

Further division of the genera *Boiga* Fitzinger, 1826 and *Chrysopelea* Boie, 1826, with the creation of a new tribe, a new genus and a new subgenus.

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ABSTRACT

For many years, the genus *Boiga* Fitzinger, 1826 has been regarded as a catch-all for similar and obviously related snakes, some quite morphologically different from one another and also at times widely separated by distribution.

Meirte (1992) divided *Boiga sensu lato* by removing the African species and placing them in the resurrected genus *Toxicodryas* Hallowell, 1857. Hoser 2012 followed this move and created new genera for two distinctive Asiatic groups, namely *Dorisius* Hoser, 2012 and *Mulvanyus* Hoser, 2012, also resurrecting the genus *Dipsadomorphus*, Fitzinger, 1843.

This paper follows on from the earlier ones and removes the species *Boiga kraepelini* Stejneger, 1902 from *Boiga* and places it within a monotypic genus, namely *Slopboiga* gen. nov.

All species formerly placed within the genus *Boiga sensu lato*, are herein placed within a new tribe to accommodate the component genera, now numbering six.

The most divergent member of the Flying snake genus *Chrysopelea* Boie, 1826, namely *Chrysopelea taprobanica* Smith, 1943, is herein placed in a new subgenus.

Keywords: Taxonomy; *Boiga*; *Chrysopelea*; new tribe; Boigaiini; new genus; *Slopboiga*; new subgenus; *Wellsserpens*.

INTRODUCTION

Hoser (2012) established that *Boiga* was a clearly composite genus in urgent need of major taxonomic review.

This paper continues the somewhat piecemeal review process of the genus.

This was most recently commenced by herpetologists such as Meirte (1992).

Meirte (1992), resurrected the genus *Toxicodryas* Hallowell, 1857 for the two African species previously assigned to the genus *Boiga*.

This move was rejected by Broadley (1998), a position that was supported by others including Hughes (2000).

However the placement of the two African species in the genus *Toxicodryas* has more recently in effect been supported by the very limited molecular data provided by Pyron *et al.* in 2011.

Their results only showed data for two species within *Boiga sensu lato*, including what they called *Boiga pulverulenta* and the well-known Asiatic species *B. dendrophila*.

While these results showed the two species to be related, the division between the two was more than ample to warrant the splitting of the species between two genera when compared to other species tested within and between related genera.

While *B. dendrophila* as it was known in 2011 (now *Dorisius*

dendrophila), is not the type species of the genus *Boiga*, it was safe to infer a similar result would have been obtained by Pyron *et al.* if they had tested Australian *Boiga irregularis* against African *Boiga pulverulenta*.

What had not yet been determined by molecular means was the differences between the Asiatic and Australian species groups within *Boiga* or for that matter differences between the various Asiatic groups.

Hoser (2012) noted that what's left of *Boiga* after the two *Toxicodryas* were removed was still a very paraphyletic group of common origin with a distribution ranging through most of Asia, from eastern Iran, across Indonesia and into north and east Australia. These species range from large moderately built species, to very thin and sometimes much smaller animals.

In terms of morphology and habits, the species are diverse and often sympatric, with different taxa occupying different habitats and ecological positions, even though all are similar in obvious key respects such as their large eyes, laterally compressed bodies and so on.

As a result, Hoser (2012) removed two well defined species groups and placed them within their own new genera.

The species *Boiga dendrophila* was placed in a monotypic genus *Dorisius* gen. nov.

The highly divergent so-called *Boiga drapiezii* group, including species both described and undescribed were placed in the genus *Mulvanyus gen. nov.*

The taxonomic position of the remainder remains generally unclear due to the fact that while there are about 30 recognized species and another 15 or so subspecies, these numbers do not give an accurate reflection of the true composition of the genus. Instead the current composition of the genus in many ways reflects collection localities and interpretations of morphological variants by different herpetologists.

Therefore I should note that the current content compositions (total numbers) of the two genera created by Hoser (2012) as well as the remaining *Boiga* beyond those listed within each, should be treated as provisional on the basis of further taxa likely to be described and/or added to given genera now identified.

Coluber irregularis Bechstein, 1802, now widely known as *Boiga irregularis* is the type species of the genus *Boiga* Fitzinger. The name *Ibiba* Gray, 1825, was suppressed under the plenary powers in ICZN Opinion 1374, and has been placed on the Official Index of Rejected and Invalid Generic Names in Zoology.

Hoser 2012 stated the obvious when he wrote: "Genus *Dipsadomorphus* Fitzinger, 1843 appears to be a valid name for the type species *Coluber trigonatus* Schneider, 1802, now known widely as *Boiga trigonatus*."

This statement has in fact been further validated by a more recent molecular study by Pyron *et al.* published in 2013 (Pyron *et al.* 2013).

Hoser 2012 noted that "*Boiga trigonatus*" as then known was divergent from other members of *Boiga sensu lato*, including the type species for *Boiga*, namely *B. irregularis*.

This statement has also been further validated by the recent molecular study by Pyron *et al.* published in 2013 (Pyron *et al.* 2013).

One species shown as divergent in molecular studies (Pyron *et al.* 2013) is the Taiwanese taxon, *Boiga kraepelini* Stejneger, 1902.

Reference to live and dead specimens of the species also shows it to be sufficiently divergent from the rest of *Boiga* morphologically to warrant being placed within its own monotypic genus.

As a result, this taxon is placed in a new genus *Slopboiga gen. nov.* named according to the Zoological Code (Ride *et al.* 1999).

While the genus *Boiga sensu lato* remains one of the less understood groups of common snakes, there are a number of relevant publications in terms of the genus and particular species. With more than 30 species taxa formally named it isn't practical for to cite all the noteworthy literature, however some of the more important relevant published studies and records include, Acala (1986), Ahl (1933), Auliya (2006), Bauer and Günther (1992), Brongersma (1934), Bulian (2000), Cox *et al.* (1998), Das (1999), Das and De Silva (2005), David and Vogel (1996), de Lang and Vogel (2005), Duméril, Bibron and Duméril (1854), Even (2009), Ferner *et al.* (2000), Gaulke (1994), Gaulke *et al.* (2003), Geissler *et al.* (2011), Greene (1989), Groen (2006, 2008), Günther (1863), Khan (1988, 2002), Kramer (1977), Leong *et al.* (2009), Leviton (1968), Longman (1915, 1918), Macleay (1877, 1884, 1888), Manamendra-Arachchi and Pethiyagoda (2007), Manthey and Grossmann (1997), McCoy (2006), Mertens (1961), Minton and Dunson (1978), Neier (1981), Nguyen *et al.* (2009), Orlov and Ryabov (2002), Orlov, *et al.* (2003), Pauwels and Vogel (2011), Pauwels *et al.* (2005), Ramadhan *et al.* (2010), Rodda and Fritts (1992), Schmidt (2012a), Smith (1943), Taylor (1923, 1965), Tillack (2006b), Tillack *et al.* (2004), van Rooijen and van Rooijen (2004), Vidal *et al.* (2007), Vogel (1994, 2000), Wall (1908b, 1909, 1921a, 1921b), Wen (1998), Werner (1899a, 1899b) Whittaker and Captain (2004) and Zhao and Adler (1993).

The so-called Flying Snakes, of the genus *Chrysopelea* Boie, 1826 are well known throughout wetter parts of southern Asia. Within the group of five described species, four form a natural grouping.

The fifth is quite morphologically different, with obvious differences in that species *Chrysopelea taprobanica* Smith, 1943 including a distinct keeling in the dorsal scales, consistent colour pattern differences and consistent differences in scalation.

In combination these are substantial and warrant taxonomic recognition above the level of species.

As a result, *Chrysopelea taprobanica* Smith, 1943 is herein (below) placed in a new subgenus, described in accordance with the Zoological Code (Ride *et al.* 1999).

Relevant papers in terms of species within *Chrysopelea* Boie, 1826 include: Auliya (2006), Boie (1827), Boistel *et al.* (2001), Bong Heang (1987), Boulenger (1890, 1894), Brongersma (1933), Brown *et al.* (1996), Bulian (1997), Chanard *et al.* (1999), Cox *et al.* (1998), David and Vogel (1996), de Lang and Vogel (2005), Devan-Song and Brown (2012), Dowling and Jenner (1998), Duméril *et al.* (1854), Ferner *et al.* (2000), Fischer (1880), Gaulke (1986, 1994, 2011, 2012), Geissler *et al.* (2001), Grismer, *et al.* (2002, 2007, 2008, 2010), Grossmann and Schäfer (2001), Grossmann and Tillack (2001a, 2001b, 2004), Ingle (2010), Iskander and Erdelen (2006), Kannan (2006), Karunarathna Suranjan and Thasun Amarasinghe (2011), Kopstein (1926), Leviton (1964), Lim and Ng (1999), Linnaeus (1758), Mahony *et al.* (2009), Malkmus (1985), Malkmus *et al.* (2002), Manthey and Grossmann (1997), Murthy (2010), Pauwels *et al.* (2000, 2003), Purkayastha *et al.* (2011), Pyron *et al.* (2011, 2013), Quah *et al.* (2011), Sang *et al.* (2009), Schmidt (2012b), Sharma (2004), Shaw (1802), Smith (1943), Stuart and Emmett (2006), Taylor (1965), Teo and Rajathurai (1997), Thompson (1913), Tillack (2006a), Tweedie (1950, 1954), van Rooijen and van Rooijen (2007), Vyas (2007), Wall (1907, 1908a, 1921) Wanger *et al.* (2011), Werner (1925), Whitaker and Captain (2004), Zhao and Adler (1993), Ziegler *et al.* (2007) and Zug *et al.* (1998).

NEW TRIBE BOIGAIINI TRIBE NOV.

(Terminal taxon: *Coluber irregularis* Bechstein, 1802)

Diagnosis: The tribe *Boigaiini* is defined herein as venomous rear fanged generally arboreal "Tree Snakes" or climbing species characterized by a broad head and large often bulbous eyes with a vertically elliptical pupil.

There are solid teeth on both jaws, the prefrontal is in contact with the nasal, the tail is more-or-less cylindrical and pointed, 19-27 mid-body rows, smooth dorsal scales, ventral scales run fully across the belly, the nostrils are usually lateral and the head is covered with large symmetrical shields, undivided anal, except for those species within the genus *Slopboiga gen. nov.* (described herein), divided subcaudals and a loreal on each side of the head.

These snakes are long and thin in build and have a laterally compressed body, the degree of these traits varying with the species.

All are oviparous.

The genus *Slopboiga gen. nov.* described below and within this tribe, conforms to the above description save for the following traits: having a divided anal and a scarcely enlarged vertebral scale series, as well as very short posterior chin shields and numerous small temporals.

Distribution: Africa, southern Asia and through nearby islands to include Australasia.

Content: *Boiga* Fitzinger, 1826, *Dipsadomorphus* Fitzinger, 1843; *Dorisius* Hoser, 2012; *Mulvanyus* Hoser, 2012; *Slopboiga gen. nov.* (this paper); *Toxicodryas* Hallowell, 1857.

NEW GENUS SLOPBOIGA GEN. NOV.**Type species:** *Boiga kraepelini* Stejneger, 1902.

Diagnosis: *Slopboiga gen. nov.* is readily separated from species within the genus *Boiga* Fitzinger, 1826 as defined herein by having a divided anal and a scarcely enlarged vertebral scale series, as well as very short posterior chin shields and numerous small temporals.

The monotypic genus is further defined by the following suite of characters: Anterior palatine teeth enlarged; diameter of eye equals its distance from anterior border of nostril; upper preocular extending to upper surface of head but separated widely from frontal; scales in 21 midbody rows, median row scarcely enlarged; ventrals 232-245; anal plate divided; subcaudals 142-143 all divided; posterior chin-shields much shorter than the anterior; temporals 4-5, scale-like, irregular.

Boiga Fitzinger, 1826 is defined herein as venomous rear fanged generally arboreal "Tree Snakes" or climbing species characterized by a broad head and large often bulbous eyes with a vertically elliptical pupil.

There are solid teeth on both jaws, the prefrontal is in contact with the nasal, the tail is more-or-less cylindrical and pointed, 19-25 mid-body rows, smooth dorsal scales, ventral scales run fully across the belly, the nostrils are usually lateral and the head is covered with large symmetrical shields, undivided anal, divided subcaudals and a loreal on each side of the head.

These snakes are long and thin in build and have a laterally compressed body, the degree of these traits varying between the species. All are oviparous.

I also diagnose the similar genera *Dorisious* Hoser, 2012 and *Mulvanyus* Hoser, 2012 within noting these were formerly placed within *Boiga* and would be included in that genus on the basis of the diagnosis above, in the absence of further information given herein below: *Dorisious* Hoser, 2012 is separated from all other snakes in the genus *Boiga* by the following suite of characters: While it is a relatively long thin snake with a laterally compressed body, sharp vertebral ridge and enlarged head, the snake is more stout and heavily bodied than most other *Boiga* and so is a heavier animal at a given length. In line with the relatively stout build is a lower ventral count of 209-239 ventrals versus 240 or more for other *Boiga* species (and *Mulvanyus* Hoser, 2012).

In *Dorisious* there are 78-110, subcaudals versus over 112 for *Boiga* species (and *Mulvanyus*).

These snakes are unmistakable by their black body with thin, incomplete yellow bands, being orangeish on juveniles, the head is black, supralabials yellow with black etching. The snake attains a maximum total length of about 2.5 metres. In line with other *Boiga*, *Dorisious* retains large eyes, smooth dorsal scales, single anal, all divided subcaudals and has an enlarged vertebral row of scales.

This genus *Dorisious* is presently monotypic for the species *Dorisious dendrophila* (Boie, 1827) including recognized subspecies, however some of the currently recognized subspecies may ultimately prove to be full species.

Mulvanyus Hoser, 2012 are a long vine-like snake with strongly laterally compressed body shape vertebral ridge, large head shields and vertical pupils.

Mulvanyus are separated from snakes of the genus *Boiga* and *Dorisious* by their greatly enlarged and blunt triangular head (distinctly blunt snout) as well as their unusually large and bulbous eyes (even when compared to other *Boiga* species).

There are 19 smooth dorsal mid-body scale rows, 250-285 ventrals, 114-168 divided subcaudals, and a single anal. The body comes in various colors depending on locality and species.

Most specimens of *Mulvanyus* are reddish or brownish with some sort of transverse bands not contacting the ventrals often with irregularly shaped white ventrolateral blotches occurring along the length of the body and tail, and with a brownish head.

Distribution: Taiwan, as well as China (incl. Hainan. westward to Sichuan and Guizhou), North Vietnam and Laos.

Etiology: Named in honor of our Great Dane named "Slop", who has guarded the research facility at Snakebusters, Victoria, Australia from thieves and trolls.

CHRYSOPELEA BOIE, 1826.

Type species: *Coluber Ornatus* Shaw, 1802

Diagnosis: The so-called flying snakes from southern Asia are a distinctive group of usually brightly coloured snakes. An individual snake will glide by using its ridge scales along its belly, pushing against rough bark surfaces of tree trunks, allowing it to move vertically up a tree. Upon reaching the end of a tree's branch, the snake continues moving until its tail dangles from the branch's end. It then makes a J-shape bend, leans forward to select the level of inclination it wishes to travel to control its flight path, as well as selecting a desired landing area. Once it decides on a destination, it propels itself by thrusting its body up and away from the tree, sucking in its stomach, flaring out its ribs to turn its body in a "pseudo concave wing" while simultaneously making a continual swaying movement of lateral undulation more-or-less parallel to the ground to stabilize its direction in midair flight so as to safely land. The combination of sucking in its stomach and making a motion of lateral undulation in the air allows the snake to glide in the air, where it also manages to save energy compared to travel by crawling on the ground and to potentially avoid terrestrial predators. The concave wing that a snake creates in sucking its stomach, flattens its body to up to twice its width from back of the head to the anal vent, which is close to the end of the snake's tail, causes the cross section of the snake's body to resemble the cross section of a flying disc. The cross sectional concavity causes increased air resistance under the centre of the snake, causing lift for the snake to glide (or "fly"). The snake continuously moves in lateral undulation to create an enhanced effect of increased air pressure underneath its arched body to glide. While the ultimate destination of the snake is best predicted by ballistics they do have some control over where they go and land, determined by in air movement.

These snakes are mildly venomous colubrids, not regarded as dangerous to humans.

Five species from the genus have been described, although one of these is only known from a single specimen.

The snakes in this genus are diagnosed as follows:

All are long and slender in build, head wider than the neck. The head shape is spatulate and with a depressed snout. The eyes are large and the pupil is round. There are 9 supralabials with the fourth, fifth and sixth touching the eyes. There are 17 mid-body scale rows and the dorsal scales are smooth, except in the species *taprobanica* where they are keeled (see below). There are 198-234 ventrals, 107-138 subcaudals and the ventral and subcaudal scales have distinctive lateral keels. 20-22 maxillary teeth, 3 and 4 being partly grooved.

Distribution: Southern Asia.

SUBGENUS WELLSSERPENS SUBGEN. NOV.

Type species: *Chrysopelea taprobanica* Smith, 1943.

Diagnosis: This is a monotypic subgenus for the type species. It is similar in most respects to the others in the genus.

However *Wellsserpens subgen. nov.* are most easily separated from other *Chrysopelea* by having the last ventral shield undivided. In all other *Chrysopelea* the last ventral shield is divided.

The species *Wellsserpens taprobanica* has noticeably keeled dorsal scales, unlike in the other species of *Chrysopelea*, where keeling at best is only slight.

Wellsserpens subgen. nov. lack orange or red rosettes, which is diagnostic for all other *Chrysopelea* meaning it does not usually present as such an attractive snake.

The coloration of the species *taprobanica* is unlike that of other *Chrysopelea*. In *Wellserspens* the color is light olive-brown above, with narrow, wavy, black cross-bars; a black spot on each ventral shield outside the lateral keel; subcaudals are not spotted below.

The head is much the same colour as seen in all other *Chrysopelea*.

Distribution: Sri Lanka.

Etymology: Named in honour of Australian taxonomist, Richard Wells, formerly of Cowra, NSW and now of Lismore, NSW, Australia.

Content: *Chrysopelea (Wellserspens) taprobanica* Smith, 1943.

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CONFLICT OF INTEREST

The author has no conflicts of interest in terms of this paper or conclusions within.