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A new species of *Anilios* (Scolecophidia: Typhlopidae) from Central Australia

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Abstract

Anilios fossor **sp. nov.** is described from a single specimen collected in 1989 from Ruby Gap Nature Park, Northern Territory. The species differs from all other *Anilios* species in the combination of 20 midbody scales, 514 dorsal scales, a rounded, non-angulate snout in lateral and dorsal profile, a nasal cleft contacting the second supralabial and not extending to the head dorsum, and a large round rostral shield in dorsal view. It is unclear whether the paucity of material of this species represents a limited distribution, or poor sampling in a remote, sparsely settled part of the continent. Evidence for the recognition of the Australian typhlopid fauna as a distinct genus *Anilios* is critically reviewed, and the genus is found to be recognizable only on genetic evidence. Some other recent nomenclatural and taxonomic changes in the Australian typhlopid fauna are considered and rejected.

Key words: Reptilia, Squamata, Serpentes, morphology, systematics, nomenclature, Northern Territory

Introduction

Modern knowledge of the typhlopid snake fauna of Australia began almost a century ago with a monographic treatment by Waite (1918). With few exceptions, knowledge of Australian typhlopid diversity since then has proceeded by the description of new species from small numbers of specimens, often only a single specimen (Kinghorn 1929, 1942; Loveridge 1945; Robb 1972; Storr 1981, 1983, 1984; Shea & Horner 1997; Aplin 1998; Couper *et al*. 1998; Venchi *et al*. 2015). However, a recent genetic survey by Marin *et al.* (2013) found evidence that even the more broadly distributed species described by Waite or earlier workers contain unresolved lineages likely to represent additional species, and hence that the diversity of the Australian typhlopid fauna is much greater than presently described. This paper continues the trend in recent typhlopid research by describing yet another species from a single specimen—a very distinctive new species from central Australia discovered misidentified in a museum collection.

Material and methods

Nomenclature of head scales follows Waite (1918), with the exception of the nomenclature of the median dorsal series, which adopts the arguments of Wallach (2003). Dorsal scale counts were taken from the frontal scale to the last scale anterior to the terminal caudal spine, inclusive. Subcaudal scales were counted from the first single normally sized scale posterior to the vent, to the last scale anterior to the terminal caudal spine, inclusive. Estimates of dorsal body scales (those of the body alone) were made by subtracting the subcaudal scale count from the total dorsal scale count. When describing the position of a longitudinal scale row on dorsal or ventral body surface, the azygous median ventral or dorsal scale row is counted as row 1. Snout-vent length (SVL) was measured with a metal ruler, with the specimen gently straightened along the ruler, from tip of snout to anterior margin of vent, to the nearest millimetre. Tail length was measured to the nearest 0.5 mm by a metal ruler viewed under a dissecting microscope, from the anterior margin of the vent (posterior margin of medial precloacal scales) to the tip of the terminal spine. Midbody width was measured to the nearest 0.1 mm with a dial caliper positioned by viewing under

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a dissecting microscope, at the nearest approximation to a cylindrical portion of the body in the middle third of the specimen.

Specimens are lodged in the collections of the Australian Museum, Sydney (AM) and Museums and Art Galleries of the Northern Territory, Darwin (NTM).

Systematics

Anilios fossor **sp. nov.**

Figs. 1–3

Holotype. NTM R14324 (field tag JCR30), Glen Annie, Ruby Gap Nature Park, Northern Territory, Australia, collected 15.x.1989 by J.R. Cole. The coordinates of the type locality are given in the NTM database as 23°28'S 135°00'E. However, from the map provided by the Gibson *et al*. (1992), the coordinates of Glen Annie are closer to 23°28'S 134°58'E, at an altitude of *ca* 500 m (from Google Earth).

Diagnosis. *Anilios fossor* is distinguished from all other described species in the genus (*sensu* Pyron & Wallach 2014) by the combination of 20 midbody scale rows, a rounded snout in lateral profile (lacking any rostroventral angulation), a nasal cleft contacting the second supralabial ventrally, but not extending to the dorsal surface of the head, and a large, round rostral scale. For more detailed comparisons with other species, see below.

FIGURE 1. Holotype of *Anilios fossor*.

Description of holotype (the only known specimen). Snout rounded in dorsal profile, with a very slight inflation of the nasal region providing a very weakly trilobed appearance. Rostral almost as broad as long, round with a slightly truncate posterior margin, maximum width 69% of head width at level of centre of eyes. Rostral overlaps nasals and frontal; nasals broadly separated by frontal; frontal wider than long, wider than postfrontal, overlapping supraoculars and postfrontal; supraoculars moderately separated by frontal-postfrontal suture; postfrontal overlaps parietals and interparietal; parietals moderately separated by postfrontal-interparietal suture, but more narrowly than separation between supraoculars. Dorsolaterally, supraoculars wider than long, extensively overlapping ocular, with narrower overlaps of postfrontal and parietal; parietal wider than long, of similar width to supraocular, and overlapping interparietal, upper postocular, and first scale of third (left side) or second and third (right side) longitudinal scale rows.

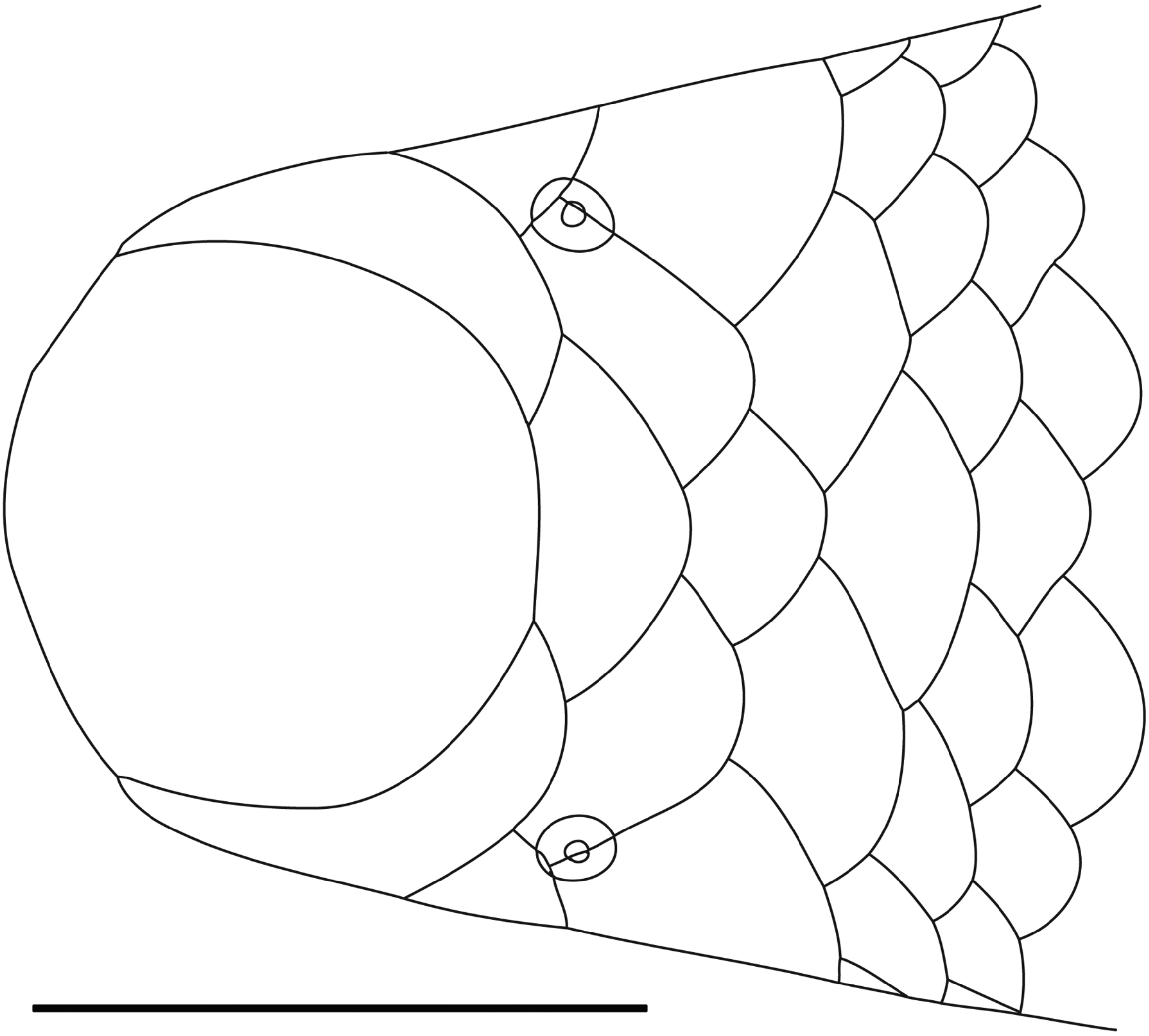

FIGURE 2. Headshields of the holotype of *Anilios fossor* in dorsal view. Scale bar = 2mm.

Snout evenly rounded in lateral profile, slightly depressed. Nasal overlaps frontal, supraocular and preocular; preocular about 2/3 width of nasal, posterior border evenly convex (no dimple to correspond to underlying eye) and overlapping supraocular and ocular; ocular wider than preocular, subequal in width to nasal, and overlapping parietal, two postoculars, and fourth supralabial. Eye moderate, pupil distinct, deep to (under) junction of supraocular, preocular and ocular scales, centre of eye just posterior to preocular.

Ventral rostral lobe moderately broad with rounded posterior margin. Nasal cleft short, from second supralabial, across anterior margin of nostril, then extending about 2/3 of the residual distance towards the rostral, not extending onto the dorsal surface of the head. First three supralabials of subequal length, first two narrow, third as tall as long. First supralabial overlapped by rostral lobe of nasal; second supralabial overlapped by rostral and caudal lobes of nasal, and preocular; third supralabial overlapped by preocular, but overlapping ocular (T-III pattern of Wallach 1993); fourth supralabial much longer than others, equal in height to third supralabial, and overlapped by ocular, but overlapping lower postocular. Postoculars two, equal in size to scales in succeeding longitudinal scale row.

Mental of similar size to adjacent infralabials and smaller than gulars; first three infralabials successively lower, fourth infralabial separated from third infralabial by first scale of third ventral longitudinal scale row. No visible marginal glands associated with head shields. Scale organs scattered over rostral and nasal scales, becoming coarser and much more sparsely distributed over supralabials, preocular, ocular and parietal. Longitudinal scale rows at midbody 20; total dorsal scale rows 514, body dorsal scale rows 503; subcaudals 11. SVL 240 mm (anterior body of holotype slightly concertinaed, so that measured SVL may be slightly underestimated); body width (BW) 4.7 mm (BW/SVL 0.0196); tail length (TL) 5 mm (TL/SVL 0.0208; TL/BW 1.06), terminal spine prominent. In preservative, pale yellow brown dorsally, yellow ventrally; no aggregations of pigment forming any stripes. Adult female, with thickened and obliquely pleated right oviduct; left oviduct absent.

Etymology. From the Latin *fossor*, a miner, in allusion to the fossorial habits of the genus and the type locality, where the numerous garnets in the bed of the Hale River, misidentified as rubies, sparked the Northern Territory's first mining rush (Gibson *et al*. 1992). The species epithet is a noun in apposition.

Comparisons with other species. *Anilios fossor* keys to *A. splendidus* (Aplin 1998) using the key provided by Cogger (2014), in having the nasal cleft contacting the second supralabial, 20 midbody scales, a head smoothly rounded in outline from above, ventral surface pale, the nasal cleft not extending onto the dorsum of the head or to the rostral to divide the nasal, and the snout rounded in profile (although *splendidus* has an angulate rostral in profile, *contra* the character state given in the key; Aplin 1998). However, it differs from *A. splendidus* in its much smaller size (mature female with SVL = 240 mm, *vs* SVL of only known specimen, also a mature female, 498 mm), paler coloration (pale yellow-brown dorsally *vs* dark grey-brown above, sharply demarcated from the pale venter), rounded snout in lateral profile (*vs* strongly angulate), larger eye, and much greater number of dorsal scales (dorsal scales to level of cloaca 503 *vs* 377) (Aplin 1998 for comparative data). Additionally, *A. splendidus* is only known from North-West Cape, Western Australia, over half a continent away.

It shares the greatest overall similarity with *A. wiedii* (Peters 1867a), a species which is similar in size (SVL of mature females, the larger sex, 175–322 mm, mean = 232.5 mm, median = 231 mm, n = 65), coloration (pale yellow-brown in preservative) and number of midbody scales (20), and also has the nasal cleft contacting the second supralabial and a rounded snout in dorsal and lateral profile. It differs from *A. wiedii* (Fig. 5) in having a much larger, more rounded rostral scale, in the nasal cleft not extending to the dorsal surface of the head (*vs* extending well onto the dorsal surface, then extending medially towards the rostral to almost or completely divide the nasal), and in having more dorsal scales (514 *vs* 379–442 for males and 421–469 for females). The only individuals of *A. wiedii* with dorsal scales greater than 434 for males and 452 for females among the 135 individuals examined are from a single sample of 11 individuals from "Darling River Floods". This series was part of a major collection made by the Australian Museum collector Robert Helms between May and June 1890. Most of the registration entries for this collection do not specify where along the Darling River these collections were made. However, one series (AM R6457–67) does more specifically note that the collection was made between Bourke and Wilcannia, and a contemporary newspaper report (Anon 1890) notes that Helms spent nearly two weeks in June 1890 collecting amongst flood debris at Tallywaka (now Talyawalka, an overflow anabranch paralleling the Darling River near Wilcannia). This is the westernmost record of *A. wiedii*, but could represent individuals washed downstream from further east. Despite the somewhat higher dorsal scale counts of these specimens, which are geographically intermediate between the distribution of *A. wiedii* and *A. fossor*, in other respects this sample is typical of *A. wiedii*, and does not represent a morphological intermediate between the two species. The geographic distance between the only known locality for *A. fossor*, and *A. wiedii* at Talyawalka is 1250 km, with the Simpson and Strzelecki Deserts in the intervening area.

Five other species of *Anilios* have a distribution that reaches central Australia: *A. bituberculatus* (Peters 1863), *A. centralis* (Storr 1984), *A. diversus* (Waite 1894), *A. endoterus* (Waite 1918) and *A. grypus* (Waite 1918), and hence could be sympatric with *A. fossor*. *Anilios bituberculatus* has a strongly trilobed snout in dorsal profile which is angulate in lateral profile, and has a much narrower rostral scale. *Anilios centralis* has a hooked snout in lateral profile, a narrower rostral scale (see Fig. 1 in Storr 1984), more subcaudal scales (12–20, the lower end of the range presumably representing females) and slightly fewer dorsal scales (425–494) (data from Storr 1984; Pyron & Wallach 2014). *Anilios diversus* has a nasal cleft contacting the preocular scale, a very narrow rostral scale, and fewer transverse scale rows (dorsal scales 403–465 *fide* Pyron & Wallach 2014; ventral scales 389–457 *fide* Storr 1981; Aplin 1998 notes that ventral scales are roughly comparable to dorsal scales counted to the level of the cloaca). *Anilios endoterus* has 22 rows of scales at midbody, a nasal cleft joining the preocular, a snout that is angular in lateral profile, and fewer dorsal scale rows (422–463; Pyron & Wallach 2014; Shea *et al*. 2000). Central Australian populations of *A. grypus* have a strongly hooked snout in lateral profile, 18 midbody scales, a narrow rostral scale, and a dark head and tail.

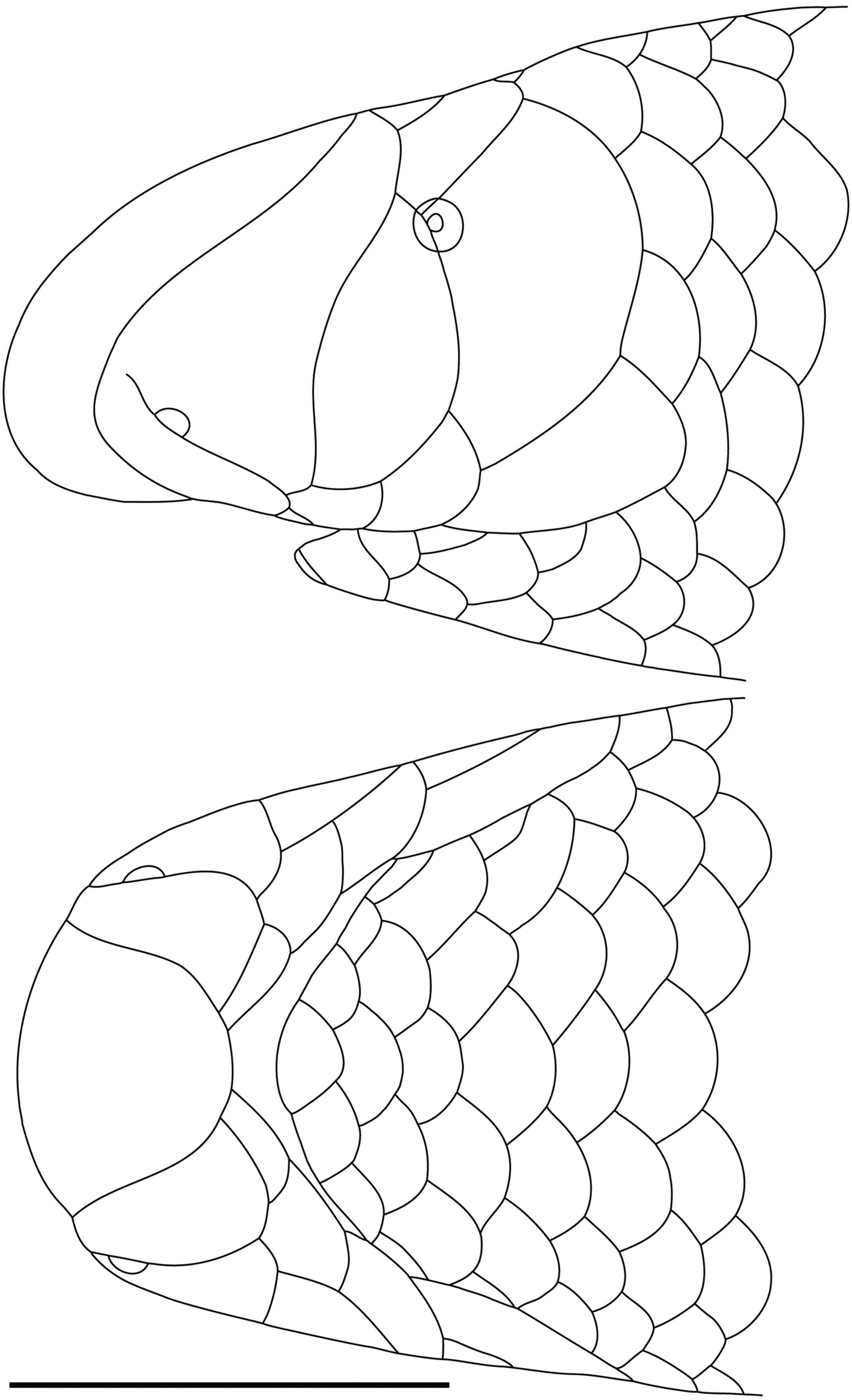

FIGURE 3. Headshields of the holotype of *Anilios fossor* in left lateral and ventral views. Scale bar = 2mm.

An additional five species of *Anilios* from semiarid and mesic parts of Australia share with *A. fossor* the combination of 20 midbody scales, and the nasal cleft contacting the second supralabial: *A. broomi* (Boulenger 1898), *A. leucoproctus* (Boulenger 1889), *A. pinguis* (Waite 1897), *A. sylvia* (Ingram & Covacevich 1993) and *A. waitii* (Boulenger 1895a). Of these, *A. waitii* of the semiarid and arid parts of Western Australia has a hooked rostral in lateral profile and a trilobed snout in dorsal view, and *A. pinguis* of south-western Australia is a much larger species (SVL up to 491 mm; Aplin 1998) with an angulate snout in lateral profile, rostral much longer than wide ("urn-shaped"; Storr, 1981), many fewer dorsal scales (to cloaca, 280–388, Aplin 1998) and a dark brown to black dorsal color. *Anilios sylvia*, a species confined to a small part of the southern Queensland coast, is a smaller species (maximum SVL 175 mm), with many fewer transverse scale rows (ventral scales 271–320), nasal cleft extending onto the head dorsum, smaller rostral scale (of similar size and shape to *A. wiedii*) and a very dark dorsum (Ingram & Covacevich 1993). *Anilios leucoproctus*, a species restricted to Cape York and the Torres Strait Islands, similarly has fewer dorsal scale rows (386–426 *fide* McDowell 1974; 377–394 *fide* Shea 1999), is darkly pigmented both dorsally and ventrally, has a narrower rostral scale, and has well-developed glands along the margins of the head shields (McDowell 1974), while *Anilios broomi*, a species of the Wet Tropics of Queensland, from the Atherton Tableland to Cooktown , is strongly striped dorsally, has fewer dorsal scale rows (456–460 *fide* McDowell 1974; 445-510 *fide* Pyron & Wallach 2014), and a nasal cleft that extends onto the dorsal surface of the head to divide or nearly divide the nasal.

All other *Anilios* species either have fewer midbody scales (16: *A. leptosoma* (Robb 1972), *A. longissimus* (Aplin 1998), *A. minimus* (Kinghorn 1929), *A. nema* (Shea & Horner 1997); 18: *A. affinis* (Boulenger 1889), *A. aspina* (Couper *et al*. 1998), *A. chamodracaena* (Ingram & Covacevich 1993), *A. guentheri* (Peters 1865), *A. howi* (Storr 1983), some *A. leptosoma*, *A. margaretae* (Storr 1981), *A. micromma* (Storr 1981), *A. nigricauda* (Boulenger, 1895b), *A. nigroterminatus* (Parker, 1931), *A. yampiensis* (Storr 1981)) or more midbody scales (22: *A. australis* Gray 1845, *A. bicolor* (Peters 1860), *A. hamatus* (Storr 1981), *A. kimberleyensis* (Storr 1981), *A. nigrescens* Gray 1845, *A. pilbarensis* (Aplin & Donnellan 1993), *A. polygrammicus* (Schlegel 1839), *A. robertsi* (Couper *et al*. 1998), *A. torresianus* (Boulenger 1889), *A. troglodytes* (Storr 1981); 24: *A. batillus* (Waite 1894), *A. ganei* (Aplin 1998), *A. ligatus* (Peters 1879), *A. unguirostris* (Peters 1867b), *A. yirrikalae* (Kinghorn 1942)), or if they have 20 midbody scales, they have the nasal cleft contacting either the first supralabial (*A. erycinus* (Werner 1901), *A. proximus* (Waite 1893)) or the preocular (*A. ammodytes* (Montague 1914), *A. tovelli* (Loveridge 1945)).

Distribution. Only known from the type locality (Fig. 4), on the upper reaches of the Hale River and at the eastern extremity of the Central Australian Ranges, between the relatively low Amarata and Harts Ranges.

Due to their fossorial habits, typhlopids are generally difficult to target by normal collecting and short-term survey methods, but are instead most often collected opportunistically by long-term residents close to settled areas. This effect is enhanced in the arid zone of Australia, where the sparse settlement means that relatively few typhlopids are collected other than around towns and homesteads, with often large gaps between known localities. The majority of typhlopid specimens from the southern Northern Territory have been collected from the environs of Alice Springs, or near major tourist venues. *Anilios fossor* is not represented among the typhlopid material from Alice Springs in the central part of the Central Australian Ranges, and hence may not extend significantly west of the type locality, towards the McDonnell Ranges. The Hale River, which flows through the Ruby Gap Nature Park and could provide a dispersal route for the species, drains into the Simpson Desert, an extensive sandridge system representing a very different geomorphology to the type locality. Hence, it is possible that the species has a very restricted distribution.

However, I cannot exclude the alternative possibility that *A. fossor* has a more extensive distribution that is yet to be identified. Another species of arid Australian typhlopid, *A. margaretae*, was described in 1981 from a single specimen from Lake Throssel in Western Australia, and is generally reported as restricted to that region (e.g., Cogger 2014; Wilson & Swan 2013), but has recently been collected opportunistically at two localities in central South Australia, over 750 km to the south-east (M. Hutchinson, pers. comm.)— the intervening area has almost no permanent human settlement, and few roads.

Given the uncertainty about the distribution of the species, it is not possible to provide a conservation assessment, but there are no grounds to think there has been any significant decline in the species that may require a threatened conservation status, and the type locality is located in a remote nature reserve with little human impact (the locality is only accessible by four wheel drive vehicular traffic). However, further work is needed in the vicinity of the type locality to determine population density of this poorly known species.

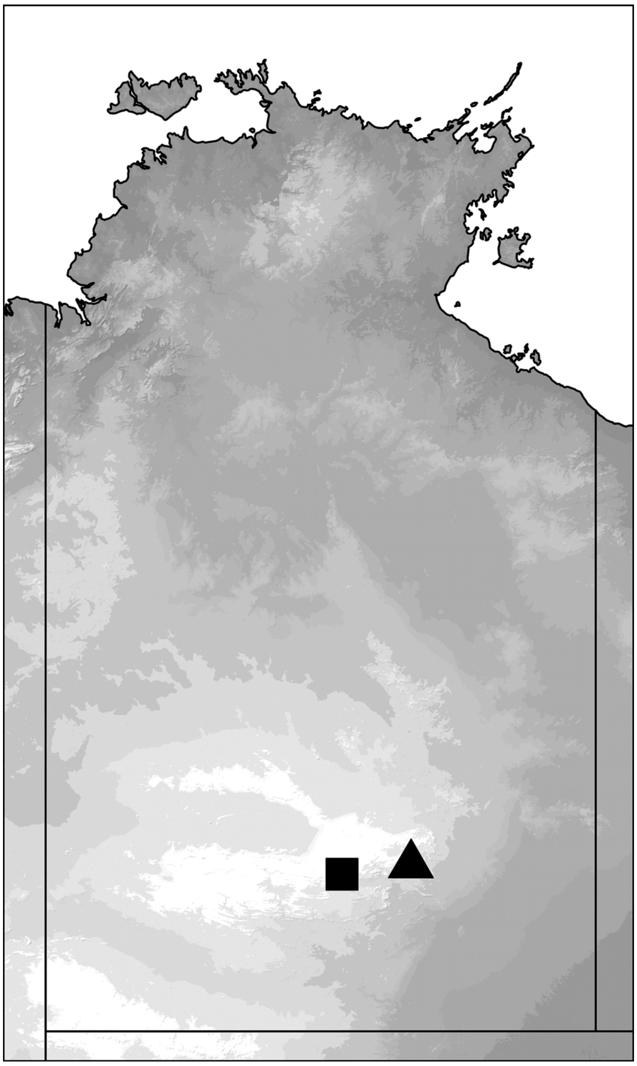

FIGURE 4. Distribution of *A. fossor* (triangle) within the Northern Territory. The nearest major settlement (Alice Springs) is marked by a square. Relief is indicated by grey shading—pale shading marks higher elevations. Northern Territory borders are 129° and 138°E and 26°S.

Habitat. The holotype was collected during a fauna survey of the Ruby Gap Nature Park (Gibson *et al.* 1992), at which time it was identified as *Ramphotyphlops centralis*. Two specimens identified as this species were collected and lodged in the Northern Territory Museum, the holotype of *A. fossor* and NTM 14316. The habitat notes for these two specimens were provided by Gibson *et al.* (1992) as "a low, open woodland of *Eucalyptus thozetiana* on stony plains, also a woodland of *Eucalyptus camaldulensis* on sandy loam soil near the Hale River". As the locality for NTM 14316, which is a specimen of *A. centralis*, is Thozet Box Camp, Loves Creek Station, a locality not on the Hale River, I presume that the second habitat description applies to *A. fossor*. The *Eucalyptus camaldulensis* vegetation association is described in the same report as a woodland with upper storey of *E. camaldulensis*, midstorey absent or with scattered *Capparis spinosa* and *Acacia victoriae*, and ground story of *Cynodon dactylon*, *Brachyachne ciliaris*, and ephemeral herbs and grasses on sand and sandy loam along major creeklines. This habitat is on Cainozoic alluvium, although the general surrounds are metamorphic quartzites, amphibolites, gneisses and tonalites of the Precambrian Heavitree Quartzites and Arunta Complex.

Generic assignment of the species, and recognition of the genus *Anilios*

Confirmation of the assignment of this species to the genus *Anilios* is made difficult by a lack of morphological diagnostic characters for *Anilios*, combined with a lack of samples for genetic analysis, and the sex of the only known specimen.

Anilios was separated from *Ramphotyphlops* on the basis of molecular analyses (Hedges *et al*. 2014; Pyron & Wallach 2014), which recovered *Anilios* as sister to *Acutotyphlops* with *Ramphotyphlops* as outgroup to these. While *Acutotyphlops* is diagnosable as morphologically distinct from *Anilios*, the latter genus has not been able to be distinguished from *Ramphotyphlops* on morphological criteria. Pyron and Wallach (2014), who provide the most detailed morphological comparison, diagnose both *Ramphotyphlops* and *Anilios* as being distinguished from all other typhlopoids by a protrusible hemipenis, retrocloacal sacs, and absence of a frontorostral and paired prefrontal scales. The remaining characters mentioned for both genera, including both internal and external features, show extensive overlap between the two genera.

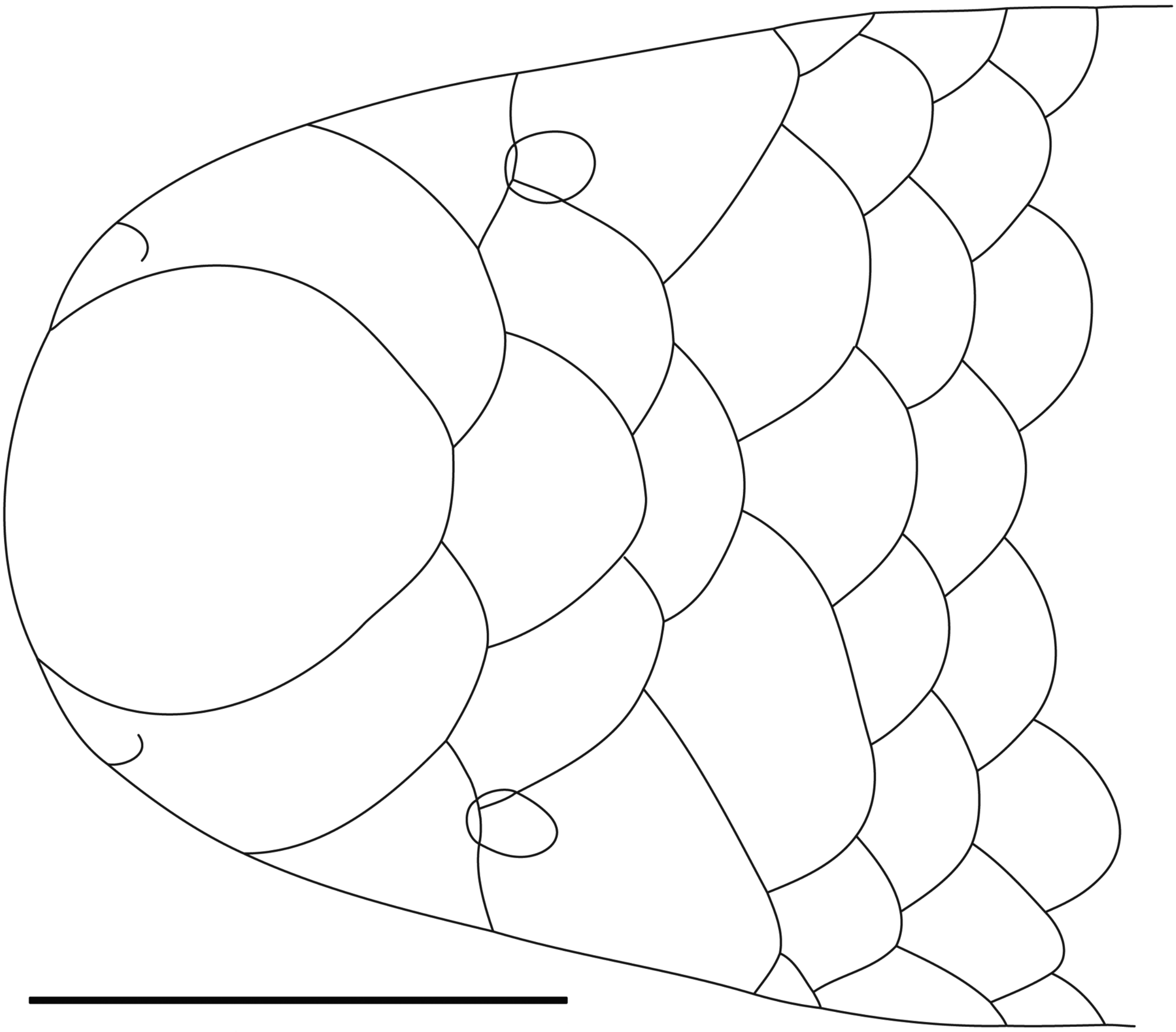

FIGURE 5. Headshields of *A. wiedii* (AM R162454) for comparison with *A. fossor*. Note the smaller, narrower, less rounded rostral, the noticeably squarer snout in dorsal profile, and the extension of the nasal cleft onto the head dorsum. Scale bar = 2 mm.

Hedges *et al*. (2014) mention four external characters purported to distinguish the genus, though these are based on means rather than absolute differences, and there are problems with all of them. In their diagnosis of *Anilios* (p. 33), they state that *Anilios* has a thinner body than all other genera (presumably including *Ramphotyphlops*) (total length/midbody diameter mean 55.8 *vs* mean of 46.6 or less in other genera), and has a relatively shorter tail than *Ramphotyphlops* (total length/tail length mean of 49.7 *vs* 31.8).

However, for the ratio of total length/midbody diameter, the ranges and means given by Hedges *et al*. for the individual species within the genera (Table 1, pp. 10-12) combined extensively overlap (overall range of Character 15A for *Anilios* 20.0–134.0, range for species means (Character 15B) 25.0–134.0 (n = 35 of 43 species), *vs* 18.1–

91.5 and 22.8-91.5, n = 21/21 species for *Ramphotyphlops*), with only three species of *Anilios* (*A. grypus*, *A. longissimus* and *A. nigroterminatus*) extending beyond the range of *Ramphotyphlops*. Additionally, although Hedges *et al*. do not indicate the source for the data in their Table 1, the values for many species are identical to those of, and appear to be derived from, Cogger (2000), who provides only an approximate range, rounded from the values provided earlier by Waite (1918). In the absence of a mean value from these authors, Hedges *et al*. seem to calculate means for each species as being the midpoint of the two extreme values. The mean values for the genera, representing the means of the species means, are inconsistently presented for *Ramphotyphlops* by Hedges *et al*. In their diagnosis of *Anilios* (p. 33), the value for *Ramphotyphlops* is given as 46.6 or less, in Table 2 (p. 19), the mean value for *Ramphotyphlops* is given as 48.8 (Character 15B), and my calculation, based on the raw values in Table 1 (pp. 11-12), is 50.6. On this corrected value, 15 of the 36 species of *Anilios* have means less than the grand mean for *Ramphotyphlops*. The median values for each genus are similarly close: 53.0 (*Anilios*) *vs* 50.0 (*Ramphotyphlops*). Hedges *et al*. have also not taken into account the potential ontogenetic change in this character, which increases with size within species. Of a large sample of *A. wiedii* I have examined (n = 137), small individuals had ratios as low as 40.1, while the highest values, up to 73.7, were exclusively found in the largest individuals. Hence, the purported difference in body elongation is inconsistent, and of no use in distinguishing the genera.

Similar issues exist for the ratio of total length/tail length (Characters 16A,B). Although in this case the means of the species means for each genus appear to be correctly calculated from their raw data, the ranges of values again extensively overlap (Table 1: *Anilios*: overall range for all species 15–111.8, range of species means 27.6–111.8, n = 38/43 species ; *Ramphotyphlops* 16.9–70 for both, due to single individuals representing species at the extremes of the range; n = 16/21 species), and Hedges *et al*. have not taken into account the extreme sexual dimorphism in this character. In the sample of *A. wiedii* examined for this paper, the overall range for the species is 25.3–87, with a mean of 46.7. However, due to the relatively longer body of females (as evidenced by the higher body dorsal scale count), and the relatively longer tail of males, the ratio was 25.3–39.4 for males (n = 62), and 43.9–87.0 for females (n = 64), giving males of this species values that reflect those assigned to *Ramphotyphlops*, and females values those of *Anilios*!

In their diagnosis of *Ramphotyphlops* (p. 39), Hedges *et al*. (2014) do not note the purported difference in body diameter, but add two more characters to relative tail length to distinguish it from *Anilios*: a higher mean number of midbody scales (grand mean for the genus 21.7 vs 20.1), and a smaller maximum size (grand means 302 vs 354 mm).

The number of midbody scales (Character 10, Table 1, pp. 5-7) for the two genera overlap extensively (*Anilios* 16–24, *Ramphotyphlops* 18–30), with the overall higher mean for *Ramphotyphlops* skewed due to the existence of one species (*R. marxi*) with an extreme value, and only one other species (*R. cumingi*) has a range extending above 24. Hence, 19/21 species of *Ramphotyphlops* and 39/43 species of *Anilios* have means in the range 18–24.

The values for maximum total length (Character 14A, Table 1, pp. 10-12) contain errors that reduce or negate the purported difference between the genera. For *Anilios*, Hedges *et al*. record three species with a maximum total length of greater than 614 mm: *A. nigrescens*, *A. proximus* (both 750 mm), and *A. unguirostris* (700 mm). They do not give the sources for these values, but they correspond to values presented by Cogger (2000). However, Cogger's values appear to be extreme overestimates. Shine and Webb (1990) provided SVL data for the former two species, based on all available material in relevant Australian museum collections—their largest *A. nigrescens* (among 299 specimens) was 576 mm, and their largest *A. proximus* was 626 mm (n = 187). The largest *A. unguirostris* measured by Storr (1981) and Waite (1918) had a total length of 610 mm. Similar overestimates are apparent for some other relatively large species, again seemingly based on the values of Cogger: *A. australis*, total length 500 mm *vs* 417 mm, n = 312 (Storr 1981); *A. ligatus*, total length 500 mm *vs* SVL 392 mm, n = 70 (Shine & Webb 1990), and *A. pinguis*, total length 550 mm *vs* SVL 491 mm (Aplin 1998). At the other extreme, the smallest maximum total length for *Anilios* species are 122 mm (*A. tovelli*), 128 mm (*A. yampiensis*) and 175 mm (*A. sylvia*), all three comparable to the smallest four species of *Ramphotyphlops* (*acuticauda*, 123 mm; *becki*, 117 mm; *mansuetus*, 150 mm; *conradi*, 175 mm).

In summary, the purported diagnostic characters distinguishing *Anilios* and *Ramphotyphlops* appear to be invalid at worst, and useless for allocation of species to the genera at best. While this does not affect the nomenclatural availability of the names, it does mean that the evidence for the distinction of the two genera rests solely on the molecular data, which in turn represent just 28/44 species of *Anilios* (64%) and 3/21 species of

Ramphotyphlops (14%). It also calls into question their generic assignment of species that are not yet represented by sequence data, other than by geography.

The lack of samples for genetic analysis prevents assessment of the relationships of *Anilios fossor* on primary molecular grounds. The female sex of the holotype prevents examination of the hemipenes, and the unique nature of the holotype has limited my dissection of the specimen. Hence, placement of this species in *Anilios* rather than *Ramphotyphlops* is tentative and reflects geography, with the only typhlopids on the mainland of Australia to date being *Anilios*, and *Ramphotyphlops* restricted to the Indopacific region.

Nomenclatural notes on the species assigned to *Anilios*

The recent generic divisions of typhlopids by Hedges *et al*. (2014) and Pyron and Wallach (2014) have introduced three nomenclatural novelties for the Australian fauna (also listed by Wallach *et al*., 2014). All list *A. aspina* as *A. aspinus*, *A. micromma* as *A. micrommus*, and *A. leptosoma* as *A. leptosomus* (the latter species emendation is also given by McDiarmid *et al*. (1999) in *Ramphotyphlops* and the latter two by Hoser (2013) in *Libertadictus*). All three alterations appear to be invalid. Couper *et al*. (1998) gave the etymology of *aspina* as "Latin, a- without and spina, a spine". Hence *aspina* is clearly intended as a noun rather than an adjective, or could be interpreted in that way. Storr (1981) noted the etymology of *micromma* as meaning "small eye", presumably from the Greek ὄμμα, or eye. Hence, *micromma* also must be treated as a noun in apposition. While Robb (1972) did not give an etymology when describing *Ramphotyphlops leptosoma*, the Greek term σῶμα, or *soma* (meaning body—hence "thin body") is a noun. Consequently, for all three species epithets, Articles 31.2.1–2 of the Code of Zoological Nomenclature apply, and the terminations of the epithets remain invariant. A similar situation arises with *Anilios nigricauda*, a species resurrected from the synonymy of *A. guentheri* by Wallach *et al*. (2014) and Pyron and Wallach (2014), but emended in both publications to *A. nigricaudus*. The Latin term *cauda* (a tail) is a feminine noun, which does not change gender despite its original combination with *Typhlops* by Boulenger (1895b)—the generic name being masculine (Smith & Larsen 1974).

The derivation of the generic name *Anilios* was not provided by Gray (1845), although Savage and Boundy (2012) suggest it was derived from the Greek *ἀν*- (lacking) + *ἠέλιος* (the sun). If so, it would be masculine, like *Typhlops*. Even if it was not derived from these roots (and many of Gray's names do appear to be meaningless), Gray's original description suggests a masculine gender for the name. He included six species in the genus. Four of the species names are either genitives (*Leachii*), based on nouns (*ruficauda*), or are adjectives that do not differ in termination in male or female gender (*australis*, *nigrescens*). The last two names, however, are adjectival, and both were given masculine terminations: *ater* and *squamosus*.

Taxonomic notes on further divisions of *Anilios*

In addition to the detailed genetic and morphological analyses by Hedges *et al*. (2014) and Pyron and Wallach (2014), which have resulted in division of the Typhlopidae into several families and further division of the genera, there have been a few other recommended taxonomic changes in the recent literature, by Wells and Wellington (1984, 1985) and Hoser (2013). These have suggested partitioning *Anilios* into multiple smaller genera or subgenera. The evidence for these proposals is very limited, largely providing a brief morphological statement for a diagnosis, or nomenclaturally recognizing branches on gene trees. I see little or no good reason for these taxonomic proposals to be accepted— they provide little or no useful phylogenetic information that is not already available in the more detailed studies by Marin *et al*. (2013), Hedges *et al*. (2014), and Pyron and Wallach (2014) (all of whom preferred to maintain a single genus) or are contradicted by these studies, and are themselves contradictory. For example, Wells and Wellington (1984) erected *Libertadictus* for a single species, *bituberculatus*, but in the following year, with no further discussion, expanded it to encompass 14 species, representing the Australian typhlopids with angulate snouts (Wells & Wellington 1985). However, genetic analyses have failed to recover monophyletic groups for either the angulate-snouted species or rounded snouted species. Of the 13 subgenera erected by Hoser (2013) for two genera, in just six pages, two (*Pattersontyphlops* and *Adelynhosertyphlops*) are not monophyletic, based on the most recent analysis of Pyron and Wallach (2014), the two genera (*Sivadictus* and *Libertadictus*) are both not reciprocally monophyletic (and neither is congruent with the previous content of these two genera by Wells and Wellington 1985), and two of the subgenera (*Buckleytyphlops*, *Sheatyphlops*) are monotypic, represent species for which tissues are unavailable for molecular studies, and in the absence of an explicit morphological analysis of relationships are phylogenetically uninformative. Most of the subgenera are diagnosed by external morphological features that have previously been used to distinguish species, but without any explicit analysis that would provide evidence for the weighting of particular character states over others as relevant to phylogenetic relationship.

Consequently, due to the largely evidence-free nature of these proposals, I maintain *Anilios* as a single genus without subgenera, and place these names in synonymy, as follows:

Anilios Gray, 1845.

Type species, *A. australis* Gray, 1845, by subsequent designation (Stejneger 1904: 683), see Savage and Boundy (2012) and Wallach and Glaw (2009). Type designation reiterated by Stejneger (1907) and Cochran (1941).

Synonymy
Libertadictus Wells & Wellington 1984: 104 (type species, *Onychocephalus bituberculatus* Peters 1863)
Sivadictus Wells & Wellington 1985: 41 (type species, *Anilios nigrescens* Gray 1845)
Austrotyphlops Wallach 2006 (type species, *A. nigrescens* Gray 1845)
Suewitttyphlops Hoser 2013: 43 (subgenus of *Libertadictus* Wells & Wellington 1984; type species, *Typhlops ligatus* Peters 1879)
Robinwitttyphlops Hoser 2013: 44 (subgenus of *Libertadictus*; type species, *Typhlops unguirostris* Peters 1867b)
Pattersontyphlops Hoser 2013: 44 (subgenus *Libertadictus*; type species, *Typhlops wiedii* Peters 1867a)
Slopptyphlops Hoser 2013: 45 (subgenus of *Libertadictus*; type species, *Typhlops ammodytes* Montague 1914)
Mantyphlops Hoser 2013: 45 (subgenus of *Libertadictus*; type species, *Typhlops guentheri* Peters 1865)
Jackyhosertyphlops Hoser 2013: 46 (subgenus of *Libertadictus*; type species, *Ramphotyphlops longissimus* Aplin 1998)
Kerrtyphlops Hoser 2013: 47 (subgenus of *Libertadictus*; type species, *Typhlops proximus* Waite 1893).
Adelynhosertyphlops Hoser 2013: 47 (subgenus of *Libertadictus*; type species, *Ramphotyphlops pilbarensis* Aplin & Donnellan 1993)
Bennetttyphlops Hoser 2013: 47 (subgenus of *Libertadictus*; type species, *Typhlops pinguis* Waite 1897).
Silvatyphlops Hoser 2013: 47 (subgenus of *Libertadictus*; type species, *Ramphotyphlops sylvia* Ingram & Covacevich 1993).
Buckleytyphlops Hoser 2013: 48 (subgenus of *Libertadictus*; type species, *Ramphotyphlops aspina* Couper *et al*. 1998).
Sheatyphlops Hoser 2013: 48 (subgenus of *Libertadictus*; type species, *Typhlops batillus* Waite 1894).
Ackytyphlops Hoser 2013: 48 (subgenus of *Sivadictus* Wells & Wellington 1985; type species, *Typhlops polygrammicus* Schlegel 1839).
Sundatyphlops Hedges *et al*. 2014: 39 (type species, *Typhlops polygrammicus* Schlegel 1839). Synonymy following the arguments of Pyron and Wallach (2014).

While some of these names may apply to definable lineages once appropriate analyses are undertaken, at the present time, they are of no value for classification, and the relationships amongst the species assigned to *Anilios* remain uncertain, with a variety of hypotheses of relationship proposed on morphological (McDowell 1974: Greer 1997) and genetic (Rabosky *et al*. 2004; Vidal *et al*. 2010; Marin *et al*. 2013; Hedges *et al*. 2014; Pyron & Wallach 2014) evidence, none based on complete or nearly complete sampling of the species in the genus. Further studies on the content and intrageneric relationships of *Anilios* are needed.

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APPENDIX. Comparative material examined (all specimens are in AM).

A. wiedii (localities lacking a state are in New South Wales): R1441, R40444, Dubbo (32.25°S 148.62°E); R1453, R175573–82, Darling River Floods [Talyawalka] (31.43°S 143.88°E); R1846, R11565, Moree (29.47°S 149.85°E); R2001, R11674, R13352, Quirindi (31.50°S 150.68°E); R2729, R6563, R6565, R6584, R165761, no locality; R3600, Koorawatha (34.03°S 148.55°E); R4122, Clarence River [approx. 29.68°S 152.93°E]; R4544, R14920, R175569–71, Boggabri (30.70°S 150.05°E); R5908, R6344, Eidsvold, Burnett River, Qld (25.37°S 151.12°E); R6587, 'Yandembah' (33.47°S 144.98°E); R7091, Singleton (32.57°S 151.17°E); R7123, Copmanhurst (29.58°S 152.77°E); R7230, 'Warrah' Station, near Quirindi (31.65°S 150.67°E); R7941, North Western NSW; R8031, Homebush near Mackay, Qld (21.28°S 149.05°E); R8427, Caswell (32.50°S 151.13°E); R9321, Mt Morgan, Qld (23.65°S 150.38°E); R9398, Blackmount, Qld (25.70°S 153.58°E); R11842, 'Bundarraga', Scone (32.00°S 150.55°E); R11885, 'Timbie' Station, Yeoval (32.7°5S 148.65°E); R12244, Bunya Mountains, Qld (26.85°S 151.57°E); R12581, Bell, Qld (26.93°S 151.45°E); R12587, 'The Ranch', Bell, Qld (27.08°S 151.45°E); R12591, Chauvel Camp, Muswellbrook (32.27°S 150.90°E); R12731, Goomeri, Qld (26.18°S 152.07°E); R12761, Walgett (30.02°S 148.12°E); R12869, Terrace Creek Gate, Doubtful Creek, near Casino (28.68°S 152.88°E); R13101, Kildary, via Beckom (34.13°S 147.00°E); R13454, Grafton (29.68°S 152.93°E); R13879, R175566–68, Coonamble (30.95°S 148.40°E); R13998, R26143, R128508, Muswellbrook (32.27°S 150.90°E); R14929, R47517, Gunnedah (30.98°S 150.25°E); R14953, R15661, R86810, Warrumbungle Range (31.43°S 149.60°E); R15291, Bourke (30.08°S 145.93°E); R15328, Graman (29.47°S 150.93°E); R16757, Mungindi (28.98°S 149.00°E); R17714, Casino (28.87°S 153.05°E); R17863, Forbes (33.38°S 148.02°E); R17922–23, R19284, R27311, Tamworth South (31.10°S 150.93°E); R19388, Collarenabri (29.55°S 148.58°E); R20758, Dunedoo (32.02°S 149.4°E); R20999, Tamworth (31.08°S 150.93°E); R27310, R71311, Inverell (29.77°S 151.12°E); R32740–41, R33038–40, R64011, 15 mi. W Gilgandra (31.65°S 148.45°E); R40104–12, R40114–16, Scott Memorial Hospital, Scone (32.05°S 150.87°E); R45484, Singleton area (32.57°S 151.17°E); R47280, 29 km S Singleton on Highway 69 (32.73°S 151.00°E); R64291, Inverell district (29.77°S 151.12°E); R66805–06, Lawrence (29.50°S 153.10°E); R69722, 'Myallvale' (30.17°S 149.53°E); R71171, Werris Creek (31.35°S 150.65°E); R84385, Cessnock (32.83°S 151.35°E); R89107, 7 km S Jerrys Plains (32.53°S 150.95°E); R91886–87, Bowling Alley Point on Tamworth–Nundle rd (31.40°S 151.13°E); R94784–85, Bellata rubbish tip (29.92°S 149.78°E); R95338, Copeton Dam (29.8994°S 150.9622°E); R95345, 3 mi. W Dungowan (31.20°S 151.05°E); R107993, Newington, Homebush Bay, Sydney (33.83°S 151.07°E); R127379, 1 Bartley Street, Forbes (33.38°S 148.02°E); R129327, Manilla rubbish tip (30.75°S 150.72°E); R130480, Grafton South Common (29.72°S 152.93°E); R144685, Mehi State Forest (29.93°S 150.75°E); R148867, 10 Wambat St, Forbes (33.38°S 148.02°E); R153961, 69 Jacaranda Drive, Moree (29.488029°S 149.841776°E); R154152, Travelling Stock Reserve on road to Poison Gate from Gwydir Highway (29.5297°S 149.2675°E); R155976, Scone (32.05°S 150.87°E); R157600, 21.1 km N on Castlereagh Hwy from turnoff to Lightning Ridge (29.1644°S 148.1175°E); R158479, Courallie State Forest: at base of NS ridge in centre of reserve (29.8678°S 150.2636°E); R158484, Severn State Forest: ridge above Upper Dungeon Ck, ~1.5 km NE Dungeon Ck and Appletree Rd (29.1161°S 150.9967°E); R160464, 'Silver Plains', approx. 10 km E of Spring Plains and 35km N of Wee Waa (29.33°S 149.93°E); R160482, 'Hadden' (29.9706°S 149.3883°E); R160484, Garnett Street, Dubbo (32.25°S 148.62°E); R161843, 9 km N Casino (28.7675°S 152.9861°E); R162454, Travelling Stock Reserve along Graman–Delungra rd (29.5039°S 150.9239°E); R162493, 53 Mitchell Street, Geurie (32.3978°S 148.8322°E); R162967, R165760, 'Narrawolga', 5 km S Werris Creek (31.40°S 150.63°E); R165243, Mehi State Forest, SW of Inverell on Meyers Rd (29.9294°S 150.7531°E); R167663, 'Rosevale', Peak Hill (32.73°S 148.18°E); R171165, Bellata area (29.9318458°S 149.8339717°E); R173049, approx. 8 km N Bellata along Newell Hwy (29.8390064°S 149.7871911°E); R174483, Baradine urban area (30.95104122°S 149.0622961°E); R178264, Watalgan, Qld (24.65°S 152.02°E).