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A new species of *Ramphotyphlops* Fitzinger, 1843 (Squamata: Typhlopidae) in the *R. flaviventer* Group from Woodlark Island, Papua New Guinea

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Abstract

I describe a new species of blindsnake of the genus *Ramphotyphlops* Fitzinger, 1843, from Woodlark Island, off the southeastern tip of New Guinea. The new species is a member of the *R. flaviventer* (Peters, 1864) group and is characterized by a unique combination of number of longitudinal scale rows, details of the shape of the rostral scale, color pattern, and shape of the tail spine. The nearest related species (*R. depressus* Peters, 1880) in this group occurs 380 km to the northeast from the new species, and the remaining species of the group lie no closer than 2570 km distant. The new species seems most similar morphologically to relatives from far western New Guinea, but this could be due to homoplasy or plesiomorphy. The species seems common in the widespread mature secondary forest that occurs across the island, but non-traditional land tenure and repeated outside proposals to deforest much of the island pose a continuing series of threats to this and other endemic species on Woodlark.

Key words: Blindsnake, conservation threats, endemism, Melanesia, Milne Bay Islands

Introduction

There are 33 species of blindsnakes distributed across Melanesia. One species, *Indotyphlops braminus* (Daudin, 1803), is not native but is widely introduced around the globe and found sporadically throughout Melanesia (Kraus, 2009). Of the native species (all endemic), 16 are uniquely characterized by having cephalic glands in the centers of the head scales; these belong to the genus *Gerrhopilus* Fitzinger, 1843, of the Gerrhopilidae (Kraus, 2017a, 2023). The remaining 16 species are characterized by having retrocloacal sacs and solid, coiled, non-eversible hemipenes in males (Robb, 1966). These unique features led Robb (1966) to resurrect the genus *Ramphotyphlops* for blindsnakes with such reproductive structures, which were found in snakes distributed across Australia, New Guinea, and southeastern Asia. Of the 16 Melanesian species with such features, Wallach (1995) erected the genus *Acutotyphlops* for four species from the Solomon and Bismarck islands that had unique features of scalation, osteology, and jaw shape. Hedges et al. (2014) removed three additional Melanesian species from *Ramphotyphlops* and assigned them to their newly resurrected *Anilios* Gray, 1845, although there was neither morphological nor statistically significant molecular evidence to justify that decision. Furthermore, the type species of *Ramphotyphlops* [*R. multilineatus* (Schlegel, 1839)] clusters closely at the base of supposed *Anilios* species (Tiatragul et al., 2023), showing the latter to be a junior synonym of the former. Hence, I will not recognize the validity of *Anilios* here. That leaves Melanesia with 12 species of *Ramphotyphlops* recognized at this time (Uetz et al., 2023). More broadly, *Ramphotyphlops* includes 23 species distributed across many islands of the western Pacific although one species (*R. mollyozakae* Wallach, 2021) occurs in Thailand, being the only species currently known from mainland Asia. An additional 45 species occur in Australia that have been assigned to the junior synonym *Anilios*.

Of the 12 Melanesian *Ramphotyphlops*, four belong to the *R. flaviventer* species group (Wallach, 1996), which is characterized by having a snout that is rounded in lateral profile and lacking a rostral keel, 20 or more longitudinal scale rows at mid-body, the inferior nasal suture contacting the second supralabial, and the superior nasal suture extending forward toward the rostral anterior to the naris (McDowell, 1974). All species of this group also are brown dorsally and yellow ventrally (Wallach 1996). Of the four Melanesian members of this group, *R. supranasalis* (Brongersma, 1934) is known only from Salawati Island just to the west of New Guinea, *R. similis* (Brongersma, 1934) only from Manokwari in the Vogelkop Peninsula of westernmost New Guinea, and *R. flaviventer* from the Vogelkop Peninsula, adjacent islands, and several of the Moluccas; only *R. depressus* Peters is more widely distributed, ranging across the Admiralty, Bismarck, and Solomon islands east and northeast of New Guinea. Seven of the remaining eight species of Melanesian *Ramphotyphlops* all have brown venters (or striped with brown in *R. multilineatus*), two of them [*R. angusticeps* (Peters, 1878), *R. multilineatus*] also have keeled rostrals, and one [*R. mansuetus* (Barbour, 1921)] also has an angulate rostral. These non-members of the *R. flaviventer* group are distributed across the Loyalty Islands (one species), Solomon Islands (three species), the trans-Fly region of southern New Guinea (two species), northern New Guinea (one species), and westernmost New Guinea and adjacent islands (one species). Only *R. erycinus* (Werner, 1901) from northern New Guinea is also reported to have a yellow venter (but pinkish white in life, pers. obs.), and it differs from species of the *R. flaviventer* group in having the superior nasal suture extending dorsally and posteriorly to contact the posterior portion of the rostral, whereas snakes of the *R. flaviventer* group have the superior nasal suture extending forward to contact (or not) the lower portion of the rostral. Most Melanesian *Ramphotyplops* species are represented by only a few specimens in museums, and they remain poorly known.

In his review of Papuan blindsnakes McDowell (1974) included six nomina in the synonymy of his polymorphic *Ramphotyphlops* (then *Typhlina*) *flaviventer*. Wallach (1996) reviewed the taxonomic status of *R. flaviventer* and showed that four very distinct species were present in McDowell's (1974) broadly construed *R. flaviventer*, though he retained three of the names in synonymy with *R. depressus*. He also discovered that the four members of the *R. flaviventer* group can be easily divided into two sets of taxa based on whether the brown dorsal coloration gradually transitions to the yellow ventral coloration over a distance of 2–5 lateral scale rows or whether the transition between these two color fields occurs abruptly from one scale row to the next. He found that only the eastern *R. depressus* had the gradual transition in color whereas the three western species (*R. flaviventer*, *R. similis*, and *R. supranasalis*) had the sharp division of color between the dorsal and ventral regions. He also detailed a number of other morphological features that serve to distinguish among these four species. Subsequent to the study by Wallach (1996), McDiarmid et al. (1999) referred the Micronesian *R. acuticauda* (Peters, 1878) from Palau to the *R. flaviventer* group, citing Van Wallach as the source for this decision. Thus, five species are now thought to belong to this group.

In 2010, during herpetofaunal surveys of Woodlark Island, which lies 220 km east of the southeastern tip of New Guinea, I discovered blindsnakes that are very similar in appearance to members of the *R. flaviventer* group, key out to that group using the information provided in McDowell (1974), but which have a sharp demarcation between the dark dorsal and pale ventral colors. This differs from the gradual transition seen in the geographically proximate *R. depressus* (nearest population 380 km to the northeast) and is instead similar to the character state seen in the western members of this group, the nearest population of which lies 2570 km distant. Closer examination of these specimens confirms that they represent a new species, which I take the opportunity to describe here.

Material and Methods

On specimens I collected, I measured total length of freshly euthanized animals to the nearest 0.5 mm in the field with a plastic ruler, and I measured their mass to the nearest 0.05 g with a 10-g Pesola scale. For these and the historical museum specimen, I also re-measured total length as above to assess shrinkage since preservation. I made all other measurements to the nearest 0.05 mm under a dissecting binocular scope fitted with an ocular micrometer. I determined sex by ventral dissection to identify sexual ducts. I counted numbers of longitudinal scale rows immediately behind the head, at midbody, and at one head length anterior to the vent; I counted numbers of mid-dorsal scales between the rostral and tail spine, excluding those two scales and any intercalary scales from these counts. Separately, I recorded numbers of intercalary scales along the mid-dorsal scale row, and I recorded counts of subcaudals and dorsocaudals. Scale terminology follows Wallach (1995) except that I use the more traditional "prefrontal", "frontal", and "interparietal" for the first three mid-dorsal scales behind the rostral; scale descriptions and measurements are based on the shape and locations of the clear shields. Supralabial imbrication patterns follow Wallach (1993). Comparisons to other species are based primarily on data provided in Peters (1878), Boulenger (1893), McDowell (1974), Wallach (1996), Shea and Wallach (2000), and Wynn et al. (2012), as well as to supplementary museum specimens (Appendix).

I use the following abbreviations: EW = eye width; HW = head width, at widest point (approximately 8–9 dorsal scales behind rostral); L = total length; LSR = longitudinal scale rows, recorded one head length behind head, at midbody, and one head length anterior to vent; M = mass; PSN = pre-oral snout length, from central posteroventral point of rostral to snout tip; RW = rostral width, measured at widest point; SN = snout length from anterior margin of eye to snout tip, measured as a straight line between those points, SVL = snout-vent length; SW = snout width measured across the anterior margin of the eyes; TL = tail length, from posterior margin of anal shield to end of tail spine; TSR = transverse scale rows, between rostral and tail spine; TW = tail width, measured at mid-tail; VW = vent width, measured across the vent; W = midbody width.

I collected specimens under applicable national and provincial permits, fixed them in 10% buffered formalin, and transferred them to 70% ethanol for storage. Specimens are deposited in the Bernice P. Bishop Museum, Honolulu (BPBM), and other relevant specimens were borrowed from the Museum of Comparative Zoology, Cambridge (MCZ).

Results

***Ramphotyphlops erebus* sp. nov.**
Figs. 1–2

Holotype: BPBM 39683 (field tag FK 14850), mature female, collected by mine workers and given to F. Kraus at Bomagai Camp, 9.1192° S, 152.7515° E, 91 m a.s.l., Woodlark Island, Milne Bay Province, Papua New Guinea, 17 October 2010.

Paratypes (*n*= 3): BPBM 39684, collected by F. Kraus at vicinity of upper Milpuai Stream, 9.0746° S, 152.7726° E, 89 m a.s.l., Woodlark Island, Milne Bay Province, Papua New Guinea, 19 October 2010; BPBM 39685 collected by F. Kraus along upper Muniai River, 9.1216° S, 152.7486° E, 67 m a.s.l., Woodlark Island, Milne Bay Province, Papua New Guinea, 19 October 2010; BPBM 17889, collected by J. Slapcinsky at Guasopa, 9.2233° S, 152.9433° E, 5 m a.s.l., Woodlark Island, Milne Bay Province, Papua New Guinea, 22 January 2003.

Diagnosis: A moderately large (SVL = 199–261 mm) species of *Ramphotyphlops* having the unique combination of 22 midbody scale rows; 355–402 transverse scale rows; 20–24 subcaudals; two postoculars; rostral sagittate dorsally, shallowly V-shaped ventrally; superior nasal suture complete to rostral shield (but not to underlying rostral scale) but not visible dorsally; a sharp, elongate tail spine; L/W = 38.3–42.0; a sharp distinction between brown dorsal and yellow ventral coloration; and yellow ventral field 6–9 scale rows wide; and lacking supranasal scales, a posterior notch in the rostral, and a yellow caudal ring.

Comparisons with other species: *Ramphotyphlops erebus* sp. nov. has a snout that lacks a rostral keel and is rounded in lateral view, 22 longitudinal scale rows at mid-body, the inferior nasal suture contacting the second supralabial, and a dark-brown dorsum and yellow venter. These characters place it in the *R. flaviventer* species group. Among the four other Melanesian members of the *R. flaviventer* group, *R. erebus* sp. nov. differs from *R. similis* in having 22 (vs. 20) midbody scale rows, 364–374 (vs. <240) transverse scale rows, 20–24 (vs. 9–12) subcaudals, two (vs. single) postoculars, superior nasal suture not visible (vs. visible) dorsally, and yellow caudal ring absent (vs. present); it differs from *R. depressus* in having a sharp distinction (vs. continuous gradation) between the brown dorsal and yellow ventral coloration, occipitals smaller than parietals (vs. as broad as parietals), better-developed tail spine, and a wider body (L/W mean = 40.0, range 38.3–42.0 in *R. erebus* sp. nov., mean = 47.9, range = 30.8–76.3 in *R. depressus*); it differs from *R. supranasalis* in lacking supranasal scales and a rostral that is notched posteriorly, and in having the light ventral field 6–9 (vs. 13) scale rows wide; and it differs from *R. flaviventer* in having a sagittate (vs. oval) rostral dorsally, a V-shaped (vs. with parallel sides) rostral ventrally, a superior nasal suture that extends to the rostral shield though not the underlying rostral scale (vs. suture ends before the rostral shield), a sharp, elongate tail spine (vs. a small nub), and the light ventral field only 6–9 scale rows wide (vs. 13 rows). *Ramphotyphlops erebus* sp. nov. differs from the Micronesian *R. acuticauda* in having a sagittate (vs. oval) rostral and the light ventral field only 6–9 scale rows wide (vs. 13–15 rows).

Description of the holotype (BPBM 39683): Female, with short ventral cuts midbody and just anterior to vent. L = 273 mm, SVL = 261 mm, TL = 12 mm, HW = 5.3 mm, SN = 2.9 mm, SW = 4.3 mm, PSN = 1.6 mm, RW = 2.05 mm, EW = 0.55 mm, W = 6.5 mm, VW = 5.3 mm, TW = 4.4 mm, L/W = 42.0, TL/SVL = 0.046, mass = 6.15 g. Head slightly wider than neck. Scales smooth, cycloid, imbricate, without pits. Snout rounded in dorsal and lateral views. Snout anterior to lower jaw angled slightly ventrally. Rostral moderately large (RW/HW = 0.39), sagittate dorsally (Fig. 1A), posterolateral margins almost straight, posterior border extending almost to level of eye, posterior margin straight; ventral surface papillate, with straight posterior margin, sides parallel posteriorly, then diverging anteriorly at approximately 45° from long axis of body, and then returning to more or less parallel. Nasals separated dorsally by prefrontal (Fig. 1A); superior nasal large, with slightly sinuous posterior margin, convex dorsally, almost straight ventrally (Fig. 1B), extending dorsally well above eye and preocular. Inferior nasal much smaller, longer than wide, extending ventrally farther than does the superior nasal. External naris circular, close to rostral, anterior half covered by inferior nasal; superior nasal suture curved dorsally, extending anterodorsally from naris to rostral shield, not extending as far as underlying rostral scale; inferior nasal suture complete, curved dorsally, contacting second supralabial at center of that scale. Prefrontal slightly larger than frontal, subequal to interparietal; supraoculars larger; all these scales papillate. Parietals larger, twice as wide as deep, right wider than left; interparietal wider than long, subequal to parietals; occipitals smaller, same size as dorsal body scales. Preocular large, semi-crescentic;

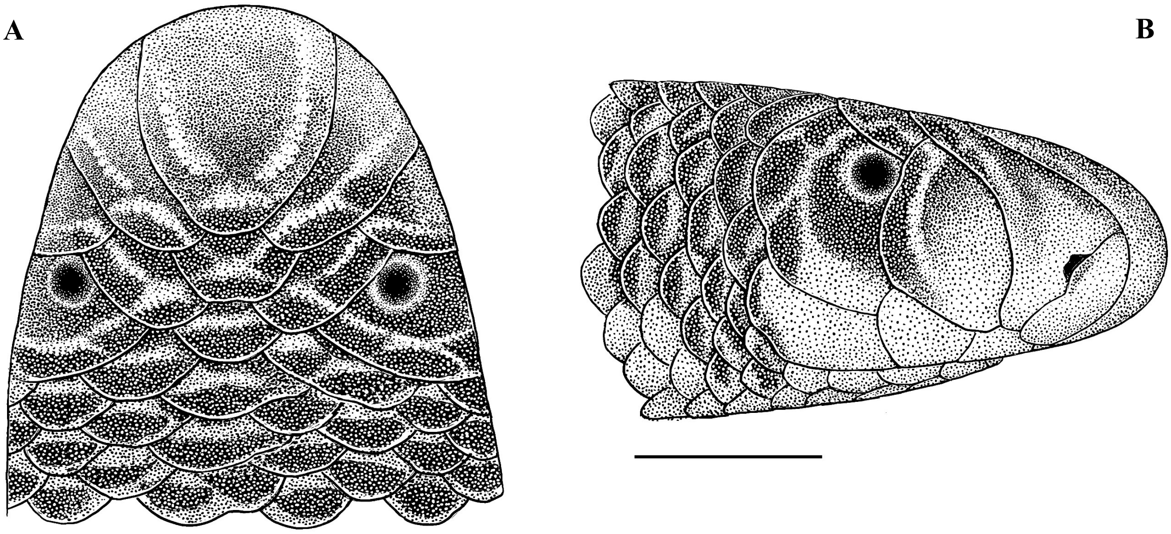

Figure 1: (A) Dorsal and (B) lateral views of head of holotype of *Ramphotyphlops erebus* sp. nov. (BPBM 39683). Scale bar = 2 mm.

smaller than ocular and superior nasal, bordered ventrally by supralabials 2 and 3, extending posteriorly almost to eye. Ocular large, extending dorsally well above preocular, extending ventrally almost as far as preocular, bordered ventrally by supralabials 3 and 4; subocular absent. Eye fairly distinct, with large pupil, situated at widest point of ocular and closer to its dorsal than ventral margin, not covered by preocular plate in lateral view. Two postoculars bordering ocular between parietal and fourth supralabial. Four supralabials, fourth the largest, all with long axis oblique to long axis of body, first approximately rectangular. Supralabial imbrication pattern T-III, posterior border of second supralabial overlaps third supralabial but overlapped by anteroventral margin of preocular, that of third supralabial overlaps fourth supralabial and anteroventral margin of ocular, overlapped by ventral margin of preocular, and ends at level of rear margin of preocular; fourth supralabial overlapped by ocular and third supralabial. Mental hexagonal, wider than long, projecting slightly beyond curve of lower jaw and fitting into notch on upper lip when mouth is closed. Infralabials two on each side, second much longer, both overlapped by supralabials.

Longitudinal scale rows 22 behind head, 22 at midbody, and 22 anterior to vent; transverse scale rows 364, seven intercalary scales along vertebral row; subcaudals 22; dorsocaudals 23; apical region with sharp, conical, spine that is downturned at approximately 45° from long axis of body and extends well past last scales.

In preservative, 12.5 years after its preservation, dorsal 13 scale rows dark brown, midventral 6–7 scale rows dark yellow, with a sharp distinction between the two; one (posteriorly) or two (anteriorly) ventral scale rows bordering the brown dorsal stripe on each side mostly yellow with some brown scales interspersed. Chin, throat, and supralabials paler yellow; rostral, nasals, and preoculars largely yellow stained with brown, with more brown dorsally and posteriorly than ventrally and anteriorly on these scales. Rows of yellow glands along anterior margins of head scales. Tail spine same brown color as adjacent scales. Iris dark gray; pupil pale gray.

Variation: The specimens comprise three females and one male. Variation in morphometric ratios among the four specimens is generally small, although eye width is more variable (Table 1), reflecting the difficulty of identifying the margin of the eye in some specimens. The tail of the male is not significantly longer than that of the females, nor are the numbers of subcaudals or dorsocaudals greater (Table 1), suggesting that sexual dimorphism in these features is absent in this species. The ocular is widest at the level of the eye in the holotype and in BPBM 39685 but is widest below this point in the other specimens. Variation in TSR is more notable, ranging from 355 to 402 scales (Table 1).

Width of the dorsal brown stripe and the yellow ventral field vary among specimens. Only the male has a relatively uniform nine pale ventral scale rows and 13 brown dorsal scale rows, though the lowest brown scale row on each side has a few scattered yellow scales. The females are more variable, with the yellow ventral field not being of uniform width throughout the body but varying by 1–4 scales along its length because brown scales are interspersed along its lateral margins (Fig. 2A-C).

BPBM 17889 has 14 brown dorsal scale rows and six rows of uniformly yellow scales, with one intervening row on each side largely yellow but with many scattered brown scales. BPBM 39685 has 15 brown dorsal scale rows, with 1–2 rows below this on each side largely yellow but with several brown scales, and the central five scale rows uniformly yellow (with one exception near the tail in which the yellow field is constricted to only three central scale rows). Hence, among all specimens, the 13–15 dorsalmost scale rows are largely brown, and the 5–9 ventralmost scale rows are yellow, with the intervening rows being largely yellow but with several to many scattered brown scales arrayed to form a ragged margin to the yellow ventral field (Fig. 2A-C).

Figure 2: Portraits in life of *Ramphotyphlops erebus* sp. nov. (A) holotype BPBM 39683, (B) paratype BPBM 39685, (C) ventral view of paratype BPBM 39685, and (D) paratype BPBM 39684.

Table 1: Character data for the type series of *Ramphotyphlops erebus* sp. nov.

Character	BPBM 39683 holotype	BPBM 17889 paratype	BPBM 39684 paratype	BPBM 39685 paratype
Sex	F	F	M	F
L	273.0	208.5	218.5	258.0
SVL	261.0	199.0	208.0	246.0
TL	12.0	9.5	10.5	12.0
M (g)	6.2	-	3.7	6.2
TSR	364	355	374	402
LSR	22\22\22	22\22\22	22\22\22	22\22\22
Subcaudals	22	20	24	23
Dorsocaudals	23	19	24	25
Pale ventral rows	6-8	6-7	9	6-7
HW	5.3	5.2	4.6	4.9
SN	2.9	2.45	2.4	3.7
SW	4.3	4.0	3.8	4.4
PSN	1.6	1.4	1.4	1.8
RW	2.05	1.85	1.6	1.95
EW	0.55	0.4	0.3	0.45
W	6.5	5.4	5.7	6.3
VW	5.3	4.5	4.8	4.9
TW	4.4	3.8	4.3	4.5
L/W	42.0	38.6	38.3	41.0
TL/SVL	0.046	0.048	0.050	0.049
HW/SVL	0.020	0.026	0.022	0.020
W/SVL	0.025	0.027	0.027	0.026
VW/SVL	0.020	0.023	0.023	0.020
TW/SVL	0.017	0.019	0.021	0.018
SN/HW	0.55	0.47	0.52	0.55
SW/HW	0.81	0.77	0.83	0.90
PSN/HW	0.30	0.27	0.30	0.37
RW/HW	0.39	0.36	0.35	0.40
EW/HW	0.104	0.077	0.065	0.092
TW/VW	0.83	0.84	0.90	0.92
TL/TW	2.7	2.5	2.4	2.7

Color in life: BPBM 39683 and 39685 were dark brown above, and either pale orange yellow (Fig. 2A) or dusky yellow orange (Fig. 2B, C) below; the area around the mouth was noted to be pale pink. BPBM 39684 was in shed and appeared pale whitish brown dorsally and pale pinkish white ventrally (Fig. 2D).

Etymology: The species epithet is the Latinized name of the Greek primeval god of darkness; it is a noun in apposition.

Distribution: Known from two areas in central Woodlark Island (the type locality at Bomagai Camp and the locality along the Upper Muniai River are functionally the same locality, being only 0.5 km apart) and one locality on the eastern tip of that island (Fig. 3). It undoubtedly occurs across the entire island.

Ecology: The holotype (BPBM 39683) was dug from soil by a mining crew during the day; BPBM 39684 and one uncaptured individual were found by me in a rotting, horizontal treefern trunk during the day. I collected BPBM 39685 at night crawling on a vine-covered tree trunk approximately 1 m above the forest floor. These last three animals occurred in well-developed secondary lowland rainforest; that from the mining camp had previously been the same type of forest prior to clearance. BPBM 39684 has a large infestation of helminths on its left kidney. All specimens appear to be sexually mature, having well-developed, pleated or convoluted sexual ducts.

Remarks: Comparison of *Ramphotyphlops erebus* to *R. acuticauda* from Palau is somewhat hampered by incomplete information on the latter species, especially details about number of scale rows and color pattern. Peters (1878) and Boulenger (1893) both gave counts of 24 for number of scale rows in *R. acuticauda*, presumably taken at midbody. Wallach (1998) gave a range of midbody scale rows of 22–24 for four specimens, and Addison Wynn (pers. comm.) has told me that all specimens from Palau that he has examined have 22 midbody scale rows. Thus, *R. acuticauda* does not appear to differ in main from *R. erebus* in this feature though some specimens may have more scale rows. This number also impacts interpretation of how these species differ in numbers of yellow ventral scale rows. Peters (1878) reported that the holotype of *R. acuticauda* had nine rows of brown dorsal scales, implying that the 15 ventralmost scale rows were yellow. Wynn et al. (2012) also reported *R. acuticauda* to have nine rows of brown dorsal scales, but 22 midbody scale rows, implying a field of 13 yellow ventral scale rows. Whether 13 or 15 rows, *R. acuticauda* clearly has a wider field of ventral yellow color than does *R. erebus*. Also of note is that the number of brown dorsal scale rows in *R. acuticauda* (and in *R. flaviventer*, pers. obs.) is sufficiently few that the pattern can readily be interpreted as a wide brown dorsal stripe (Wynn et al., 2012). In contrast, the brown dorsal and lateral scale rows in *R. erebus* are subtended by rows of mixed yellow and brown scales that obscure any interpretation of the dorsal pattern as a clear stripe (Fig. 2).

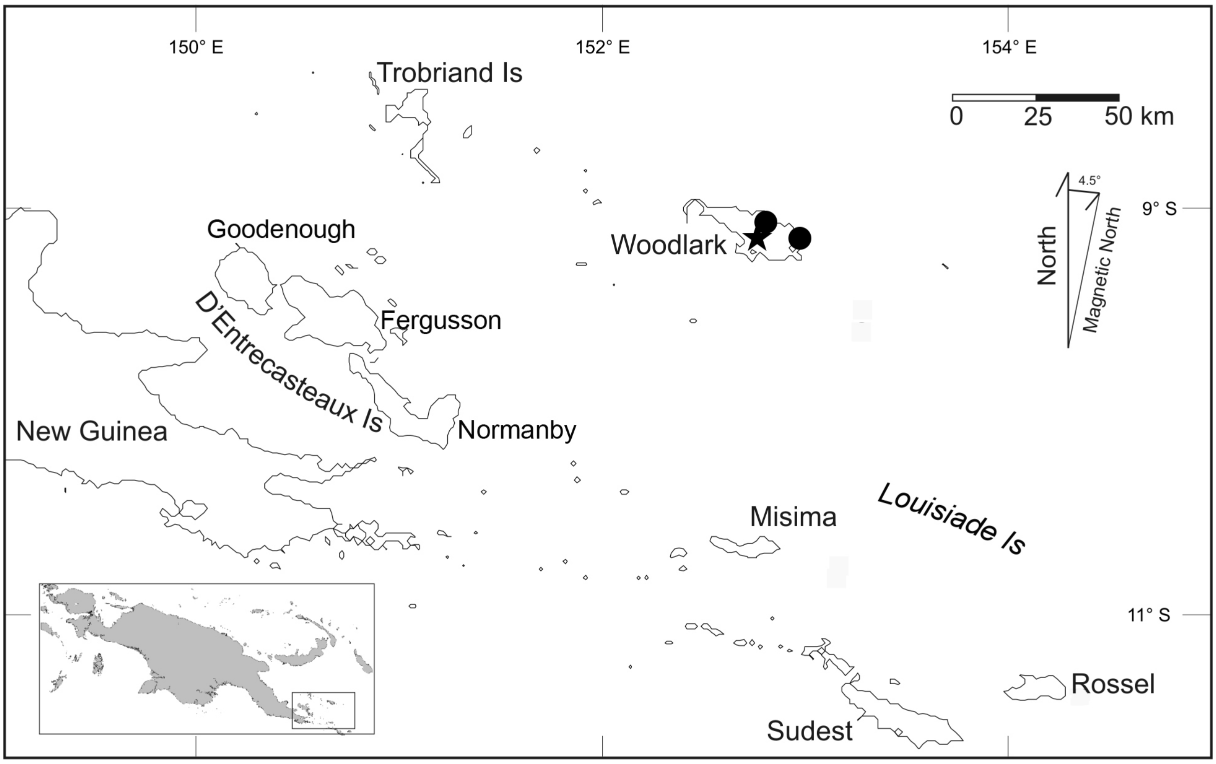

Figure 3: Map of southeastern Papua New Guinea showing type locality for *Ramphotyphlops erebus* sp. nov. (star) and two additional collecting localities (filled circles) on Woodlark Island, Milne Bay Province, Papua New Guinea.

Discussion

The discovery of a member of the *Ramphotyphlops flaviventer* Group on remote Woodlark Island came as a surprise. The distance of *R. erebus* sp. nov. from other members of this group having the abrupt demarcation between dorsal and ventral color fields could have a number of explanations. First, animals with this character state may not be monophyletic, and the color pattern could be homoplastic or plesiomorphic among the several species currently assigned to this group. This seems possible inasmuch as the geographically nearest relative to *R. erebus* sp. nov. has a gradual transition in color pattern from the dorsal to ventral fields. Related to this, the members of the *R. flaviventer* Group may themselves not be monophyletic inasmuch as no detailed examination of phylogenetic relationships among Melanesian, Asian, or Micronesian *Ramphotyphlops* has been done. Secondly, it is possible that geographically intervening species of *Ramphotyphlops* of the *R. flaviventer* Group have simply been unsampled—blindsnakes are generaly poorly sampled across New Guinea. Thirdly, it may be that such intervening species may be extinct, leaving members of this group—assuming its monophyly—with a largely peripheral distribution around the insular margins of New Guinea. The paucity of specimens for most members of the *R. flavivente*r Group (*R. depressus* is an exception) makes it impossible to assess which of these explanations is most likely.

Woodlark Island has a unique terrestrial herpetofauna that includes at least 40 species, of which nine are frogs, 23 are lizards, and eight are snakes (one an introduced alien, *Indotyphlops braminus*). Of these, at least seven of the nine frogs, three of the 23 lizards, and three of the seven native snakes are endemic to the island, although not all have yet been described and named. Hence, *R. erebus* sp. nov. is the eleventh named endemic herptile from Woodlark Island, contributing importantly to the global standing of the Milne Bay Region as having the highest density in the world of endemic reptiles and amphibians in such a small geographical area (Kraus, 2021). Woodlark's endemic diversity occurs on an island only 850 km^2 in area, and Woodlark's high number of reptile and amphibian species suggests prior connection to New Guinea inasmuch as many of the genera involved are poor trans-marine dispersers, an argument previously made for identical reasons for the nearby D'Entrecasteaux Islands (Kraus, 2015).

Historically, the islands of the Louisiade Archipelago (including Misima, Sudest, Rossel, and smaller satellite islands) formed the southern terminus of the Owen Stanley Range of New Guinea. They were separated from New Guinea as islands with the opening of the Woodlark Rift over the past 6 MY, at which time the intervening land became submerged due to crustal extension and the islands formed (Taylor et al., 1999). It is uncertain whether Woodlark was also continuous with this broader New Guinean landmass prior to this rifting or was narrowly separated from it, but the land that forms modern Misima Island was that part of the former peninsula closest to Woodlark, and the two have grown more distant from each other since the opening of the rift. Hence, it seems most likely that Woodlark obtained most of its ancestral herpetofauna while being part of New Guinea or lying very closely offshore, and that the high endemism rate among the herpetofauna stems from the island's long isolation from nearby landmasses subsequent to initiation of rifting. When this rifting began, the D'Entrecasteaux Islands to the west of Woodlark did not yet exist, inasmuch as they are active metamorphic core complexes that began to form 4 MYA (Baldwin et al., 1993); hence, they would not have served as an ancestral source area for Woodlark's herpetofauna. However, blindsnakes are good transmarine dispersers, presumably residing within flotsam (Vidal et al., 2010), and, should color pattern be homoplastic in the *R. flaviventer* group, then it seems equally likely that *R. erebus* sp. nov. dispersed from the relatively nearby Solomon Islands, which contain its close relative *R. depressus*. This alternative hypothesis is supported by the apparent absence of members of the *R. flaviventer* group in eastern New Guinea.

At this time, Woodlark Island remains well covered by mature secondary rainforest, so plenty of excellent habitat exists to support *Ramphotyphlops erebus* sp. nov. and other endemic species. However, I have previously pointed out that Woodlark Island is unusual within PNG in having most of its land owned by the national government instead of under traditional, village-controlled land tenure, and that this makes the land more liable to sacrifice for outside commercial interests due to limited legal options for villagers to defend against such interests (Kraus, 2017b, 2021). A series of such threats have surfaced over the past 20 years on Woodlark, including a proposal to convert most of the island to oil-palm plantations, a proposal to log 40% of the island, and extensive exploration for gold with plans to develop a large open-pit mining operation (Cerullo, 2019, 2020). The oil-palm proposal was defeated for a time by local and international opposition (Barry, 2008), but the legality of such a proposition was upheld by a PNG national court in 2020 (Robby, 2020), so similar proposals may be anticipated in future. Any proposal involving widespread habitat removal on the island can be expected to seriously threaten many of the island's documented 48 endemic species (Kraus, 2021), including *R. erebus* sp. nov. Efforts to protect a significant portion of this island from habitat clearance under some form of official government conservation plan would be desirable, and such a goal would be a worthwhile goal for local non-government organizations. However, funding to support such efforts has traditionally been lacking.

Conclusion

With the description of *Ramphotyphlops erebus* sp. nov., the number of Melanesian species in that genus is now 13, with five of those (plus one Micronesian species) forming the *R. flaviventer* group. The distribution of members of the *R. flaviventer* group is largely on islands or former islands lying peripheral to the northern perimeter of New Guinea. *Ramphotyphlops erebus* sp. nov. is the third snake and thirteenth herptile endemic to Woodlark Island. Woodlark is under continuing threat of significant deforestation from outside interests, so development of conservation plans to preserve habitat on that island would be highly desirable.

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Conflict of interest

The author declares no conflicting issues related to this research article.

Appendix: Additional specimens examined.

Ramphotyphlops depressus. Papua New Guinea: Madang Province: Crown Island (UMMZ 247715–16); Morobe Province: Sakar Island (UMMZ 247725–28), Tolokiwa Island (UMMZ 247717–24), Umboi Island (UMMZ 247729–30).

Ramphotyphlops flaviventer. Indonesia: North Maluku Province: Halmahera Island, ca. 3 km E Sidangoli (MVZ 171562–63).

References

Baldwin, S. L., Lister, G. S., Hill, E. J., Foster, D. A. and McDougall, I. (1993). Thermochronologic constraints on the tectonic evolution of active metamorphic core complexes, D'Entrecasteaux Islands, Papua New Guinea. *Tectonics*, 12 (3): 611–628. https://doi.org/10.1029/93TC00235

Barbour, T. (1921). Reptiles and amphibians from the British Solomon Islands. *Proceedings of the New England Zoological Club*, 7: 91–112. https://doi.org/10.5962/bhl.part.12096

Barry, G. (2008). Woodlark rainforests spared for now from clearing for oil palm. http://ecointernet.org/2008/01/16/press_release_woodlark_rainfor/ (Accessed 3 January 2017).

Boulenger, G. A. (1893). *Catalogue of the Snakes in the British Museum (Natural History). Volume I.* Taylor and Francis, London, England. xiii + 448 pp.

Brongersma, L. D. (1934). Contributions to Indo-Australian herpetology. *Zoologische Mededelingen*, 17 (3–4): 161–251.

Cerullo, G. (2019). Logging, mining companies lock eyes on a biodiverse island like no other. https://news.mongabay.com/2019/07/logging-mining-companies-lock-eyes-on-a-biodiverse-island-like-no-other/ (Accessed 25 August 2023).

Cerullo, G. (2020). Land grab, logging, mining threaten biodiversity haven of Woodlark Island. https://news.mongabay.com/2020/10/land-grab-logging-mining-threaten-biodiversity-haven-of-woodlark-island/ (Accessed 25 August 2023).

Daudin, F. M. (1803). *Histoire Naturelle, Générale et Particulière des Reptile, Volume 7.* Dufart, Paris, France. 436 pp.

Fitzinger, L. (1843). *Systema Reptilium, fasciculus primus, Amblyglossae*. Braumüller et Seidel, Vienna, Austria. 106 pp. https://doi.org/10.5962/bhl.title.4694

Gray, J. E. (1845). *Catalogue of the specimens of lizards in the collection of the British Museum*. Trustees of the British Museum/Edward Newman, London, England. xxvii + 289 pp.

Hedges, S. B., Marion, A. B., Lipp, K. M., Marin, J. and Vidal, N. (2014). A taxonomic framework for typhlopid snakes from the Caribbean and other regions (Reptilia, Squamata). *Caribbean Herpetology*, 49: 1–61. https://doi.org/10.31611/ch.49

Kraus, F. (2009). *Alien reptiles and amphibians: a scientific compendium and analysis*. Springer Science and Business Media B.V., Dordrecht, Netherlands. 563 pp.

Kraus, F. (2015). A new species of the miniaturized frog genus *Paedophryne* (Anura: Microhylidae) from Papua New Guinea. *Occasional Papers of the University of Michigan Museum of Zoology*, 745: 1–11.

Kraus, F. (2017a). New species of blind snakes (Squamata: Gerrhopilidae) from the offshore islands of Papua New Guinea. *Zootaxa*, 4299 (1): 75–94. https://doi.org/10.11646/zootaxa.4299.1.3

Kraus, F. (2017b). A new insular species of *Oreophryne* (Anura, Microhylidae) from Papua New Guinea. *Journal of Herpetology*, 51 (4): 552–558. https://doi.org/10.1670/17-002

Kraus, F. (2021). A herpetofauna with dramatic endemism signals an overlooked biodiversity hotspot. *Biodiversity and Conservation*, 30: 3167–3183. https://doi.org/10.1007/s10531-021-02242-3

Kraus, F. (2023). A revision of *Gerrhopilus inornatus* (Squamata: Gerrhopilidae) reveals a multi-species complex. *Zootaxa*, 5231 (1): 1–23. https://doi.org/10.11646/zootaxa.5231.1.1

McDiarmid, R.W., Campbell, J. A. and Touré, T. A. (1999). *Snake species of the world: a taxonomic and geographic reference, Volume 1.* The Herpetologists' League, Washington, D.C., USA. 511 pp.

McDowell, S. B. (1974). A catalogue of the snakes of New Guinea and the Solomons, with special reference to those in the Bernice P. Bishop Museum. Part I. Scolecophidia. *Journal of Herpetology*, 8 (1): 1–57. https://doi.org/10.2307/1563076

Peters, W. (1864). Über neue Amphibien (*Typhloscincus*, *Typhlops*, *Asthenodipsas*, *Ogmodon*). *Monatsberichte der Königlich Preussischen Akademie der Wissenschaften zu Berlin*, 1864: 271–276. [In German]

Peters, W. (1878). Bemerkungen über neue oder weniger bekannte Amphibien. *Monatsberichte der Königlich Preussischen Akademie der Wissenschaften zu Berlin*, 1877: 415–423. [In German]

Peters, W. (1880). Eine Mittheilung über neue oder weniger bekannte Amphibien des Berliner Zoologischen Museums. *Monatsberichte der Königlich Preussischen Akademie der Wissenschaften zu Berlin*, 1880: 217–224. [In German]

Robb, J. (1966). The generic status of the Australasian typhlopids (Reptilia: Squamata). *Annals and Magazine of Natural History, series 13*, 9: 675–679. https://doi.org/10.1080/00222936608651678

Robby, M. (2020). Court ruling unsettles islanders. *The National*, 26 January 2020. https://www.thenational.com.pg/court-ruling-unsettles-islanders/ (Accessed 25 August 2023).

Schlegel, H. (1839). *Abbildungen neuer oder unvollständig bekannter Amphibien, nach der Natur oder dem Leben entworfen und mit einem erläuternden Texte begleitet.* Arne and Co., Düsseldorf, Germany. xiv + 141 pp.

Shea, G. M. and Wallach, V. (2000). New records and data for typhlopid snakes from Papua New Guinea. *Science in New Guinea*, 25 (1, 2, 3): 67–69.

Taylor, B., Goodliffe, A. M. and Martinez, F. (1999). How continents break up: Insights from Papua New Guinea. *Journal of Geophysical Research*, 104 (B4): 7497–7512. https://doi.org/10.1029/1998JB900115

Tiatragul, S., Brennan, I. G., Broady, E. S. and Keogh, J. S. (2023). Australia's hidden radiation: phylogenomics analysis reveals rapid Miocene radiation of blindsnakes. *Molecular Phylogenetics and Evolution*, 185: 107812. https://doi.org/10.1016/j.ympev.2023.107812

Uetz, P., Freed, P., Aguilar, R., Reyes, F. and Hošek, J. (Eds.). (2023). The Reptile Database, http://www.reptile-database.org (Accessed 3 July 2023).

Vidal, N., Marin, J., Morini, M., Donnellan, S., Branch, W. R., Thomas, R., Vences, M., Wynn, A., Cruaud, C. and Hedges, S. B. (2010). Blindsnake evolutionary tree reveals long history on Gondwana. *Biology Letters*, 6: 558–561. https://doi.org/10.1098/rsbl.2010.0220

Wallach, V. (1993). The supralabial imbrication pattern of the Typhlopoidea (Reptilia: Serpentes). *Journal of Herpetology*, 27 (2): 214–218. https://doi.org/10.2307/1564940

Wallach, V. (1995). A new genus for the *Ramphotyphlops subocularis* species group (Serpentes: Typhlopidae), with description of a new species. *Asiatic Herpetological Research*, 6: 132–150. https://doi.org/10.5962/bhl.part.7989

Wallach, V. (1996). The systematic status of the *Ramphotyphlops flaviventer* (Peters) complex (Serpentes: Typhlopidae). *Amphibia-Reptilia*, 17 (4): 341–359. https://doi.org/10.1163/156853896X00072

Wallach, V. (1998). The visceral anatomy of blindsnakes and wormsnakes and its systematic implications (Serpentes: Anomalepididae, Typhlopidae, Leptotyphlopidae). PhD thesis. Department of Biology, Northeastern University, Boston, Massachusetts, USA.

Wallach, V. (2021). Addendum to the description of the new species *Ramphotyphlops mollyozakiae* Wallach, 2020 (Serpentes: Typhlopidae). *Podarcis, n. s.*, 12 (2): 22–23.

Werner, F. (1901). Über Reptilien und Batrachier aus Ecuador und Neu-Guinea. *Verhandlungen der Kaiserlich-Königlichen Zoologisch-Botanischen Gesellschaft in Wien*, 51: 593–614. https://doi.org/10.5962/bhl.part.4586

Wynn, A. H., Reynolds, R. P., Buden, D. W., Falanruw, M. and Lynch, B. (2012). The unexpected discovery of blind snakes (Serpentes: Typhlopidae) in Micronesia: two new species of *Ramphotyphlops* from the Caroline Islands. *Zootaxa*, 3172: 39–54. https://doi.org/10.11646/zootaxa.3172.1.3