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## Additions to Philippine Slender Skinks of the *Brachymeles bonitae* Complex (Reptilia: Squamata: Scincidae) III: a new species from Tablas Island

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### Abstract

Studies of the diversity of Philippine amphibians and reptiles have resulted in the continued description of cryptic species. Species formerly thought to range across multiple recognized faunal regions are now considered to be assemblages of multiple unique species, each restricted to a single faunal region. This pattern continues to hold true when considering Philippine skinks of the genus *Brachymeles*. Recent studies have resulted in the description of numerous unique species with many exhibiting various degrees of digit loss or limb reduction, as well as suggesting that unique lineages are still present in the *B. bonitae* Complex. In this paper, we describe a new species of fossorial skink within this species complex from Tablas Island based on collections made nearly 50 years ago. Although no genetic data are available for the new species, examinations of morphological data (qualitative traits, meristic counts, and mensural measurements) support its distinction from all other members of the genus. *Brachymeles dalawangdaliri* sp. nov. is differentiated from other members of the genus based on a suite of unique phenotypic characteristics, including a small body size (SVL 66.0–80.9 mm), bidactyl fore-limbs, digitless, unidactyl, or bidactyl hind limbs, a high number of presacral vertebrae (49), the absence of auricular openings, and distinct dorsal head scale patterns. The description of the new species increases the diversity of endemic vertebrates recognized to occur in the Romblon Island Group in the central Philippines.

**Key words:** biodiversity, endemism, faunal region, fossoriality, limb reduction, non-pentadactyl, pentadactyl, Romblon Island Group

### Introduction

The islands of the Philippines are well known for their high levels of amphibian and reptile biodiversity (Brown *et al.* 2013; Diesmos *et al.* 2015) with the number of recognized species of amphibians and reptiles experiencing substantial growth over the last century, particularly over the past decade (e.g. Siler *et al.* 2009, 2010a,b, 2014a; Siler & Brown 2010; Davis *et al.* 2014, 2015). Many of these newly described species were formerly part of poorly understood species complexes that spanned multiple recognized faunal regions (Siler *et al.* 2014b). Both molecular and genetic investigations into widespread species complexes have resulted in the identification of multiple, unique lineages, each typically restricted to a single faunal region (Welton *et al.* 2009, 2010a,b; Siler *et al.* 2010a,b, 2011a; Siler & Brown 2010). The identification of these cryptic or secretive species has further increased the remarkable

level of endemism in the Philippines. The island nation is home to a wide variety of endemic skinks (family Scincidae), including a unique radiation of semi-fossorial species in the genus *Brachymeles* Duméril & Bibron.

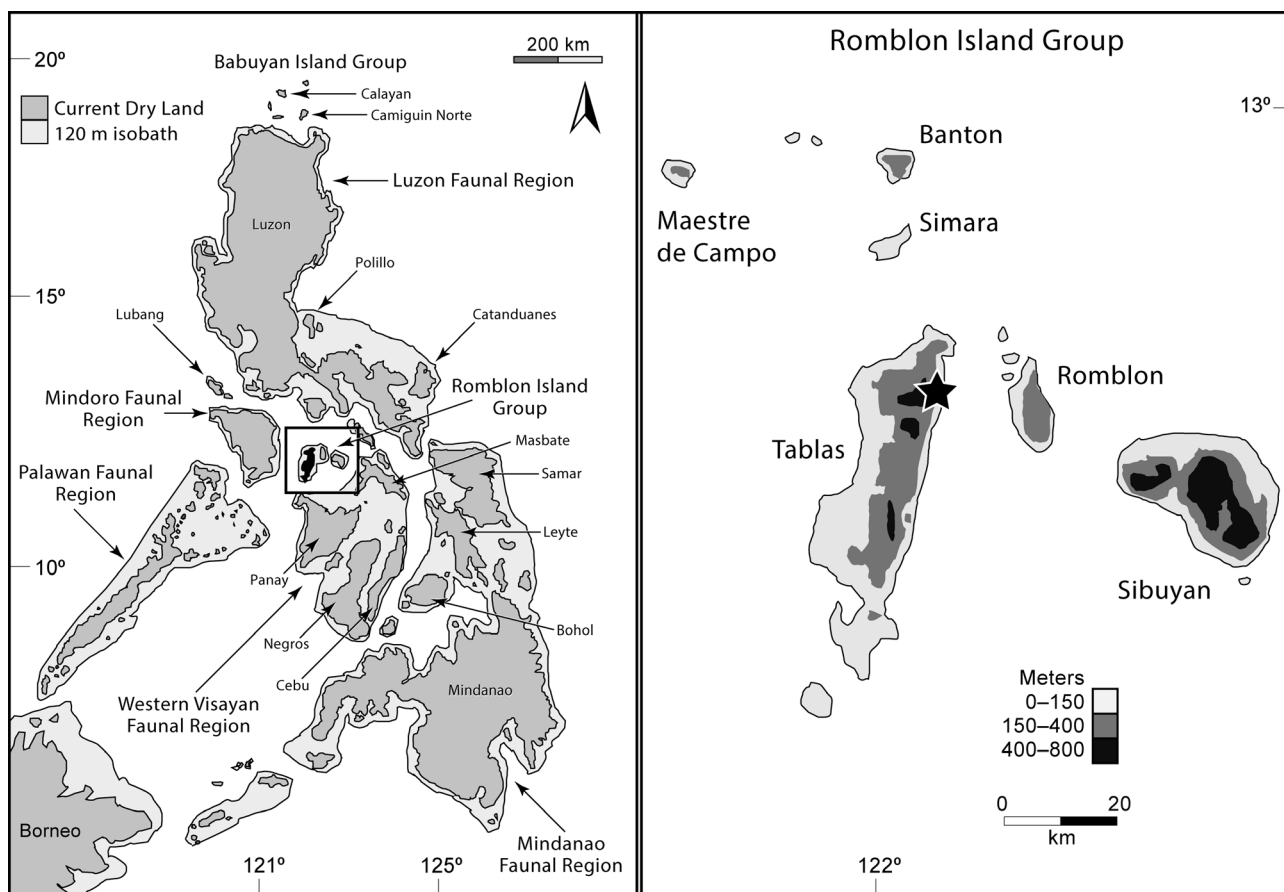
The genus *Brachymeles* consists currently of 40 species (Davis *et al.* 2014; Geheber *et al.* 2016; Siler *et al.* 2016), with all but two species occurring in the Philippines (*B. apus* Hikida in Borneo and *B. miriamae* Heyer in Thailand; Siler *et al.* 2009, 2010a,b, 2011a,b,c,d, 2012a, 2016; Siler 2010; Siler & Brown 2010, 2011; Davis *et al.* 2014; Geheber *et al.* 2016). Species in this genus are known to be both secretive and semi-fossorial, with individuals often inhabiting decomposing organic matter (i.e., decaying coconut husks, rotting tree logs). The climatic distribution of *Brachymeles* spans multiple different ecoregions of an island, from warm, low-elevation forests to cool, mid-elevation forests (Siler & Brown 2010; Siler *et al.* 2011a, 2012a) and this habitat diversity is paralleled by the incredible diversity of body forms observed in this genus (Siler & Brown 2011). *Brachymeles* is one of only five skink genera to have pentadactyl, non-pentadactyl, and externally limbless species (Siler & Brown 2011). Among non-pentadactyl species, digit numbers vary substantially, with some species having highly reduced limbs and digit numbers (e.g., *B. bonitae* Duméril & Bibron, *B. cebuensis* Brown & Rabor, *B. muntingkamay* Siler, Rico, Duya & Brown, *B. samarensis* Brown, *B. tridactylus* Brown; Siler *et al.* 2009), and others having nearly pentadactyl body forms such as *B. pathfinderi* Taylor with five fingers and four toes (Siler *et al.* 2011b).

Over the last decade, species richness in this genus has grown substantially; since 2009, the number of recognized species has increased by more than 220% (Siler *et al.* 2012a, 2016; Davis *et al.* 2014; Geheber *et al.* 2016). Despite the observed variance in body forms among recognized taxa, a suite of recent studies has revealed that a general convergence on gross overall morphological appearances within phylogenetically-identified subclades has led to broad underestimation of alpha diversity (Siler *et al.* 2009, 2010a,b, 2011a,b,c,d, 2012a, 2016; Siler 2010; Siler & Brown 2010, 2011; Davis *et al.* 2014; Geheber *et al.* 2016). Recent molecular data has provided insight into the distribution of previously unrecognized diversity within the genus, leading to the recognition of several species complexes (Siler & Brown 2010; Siler *et al.* 2011d; Davis *et al.* 2014). One species complex in particular, the *B. bonitae* Complex *sensu* Davis *et al.* (2014), was originally thought to be a single widely distributed species with variable morphology (Brown & Rabor 1967). For example, individuals once recognized as *B. bonitae* could have as many as two digits on each limb or lack digits entirely (Brown 1956; Davis *et al.* 2014). Recently, however, a systematic study of the complex formally recognized four evolutionary lineages: *B. bonitae*, *B. tridactylus*, *B. isangdaliri* Davis, Feller, Brown & Siler, and *B. mapalanggaon* Davis, Feller, Brown & Siler and provided taxonomic stability to the *B. bonitae* and *B. tridactylus* clades (Davis *et al.* 2014). Furthermore, two additional species from this species complex have recently been described: *B. ilocandia* Siler, Davis, Freitas, Huron, Geheber, Watters, Penrod, Papeş, Amrein, Anwar, Cooper, Hein, Manning, Patel, Pinaroc, Diesmos, Diesmos, Oliveros & Brown and *B. ligtas* Geheber, Davis, Watters, Penrod, Feller, Davey, Ellsworth, Flanagan, Heitz, Moore, Nguyen, Roberts, Sutton, Sanguila, Linkem, Brown & Siler (Geheber *et al.* 2016; Siler *et al.* 2016). Although these studies have described unique lineages within the *B. bonitae* Complex, other distinct lineages, many corresponding to isolated islands within the Philippines, may still be present (Siler *et al.* 2011a, 2016; Davis *et al.* 2014; Geheber *et al.* 2016). This presents an issue for setting conservation priorities, as unique but unrecognized biodiversity will escape appropriate IUCN evaluations and management decisions.

Here, we describe a new species within the *B. bonitae* Complex from Tablas Island in the Romblon Island Group of the central Philippines (Fig. 1). This new lineage can be diagnosed on the basis of a suite of unique morphological characters from all other members of the *B. bonitae* Complex. In addition to describing this new species, we discuss what is known about its geographic distribution, natural history, ecology, and suggest an appropriate IUCN classification.

## Material and methods

**Field work, sample collection, and specimen preservation.** In addition to historical collections available in museums, fieldwork was conducted on Camiguin Norte, Catanduanes, Lubang, Luzon, Marinduque, Masbate, Mindoro, Polillo, Sibuyan, and Tablas islands, all in the Philippines (Fig. 1) between 1991 and 2012. Specimens were collected during the day, euthanized with MS-222, dissected for tissue samples (liver preserved in 95% ethanol), fixed in 10% formalin and eventually (< 2 mo) transferred to 70% ethanol. Specimens are deposited in U.S. and Philippine museum collections (Acknowledgments and Specimens Examined). Museum abbreviations for specimens examined follow those from Sabaj Pérez (2014).



**FIGURE 1.** (Left) Map of the Philippine islands, with labels provided for islands with representative samples used for this study. The five recognized major faunal regions (PAICs), major island groups, and additional deep-water islands are labeled for reference. Current islands in the Philippines are shown in medium grey to black; light gray areas enclosed in black 120 m bathymetric contours indicate the hypothesized maximum extent of land during the mid- to late Pleistocene. Location of the Romblon Island Group outlined by a square; Tablas Island highlighted in black. (Right) Map of Romblon Province in relation to the remainder of the Philippines. Known distribution of *Brachymeles dalawangdaliri* sp. nov. on Tablas Island is indicated with a star.

**Morphological data.** We examined fluid-preserved specimens (Appendix I) for variation in qualitative, meristic (scale counts) and mensural (measurements) characters. Sex was determined by gonadal inspection, and measurements were taken to the nearest 0.1 mm with digital calipers by CDS. X-rays were taken with a company cabinet X-ray on Kodak MIN-R 2000 film exposed at 5 milliamperes and 30 volts for 1 minute 15 seconds.

Meristic and mensural characters were chosen based on Siler *et al.* (2009, 2010a,b): snout–vent length (SVL), axilla–groin distance (AGD), total length (TotL), midbody width (MBW), midbody height (MBH), tail length (TL), tail width (TW), head length (HL), head width (HW), snout–forearm length (SnFa), eye diameter (ED), eye–nares distance (END), snout length (SNL), fore-limb length (FLL), hind limb length (HLL), midbody scale-row count (MBSR), paravertebral scale-row count (PVSr), axilla–groin scale-row count (AGSR), supralabial count (SL), infralabial count (IFL), supraciliary count (SC), and supraocular count (SO). Additionally, we counted the number of presacral vertebrae (PSV) from X-ray images of specimens. In the description, ranges are followed by mean  $\pm$  standard deviation in parentheses.

**Species concept.** For this study, we consider phenotypically divergent populations as distinct lineages, especially if such populations are allopatric. We diagnose a new species based on diagnostic character differences in non-overlapping morphological character states. This approach is in line with the General Lineage Concept of species (de Queiroz 1998, 1999), as an extension of the Evolutionary Species Concept (Simpson 1961; Wiley 1978; Frost & Hillis 1990).

**Research experience in the undergraduate classroom.** As part of the Spring 2015 Herpetology Course (BIOL 4083) taught by CDS at the University of Oklahoma, students took part in a semester long, small group

writing assignment, with each group assigned a distinct lineage of *Brachymeles* to describe under a structured writing and mentoring program (Siler *et al.* unpublished data). Detailed description of this course project has been made freely available at <http://www.webcitation.org/6hEkRmogM> (Watters & Siler 2016).

## Taxonomic account

### *Brachymeles dalawangdaliri* sp. nov.

(Figs. 2, 3)

*Brachymeles bonitae* Duméril & Bibron 1839; Taylor 1917; Brown 1956:5; Brown & Rabor 1967:526; Brown & Alcalá 1970; Brown & Alcalá 1980:20; Davis *et al.* 2014; Geheber *et al.* 2016; Siler *et al.* 2016.

**Holotype.** CAS 137149, adult male, collected among rotting leaves in early secondary growth forest on 24 May 1972, in Barrio Dubduban, Municipality of San Augustin, Romblon Province, Tablas Island, Philippines (12.58333° N, 122.10000° E; WGS 84; 500–800 ft. elev.), by L.C. Alcalá.

**Paratypes.** Five adult females (CAS 137148, 137150, 137151, 137153, 137154) and one adult male (CAS 137152) were collected in Barrio Dubduban, Municipality of San Augustin, Romblon Province, Tablas Island, Philippines (12.58333° N, 122.10000° E; WGS 84), by L.C. Alcalá. CAS 137148 was collected in a rotting coconut trunk on 23 May 1972 (150–250 ft. elev.), CAS 137150–137152 were collected in humus under a rotting log in original forest on 1 June 1972 (450 ft. elev.), and CAS 137153, 137154 were collected in humus under a rotting log in original forest on 2 June 1972 (550 ft. elev.).

**Diagnosis.** Following recent taxonomic revisions of *Brachymeles* (Siler *et al.* 2011; Davis *et al.* 2014) the new species is assigned to the *B. bonitae* Complex based on the following suite of morphological characters: (1) limbs present, (2) non-pentadactyl, (3) fore-limbs with 0–3 fingers, (4) hind limbs with 0–2 toes, (5) paravertebral scale rows  $\geq 91$ , (6) presacral vertebrae 47–53, (7) supraoculars four, (8) enlarged, differentiated nuchals present, (9) longitudinal rows of dark spots around the body absent, and (10) auricular opening absent.

*Brachymeles dalawangdaliri* sp. nov. can be distinguished from congeners by the following combination of characters: (1) body size small (SVL 66.0–80.9 mm), (2) fore-limbs bidactyl, (3) hind limbs digitless, unidactyl, or bidactyl, (4) limb length short, (5) supralabials six or seven, (6) infralabials six or seven, (7) supraciliaries five, (8) supraoculars four, (9) midbody scale rows 24 or 25, (10) axilla–groin scale rows 80–83, (11) paravertebral scale rows 97–101, (12) prefrontal contact absent, (13) frontoparietal contact present or absent, (14) enlarged chin shields in two pairs, (15) nuchals enlarged, (16) auricular opening absent, (17) presacral vertebrae 49, and (18) uniform body color (Tables 1, 2).

**Comparisons.** *Brachymeles dalawangdaliri* sp. nov. can be distinguished from *B. ilocandia*, *B. isangdaliri*, *B. mapalanggaon*, and *B. tridactylus* by having bidactyl fore-limbs and 0–2 digits on the hind limbs (*versus* being digitless [*B. ilocandia*, *B. mapalanggaon*], unidactyl [*B. isangdaliri*], or tridactyl [*B. tridactylus*]); from *B. bonitae* by having fewer number of presacral vertebrae (49 *versus* 53), fewer number of axilla–groin scale rows (80–83 *versus* 83–90), fewer number of paravertebral scale rows (97–101 *versus* 103–110), a greater number of infralabials (6, 7 *versus* 5), and by the absence (*versus* presence) of a 3<sup>rd</sup> chin shield and fused mental; from *B. ilocandia* by having a longer fore-limb (1.4–2.2 mm *versus* 1.1–1.4) and hind limb length (1.9–2.2 mm *versus* 1.6–1.9), fewer number of presacral vertebrae (49 *versus* 50–53), and by the absence (*versus* presence) of a 3<sup>rd</sup> chin shield pair; from *B. isangdaliri* by having a longer snout–vent length (66.0–80.9 mm *versus* 59.5), a longer fore-limb length (1.4–2.2 mm *versus* 1.3), a greater number of presacral vertebrae (49 *versus* 47), greater number of midbody scale rows (24, 25 *versus* 22), a greater number of axilla–groin scale rows (80–83 *versus* 73), and fewer number of supraciliaries (5 *versus* 6); from *B. ligtas* by having a longer fore-limb length (1.4–2.2 mm *versus* 1.2–1.4), fewer number of presacral vertebrae (49 *versus* 50), a greater number of midbody scale rows (24, 25 *versus* 22), a greater number of axilla–groin scale rows (80–83 *versus* 74–76), a greater number of paravertebral scale rows (97–101 *versus* 91–93), and by the absence (*versus* presence) of a 3<sup>rd</sup> chin shield pair; from *B. mapalanggaon* by having a longer fore-limb (1.4–2.2 mm *versus* 0.8–1.0) and hind limb length (1.9–2.2 mm *versus* 1.2–1.6), fewer number of presacral vertebrae (49 *versus* 51), and a greater number of midbody scale rows (24, 25 *versus* 22, 23); from *B. tridactylus* by having a shorter hind limb length (1.9–2.2 mm *versus* 2.6–3.6), a greater number of

presacral vertebrae (49 *versus* 47), a greater number of axilla–groin scale rows (80–83 *versus* 72–79), and by the absence (*versus* presence) of a 3<sup>rd</sup> chin shield pair.

*Brachymeles dalawangdaliri* **sp. nov.** can be distinguished from all limbless species of *Brachymeles* by having limbs, and from all pentadactyl species of *Brachymeles* by having bidactyl fore-limbs and digitless, unidactyl, or bidactyl hind limbs.

**Description of holotype.** Details of the head scalation are shown in Figure 2. Adult, male, body small, slender, SVL 74.9 mm; head weakly differentiated from neck, nearly as wide as body, HW 7.9% SVL, 107.3% HL; HL 37.1% SnFa; SnFa 19.7% SVL; snout narrow, sharply rounded in dorsal and lateral profile, SNL 60.2% HL; ear completely hidden by scales; eyes small, ED 17.9% HL, 40.5% END, pupil subcircular; body slightly depressed, nearly uniform in thickness, MBW 100.0% MBH; scales smooth, glossy, imbricate; longitudinal scale rows at midbody 24; paravertebral scale rows 97; axilla–groin scale rows 80; limbs short, diminutive, bluntly rounded, with digits reduced to two small digit growths on fore-limbs, single digit growth on hind limb; finger and toe lamellae absent; FLL 3.6% AGD, 2.8% SVL; HLL 3.9% AGD, 3.0% SVL; tail not as wide as body, TW 72.6% MBW, autotomized posterior to cloaca, length unavailable.

Rostral projecting onto dorsal snout to level in line with posterior edge of nasal, roughly equal in width and height, in contact with frontonasal; frontonasal wider than long; nostril small, ovoid, in center of single trapezoidal nasal, longer axis directed posterodorsally and anteroventrally; supranasals present; postnasals absent; prefrontals moderately separated; frontal roughly hexagonal-shaped, its anterior margin in moderate contact with frontonasal, in contact with first two anterior supraoculars, 4× wider than anterior supraocular; supraoculars four; frontoparietals moderate in size, in moderate medial contact, frontoparietals in contact with supraoculars two and three; interparietal moderate in size, its length roughly equal to 2× midline length of frontoparietal, longer than wide, diamond-shaped, wider anteriorly, pineal eyespot not visible; parietals wider than frontoparietals, in moderate contact behind interparietal; head scales damaged in nuchal region; enlarged nuchals present; loreals two, anterior loreal about as long as and slightly higher than posterior loreal; preoculars two; presubocular one; supraciliaries five, the anteriormost contacting prefrontal and separating posterior loreal from first supraocular, posteriormost extending to midline edge of fourth supraocular; subocular scale row single, incomplete, in contact with supralabials; lower eyelid with one row of scales; supralabials seven, first twice the width of others, third, fourth and fifth subocular; infralabials seven (Figs. 2, 3).

Mental wider than long, in contact with first infralabial on left side of head, fused with first infralabial on right side of head; postmental single, enlarged, its width equal to width of mental; followed by two pairs of enlarged chin shields, first pair moderately separated, second pair slightly smaller than first, broadly separated by three medial scales (Figs. 2, 3). Scales on limbs smaller than body scales.

**Variation.** Differences in digit number and scalation patterns were observed between the holotype and paratype series. The holotype (CAS 137149) and three paratypes (CAS 137148, 137153, 137154) possessed seven supralabials and seven infralabials, with three other paratypes (CAS 137150–137152) having six supralabials and six infralabials. Unlike the holotype and majority of paratypes, the frontoparietal scales were observed to contact medially in two specimens (CAS 137153, 137154). Observed digit number variation included body plans with two fingers and one toe (CAS 137149 [holotype], 137151, 137153, 137154), two fingers and two toes (CAS 137148, 137150), and two fingers and no toes (CAS 137152).

**Coloration of holotype in life.** Coloration in life is unrecorded; however, because *Brachymeles* specimens do not change significantly during preservation (Siler & Brown 2010; Siler *et al.* 2011a, 2012a; Davis *et al.* 2014), we suspect that the preserved coloration and patterns are much like those in life.

**Coloration of holotype in preservative.** The background color on the dorsal, lateral and ventral sides of the body and tail is a solid Prout's Brown (Color 47; Köhler 2012). The ventral side of the head is the same solid color as the ventral side of the body (Fig. 3; Prout's Brown; Color 47; Köhler 2012). On the dorsal and lateral sides of the head, a single Fuscous splotch can be seen just above each orbit (Fig. 3; Color 283; Köhler 2012).

**Etymology.** The name of the new species presented in this paper is derived from the Tagalog (Filipino) terms 'dalawa,' meaning two, and 'daliri,' meaning finger, referencing one of the defining characteristics of the new species, the two digits on the fore-limbs. Suggested common name: Tablas Slender Skink.

**Distribution.** *Brachymeles dalawangdaliri* **sp. nov.** is known only from Tablas Island, Romblon Island Group, Philippines (Fig. 1).

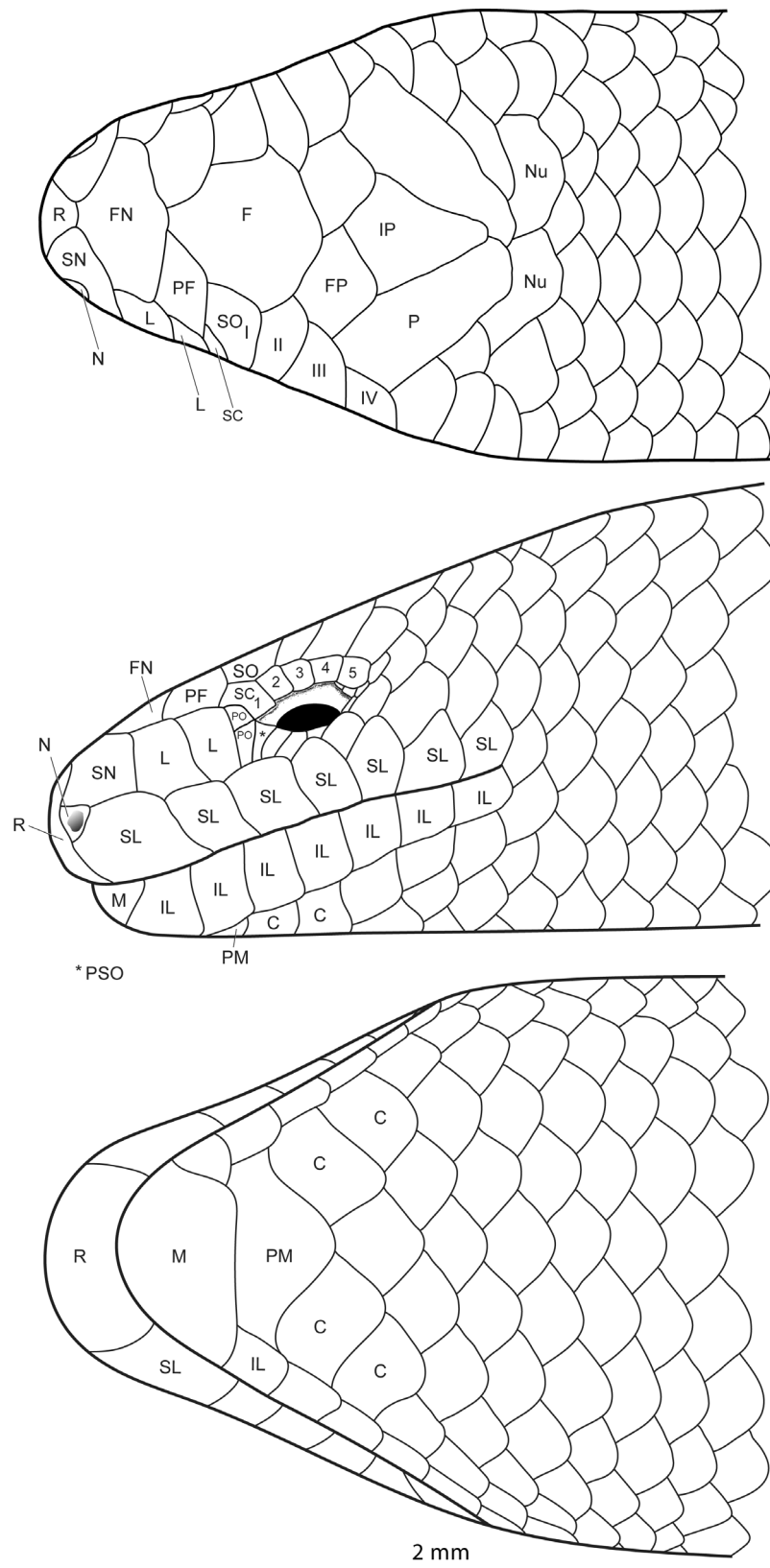
**TABLE 1.** Summary of meristic and mensural characters among species of the *Brachymeles bonitae* Complex. Sample size, body length and total length among males and females, and general geographical distribution (PAIC = Pleistocene Aggregate Island Complexes, sensu Brown & Diesmos [2002]) are included for reference (SVL, TotL, FLL, and HLL given as range over mean  $\pm$  standard deviation; all body proportions given as percentage over mean  $\pm$  standard deviation).

Range	<i>bonitae</i> (3 m, 1 f)	<i>datawangdaliri</i> sp. nov. (2 m, 5 f)	<i>ilocandia</i> (9 f)	<i>isangdaliri</i> (1 f)	<i>ligtas</i> (3 m, 2 f)	<i>mapalanggaon</i> (3 m, 6 f)	<i>tridactylus</i> (12 m, 9 f)
	Luzon & Polillo islands	Tablas Island	Luzon & Camiguin Norte islands	Luzon Island	Lubang Island	Masbate Island	West Visayan PAIC
SVL (f)	69.4	69.8–80.9 (73.6 $\pm$ 4.4)	65.7–77.6 (73.7 $\pm$ 3.7)	59.5	60.7–69.2 (65.0 $\pm$ 6.0)	61.7–75.8 (67.2 $\pm$ 5.4)	59.9–82.3 (71.4 $\pm$ 6.9)
SVL (m)	69.7–78.4 (72.8 $\pm$ 4.8)	66.0–74.9 (70.4 $\pm$ 6.3)	N/A	N/A	69.4–79.6 (74.5 $\pm$ 5.1)	65.1–72.7 (68.4 $\pm$ 3.9)	60.7–77.6 (69.0 $\pm$ 6.0)
TotL (f)	N/A	N/A	122.3–146.0 (134.1 $\pm$ 8.0)	106.1	119.4	120.2	133.6 <sup>1</sup>
TotL (m)	122.0	N/A	N/A	N/A	160.6	112.6–118.6 (115.6 $\pm$ 4.3)	120.9–154.1 (136.0 $\pm$ 9.8)
TL/SVL	73	N/A	81–90 (85 $\pm$ 3)	78	97–102 (99 $\pm$ 4)	67–84 (78 $\pm$ 9)	85–112 (95 $\pm$ 10)
FLL	1.0–1.7 (1.3 $\pm$ 0.3)	1.4–2.2 (1.9 $\pm$ 0.3)	1.1–1.4 (1.3 $\pm$ 0.1)	1.3	1.2–1.4 (1.3 $\pm$ 0.1)	0.8–1.0 (0.9 $\pm$ 0.1)	1.5–2.5 (2.0 $\pm$ 0.3)
FLL/SVL	1–2 (2 $\pm$ 0)	2–3 (3 $\pm$ 0)	1–2 (2 $\pm$ 0)	2	2–2 (2 $\pm$ 0)	1–2 (1 $\pm$ 0)	2–4 (3 $\pm$ 0)
HLL	1.5–2.3 (1.9 $\pm$ 0.3)	1.9–2.2 (2.1 $\pm$ 0.1)	1.6–1.9 (1.8 $\pm$ 0.1)	2.2	1.6–2.0 (1.8 $\pm$ 0.1)	1.2–1.6 (1.4 $\pm$ 0.1)	2.6–3.6 (3.1 $\pm$ 0.3)
HLL/SVL	2–3 (3 $\pm$ 0)	2–3 (3 $\pm$ 0)	2–3 (2 $\pm$ 0)	4	2–3 (3 $\pm$ 0)	2–2 (2 $\pm$ 0)	3–6 (5 $\pm$ 1)

**TABLE 2.** Summary of meristic and qualitative diagnostic characters (present, absent) among species of the *Brachymeles bonitae* Complex. The pairs of enlarged scales posterior to the postmental scale are abbreviated as chin shield pairs with reference to the 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> pairs (when present). In cases of scale count variation within species, numbers of individuals showing specific counts are given in parentheses.

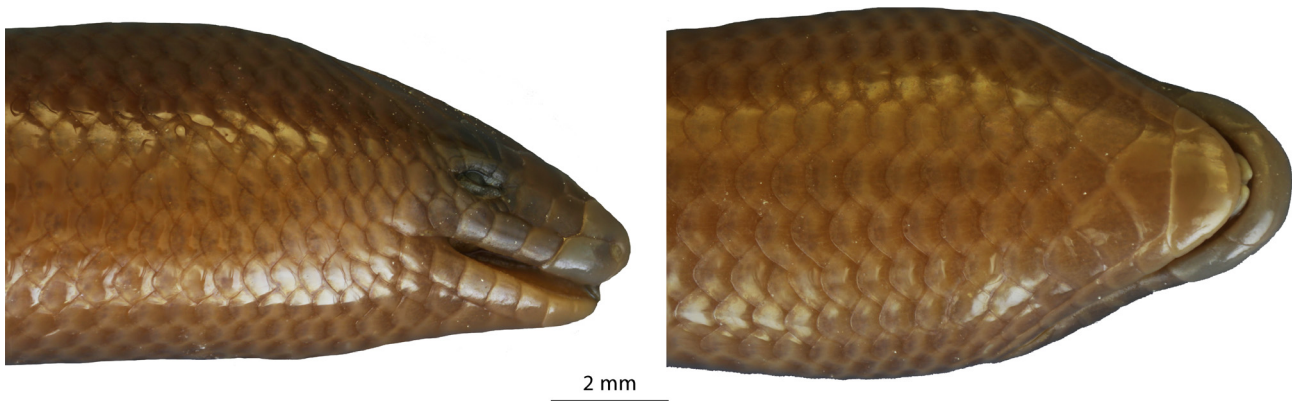
	<i>bonitae</i> (3 m, 1 f)	<i>dawalawangdaliri</i> sp. nov. (2 m, 5 f)	<i>ilocandia</i> (9 f)	<i>isangadaliri</i> (1 f)	<i>ligtas</i> (3 m, 2 f)	<i>mapalangaon</i> (3 m, 6 f)	<i>tridactylus</i> (12 m, 9 f)
Number of digits (fingers/toes)	0/0 <sup>1</sup> 2/1 <sup>1</sup>	2/0-2	0/0	1/1	2/0	0/0	3/3
PSV	53	49	50-53	47	50	51	47
MBSR	21-24	24, 25	22-24	22	22	22, 23	22-24
AGSR	83-90	80-83	80-82	73	74-76	80-84	72-79
PVSR	103-110	97-101	97-100	97	91-93	99-102	90-98
SL	6	6 (3) 7 (4)	6	6	6	6	6 (13) 7 (8)
IFL	5	6 (3) 7 (4)	5 (3) 6 (6)	6	6	5 (8) 6 (1)	6 (13) 7 (8)
SC	5	5	5	6	5	5	5
SO	4	4	4	4	4	4	4
Prefrontal contact	Absent	Absent	Absent or Point contact	Absent	Absent	Absent	Absent
Frontoparietal contact	Absent	Present or Absent	Absent	Absent	Present	Point contact or Absent	Absent
1 <sup>st</sup> chin shield pair contact	Absent	Absent	Absent	Absent	Present or Absent	Absent	Present or Absent
3 <sup>rd</sup> chin shield pair	Present	Absent	Present	Absent	Present	Present or Absent	Present
Mental/1 <sup>st</sup> IFL fusion	Present	Absent	Present or Absent	Absent	Absent	Present or Absent	Absent
Enlarged nuchals	Present	Present	Present	Present	Present	Present	Present
Longitudinal rows of dark spots	Absent	Absent	Absent	Absent	Absent	Absent	Absent

<sup>1</sup>Observed for two individuals.



**FIGURE 2.** Illustration of the head of *Brachymeles dalawangdaliri* sp. nov. (CAS 137149, holotype) in dorsal, lateral, and ventral views. Taxonomically diagnostic head scales are labeled as follows: C, chin shield; F, frontal; FN, frontonasal; FP, frontoparietal; IL, infralabial; IP, interparietal; L, loreal; M, mental; N, nasal; Nu, nuchal; P, parietal; PF, prefrontal; PM, postmental; PO, preocular; PSO, presubocular; R, rostral; SC, supraciliary; SL, supralabial; SN, supranasal; and SO, supraocular. Roman numerals indicate scales in the supraocular series, with Arabic numbers indicating scales in the supraciliary series. Illustrations by MLP and CDS.





**FIGURE 3.** Photograph of lateral and ventral views of head of preserved holotype of *Brachymeles dalawangdaliri* **sp. nov.** (CAS 137149). Photographs taken by JLW and MLP.

**Natural history.** Presumably, *Brachymeles dalawangdaliri* **sp. nov.** once occurred in primary growth forest; however, little to no primary forest remains on Tablas Island. This species has never been observed in high densities, a pattern consistent with many members of the *B. bonitae* Complex. Furthermore, no recent collections of this species have been made, with the last documented observation of *B. dalawangdaliri* **sp. nov.** in the wild occurring more than four decades ago. *Brachymeles dalawangdaliri* **sp. nov.** may be found in sympatry with *B. talinis* (Siler & Brown 2010).

Little is known about the ecology and distribution of *Brachymeles dalawangdaliri* **sp. nov.** on Tablas Island. However, this species is endemic to an island with complete or near complete deforestation and no recent observations of wild populations. Therefore, in evaluating *B. dalawangdaliri* **sp. nov.** against the IUCN criteria for classification, we find that it qualifies for the status of Vulnerable (VU) based on the following criteria: VU B2ab(iii,iv); D2 (IUCN 2015).

## Discussion

It is clear that more work is required to accurately assess species-level diversity within the *Brachymeles bonitae* Complex. This study results in the recognition of a new, distinct evolutionary lineage, *B. dalawangdaliri* **sp. nov.**, and further increases the total number of known species of *Brachymeles*. Although few species in the genus are documented to possess variation in fore- and hind limb digit numbers, observations of such variation have been made in previous studies (Siler *et al.* 2011b; Davis *et al.* 2014). Currently, *Brachymeles bonitae sensu stricto* Davis *et al.* (2014) is recognized as a limbed species with individuals documented to possess either a digitless body form or bidactyl fore-limbs and unidactyl hind limbs. Interestingly, individuals of *B. bonitae* collected in the same putative populations show this same level of variation in the central Philippines (e.g., Mt. Makiling: CAS 62578, MCZ 26584, 26585); Polillo Island: CAS 62278, 62279, 62575, KU 307747–49, 307755). The only non-pentadactyl species recognized to occur on Mindanao Island in the southern Philippines, *B. pathfinderi*, also shows low levels of variation in hind limb digit number (Siler *et al.* 2011b). Recognized as a species with five fingers and four toes, examinations of 40 specimens collected recently at the type locality of *B. pathfinderi* revealed three specimens with five toes on one of the hind limbs but four on the other (KU 324060, 324071, 324076). Although rarely observed, some population-level variation in digit morphology exists for several species within the genus. However, the plasticity of limb development and digit morphology in *Brachymeles* remains unknown.

Studies attempting to provide taxonomic stability to non-monophyletic species complexes composed of multiple, recognized taxa (Siler & Brown 2010; Siler *et al.* 2011a, 2012a, 2014a,b; Davis *et al.* 2014; Brown *et al.* 2015) are vital to our understanding of Philippine biodiversity. For the genus *Brachymeles*, our understanding of species-level diversity has increased exponentially during the last decade (Siler 2010; Siler & Brown 2010; Siler *et al.* 2009, 2010a,b, 2011a,b,c,d, 2012a, 2013, 2016; Davis *et al.* 2014; Geheber *et al.* 2016), a direct result of three important factors: (1) continued biodiversity survey efforts at multiple sites throughout the Philippines, (2) collection of high quality, vouchered museum specimens with associated genetic data, and (3) careful inspection of

historical museum specimens to identify populations with unique suites of diagnostic morphological characters (Siler & Brown 2010). The first two factors are the most important for the continued study and conservation of one of the world's most important biodiversity hotspots (Brown *et al.* 2013). Without such surveys throughout the archipelago, and the collection of high quality, vouchered specimens for natural history collections (e.g., National Museum of the Philippines), type material simply would not exist for many of the amphibian and reptile species described over the last two decades alone (Siler & Brown 2010; Siler *et al.* 2011b,c). Currently there are more than 380 species of amphibians and reptiles recognized to occur in the Philippines, with more than 75% of these species endemic to the archipelago (Brown & Diesmos 2009). Without global collaborations aimed at studying this highly endemic herpetofauna, and the continued development of high quality natural history collections, the discovery and description of nearly 100 endemic species of amphibians and reptiles over the last two decades would never have occurred. Simply put, we would be facing an effective loss of our understanding of more than 25% of the recognized species diversity, and nearly 10% of the total endemic diversity, of amphibians and reptiles in the Philippines.

Beyond continuing a globally collaborative effort to study the highly endemic vertebrate fauna of the Philippines, there are several critical conservation concerns facing species in the Philippines. One of these major concerns for conservation efforts in the archipelago is the impact that climate change may have on sea level rise (Alcala *et al.* 2012): an issue for all island ecosystems. Bellard *et al.* (2014) recently predicted the Philippines to be one of the top three biodiversity hotspots where significant loss of insular habitat will result from rising sea levels. A sea level rise of one meter alone would result in the potential loss of as many as 48 islands, with a six-meter rise in sea level submerging as many as 113 islands (Bellard *et al.* 2014). A second concern is the continued loss of primary growth forests (coastal and inland) and complete deforestation (Primavera *et al.* 2004; Posa & Sodhi 2006; Duke *et al.* 2007; Polidoro *et al.* 2010; Rickart *et al.* 2011). Primary growth forests on Tablas Island, the only known habitat for *B. dalawangdaliri* **sp. nov.**, are nearly all cleared (CDS, RMB, *personal observations*) and conservation efforts should focus on protecting what little primary growth forests remain. One thing is clear: the majority of amphibian and reptile species in the Philippines are endemic to the archipelago (Brown & Diesmos 2009; Brown *et al.* 2013; Diesmos *et al.* 2015). Without a thorough understanding of diversity, including studies of widespread, secretive, and cryptic species alike, there is a risk of extinction before recognition.

The distribution of this unique species on Tablas Island in the Romblon Island Group is not surprising given the number of endemic amphibian and reptile species present throughout this isolated deep-ocean island system (e.g., *Platymantis lawtoni* Brown & Alcala, *P. levigatus* Brown & Alcala, *Gekko romblon* Brown & Alcala, *G. coi* Brown, Siler, Oliveros, Diesmos & Alcala; Brown *et al.* 2011; Siler *et al.* 2012b), including divergent populations hypothesized to be unique species worthy of recognition (e.g., *Pseudogekko* cf. *compresicorpus* Taylor [Tablas Island]; Siler *et al.* 2014a). Although we would expect genetic data to reveal *B. dalawangdaliri* **sp. nov.** as a deeply divergent lineage within the *B. bonitae* Complex, to date, no vouchered tissue samples are available in museum collections for inclusion in phylogenetic analysis. However, genetic diversity among other closely-related congeners is considerable, with mitochondrial sequence divergences between sampled members of the *B. bonitae* Complex (*Brachymeles bonitae*, *B. ilocandia* **sp. nov.**, *B. isangdaliri*, *B. ligtas*, *B. mapalanggaon*, and *B. tridactylus*) ranging from 6.9–11.2%, with an average among lineage uncorrected pairwise mitochondrial sequence divergence of 9.9% (Siler *et al.* 2016).

Studies of the *Brachymeles bonitae* and *B. samarensis* complexes have revealed smaller species ranges for limb-reduced, non-pentadactyl species and limbless species as compared to larger, pentadactyl species in the genus (Siler *et al.* 2011a; Davis *et al.* 2014). With non-pentadactyl species never observed outside of rotting log and loose root network microhabitats (CDS, *personal observations*), it is likely that functional and locomotor capacities play a role in the repeated documentation of smaller, patchy, geographic distributions of limb-reduced and limbless species in the genus. As no studies to date have investigated fine-scale ecological or functional aspects for any species of *Brachymeles*, future studies in such areas of research likely would result in exciting insights into dispersal capabilities and population dynamics of a unique radiation of burrowing reptiles.

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## Author contributions

CDS conceived the idea; CDS, ADG, and JLW carried out assignment instruction and mentoring; MBS, RMB, and CDS participated in fieldwork; MLP and KDF created scientific illustrations; AS, JK, DN, KS, KS, CW, and RW compiled and analyzed the dataset; AS, JK, DN, KS, KS, CW, and RW led the writing; DRD, ADG, JLW and CDS assisted in finalizing the manuscript for publication; DRD, ADG, JLW, MLP, KDF, AS, JK, DN, KS, KS, CW, RW, MBS, RMB, and CDS edited drafts of the manuscript.

## APPENDIX I. Additional specimens examined.

Specimens examined in addition to those in Geheber et al. (2016). Numbers in parentheses indicate the number of specimens examined. All specimens examined are from the Philippines. Several sample sizes are greater than those observed in the description due to the examination of sub-adult specimens which were excluded from morphometric analyses.

*Brachymeles dalawangdaliri* **sp. nov.** (7). TABLAS ISLAND: ROMBLON PROVINCE: *Municipality of San Agustin*: Holotype (CAS 137149), Paratypes (CAS 137148, 137150–137154).

*Brachymeles ilocandia* (9). CAMIGUIN NORTE ISLAND: CAGAYAN PROVINCE: *Municipality of Calayan*: Holotype (PNM 9819), Paratopotypes (KU 307967, 308019, 308020, 308027, 308030), Paratype (KU 304567); LUZON ISLAND: KALINGA PROVINCE: Paratype (FMNH 259449); LUZON ISLAND: MOUNTAIN PROVINCE: Paratype (CAS 61377).