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Species boundaries in Philippine montane forest skinks (Genus *Sphenomorphus*): three new species from the mountains of Luzon and clarification of the status of the poorly known *S. beyeri*, *S. knollmanae*, and *S. laterimaculatus*

By

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ABSTRACT Recent collections of *Sphenomorphus beyeri* Taylor 1915 from the type locality (Mt. Banahao, Luzon Isl., Philippines) serve as the basis for a thorough analysis of topotypic variation in external morphology within the species, and allow for detailed comparisons to other taxa. We clarify the taxonomic status of *S. beyeri* with respect to other, phenotypically similar species and evaluate species boundaries between allopatric populations referred to this taxon. The high elevation (1400–1700 m) population of *Sphenomorphus* (Brown et al., 1995a) from the Zambales Mountains and Bataan Peninsula of Luzon Island (previously referred by us to *S. beyeri*) is a new species that we describe here. We also describe two additional new species from the isolated, high elevation (1650–1750 m) forests of the Northern Cordillera and the Sierra Madre of Luzon, specimens of both of which had been previously identified as *S. beyeri*. All three new species differ from each other and all other *Sphenomorphus* species by scalation, body size, and coloration and all have non-overlapping distributions, associated with separate, isolated, geological components of Luzon Island.

In this paper we also formally redescribe *S. beyeri* on the basis of a large series of specimens from the type locality (Mt. Banahao, southern Luzon Island) that we have accumulated over the last 15 years. We place *S. knollmanae* Brown, Ruedas, and Ferner 1995 in synonymy with *S. laterimaculatus* (Brown and Alcala, 1980) and redescribe the latter species on the basis of the holotype and 20 additional newly collected specimens from six localities on the Bicol Peninsula of Luzon Island and Marinduque Island. These and other data suggest that species boundaries in Philippine *Sphenomorphus* are poorly understood and that taxonomic diversity is substantially underestimated and in need of comprehensive taxonomic review.

KEY WORDS: Aurora Memorial National Park; Balbalasang; Cordilleras; forest skinks; Mt. Mingan; Mt. Banahao; new species; Sierra Madre; Southeast Asia; Zambales Mountains; *Sphenomorphus.*

INTRODUCTION

Some of the rarest species of Philippine lizards are members of the family Scincidae Gray, genus *Sphenomorphus* Fitzinger that are known only from the original collections, and descriptions based on one or two specimens (Taylor, 1922; Brown and Alcala, 1980). Examples include *S. lawtoni* Brown and Alcala, 1980, *S. laterimaculatus* Brown and Alcala, 1980, *S. luzonensis* (Boulenger, 1894), *S. leucospilos* (Peters, 1872), and *S. beyeri* Taylor 1922. With the exception of *S. beyeri*, all of these small type series lack precise locality data and confusion regarding their current distribution predominates (Brown and Alcala, 1980).

Taylor (1922a, 1922b, 1922c, 1923, 1925) recognized 19 Philippine species in the genera *Otosaurus, Insulasaurus*, and *Sphenomorphus*. Taylor (1922c) described *Sphenomorphus beyeri* from a single specimen he collected at approximately 1,500 meters above sea level on Mt. Banahao (Banahaw) on southern Luzon Island, Philippines (Fig. 1). Although no additional specimens of this species were collected for almost 60 years, Brown and Alcala (1980) recognized the distinctiveness of the holotype and considered *S. beyeri* a valid species on the basis of Taylor's single specimen (EHT 17: CAS 61183). At the time of their review, Brown and Alcala (1980) followed Greer and Parker (1967) and Greer (1970) in recognizing *Otosaurus* and *Insulasaurus* as synonyms of *Sphenomorphus,* they described an additional four species from the Philippines, and the authors placed all 23 species of Philippine *Sphenomorphus* into six species groups (Groups I–VI) on the basis of body size and scale counts. Brown and Alcala (1980) placed *S. beyeri* and its phenotypically most similar congener (*S. diwata*; from northeastern Mindanao Isl.; see comments by Brown et al., 1995a, 1995b, 2000a) into the two species taxonomic couplet Group I *Sphenomorphus*. At the time of Brown and Acala's species group assignments, the authors emphasized the artificial nature of these assemblages but stressed their convenience for grouping Philippine species into cohesive phenotypic classes, largely for the purpose of identification (Brown and Alcala, 1980).

Earlier, we (Brown et al., 1995a, 1995b, 1996) reported on the discovery of a unique population of Group I *Sphenomorphus* from the Zambales Mountains of western Luzon (Fig. 1). At the time of that study, only the *S. beyeri* holotype was available for comparison and, although we noted several discrepancies with Taylor's (1922) description (Brown et al., 1995a), we were not confident in describing this population as a new species with only one *S. beyeri* specimen available for comparative purposes. Thus, at that time, the most conservative course of action was to note the significance of the Zambales population but to not recognize it taxonomically (see comments by Diesmos, 1998). However since the time of that publication (Brown et al., 1995a) a large series of topotypic specimens of *S. beyeri* have become available, enabling

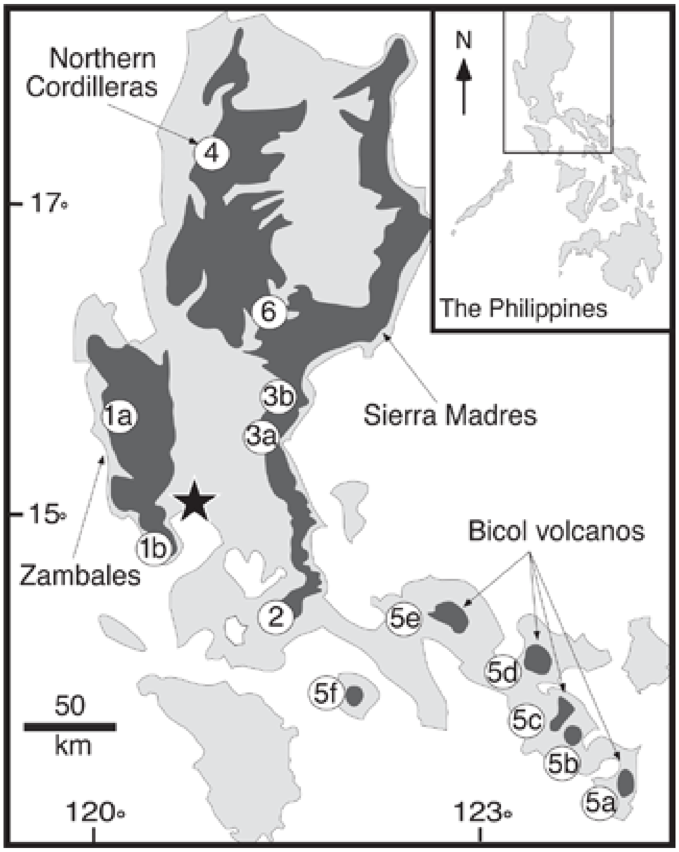

Fig. 1. Luzon Island in relation to the remaining islands of the Philippines (inset), and with the major montane components of the island indicated (dark shading). Type locality of *Sphenomorphus boyingi*, new species, in the Zambales Mountains (1a) and the Bataan Peninsula population (1b); (2) type locality of *S. beyeri* on Mt. Banahao; (3a) type locality for *S. hadros*, new species, on Mt. Mingan, Dingalan Municipality, and (3b) Mt. Aling-aling, Aurora Memorial National Park; (4) type locality for *S. igorotorum*, new species, at Magdallao, Balbalasang, Central Cordilleras; (5a) type locality for *S. laterimaculatus* at the vicinity of Mt. Bulusan, (5b), Mt. Mayon, (5c) Mt. Malinao, (5d) Mt. Isarog, (5e) Mt. Labo, and (5f) Marinduque Island; locality for single specimen , tentatively identified as *S.* cf *beyeri* from (6) Mt. Palali, Caraballo Mountains. Star = Manila.

both an expanded definition of the phenotypic variation in *S. beyeri*, and the confident designation of the isolated Zambales Mountain population as a distinct evolutionary lineage (*sensu* Simpson, 1961; Wiley, 1978; Frost and Hillis, 1990). The initial purpose of this paper was to diagnose, name, and describe the new species and to clarify its taxonomic status with respect to other closely related and/or newly described species. During the process of this effort and following fieldwork in the Sierra Madre (Brown et al., 2000a) and the Central Cordillera of Luzon (Diesmos et al., 2004), we identified two additional new, high elevation species that we describe here as well. Both bear morphological resemblance to members of Brown and Alcala's Group I *Sphenomorphus* but differ from these and all other congeners by a suite of characters related to body size and scalation.

Finally, Brown and Alcala (1980) described *S. laterimaculatus* on the basis of a single specimen, presumably collected from the southern tip of the Bicol Peninsula. Later, Brown et al. (1995b) described *S. knollmanae* on the basis of five specimens from Mt. Isarog at the northern end of the Bicol Peninsula (Fig. 1). Although Brown et al. (1995b) emphasized similarities to, and differences from, *S. knollmanae* and the members of Brown and Alcala's Group I *Sphenomorphus* (*S. beyeri* and *S. diwata*), they noted only slight differences between their new species and *S. laterimaculatus*. Over the past 15 years, small collections from several localities between the extreme southern and northern end of the Bicol Peninsula (Fig. 1) have become available, allowing us to critically examine a full range of phenotypic variation at localities between the type localities of these two putative taxa.

In this paper we describe the three new species, redescribe *S. beyeri* and clarify the status of this species with respect to congeners, place *S. knollmanae* in synonymy with *S. laterimaculatus*, and provide a full redescription of *S. laterimaculatus*.

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MATERIALS AND METHODS

Specimens were collected by hand and pitfall traps between 1991 and 2009 (Brown et al., 1995a, 199b, 1996, 1999, 2000a; Diesmos, 1998; Diesmos et al., 2004; Linkem et al., 2010a, b). All specimens were fixed in 10% buffered formalin and transferred to 70% ethanol 1–3 months later. Measurements were taken with digital calipers (to the nearest 0.1 mm) and sex was determined by gonadal inspection.

Measurements (see Brown et al., 1995a, and Linkem et al., 2010a, for character definitions) included snout–vent length (SVL), tail length, axilla–groin, hindlimb length, head length, head width, snout-to-forelimb length, snout length, interorbital distance, internarial distance, eye diameter, and diameter of auricular opening.

Scale counts were made on the right side of the body and included the numbers of paravertebrals from the parietals to the posterior edge of the hindlimb insertion, midbody scales, midventrals between limb insertions, supralabials, infralabials, enlarged supraoculars, loreals, and subdigital lamellae of fingers and toes. Loreal scales are defined based on position in loreal region. To clarify loreal scale homology, we describe the position of the loreal scales instead of a simple count of scales in the region. Loreal scales are broken into anterior and posterior sets. If latitudinally divided, they are described based on position (i.e., anteriodorsal, anterioventral, posteriodorsal, posterioventral, posteriomedial, etc.).

We adopt the General Lineage Concept of de Queiroz (1998) as an extension of the Evolutionary Species Concept (Wiley, 1978; Frost and Hillis, 1990) for species recognition. We consider as new species morphologically diagnosable forms when accompanied by some evidence of lineage cohesion (insular geography, genetic or ecological isolation, etc.) or, in the case of sympatric species, lineages for which the hypothesis of conspecificity can be confidently rejected on the basis of discontinuous character states observed in morphological, genetic, and/or ecological data.

DEFINITION AND DIAGNOSIS OF GROUP I PHILIPPINE *SPHENOMORPHUS*

We assign the three new species described below to the morphologically and ecologically cohesive Group I of Philippine *Sphenomorphus*, the *S. beyeri* complex (Brown and Alcala, 1980; Brown et al., 1995a, 1995b). Members of this species group are characterized by the unique combination of moderate to large body size (usually 50 to 80 mm SVL in adults), high numbers of paravertebrals (88–111, usually above 90), midventrals (38–57), and midbody scale rows (34–47), four large supraoculars, fused frontoparietals (except *S. diwata*), variable brown dorsal coloration, bright yellow or orange ventral coloration, and ecological preferences for semi-fossorial microhabitats among forest floor detritus in high elevation, cool, moist mid- to upper montane forests (Taylor, 1922; Brown and Alcala, 1980, Brown et al., 1995a).

All members of this group (*S. beyeri*, *S. diwata*, and the three new species described below) are distinguished from Group II Philippine *Sphenomorphus* (*S. atrigularis*, *S. biparietalis*, *S. lawtoni*, *S. luzonense*, *S. steerei*, *S. tagapayo* and the members of the genus *Parvoscincus*: *P. palawanensis*, *P. sisoni*) by much larger body size, a greater number of paravertebrals, midventrals, midbody scales, and 4th toe lamellae and a variety of additional scalation and color pattern characters (Table 1; Brown et al., 1999).

All five members of Group I Philippine *Sphenomorphus* differ from Group III Philippine *Sphenomorphus* (*S. leucospilos*, *S. mindanensis*, *S. victoria*, *S. laterimaculatus*, *S. acutus*, and *S. kitangladensis*) by a greater number of paravertebrals, and from all species in this group except *S. laterimaculatus* and *S. kitangladensis* by a higher number of midbody scales. All members of Group I *Sphenomorphus* except *S. diwata* further differ from *S. mindanensis* and *S. victoria* by the possession of fused (vs. separate) frontoparietals, from *S. acutus* by fewer 4th toe lamellae, and from *S. kitangladensis*, *S. leucospilos*, and *S. laterimaculatus* by a higher number of 4th toe lamellae (Table 1).

All five members of Group I Philippine *Sphenomorphus* differ from members of Group IV Philippine *Sphenomorphus* (*S. arborens*, *S. decipiens*, *S. variegatus*, *S. wrighti*, *S. cumingi*, and *S. traanorum*; Linkem et al., 2010a) except *S. cumingi* by a greater number of paravertebrals and most (except *S. diwata*) differ from all these same species except *S. arborens* by the presence of fused (vs. not fused) frontoparietals. All Group I Philippine *Sphenomorphus* members

Table 1. Distribution of diagnostic morphological character states in members of Brown and Alcala's Group I Philippine *Sphenomorphus* (*S. beyeri* and *S. diwata*), three new species that we assign to this species group. and the remaining Philippine *Sphenomorphus*. Characters are Snout–vent length (SVL), paravertebrals (PVS), midventrals (MVS), midbody scales (MBS), number of supraoculars contacting frontal (nSOR), fourth toe lamellae (4thTL) prefrontal condition (PF: in contact, separate, or variable), frontopariental condition (FP: fused, unfused). PAIC = Pleistocene Aggregate Island Complex (Brown and Diesmos, 2002).

Group	Species	Range	SVL	PVS	MVS	MBS	nSOF	4thTL	PF	FP	Venter
Group I	*S. boyingi*	Zambales & Bataan Mtns, Luzon	46.1–66.7	88–96	47–50	37–42	2 or 3	19–21	variable	fused in adults	bright orange, yellow spots
	S. igorotorum	Northern Cordilleras, Luzon	51.9, 57.5	98, 106	51, 52	44, 45	3	20	separate	fused	deep orange
	S. hadros	Sierra Madre, Luzon	73.5–86.7	108–111	54–57	45–47	2	18–22	separate	fused	pale yellow
	S. beyeri	Mt. Banahao, Luzon	57.8–72.9	88–102	38–43	38–42	2	18–21	separate	fused	bright golden yellow
	S. diwata	Diwata Mtns., Mindanao	51.4–58.5	90–93	44–46	38–42	2	14–16	contact	not fused	pale yellow
Group II	*S. atrigularis*	W. Mindanao & Basilan	29.5–34.5	53–60	—	28–30	2	8–11	variable	not fused	salmon to red
	S. biparietalis	Basilan & Sulus	31.3–36.0	61–68	—	30–34	2	9–11	variable	not fused	ivory
	S. lawtoni	N. Luzon	33.1–47.0	58–64	—	28–29	2	12–15	contact	fused	ivory
	S. luzonense	N. Luzon	39.9–47.8	65–73	—	27–29	2	9–12	variable	fused	golden yellow
	P. palawanensis	Palawan	28.1–34.3	48–54	—	22–24	2	10–12	absent	not fused	white
	P. sisoni	Panay	26.5–33.6	62–68	—	24–26	2	11–12	separate	not fused	white
	S. steerei	Widespread	26.4–36.0	52–63	—	28–32	2	9–14	contact	fused	pale yellow
	S. tagapayo	Sierra Madre	23.1–32.1	61–54	—	28–30	2	9–11	variable	fused	yellow
Group III	*S. laterimaculatus*	S. Luzon	42.1–57.1	74–83	42–48	34–38	3	17–18	contact	fused	bright orange, yellow spots
	S. mindanensis	E. Mindanao PAIC	42.0–56.0	66–78	—	30–32	2	17–20	separate	not fused	yellow
	S. leucospilos	S. Luzon, Sierra Madre	52.0–55.0	63–68	—	30–32	2 or 3	16–18	contact	fused	yellow
	S. kitangladensis	Central Mindanao	50.0–57.0	73–76	—	34–38	2	15–17	contact	fused	ivory
	S. victoria	Palawan	45.0–47.2	64–66	—	30–32	2	18–20	separate	not fused	yellow
	S. acutus	Mindanao PAIC	63.0–76.1	51–63	—	26–30	3	28–36	contact	fused	ivory
Group IV	*S. arborens*	Visayan PAIC	45.0–66.0	64–75	—	36–39	2	18–22	contact	fused	golden yellow
	S. decipiens	Widespread	31.1–45.0	57–66	—	32–38	2	14–18	contact	not fused	ivory to yellow
	S. variegatus	Mindanao PAIC	49.9–62.6	66–76	—	38–44	3	19–25	separate	not fused	golden yellow
	S. wrighti	Palawan	54–64	71–78	—	37–41	2 or 3	22–25	contact	not fused	tan
	S. cumingi	Widespread	115.0–156.5	75–90	—	48–54	4	22–27	separate	not fused	cream
	S. traanorum	Palawan	48.0–53.2	62–69	—	29–33	2 or 3	15–17	contact	not fused	ivory to golden yellow
Group V	*S. a. abdictus*	Mindanao PAIC	81.3–91.0	63–74	—	36–42	2 or 3	21–25	variable	not fused	ivory
	S. a. aquilonius	Luzon PAIC	79.0–95.1	62–73	—	34–38	2	20–25	variable	not fused	ivory
	S. c. coxi	Mindanao PAIC	65.0–85.0	62–72	—	32–38	2	19–26	variable	fused	ivory
	S. c. divergens	Luzon PAIC, Mindoro	63.0–90.0	64–75	—	38–40	2	21–26	variable	fused	ivory
	S. j. jagori	Widespread	70.9–108.8	63–73	—	34–42	2	24–30	separate	not fused	ivory
	S. j. grandis	Visayan PAIC	70.0–110.3	68–80	—	38–44	2 or 3	22–28	separate	not fused	ivory
	S. llanosi	Leyte, Samar	71.0–90.0	67–70	—	38–42	2 or 3	20–24	variable	not fused	ivory
Group VI	*S. fasciatus*	Mindanao PAIC	59.0–80.7	78–90	—	28–32	2	18–26	contact	not fused	ivory

further differ from *S. cumingi* by much smaller body size, fewer midbody scale rows, and 4th toe lamellae (Table 1); all differ further from S. arborens by the presence of four (vs. five) large supraoculars.

All five members of Group I Philippine *Sphenomorphus* species differ from the species of Group V Philippine *Sphenomorphus* (*S. abdictus abdictus*, *S. a. aquilonius*, *S. coxi coxi*, *S. c. divergens*, *S. jagori jagori*, *S. j. grandis* and *S. llanosi*) by a greater number of paravertabrals and most (except *S. diwata*) differ from all these taxa except *S. c. coxi* and *S. c. divergens* by fused (vs. not fused) frontoparietals. Although the ranges of body size overlap slightly, most Group I Philippine *Sphenomorphus* species further differ from Group V Philippine *Sphenomorphus* taxa by their consistently smaller general body size (Table 1). In addition to its much smaller body size, *S. diwata* differs from all five Group V Philippine *Sphenomorphus* species by possession of fewer 4th toe lamellae and its dark overall coloration, lacking any vestiges of transverse banding or dark bars beneath the eyes (Taylor, 1922; Brown and Alcala, 1980; Linkem et al., 2010b).

The five members of Group I Philippine *Sphenomorphus* differ from the sole member of Group VI Philippine *Sphenomorphus* (*S. fasciatus*) by greater numbers of midbody scale rows, striking differences in adult coloration (dorsal coloration variable brown, vs. dorsum black with transverse thin white or yellow bands), and except *S. diwata*, fused (vs. not fused) frontoparietals. In the following section, we diagnose each new species from their phenotypically and ecologically similar congeners of Group I Philippine *Sphenomorphus*.

SPECIES DESCRIPTIONS

Sphenomorphus boyingi new species

Syn. *Sphenomorphus beyeri* Brown, Ferner and Sison, 1995:9 (in part).

Figs. 2, 4–6 (see Brown et al., 1995a:figs. 3, 4)

Holotype.—PNM 2302 (male, SVL 62.7 mm), collected by RMB, 16 March, 1992 at 1460 m above sea level on west face of Mt. High Peak (4.3 km N, 0.5 km E of peak; 15° 31′ N, 120° 07′ E), Barangay Coto, Municipality of Masinloc, Zambales Province, Luzon Island, Philippines.

Paratopotypes.—PNM 2301, CMNH 3652 (females, collected at 1520 m), 12 March 1992; PNM 2305, CMNH 3653–54 (male, 1550 m; juvenile and female, 1575 m) 13 March, 1992; USNM 337768 (male collected at 1535 m), PNM 2304 (male; 1460 m), 2302–03 (males, 14690 m), CMNH 3655, 3657 (males; 1460 and 1535 m, respectively), 16 March, 1992; PNM 2307, CMNH 3658–59 (female and two males, 1500 m) collected 17 March 1992. All collected by R. M. Brown, J. W. Ferner, and R. V. Sison.

Other paratypes.—PNM 2300, male collected by J. W. Ferner, 25 February 1992 at 1265 m, Mt. Apoy (5 km E, 3 km N Barangay Coto; 15° 35′ N, 120° 08′ E), Barangay Coto, Municipality of Masinloc, Zambales Province, Luzon; FMNH 267561 and 267664, two males, collected by D. Balete and L. Heaney on Mt. Natib at 900 (27 March) and 1000 m (21 March 2005), respectively, Barangay Tala, Municipality of Orani, Bataan Province, Luzon.

Diagnosis.—A species of *Sphenomorphus*, distinguished by the following combination of characters: (1) body size moderate, SVL 46.1–66.7 mm; (2) prefrontals moderate, separate in 52% of specimens; (3) frontoparietals fused in adults; (4) labials 6–7; (5) large supraoculars 4; (6) paravertebrals 88–96; (7) midventrals 47–50; (8) scales around midbody 37–42; (9) fourth toe lamellae 19–21; (10) mid-dorsal coloration medium brown, with or without a thin vertebral series of black elongate spots; (11) dorsolateral surfaces of head and neck black, ventrolateral tan with brown labial bars; (12) a prominent inverted obtusely-triangular marking present above forelimb insertion; and (13) ventrum bright orange with pale yellow spots.

Comparisons.—The relevant comparisons for the recognition of the new species are to the other currently recognized, phenotypically similar members of Group I Philippine *Sphenomorphus*, namely *S. beyeri*, and *S. diwata* (Table 1). The new species is distinguished from *S. beyeri* by a smaller maximum body size, a greater number of midventrals, prefrontal contact variable (i.e., separate or in contact; vs. consistently separate), dorsal coloration a homogenous light brown, with or without a midvertebral stripe (vs. dorsum dark brown with evenly-spaced, distinct, round white spots), an obtusely (vs. acutely) triangular inverted black marking above forelimb insertion, and a bright orange ventrum with pale yellow spots (vs. venter bright golden yellow). The new species differs from *S. diwata* by the possession of more midventrals, more 4th toe lamellae, fused (vs. not fused) frontoparietals, presence (vs. absence) of an inverted obtusely triangular black marking above forelimb insertion, a lighter overall coloration, dorsum homogenous light brown (vs. dorsum very dark brown with light flecks and dark dorsolateral bars), a light tan neck and throat with dark flecks (vs. neck and throat marbled black and white), and a bright orange venter with pale yellow spots (vs. ventrum pale yellow). These and other comparisons are summarized in Table 1.

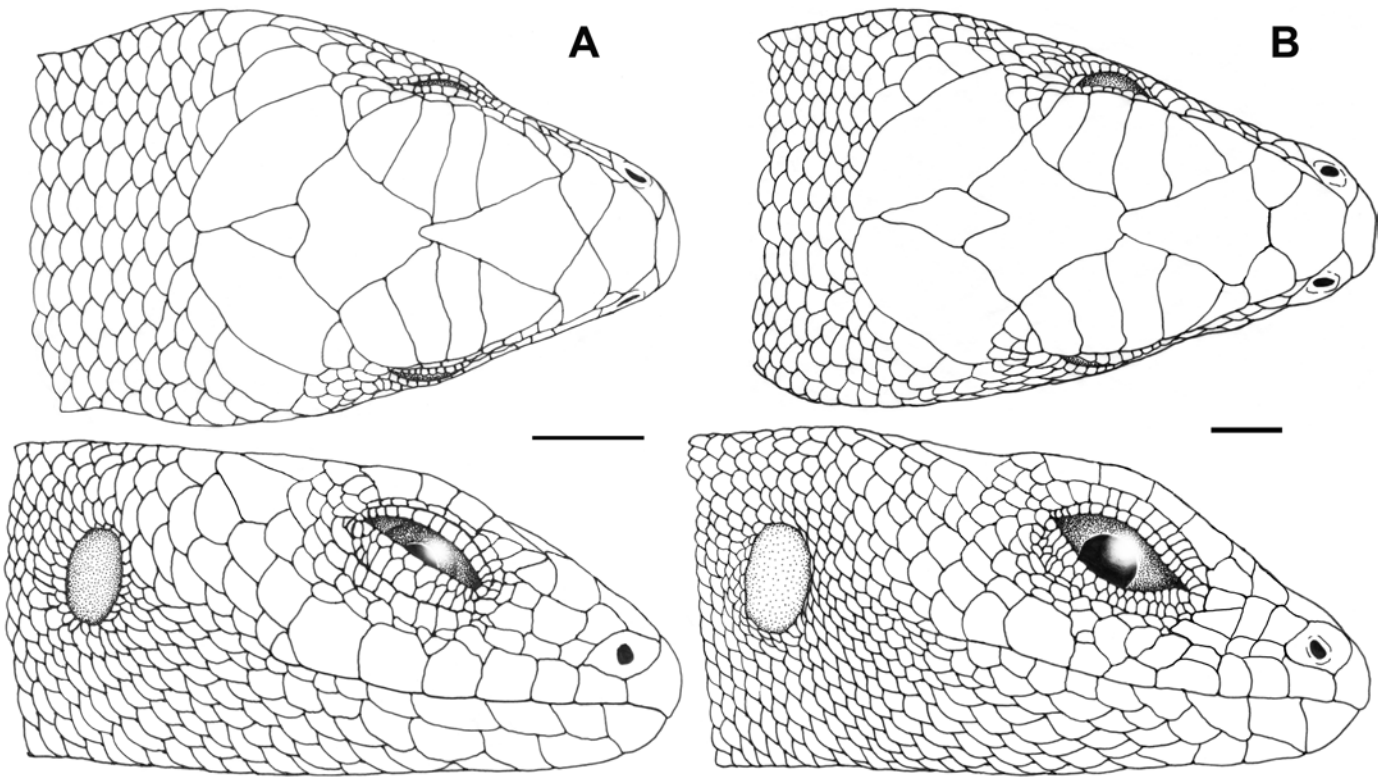

Fig. 2. Dorsal (above) and lateral (below) views of head scalation in (A) *Sphenomorphus boyingi*, new species, paratype (CMNH 3653) and (B) a topotypic specimen of *S. beyeri* (TNHC 62674). Scale bars = 4 mm.

Description of holotype.—Medium-sized (SVL 62.7 mm), undissected, well preserved adult male specimen with hemipenes everted, and tail complete (91.6 mm). Body slender, elongate (axilla–groin distance/SVL = 0.53), limbs well developed (hind limb length/SVL = 0.37), fore- and hind limbs not overlapping when adpressed, tail long (SVL/tail length = 0.68); head robust, distinct from neck (head length/SVL = 0.21), longer than wide (head width/head length = 0.69).

Snout moderate, bluntly rounded in dorsal and lateral views (snout length/head length = 0.35); rostral wide, contacting anterior frontonasal and nasals; frontonasal wider than long, in contact with nasals, rostral, anteriodorsal loreal, and prefrontals; prefrontals in medial point contact, contacting dorsal loreals, frontal, frontonasal, 1st supraciliary, and 1st supraocular; frontal longer than wide, in broad contact with two anterior supraoculars, barely contacting third supraocular; enlarged supraoculars four, 1st largest, 2nd widest; frontoparietals fused into a single plate, in contact with 3 supraoculars; interparietal kite-shaped with longest ramus pointing posteriorly; parietals in moderate overlap behind interparietal, left overlapping right, barely contacting fourth supraocular, postsupraocular region containing multiple scales, and both primary and secondary temporals; nuchals undifferentiated, non-elongate.

Nasal pierced in center by naris, surrounded anteriorly by rostral, dorsally by frontonasal, posteriorly by anterior pair of loreals, and ventrally by 1st supralabial; anterior and posterior loreals paired, dorsal scales larger than ventrals; preoculars 3, median largest; supralabials 7, 5th under center of eye; ciliaries 16, largest in the middle of the series, immediately above pupil; lower ciliaries 10; lower eyelid scaly and transparent, lacking non-scaled "window;" suboculars 10, largest anteriorly; primary temporals 3, ventral largest, uppers overlapping lower; secondary temporals 3, dorsal largest, upper overlapping lower, auricular opening large (ear diameter/eye diameter = 0.60) , vertically ovoid, moderately sunk, tympanum visible.

Infralabials 8, decreasing in size; mental large, forming a slightly curved suture with a single large postmental, first infralabials, and first supralabials; chin scales increasing in number posteriorly (1, 2, 3) and then blending into size and shape of gular scales; gular scales subequal to ventrals.

Body cylindrical, with 96 paravertebrals, midbody scales 39, and midventrals 47; dorsal trunk scales slightly convex and smaller, than slightly larger ventrals; all trunk scales imbricate, smooth, without striations, keels or pits; tail elongate, 1.4x body, subsquarish in cross section at base, becoming approximately circular in cross section; subcaudal scales nondifferentiated, not enlarged for proximal half of tail, enlarged and scute like for distal half (tail original).

Forelimbs smaller than hind limbs, all limbs pentadactyl; forelimb scales equal in size to body scales, imbricate and smooth, reducing slightly closer to manus; supradigitals single on Finger I, wrapped across dorsal surface of digit; supradigitals double above Fingers II–V, in alternating "braided" configuration across dorsal surface of remaining fingers; lamellae becoming slightly keeled distally on each digit; relative digit length with lamellae (L/R) in parentheses: III(13/12) = IV(14/15) > II(8/8) > V(10/10) > I(5/5); palmar scales raised, forming irregular ventral protrusions from palmar surface of manus; enlarged scales with raised distal edges forming spade-like protusions along edge of palm, between base of Finger I and Finger V.

Hind limbs moderate (hind limb length/axilla–groin distance = 0.71); scales of dorsal limb surface of hind limb equal in size and shape to body scales; supradigitals double above Toes I–V, in alternating "braided" configuration across dorsal surface of remaining toes; subdigital lamellae keeled; relative digit length with lamellae (L/R) in parentheses: IV(20/21) > III(17/18) > II(11/11) > V(10/11) > I(7/6); plantar scales irregular, slightly raised, with three large, pointed scales, with raised, ventral surfaces forming spade-like protusions along ankle/plantar margin.

Precloacal region with four rows of enlarged scales between pelvic region and cloaca; medial precloacal scales highly enlarged (left overlaps right), larger than and overlapping lateral undifferentiated precloacals.

Measurements of holotype (in mm).—SVL 62.7; tail length 91.6 (original); axilla–groin distance 33.3; hind limb length 23.5; snout–forelimb length 24.0; head length 13.1; head width 9.1; snout length 4.6; interorbital distance 4.0; internarial distance 2.9; eye diameter 2.4; auricular opening diameter 1.7.

Coloration in preservative.—The following color description was written in 1997 following five years storage in 70% ethanol. Current condition is somewhat faded and browned due to one-year storage in denatured alcohol. Coloration generally faded throughout compared to specimen in life (see below).

Dorsal ground color dark brown with a midvertebral black line, broken posteriorly into a series of elongate black spots (two scale rows wide, 4 scale rows long); dorsolateral region marked by a wavy boarder between dark brown dorsal coloration and black lateral coloration, blotched with tan; demarcation between brown dorsal color and black lateral color enhanced by a series of indistinct tan spots (anteriorly) and blotches (posteriorly); contrast in dorsolateral pattern strongest in nuchal region, becoming less distinct towards posterior portions of trunk and tail.

Dorsal surfaces of the head brown with light areas and indistinct black mottling; supraoculars nearly dark gray; lateral surfaces of head and neck stratified, with three distinct color regions: brown above; a black stripe extending from tip of snout, through narial, loreal, ocular and parietal regions, passing above auricular opening; ventrolateral surfaces ivory, blotched with gray; labials gray, each with a round ivory spot near center; chin and throat ivory with scattered irregular gray blotches; ventrum immaculate ivory.

Dorsal surfaces of limbs dark brown with distinct white round spots; dorsal surfaces of manus and pes marbled black and ivory; dorsal surfaces of digits gray with black bars above interphalangeal articulations; ventral surfaces of arms and legs immaculate ivory; subdigital lamellae, palmar surface of manus, and plantar surface of pes dark gray; claws black; tail medium brown with tan dorsal blotches and darker lateral blotches; lateral tail blotches fuse to form distinct black line on distal fourth of tail; tail tip black; ventral tail surfaces immaculate ivory, basal portions devoid of any dark pigmentation; distal portions with black blotches, fusing to form solid black pigmentation by tail tip.

Coloration in life.—Based on color notes of RMB (see also Figs. 3 and 4; and Brown et al., 1995a). Dorsolateral surfaces of head, neck dark brown; mid-dorsal surfaces of trunk and limbs relatively homogeneous light brown, with a midvertebral line of 25 black spots encompassing two scale rows each; spot series fades slightly by point of rear limb insertion; dorsolateral surfaces of head and neck black with tan blotches and flecks, forming a solid band on neck, continuous with an inverted, obtusely triangular marking above the forelimb insertion; similar black coloration congregated above the hind limb and extends posteriorly to tail base; black lateral head and neck band, bordered dorsally by thin, golden-yellow line; ventrolateral surfaces of head and neck tan with dark brown spots and flecks; chin translucent pinkish-tan; labial scales lavender to purplish, each with white spot in center or on ventral border of scale.

Dorsal portions of limbs dark brown with distinct white spots; dorsal surfaces of digits alternating dark and light brown; dorsal portions of tail brown with black tip; lateral portions of tail with continuous black bloches, forming indistinct lateral bars on either side, continuous with dark lateral coloration of trunk and head.

Ventrolateral surfaces of axilla–groin region and venter bright orange with distinct round yellow spots; midventer bright yellow; sternal region, neck and tail base pinkish-tan with light sky-blue flecks; mid-ventral portions of tail medium brown; distal portions with black tip; ventral surfaces of fore- and hind limbs bright golden-yellow; posterior edge of hind limbs with yellow spots surrounded with brown borders. Iris brown with gold highlights; tongue purplish gray.

Variation.—Raw morphometric data and scale counts for most specimens of the type series are presented in Brown et al. (1995a:table 1). Ten of 19 specimens have separate prefrontals, (three of which have prefrontals separated by an azygous interprefrontal), three specimens have prefrontals in narrow point contact, and six have prefrontals in broad contact. The number of supraoculars in contact with the frontal varies from 2 (FMNH 267561, 267664; CMNH 3655, 3657, 3659) to 3 (e.g., CMNH 3652–54, 3658); labials vary (left/right): supralabials, 6–7/5–7; infralabials: 6–8/6–8. Paravertebrals vary 84–96 ($\bar{x}$ = 90.5, ± 2.4, n = 19) as do midbody scales: 38–42 ($\bar{x}$ = 40.1, ± 1.2, n = 19). Subdigital lamellae of fourth toe vary 19–21 (9) ($\bar{x}$ = 21.3/21.4 ± 0.8/0.7; n = 19) and first finger, 5–7 ($\bar{x}$ = 6.4/6.4 ± 2.3/2.3 SD; n = 19). One specimen is a recently hatched subadult (CMNH 3654), and is identical to all other specimens except that it exhibits unfused or separate frontoparietals scales.

Color pattern varies slightly, with some specimens possessing more black lateral pigment, a bold black vertebral stripe, darkly blotched throat, and ventral tail surface with black spots (e.g., CMNH 3655, FMNH 267561) and some lacking all dark lateral pigment (save for the inverted obtusely triangle marking above the forelimb insertion) possessing only a very faint vertebral stripe, and lacking any dark pigment on the ventral surface of the tail (e.g., CMNH 3657). Dorsal surface of regenerated tails light orangish-brown (e.g., CMNH 3658). Comparisons to juveniles and immature specimens suggests that ontogenetic pattern variation occurs in this species (PNM 2303, CMNH 3654).

Habitat and natural history.—A single specimen was collected under leaf litter at 1265 m, and moved in a rapid serpentine manner in an attempt to escape by burrowing under leaf litter when disturbed. Two specimens (CMNH 3652, a gravid female and PNM 2301, a mature female without eggs) were captured in pitfall traps at 1510 m, and 1610 m respectively. All other specimens were captured by splitting open rotten logs lying horizontally in contact with the forest floor, or at an angle with one end elevated somewhat by the slope of the landscape. Two of the specimens were gravid females (CMNH 3652 and 3653), each containing two, yellowish, thickly shelled oviductal eggs. Habitat descriptions, circumstances surrounding capture of *S. beyeri* specimens, and accounts of other faunal communities found at the *S. boyingi* type locality are available in Ruedas et al (1994) and Brown et al (1995a, 1996); detailed descriptions of the habitat of *S. beyeri* on Mt. Banahao have been provided by Diesmos (1998). Other scincid species known from the Zambales (and potentially sympatric with *S. boyingi*) include *S. abdictus aquilonius, S. cumingi, S. jagori, S. lawtoni, S. steerei, Eutropis multicarinata borealis, E. cumingi, E. multifasciata, Lipinia pulchella taylori*, and *Lamprolepis smaragdina* (Brown et al., 1996).

Etymology.—The specific epithet is a patronym in the genitive singular honoring our good friend and frequent field companion Renato “Boying” Fernandez. We are pleased to name this distinctive species for Boying in recognition of his unique abilities as a field biologist and in thanks for the enthusiastic company he has provided us over the years. Suggested common name: Boying’s Zambales Mountain Skink.

Sphenomorphus igorotorum, new species
Syn. *Sphenomorphus* sp. A. Diesmos et al (2004)
Figs. 3–5, 6

Holotype.—PNM 9623 (formerly FMNH 259445; Field Number: RMB 3169), collected by RMB, 14 March 2001 at 1400 m above sea level in area known locally as “Mapga,” (N: 17.442°; E: 121.075), Balbalan-Balbalasang National Park, Barangay Balbalasang, Municipality of Balbalan, Kalinga Province, Luzon Island, Philippines.

Paratopotype.—FMNH 259448 (Field Number: ACD 1150), same date and exact locality as holotype.

Diagnosis.—A species of *Sphenomorphus*, distinguished by the following combination of characters: (1) body size small, SVL 51.9 mm, 57.5; (2) prefrontals moderate, separate; (3) frontoparietals fused; (4) labials 7–9; (5) large supraoculars 4; (6) paravertebrals 98, 106; (7) midventrals 51, 52; (8) scales around midbody 44, 45; (9) fourth toe lamellae 20; (10) dorsal coloration medium brown with a thin series of black, elongate, vertebral spots and indistinct white spots along medial margins of dark, wavy, dorsolateral bands on head, neck, and trunk; (11) dorsolateral surfaces of head dark brown, with black bar running across snout, through eye, auricular opening, and onto neck; ventrolateral surfaces of neck and head immaculate tan (deep orange in life); (12) triangular marking above forelimb absent; and (13) ventrum deep orange in life.

Comparisons.—*Sphenomorphus igorotorum,* new species, differs from *S. beyeri* by a smaller maximum body size, a greater number of midventrals, dorsal coloration a homogenous dark brown, with a broken midvertebral stripe (vs. dorsum dark brown with evenly-spaced, distinct, round white spots), nuchal region and trunk with bold dorsolateral brown bar (vs. acutely triangular inverted black marking above forelimb insertion), and a deep orange ventrum (vs. ventrum bright golden-yel-

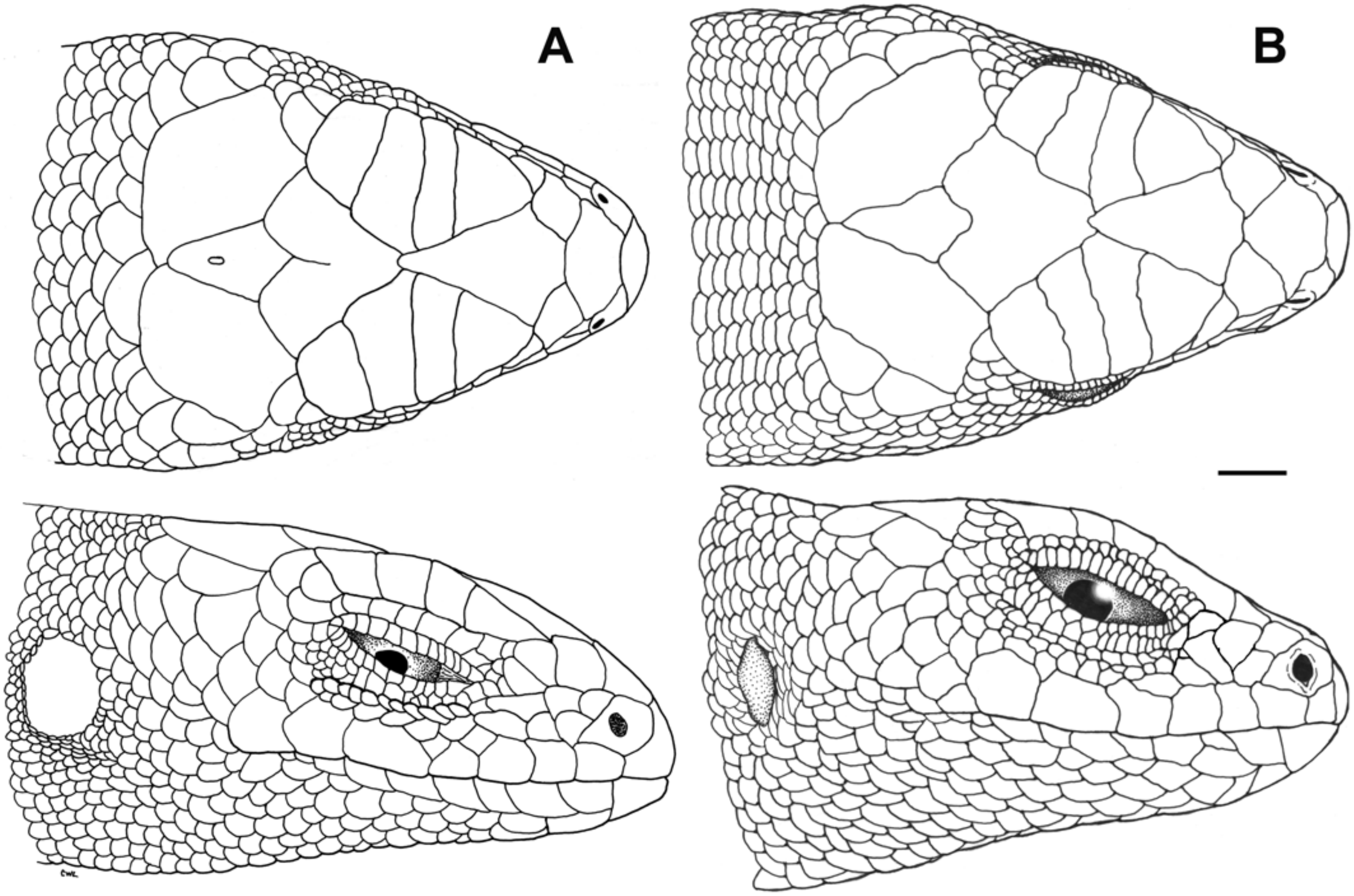

Fig. 3. Dorsal (above) and lateral (below) views of head scalation in (A) the *Sphenomorphus igorotorum*, new species, holotype (PNM 9623) and (B) a paratype of *S. hadros*, new species, (CMNH 5772). Scale bar = 4 mm.

low). The new species differs from *S. diwata* by the possession of more midventrals and 4th toe lamellae, fewer midbody scales, and fused (vs. not fused) frontoparietals. Finally, the new species is distinguished from the species described above, *S. boyingi*, by fewer paravertebrals, a greater number of midventrals and midbody scale rows, dorsum dark (vs. light) brown, nuchal region and trunk with bold dorsolateral brown bar (vs. obtusely triangular inverted black marking above forelimb insertion), and a deep orange ventrum (vs. ventrum bright orange with yellow spots). These and other comparisons are summarized in Table 1.

Description of holotype.—(Figs. 3–5, 6) Well preserved mature male specimen (SVL 57.5 mm, tail length 80.1 mm, original) with hemipenes inverted and a midventral incision with a portion of liver removed and preserved separately. Body slender, elongate (axilla–groin distance/SVL = 0.48), limbs well developed (hind limb length/SVL = 0.38), fore- and hind limbs not overlapping when adpressed, tail long (SVL/tail length = 0.68); head robust, distinct from neck (head length/SVL = 0.23), longer than wide (head width/head length = 0.72).

Snout moderate, rostrum acutely pointed, snout bluntly rounded in dorsal and lateral view (snout length/head length = 0.28); rostral wide, contacting frontonasal and nasals; frontonasal wider than long, in contact with nasals, rostral, anteriodorsal loreal, and prefrontals; prefrontals widely separated, contacting both dorsal loreals, frontal, frontonasal, 1st supraciliary, and 1st supraocular; frontal longer than wide, in broad contact with two anterior large supraoculars, narrow contact with third large supraocular; large supraoculars four, 1st largest, 3rd widest; frontoparietals fused into a single plate with medial cleft indicating incomplete fusion of separate elements, in contact with 2 large supraoculars, contact with postsupraorbitals occluded by contact between fourth supraocular and parietal; interparietal moderate, kite-shaped, with longest ramus pointing posteriorly; parietals in narrow contact behind interparietal, left overlapping right, barely contacting fourth supraocular, postsupraocular, and both primary and secondary temporals; nuchals undifferentiated, non-elongate.

Nasal pierced in center by naris, surrounded anteriorly by rostral, dorsally by frontonasal, posteriorly by dorsal and ventral anterior loreals, and ventrally by 1st supralabial; loreals divided into anterior and posterior pairs, anteriodorsal scale higher on head and slightly larger than latitudinally elongate anterioventral scale, posteriodorsal scale largest; preoculars 2, triangular, equivalent in size, latitudinally elongate; supralabials 8, 5th under center of eye; supraciliaries 10, equivalent in size; lower ciliaries 9; lower eyelid scaly and transparent, lacking non-scaled "window;" suboculars 8, largest anteriorly; primary temporals 3, ventral largest, upper overlapping lower; secondary temporals 3, dorsal largest, lower overlapping upper; tertiary temporals 2, lower overlapping upper; auricular opening large (ear diameter/eye diameter = 0.50), vertically ovoid, moderately sunk, tympanum visible.

Infralabials 8, decreasing in size, 5th below center of eye; mental large, forming a slightly curved suture with a single large postmental, first infralabials, and first supralabials; chin scales increasing in number posteriorly (1, 2, 4) and then blending into size and shape of gular scales; gular scales subequal to ventrals.

Body horizontally ovoid in cross section, with 98 paravertebrals, midbody scales 45, and midventrals 52; dorsal trunk scales slightly convex and slightly smaller than flatter ventrals; all trunk scales imbricate, smooth, without striations, keels or pits; tail elongate, 1.4X body, subsquarish in cross section at base (due to hemipenal bulges), becoming approximately circular in cross section medially; subcaudal scales undifferentiated, not enlarged or broadened in original tails.

Forelimbs smaller than hind limbs, all limbs pentadactyl; dorsal and ventral forelimb scales substantially smaller than body scales, imbricate and smooth, reducing severely closer to manus; supradigitals of all fingers double, in alternating "braided" configuration across dorsal surface of digits; lamellae becoming slightly keeled distally on each digit; relative digit length with lamellae (L/R) in parentheses: III(13/13) = IV(13/13) > II(8/9) > V(9/9) > I(5/5); palmar scales convex, raised, and granular, relatively homogenous across palmar surface of manus; enlarged scales with raised distal edges forming slight spade-like protrusions along edge of palm, at base of Fingers I and V.

Hind limbs moderate (hind limb length/axilla–groin distance = 0.78); scales of dorsal and ventral limb surfaces of hind limb much smaller than body scales, extremely reduced near pes; supradigitals double above Toes I–V, in alternating "braided" configuration across dorsal surfaces; subdigital lamellae keeled; relative digit length with lamellae (L/R) in parentheses: IV(20/21) > III(16/15) > I I(11/11) > V(13/13) > I(7/7); plantar scales, raised, conical to pyramid-shaped, with a row of six large, pointed scales, forming spade-like protrusions along ankle/plantar margin.

Precloacal region with three rows of posteriorly elongate scales between pelvic region and cloaca; 4 precloacals, medial pair largest (left overlapping right), overlapping lateral precloacals.

Measurements of holotype (in mm).—SVL 57.5; tail length 80.1; axilla–groin distance 27.9; hind limb length 21.7; snout–forelimb length 21.6; head length 13.4; head width 7.9; snout length 4.0; interorbital distance 3.8; internarial distance 2.6; eye diameter 2.1; auricular opening diameter 1.0. In life, the holotype weighed 4.8 g.

Coloration in preservative.—Dorsal ground color dark brown with a vertebral series of elongate black spots (two scale rows wide, 4–6 scale rows long); dorsolateral region marked by long, wavy black lines, bordered medially by a dorsolateral series of white spots and blotches; dorsolateral pattern strongest in nuchal region and becoming less distinct towards posterior portions of trunk, eventually becoming indistinguishable at midpoint of tail; dorsal surfaces of the head a relatively uniform brown with indistinct black mottling; supraoculars nearly black; frontoparietals, interparietal, and parietals with distinct black posterior edges; lateral surfaces of head stratified in three distinct color regions: brown with black blotches above, with a thick black bar extending from tip of snout, through narial, loreal, ocular, parietal and auricular regions, distinguished by a sharp line of pigment from immaculate ivory on ventrolateral surfaces; ventral half of lateral head surfaces pure ivory: subocular and labial regions, as well as chin and throat devoid of dark pigment; although sharp demarcation between dark (above) and pigmentless (below) becomes less distinct posteriorly, general stratified color pattern continues throughout remainder of body and basal half of tail; distal portions of tail medium brown with darker lateral blotches.

Dorsal surfaces of limbs dark brown with distinct white round spots; dorsal surfaces of manus and pes marbled dark brown and white; dorsal surfaces of digits barred brown and white; ventral surfaces of arms and legs immaculate ivory; subdigital lamellae, palmar surface of manus, and plantar surface of pes dark gray. Venter and tail immaculate ivory, devoid of any dark pigmentation.

Coloration in life.—Dorsal ground coloration of body dark brown with small subcircular gold spots, and vertebral series of squarish black spots; dorsal surface of head dark brown with borders of scales delineated by black borders; dorsal surfaces of limbs black with dark brown circular spots; dorsolateral surfaces of body dark brown with a distinct series of bright yellow spots, each enclosed with a fine black border; a bold, continuous, black (anteriorly, on head and neck) to dark brown (posteriorly, on trunk and tail) bar extends from the tip of the snout, through the loreal, ocular, supraauricular and nuchal region and remainder of body; on head and neck, ventral edge of brown-black bar marked with a fine bright yellow line (loreal and ocular-auricular regions) or a series of bright yellow spots; between auricular region and forelimb insertion, bright yellow spots distinct and bordered dorsally with black; posteriorly on trunk, bright yellow spots becoming increasingly less distinct and bordered by indistinct melanic pigment; ventrum and ventrolateral flank surfaces bright orange with gold-yellow flecks; chin and throat yellow-orange; ventral surfaces of limbs bright orange, palmar surface of manus and plantar surface of pes gray; ventral surface of tail orangish-brown; iris dark brown; tongue dark gray.

Variation.—The single paratype differs from the holotype in only a few character states. In the paratype, the parietals barely contact behind the interparietal. Additionally, the paratype has three primary, three secondary, and three tertiary temporals on the left, and two primary, three secondary, and three tertiary temporals on the right. The paratype differs from the holotype by the following scale counts: paravertebrals 106, midventrals 51; midbody scales 44. Measurements of the paratype also differ: SVL 51.9; tail 39.0 (regenerated); axilla–groin distance 25.6; hind limb length 18.9; snout–forelimb length 18.3; head length 12.6; head width 7.0; snout length 3.9; interorbital distance 3.1; internarial distance 2.4; eye diameter 1.5; auricular opening diameter 0.8. In life the paratype weighed 2.2 g. The only noticeable color differences include gray blotches on the throat of the paratype (absent in the holotype), slightly darker, orange ventrolateral surfaces of head and neck, orange-brown pigment on labials, and pattern-less light brown dorsal surface of the regenerated tail.

Habitat and natural history.—The only two specimens of *S. igorotorum* were collected between 1400 (the holotype) and 1480 (paratype) m at Magdallao, Balbalasang (Diesmos et al., 2004). The holotype was captured by splitting open a rotten log, 30 cm in diameter, in contact with the forest floor; the paratype was taken from below mossy bark on the forest floor. The habitat was mature montane rainforest dominated by oaks and Benguet pine trees reaching heights of ca. 15 m. Several small streams and some relatively flat areas provided abundant moist habitat. At the time of our visits to the area (February and March) atmospheric conditions were typical of northern Philippine "dry season," but the high elevation mossy forests were moist, experiencing cloud cover in the afternoons and evenings, frequent fog, and light rains on some evenings. Despite extensive efforts (more than 30 person hrs of search time) on the part of five field biologists, only two specimens were encountered. Other sympatric scincids include *S. luzonensis*, *S. abdictus aquilonius*, *Eutropis* cf. *cumingi*, *E. multicarinata borealis*, *Brachymeles bicolor*, and *B. bonitae* (Brown et al., 1999; Diesmos et al., 2004) and other congeners from northern Luzon include *S. cumingi, S. decipiens, S. jagori, S. lawtoni, S. steerei, and S. tagapayo* (Brown and Alcala, 1980, Brown et al., 1996, 1999, 2000a).

Etymology.—We are pleased to name this distinctive new Northern Cordillera endemic skink for the dominant indigenous peoples group of the area: the Igorot (including the enthno-linguistic groups of the Bontoc, Ibaloi, Ifugao, Isneg, Kalinga, and the Kankana-ey). Igorots are distinguished by a tradition of fierce self-determination, warrior-like dispositions, a tradition of head hunting, and a history of armed resistance against invading forces seeking to control or exploit their forested homelands. Never conquered by colonialists, Igorots fought Spanish hegemony for 325 years and have subsequently resisted, Japanese, American, and Philippine government subjugation for the last 110 years. Suggested common name: Igorot Cordillera Mountains Skink.

Sphenomorphus hadros new species
Figs. 3–5, 6

Holotype.—PNM 9618 (Field number MVD 157, male, SVL 86.7 mm), collected by Liza V. Duya, 3 June 2006 at 1540 m above sea level on Mt. Mingan (N: 15.468°; E: 121.395°), Municipality of Dingalan, Aurora Province, Luzon Island, Philippines.

Paratopotypes.—Same locality and collector as holotype, with the following exceptions: PNM 9624 (MVD 134), collected 1 June, 2006; PNM 9620 (MVD 158), 9625 (MVD 147) collected 4 June 2006; PNM 9632 (DSB 4220), collected 11 June 2006, 1476 m, N 15.46620°, E 121.38846°; PNM 9619 (MVD 109), KU 320132 (MVD 110), and KU 320133 (MVD 108): N 15.466°; E 121.396°, 1677 m, 29 May, 2006.

Other paratypes.—CMNH 5772 (Field Number RMB 1010) collected 20 May 1997 at 1200 hr by RMB 1050 m on the south slope of Mt. Ma-aling-aling, (N: 15.652°, E: 121.352°), Kabatangan River drainage, Aurora National Park, 1.2 km S, 1.3 km E of Barangay Villa Aurora, Municipality of San Luis, Aurora Province, Luzon Island, Philippines.

Diagnosis.—Large species of *Sphenomorphus*, distinguished by the following combination of characters: (1) body size large, SVL 73.5–86.7 mm; (2) prefrontals moderate, separate; (3) frontoparietals fused; (4) labials 7–8; (5) large supraoculars 4; (6) paravertebrals 108–111; (7) midventrals 54–57; (8) scales around midbody 45–47; (9) fourth toe lamellae 18–22; (10) mid-dorsum dark brown with scattered tan spots and vertebral series of thick, black spots; (11) ventrolateral surfaces of neck and head black with gray and tan blotches and white spots on labials; (12) a prominent inverted acutely triangular black marking present above forelimb insertion; and (13) ventrum pale yellow.

Comparisons.—*Sphenomorphus hadros* is distinguished from *S. beyeri* by a larger maximum body size, a greater number of paravertebrals, midventrals, and midbody scale rows, and a pale yellow (vs. bright, golden-yellow) ventrum. The new species differs from *S. diwata* by a much larger body size, more paravertebrals, midventrals, midbody scale rows, 4th toe lamellae, fused (vs. not fused) frontoparietals, and the presence (vs. absence) of an inverted acutely triangular black marking above forelimb insertion. *Sphenomorphus hadros* is distinguished from the species described herein, *S. boyingi*, by a much larger body size, greater number of paravertebrals, midventrals, and midbody scale rows, dorsum dark brown with white spots (vs. homogeneous light brown), possession of an acutely (vs. obtusely) triangular inverted black marking above forelimb insertion, and a pale yellow ventrum (vs. ventrum bright orange with yellow spots). Finally, the new species is distinguished from the new species described above, *S. igorotorum*, by a much larger body size, a greater number of paravertebrals, midventrals and midbody scales, and possession of an inverted, acutely triangular black marking above forelimb insertion (vs. a distinct black bar from snout, through eye, tympanum, and neck), and by a pale yellow ventrum (vs. ventrum deep orange). These and other comparisons are summarized in Table 1.

Description of holotype.—(Figs. 3–6) Large-sized (SVL 86.7 mm), dissected for liver sample, well preserved adult male specimen with hemipenes inverted. Body elongate (axilla–groin distance/SVL = 0.51), limbs well developed (hind limb length/SVL = 0.32), fore- and hind limbs not overlapping when adpressed, tail inferred to be long (SVL/tail length should be approximately 0.7) but holotype's tail autotomized and partially regenerated (55.0 mm); head robust, distinct from neck (head length/SVL = 0.21), longer than wide (head width/head length = 0.68), widest at point between eye and auricular opening.

Snout moderate, bluntly rounded in dorsal and lateral view (snout length/head length = 0.34); rostral wide, contacting frontonasal and nasals; frontonasal wider than long, in contact with nasals, rostral, anteriodorsal loreal, and prefrontals; prefrontals separate, each contacting dorsal loreals, frontal, frontonasal, 1st supraciliary, and 1st supraocular; frontal longer than wide, in broad contact with two anterior supraoculars; enlarged supraoculars four, 1st largest, 2nd widest; frontoparietals fused into a single plate, in contact with 2nd, 3rd, and 4th supraoculars; interparietal kite-shaped with longest ramus pointing posteriorly; parietals in point contact behind interparietal, barely contacting fourth supraocular; postsupraocular region with multiple, differentiated scales separating the parietal from supraocular 4; nuchals nonelongate.

Nasal pierced by naris slightly posterior of center; nasal surrounded anteriorly by rostral, dorsally by frontonasal, posteriorly by anteriodorsal and anterioventral loreal scales, and ventrally by 1st supralabial (nearly touching 2nd supralabial); loreal region with three scales, anteriodorsal, anterioventral and a single posterior loreal, posterior loreal wider dorsally, extending to a point ventrally; preoculars 3, median largest, extending anterioventrally and contacting the second supralabial; supralabials 7, 5th under center of eye; supraciliaries 16, largest in the middle of the series; lower ciliaries 14; lower eyelid scaly and transparent, lacking non-scaled "window;" suboculars 12, subequal; temporal region dominated by small, differentiated scales, two enlarged temporal scales border the lateral edge of the parietal, all other scales non-distinct; auricular opening moderate (ear diameter/eye diameter = 0.45), vertically ovoid, moderately sunk, tympanum visible.

Infralabials 8, 5 and 6 below center of eye, decreasing in size; mental large, forming a straight suture with a single large postmental, first infralabials, and first supralabials; chin scales increasing in number posteriorly (1, 2, 4, 6, etc) and then blending into size and shape of gular scales; gular scales subequal to postmentals, smaller than ventrals.

Body cylindrical, with 109 paravertebrals, midventrals 56, and midbody scales 44; dorsal trunk scales slightly convex and slightly smaller than flatter ventrals; all trunk scales imbricate, smooth, without striations, keels or pits; tail elongate, regenerated in holotype (55.0 mm) but estimated at approximately 120 mm in original (based on 1.4x body ratio, derived from paratype with intact tail), subsquarish in cross section at base (due to slight hemipenal bulge), becoming approximately circular in cross section at point of regrowth; subcaudal scales slightly widened at tail base, undifferentiated for basal half of tail, irregular after autotomy scar on regenerated tail portions.

Forelimbs smaller than hind limbs, all limbs pentadactyl; forelimb scales smaller than body scales, imbricate and smooth, reducing successively closer to manus; supradigital scales double above all digits, in alternating "braided" configuration across fingers; lamellae becoming keeled, sharply on distal portions of digits; relative digit length with lamellae (L/R) in parentheses: III(13/12) = IV(13/13) > II(9/8) > V(8/8) > I(6/5); palmar scales raised, forming irregular ventral protrusions from palmar surface of manus; one row of 5 enlarged scales, with slightly raised distal edges along edge of palm.

Hind limbs moderate (hind limb length/axilla–groin distance = 0.63); scales of dorsal limb surfaces of hind limb subequal in size and shape to body scales except where greatly reduced at limb insertion; supradigitals

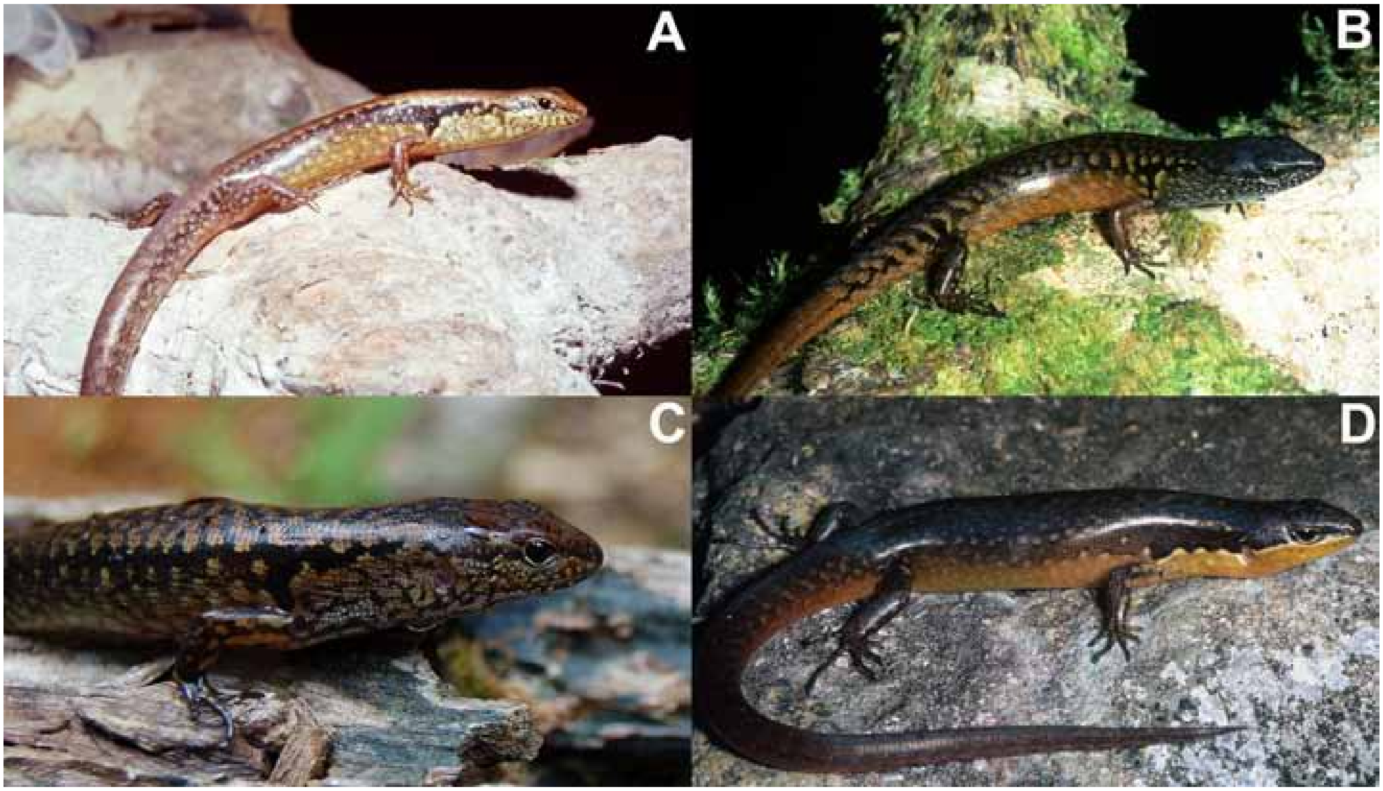

Fig. 4. Color photos of *S. boyingi*, new species (A), *S. beyeri* (B), *S. hadros*, new species (C), and *S. igorotorum*, new species (D), in life.

double above Toes I–V, in alternating "braided" configuration across dorsal surface of remaining toes; subdigital lamellae keeled, sharpest keels distally; relative digit length with lamellae (L/R) in parentheses: IV(21/13, toe damaged) > III(18/17) > II(11/12) > V(11, claw damaged/12) > I(7/6); plantar scales irregular, slightly raised, with 5 large, pointed scales, with raised, ventral surfaces forming spade-like protrusions along ankle/plantar surface of pes margin.

Precloacal region with 3 enlarged rows of elongate scales between pelvic region and cloaca; precloacals 8, medial pair enlarged (left overlapping right), enlarged precloacals overlap lateral, undifferentiated scales.

Measurements of holotype (in mm).—SVL 86.7; tail length 55.0 (regenerated); axilla–groin distance 44.5; hind limb length 27.9; snout–forelimb length 30.0; head length 18.4; head width 12.5; snout length 6.2; interorbital distance 5.9; internarial distance 3.0; eye diameter 2.9; auricular opening diameter 2.0.

Coloration in preservative.—Dorsal ground color very dark brown, lacking vertebral line darker pigment; middorsal region very dark brown with light brown to tan distinct subcircular to round spots; dorsolateral region marked by a series of large light tan spots, bordered laterally by long, wavy black lines that form the dorsomedial edge of bold, black, lateral trunk coloration; black lateral trunk pattern strongest in nuchal region and above limb insertions, less distinct at mid trunk and base of tail where bold black coloration is broken into a series of black blotches; ventrolateral trunk coloration progressively fades to a gray-on-tan reticulum of scattered pigment; dorsal surfaces of the head a relatively uniform brown with indistinct black mottling and sharp black pigment concentrated on borders of head plates; supraoculars 2–4 nearly black; lateral surfaces of head with dark brown above, a thick black bar extending from tip of snout, through narial, loreal, ocular, parietal and auricular regions (boldest in loreal region); supraoculars gray with tan blotches and tan spots on supralabials, infralabial and gulars, black with tan blotches and distinct spots on infralabials; throat black with tan blotches.

Dorsal surfaces of limbs black with round brown spots; dorsal surfaces of manus and pes marbled black and tan; dorsal surfaces of digits barred black and tan; ventral surfaces of arms and legs ivory with black spots; subdigital lamellae, palmar surface of manus, and plantar surface of pes dark gray to black; ventrum ivory, devoid of any dark pigmentation; ventral tail ivory with black spots; distal subcaudals black.

Coloration in life.—(Based on color photographs of KU 320133). In life, color pattern does not differ markedly from specimens in preservative; differences are enu-

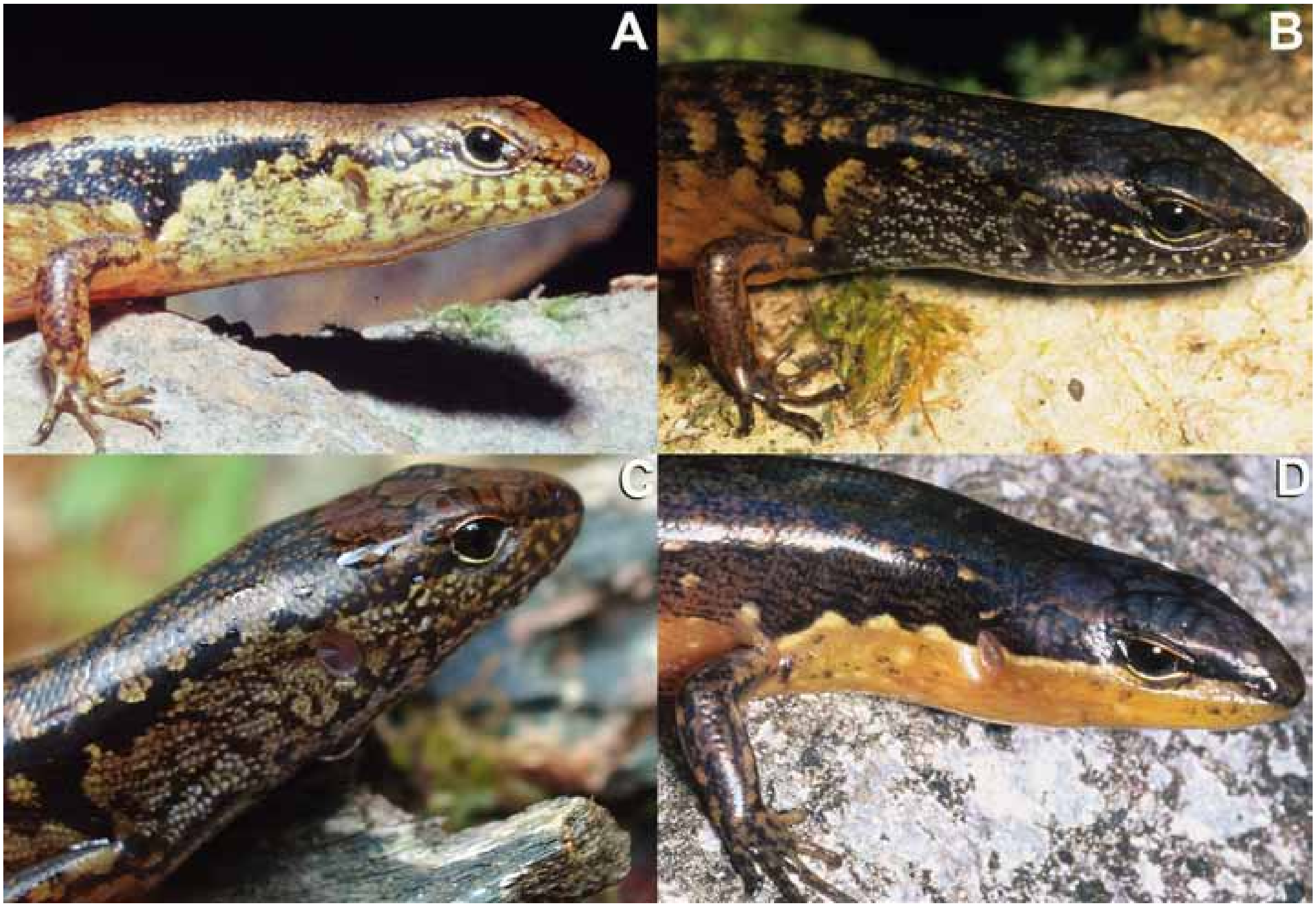

Fig. 5. Variation in color patterns of heads of *S. boyingi*, new species (A), *S. beyeri* (B), *S. hadros*, new species (C), and *S. igorotorum*, new species (D), in life.

merated below. Dorsal body ground color medium golden-brown with black overlying pattern elements; contrast between golden-brown and black pattern particularly intense in region of forelimb insertion; nuchal region predominantly black (with gray and golden-brown flecks), in contrast to dark brown coloration of head plates, each delineated with prominent black borders; lateral head coloration predominantly black with gold and black spots; ciliaries bright yellow; tympanum medium pink; labials black with gold spots; loreal, preocular and post ocular regions black; lateral and ventral gular region bluish-gray with black reticulum; flanks golden-brown with black reticulum; dorsal and lateral surfaces of limbs dark brown with distinct orange spots and bars; dorsal surfaces of manus, pes, and digits brown and orange; throat bluish-silver, ventrum and ventral tail pale yellow; lateral tail surfaces pale blue with black blotches; iris purplish-brown; live tongue color unrecorded.

Variation.—In our small series of six specimens, vertebrals vary 108–111, midventrals, 54–57, midbody scale rows 44–47, and 4th toe lamellae 18–22. The arrangement of head scales in our small series is nearly invariant, with the one exception being a single paratype with prefrontals nearly in medial point contact (PNM 9619); this leads us to believe that degree of prefrontal contact may vary in the new species and that a large sample size might reveal additional instances of polymorphism in this character.

The four paratypes exhibit color patterns that agree well with holotype; KU 320133 a slight concentration of dorsal melanic pigment into a vague series of middorsal vertebral spots. Three paratypes (PNM 9619, 9620, KU 320132) exhibit nearly completely black lateral head and neck coloration. In these specimens the black-on-tan ventrolateral reticulum wraps on to ventral trunk surfaces more extensively. The holotype and paratype PNM 9620 have markedly lighter lateral coloration. In one specimen (KU 320132) the head is nearly black, with only a few dark brown blotches in the center of larger head plates. In specimens with regenerated tails (PNM 9618, 9619) and original tails (PNM 9620), the tail tip is consistently black on dorsal, lateral, and ventral surfaces.

Habitat and natural history.—Localities for this species include Mt. Ma-aling-aling (approximately 900 m; Brown et al., 2000a), northern Aurora Province and Mt. Mingan (1540–1677 m; Fig. 1), southern Aurora Province. Other congeners collected in the mountains of Aurora include *S. abdictus aquilonius*, *S. cumingi*, *S. decipiens*, *S.* cf. *lawtoni*, *S. steerei*, *S. leucospilos*, and *S. tagapayo* (Brown et al. (2000a). See Brown et al. (1999, 2000a) for full descriptions of forest and vegetation characteristics.

Etymology.—The specific epithet is derived from the Greek *hadros*, meaning well-developed, bulky, strong, in reference to the new species' large body size and the fact that it exceeds all other members of Group I *Sphenomorphus* in both mensural and meristic characters. Suggested common name: Aurora Mountain Skink.

Redescription of *Sphenomorphus beyeri* Taylor, 1922
Syn. *Sphenomorphus beyeri* Taylor, 1922: 283; Brown, Ferner, and Sison, 1995 (part)
Figs. 2, 4–6

Holotype.—Philippines, Luzon Island, Quezon Province, Municipality of Tayabas, Mt. Banahao: CAS 61183, collected by E. H. Taylor, 31 May 1920 at approximately 1500 m.

Referred specimens.—Municipality of Tayabas, Barangay Lalo, Hasaan, 1275 m, Mt. Banahao: PNM 6757, 6666–67, PNM 9626–9628, 9629–9631, KU 320128, 320134, TNHC 62673–74; Barangay Lalo: FMNH 26612–26619, 267559, 267560.

Diagnosis.—A species of *Sphenomorphus*, distinguished by the following combination of characters: (1) body size large, SVL 57.8–72.9; (2) prefrontals moderate, separate; (3) frontoparietals fused; (4) labials 6–7; (5) large supraoculars 4; (6) paravertebrals 88–102; (7) midventrals 38–43; (8) scales around midbody 38–42; (9) fourth toe lamellae 18–21; (10) dorsal coloration medium to dark brown with evenly-spaced round white spots, with or without a pair of wavy, black, dorsolateral stripes on trunk; (11) ventrolateral surfaces of neck and head brown or black with black labials, each with a white spot; (12) a prominent inverted acutely triangular marking present above forelimb insertion; and (13) ventrum bright golden-yellow in life.

Comparisons.—*Sphenomorphus beyeri* is distinguished from *S. boyingi* by larger maximum body size, fewer midventrals, consistently separate prefrontals (vs. prefrontals in variable contact), dorsum dark brown with evenly-spaced, distinct, round white spots, (vs. dorsal coloration a homogenous light brown, with or without a midvertebral stripe), an acutely (vs. obtusely) triangular inverted black marking above forelimb insertion, and a ventrum bright golden-yellow (vs. bright orange ventrum with pale yellow spots; Table 1). *Sphenomorphus beyeri* differs from *S. igorotorum* by a larger body size, fewer midventrals and midbody scales, by dorsolateral surfaces of neck and head black with white spots (versus lateral dorsolateral pattern distinctly stratified in *S. igorotorum,* with dark brown on head and lateral surfaces divided by a distinct black bar across snout, through eye, auricular opening, and onto neck; deep orange on ventrolateral surfaces of head and neck), presence (vs. absence) of an inverted acutely triangular marking above forelimb insertion, and by a bright golden-yellow (versus deep orange) ventrum. *Sphenomorphus beyeri* differs from *S. hadros* by a smaller body size, fewer paravertebrals, midventrals, and midbody scales, lighter overall coloration throughout body (but similar color pattern characteristics), and a bright golden-yellow (vs. pale yellow) ventrum. Finally, *S. beyeri* differs from *S. diwata* by a larger maximum body size, fewer midventrals, separate (vs. contacting) prefrontals, fused (vs. not fused) frontoparietals, presence (vs. absence) of an inverted obtusely triangular black marking above forelimb insertion, and lighter overall coloration.

Description and variation (including holotype).— (based on 23 specimens, including holotype) A large species (adult SVL 57.8–72.9 mm). Body slender, elongate (axilla–groin distance/SVL = 0.50–0.61), limbs well developed (hind limb length/SVL = 0.33–0.39), fore- and hind limbs not overlapping when adpressed, tail long (SVL/tail length = 0.61–0.72); head robust, distinct from neck (head length/SVL= 0.19–0.21), longer than wide (head width/head length = 0.62–0.69).

Snout moderate, bluntly rounded in dorsal and lateral view (snout length/head length = 0.34–0.36); rostral wide, contacting frontonasal and nasals; frontonasal wider than long, in contact with nasals, rostral, anteriodorsal loreal, and prefrontals; prefrontals separate or rarely in medial point contact with each other (holotype prefrontals separate); prefrontals contact dorsal loreals, frontal, frontonasal, 1st supraciliary, and 1st supraocular; frontal longer than wide, in broad contact with two anterior supraoculars; enlarged supraoculars four, 1st largest, 2nd widest; frontoparietals fused into a single plate, in contact with 3 supraoculars; interparietal kite-shaped with longest ramus pointing posteriorly; parietals in moderate contact behind interparietal, right overlapping left, or barely in contact with no discernable overlap; parietals barely contacting fourth supraocular, postsupraocular region with multiple small scales, and small scales in the temporal region; nuchals undifferentiated, non-elongate.

Nasal pierced in center by naris, surrounded anteriorly by rostral, dorsally by frontonasal, posteriorly by anteriodorsal and anterioventral loreals, and ventrally by 1st supralabial; loreals divided into anterior and posterior

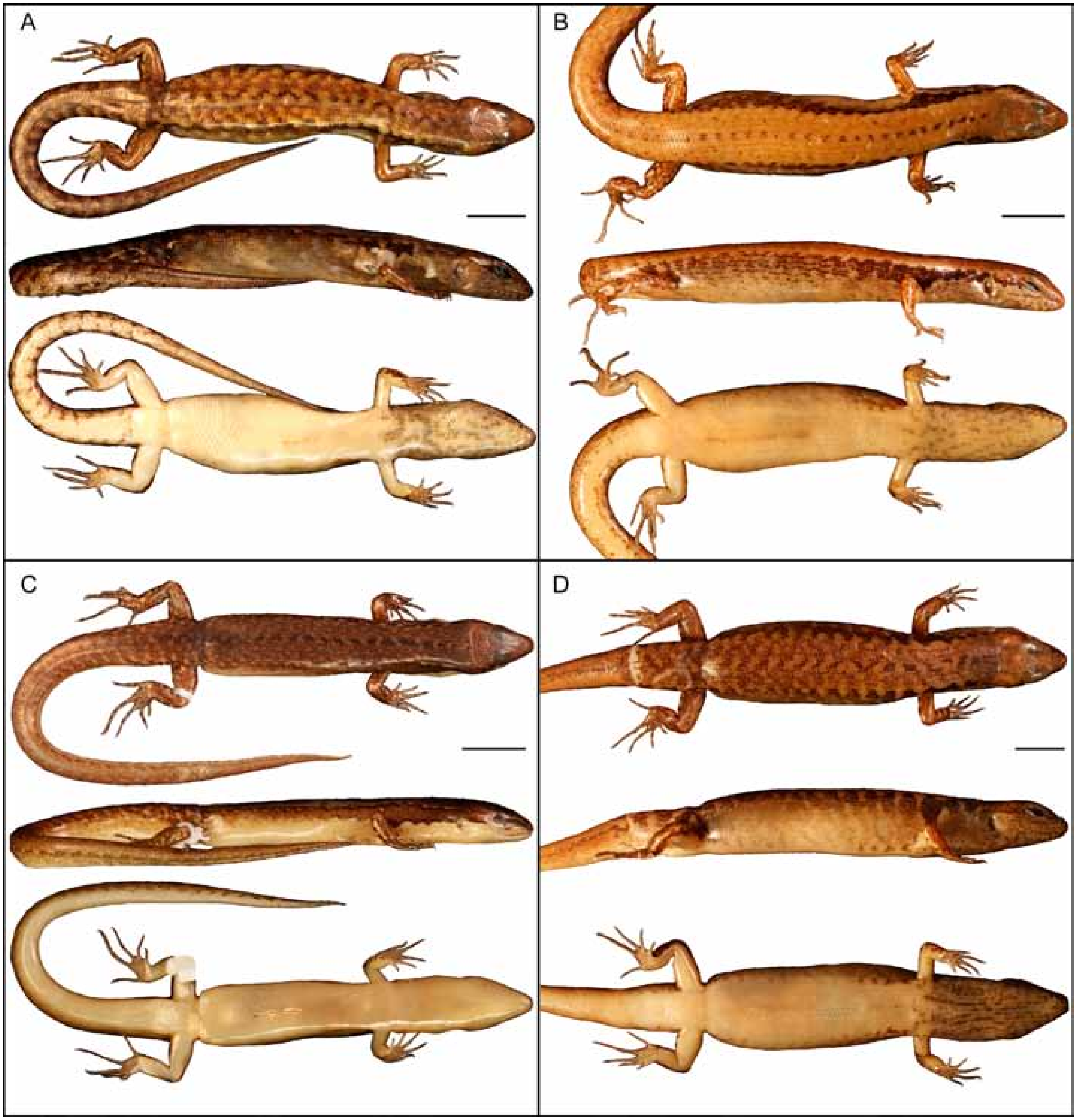

Fig. 6. Preserved specimen photos: *S. beyeri* (A; CMNH 3653), *S. boyingi*, new species (B; TNHC 62673), *S. igorotorum*, new species (C; holotype PNM 9623), and *S. hadros*, new species (D; paratype CMNH 5772). Scale bars = 10 mm.

pairs, dorsal scales larger than ventrals; preoculars 2 or 3, subequal in size; supralabials 6–8 (rarely 9; holotype 6 left/7 right), 5th under center of eye; supraciliaries 10–16, largest anteriorly (holotype 10); lower ciliaries 10–14 (holotype 11); lower eyelid scaly and transparent, lacking non-scaled "window;" suboculars 10–12, largest anteriorly; temporal region dominated by small scales, lacking large shield-like temporal scales; auricular opening large (ear diameter/eye diameter = 0.56–63), vertically ovoid, moderately sunk, tympanum visible.

Infralabials 7–9 (holotype 7/7), decreasing in size; mental large, contacting postmental, first infralabials, and first supralabials; chin scales increasing in number posteriorly (1, 3, 5, etc.; lateral chin scales largest) and then blending into size and shape of gular scales; gular scales subequal to ventrals.

Body cylindrical, with 88–102 paravertebrals (holotype 94), midbody scales 38–42 (holotype 40), and midventrals 38–43 (holotype 38); dorsal trunk scales slightly convex and slightly smaller than flatter ventrals; all trunk scales imbricate, smooth, without striations, keels or pits; tail elongate, approximately 1.4X body, subsquarish (males) to circular (females and juveniles) in cross section at base; subcaudal scales undifferentiated, non-elongate.

Forelimbs smaller than hind limbs, all limbs pentadactyl; forelimb scales equal in size to body scales, imbricate and smooth, reducing slightly closer to manus; supradigitals double on all fingers, in alternating "braided" configuration; lamellae keeled (especially distally) on each digit; relative digit length III = IV > II > V > I ; Finger I lamellae 5–7 (holotype 5/5); palmar scales raised and irregular, forming ventral protrusions from palmar surface of manus; enlarged scales with raised distal edges forming raised protusions along edge of palm, between base of Fingers I and V.

Hind limbs moderate (hind limb length/axilla–groin distance = 0.67–74); scales of dorsal limb surfaces of hind limb equal in size and shape to body scales; supradigitals double above Toes I–V, in alternating "braided" configuration; subdigital lamellae keeled, sharpest distally; relative digit length: IV > III > II > V > I; Toe IV lamellae 18–21 (holotype 19/20); plantar scales irregular, slightly raised, with three large, pointed scales, with raised, ventral surfaces forming spade-like protrusions along ankle/plantar margin.

Precloacal region with 4–6 rows of enlarged scales between pelvic region and cloaca; medial pair of precloacal scales highly enlarged (left overlaps right), larger than and overlapping lateral undifferentiated precloacals.

Measurements of adults (in mm) (juvenile holotype in parentheses).—SVL 57.8–72.9 (43.0); tail length 83.8–94.2 (n = 4 original tails; holotype tail lost); axilla–groin distance 31–38.5 (20.9); hind limb length 24.7–28.7 (17.1); snout–forelimb length 22.4–29.3 (17.4); head length 13.1–18.4 (11.5); head width 8.3–10.7 (6.5); snout length 4.2–6.1 (3.8); interorbital distance 4.0–5.4 (3.9); internarial distance 2.4–3.6 (1.8); eye diameter 1.9–2.7 (3.3); auricular opening diameter 1.3–1.9 (1.5).

Coloration in preservative.—(based on 19 specimens, including holotype) All specimens exhibit dorsal ground color dark brown with a distinct pattern of evenly-spaced, round tan-yellow spots. Some specimens exhibit to varying degrees concentration of melanic pigment along the spine, forming a vertebral series of irregular black spots. In some specimens, the black vertebral spot row is composed of large, irregular blotched markings (FMNH 26114, 26118), in others thin black elongate markings almost fuse to form a single vertebral line (FMNH 26113, TNHC 62674, PNM 6666), in some specimens, spot rows alternate and fuse into a jagged, zig-zag black line (TNHC 62673, PNM 6757, KU 320134), in some specimens the vertebral line is extremely faint (FMNH 267560), and in others entirely absent (KU 308666, PNM 6666).

In all specimens, the dorsolateral body surfaces are marked by long, wavy black lines, that delineate middorsal coloration (dark brown with tan round spots) from predominantly lighter lateral neck and flank coloration. The intensity of the dorsolateral, wavy black color pattern is strongest in nuchal region and above both limb insertions. Black dorsolateral lines become less distinct towards posterior portions of trunk, and their vestiges continue on to the lateral tail surface, eventually becoming indistinguishable at two-thirds of the way down original tails.

The dorsal surfaces of the head are brown (FMNH 26613, 266114, PNM 6667, KU 320134, TNHC 62673) to very dark brown or black (FMNH 267559, 267560, PNM 6666, KU 308666, KU 320128, TNHC 62674) with or without indistinct black mottling. In brown-headed specimens, brown may be immaculate and homogeneous (FMNH 266113) or margins of head scales may be marked with black borders (TNHC 62673, FMNH 266114). Some very dark brown or black-headed specimens possess distinct, yellowish-gold spots, which contrast strongly the black background (TNHC 62674, KU 308666); in others (FMNH 267559–60) these markings are nearly indistinct. In light-headed specimens, supraoculars are dark gray or nearly black.

Lateral surfaces of head fall into two color patterns. The first is a stratified pattern, with dark brown above the level of the ventral border of the eye (snout, loreal region, ocular, and supraauricular region brown), with light purplish gray with dark gray spots covering ventrolateral portions of the head, throat and chin (e.g., KU 320134, TNHC 62673, FMNH 266113). In all remaining specimens, ventrolateral head surfaces are jet black with distinct gray metallic and/or bluish gray spots. In these specimens, the labial region, chin, throat, infra- and post auricular regions are pure black with distinct round spots on nearly every scale. In all specimens, the bold, black, inverted acutely triangular marking above the forelimb insertion is bordered by white to light tan radiating lines on its ventral surface, forming a prominent "V" shaped marking (enclosing the inverted acutely triangular marking) immediately above the forelimb. In most specimens, throat and chin color is gray to black (with many minute white to tan spots) or ivory with black marbling (e.g., KU 308666, FMNH 266118); dark throat coloration contrasts sharply with the species' immaculate ivory ventrum.

The dorsal surfaces of limbs are dark brown with distinct white to tan round spot and the dorsal surfaces of the manus and pes are dark brown with white to yellow distinct round spots. Dorsal surfaces of digits are barred brown and tan. The ventral surfaces of arms and legs are immaculate ivory and the palmar surface of manus, and plantar surface of pes are dark gray. Subdigital lamellae are darker gray, especially distally, and claws are black.

Distal portions of the tail are medium brown with darker lateral blotches, either indistinct and suffuse (e.g., KU 308666) or congregated into bold black blotches (FMNH 266118, 267559–60). Ventral portions of the tail ivory, with dark pigmentation, around the edges (TNHC 62673–74), scattered as spots across the ventral surface (FMNH 267559–60) or completely absent (KU 308666). Dark pigment is congregated at the tail tip, resulting in a solid black tip to the tail of most specimens.

Coloration in life.—In life (Figs. 4 and 5) *S. beyeri* dorsal ground color is yellowish-brown with black pattern. Middorsal coloration dark brown with yellow spots. Yellow color is particularly intense surrounding forelimb insertion, contrasting brightly with bold black inverted triangular marking above forelimb insertion. In life, head coloration is deep brown with gold blotches or pure black with gold spots. Lateral surfaces of head are black with gold spots on the rostrum, gold upper and lower ciliaries, and a bright yellow postoccular bar. The labials are black with gold spots for the first four or five scales, fading to slightly green or blue spots by the rear labials. The lateral nuchal region and throat are black with distinct blue flecks; rear labials, and infralabials are black with distinct blue spots.

Lateral trunk coloration yellowish-brown with black wavy dorsolateral bands; ventrolateral coloration is increasingly golden-yellow and orange, often with bright, round yellow spots. Dorsal surfaces of limbs and digits are orangish-brown with yellow spots; ventral limb surfaces are bright yellow. The ventrum is bright golden-yellow, contrasting strikingly with the black throat with blue spots and flecks. The iris is dark purplish brown and live tongue color is grayish purple.

Habitat and natural history.—We have encountered *S. beyeri* in forested habitats of Mt. Banahao (the type locality) between 900 and 1600 m, through the transition from mid-montane to upper montane forest (Whitmore, 1984). At these higher elevations, atmospheric conditions are cool and moist and forest canopy is closed. Vegetation characteristics have been described by Diesmos (1998). At the type locality, *S. beyeri* is not uncommon and can predictably be encountered by raking leaf litter and forest debris surrounding the trunks of large trees, or by turning rotting logs in contact with the forest floor (Diesmos, 1988). Other sympatric congeners at these sites include *S. abdictus aquilonius, S. cumingi, S. decipiens, S. jagori, S. leucospilos*, and *S. steerei.*

Redescription of *Sphenomorphus laterimaculatus*
Brown and Alcala, 1980
Sphenomorphus laterimaculatus Brown and Alcala, 1980
Syn. *Sphenomorphus knollmanae* Brown, Ruedas, and Ferner, 1995
Figs. 7–9

Holotype.—Philippines, Luzon Island, Sorsogon Province, Municipality of Bulusan, Barangay San Roque (N: 12.751°; E: 124.084°), collected by D. S. Rabor, April–May, 1961: CAS-SU 24204.

Referred specimens.—Luzon Island, Camarines Norte Province, Municipality of San Lorenzo Ruis, Mt. Labo Range: PNM 2119, 2128, FMNH 27021, 27022; Albay Province, Municipality of Tabaco, Barangay Buang, Mt. Mayon National Park, Mt. Mayon: PNM 5306; Municipality of Tiwi, Baranga Banhaw, Sitio Purok 7, Area "Tamagong," Mt. Malinao, 950 m: TNHC 62676–62678, KU 321816, 321817; Camarines Sur Province, Municipality of Naga City, Barangay Panicuason, Mt. Isarog National Park, Mt. Isarog (N: 13.667° E: 123.367°) 1125 m: PNM 2311 (formerly USNM 318342; holotype of *S. knollmanae*); 1350 m: USNM 318341, 318343, 318344, CAS 191800, paratypes of *S. knollmanae*); Mt. Isarog, 825 m: TNHC 62675, PNM 9673; Marinduque Island, Marinduque Province, Municipality of Boac: LSUMZ 52589–52591.

Diagnosis.—Small species of *Sphenomorphus*, distinguished by the following combination of characters: (1) body small, SVL 42.1–57.1 mm; (2) prefrontals in moderate to narrow point contact; (3) frontoparietals fused; (4) labials 6–7; (5) large supraoculars 4; (6) paravertebrals 74–83; (7) midventrals 42–48; (8) scales around midbody 34–38; (9) Toe IV lamellae 16–18; (10) dorsal coloration medium to dark brown with dark brown and black flecks between a pair of wavy, black, dorsolateral stripes on trunk; (11) ventrolateral surfaces of neck and head orange with brown flecks and golden yellow round spots; (12) an inverted acutely triangular marking present above forelimb insertion; and (13) ventrum deep orange with golden-yellow spots in life.

Comparisons.—*Sphenomorphus laterimaculatus* is distinguished from *S. boyingi* by fewer paravertebrals, and 4th toe lamellae, and a bright orange chin and throat with golden yellow spots (vs. tan with brown flecks). *Sphenomorphus laterimaculatus* differs from *S. igorotorum* by fewer paravertebrals, midventrals, midbody scales, 4th toe lamellae, and variable (vs. constant) contact between fron-

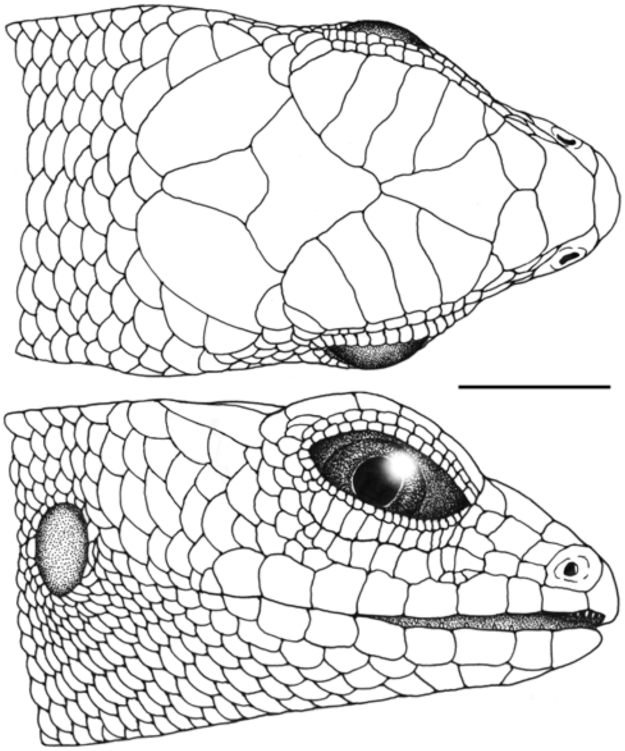

Fig. 7. Dorsal (above) and lateral (below) views of head scalation of *Sphenomorphus laterimaculatus* (KU 321817). Scale bar = 4 mm.

toparietals. *Sphenomorphus laterimaculatus* differs from *S. hadros* by a smaller body size, fewer paravertebrals, midventrals, midbody scales, and 4th toe lamellae, frontoparietals in contact (vs. separate), and a deep orange ventrum with golden-yellow spots (vs. ventrum pale yellow). Finally, *S. laterimaculatus* differs from *S. diwata* by fewer paravertebrals, midventrals, and midbody scales, a greater number of 4th toe lamellae, separate (vs. contacting) prefrontals, fused (vs. not fused) frontoparietals, and lighter overall coloration. These and other comparisons to the remaining species of Philippine *Sphenomorphus* and *Parvoscincus* are summarized in Table 1.

Description and variation (including holotype).— (based on 21 specimens, including holotype) Small species (adult SVL 42.1–57.1 mm). Body slender, elongate (axilla–groin distance/SVL = 0.45–0.57), limbs well developed (hind limb length/SVL = 0.31–0.42), fore- and hind limbs not overlapping when adpressed, tail long (SVL/tail length = 0.68–0.71); head moderate, barely distinct from neck (head length/SVL = 0.19–0.21), longer than wide (head width/head length = 0.55–0.62).

Snout moderate, bluntly rounded in dorsal and lateral view (snout length/head length = 0.31–0.39); rostral wide, contacting frontonasal and nasals; frontonasal wider than long, in contact with nasals, rostral, anteriodorsal loreal, and prefrontals; prefrontals usually in moderate contact, rarely in medial point contact (FMNH 270202, KU 321816 (holotype prefrontals in broad contact); prefrontals also contact dorsal loreals, frontal, frontonasal, 1st supraciliary, and may barely contact 1st supraocular (e.g., KU 321816, 321817, PNM 5306, TNHC 62675, CAS-SU 24204 [holotype]) or not (FMNH 27201, 27202, PNM 2119, 2128, TNHC 62676, 62678); frontal longer than wide, in broad contact with first supraciliary, and 2 or 3 anterior large supraoculars (3/3 in holotype); enlarged supraoculars four, 1st largest, 2nd widest; frontoparietals fused into a single plate, in contact with 2 or 3 supraoculars (2/2 in holotype); interparietal kite-shaped with longest ramus pointing posteriorly; parietals in moderate contact behind interparietal, right overlapping left, or in medial contact with no discernable overlap; parietals barely contacting fourth supraocular; nuchals undifferentiated, non-elongate.

Nasal pierced in center by naris, surrounded anteriorly by rostral, dorsally by frontonasal, posteriorly by anteriodorsal and anterioventral loreals, and ventrally by 1st supralabial; loreals four, divided into anterior and posterior pairs, dorsal scales larger than ventrals; preoculars 2 or 3 (holotype 2/2), subequal in size; supralabials 6–8 (holotype 6 left/7 right), 5th under center of eye; supraciliaries 10–14, largest anteriorly (holotype 11); lower ciliaries 8–12 (holotype 10); lower eyelid scaly and transparent, lacking non-scaled "window;" suboculars 9–12 (holotype 11), largest anteriorly; postsupraocular region with multiple small scales; temporal region variable, with only one or two large anterior shield-like temporal scales (and the rest of the temporal region composed of small, undifferentiated scales), or with 2 or 3 well developed rows of enlarged, temporal shields (holotype, FMNH 27201, 27202, TNHC 67676); auricular opening small (ear diameter/eye diameter = 0.7–1.3) , vertically ovoid, moderately sunk, tympanum visible.

Infralabials 7–8 (holotype 7/7), decreasing in size; mental large, contacting postmental, first infralabials, and first supralabials; postmentals increasing in number posteriorly (2, 3, 5, etc.) and then blending into size and shape of gular scales; gular scales subequal to ventrals.

Body cylindrical, with 74–83 paravertebrals (holotype 74), midbody scales 34–40 (holotype 38), and midventrals 42–48 (holotype 45); dorsal trunk scales slightly convex and slightly smaller than flatter ventrals; all trunk scales imbricate, smooth, without striations, keels or pits; tail elongate, approximately 1.3X body, subsquarish (males) to circular (females and juveniles) in cross section at base; subcaudal scales non-elongate, except for a single median row of slightly enlarged scales; median row and flanking adjacent rows fuse by midtail to form a single moderately enlarged row of subcaudals in distal half of tail of most specimens with complete tails.

Forelimbs smaller than hind limbs, all limbs penta-

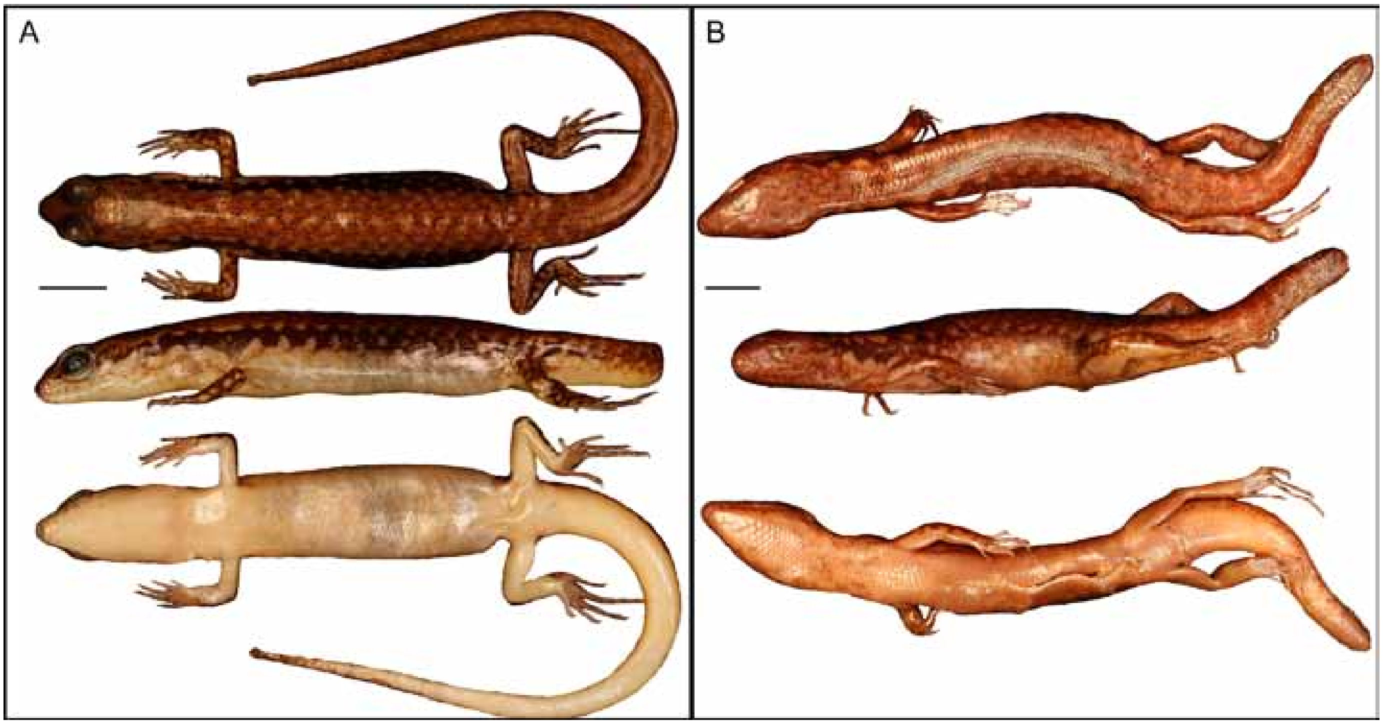

Fig. 8. Preserved specimens of *Sphenomorphus laterimaculatus*: KU 321817 (above) from Mt. Isarog and holotype CAS-SU 24204 (below) from Sitio San Roque, Municipality of Bulusan, Sorsogon Province, Luzon Isl. (below). Scale bars = 8 mm.

dactyl; forelimb scales much smaller than body scales, imbricate and smooth, reducing slightly closer to manus; supradigitals double on all fingers, in alternating "braided" configuration; lamellae keeled (especially distally) on each digit; relative digit length III = IV > II > V > I; Finger I lamellae 5 or 6 (holotype 5/5); palmar scales raised and irregular, forming ventral protrusions from palmar surface of manus; enlarged scales with raised distal edges forming raised protusions along edge of palm, between base of Fingers I and V.

Hind limbs moderate (hind limb length/axilla–groin distance = 0.61–87); hind limb scales much smaller than body scales; supradigitals double above Toes I–V, in alternating "braided" configuration; subdigital lamellae keeled, sharpest distally; relative digit length IV > III > V > II > I; Toe IV lamellae 16–19 (holotype 19/18); plantar scales irregular, slightly raised, with three large, pointed scales, with raised, ventral surfaces forming spade-like protrusions along ankle/plantar margin.

Precloacal region with 2–4 rows of enlarged scales between pelvic region and cloaca (holotype with one very enlarged row and one slightly enlarged row); medial pair of precloacal scales highly enlarged (right overlaps left), larger than and overlapping lateral undifferentiated precloacals.

Measurements of adults (in mm) (holotype in parentheses).—SVL 42.1–57.1 (53.0); original tail length 60.3–78.6 (n = 6 original tails; holotype tail incomplete); axilla–groin distance 21.7–32.6 (26.0); hind limb length 16.5–21.0 (20.0); snout–forelimb length 15.9–21.8 (20.1); head length 10.2–12.4 (12.0); head width 5.8–7.6 (7.4); snout length 3.5–4.8 (4.3); interorbital distance 3.1–4.1 (3.2); internarial distance 2.0–2.4 (2.0); eye diameter 1.1–2.1 (1.7); auricular opening diameter 1.1–1.9 (1.2).

Coloration in preservative.—(Fig. 8) (based on 20 specimens, including holotype) All specimens exhibit dorsal ground color dark brown to nearly black (FMNH 270201–270202) with lighter dorsal markings ranging from white to tan random speckling (FMNH 270202, TNHC 62677, KU 321817, PNM 2119) to round light spots arranged in three semi-regular rows: a vertebral row and two dorsolateral rows, each composed of 14–18 spots (TNHC 62675, 62676, KU 321816, the holotype CAS-SU 24204).

In all specimens, the dorsolateral body surfaces lateral to dorsolateral light spot rows are marked by long, wavy, thick black lines, that delineate middorsal coloration (dark brown with light flecks of spots) from much lighter yellow to tan ventrolateral neck and flank coloration. The intensity of the thick dorsolateral wavy black color lines is strongest between the auricular region and forelimb insertions, but extends the length of the body in some specimens (e.g., TNHC 62676, FMNH 720201, 720202, KU321816, 321817) but fades posteriorly in others (TNHC 62675, 62677, PNM 2119, 2128, 5306). If black dorsolateral lines are present on posterior portions of the trunk, they become less distinct above the hind limb and their vestiges barely continue on to the lateral tail surface. In most specimens dorsal and lateral portions of the tail are medium dark brown, becoming very dark brown to black at the tip.

The dorsal surfaces of the head are medium brown, with or without indistinct black mottling and speckling; in FMNH 270201 and 270202 dorsal cephalic coloration is completely black. In brown-headed specimens, margins of head scales may be marked with black borders (TNHC 62675–62678); in some specimens (PNM 2119, 2128), dorsal head surfaces are marbled brown and tan.

Lateral surfaces of head are stratified, dark brown above the eye and light below. A continuous demarcation (dark above, light below) divides the lateral head and nuchal surfaces from the tip of the snout, through the loreal region, through the ocular, and auricular regions. The darkest lateral pigmentation occurs at the ventral edge of dark pigmentation, such that in some specimens with light brown heads (e.g., TNHC 62677–62678), the postocular region exhibits a black stripe, bordered ventrally by a white line. A few specimens have a distinctive inverted crescent shaped black arc beneath the orbit (TNHC 62675, 61677, 62678; KU 321816, 321817)

The dorsal surfaces of limbs are patterned much like dorsal trunk coloration: dark brown with distinct white to yellow round spots. Lateral portions of the limbs dark gray with yellow spots. Dorsal surfaces of the manus, pes, and digits are light yellowish brown with dark brown blotches and bars. The ventral surfaces of arms and legs are immaculate ivory and the palmar surface of manus, and plantar surface of pes are dark gray. Subdigital lamellae are darker gray, claws black. Chin, throat, and ventral nuchal color is ivory with black lateral flecks (e.g., FMNH 270201, 270202; TNHC 62675, 62677); ventrum and proximal portions of ventral tail immaculate ivory; tail tip dark gray to black. The holotype is considerably faded and darkened with age but its color pattern otherwise matches that of the remaining specimens.

Coloration in life.—In life (Fig. 9) *S. laterimaculatus* middorsal ground color is dark brown with black spots, two dorsolateral black bands on head and trunk, bordered dorsomedially by two rows of distinct gold spots. Lateral surfaces are stratified, with black dorsolateral bands above, and deep orange with golden-yellow spots ventrolaterally. Head coloration is deep brown dorsally, with a black band from snout, along canthus, and through ocular, temporal and auricular region, bordered ventrolaterally with bright orange on chin and throat. Labial scales are orange with bright yellow or gold spots on each scale and black borders between scales.

Lateral trunk with broken dorsolateral band and bright orange with yellow spots ventrolaterally; ventrum bright orange with golden-yellow highlights. Dorsal surfaces of limbs and digits dark brown with golden-yellow spots; ventral limb surfaces are bright yellow. The iris is dark purplish-brown and live tongue color is medium gray.

Fig. 9. Lateral view of body (above; TNHC 62676, from Mt. Isarog, Camarines Sur Province) and close-up of head of *Sphenomorphus laterimaculatus* (below; KU 321817, from Mt. Malinao, Albay Province), in life.

Remarks.—The expanded sampling afforded by numerous recent collections of this species serves as the basis for an expanded definition of *S. laterimaculatus* and reveals that the range of morphological variation in this species fully encompasses the slight differences between the holotype of *S. laterimaculatus* and the small type series of Brown et al.'s (1995b) *S. knollmanae*. Thus, we adopt the more conservative action of considering all populations of Bicol Peninsula (and Marinduque Isl.) forest skinks as a single species. At present, none of Brown et al.'s (1995b) diagnostic characters continue to distinguish *S. knollmanae* from *S. laterimaculatus* and so we place the former in synonymy with the latter pending the availability of new data that might substantiate the validity of the Mt. Isarog (or any other) population as a separate species. Should genetic samples become available from the type locality and Marinduque, the subject of differentiation between these isolated populations should be revisited.

Habitat and natural history.—Although infrequently encountered and collected in limited numbers, *S. laterimaculatus* is now known from multiple volcanic mountains of the Bicol Peninsula of Luzon Island (Mt. Bulusan [presumed type locality], Mt. Malinao, Mt. Mayon, Mt. Isarog, and Mt. Labo) and the central mountains of the small Marinduque Island which was connected to southern Luzon numerous times during the Pleistocene (Voris, 2000; Brown and Diesmos, 2009). All specimens with associated elevational data have been collected from moist, closed-canopy forests, above 900 m in mid- to upper montane forest (Whitmore, 1984). Despite targeted surveys by RMB at the type locality (Lake Bulusan, Barangay San Roque, in the foothills of Mt Bulusan), no specimens have been taken at the inferred type locality (see comments by Brown and Alcala, 1980) since Rabor's original collection (1961). Other sympatric congeners found in the vicinity of *S. laterimaculatus* collection sites include *S. abdictus aquilonius*, *S. coxi*, *S. cumingi*, *S. decipiens*, *S. jagori*, *S. leucospilos*, and *S. steerei*.

DISCUSSION

It is not surprising that each of the geologically distinct mountain massifs of Luzon Island (Fig. 1; Rutland, 1968; Auffenberg, 1988; Yumul et al., 2008, 2009) contain populations of endemic, high elevation moist forest scincid lizards, for the most part limited to montane environments above 1000 m. The high elevation forest habitats of each of these mountain ranges (Auffenberg, 1988; Brown et al., 2000a:fig. 1) are isolated from those in the other isolated components, and the volcanoes of the Bicol Peninsula by wide expanses of low elevation plains that represent habitat unsuitable for montane species. No suitable habitat currently connects these mountain ranges and geological evidence strongly supports the contention that each possesses a long history of isolation as separate paleoislands and/or environmentally isolated habitat "islands" (Auffenberg, 1988; Ruedas et al., 1994; Brown et al., 1996, 2000a; Hall, 1996, 1998; Yumul et al., 2008, 2009). Although we cannot wholly dismiss the possibility that gene flow between these separate components of Luzon may have occurred as recently as the late Pleistocene (especially in the region of the Caraballo Mountains saddle between the Sierra Madre and Cordilleras), the major montane components of Luzon currently are isolated from one another by 120–200 km of inhospitable low elevation plains that form an effective barrier against dispersal between the cooler, moist subclimates (Whitmore, 1984) of high elevation cloud forests. These isolated highland habitats represent a level of insularization that may have further contributed to the diversification of Luzon's fauna (a pattern also seen in murid rodents; Steppan et al., 2003; Rickart et al., 2005; Jansa et al., 2006; Balete et al., 2006, 2007). Thus it appears that *S. boyingi* is a Zambales–Bataan endemic, *S. igorotorum* is endemic to the Cordilleras, *S. hadros* is endemic to the central and northern Sierra Madre, *S. beyeri* is endemic to the Mt. Banahao massif, and *S. laterimaculatus* is endemic to the volcanoes of the Bicol Peninsula and Marinduque. A parallel pattern of local endemism, and in the same high elevation habitats, is evident in the endemic vermivore clade of murid rodents on Luzon (Thomas, 1898; Musser and Freeman, 1981; Balete et al., 2007). We would not be surprised if future phylogenetic studies demonstrated the monophyly of these high elevation Luzon endemics, despite their putative classification in different phenotypic species groups (Brown and Alcala, 1980).

In comparing the morphology of *S. laterimaculatus* (= "*S. knollmanae*") to *S. beyeri* and *S. diwata*, Brown et al. (1995b) discussed the non-phylogenetic nature of Brown and Alcala's (1980) species groups and acknowledged the possibility that some members of Groups III and IV might be more closely-related to *S. beyeri* and *S. diwata* than currently suggested by their inclusion in Brown and Alcala's (1980) different species assemblages. Whatever the case, evidence supporting taxonomic distinctiveness of many other amphibian and reptile populations on separate Luzon massifs includes the recognition of numerous species known only from one of these mountain ranges but not the others (R. Brown et al., 1995a, 1995b, 1996, 1999, 2000a, b; Diesmos, 1998; W. Brown et al., 1997a, 1997b, 1997c, 1999a, 1999b).

What lessons can be extrapolated from the Group I Philippine *Sphenomorphus* and the *S. beyeri* complex to the larger issue of species diversity in the remaining Philippine members of the genus? Can we expect similar patterns of species distributions and endemism in the northern Philippines? Without modern and reliable distribution data, or a phylogenetic estimate, and with an admittedly outdated and largely polytypic species-level taxonomy (Brown and Alcala, 1980), we are left to hypothesize biodiversity patterns from higher level (Brown and Alcala, 1980, species-group) taxonomy, and ecological characteristics of the taxa involved. Although this exercise is not as predictive as we would like, some general expectations can be derived from the combination of species complex distributions and a cursory knowledge of the geological components of Luzon (Aufferberg, 1988;

Brown et al., 2000a; Hall, 1996; Yumul et al., 2009). Several widespread "species" are worthy of consideration. First, the *Sphenomorphus jagori* complex (including *S. coxi* and *S. abdictus*; Brown and Alcala, 1980) has been the subject of a recent comprehensive analysis of genetic diversity, the results of which indicate that Luzon species diversity may have been severely underestimated (Linkem et al., 2010b). Like the *S. jagori* complex, *S. decipiens* and *S. steerei* are equally widespread, with populations referred to these species throughout the archipelago (Brown and Alcala, 1980). Based on the results of this study, and that of Linkem et al. (2010b), we expect that the allopatric PAIC populations of both these species complexes will show equivalent levels of divergence (e.g., Brown et al., 2000b, Brown and Diesmos, 2002, 2009), commiserate with levels of morphological divergence detected here and molecular divergence detected by Linkem et al. (2010b). Thus, if equivalent cryptic species diversity resides in the *S. decipiens* and *S. steerei* complexes to the extent found in the *S. jagori/abdictus/coxi* group (Linkem et al., 2010b) and Group I Philippine *Sphenomorphus* (this paper) we might conservatively expect an additional 10–20 lineages worthy of specific status to be uncovered in future systematic treatments.

Although we have treated Group I Philippine *Sphenomorphus* as comprehensively as possible in this work, we suspect that species diversity in this complex may still be underestimated. We note that no specimens are currently available from portions of the Sierra Madre mountain range north of the Mid-Sierra Filter Zone (Welton et al., 2010), an apparent biogeographic boundary for some montane taxa that coincides with both a major geological fault (Defant et al., 1989; Yumul, 2009) and several low elevation valleys that may serve as ecological barriers for dispersal for high elevation cloud forest species (Welton et al., 2010). If specimens of Group I Philippine *Sphenomorphus* can be obtained from the northern Sierra Madre in future studies, these should be scrutinized for character differences with the species described here. Additionally, a single specimen, tentatively identified as *S.* cf *beyeri* (KU 308666) has been collected from geographically isolated Mt. Palali, Nueva Vizcaya Province, central Luzon (midway between the Cordillera and the Sierra Madre; Fig. 1). This specimen is similar to the distantly allopatric populations of *S. beyeri* from Mt. Banahao, however we find it highly unlikely that two widely disjunct populations of *S. beyeri* occur at these distant localities (separated by several localities known to support the distinct species *S. hadros*). Given the single available specimen and the lack of corroborating evidence from other sources of data (e.g., DNA sequences), we hold the identification of this single specimen in abeyance until more specimens or data are available. Clearly the subject of species boundaries in the various complexes of widespread Philippine forest skinks is an issue warranting future study.

These and other studies may result in significant changes in conservation planning if large portions of cryptic biodiversity have been underestimated in past priority setting exercises. We suspect that such cases have focused on a few forested regions where biodiversity is reasonably well known but have failed to assimilate true biogeographical patterns and embrace the evolutionary processes that give rise to them (Catibog-Sinha and Heaney, 2006; Ong et al., 2002; Posa et al., 2008; Brown and Diesmos, 2009; Brown et al., 2009).

LITERATURE CITED

Alcala, A. C., W. C. Brown, and A. C. Diesmos. 1998. Two new species of the genus *Platymantis* (Amphibia: Ranidae) from Luzon Island, Philippines. Proceedings of the California Academy of Sciences 50:381–388.

Auffenberg, W. 1988. *Gray's Monitor Lizard*. Gainsville, Florida: University of Florida Press. 419 pp.

Balete, D. S., E. A. Rickart, and L. R. Heaney. 2006. A new species of shrew-mouse, *Archboldomys* (Rodentia: Muridae: Murinae), from the Philippines. Systematics and Biodiversity 4: 489–501.

Balete, D. S., E. A. Rickart, R. G. B. Rosell-Ambal, S. Jansa, and L. R. Heaney. 2007. Description of two new species of *Rhynchomys* Thomas (Rodentia: Muridae: Murinae) from Luzon Isalnd, Philippines. Journal of Mammalogy 88:287–301.

Brown, R. M., and A. C. Diesmos. 2002. Application of lineage-based species concepts to oceanic island frog populations: the effect of differing taxonomic philosophies on the estimation of Philippine biodiversity. Silliman Journal 42:133–162.

Brown, R. M., and S. I. Guttman. 2002. Phylogenetic systematics of the *Rana signata* complex of Philippine and Bornean stream frogs: reconsiderations of Huxley's modification of Wallace's Line at the Oriental-Australian faunal zone interface. Biological Journal of the Linnean Society 76:393–461.

Brown, R. M., J. W. Ferner, and R. V. Sison. 1995a. Rediscovery and redescription of *Sphenomorphus beyeri* Taylor (Reptilia: Lacertilia: Scincidae) from the Zambales Mountains of Luzon, Philippines. Proceedings of the Biological Society of Washington 108:6–17.

Brown, R. M., J. W. Ferner, and L. A. Ruedas. 1995b. A new species of lygosomine lizard (Reptilia: Lacertilia: Scincidae; *Sphenomorphus*) from Mt. Isarog, Luzon Island, Philippines. Proceedings of the Biological Society of Washington 108:18–28.

Brown, R. M., J. W. Ferner, R. V. Sison, P. C. Gonzales, and R. S. Kennedy. 1996. Amphibians and reptiles of the Zambales Mountains of Luzon Island, Republic of the Philippines. Herpetological Natural History 4:1–22.

Brown, R. M., J. A. McGuire, and A. C. Diesmos. 2000b. Status of some Philippine frogs related to *Rana everetti* (Anura: Ranidae), description of a new species, and resurrection of *Rana igorota* Taylor 1922. Herpetologica 56:81–104.

Brown, R. M., J. A. McGuire, J. W. Ferner, and A. C. Alcala. 1999. A new diminutive species of skink (Squamata; Scincidae; Lygosominae: *Sphenomorphus*) from Luzon Island, Republic of the Philippines. Copeia 1999:362–370.

Brown, R. M., J. A. McGuire, J. W. Ferner, N. Icarangal, Jr., and R. S. Kennedy. 2000a. Amphibians and reptiles of Luzon Island, II: preliminary report on the herpetofauna of Aurora Memorial National Park, Philippines. Hamadryad 25:175–195.

Brown, R. M., C. D. Siler, A. C. Diesmos and A. C. Alcala. 2009. The Philippine frogs of the genus *Leptobrachium* (Anura; Megophryidae): phylogeny-based species delimitation, taxonomic revision, and descriptions of three new species. Herpetological Monographs 23:1–44.

Brown, W. C., and A. C. Alcala. 1980. *Philippine Lizards of the Family Scincidae*. Dumaguete City, Philippines: Silliman University Press. 264 pp.

Brown, W. C. 1995. A new lizard of the genus *Sphenomorphus* (Reptilia: Scincidae) from Mt. Kitanglad, Mindanao, Philippine Islands. Proceedings of the Biological Society of Washington 108:388–391.

Brown, W. C., R. M. Brown, and A. C. Alcala. 1997a. Species of the *hazelae* group of *Platymantis* (Amphibia: Ranidae) from the Philippines, with descriptions of two new species. Proceedings of the California Academy of Sciences 49:405–421.

Brown, W. C., A. C. Alcala, A. C. Diesmos, and E. Alcala. 1997b. Species of the *guentheri* group of *Platymantis* with descriptions of four new species. Proceedings of the California Academy of Sciences 50:1–20.

Brown, W. C., A. C. Alcala, and A. C. Diesmos. 1997c. A new species of the genus *Platymantis* (Amphibia: Ranidae) from Luzon Island, Philippines. Proceedings of the Biological Society of Washington 110:18–23.

Brown, W. C., A. C. Alcala, P. S. Ong, and A. C. Diesmos. 1999a. A new species of *Platymantis* (Amphibia: Ranidae) from the Sierra Madre Mountains of Luzon Island, Philippines. Proceedings of the Biological Society of Washington 112:510–514.

Brown, W. C., A. C. Alcala, and A. C. Diesmos. 1999b. Four new species of the genus *Platymantis* (Amphibia: Ranidae) from Luzon Island, Philippines. Proc. California. Acad. Sci. 51:449–460.

Catibog-Sinha, C. S. and L. R. Heaney. 2006. *Philippine Biodiversity: Principles and Practice.* Quezon City, Philippines: Haribon Foundation for Conservation of Natural Resources. 495 pp.

Defant, M. J., Jacques, D., Maury, R. C., De Boer, J., & Joron, J.-L. 1989. Geochemistry and tectonic setting of the Luzon arc, Philippines. Geol. Soc. America Bull. 101, 663–672.

de Queiroz, K. 1998. The general Lineage concept of species, species criteria, and the process of speciation, pp 57–75, *in* Howard, D. J., Berlocher, S. H. (eds*), Endless Forms: Species and Speciation*. New York: Oxford University Press

Diesmos, A. C. 1998. *The amphibian faunas of Mt. Banahao, Mt. San Cristobal, and Mt. Maquiling, Luzon Island, Philippines*. Masters Thesis. Los Baños, Laguna, Philippines: University of the Philippines at Los Baños.

Diesmos, A. C., R. M. Brown, and G. V. A. Gee. 2004. Preliminary report on the amphibians and reptiles of Balbalasang-Balbalan National Park, Luzon Island, Philippines. Sylvatrop, Technical Journal of Philippine Ecosystems and Natural Resources 13:63–80.

Frost D. R., and D. M. Hillis. 1990. Species in concept and practice: herpetological applications. Herpetologica 46:87–104.

Greer, A. E. 1970. A subfamilial classification of scincid lizards. Bulletin of the Museum of Comparative Biology, Harvard 139:151–183.

Greer, A. E. and F. Parker. 1967. A second skink with fragmented head scales from Bougainville, Solomon Islands. Breviora 279:1–12.

Hall, R. 1996. Reconstructing Cenozoic SE Asia, Pp. 153–184, *In* Hall, R., and Blundell, D. (eds*.), Tectonic Evolution of Southeast Asia*. London, England: Geological Society of London.

Jansa, S., K. Barker, and L. R. Heaney. 2006. Molecular phylogenetics and divergence time estimates for the endemic rodents of the Philippine Islands: evidence from mitochondrial and nuclear gene sequences. Systematic Biology 55:73–88.

Linkem, C. W., A. C. Diesmos, and R. M. Brown. 2010a. A new scincid lizard (Genus *Sphenomorphus*) from Palawan Island, Philippines. Herpetologica 66:67–79.

Linkem, C. W., K. Hesed, A. C. Diesmos, and R. M. Brown. 2010b. Species boundaries and cryptic lineage diversity in a Philippine forest skink complex (Reptilia; Squamata; Scincidae: Lygosominae). Molecular Phylogenetics and Evolution. 56: 572–585.

Musser, G. G., and P. W. Freeman. 1981. A new species of *Rhynchomys* (Muridae) from the Philippines. Journal of Mammalogy, 62: 154–159.

Ong, P. S., L. E. Afuang, and R. G. Rosell-Ambal (Eds.) Philippine Biodiversity Conservation Priorities: a Second Iteration of the National Biodiversity Strategy and Action Plan. Quezon City, Philippines: Department of the Environment and Natural Resources–Protected Areas and Wildlife Bureau, Conservation International Philippines, Biodiversity Conservation Program–University of the Philippines Center for Integrative and Developmental Studies, and Foundation for the Philippine Environment.

Posa, M. R, C., A. C. Diesmos, N. S. Sodhi, and T. M. Brooks. 2008. Hope for threatened tropical biodiversity: lessons from the Philippines. Bioscience 58: 231–240,

Rickart, E. A., L. R. Heaney, S. M. Goodman, and S. Jansa. 2005. Review of the Philippine genera Chrotomys and Celaenomys (Murinae) and description of a new species. Journal of Mammalogy 86:415–428.

Ruedas, L. A., J. R. Demboski, and R. V. Sison. 1994. Morphological and ecological variation in *Otopteropus cartilagonodus* Kock, 1969 (Mammalia: Chiroptera: Pteropodidae) from Luzon, Philippines. Proceedings of the Biological Society of Washington 107:1–16.

Rutland, R. W. 1968. A tectonic study of part of the Philippine Fault Zone Quart. J. Geological Society of London 123:293–325.

Simpson, G. G. 1961. Principles of Animal Taxonomy. New York, New York: Columbia University Press. 261 pp.

Steppan, S. J., C. Zawadzki, and L. R. Heaney. 2003. Molecular phylogeny of the endemic Philippine rodent Apomys (Muridae) and the dynamics of diversification in an oceanic archipelago. Biological Journal of the Linnean Society 88:699–715.

Taylor, E. H. 1922a. The Lizards of the Philippine Islands. Philippine Bureau of Science, Monogr. 17, Manila, Philippines.

Taylor, E. H. 1922b. Additions to the herpetological fauna of the Philippine Islands, I. Philippine Journal of Science 21:161–206.

Taylor, E. H. 1922c. Additions to the herpetological fauna of the Philippine Islands, II. Philippine Journal of Science 21: 257–303.

Taylor, E. H. 1923. Additions to the herpetological fauna of the Philippine Islands, III. Philippine Journal of Science 22:515–557.

Taylor, E. H. 1925. Additions to the herpetological fauna of the Philippine Islands, IV. Philippine Journal of Science 26:97–111.

Thomas, O. 1898. On the mammals collected by Mr. John Whitehead during his recent expedition to the Philippines with field notes by the collector. Transactions of the Zoological Society of London 14: 377–412.

Welton, L. J., C. D. Siler, D. Bennett, A. C. Diesmos, M. R. Duya, R. Dugay, E. L. Rico, M. van Weerd, and R. M. Brown. 2010. A spectacular new Philippine monitor lizard reveals a hidden biogeographic boundary and a novel flagship species for conservation. Biology Letters. doi: 10.1098/rsbl.2010.0119

Whitmore, T. C. 1984. *Tropical Rain Forests of the Far East*. Oxford, England: Clarendon Press. 718 pp.

Wiley, E. O. 1978. The evolutionary species concept reconsidered. Systematic Zoology 21:17–26.

Yumul, G., Jr., C. Dimilanta, V. B. Maglambayan, and E. Marquez. 2008. Tectonic setting of a composite terrane: A review of the Philippine island arc system. Geosciences Journal 12:7–17.

Yumul, G., Jr., C. Dimilanta, K. Queaño, and E. Marquez. 2009. Philippines, Geology, pp. 732–738, *in* Gillespie, R., and Clague, D. (eds.), *Encyclopedia of Islands*. Berkeley, California: University of California Press.

APPENDIX
Specimens Examined

Sphenomorphus abdictus

PHILIPPINES: Polillo Island, Quezon Province, Municipality of Polillo, Barangay Pinaglubayan: KU 302911–302922; Lubang Island, Occidental Mindoro Province, Municipality of Lubang, Barangay Vigo: KU 304041–304049; Babuyan Claro Island, Cagayan Province, Municipality of Calayan, Barangay Babuyan Claro: KU 304787–304790.

Sphenomorphus acutus

PHILIPPINES: Samar Island, Eastern Samar Province, Municipality of Taft, Barangay San Rafael: KU 310818; Mindanao Island, Agusan del Sur Province, Municipality of San Francisco, Barangay Bagasan II, Mt. Magdiwata: KU 319961–319964.

Sphenomorphus arborens

PHILIPPINES: Panay Island, Antique Province, Municipality of San Remigio, Barangay Aningalan: KU 306805–306809, 306830.

Sphenomorphus atrigularis

PHILIPPINES: Mindanao Island, Zamboanga City Province, Municipality of Pasonanca, Barangay Pasanonca; Sitio Canucutan; Tumaga River, Pasonanca Natural Park, 90 m: KU 305031–305060; Davao City Province, Municipality of Malalag, Kibaualan: CAS-SU 28789, 28791, 28794-95; Basilan Island, Basilan Province, Municipality of Abung-abung: CAS 60242, 60244, 60246-47.

Sphenomorphus beyeri

See Holotype and Referred Specimens sections.

Sphenomorphus cf. *beyeri*

PHILIPPINES: Luzon Island, Nueva Vizcaya Province, Municipality of Quezon, Barangay Maddiangat, Caraballo Mountains, Mt. Palali: KU 308666.

Sphenomorphus bipatietalis

PHILIPPINES: Jolo Island, Jolo Province, Municipality of Jolo: CAS 60703-04, 60706-08, 60711, 60714, 60718.

Sphenomorphus boyingi

See Holotype and Paratypes sections.

Sphenomorphus coxi

PHILIPPINES: Mindanao Island, Davao Province: FMNH 52571–51573; Agusan del Sur Province, Agusan Valley, Bunawan: CAS 62044–62046.

Sphenomorphus cumingi

PHILIPPINES: Polillo Island, Quezon Province, Municipality of Polillo, Barangay Pinaglubayan, KU 302923; Mindoro Island, Occidental Mindoro Province, Municipality of Sablayan, Barangay Batong Buhay: KU 304067–304068, 304070, 304072, 305728; Luzon Island, Camarines Sur Province, Naga City: Barangay Panicuason, Mt. Isarog: TNHC 62748; Zambales Province, Municipality of Olongapo: SBMA Naval Base: TNHC 62749.

Sphenomorphus decipiens

PHILIPPINES: Luzon Island, Camarines Norte Province, Municipality of Labo, Barangay Tulay Na Lupa, Mt. Labo: KU 306559–306561, 313849, 313859–313869; Camarines Sur Province, Naga City, Barangay Panicuason, Mt. Isarog: TNHC 62883, 62885–62888, 62891; Albay Province, Municipality of Malinao, Barangay Tagoytoy, Mt. Malinao: TNHC 62896–62898.

Sphenomorphus diwata

PHILIPPINES: Mindanao Island, Agusan del Norte Prov., Diwata Mountains CAS 2478 (holotype) 13314–15; PNM 9633–9635, KU 320129–320131.

Sphenomorphus fasciatus

PHILIPPINES: Mindanao Island, Davao City: FMNH 52623–52627; Mindanao Island, Zamboanga City Province, Municipality of Pasonanca, Barangay Pasanonca; Sitio Canucutan; Tumaga River, Pasonanca Natural Park: KU 315061–315066; Leyte Island, Leyte Province, Municipality of Baybay, Pilim, San Vicente: KU 311252, 311253; Samar Island, Eastern Samar Province, Municipality of Taft, Barangay San Rafael: KU 310808; Western Samar Province, San Jose de Buan, Barangay Poblacion: KU 310807; Dinagat Island, Dinagat Province, Municipality of Loreto, Barangay Sn. Juan, (Near Venus Dias Cave): KU 310093.

Sphenomorphus hadros

See Holotype and Paratypes sections.

Sphenomorphus igorotorum

See Holotype and Paratype sections.

Sphenomorphus jagori

PHILIPPINES: Panay Island, Antique Island, Municipality of San Remigio, Barangay Aningalan: KU 306805–306809; Dinagat Island, Dinagat Province, Municipality of Loreto, Barangay San Juan: KU 306535–306544.

Sphenomorphus kitangladensis

PHILIPPINES: Mindanao Island, Bukidnon Province, Mt. Kitanglad Range, SE of Baunson: CAS 191084, 250641–250643 (paratypes), 250644 (holotype).

Sphenomorphus laterimaculatus

See Holotype and Referred Specimens sections.

Sphenomorphus lawtoni

PHILIPPINES: Luzon Island: FMNH 177674; Bicol Peninsula: FMNH 270525–270527; Nueva Vizcaya Province, Municipality of Quezon, Barangay Maddiangat, Mt. Palali: KU 308643, 308652, 308661, 308662, 308668, 308686; Kalinga Province, Municipality of Balbalan: CAS 61501–61502, 61504.

Sphenomorphus leucospilos

PHILIPPINES: Luzon Island, Quezon Province, Municipality of Tayabas, Barangay Lalo, Mt. Banahao: TNHM 62680–62683, PNM 9636–9639; Camarines Norte Province, Municipality of Labo, Barangay Tulay Na Lupa, Mt. Labo: KU 313870;

Sphenomorphus llanosi

PHILIPPINES: Leyte Island, Leyte Province, Municipality of Baybay, Pilim, San Vicente: KU 311269, 311270; Samar Island, Eastern Samar Province, Municipality of Taft, Barangay San Rafael: KU 310322–310324, 310786–310795, 310840, 310856, 310857.

Sphenomorphus luzonensis

PHILIPPINES: Luzon Island, Highlands of Kipanto: CAS-SU 24147; Luzon Island, Mountain Province, Municipality of Bauko, Barrio Sinta: USNM 512760-62; Kalinga Province, Municipality of Balbalan, Balbalasang: FMNH 258990.

Sphenomorphus mindanensis

PHILIPPINES: Mindanao Island, Agusan Del Norte Province: CAS 133291, 133322; Dinagat Island, Dinagat Province, Municipality of Loreto, Barangay Santiago, sitio Cambinlia (Sudlon): KU 310135; Samar island, Eastern Samar Province, Municipality of Taft, Barangay San Rafael: KU 310809.

Sphenomorphus steerei

PHILIPPINES: Luzon Island, Municipality of Masinloc, Barangay Coto, south slope, Mt. Apoy: CMNH 4361-67; PNM 2457-64; Cebu Island, Cebu Province, Cebu City, Taptap barrio: CAS 139099, 139101–07, 139111–139112.

Sphenomorphus tagapayo

PHILIPPINES: Luzon Island, Aurora Province, Municipality of San Luis, Barangay Villa Aurora, Aurora National Park, Kabatangan River drainage: PNM 5767 (holotype), 5766, 5668, CMNH 5631, 5632 (paratypes); Municipality of Maria Aurora, Barangay Villa Aurora, Kamatis River drainage: CMNH 5633 (paratype); Nueva Viscaya Province, Municipality of Quezon, Barangay Maddiangat, Mt. Palali: KU 325818–325825.

Sphenomorphus traanorum

PHILIPPINES: Palawan Island, Palawan Province, Municipality of Rizal, SW of Mt. Mantalingajan peak: PNM 9640 (holotype); Municipality of Rizal, Mt. Paray-Paray, 1593 m: KU 311440, 311441, 311443 (paratypes); Municipality of Rizal, Mt. Mantalingahan peak 2, 2068 m: KU 311423, PNM 9641 (paratypes).

Sphenomorphus variegatus

PHILIPPINES: Mindanao Island, Davao City: FMNH 52617, 52627, 52630, Camiguin Sur Island, Camiguin Province, Municipality of Mambajao: Barangay Pandan, KU 309899–309907;

Sphenomorphus victoria

PHILIPPINES: Palawan Island, Palawan Province, Municipality of Brooke's Point, Barangay Samarinana, Mt. Mantalingahan Range: KU 309443.

Sphenomorphus wrighti

PHILIPPINES: Palawan Island, Palawan Province: FMNH 5263, 62633; Municipality of Rizal, Mt. Paray-Paray: KU 311417–311422; Mt Mantalingahan peak 2: KU 311436–311439.

Parvoscincus palawanensis

PHILIPPINES: Palawan Island, Palawan Province, Municipality of Puerto Princesa, Barangay Iwahig, Malabo Peak: CAS-SU 23122 (holotype), 91905 (paratype).

Parvoscincus sisoni

PHILIPPINES: Panay Island, Antique Province, Municipality of Culasi, Barangay Alojipan, Hanggud Tubig, Mt. Madja-as, 1400 m: PNM 2308 (holotype), 2309; CAS 193110; CMNH 3797–3799 (paratypes); ACD 002 (deposited at PNM).

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