silva on 5 July 2007, field number MTR 13998.

Paratype.—MZUSP 95588, adult female, collected by Marco Antonio de Freitas and Thais Figueiredo Santos Silva on 8 December 2005, field number MTR 11786, all other data as for the holotype.

Etymology.—A reference to the northern occurrence of the new species.

Diagnosis.—A small *Heterodactylus* (maximum SVL 52 mm) with a vestigial interparietal, 37–39 dorsal and 27–29 ventral transverse scale rows, 23–25 scales around body, 9–11 fourth finger and 14–15 fourth toe infradigital lamellae, and six gular scale rows. It differs from *H. imbricatus* (data in parenthesis) by its smaller size (maximum SVL 125 mm); by having a sixth supralabial extremely wide, high, and diagonally disposed (narrow and low); posterior margin of ventral scales almost straight (rounded); anterior dorsal scales smooth (lanceolate and strongly keeled along the entire dorsum); and contact between parietals restricted to their anterior part (parietal scales in extensive contact). *Heterodactylus septentrionalis* can be immediately separated from *H. lundii* by the absence of contact between frontal and interparietal. In *H. lundii*, the parietal scales are broadly separated by the contact between interparietal and the posterior part of frontal which is extremely long. In *H. septentrionalis*, the posterior part of frontal is short and frontal and interparietal are broadly separated either by a broad contact between anterior part of parietals (holotype) or by the presence of a narrow and elongate azygous scute that follows frontal. In *H. lundii*, the parietals are longer than wide, whereas in *H. septentrionalis*, they are wider than long. In *H. lundii* there is a small scale following the sixth supralabial before the granular scales of the correspondent ear opening area; in *H. septentrionalis* such scale does not exist and is fused to sixth supralabial which reaches the granules of the ear depression. Posterior dorsal scales of *H. lundii* are clearly keeled and mucronate; in *H. septentrionalis*, the central part is broadly elevated but lacking keel. Posterior ventral scales are slightly longer than wide in *H. lundii*; they are almost twice as long as wide in *H. septentrionalis*. The two species also differ in number of scales around midbody: 27–29 in *H. lundii* versus 23–25 in *H. septentrionalis*. Finally, the body of *H. lundii* its not as elongate as that of *H. septentrionalis*. This is confirmed by comparison

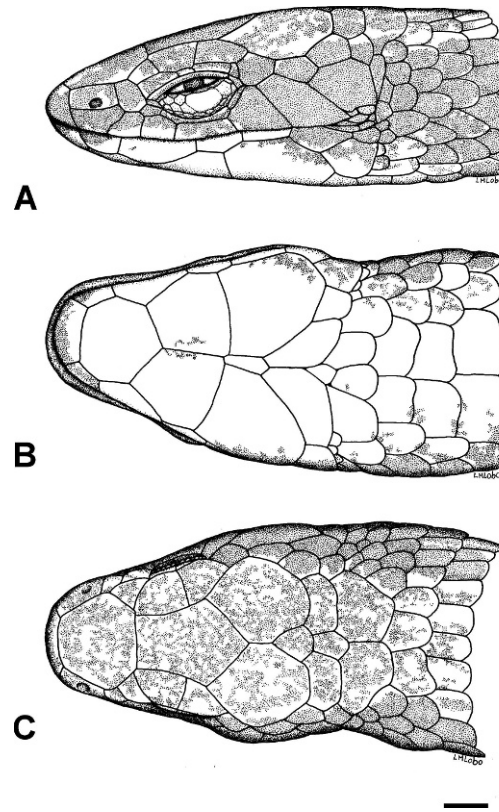

Fig. 1. Lateral (A), ventral (B), and dorsal (C) views of the head of the holotype of *Heterodactylus septentrionalis* (MZUSP 98087). Scale bar = 1 mm.

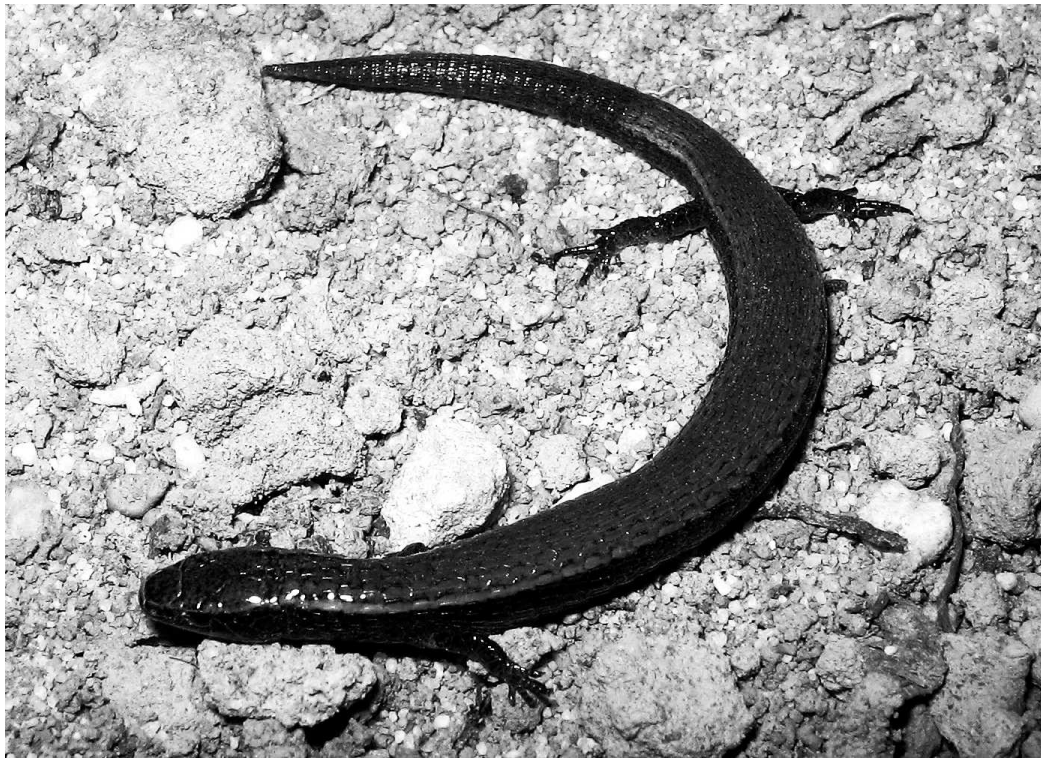

FIG. 2. Holotype of *Heterodactylus septentrionalis* in life (MZUSP 98087).

between SVL and the distance between posterior margin of fore- and hind limbs in the two species (Fig. 3). This difference in body elongation also explains why *H. septentrionalis,* which has much longer ventrals than its congener, does not show a significant difference in number of ventral scales. There are no important differences between these two species in any other scale counts, which are as follows (data for *H. lundii* and *H. septentrionalis*, respectively): dorsals (38–39 vs. 37–39); ventrals (26–27 vs. 27–29); fourth finger infradigital lamellae (9–12 vs. 10–11); fourth toe infradigital lamellae (15–18 vs. 14–15); and number of gular rows (6–7 vs. 6).

Heterodactylus septentrionalis and *H. lundii* are very similar in body size (maximum SVL 52 and 60 mm, respectively), which immediately separated them from the much larger *H. imbricatus*. In addition to body size, several morphological characters readily distinguish *H. imbricatus* from the smaller *H. lundii* and *H. septentrionalis*. The sixth supralabial is narrow and low in *H. imbricatus*, whereas it is extremely large, and diagonally disposed in *H. lundii* and *H. septentrionalis*, in which it is fused to the temporal below the postocular. The posterior margin of ventral scales is rounded in *H. imbricatus* but almost straight in *H. lundii* and *H. septentrionalis*. Dorsal scales in *H. imbricatus* are lanceolate, strongly keeled along the entire dorsum, only the posterior dorsals are keeled in *H. lundii* and

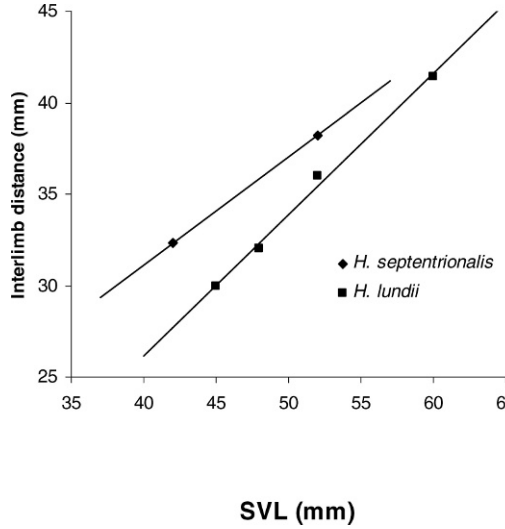

FIG. 3. Relationship between SVL and interlimb distance in *Heterodactylus septentrionalis* and *Heterodactylus lundi.*

they are smooth in *H. septentrionalis*. Parietal scales are in broad contact medially, and their posterior margin is almost straight in *H. imbricatus*; this is not the case in the two smaller species where they are rounded posteriorly and widely separated by the contact between frontal and interparietal (*H. lundii*) or the contact between parietals is restricted to their anterior part (*H. septentrionalis*). Finally, the first finger is absent in the three species, but there is a vestigial tubercle marking its position in *H. imbricatus*, whereas there is no vestige of its presence in *H. lundii* and *H. septentrionalis*.

Description of the Holotype.—Rostral broad, wider than high, contacting first supralabial, nasal, and frontonasal (Figs. 1, 2). Frontonasal octogonal, as wide as high, contacting rostral, nasal, loreal, first and second supraocular, and frontal. Prefrontals absent. Frontal pentagonal, with concave and posteriorly divergent lateral margins, longer than wide, anteriorly straight, wider posteriorly, indenting suture with parietals. Frontoparietals absent. Parietals as wide as long, as large as frontonasal, in broad contact anteriorly, roughly heptagonal, contacting frontal, third supraocular, postocular, temporals, occipital, and interparietal. Interparietal small, slightly longer than wide, slightly longer than suture between parietals and following it. One pair of enlarged, wider than long occipitals following parietals, separated by an azygous much smaller scale subequal to interparietal and following it, and one pair of larger postoccipitals in broad contact medially. Three supraoculars, first the smallest, second the largest; second and third in contact with frontal. Nasal above first supralabial, large, longer than wide, with the nostril in the center and lower part of scale, contacting supralabial suture. Loreal posterior to nasal, wider than long, diagonally oriented; contacting first and second supralabials, frenocular, preocular, first superciliary, first supraocular, frontonasal, and nasal. Frenocular small, elongate, below preocular, followed posteriorly by a long and narrow subocular. Six supralabials, fourth under the center of eye, fifth and sixth contacting postocular, sixth the largest, diagonally oriented and reaching posteriorly the granular scales of ear depression. Four superciliaries, first largest, wider anteriorly, longer than first supraocular, in point contact with a small, narrow and elongate preocular, loreal, first and second supraoculars, second superciliary, and an incompletely divided ciliaries of upper eyelid. Second and fourth superciliaries about the same size, the former longer than wide and contacting second supraocular, the latter wider than long. Third superciliary as long as but narrower than first and contacting second and third supraoculars. Lower eyelid with a semitransparent central disc formed by an enlarged palpebral and surrounded by 5–6 small and slightly pigmented granules. Six strongly pigmented and elongate ciliaries in the lower eyelid. Four temporals between sixth supralabial and parietals, the lower the largest, broadly contacting sixth supralabial. External ear opening absent, its position mostly covered by the enlarged temporal which is followed ventrally by a cluster of four small granules near infralabial level.

Mental broad, wider than high with posterior margin almost straight. Postmental heptagonal, as long as wide. Two pairs of genials in contact with infralabials; the first smaller, in broad contact at midline; second pair separated at midline by an elongate scale. An enlarged pair of chevron like flat postgenials follows the second pair of genials. Five infralabials, second the largest. All head scales smooth, juxtaposed. Lateral surface of neck with a series of seven transversely disposed, smooth, imbricate, rounded, slightly longer than wide, and almost cycloid scales. Gulars smooth, imbricate, disposed in six series of transverse and mostly wider than long scales; posterior gular row with three slightly more elongate scales. Interbrachial region with seven scales, the two lateral smaller, the central ones larger, longer than wide, twice as long as gulars. Collar fold absent.

Dorsal scales smooth, imbricate, in regular tranversal rows; posteriorly rounded from occipitals to arm level, becoming progressively narrower, more elongate, hexagonal and acuminate, with central part broadly elevated longitudinally; lateral sides parallel and almost juxtaposed posteriorly. Thirty-eight transverse rows between interparietal and the posterior level of hind limbs. Lateral scales smooth, slightly enlarged, strongly imbricate laterally and less acuminate than dorsals. A distinctive area with granular scales surrounds the area of arm insertion. Twenty-three scales around midbody. Ventral scales smooth, longitudinally imbricate, laterally juxtaposed, posteriorly rounded; anterior rows quadrangular, posterior ones almost twice longer than wide; 29 transverse rows from interbrachials (excluded) to preanal region. Five parallel elongate scales in precloacal region, central and paramedials the largest. One preanal pore on each side.

Scales of tail similar in size to midbody dorsals, disposed in regular annuli, keeled, strongly imbricate at the base. Most of tail regenerated, regenerated part with imbricate, smooth, elongate and posteriorly rounded scales disposed in regular transverse annuli.

Forelimbs with large, smooth and imbricate scales, those on ventral part of brachium much smaller. Tibia and anterior part of thigh with

large, smooth, and imbricate scales. Posterior part of thigh with granular, juxtaposed scales, grading progressively to larger, smooth, imbricate scales. Carpal and tarsal scales large, smooth, imbricate; supradigital scales smooth, wider than long, imbricate. Palmar and plantar surfaces with smooth, small granules; infradigital lamellae single, nine on Finger IV and 15 on Toe IV. First finger absent. All fingers and toes clawed in the following order of relative size, respectively: $5 < 2 < 3 < 4$ and $1 < 2 = 5 < 3 < 4$.

In preservative, dorsal surfaces of head, body, and tail are light brown with an irregularly distributed darker reticulum. Lateral parts of head, body and tail dark grey, slightly and gradually mottled toward ventral parts by an irregular light yellowish-cream pattern. A conspicuous light cream, one scale wide, dorsolateral stripe extends from anterior part of parietal to tail. Ventral parts of head, body, and tail immaculate, creamy white. Regenerated part of tail uniformly grey. Limbs dark greyish dorsally, creamy white and immaculate ventrally.

Measurements of the Holotype.—SVL: 52 mm; tail length (regenerated) 32 mm.

Variation.—The paratype is an adult female with 42 mm SVL, with the tail broken at the base, 37 transverse rows of dorsal scales, 27 transverse rows of ventrals, 25 scales around midbody, six gular rows, 10 and 14 infradigital lamellae under the fourth finger and fourth toe, respectively, three supraoculars, and four superciliaries. The only other relevant differences with respect to the holotype are the presence of three (instead of four) temporals between last supralabial and parietal, the presence of five (instead of six) supralabials on the left side which makes the third (instead of four) supralabial be under the eye, and the presence of a minute scale between frontal and interparietal.

Habitat and Natural History.—The two specimens of *H. septentrionalis* were collected at Fazenda Caraibas, municipality of Mucugê, state of Bahia Brazil. The type locality is a 5,200-ha farm situated on a relatively flat upland plateau around 1,100 m elevation on the west side of the escarpments of Serra do Sincorá, a section of Chapada Diamantina, the reference name for this northern segment of Serra do Espinhaço (Fig. 4). The highest elevations of Serra do Sincorá form an extensive ridge emerging from the plateau and reaching up to 1,620 m. At the eastern part of Fazenda Caraibas, near the escarpment of Serra do Sincorá, the relief is more pronounced and dominated by extensive areas of white sandy soils covered by an open cerrado-like vegetation, mixed with that of campos rupestres (rocky meadows, see Giulietti and Pirani, 1988) where quartzitic sandy soils and rocky outcrops are frequent. The western part of Fazenda Caraibas is dominated by an extensive plateau covered by a semideciduous forest that grows on the sandy soils dominated by thin semideciduous dry forests locally referred to as ''carrasco''. This habitat is characterized by low and thin trees of about 4–5 m high and 5–10 cm diameter with scattered emergent trees not higher than 15 m. For more information and an illustration of this habitat, see Rodrigues et al. (2006). Specimens of *H. septentrionalis* were found in the latter habitat. One specimen was found dead when the carrasco was being manually cleared for agriculture, the other when a tractor was deforestating the carrasco.

Discussion

Heterodactylus imbricatus occurs in the states of São Paulo, Rio de Janeiro, Minas Gerais, and Espirito Santo in areas of high altitude associated with Atlantic Forest, *H. lundii* is only known from a couple of localities in the state of Minas Gerais and, as far as we know, *H. septentrionalis* only occurs in Mucugê in the state of Bahia (Fig. 4). The three species are restricted to areas of cold climates associated with high latitudes and mountainous areas of eastern Brazil (Rodrigues et al., 2009, in press). This pattern was first recognized by Vanzolini and Ramos (1977) in their description of a new species of *Colobodactylus* from the Itatiaia mountains of eastern Brazil. Based on distributional records they hypothesized that the two species of *Colobodactylus* (*Colobodactylus taunayi* and the new one described as *Colobodactylus dalcyanus*) and *Heterodactylus* were more widely distributed during cooler episodes of the Quaternary and that they are presently restricted to mountains or areas dominated by favorable cooler climates (Vanzolini and Ramos, 1977). The discovery of *H. septentrionalis* in the mountains of Chapada Diamantina at 1,100 m altitude in a northern latitude supports this hypothesis. *Heterodactylus lundii*, its likely closest relative, is restricted to mountain areas about 1,000 km south of Mucugê. The similarity between *H. lundii* and *H. septentrionalis* in body size and scalation is so extensive that, even in the absence of a phylogeny, it is possible to speculate that the ancestor extended its distribution to northern latitudes during cooler episodes in the Quaternary. In the same vein, it is possible to think that the subsequent progressive warming interrupted the favorable conditions isolating relictual populations in mountains and provoking speciation. The fact that *Colobodactylus*, *Heterodactylus*, and a new genus being described from high mountains of eastern Brazil, are a monophyletic clade brings additional support to

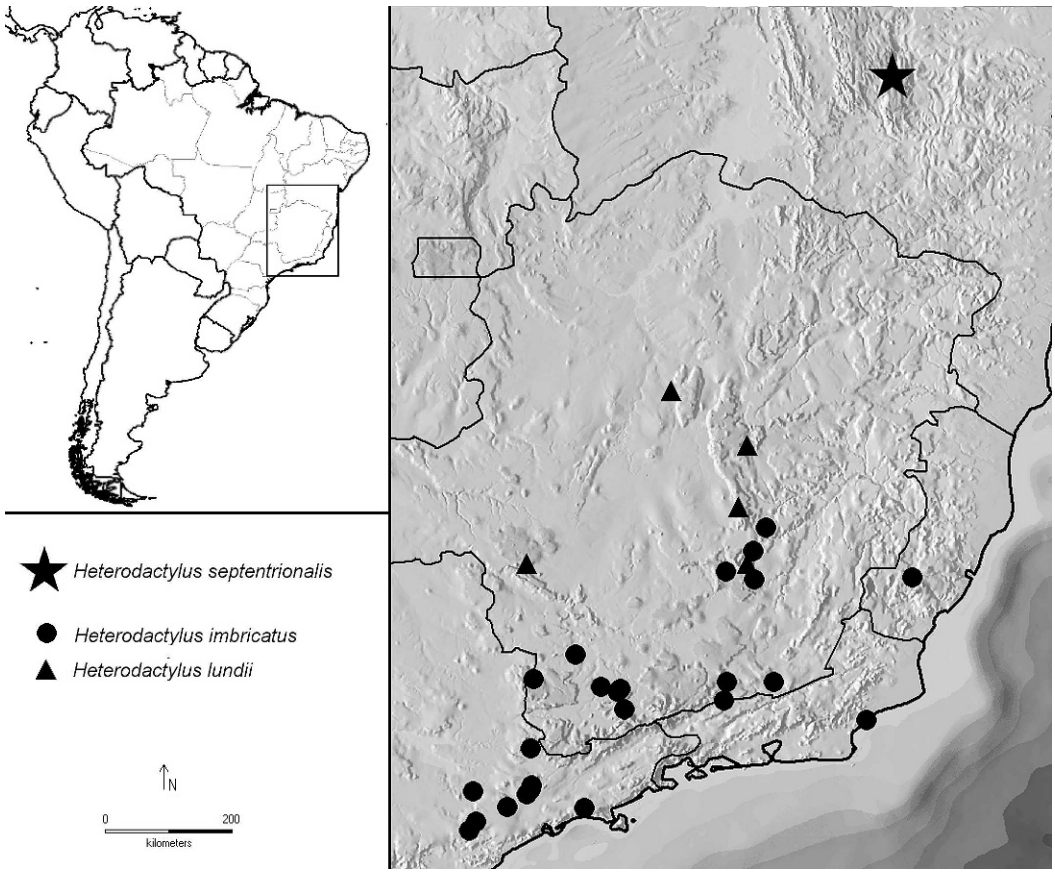

FIG. 4. Distributional records of *Heterodactylus imbricatus*, *Heterodactylus lundii*, and *Heterodactylus septentrionalis* in Brazil based on collection records and literature.

this possibility (Pellegrino et al., 2001; Rodrigues et al., 2009, in press).

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APPENDIX 1

Additional Specimens Examined

Heterodactylus imbricatus. ESPIRITO SANTO: Venda Nova do Imigrante: MZUSP 88147. MINAS GERAIS: Alfenas (Parque Estadual Manuel Pedro Rodrigues: MZUSP 94049, 94050; Itabira: MZUSP 87786; Itabirito: MZUSP 95185; Lambari (Parque Estadual Nova Badem): MZUSP 94047, 94048; Mariana: MZUSP 2999; Rio Preto: MZUSP 57971; Poços de Caldas: MZUSP 93078; Santa Bárbara (Serra do Caraça): MZUSP 3309; São Gonçalo do Sapucaí: MZUSP 4659; São Pedro do Piqueri: MZUSP 10409. RIO DE JANEIRO: Macaé: MZUSP 445. SÃO PAULO: Amparo (Pinhalzinho): MZUSP 93224; Boracéia: MZUSP 74908; Mairiporã: MZUSP 88871; Parque Estadual da Cantareira (Núcleo Pedra Grande): MZUSP 89185,89186; Vila Elvio (20 Km Piedade). *Heterodactylus lundii*: MINAS GERAIS: Caeté (Alto da Serra da Piedade): MZUSP 7649, 7650; Joaquim Felício (Serra da Pedra Redonda): MZUSP 57488; São Roque de Minas (Serra da Canastra): MZUSP 94704; Serra do Caraça: MZUSP 79747; Serra do Cipó: MZUSP 36966.