

THE NOMENCLATURE AND SYSTEMATICS OF SOME AUSTRALASIAN HOMALOPSID SNAKES (SQUAMATA: SERPENTES: HOMALOPSIDAE)

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ABSTRACT. – The external morphology and systematics of Australasian homalopsid snakes are examined against the background of recent molecular work. Two new species (*Myron karnsi* and *Myron resetari*) in the genus *Myron* Gray 1849 are described using the external morphology commonly applied to snake species. *Cantoria annulata* Jong 1926 and *Hypsirhina polylepis* Fisher 1886 represent endemic Australasian genera; *Cantoria annulata* is assigned a new genus, and the genus *Pseudoferania* Ogilby 1891 is resurrected for *Enhydris polylepis*. The zoogeography of the Australasian homalopsid clade is discussed.

KEY WORDS. – homalopsids, *Myron*, *Cantoria*, *Enhydris*, *Heurnia*, nomenclature, new genus, new species.

INTRODUCTION

The Homalopsidae is a moderately diverse clade of semi-aquatic and aquatic snakes long considered a subfamily of the very large and paraphyletic family ‘Colubridae’. The monophyletic status of the homalopsids was supported using molecular sequences by Alfaro et al. (2008). Lawson’s (2005) molecular phylogenetic analyses recovered the Homalopsidae as an early branching lineage within the highly diverse advanced snake clade Colubroidea. Vidal et al. (2007) also found an early origin of the homalopsids and elevated them to superfamilial rank, Homalopsoidea, the sister to the Colubroidae and Elapoidae.

The Indochinese Peninsula contains the largest number of extant homalopsids and it appears they have dispersed westward to Pakistan and eastward to Australasia (Murphy, 2007). Voris et al. (2002) demonstrated that the widespread, specious Asian genus *Enhydris* is polyphyletic, containing a minimum of five separate lineages. Recently Alfaro et al. (2008) recovered *Myron richardsonii* as the sister to *Enhydris polylepis*. The implication of these findings is that Australasia has been invaded at least three times by homalopsids: once by the *Cerberus* clade which has produced the extant Australian bockadam, *Cerberus australis*; once by the crab-eating snake, *Fordonia leucobalia*; and at least once by the lineage(s) that resulted in the other Australasian homalopsids (*Heurnia ventromaculata* Jong, 1926; *Myron* Gray, 1849; *Hypsirhina polylepis* Fisher, 1886; and *Cantoria annulata* Jong, 1926).

The examination of museum material suggested that *Myron* is not monotypic and contains three species. A comparison of other Australasian homalopsids against the background of the previously mentioned molecular studies suggests adjustments to the generic assignments presented in Gyi (1970) and more recently, Murphy (2007). The monotypic genus *Heurnia* Jong 1926 is known only from the holotype and its type locality at Pionierbivak, Manberano River, in northern Irian Jaya, Indonesia. The genus *Cantoria* Girard, 1858 currently contains two species: *C. violacea* Girard, 1858 the type species for the genus, with a Southeast Asian distribution; and *C. annulata* Jong 1926, a southern New Guinea coastal endemic. Murphy (2007) proposed that this genus is polyphyletic based on morphology. Additionally, the Australasian endemic *Hypsirhina polylepis* Fisher, 1886 clearly does not belong in the Asian genus *Enhydris* given the results of Voris, et al. (2002) and Alfaro, et al. (2007) (see Fig. 1).

MATERIAL AND METHODS

Examination of museum material was done primarily at the Field Museum, but included visits to the Australian National Museum, the British Museum of Natural History, and the Zoological Reference Collection, National University of Singapore. Scale counting methodologies generally follow those presented by Peters (1964) with some minor exceptions (dorsal scales were counted on the neck at about the 10th ventral, at mid body, and about 10 ventral scales anterior to the vent, and they were counted on the diagonal). Dorsal scale

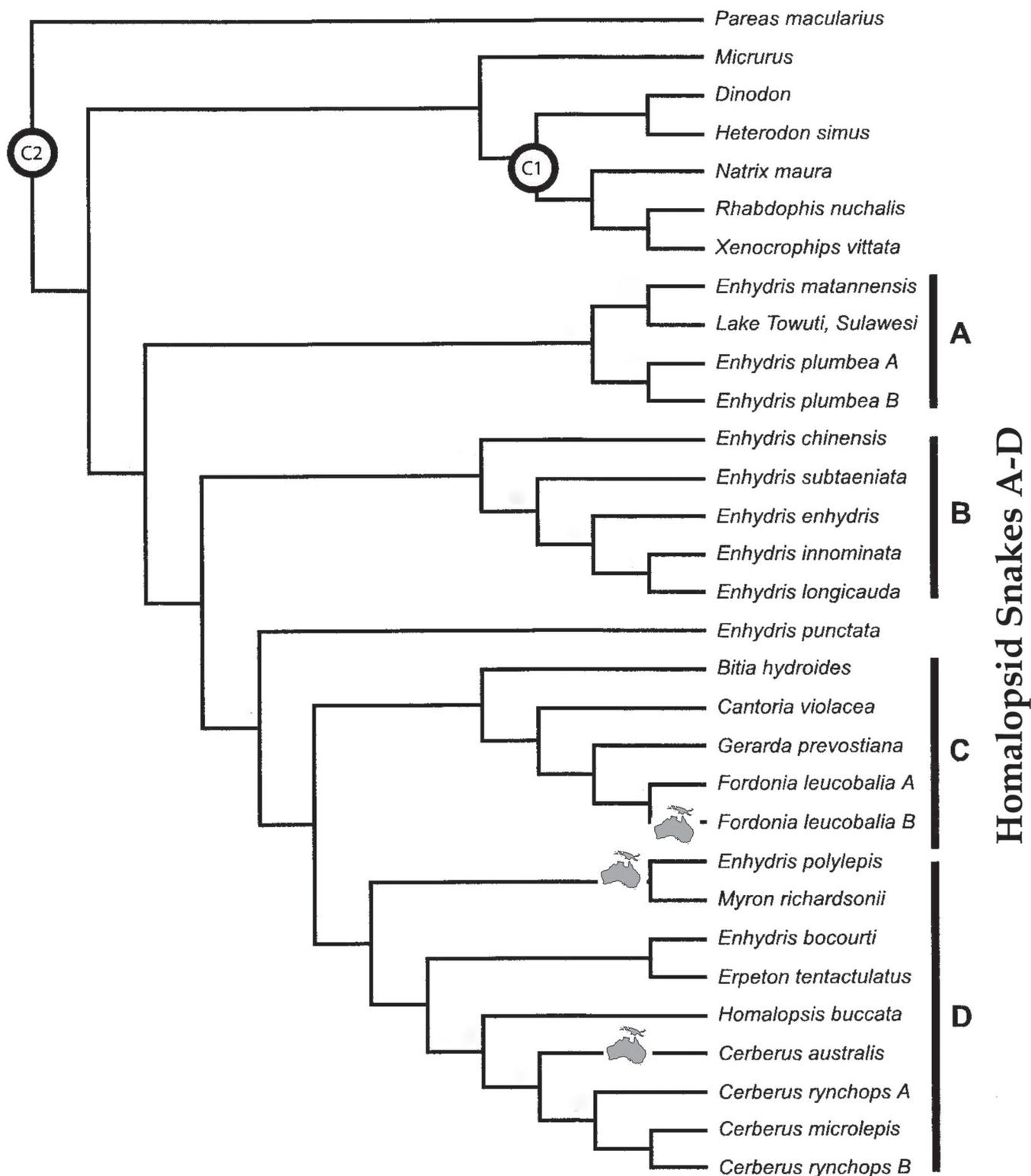


Fig. 1. The maximum likelihood tree of the Homalopsidae from Alfaro et al. (2008), modified to show that Australasia has been colonized by at least three lineages of homalopsid snakes (Australasian Icon Map): one colonization by the lineage that gave rise to the coastal Australian bockadam, *Cerberus australis*; one colonization by the coastal crab-eating snake, *Fordonia leucobalia* and; one colonization by the lineage that gave rise to both the coastal *Myron* species as well as the freshwater *Enhydris polylepis* (and probably *C. annulata* and *Heurnia ventromaculata*). The other lineages shown on the tree are South Asian or Southeast Asian.

rows expressed here as 19–19–17 refers to the number of rows on the neck, at mid body, and at posterior body, respectively. Scale counts and scale measurements on most specimens were done under a dissection microscope. Measurements were taken with a meter stick, metric tape, and dial calipers. Snake sizes are given in millimeters. Scale counts separated by a dash (–) represent a range taken from different individuals. Scale counts separated by a slash (/) represent scale counts taken from a single individual; the number on the left is the number of scales on the snake's left, and the number to the right is the number of scales on the specimen's right side. Photographs of scale arrangements were taken with a Leica digital microscope. The plates show scale arrangements that may be useful for identification and understanding character states. Sex was determined by probing, tail shape, dissection, and visual inspection of the hemipenes, testes, and ovaries. Museum acronyms follow McDiarmid et al. (1999) and they can be found in the Acknowledgements.

RESULTS

DNA from *Cantoria annulata* and *Heurnia ventromaculata* has not been available but the morphological data presented here suggests that these two Australasian species share some morphology with *Myron* and *H. polylepis* that imply they may belong to the same lineage.

Morphological comparisons of the snakes *Cantoria annulata*, *Enhydris polylepis*, *Heurina*, and *Myron* show that while they are morphologically diverse they share enlarged occipital scales and have the 2nd and 3rd (and sometimes also 4th) upper labial scales contacting the loreal scale. *Cantoria*, *Heurina* and *Myron* all have an internasal scale that separates the nasal scales. *Enhydris polylepis* is also a member of this clade (Alfaro et al., 2008) and while its nasal scales are in contact, it has keeled scales on the posterior body, a character shared with *Myron* and *Cantoria annulata*. Nasal scales separated by an internasal are associated with Clade C of Alfaro et al. (2008), as well as the Australasian portion of their Clade D (see Fig. 1). Also, *Heurnia* and some populations of *E. polylepis* have upper labials 5–6 under the orbit, while *Myron* and *C. annulata* have upper labial 4 under the orbit. Following this pattern, *Heurnia* has 27 scale rows at mid body and some individuals of *E. polylepis* have 27 rows at mid body (range is 21 to 27). While the morphology alone is not enough to suggest these four divergent species shared an ancestor. The DNA evidence from Alfaro et al. (2008) revealed the dwarf, saltwater *Myron* and the large, freshwater *Enhydris polylepis* are in fact sisters; this evidence combined with the morphology and the geographic distribution seems to suggest that *Myron*, *C. annulata*, *E. polylepis*, and *Heurnia* shared an ancestor that colonized Australasia from Southeast Asia.

Review of *Myron*. – The Australasian genus *Myron* Gray, 1849 has been considered monotypic with the species *Myron richardsonii* Gray the type species (Gyi, 1970; Murphy, 2007). This poorly known estuarine snake is not known to exceed 415 mm total length and is therefore considered a dwarf in a clade where most species approach or slightly

exceed one meter in maximum length (Murphy, 2007). *Myron* has been reported to inhabit the Aru Islands of Indonesia, coastal Papua New Guinea, and coastal northern Australia from the Gulf of Carpentaria, Queensland to Broome, Western Australia.

Seventeen specimens of *Myron* were examined including the type specimen of *M. richardsonii*. Three of these specimens presented distinct morphology separating them from *M. richardsonii*.

Myron Gray, 1849

1849 *Myron* Gray (in part) p. 70.

Type species: *Myron richardsonii* Gray, 1849.

1887 *Neospades* Type species: *Neospades kentii* De Vis, 1889.

Diagnosis. – Head distinct from neck; parietals entire; internasal usually single and separating nasals; loreal present; dorsal scales weekly keeled on posterior of body, and in 19–21 rows at mid body, usually reduced to 17 near the vent; ventrals broad; upper labials 2–3 or 2–4 contact loreal; upper labial 4 enters the orbit; enlarged occipital scales present; three pairs of chin shields present with the middle pair the longest. Note that this genus is gender neutral.

Myron karnsi, new species

Fig. 2

Holotype: SMF 19569. Type Locality: Indonesia Aru, Kobroor, Selrutti (about 5°46'S and 134°31'E).

1917 *Myron richardsoni* — Rooij, 2:192.

Diagnosis. – A melanistic species with 21 scale rows at mid body; a semi-divided nasal scale; the third pair of chin shields are as wide as they are long; all of which will distinguish it from the other new species described here. The black coloration, narrow yellow cross bands, enlarged occipital scales posterior and lateral to the parietals, and keeled scales

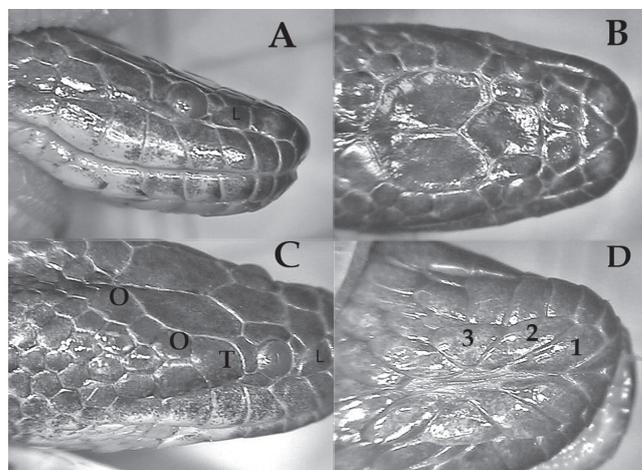


Fig. 2. The holotype of *Myron karnsi*, SMF 19569. A and B: show the overall of head plates. C: illustrates the enlarged occipital scales (O) and their relationship to the temporal (T). D: has the three pair of chin shields numbered and the 3rd pair is as wide as long.

starting on row 3 (as opposed to row 5 or 6) will separate it from *M. richardsonii*.

Holotype: Female (SMF 19569), SVL 333 mm, tail 64 mm; dorsal scale rows 22–21–17; ventrals 139; subcaudal scales 37. On the head: rostral broader than tall; nasal scales larger than eye diameter, nasal semi-divided; internasal small and partially divided; frontal about two-thirds the length of parietals; the posterior parietal edge contacts two plate-like occipital scales which do not extend along the lateral edge of the parietal scales; preoculars 2/2; postoculars 2/2; upper labials 8/8, number 6 is fragmented on the right side; labials at loreal 2–4/2–4; tallest upper labial 6/6; lower labials 11/10; labials at first chin shield 3/3; largest lower labial 6/6; three pair of chin shields, the second pair is the longest, the third pair is as broad as long. On the body: dorsal scale rows smooth anteriorly, but posteriorly weakly keeled scales start on row 3. The tail is slightly laterally compressed in cross section. Colour in alcohol: the crown, sides of face, upper and lower labials are black; the dorsum is mostly black with cream colored mottling on dorsal rows 1–2; yellow transverse bands are less than one scale row wide and start on dorsal row 4; each ventral scale is black with a narrow light yellow posterior edge, this coloration continues onto the subcaudals. Overall, this snake is black with narrow yellow cross bands.

Etymology. – This species is named in honour of Daryl R. Karns, Hanover College and the Division of Amphibians and Reptiles, Field Museum of Natural History for his contributions to herpetological research and work with homalopsid snakes.

Distribution. – Known only from the type locality.

Myron resetari, new species
Fig. 3

Holotype: QM J52861. Type locality: Broome, Western Australia (about 17°58'S and 122°14'E).
1970 *Myron richardsonii* — Gyi, pages 172–174, Fig. 28.

Diagnosis. – A *Myron* with 19 scale rows on the neck and at mid body; one preocular scale; large, plate like occipital scales that are posterior and lateral to the parietals. *M. resetari* can be distinguished from *M. richardsonii* by its lower scale row count on the neck and at mid body (19 vs. 21); one preocular (two in *M. richardsonii* and *M. karnsi*); and its largest upper labial is the 5th compared with the largest upper labial of 6 or 7 in *M. richardsonii*. It can be distinguished from *M. karnsi* by the lower number of scale rows at mid body (19 vs. 21) and the blotched pattern on a gray ground color (as opposed to the black ground color and thin yellow crossbands of *M. karnsi*).

Description of the holotype: On the head: rostral as broad as tall with the dorsal edge extending between the nasal scales; nasals are smaller than the diameter of the eye, separated by the internasal from the posterior edge and the rostral from

the anterior edge; upper labials 2–4 contact the loreal; the internasal contacts the loreal on both sides; each prefrontal is slightly larger than the internasal; frontal is pentagonal and slightly shorter than the parietals; upper labials 8/8; labial number 4 enters orbit; supraocular single; preocular single; postoculars 2; the temporal formula 1+2/1+1; lower labials 10/10 (number 5 is the largest in both specimens); 3 pair of chin shields, second pair the largest; the 3rd pair is longer than broad. On the body: dorsal scale rows 19–19–17; dorsal rows on the anterior body are smooth, posteriorly scale rows 1–4 are not keeled, rows 5 and above are weakly keeled; dorsal scale rows 1–6 are extremely ovate, other rows become lanceolate toward mid-line. QM J52861 a male, SVL 330, total length 395 mm; ventrals 142, subcaudals 36; the tail is slightly compressed in cross section.

Paratype. BMNH 1935.7.65.2, locality is given as “N. Australia.” This is probably a juvenile female, SVL 246 mm, total length 290 mm; ventrals 137, subcaudals 37. It has a similar head scale arrangement as the holotype except that the internasal scale does not contact the loreal.

Etymology. – The specific name is in honour of Alan Resetar of the Division of Amphibians and Reptiles, Field Museum of Natural History for his life long dedication to herpetology and his behind the scenes contributions to homalopsid snake research.

Distribution. – Known only from the type locality, Broome, Western Australia; but it may be more widespread. Given *Myron*'s use of mangroves and mudflats it seems likely this snake is from the Roebuck Bay area of the Dampier Peninsula.

Myron richardsonii Gray, 1849

Type Locality: North Western Australia. Restricted here to Buffalo Creek, Northern Territory, Australia (about 12°40'S and 131°29'E).

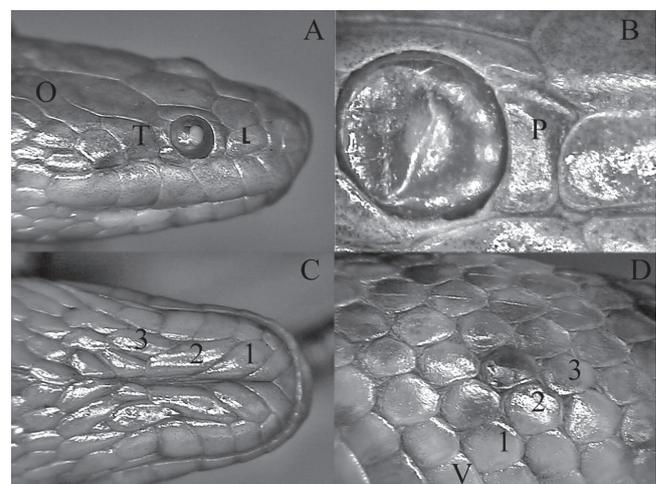


Fig. 3. The paratype of *M. resetari*, BMNH 1935.7.65.2. A: shows the enlarged occipital scales (O) and their relationship to the temporal (T). B: illustrates the single preocular scale. C: illustrates the three pairs of chin shields with the 3rd pair longer than wide. D: illustrates the edge of the ventral scales (V) and first 3 dorsal rows and the keels on the scales above dorsal row 3.

Table 1. A comparison of the three species of *Myron*.

Characteristic	<i>M. richardsonii</i>	<i>M. resetari</i>	<i>M. karnsi</i>
n=	14	2	1
Scale rows on neck	21–22	19	22
Scale rows mid body	21	19	21
Internasal smaller than nasal	yes	yes	no
Preocular Scales	2	1	1
Plate-like occipitals	posterior to parietals	posterior and lateral to parietals	posterior and lateral to parietals
Upper labials	9	8/7	8
Largest lower labial	6	5	6
Nasal scale completely divided	yes	yes	no
Tail/SVL Males	0.17–0.19	0.18	No data
Tail/SVL Females	0.16–0.17	0.20	0.19
Ventrals	131–139	137 and 142	139
Pattern	dorsolateral spots	dorsolateral spots	black with transverse yellow bands

Diagnosis. – A *Myron* with 21 scale rows on the neck and at mid body that are reduced to 17 or 19 rows near the vent; the posterior dorsal scale rows above row 6 are weakly keeled; two preocular scales; upper labials usually number 8 or 9; plate-like occipital scales located on the posterior edge of the parietals; 8 to 10 upper labials; and a dorsal pattern of blotches that number 35 to 48. The presence of 21 scale rows and two preoculars will distinguish it from *M. resetari*. The 8 to 10 upper labials and blotched pattern will separate it from *M. karnsi* which is melanistic with narrow yellow crossbands.

Eight males had 131–137 ventrals (\bar{x} =133.8, sd =1.80) and 33–39 subcaudals (\bar{x} =35.6, sd =1.76). Six females had 131–139 ventrals (\bar{x} =135.5, sd =3.62) and five females had 30–34 subcaudals (\bar{x} = 31.6, sd =1.82). While the ventral counts show no sexual dimorphism, the subcaudal counts based on this limited sample size most likely do.

Distribution. – Coastal northern Australia from the Gulf of Carpentaria to Western Australia and northward to the south coast of New Guinea.

A comparison of the three species of *Myron* can be found in Table 1.

Reassignment of *Cantoria annulata*. – *Cantoria* Girard, 1858, was described on the basis of a specimen from Singapore. The type species is the morphologically distinctive *Cantoria violacea* Girard, the type species for the genus by monotypy. *C. violacea* has a long, slender body, dorsal scales in 19 rows at mid body; the ventral count ranges from 234–284, other scale characters are given in Table 2. *C. violacea* appears to prey exclusively on *Alpheus* shrimp in mangrove forests and their associated mud flats (Voris & Murphy, 2002). Molecular analysis found that *Cantoria violacea* is the sister to *Gerarda* and *Fordonia* (Alfaro et al., 2008), both crustacean-eating species with widespread coastal distributions.

Cantoria annulata Jong, 1926 was described from a specimen from Prins Hendrik-eiland, New Guinea which had 21 scale rows at mid body and ventral counts that range from 168–182. While *C. annulata* has its nasal scales separated by the internasal (as does *C. violacea*), it also has the internasal in contact with the frontal scale, a character state unknown in other homalopsids. Given these differences and the others noted in Table 2, removing *annulata* from *Cantoria* is warranted, and here placed in a new genus.

Djokoiskandarus, new genus

Type species. – *Cantoria annulata* Jong, 1926 by monotypy.

Etymology. – The genus is named in honour of Indonesian herpetologist Djoko Iskandar. Gender of genus is masculine.

Distribution. – Southern coast of New Guinea.

Morphological Diagnosis. – Dorsal scale rows 21 at mid body; internasal separates prefrontal and nasals scales; frontal's contact with the internasal makes this species readily distinguishable from all other homalopsids, including *Cantoria violacea* which has 19 scale rows at mid body and the prefrontal scales in broad contact. A number of species of *Enhydryis* have 21 scale rows at mid body, but all of them have the nasal scales in contact. *D. annulatus* also has keeled scales in the first three dorsal scale rows just anterior to the vent. A male is 578 mm in total length with a 108 mm tail; four females were 277–548 mm in total length. See Murphy (2007) for a more exhaustive description.

Djokoiskandarus annulatus, new combination

Type Locality. – Prins Hendrik-eiland (Yos Sudarso), New Guinea, Indonesia (about 7°56'S and 138°21'E).

Distribution. – Southern coastal New Guinea.

Table 2. A comparison of *Cantoria violacea* and *C. annulata*.

Characters	<i>C. violacea</i> Girard 1858	<i>C. annulata</i> Jong, 1926
N=	16	4
Distribution	Southeast Asia	New Guinea
Scale rows	19–19–17	21–21–17
Internasal contacts frontal	no	yes
Ventral counts	234–284	168–182
Keeled scales on posterior body	no	yes
Upper labials	5	6–9
Subocular scales	yes	no
Labials at loreal	1–2 or 1–3	2–3 or 3–4

Resurrection of *Pseudoferrania Ogilby*. – *Hypsirhina polylepis* Fisher, 1886, was described on the basis of a specimen from the Fly River, Papua New Guinea. Ogilby (1891) described *Pseudoferrania macleayi* from Queensland's Herbert River, Boulenger (1896) placed *macleayi* in *Hypsirhina* and Kinghorn (1929) placed *macleayi* in the synonymy of *polylepis* and assigned *polylepis* to *Enhydris*. The overall appearance of *polylepis* suggests it is related to the Southeast Asia *Enhydris* which has the nasals scales in contact and parietal scales that are entire (Gyi, 1970). However, using DNA sequence data from three mitochondrial genes and one nuclear gene, Alfaro et al. (2008) have clearly shown that *polylepis* is not part of the Southeast Asian *Enhydris*, but part of a Australasian clade which includes *Myron*. Morphological support for this relationship can be found in the enlarged occipital scales and upper labials 2–3 or 2–4 at the loreal. Additionally the weekly keeled scales on the posterior body of *polylepis* do not occur in any Southeast Asian taxa, but do occur in *Myron* and *Djokoiskandarus*.

DISCUSSION

Much remains to be learned about the homalopsids of Australasia. *Myron* is of interest for several reasons. This dwarf homalopsid genus shares its distribution with the only known dwarf 'true' sea snakes (Hydrophiidae): *Ephalophis greyi* and *Hydrelaps darwiniensis*; it apparently has a generalised diet that includes nudibranchs (Nobbs & Blamires, 2004); and, despite its small size, *Myron* will use relatively deep water (Parker, 1982). The melanistic Aru Island *M. karnsi* may have evolved its colour pattern to rapidly warm its body after diving, why this would occur in this population and not others remains open for future investigation. The Western Australian *M. resetari* may be restricted to the Broom/Derby coasts of the Dampier Peninsula and represent the most southwestern extent of the distribution of the genus, despite the fact that mangrove habitat and associated mudflats extend further to the south. The Dampier Peninsula appears to be a center of endemism and contains other endemic or near endemic squamates, including: the agamid *Diporiphora pinan*; the gecko *Gehyra occidentalis*; the skinks *Ctenotus angusticeps*, *Lerista apoda*, *L. separanda*, *Morethia storri*; the typhlopids *Ramphotyphlops yampiensis*; the elapids *Simoselaps minimus*, and the near

endemic Mjoberg's Sea Snake, *Aipysurus tenuis* (Wilson & Swan, 2003).

Morphology alone suggests that *Djokoiskandarus annulatus* may be the sister to *Myron*. Its distribution and habits are all but unknown. It uses mangroves and *Nypa* palm communities and it seems likely that its natural history will add an interesting piece to the homalopsid puzzle.

The combination *Pseudoferrania polylepis* has been previously used, albeit spuriously and without justification by Wells & Wellington (1985). Its natural history is better known than the other Australasian homalopsids and its morphology suggests it may be a composite of several taxa (see Murphy, 2007 for a summary).

Homalopsids presumably invaded Australasia from the Indonesian Archipelago (Shine, 1991). It is significant that of the three lineages that have reached Australasia all contain species that are coastal (brackish water and saltwater) taxa. The *Myron* lineage likely contains one, if not two, freshwater species (*P. polylepis* and *Heurnia ventromaculata*). The molecular analysis of Alfaro et al. (2008) suggested that *Myron* and *P. polylepis* last shared an ancestor 12.1 MYA (7.9–16.3 MYA) and that the Southeast Asian *Cerberus* last shared an ancestor with the Australian *C. australis* about 9.6 MYA. These dates are in the late Mid Miocene and early Late Miocene when Australia was undergoing rapid movement toward the Sunda Plate and there was a downward deflection of the surface topography due to mantle convection. The continent was higher than it is today and much, if not all, of the continental shelf was exposed (Heine et al., 2010). This reduced the over-water distance Southeast Asian species had to travel to reach Australia. Homalopsids are not strong swimmers and with all of the northwest continental shelf exposed it increased the likelihood of Australasian colonization by Southeast Asian taxa.

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Appendix 1

Material Examined

Djokoiskandarus annulatus: Papua New Guinea: Bobo Island MCZ 136063; Daru Island CAS 133812; MCZ 139340. Oriomo River, Abam: MCZ 129160. *Heurnia ventromaculata*: Indonesia: ZMA 11066. *Pseudoferania polylepis*: Australia. Northern Territory: AM 10221, 10223–24, 10225; USNM 213440, 128450. Queensland: AMNH 82443, 69306; CAS 103021, 121101; FMNH 97265; MCZ 140183; QM 20282, 23221, 28314, 37578, 51352, 51961. Papua New Guinea – AMNH 111769–70, CAS 132210; MCZ 121562; 129135, 134728–30, 134898, 136088, 137329, 141689. *Myron karnsi*: Indonesia: SMF 19569. *Myron resetari*: Australia: northern Australia BM 1935.7.6.2; Broome, WA QM J52861. *Myron richardsonii*: Australia: AMS 112001–02, 119448–49, 130697, BMNH 1946.1.2.43; FMNH 97649, QM J52861; SAMA 24824–27. New Guinea: BMNH 1987.923; FMNH 116769. New Guinea: BMNH 1987.923; FMNH 116769. No Data: BMNH 55.10.66.