

An Enigmatic New Species of Blind Snake from Luzon Island, Northern Philippines, with a Synopsis of the Genus *Acutotyphlops* (Serpentes: Typhlopidae)

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ABSTRACT.—We describe a strikingly distinct new species of *Acutotyphlops* from Kalinga Province of Luzon Island, Philippines. The new species is most closely related to other members of the genus *Acutotyphlops* from Papua New Guinea and the Solomon Islands and represents a new genus and species group record for the Philippines. A revised definition of *Acutotyphlops* is presented along with a synopsis of the genus. The discovery of this species, combined with consideration of its morphology and distribution, represents a curious new systematic and biogeographical problem in Southeast Asian and southwest Pacific scolecophidian snake systematics.

The family Typhlopidae is the most speciose of the three scolecophidian families, containing some 265 of the 395 total species (VW, unpubl. data). Although the Leptotyphlopidae has two recognized genera (*Leptotyphlops* and *Rhinoleptus*) and the Anomalepididae has four (*Anomalepis*, *Helminthophis*, *Liotyphlops*, and *Typhlophis*), recent years have seen the fragmentation of the cosmopolitan blindsnake genus *Typhlops* into a number of genera: *Acutotyphlops* Wallach (1995), *Austrotyphlops* Wallach (2006), *Cyclotyphlops* Bosch and Ineich (1994), *Grypotyphlops* Peters (1881), *Letheobia* Cope (1869), *Ramphotyphlops* Fitzinger (1843), *Rhinotyphlops* Fitzinger (1843), and *Xenotyphlops* Wallach and Ineich (1996). *Grypotyphlops* and *Letheobia* were resurrected from synonymy by Wallach (2003) and Broadley and Wallach (2007), respectively.

The Typhlopidae of the Philippines currently includes 14 species (Gaulke, 1996; McDiarmid et al., 1999): five species placed in *Ramphotyphlops* (*braminus*, *cumingii*, *marxi*, *olivaceus*, and *suluensis*) and nine species in *Typhlops* (*canlaonensis*, *castanotus*, *collaris*, *hedraeus*, *hypogius*, *luzonensis*, *manilae*, *ruber*, and *ruficaudus*). These species can be divided into four species groups: the *R. braminus* group (*braminus*), the *R. multilineatus*

group (*cumingii*, *marxi*, *olivaceus*, and *suluensis*), the *T. ater* group (*hedraeus*, *hypogius*, and *manilae*), and the *T. ruficaudus* group (*canlaonensis*, *castanotus*, *collaris*, *luzonensis*, *ruber*, and *ruficaudus*). The latest reviews of Philippine taxa were provided by Wynn and Leviton (1993) and Wallach (1993a, 2003).

The Typhlopidae of Papua New Guinea and the Solomon Islands includes 18 species (O'Shea, 1996; Wallach, 1996, 1997, 2003; Shea and Wallach, 2000): four species placed in *Acutotyphlops* (*infralabialis*, *kunuaensis*, *solomonis*, and *subocularis*), nine species in *Ramphotyphlops* (*angusticeps*, *becki*, *braminus*, *depressus*, *erycinus*, *leucoproctus*, *mansuetus*, *multilineatus*, and *polygrammicus*), and six species in *Typhlops* (*ater*, *depressiceps*, *inornatus*, *mcdowellii*, and *fredparkeri*). These species can be divided into six species groups: the *A. subocularis* group (*infralabialis*, *kunuaensis*, *solomonis*, and *subocularis*), the *R. braminus* group (*braminus*), the *R. flaviventer* group (*becki*, *depressus*, *leucoproctus*, and *mansuetus*), the *R. multilineatus* group (*angusticeps*, *multilineatus*), the *R. polygrammicus* group (*erycinus* and *polygrammicus*), and the *T. ater* group (*ater*, *depressiceps*, *inornatus*, *mcdowellii*, and *fredparkeri*).

Ramphotyphlops, *Acutotyphlops*, and the recently separated *Austrotyphlops* are differentiated from all other Scolecophidia by the presence of unique specializations of the male reproductive system: a pair of solid eversible hemipenes

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with apical awns and a pair of retrocloacal sacs in the posterior coelom (Robb, 1960, 1966). In preserved specimens, this hemipenis type is easily recognizable by its corkscrew coiling inside the tail in the retracted state. The condition in *Cyclotyphlops* is unknown because the only specimen is female, but since it occurs within the range of *Ramphotyphlops* and has similar scale counts and morphology, it may possess these derived features. Previously it was believed that these two reproductive synapomorphies implied a monophyletic relationship of *Ramphotyphlops* + *Acutotyphlops*, but with the separation of Australian *Austrotyphlops* from Indonesian *Ramphotyphlops* (Wallach, 2006), it now appears that they represent a case of convergence. In fact, the preferred phylogenetic hypothesis of Wallach (1998:fig. 4) indicated four different clades with the male reproductive structures discovered by Robb (1960), suggestive of at least three independent origins. Conversely, an alternate hypothesis based on an equal length tree (Wallach, 1998:fig. 6) clustered all of the above taxa on a single clade with Malagasy *Typhlops* and *Xenotyphlops* in between. It should be noted that the reproductive condition in *Xenotyphlops* is not yet known because the three existing specimens are all female (Wallach and Ineich, 1996; Wallach et al., 2007). Males of both *Xenotyphlops* and *Cyclotyphlops* are sorely needed to clarify their relationships.

The genus *Acutotyphlops* was established for McDowell's (1974) *Ramphotyphlops subocularis* species group based on a suite of unique typhlopoid characters (Wallach, 1995). In addition to the solid hemipenes and retrocloacal sacs, other characters included a middorsal parietal spike separating the frontal bones of skull, a V-shaped lower jaw, two or more subocular shields, a frontorostral shield, five or more infralabial shields, sum of preocular and ocular shields three or more, and the presence of a short, narrow rostral that does not reach interocular level. Other characters shared by most of the four species, but not diagnostic of the entire group and not unique among Typhlopidae, include a high number of midbody scale rows (26–36), a pointed snout, and a bicolored pattern with a brown dorsum sharply demarcated from an immaculate yellow venter. *Acutotyphlops* is a genus endemic to the islands of the southwest Pacific, being known only from eastern Papua New Guinea (mainland Alotau, Bismarck Archipelago, and Bougainville) and the Solomon Islands, where it occurs from sea level to 1,065 m in elevation (Fig. 1). Its center of diversity is Bougainville Island, which supports three of the four known species, *A. infralabialis* (Waite, 1918), *A. kunuaen-*

sis Wallach, 1995, and *A. solomonis* (Parker, 1939).

A species resembling *Acutotyphlops solomonis*, but differing in a number of characteristics, including the diagnostic reproductive system synapomorphies of *Acutotyphlops*, has been discovered in the mountainous region of Kalinga Province in the Cordillera Central of northern Luzon (Diesmos et al., 2004). This taxon represents a new species group of *Acutotyphlops* in the Philippines and is separated from its nearest relatives by more than 4,000 km. As such, the new species presents a major biogeographical and systematic problem for future research.

MATERIALS AND METHODS

All specimens were examined under a binocular microscope; body measurements were made to the nearest 0.5 mm, and scale measurements were made to the nearest 0.1 mm with either metric ruler or vernier calipers. Body diameters were measured in the horizontal plane. Rostral width, midbody diameter, tail width, and hemipenis diameter were measured at the longitudinal midpoint. Head width was measured at the interocular level (on a line through middle of eyes). Eye–snout length was measured from snout tip to middle of eye. Middorsal scales were counted between rostral and terminal spine. Dorsocaudals are defined as the number of vertebral scales along the tail, counted between a line extrapolated perpendicularly to the vent and the apical spine. The dorsocaudal count in samples is usually less variable than the count of midventral subcaudals, which are often irregularly arranged (Wynn and Leviton, 1993). Paired scale counts are presented as left/right. Digital radiographs of the skull were taken with a Thermo Kevex X-ray machine, model PXS10 (Thermo Scientific, Waltham, Massachusetts) using a PaxScan 4030R system with ViVA software (Starbridge Systems Inc., Midvale, Utah). All species of *Acutotyphlops* were examined to confirm the presence of synapomorphies shared between other members of the genus and the new species described here.

The supralabial imbrication patterns (SIP) of the Typhlopidae consist of five states, each of which is denoted by the supralabial numbers that overlap the shields dorsal to them: T-I with first supralabial overlapping preocular, T-II with second supralabial overlapping preocular or presubocular, T-III with third supralabial overlapping ocular or subocular, T-V with both second and third supralabials overlapping shields above them, and T-0 with no overlapping supralabials (Wallach, 1993b).

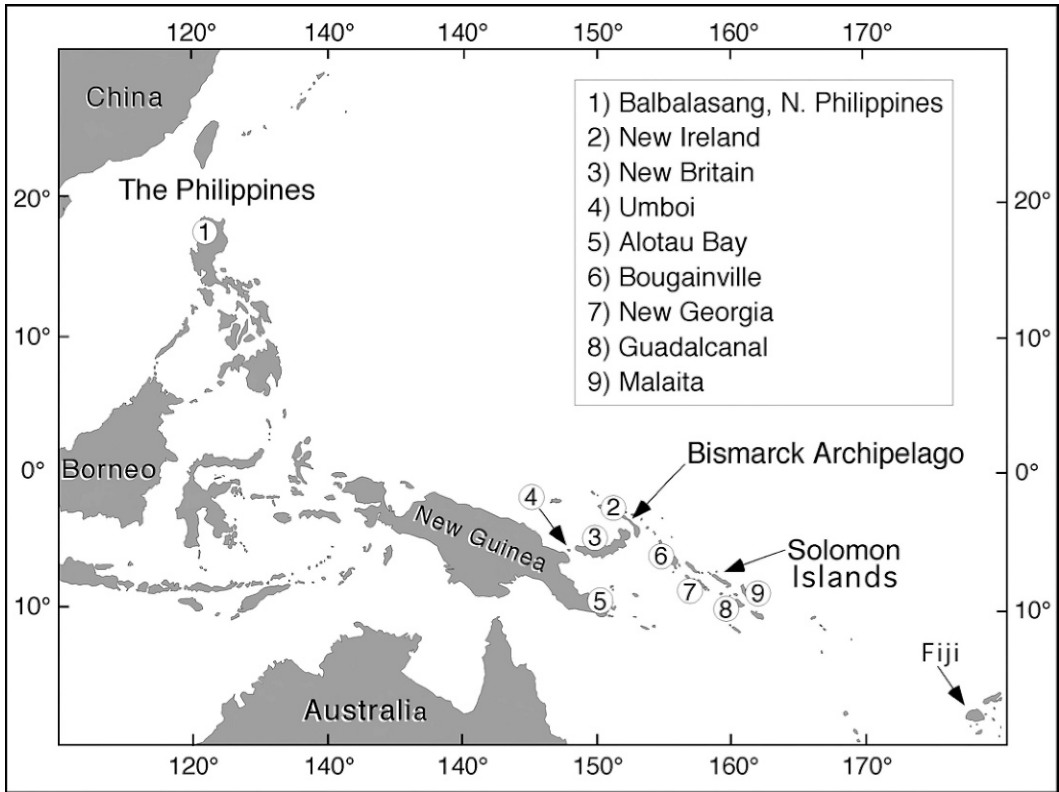


FIG. 1. Map of known localities and range of *Acutotyphlops*.

Papua/Solomon is used in reference to the four species of *Acutotyphlops* inhabiting eastern Papua New Guinea, the Bismarck Archipelago, Bougainville Island, and the Solomon Islands. NSL denotes near sea level in elevation. Museum acronyms follow Leviton et al. (1985).

RESULTS

Acutotyphlops banaorum nov. sp.

Figures 2, 3C–D, 4

Typhlopidae sp. Diesmos et al., 2004:75.

Holotype.—PNM 9280 (formerly FMNH 259604; field number GVAG 219), a juvenile male collected from an irrigation ditch in a muddy area of water pools near Barangay Balbalasang, Municipality of Balbalan, Kalinga Province, Luzon Island, The Philippines (17°29'N, 121°03'E), 900 m above sea level, by G. V. A. Gee on 28 March 2001.

Paratype.—FMNH 262249 (field number GVAG 348), an adult male collected on a trail in agricultural area between Saltan and Balbalasang, Barangay Balbalasang, Municipality of Balbalan, Kalinga Province, Luzon Island, The Philippines (17°29'N, 121°03'E), 1,050 m above sea level, by G. V. A. Gee on 4 March 2003.

Diagnosis.—*Acutotyphlops banaorum* can be distinguished from all Typhlopidae except Papua/Solomon *Acutotyphlops* by any of the following characters: (1) V-shaped lower jaw; (2) short, narrow rostral; (3) an enlarged frontorostral shield; (4) occipital condyle formed solely from the basioccipital; and (5) acuminate contact of four braincase bones (parietal and basisphenoid, frontal and prootic) forming an X-shaped pattern. From the Papua/Solomon *Acutotyphlops* it can be separated by the presence of (1) a single ocular and preocular shield (vs. fragmentation into 6–10 shields), (2) three infralabials (vs. 5–7 shields), (3) fourth supralabial as tall as long (vs. at least twice as long as tall), (4) uniformly light dorsum and venter with irregular dark dorsal spots (vs. dark dorsum and light venter separated by a sharp demarcation), and absence of (5) retrocloacal sacs, and (6) a solid, awned hemipenis with helical coils in tail when retracted.

Description (holotype, followed parenthetically by paratype if different).—Snout-vent length 120.5 (319.7) mm, tail length 4.5 (13.3) mm, total length 125.0 (333.0) mm, head width (at eye level) 3.0 (4.5) mm, nuchal diameter (behind skull) 3.7 (5.9) mm, midbody diameter 3.9 (6.5)

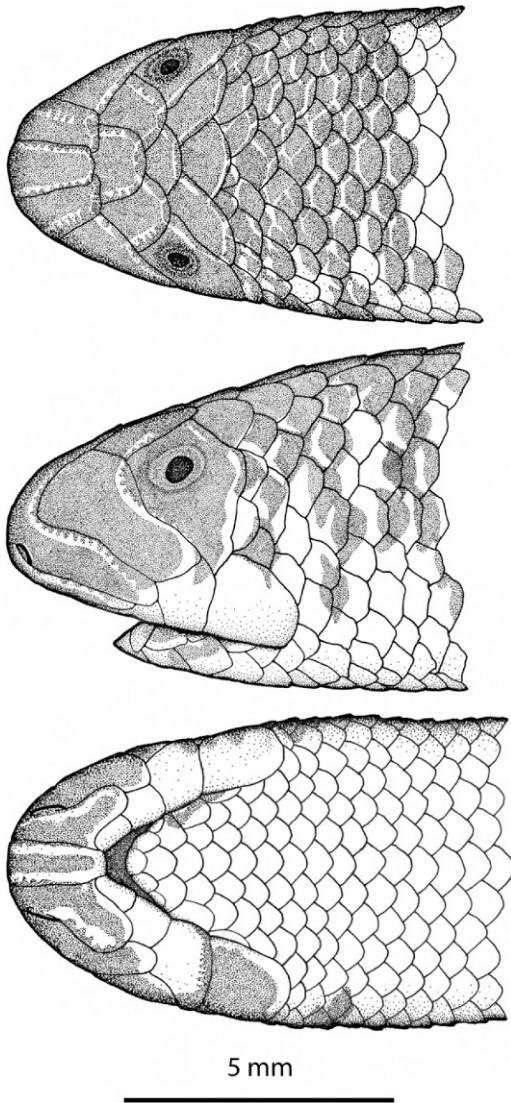


FIG. 2. Illustration of the paratype of *Acutotyphlops banaorum* (FMNH 262249): (A) dorsal view; (B) lateral view; and (C) ventral view.

mm, preloacal diameter 2.9 (5.1) mm, midtail diameter 1.7 (4.3) mm, tail/total length 3.6% (4.0%), total length/midbody diameter 32.1 (51.2), tail length/width 2.7 (3.1); total middorsals 352 (361), scale rows 30-26-24, subcaudals 19 (16), dorsocaudals 20 (18), midbody mid-dorsal scales subhexagonal (rounded) with width/length ratio of 2.0 (1.25); midventral scale row slightly enlarged (nuchal region midventral 1.18 times the width of a costal scale, midbody region 1.22 times costal width, preloacal region 1.27 times costal width); three large cloacal scales covering vent; apical spine minute and straight with broad basal attach-

ment; head narrower than neck and tapered in dorsal view with bluntly rounded snout, nuchal region hypertrophied as in the Papua/Solomon *Acutotyphlops* and some Uropeltidae (Gans, 1976; Gans et al., 1978); rostral short, extending 0.70 (0.66) snout-interocular distance, and narrow, 0.23 (0.26) head width, with oval but nearly parallel sides; frontorostral larger than frontal or interparietal, extending to eye level in holotype, just anterior to eye in paratype, slightly wider than long with rounded edges; frontorostral and frontal bordered laterally by a pair of large supraoculars that contact the nasal, preocular, ocular, parietal, frontal, and frontorostral; interparietal wider than long; parietals oblique and twice the width of costal scales; distinctly enlarged occipitals lacking; snout blunt in lateral view; nasals incompletely divided, inferior nasal suture contacting second supralabial, superior nasal suture extending horizontally from nostril across 0.80 (0.75) nostril-rostral distance; nostril directed laterally, its axis on a 45° angle to the perpendicular; nasal with a deep concavity in caudal border; preocular single and undivided, oblique, about twice as tall as broad; ocular single and undivided, oblique, and slightly broader than preocular; eye reduced to a small black spot under a clear circular window in ocular shield, located anteriorly beneath dorsal portion of ocular; 3/3 (4/4) postoculars bordering ocular on each side between last supralabial and parietal; supralabial imbrication pattern T-III, first supralabial as broad as tall, second supralabial as broad as tall and twice the size of first, third supralabial twice as tall as broad and twice the size of the second, fourth supralabial as tall as broad, twice the size of the third; three infralabials.

Skull osteology.—Based upon radiographs taken in dorsal, lateral, and ventral aspect, a spike-like projection of the parietal bone separating the posterior frontal bones cannot be positively identified. Until a skull of *Acutotyphlops banaorum* can be prepared, the presence or absence of this character will remain unknown. Radiographs do clearly reveal the separation of the parietal and basisphenoid bones by projections of the frontal and prootic that meet midlaterally as well as the extension of the occipital condyle on a neck.

Coloration (in preservative).—Dorsum pale golden orange (orangish-brown) with approximately 90 (80) irregular black spots and bars middorsally on body, most closely resembling that of *Rhinotyphlops schinzi* (Boettger, 1887) of South Africa (Marais, 2004). Each dark mark is 2-4 scales in width and 1-3 scales in length but the pigmentation does not correspond to the scales themselves; rather the black pigment

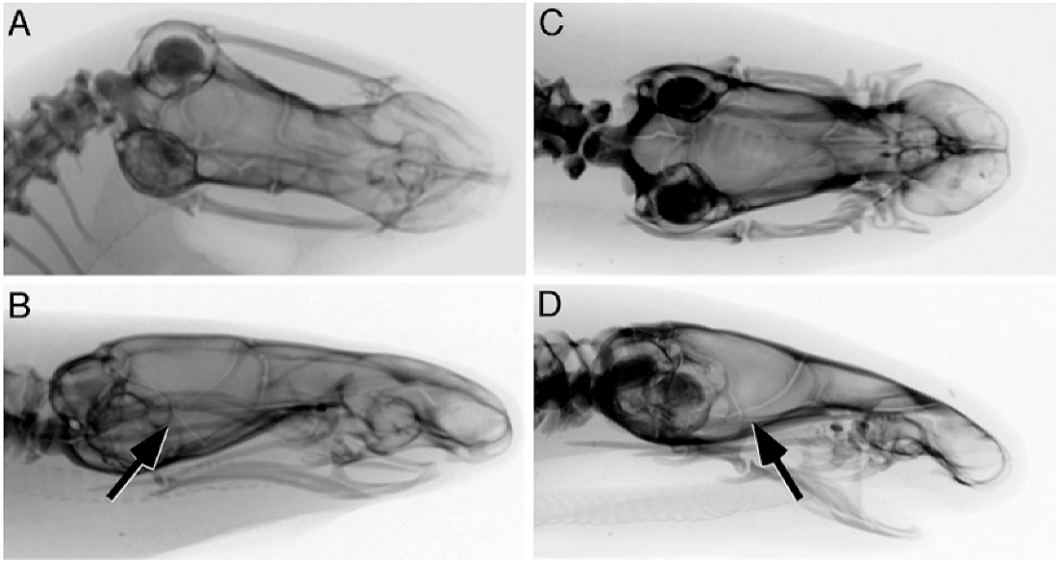


FIG. 3. Radiographs of *Acutotyphlops solomonis* (MCZ 175090): (A) dorsal view; (B) lateral view; *Acutotyphlops banaorum* (FMNH 262249): (C) dorsal view; (D) lateral view. Arrow denotes X-shaped acuminated contact of parietal, basisphenoid, frontal and prootic.

consistently covers only part of each particular scale. Venter immaculate gold (brownish-orange) with no line of demarcation present between dorsal and ventral coloration, only a gradual transition from a more brownish to a more orangish color ventrolaterally. Anterior orange-brown coloration of body darker than posterior portion, both dorsally and ventrally, but tail almost entirely black with 15/20 (18/18) vertebral dorsocaudals pigmented. Head black, pigmentation extending caudally 6 (5) scales beyond the postfrontal, only the first to third supralabials light. Head glands conspicuous, resembling those of Papua/Solomon *Acutotyphlops* in having a saw-tooth pattern with apices directed toward the inner portion of the shield rather than a series of circular or oval glands as

in other species within Typhlopidae, inferior nasal gland distinct.

Coloration in life.—Field notes record the coloration as black head, shiny orange-brown dorsum with irregular black markings, and light orange-brown venter.

Etymology.—We are pleased to name the new species in recognition of the Banao tribespeoples of the Central Cordillera. The Banao's age-old tradition of ardent appreciation and fierce protection of the natural resources contained within ancestral homelands has resulted in the persistence of the forests of Balbalasang-Balbalan National Park. This region of the Central Cordillera represents one of the most extensive and best managed forest ecosystems remaining in the Philippines.



FIG. 4. Photograph of preserved paratype of *Acutotyphlops banaorum* (FMNH 262249) showing dorsal color pattern.

Variation.—There appears to be ontogenetic variation in the shape and proportions of the midbody scales in *Acutotyphlops*. The juvenile *A. banaorum* holotype has broad subhexagonal scales whose width is twice the length, whereas the adult paratype has rounded scales that are barely wider than long (width/length = 1.25). A similar situation was observed in *A. kunuaensis*, where juveniles have elongate hexagonal scales and adults have rounded scales with nearly equal dimensions.

Ecology.—The area surrounding the town of Balbalasang (the Saltan River valley) is now primarily agricultural cropland (stone-walled rice terraces) and pasture. The immediate slopes surrounding the Saltan River valley, from 950–2,000 m elevation are approximately 20% covered with native pine forest (*Pinus kesiya*) which is maintained by frequent burning. The remaining forest in the vicinity of Balbalasang, is mature, broad-leaf, midmontane to upper-montane rain forest (Whitmore, 1984), and a transition to mossy forest occurs at approximately 2,000 m (Diesmos et al., 2004; Heaney et al., 2004, and unpublished technical reports cited therein). The climate is cool and temperate with a pronounced wet and dry season, rainfall occurring from May to October (Type I of Diesmos et al., 2004).

The holotype was collected in an area now dominated by pine forest and grassland or brushy secondary growth. The paratype originated from cultivated land surrounded by a lower montane to midmontane transitional rainforest dominated by oaks (Whitmore, 1984). Although the circumstances of capture of both specimens suggests a human commensal lifestyle, this species is either fossorial or semifossorial and was probably collected by chance in agricultural areas, where the ground was disturbed by human activities. It may well thrive in cultivated areas, but its native habitat is most likely the original montane forest, and it is entirely possible that both specimens were washed down from the higher mountains during heavy rains as is suspected with the types of *Typhlops lazelli* from Hong Kong (Wallach and Pauwels, 2004). Scolecophidians must leave their subterranean confines when the ground becomes saturated and they are often seen and collected during or after rains that bring them to the surface (Greer, 1997; Broadley et al., 2003).

DISCUSSION

In defining *Acutotyphlops*, Wallach (1995) noted the following six diagnostic characters: one osteological (parietal spike between frontal bones), one morphological (V-shaped lower

jaw), and four scutellation features (frontorostral, suboculars, ocular and/or preocular divided, and 5–7 infralabials). A character mentioned in the generic description that is also a synapomorphy for *Acutotyphlops* is the rostral, which is narrow (0.10–0.25 head width) and short (extending posteriorly about halfway to the eyes). Of those seven characters, three are unequivocally present in *A. banaorum*, a fourth (ocular and preocular division) is not inconsistent with the previous definition, and two (parietal spike and infralabials) may eventually be demonstrated to be compatible. Additionally, two new osteological synapomorphies have been discovered that unite the five species of *Acutotyphlops*.

In the basal scolecophidian family Anomalepididae (Wallach, 1998; Zug et al., 2001), the prefrontal shields, corresponding to the prefrontal bones, are paired in *Anomalepis*, *Helminthophis*, and *Liotyphlops* (Dunn, 1944; Peters and Orejas-Miranda, 1970). Kinghorn (1948) coined the term frontonasal for the median azygous shield between the rostral and frontal in *Typhlops keasti* (= *Acutotyphlops subocularis*), and Wallach (1995) referred to it more appropriately as the frontorostral. Both Kinghorn and Wallach erred in labelling the paired shields laterally bordering this shield as prefrontals when in reality they are supraoculars. The recognition of Kinghorn and Wallach's "prefrontals" as supraoculars necessitates five changes in the scale terminology to correct the nomenclature in *Acutotyphlops* as used by Wallach (1995:fig. 1): "prefrontal" = supraocular, "supraocular" = parietal, "parietal" = occipital, "postfrontal" = interparietal, and "interparietal" = interoccipital. With this modified terminology, all of the head shields of *Acutotyphlops* correspond to those of most other Typhlopidae, the exception being the presence of a unique frontorostral. There is ambiguity in the homology of the pair of shields in *Acutotyphlops subocularis* known as supranasals in that they could also be the prefrontals. The holotype of *Typhlops bergi* (= *Acutotyphlops infralabialis*) is atypical in possessing a pair of supraoculars on each side of the head (Peters, 1948). However, three specimens (1.2%) out of 255 *Acutotyphlops kunuaensis* also exhibit this condition, which is partly why it is not given more weight in the recognition of *T. bergi* as a valid species.

The ocular and preocular are both single in *A. banaorum*, but because the preocular is single in *A. infralabialis* and *A. kunuaensis* and the ocular is single in *A. solomonis*, the condition in *A. banaorum* is not inconsistent with states present in other *Acutotyphlops* species. By definition the preocular and ocular in *Acutotyphlops* may be single or divided.

With the two additional osteological characters (occipital condyle formed solely from the basioccipital and separation of the parietal and basisphenoid by the frontal and prootic bones), *A. banaorum* shares five unambiguous synapomorphies with the Papua/Solomon *Acutotyphlops*: presence of a (1) frontorostral, (2) short and narrow rostral, (3) V-shaped lower jaw, (4) occipital condyle formed entirely by the basioccipital and supported by a neck that extends more than one condyle's length from the skull, and (5) reduction of broad contact laterally between the parietal and basisphenoid bones by contact or near-contact of acuminate projections of the frontal and prootic. Additionally, it agrees with other species of *Acutotyphlops* (and some other typhlopids) in having obliquely oriented ocular and preocular shields, a deeply concave postnasal border, both anterior and posterior scale row reduction, and a high number of scale rows.

Certain characters appear intermediate between *Acutotyphlops* and other typhlopids and are presumably plesiomorphic with respect to Papua/Solomon *Acutotyphlops*. The width of the nuchal region of *A. banaorum* is not greater than its midbody diameter (as in the Papua/Solomon *Acutotyphlops*), but it approaches this condition. Midbody scale rows range from 26–36 in Papua/Solomon *Acutotyphlops*, and *A. banaorum* has 26 rows, also plesiomorphic under the assumption that scale fragmentation and increase in number of scale rows are derived conditions. The sum of anterior, midbody, and posterior scale row numbers in Papua/Solomon *Acutotyphlops* ranges from 82–110; the sum in *A. banaorum* is 80, which extends the range at the lower end of the spectrum. Also, the mean number of middorsals in *A. banaorum* (356.5) is lower than that for the other four species but most closely resembles that of *A. solomonis* (380.9). Unlike most *Acutotyphlops*, the dorsal and lateral snout profiles are bluntly rounded, most similar to *A. solomonis*, and again an apparently primitive condition. Hemipenis attenuation, as indicated by the hemipenis diameter/tail width ratio, suggests affinity of *A. banaorum* with *Acutotyphlops* as in situ measurements of hemipenes provide the following values: *Typhlops platycephalus*, 0.17, *Typhlops gierrai*, 0.19, *Acutotyphlops solomonis*, 0.13, *A. banaorum*, 0.11, *A. kunuaensis*, 0.08, and *A. infralabialis*, 0.07.

Acutotyphlops banaorum differs from the Papua/Solomon *Acutotyphlops* in lacking these previously diagnostic characters: (1) solid, awned hemipenes; (2) retrocloacal sacs; (3) two or more suboculars; (4) sum of preocular and ocular shields equal to three or more; (5) five or more infralabials; (6) an elongated fourth

supralabial; (7) a bicolored pattern; (8) widest part of body in nuchal region; and (9) parietal spike between frontal bones (Table 1). With a larger sample size and/or prepared skull, some of the above characters may eventually be confirmed once again to be diagnostic of *Acutotyphlops*. Inter- and intraspecific variation within Papua/Solomon *Acutotyphlops* is already known in characters such as the supralabial imbrication pattern (T-III and T-0), which is normally diagnostic of genera and species groups, the contact of the inferior nasal suture with supralabials (SL1 and SL2), and number of preocular (1–2), ocular (1–4), and subocular (2–7) shields; thus, it is not surprising that *A. banaorum* exhibits even greater variation. *Acutotyphlops banaorum* is unique among scolecophidians in having an irregular spotted pattern of pigmentation that does not conform to scale borders. It most closely resembles the pattern of *Rhinotyphlops schinzi* (Boettger 1887; Coborn, 1991; Marias, 1992, 2004), which differs in having a pink (unpigmented) ground color with dark pigmentation entirely covering the individual scales.

The presence of the two male reproductive synapomorphies is not invariable because there are a few species known in which the hemipenis exhibits either no coils (*Austrotyphlops guentheri*, *A. nema*, and *Ramphotyphlops cumingii*) or merely a kink or half coil (*Austrotyphlops minimus* and *Ramphotyphlops ozakiae*) and retrocloacal sacs are absent (*Austrotyphlops endoterus*, *A. guentheri*, and *A. hamatus*) (Alpin and Donnellan, 1993; Wallach, 1998). *Austrotyphlops guentheri* is notable in lacking both synapomorphies. This absence of coiled hemipenes and/or retrocloacal sacs was previously assumed to be an apomorphic condition resulting in the simplification or loss of the structures (Alpin and Donnellan, 1993). Now, however, with *A. banaorum* exhibiting identical conditions, it is possible that *A. guentheri* is a basal Australian species within the genus *Austrotyphlops*. Only a phylogenetic analysis can determine which hypothesis is correct.

Although *A. banaorum* possesses a set of traits shared with the derived morphology of Papua/Solomon *Acutotyphlops*, it also lacks some of the key characters previously considered diagnostic for this genus. Our assignment of *A. banaorum* to *Acutotyphlops* is provisional and based on the overwhelming number of putative synapomorphies shared between the new species and other members of the genus. However, it is clear that *A. banaorum* blurs the distinction between *Acutotyphlops* and other typhlopids, suggesting that additional studies of the morphology of these rare Asian typhlopids will be necessary to ascertain their true relationships.

TABLE 1. Comparison of the Philippine *Acutotyphlops bannaorum* nov. sp. with Solomon Island/Papua New Guinea *Acutotyphlops* species (data taken from Wallach, 1995); head shield values refer to one side of head only; meristic characters presented as mean (range) sample size; rare conditions (<10%) enclosed in parentheses. Snout profiles (R = rounded, W = wedge-shaped, P = pointed), inferior nasal suture contact (SL1 = first supralabial, SL 2 = second supralabial), apical spine (S = spinelike, T = thornlike, 0 = absent).

Character	<i>A. bannaorum</i> nov. sp.		<i>A. solomonis</i>		<i>A. stibocularis</i>		<i>A. infralabialis</i>		<i>A. kumauensis</i>	
	Luzon, P.I.	Bougainville (PNG)	Bougainville (PNG)	Bismarck Arch. (PNG)	Solomons	Bougainville	Solomons	Bougainville	Solomons	Bougainville
Distribution	229 (125-333) 2	358 (164-487) 31	270 (191-394) 29	254 (115-372) 12	237 (104-373) 255	254 (115-372) 12	237 (104-373) 255	254 (115-372) 12	237 (104-373) 255	237 (104-373) 255
Dorsal pattern	light with spots	uniformly dark	uniformly dark	uniformly dark	uniformly dark	uniformly dark	uniformly dark	uniformly dark	uniformly dark	uniformly dark
Length/width ratio	41.7 (32.1-51.2) 2	31.5 (18.2-42.5) 31	32.2 (23.2-43.8) 29	32.2 (23.2-43.8) 29	45.1 (33.4-57.4) 12	45.1 (33.4-57.4) 12	45.1 (33.4-57.4) 12	45.1 (33.4-57.4) 12	45.1 (33.4-57.4) 12	45.1 (33.4-57.4) 12
Dorsal snout profile	R	R	R	R	P	P	P	P	P	P
Lateral snout profile	R	R	W (P)	W (P)	P	P	P	P	P	P
Inferior nasal suture	SL 2	SL 2	SL 2	SL 2	SL 1-SL 2	SL 2	SL 2	SL 2	SL 2	SL 2
Supralabial imbrication pattern	T-III	T-III	T-0 (T-III)	T-0 (T-III)	T-III	T-III	T-III	T-III	T-III	T-III
Rostral/head width	0.25 (0.23-0.26) 2	0.16 (0.15-0.21) 5	0.15 (0.10-0.20) 2	0.15 (0.10-0.20) 2	0.23 (0.21-0.24) 5	0.22 (0.21-0.24) 5	0.23 (0.21-0.24) 5	0.22 (0.21-0.24) 5	0.22 (0.21-0.24) 5	0.22 (0.21-0.24) 5
Supranasals	0	0	1	1	0	0	0	0	0	0
Preoculars	1	2	2	2	1	1	1	1	1	1
Oculars	1	2-3 (4)	1	1	2	2	2	2	2	2 (3)
Suboculars	0	2 (3-5)	4-5 (6, 7)	4-5 (6, 7)	3	3	3	3	3	3 (2, 4)
Postoculars	3-4	(3) 4-5	(3) 4-5	(3) 4-5	3-5	3-5	3-5	3-5	3-5	3-4 (5)
Supraoculars	1	1	1	1	1-2	1	1-2	1	1	1
Occipitals	0	0	1	1	1	1	1	1	1	1
Infralabials	3	6-7	5-7	5-7	6-7	6	6-7	6	6	6
Cloacal shields	3	5	5	5	5	5	5	5	5	5
Total middorsals (male)	356. 5 (352-361) 2	363.4 (334-381) 9	399.6 (363-472) 17	399.6 (363-472) 17	484.8 (418-526) 6	405.7 (360-532) 114	484.8 (418-526) 6	405.7 (360-532) 114	484.8 (418-526) 6	405.7 (360-532) 114
Total middorsals (female)	—	388.1 (362-424) 22	398.8 (363-428) 12	398.8 (363-428) 12	469.0 (422-511) 6	421.6 (360-542) 141	469.0 (422-511) 6	421.6 (360-542) 141	469.0 (422-511) 6	421.6 (360-542) 141
Dorsocaudals (male)	19 (18-20) 2	28.0 (25-30) 9	25.6 (21-28) 17	25.6 (21-28) 17	24.8 (23-28) 6	23.1 (19-31) 114	24.8 (23-28) 6	23.1 (19-31) 114	24.8 (23-28) 6	23.1 (19-31) 114
Dorsocaudals (female)	—	20.7 (18-24) 22	20.3 (14-23) 12	20.3 (14-23) 12	16.8 (14-18) 6	15.0 (11-19) 141	16.8 (14-18) 6	15.0 (11-19) 141	16.8 (14-18) 6	15.0 (11-19) 141
Tail length/total length (male)	3.8 (3.6-4.0) 2	6.8 (5.2-7.7) 9	5.5 (3.0-6.3) 17	5.5 (3.0-6.3) 17	4.2 (3.2-5.3) 6	4.9 (3.4-6.7) 114	4.2 (3.2-5.3) 6	4.9 (3.4-6.7) 114	4.2 (3.2-5.3) 6	4.9 (3.4-6.7) 114
Tail length/total length (female)	—	3.9 (2.9-4.9) 22	3.7 (3.0-4.5) 12	3.7 (3.0-4.5) 12	2.1 (1.0-3.1) 6	2.7 (1.8-3.8) 141	2.1 (1.0-3.1) 6	2.7 (1.8-3.8) 141	2.1 (1.0-3.1) 6	2.7 (1.8-3.8) 141
Anterior scale rows	30.0 (30-30) 2	33.7 (30-36) 31	40.0 (36-44) 29	40.0 (36-44) 29	34.0 (32-36) 12	37.5 (34-42) 255	34.0 (32-36) 12	37.5 (34-42) 255	34.0 (32-36) 12	37.5 (34-42) 255
Midbody scale rows	26.0 (26-26) 2	32.0 (29-34) 31	34.5 (32-36) 29	34.5 (32-36) 29	27.0 (26-28) 12	32.4 (30-36) 255	27.0 (26-28) 12	32.4 (30-36) 255	27.0 (26-28) 12	32.4 (30-36) 255
Posterior scale rows	24.0 (24-24) 2	26.6 (24-28) 31	30.8 (28-34) 29	30.8 (28-34) 29	25.0 (22-26) 12	28.4 (26-33) 255	25.0 (22-26) 12	28.4 (26-33) 255	25.0 (22-26) 12	28.4 (26-33) 255
Apical spine	S	S	T	T	S (0)	S	S (0)	S	S (0)	S

Acutotyphlops is unusual in that the genus contains species in eastern Papua New Guinea/Solomon Islands and the Philippines, with no members discovered to date in the intervening regions of eastern Indonesia, the New Guinea mainland (with the exception of a single *A. solomonis* from coastal Alotau, Milne Bay Province, that could be a waif), or the islands of the Sunda Shelf (Fig. 1). We assume that the phenotypic similarity observed here between Solomon and Philippine populations is reflective of common ancestry and not convergence. Given this assumption, we note that *Acutotyphlops* possesses a peculiar geographic range that is nearly unique among amphibians and reptiles of Southeast Asia and the southwest Pacific. The distribution of the genus suggests a seldom-conceived biogeographic link between the northern Philippines and the Solomon islands. There are only a few other amphibian and reptile groups shared by (and primarily limited to) the Philippines and the Solomon-Bismarck Archipelagos. The most notable of these is the rapid frog genus *Platymantis*, which possesses major centers of diversity in the Philippines and the Solomon-Bismarck Archipelago (Foufopoulos and Brown, 2004; Brown et al., 2006a,b) but has minor radiations and single-island endemics also distributed in eastern Indonesia, Palau, New Guinea, and Fiji (Allison, 1996; Brown, 1952, 1997).

Assuming common ancestry, the distribution of the genus suggests that either (1) additional species from intervening regions exist but have not been discovered, (2) additional species at one time existed and have subsequently gone extinct, or (3) the disjunct distribution of the known taxa has resulted from a single long-distance over-water dispersal event or a more saltatory process in dispersal along island arcs with eastern Indonesian and Papuan island intermediates (Allison, 1996; Brown, 1997; Inger, 1999). We are unwilling to speculate as to the polarity of hypothetical dispersal events, but note that the biogeographers who have attempted to explain the similar distribution found in *Platymantis* have evoked forms of both west-to-east (Noble, 1931; Ota and Matsui, 1995; Mahoney et al., 1996) and east-to-west scenarios (Kuramoto, 1985, 1997; Allison, 1996; Brown, 1997).

The disjunct distribution that separates *Acutotyphlops banaorum* of the Philippines from the Papua/Solomon *Acutotyphlops* by 4,000 km presents a compelling problem that will require additional fieldwork, a full understanding of the geological complexity of the region (Hall, 1996, 1998), and an independent phylogenetic estimate for the genus and its relatives.

TAXONOMIC SUMMARY

Acutotyphlops Wallach, 1995

Revised diagnosis.—A genus of Typhlopidae characterized by the following synapomorphies: (1) frontorostral; (2) short and narrow rostral shield; (3) V-shaped lower jaw; (4) occipital condyle formed entirely of basioccipital; and (5) reduction of parietal and basisphenoid contact by acuminate projections of frontal and prootic. Additionally, the four Papua New Guinea/Solomon Island species possess a parietal spike between the frontal bones, retrocloacal sacs, and solid awned hemipenes with 3–9 coils in the retracted state. There is a tendency toward narrowing and pointing of the snout, hypertrophy of the neck musculature resulting in nuchal diameter greater than midbody diameter, fragmentation of the preocular and ocular shields into smaller units, elongation of the fourth supralabial, increase in infralabial number, increase in number of longitudinal scale rows, caudal sexual dimorphism, and a dichromatic bicolor pattern, all of which are presumably apomorphic.

Content.—Five species comprising two species groups.

I. *Acutotyphlops banaorum* Species Group (Philippine).

Acutotyphlops banaorum nov. sp.

Holotype: PNM 9280 (formerly FMNH 259604; field no. GVAG 219), a juvenile male collected near Barangay Balbalasang, Municipality of Balbalan, Kalinga Province, Luzon Island, The Philippines (17°29'N, 121°03'E, 900 m), by G. V. A. Gee on 28 March 2001.

II. *Acutotyphlops subocularis* Species Group (Papua/Solomon).

Acutotyphlops infralabialis (Waite, 1918)

Synonyms: *Typhlops bergi* Peters, 1948, holotype UMMZ 95445, a 171 mm male from Segi Point, New Georgia Island, Solomon Islands (8°34'S, 157°55'E, NSL), collected by C. O. Berg, April 1944; *Typhlops adamsi* Tanner, 1951, holotype MVZ 40753, a 151 mm female from Nalimbiu River (1 mi. inland), Guadalcanal Island, Solomon Islands (approximately 9°24'S, 160°09'E, 15 m), collected by L. Adams, 6 June 1944.

Holotype: AMS R4609, a 305 mm female presented by J. Caulfield. *Type locality*: Malaita, Solomon Islands. *Range*: Papua New Guinea (Bougainville) and Solomon Islands (Guadalcanal, Malaita, New Georgia), 0–245 m.

Acutotyphlops kunuaensis Wallach, 1995

Holotype: MCZ 76964, a 221 mm male collected by F. Parker, 19 August 1963. *Type*

locality: Kunua, Bougainville Island, Papua New Guinea (5°46'S, 154°43'E, 30 m). Range: Papua New Guinea (Bougainville Island), 0–915 m.

Acutotyphlops solomonis (Parker, 1939)

Holotype: IRSNB 2029, a 427 mm female collected by J. B. Poncet, 2 June 1938. Type locality: Buin, Bougainville Island, Papua New Guinea (6°44'S, 155°41'E, 60 m). Range: Papua New Guinea (Alotau and Bougainville Island), 0–915 m.

Acutotyphlops subocularis (Waite, 1897)

Synonym: *Typhlops keasti* Kinghorn, 1948, holotype AMS R12856, a 373 mm male from Jacquinot Bay, New Britain, Bismarck Archipelago, Papua New Guinea (5°34'S, 151°30'E, NSL), collected by J. A. Keast, June 1945.

Holotype: AMS R2202, a 361 mm male collected by G. Brown "many years ago." Type locality: Duke of York Island, Bismarck Archipelago, Papua New Guinea (4°10'S, 152°28'E, <50 m).

Range: Bismarck Archipelago (Duke of York, New Britain, New Ireland, Umboi), 0–1,065 m. The paratype, entered into the museum register as AMS R2203, has been missing (Cogger, 1979, Wallach, 1995); however, a specimen of *A. subocularis* with identical measurements and scale counts was discovered by Shea, 1999, with apparently the wrong tag. It is AMS R2169, locality unknown, presented by E. Sutton (Shea and Sadlier, 1999).

KEY TO THE GENUS *ACUTOTYPHLOPS*

- 1a. Midbody scale rows 26–28; dorsum lineate or spotted 2
- 1b. Midbody scale rows 29–36; dorsum uniformly dark 3
- 2a. Two preoculars; three suboculars; total middorsals >400 *A. infralabialis*
- 2b. One preocular; no suboculars; total middorsals <390 *A. banaorum* nov. sp.
- 3a. One preocular; dorsal and lateral snout profiles acutely pointed *A. kunuaensis*
- 3b. Two preoculars; dorsal and lateral snout profiles not pointed 4
- 4a. Supranasals absent; two or more oculars; occipitals absent; usually two suboculars *A. solomonis*
- 4b. Supranasals present; one ocular; occipitals present; usually 4–5 suboculars *A. subocularis*

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APPENDIX 1

Specimens Examined

Specimens in bold text were examined for osteological characters (skull radiographs); the following prepared skulls were also examined: *Acutotyphlops kunuaensis* (MCZ 64226 [erroneously listed as *Acutotyphlops infralabialis* by Wallach, 1995], 76699), *Acutotyphlops solomonis* (MCZ 65597, 65993, 72084), *Acutotyphlops subocularis* (NMBA 11704).

Acutotyphlops banaorum.—See holotype and paratype sections.

Acutotyphlops infralabialis.—BOUGAINVILLE: Buin (MCZ 72129), Malabita (MCZ 65991), Turiboiru (MCZ 92504); Melelup (**MCZ 175089**); GUADALCANAL: Makaruka (MCZ 110249), Mt. Austen (AMS 77116), Nalimbu River (MVZ 40753 [holotype of *Typhlops adamsi*]), Visale (AMS 71360), no specific locality (BYU 7040); MALAITA: Buma (NMBA 10155), Mbita'ama (AMS 87396), no specific locality (AMS 4609 [holotype]); NEW GEORGIA: Segi Point (UMMZ 95445 [holotype of *Typhlops bergi*]).

Acutotyphlops kunuaensis.—BOUGAINVILLE: Buin (MCZ 65990), Cape Torokina (USNM 120949), Empress Augusta Bay (FMNH 44800-01), Kieta (AMNH 87360-62; MCZ 64226-36, 72104-05; NMV 10109), Kunua (MCZ 76964 [holotype], 72067-74, 72075-78, 72080, 72130-36, 76206, 76682-87, 76690-700, 76704-12, 76714, 76716-26, 76926-27, 76929-32, 76935-39, 76948, 76950, 76955-57, 76959-63, 76965, 76967-74, 76977, 76979-80, 76982-83, 76986-96, 76998-7013, 77016-33, 77036-38, 77267-79, 77282-90, 77292-306 [paratypes]), Mutuhai (MCZ 87605, 174754-55, 174759), North Nasioi (MCZ 66010-14), Piva, Torokina (AMS 121582-84, 121698-700, 121769, 121909, 121956-57, 123393-99, 123402-03), Topanos (MCZ 87606-07, 88049, 175082-88), Torokina Bay (USNM 120931, 120933-34, 120935-48), no specific locality (USNM 120211).

Acutotyphlops solomonis.—BOUGAINVILLE: Buin (AMS 11451-52; MCZ 65999, 72084), Empress Augusta Bay

(FMNH 44802), Kieta (MCZ 64225, 65992-98; NMV 10108), Kunua (MCZ 72083, 72085-86, 72138-39, 72938, 73766, 76688, 175099), Melelup (MCZ 175090), Mutuhai (MCZ 174756-58, 174760), Torokina (USNM 120932, 120934), no specific locality (IRSNB 2029 [holotype]). PAPUA NEW GUINEA: Alotau (MCZ 145955).

Acutotyphlops subocularis.—BISMARCK ARCHIPELAGO: no specific locality (ZMB 38612, 50458); DUKE OF YORK: no specific locality (AMS 2202 [holotype]); NEW BRITAIN: Iambon (AMNH 82317), Jacquinot Bay (AMS 12856 [holotype of *Typhlops keasti*]; NMBA 11704), Keravat (UPNG 1101), Kokopo (ZMH 3968), Mosa (PNGM 24600-03), Talasea (MCZ 175091), Wunung (NMBA 11705-08); NEW IRELAND: Fissoa (NMBA 11709-10), Lemkamin (ZMUC 5269), Medina (UPNG 5652), Radina ? (AMS 41253-54), Yalom (ZMUC 5265-68); UMBOI: Awelkon (BPBM 5457), "NEW GUINEA": no specific locality (ZMB 24341).