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OBSERVATIONS AND RE-DESCRIPTION OF *ZONOSAURUS BOETTGERI* STEINDACHNER 1891 AND DESCRIPTION OF A SECOND NEW SPECIES OF LONG-TAILED *ZONOSAURUS* FROM WESTERN MADAGASCAR

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ABSTRACT.—The recent rediscovery of *Zonosaurus boettgeri* Steindachner, 1891, at its type locality and at other sites allows the redescription of this species. In addition, an individual from the Antsalova region of western Madagascar is recognized as a new species, ***Zonosaurus maramaintso***, which appears to be closely related to *Z. boettgeri*. Both species differ from other Madagascan gerrhosaurids by their very low number of scales around mid-body (fewer than 17), extremely long original tail (more than 2.5 times longer than their snout-vent length), and conspicuous color pattern of transverse dark bars. Arboreal adaptations shared by the two species are long tails, well-developed claws, and tubercles under the digits. *Zonosaurus maramaintso* differs from *Z. boettgeri* by coloration. Both species are arboreal canopy specialists, and both have limited distributions in low elevation humid or transitional forests. *Zonosaurus boettgeri* is restricted in distribution to north of 14° latitude, and *Z. maramaintso* occurs south of 18° latitude.

Key words: Madagascar, Squamata, Sauria, Gerrhosauridae, *Zonosaurus boettgeri*, *Zonosaurus maramaintso*, new species.

INTRODUCTION

The herpetofauna of Madagascar is poorly understood, and until recently many species were known from a single or very few specimens collected over 100 years ago. This led to speculation that some of these species were extinct. Beginning in the early 1990s, field work in

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Madagascar increased dramatically, and some of these rare species were rediscovered along with numerous entirely new species. Examples of rediscovered rare species include *Uroplatus alluaudi* Moquard 1894 and *Pseudoxyrhopus ambreensis* Mocquard 1894 (Raxworthy & Nussbaum, 1994), *Matoatoa (Phyllodactylus) brevipes* Moquard 1900 (Nussbaum *et al*., 1998), and *Paragehyra petiti* Angel 1929 (Raxworthy, Raselimanana and Ramanamanjato, pers. obs.). Another small group of species described many years ago have not yet been rediscovered, and some of them may well be extinct. Examples are the gecko *Ailuronyx (Platydactylus) trachygaster* (Duméril, 1851) and the skinks *Cryptoscincus minimus* Mocquard 1909 and *Mabuya betsileana* Mocquard 1906. It is possible that *A. trachygaster* and *M. betsileana* were mistakenly recorded for Madagascar. The former is related to a species which occurs in the Seychelles Archipelgo, and the latter is similar, if not identical, to an African species.

In this paper, we report the rediscovery of yet another rare species of lizard from Madagascar, *Zonosaurus boettgeri* Steindachner, 1891. We include an outline of the nomenclatural history of the species and describe its distribution and morphometric variation. We also describe a new species which is the apparent sister species of *Z. boettgeri*.

NOMENCLATURAL HISTORY

Steindachner (1891) described *Zonosaurus boettgeri* from a single specimen collected by Dr. Brancsik on Nosy Be, an island near the northwestern coast of Madagascar. Subsequently, Mocquard (1900) described a similar new species, *Zonozaurus* (sic) *longicaudatus*, based on a single specimen from the northeastern mainland of Madagascar near "Andoarano" (probably Andoharano, a common Malagasy village name). In 1902, Mocquard synonymized *Z. longicaudatus* with *Z. boettgeri*. Angel (1942) described and presented a figure of *Z. boettgeri* (Planche XIV, Fig. 1), which he based on the holotype of *Z. longicaudatus*. Angel (1942: 94) wrote that the type (No. 99-361, Paris) of *Z. longicaudatus* is from "Andoharano, environs de Vohémar (côte Nord-est)." Guibé (1954) indicated that the holotype (MNNP 99-361) of *Z. longicaudatus*, a female 456 mm long collected by Grandidier, was present in the Paris Museum at that time. Brygoo (1985), reported that the holotype of *Z. longicaudatus* was no longer present in the Paris Museum as of 1983, and he stated that the holotype of *Z. boettgeri* is also apparently lost as it does not appear on any list of the principal foreign museums. Thus, according to Brygoo (1985), there were no known specimens of *Z. boettgeri*.

In October 1993, 102 years after the first specimen of *Zonosaurus boettgeri* was described, we rediscovered this species at or near its

type locality in Lokobe Special Reserve on Nosy Be. We also found that, contrary to Brygoo (1985), the holotype of *Z. boettgeri* is present in the Vienna Museum, just where it would be expected to be, and we confirmed its identification. Given the lack of information about this species, we provide a detailed description of it and information about its ecology.

Recent surveys in the Antsalova region of western Madagascar revealed a new arboreal species of *Zonosaurus*, which is morphologically very similar to *Z. boettgeri*. We describe this new species herein.

MATERIALS AND METHODS

Herpetological survey methods followed techniques described by Raxworthy & Nussbaum (1994). Specimens were photographed after capture to record their natural color. Chlorotone was used to euthanize the animals before fixing them in buffered, 10% formalin. Formalin was removed after fixation by soaking specimens in water. The specimens were stored in 75% ethanol. Prior to fixation, tissue samples were removed and frozen in liquid nitrogen for genetic studies. All measurements were made on preserved specimens. Snout-vent length (SVL) and tail length, were measured to the nearest 1 mm using a ruler. Dial calipers were used for the other measurements, either to the nearest 1 mm (axilla-groin, forelimb, hindlimb) or to the nearest 0.1 mm. Ventral scales were counted along the mid-ventral line from the post-mental scales (mental scale excluded) to the anal scale (included). Dorsal scale rows is the number of longitudinal rows between the lateral folds at mid-body. Specimens examined are housed in the Museum of Zoology, The University of Michigan (UMMZ); the Laboratoire de Zoologie, Département de Biologie Animale, Université d'Antananarivo (UADBA); and Naturhistorisches Museum Wien (NMW).

Zonosaurus boettgeri Steindachner, 1891

HOLOTYPE. NMW 23348, presumably an adult, sex unknown, collected or obtained during or prior to 1891 by "Herrn Dr. Brancsik" at "Nossi-Bé," Nosy Be Fivondronana, Antsiranana Province, Madagascar.

OTHER SPECIMENS. UMMZ 207188 (RAN 43957), Fig. 1a, adult male collected 16 October 1993; UMMZ 207189 (RAN 44099), mature female collected 26 October 1993; UMMZ 207190 (RAN 44205), unsexed juvenile collected 29 October 1993; all three collected by C. J. Raxworthy, J. B. Ramanamanjato and A. P. Raselimanana at Ampasindava, 20-60 m elevation, 13°25'S, 48°19'E. Lokobe Special Reserve, Nosy Be Fivondronana, Antsiranana Province, Madagascar. UADBA 08427 (Field Number 1977) juvenile female and UADBA 08428 (Field Number 1978) adult female collected 25 July-22 August 1998 by L. Rakotozafy, at Amparihirano (Bekaraoka Classified Forest), 13°06'38.2"S, 49°41.55.3"E and Sahaka Littoral Forest, 13°05'55.2"S, 49°54.40.0"E Antsiranana

Province, Madagascar.

IDENTIFICATION. A medium-sized *Zonosaurus* with long tail (2.57-3.11 times longer than SVL) and subcylindrical body. In life, dorsal and lateral surfaces of head, neck, and body brown with darker brown crossbands on neck and body, crossbands fading posteriorly in adults but more distinct and continuous posteriorly in juveniles; head, neck, and anterior body with dull grayish green spots dorsally and bolder grayish green markings laterally in front of and behind forelimbs; upper surfaces of forelimb grayish green with darker spots; upper surfaces of hindlimbs and tail brown; central throat and chest cream with some dark spots; lateral throat and chest, entire belly and undersurface of tail grayish brown. No dorsal and dorsolateral longitudinal stripes. Dorsal skin on head transparent revealing underlying sutures between skull bones. Interparietal present, small or rudimentary. Tail with verticillae formed by scales with well-developed median keel. Dorsal and ventral scales smooth. Four upper labials anterior to subocular, two posterior to subocular. Ventral scales between chin and cloaca 46 to 49. Low number of dorsal scale rows at mid-body (14-15). Moderate number of femoral pores (13-17 on each side). Scales on ventral face of distal segment of forelimb keeled. Scales beneath distal segment of hindlimb and on ventral face of body smooth. Scales beneath pes and manus circular and tuberculate. Well-developed claws. Antehumeral mite pocket absent. Lower eyelid includes heterogeneous window-like scales (Fig. 2). Dorsal transverse scale rows parallel, without imbricate suture at mediodorsal line. Differs from other *Zonosaurus* species except *Z. maramaintso* by the much longer tail (> 2.57 times longer than SVL, less than 2.57 times longer in other species) and lower number of dorsal scales rows around mid-body (14-15, compared to 18 or more in other species). Differs from *Z. maramaintso* in coloration (see *Z. maramaintso* diagnosis below for comparison).

DESCRIPTION (based on UMMZ 207188, Fig. 1a). Adult male, 105 mm SVL; head, neck, and body nearly same width, body moderately robust, subcylindrical; tail 307 mm long, 2.92 times SVL, cylindrical, complete, unregenerated. Other morphometric and meristic data in Tables 1 and 2.

Two parietal scales in contact medially; an ellipsoidal interparietal scale; frontoparietal suture well defined, without distinct frontoparietal scale. One frontal scale with distinct suture line of frontal bones underneath; prefrontal scales separated by contact of frontal and frontonasal scales. Two loreal scales, first wider than high, lies largely above second and third upper labials, very narrow contact with first upper labial; second loreal above third upper labial, in very narrow contact with the fourth upper labial. Subocular scale part of upper labial shield; two upper labials behind the subocular scale; the first larger than the second and borders ventro-posteriorly two subciliaries. Three temporal scales, the

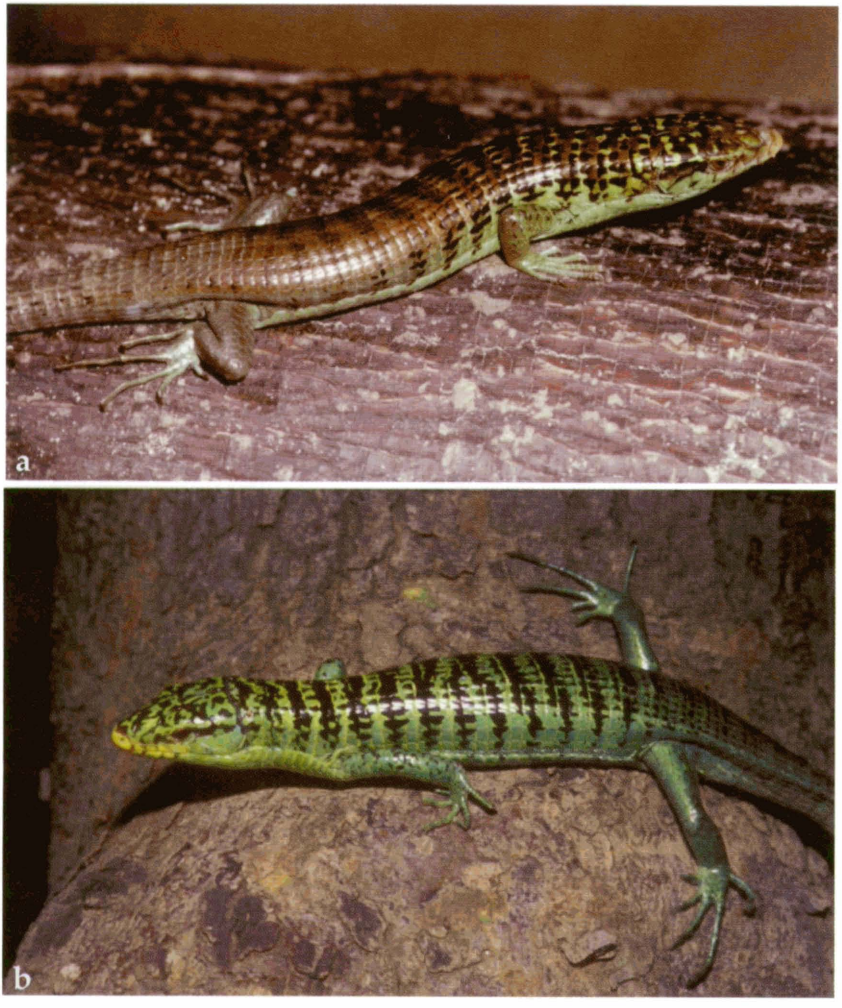

Fig. 1. **a**. *Zonosaurus boettgeri* (UMMZ 207188) male from near the type locality on Nosy Be; **b**. *Zonosaurus maramaintso* male holotype (UMMZ 221904).

superior meets the posterior-most supraocular. One preocular situated above fourth upper labial, in contact with subocular; two postoculars, the superior separated from parietal by contact of supratemporal and posterior-most supraocular. Four supraoculars, first and last smaller than central two. Supraciliaries 6-6, second much larger than others. Subciliaries 7-7, situated between pre- and postocular scales. Lower eyelid with two irregular rows of 5-5 window-like scales of variable size. Nostril opening above tip of first upper labial; borders first upper labial, postnasal, nasal, and rostral. Rostral rounded, in contact with frontonasal. Three lower labials, second largest. Postmentals in contact

Table 1. Measurement (mm) of specimens of *Zonosaurus boettgeri* and *Z. maramaintso*.

Characters	**UMMZ 207188**	**UMMZ 207189**	**UMMZ 207190**	**UADBA 08427**	**UADBA 08428**	**MNW* 23348**	**MHNP** 99.361**	**UMMZ*** 221904**
Snout vent length	105	120	57	93	120	115	111	120
Tail length	307	167****	161	170*****	308	353	345	300
Axilla-groin length	54	62	27	48	67	57		60
Head length	24	27	15	20	24	30		27.7
Head width	15	17	9	12	15	18		18.4
Head depth	12	13	7	9	12	16		14.9
Snout Length	9	10	5	7	9	13		11.6
Orbital diameter	6	5	4	7	6	7		5.9
Nostril diameter	4	4	3	3	4	5		4.3
Orbital distance	9	10	5	7	10	13		9.9
Forelimb	32	34	19	26	36	37		36
Hindlimb	49	52	29	42	52	55		57
Finger III	9	9	5	8	10	12		9.1
Finger IV	9	10	5	8	10	12		9.1
Toe III	13	16	7	12	13	19		13
Toe IV	18	19	10	16	18	23		19.5
Toe V	11	11	6	8	9	13		10.5

*Holotype of *Z. boettgeri*; ** from Brygoo, 1985; *** holotype of *Z. maramaintso*; ****regenerated tail, ***** probably regenerated.

Table 2. Meristic data of specimens of *Zonosaurus boettgeri* and *Z. maramaintso*.

Characters	UMMZ 207188	UMMZ 207189	UMMZ 207190	UADBA 08427	UADBA 08428	NMW* 23348	MHNP** 99.361	UMMZ*** 221904
Ventral Scales	48	47	46	47	49	45		46
Dorsal scales rows	15	15	15	14	15	14		14
Supralabials anterior	4-4	4-4	4-4	4-4	4-4	4-4		4-4
Supralabials posterior	2-2	2-2	2-2	2-2	2-2	2-2		2-2
Infralabails	3-3	3-3	3-3	4-4	4-4	3-3		5-4
Supraoculars	4-4	4-4	4-4	4-4	4-4	4-4		4-4
Supraciliaries	6-6	5-5	5-5	4-4	4-5	5-5		5-5
Subciliaries	7-7	6-6	7-8	7-7	7-7	7-7		6-6
Windows lower eyelid	5-5	mosaic	5-6	5-5	5-5	7-7		5-5
Preoculars	1	1	1	1	1	1		1
Postoculars	2	2	2	2	2	2		2
Temporals	3-3	3-3	3-3	4-4	4-4	4-4		3-3
Loreals	2	2	2	2	2	2		2
Sdm I (L-R)[&]	6-6	6-6	6-6	5-5	7-6	5-5		6-6
Sdm II (L-R)	9-10	10-10	8-9	9-9	10-10	10-10		10-10
Sdm III (L-R)	13-14	14-14	11-11	12-11	13-13	14-14		11-11
Sdm IV (L-R)	14-14	14-14	12-12	12-12	13-13	14-14		12-12
Sdm V (L-R)	9-10	10-10	10-10	9-9	9-10	10-10		9-10
Sdp I (L-R)[#]	6-7	7-7	7-7	7-7	8-8	7-7		6-6
Sdp II (L-R)	11-11	12-11	10-11	12-12	12-12	13-12		11-damaged
Sdp III (L-R)	17-17	19-18	16-16	15-16	18-18	16-17		16-16
Sdp IV (L-R)	22-21	24-24	21-22	22-22	23-22	22-21		21-21
Sdp V (L-R)	14-13	14-14	14-14	12-12	14-13	13-13		13-13
Femoral pores (L-R)	15-16	15-16	16-15	13-15	15-14	17-16	15-16	14-14

*Holotype of *Z. boettgeri*; **from Brygoo, 1985; ***holotype of *Z. maramaintso*; [&]Sdm = subdigital scales of manus I-V, left to right; #Sdp = subdigital scales on toes of pes I-V, left to right.

medially; post postmental scales separated by first gular; first gular smaller than second. Tympanum exposed, without opercular shield.

Forty-eight scales between mental and anal scales; 15 scale rows

around mid-body; 29 scales above lateral fold between axilla and groin, first and posterior-most three much smaller. Ventral scales smooth, in eight longitudinal rows on body, and seven scale rows at throat. Latero-ventral scales of body smooth. Dorsal scales slightly keeled; 48 dorsal scale rows between parietal and level of cloaca, first row with smallest scales, first ten rows with imbricate medio-dorsal suture line. Caudal verticillae nearly uniform width; median keel of caudal scales well developed resulting in verticillae with denticulate shape at posterior edge. Scales on ventral surface of distal segment of forelimb keeled, those beneath distal segment of hindlimb smooth; scales beneath manus and pes circular and tuberculate; scales beneath fingers and toes raised (tuberculate) and smooth. Upper scales of manus smooth, those of pes and legs strongly keeled. Claws well developed.

Scales beneath fingers (left/right I-V): 6-9-13-14-9/6-10-14-14-10; scales beneath toes (left/right I-V): 6-11-17-22-14/7-11-17-21-13; femoral pores (left/right): 15-16.

Cloaca not covered by anal scales; cloaca without dark pigmentation; lateral fold complete, no antehumeral mite pockets. Hemipenis with faint dark pigmentation, without distinct lobes, but with 14 obvious plicae and large sulcus with heart-shaped tip.

Coloration in life (Fig. 1a): Upper and lateral head, neck, and body brown with darker crossbands beginning on neck and fading posteriorly. Dull grayish green spots on head, neck, and anterior body. Anterior flanks and upper surfaces of forelimbs grayish green with scattered dark spots. Ventral surfaces of head and body cream colored along the mid-ventral line with light grayish brown encroaching from the latero-ventral scales; central cream color of venter obscured by grayish brown posteriorly. Upper surfaces of hindlimbs brown. Ventral surfaces of limbs light grayish brown. Dorsolateral surface of tail light grayish brown with scattered darks spots. After six years in alcohol: Brown coloration somewhat faded, darker dorsolateral crossbands on neck and body still strongly evident; lighter grayish green coloration faded to grayish cream. Mental, postmental, post postmental, and gular shields whitish. Dorsal surfaces of fore- and hindlimbs brown with dark spots. Ventral surfaces of body dark gray, lighter midventrally and anteriorly. Dorsal surface of tail light brown; subcaudal surface grayish. Mesenteries black. Skin between dorsal scales dark brown.

VARIATION. In juveniles, there are 15 dark, transverse, bands between the neck and the level of the cloaca. These dorsal bands are strongly expressed and regular anteriorly, becoming more irregular posteriorly. In adults, the transverse dorsal bands are less distinct and present only anteriorly. Scales on the anterior part of the dorsal and lateral surfaces of the body are smooth in females; keeled scales appear only at mid-body. Males have weak keels anteriorly, which become progressively

stronger posteriorly, and at the cloacal level, the median keels are very well developed with peripheral small keels. Variation in scale counts is given in Table 2. Frontonasal scales are in contact medially in one female (UMMZ 207189). The postocular inferior scales may be split into two scales: on one side (right) for the latter female and both sides for a juvenile (UMMZ 207190). The window-like scales on the lower eyelids are extremely irregular in some specimens forming a mosaic of variable sized scales (Fig. 2); holotype exceptional in having a distinct row of 7 lower eyelid scale on each side.

Zonosaurus boettgeri from Daraina forest have more pronounced dark transverse bands on the body. They also have some well-developed windows on the lower eyelids, but form an irregular mosaic with the smaller ones. Daraina specimens have slightly fewer femoral pores, and many of them are not as well developed.

ETYMOLOGY. The specific name "*boettgeri*" is a patronym honoring Oskar Boettger, who described much of the early reptile collections from Madagascar.

DISTRIBUTION. The terra typica of the species is Nossi-Bé (Nosy Be), a near-shore island along the northwestern coast of Madagascar. Our specimens were collected near the type locality within Lokobe Special Reserve on Nosy Be. A member of our team (A. Razafimanantsoa) also observed a specimen on a tree trunk at about 4 m height, in a relict patch of forest at Mont Ankify (13°33'S. 48°21'E, 320 m elevation) on 1 November 1993, at 12:30. This site is on the mainland directly opposite Nosy Be. All of these northwestern sites are within Sambirano Domain rainforest (Humbert, 1955). A specimen collected by Grandidier (probably between 1885-1887) was reported from Andoharano (Vohémar region), a mainland site in northeastern Madagascar. We also have two records from this region: one from the Sahaka littoral forest about 35 km north of Vohemar, and a second from Amparihirano, about 45 km northwest of Vohemar. The latter site includes transitional forest between 100-500 m elevation.

There is also photographic evidence documenting this species in the Masoala Peninsula. Russell Thorstrom, while making canopy observations for rainforest raptors, observed and photographed a specimen at a height of 25 m off the ground, 13:18 h, 24 January 1994, at the Anaovandrano River (15°44,20'S, 50°10.93'E), at 100 m elevation. This specimen was observed climbing along branches. We confirmed the identification of this specimen via the photograph (color photo on file, Herpetology Division, The American Museum of Natural History, NY). Subsequently, a specimen was also seen by Thorstrom at a different locality on the Masoala Peninsula, at 14:23 h, on 12 January 1997. This lizard was 20 m off the ground, and approximately 150 m up river from the Andranobe Field Station (15°40'S, 49°50'E), at 10 m

elevation. It was observed for about 15 minutes walking and climbing on tree branches. Three other observations were made from a hide used to observe Serpent Eagles (*Eutriorchis astur*) 4 km east of Ambanizan at 15°37'S; 49°58': 18 and 24 December 1997 a male Serpent Eagle was observed delivering a headless *Zonosaurus boettgeri* to the adult female at the nest; 8 January 1998 an individual *Zonosaurus boettgeri* was seen climbing at 30 m height in the canopy close to the hide at 15:00 h.

HABITAT. This species has been found only in low elevation primary forest habitats: either humid rainforest, transitional forest, or littoral forest, up to a maximum of 320 m elevation. UMMZ 207188 was found at 12:30 on the trunk (10 cm diameter) of a mango tree, 3.5 m above ground. The female (UMMZ 207189) was found in a pitfall trap in the morning (the tail was accidentally broken during removal from the pitfall trap). The juvenile (UMMZ 207190) fell from a tree at 4m (apparently disturbed by a nocturnal lemur, *Lepilemur dorsalis*) and landed on APR's head during a night survey (22:00 h). We strongly suspect that *Z. boettgeri* is primarily confined to the canopy, based on both the valuable canopy observations made by Thorstrom, and the extreme rarity of other observations made for this species from the ground.

NOTES. Stomach contents indicate that *Zonosaurus boettgeri* is insectivorous, feeding on flying insects. Other arboreal, insectivorous and diurnal lizards in this area include *Phelsuma*, *Lygodactylus*, and chameleons (*Furcifer* and *Calumma*). With the exception of the Serpent Eagle, other predators of *Z. boettgeri* are unknown, but there are at least three species of arboreal snakes (*Boa manditra*, *Langaha madagascariensis*, *Ithycyphus miniatus*) in the Lokobe Reserve that might be predators of *Z. boettgeri*, and it seems certain they would also be eaten by larger birds. The "drop" behavior that we observed of the specimen disturbed at night by a *Lepilemur* is similar to the perch release behavior seen in roosting chameleons, and suggests that all these arboreal lizards are vulnerable to predation from some species of nocturnal lemur.

Very little is known about reproduction, although this species is probably oviparous. The left ovary of UMMZ 207189 contains 12 ova, the largest of which is 8.2 mm in diameter.

Zonosaurus maramaintso new species

HOLOTYPE. UMMZ 221904 (RAN 57190), Fig. 1b, adult male, collected December, 1996, by a local collector in the Antsalova region, Antsalova Fivondronana, Mahajanga Province, Madagascar.

PARATYPES AND OTHER SPECIMENS. None

IDENTIFICATION. A long-tailed *Zonosaurus*, tail 2.6 times SVL. Body subcylindrical. Dorsolateral color of head, neck, body, tail, and upper surfaces of limbs green in life, brighter yellowish green anteriorly and

duller green posteriorly (grayish blue after 4 years in alcohol). Fourteen black, dorsal crossbands between neck and cloaca level, first and last bands indistinct and irregular, each band spans about two scale rows and is separated from adjacent bands by lighter green color covering one scale row. No longitudinal stripes. Top and sides of head with large irregular black markings. Neck and body with scattered dark spots and speckles. Lips yellow. Dorsal skin on head transparent revealing bony sutures of skull. Unpigmented tongue. Low number (14) of dorsal scale rows around mid-body. Relatively few (46) scales between mental and anal scales. Four supralabials anterior to subocular shield; two posterior supralabials. Postocular in contact with supratemporal scale. Interparietal scale present and close to the posterior edge of parietal. Well-developed, distinct, and regular window-like scales on lower eyelids (5 windows per lower eyelid) surrounded by smaller, irregular scales. Dorsal and lateral scales smooth on anterior part of body, nearly smooth on posterior part of body. Scales on ventral face of forelimb keeled. Scales beneath hindlimb and on ventral face of the body smooth. Scales underneath manus and pes round and tuberculate. Caudal verticillae denticulate with scales bearing well-developed median keel. Moderate number (14) of femoral pores on each thigh.

Differs from other *Zonosaurus species* (except *Z. boettgeri*) by long tail, subcylindrical body, and color pattern of transverse bands rather than longitudinal stripes. Differs from *Z. boettgeri* as follows. *Z. maramaintso* is green dorsolaterally with black crossbands on neck and body, with brighter (yellowish) green on head and neck and duller green on tail and limbs, becoming grayish blue in preservative; whereas *Z. boettgeri* green spots and markings anteriorly on the head, neck, and anterior flanks. Darker transverse bands of juvenile *Z. boettgeri* fade in adults and are expressed only anteriorly, whereas transverse bands of *Z. maramaintso* are retained fully expressed in adults.

DESCRIPTION OF THE HOLOTYPE. Adult male, excellent condition, 120 mm SVL; body subcylindrical; neck same width as head and adjacent body; tail 300 mm, unregenerated and complete. Some claws on fingers and toes damaged. Cloaca not covered by anal scales, opening without dark pigmentation. Lateral folds complete, not bearing antehumeral mite pockets. Hemipenis faintly pigmented with melanophores, without distinct lobes, with sixteen plicae, large sulcus. Tongue unpigmented.

Measurements in Table 1, meristic data in Table 2. Two parietal scales in contact medially; an ellipsoidal interparietal scale close to posterior edge of parietal; no distinct frontoparietal scale. One frontal in contact with frontonasal; prefrontal scales separated medially. Two loreal scales, first wider than high, situated above second supralabial, in very narrow contact with first supralabial on both sides and with third supralabial on left side; second loreal above third supralabial, separated from

fourth supralabial, in very narrow contact with second supralabial on right side. Subocular scale part of supralabial shield; four supralabials anterior to subocular; two supralabials behind the subocular scale, first larger than second, borders ventro-posteriorly two subciliaries. Three temporal scales, the superior contacts the posterior-most supraocular; right supratemporal divided into two scales, anterior larger than posterior. One preocular situated above fourth supralabial and in contact with subocular and with third supralabial; two postoculars, superior separated from parietal by contact of supratemporal and posterior-most supraocular. Postocular inferior divided into two scales, posterior scale smaller. Four supraoculars, first and last smaller than two central. Supraciliaries, 5-5, second much larger than others; subciliaries, 6-6, situated between pre- and postoculars. Lower eyelid with 5-5 window-like scales (Fig. 2). Nostril open above tip of first supralabial, borders first supralabial, postnasal, nasal, and rostral. Rostral rounded, contacts frontonasal. Infralabials, 5-4, last much smaller than others. Postmentals in contact medially; post postmental scales separated by two gulars, first gular slightly smaller than second. Tympanum exposed, without opercular shield.

Scales between mental and anal scales in 46 rows; 14 dorsal scale rows at mid-body; 30 scales above lateral fold between axilla and groin, first and posterior-most three much smaller than others. Ventral scales smooth, in eight longitudinal rows, seven scale rows at throat level; latero-ventral scales smooth. Dorsal scales smooth on anterior part of the body, slightly keeled posteriorly; 48 dorsal scale rows between parietal and level of cloaca, first row with smallest scales, no obvious imbricated suture line at mid-dorsal line. Caudal verticillae uniform in width, denticulate posteriorly by enlargement of median keel. Scales on ventral surface of forelimb keeled, those beneath hindlimb smooth; scales beneath manus and pes circular, tuberculate and smooth; scales beneath fingers and toes smooth. Upper scales on manus smooth, those on pes and legs strongly keeled. Subcaudal scales keeled; lateral scales posterior to cloaca transform into strong spur-like scales.

Scales underneath fingers (left/right I-V): 6-10-11-12-9/6-10-11-12-10; scales underneath toes (left/right I-V): 6-11-16-21-13/6-?-16-21-13. Femoral pores (left/right): 14-14.

Coloration in life (Fig. 1b): dorsolateral color green, brighter green with yellowish tinge anteriorly, fading to duller green above pelvis; with 12 black, crossbands along neck and body. Dorsal surfaces of limbs green with few small black spots; ventral surfaces of limbs yellowish green. Venter yellowish green. Dorsal surface of tail dull green with many dark flecks and spots. Ventral surface of tail yellowish green. Head bright green above with irregular black markings. Lips and throat

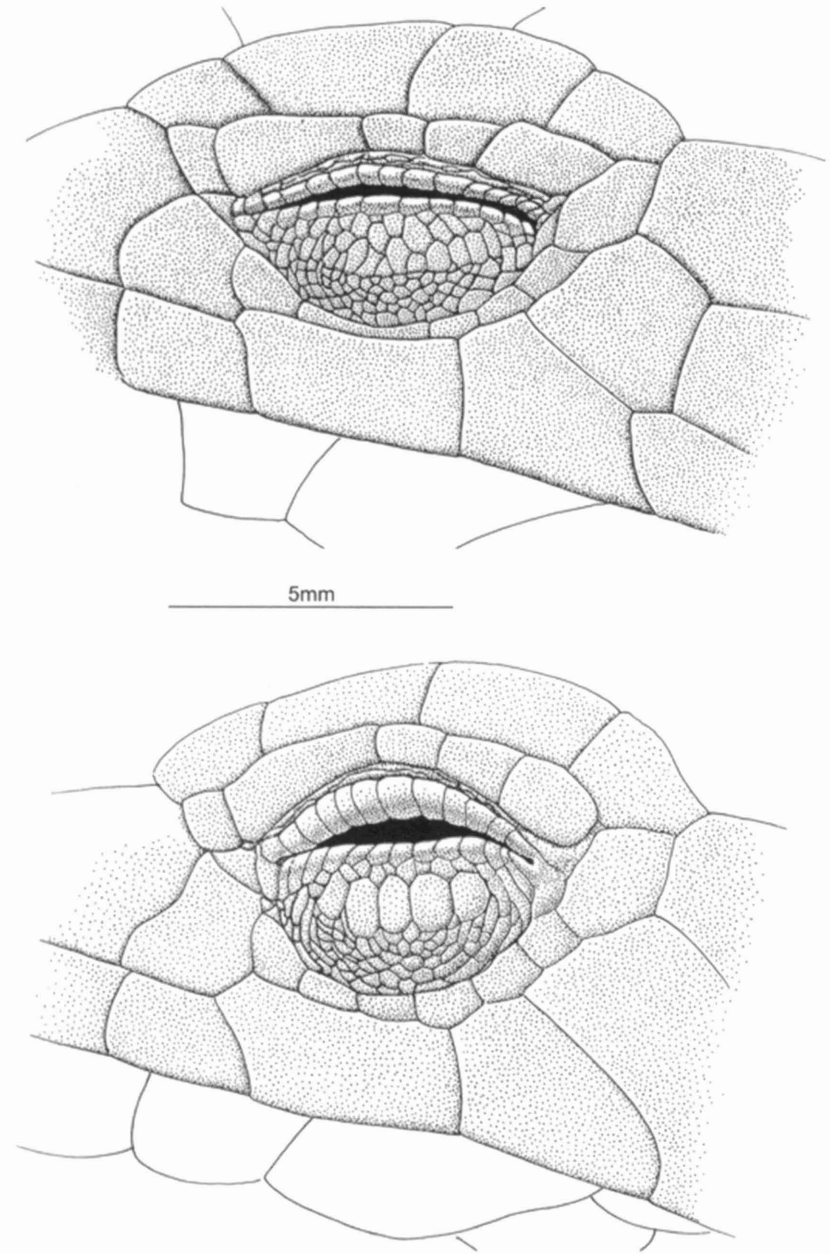

Fig. 2. Lower eyelid scales of *Zonosaurus boettgeri* (UMMZ 207189) (upper) in which the "window" scales from an irregular mosaic; the exception among specimens of *Z. boettgeri* is the holotype (NMW 23348) in which the window scales include a regular row of 7 large scales on each side similar to the pattern observed in the holotype of *Zonosaurus maramaintso* (UMMZ 221904) (lower).

yellow. Sutures of labials darker. Black line behind eye, nearly broken at supratemporal level. In preservative (after four years in alcohol), bright green dorso-dorsolateral coloration becomes bluish gray. Yellow coloration becomes white-cream.

VARIATION. Known from only a single specimen.

ETYMOLOGY. The unlatinized specific epithet "*maramaintso*," pronounced "maramine-soo," is a Malagasy word designating a color pattern of darker spots or patches on a green background.

DISTRIBUTION. The terra typica of *Zonosaurus maramaintso* is the Antsalova region.

HABITAT. The holotype was reported to have been found on a tree in semi-deciduous, tropical forest. Rock formations in this region are largely karstic.

DISCUSSION

Zonosaurus boettgeri is very rarely recorded. About 102 years elapsed between the capture of the first two specimens of this species and its rediscovery by us in 1993. We have no information about the status of the six known populations of this species. The species is recorded from only seven individuals, plus six reliable sight records; therefore this species could be considered rare and vulnerable to extinction. However, we strongly suspect that the arboreal habits of this species make it difficult to detect, and thus it may be much more widespread than currently recognized.

Suitable low elevation forest habitat for this species has been fragmented by the clear-cutting of forests and the annual burning of brush and grassy areas for grazing. Because *Zonosauus boettgeri* is a low elevation species, the interior mountains of the north (Tsaratanana and the Northern Highlands) also confine this species to the peripheral coastal regions which are under the greatest pressure from human populations.

Although *Zonosaurus boettgeri* is known from six areas (Nosy Be, mainland area adjacent to Nosy Be, Daraina region, Sahaka, and the eastern and western Masoala Peninsular), the relatively few number of sites and the largely degraded forest conditions indicate that *Z. boettgeri* is a species of special concern. *Zonosaurus boettgeri* occurs in Lokobe Special Reserve. The forest is managed well, but the reserve is small and positioned in an area that receives many tourists and other visitors. For this reason, illegal collecting may be a danger for the survival of this species on Nosy Be. During our survey within Lokobe Special Reserve, we found cloth bags used by collectors for the pet trade. The relict forest at Ankify on the mainland near Nosy Be is now highly

degraded and probably will not recover. Ankify is also one of the few known localities for the rare day gecko, *Phelsuma klemmeri* Seipp 1991. The forests at Daraina are highly disturbed as a result of clearing and erosional problems associated with gold mining. These isolated and frequently degraded forest patches of northern Madagascar appear to be rich in diversity (*e.g.*, see Raxworthy & Nussbaum, 1997, for chameleons) and should be intensively surveyed in order to establish long-term conservation and restoration strategies.

The herpetofauna of the western region of Madagascar where *Zonosaurus maramaintso* occurs is poorly explored. Recently, our one-month herpetofaunal survey in this area revealed many new lizard species (*e.g.*, Nussbaum *et al.*, 1999; Raselimanana *et al.*, 2000). These and other surveys did not, however, yield additional specimens of *Z. maramaintso*. Therefore, this new species seems to be rare or at least very difficult to observe. Clearly it should be viewed as a species of special concern. Bemaraha National Park and the Ramsar site in this region include large forest patches. However, because of the uncertain specific locality of the single known specimen of *Z. maramaintso*, we have no proof of the existence of this new species within these protected and well managed forests. Additional herpetofaunal surveys in this area are critical in order to determine the status of *Z. maramaintso* and many other species that are restricted to this area.

Zonosaurus boettgeri and *Z. maramaintso* are phenetically very similar to each other, and share several apotypic features (reduced scale rows around body, elongated tail, and greenish coloration with transverse bars) that strongly support a sister species relationship. Although it could be argued that the two forms are geographic variants of a single species, their differences in coloration are equal to or exceed coloration differences between other good species-pairs of *Zonosaurus*, which justifies recognizing them as distinct species. Furthermore, we suspect that additional morphological differences will emerge when larger samples of the two forms become available. The large geographic distance separating them suggests ancient isolation consistent with recognizing them as distinct species. The hypothesis that they are distinct species could be falsified by the discovery of geographically and morphologically intermediate populations.

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