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# ***Australasian Journal of Herpetology***



**Viper taxonomy.**

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### ***Australasian Journal of Herpetology***

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**African Adders (*Bitis* Gray, 1842), reviewed, including, two new subgenera, five new species of Puff Adder, all formerly *Bitis arietans* (Merrem, 1820) subspecific division of *Bitis caudalis* (Smith, 1839) and division of the Berg Adders *Bitis atropos* (Linnaeus, 1758) (Serpentes: Viperidae: Bitisini).**

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**ABSTRACT**

In 1999, Lenk *et al.* proposed that the Viper genus *Bitis* Gray, 1842 be split into four subgenera, resurrecting *Macrocerastes* Reuss, 1939 for the *gabonica* group and *Calechidna* Tschudi, 1845 for the *atropos* (Linnaeus, 1758) group. For the species *worthingtoni*, they erected the name *Keniabitis* Lenk *et al.*, 1999. In this paper the subgenus *Calechidna* is split with a new name (*Klosevipera* subgen. nov.), allocated according to the Zoological Code (Ride *et al.* 1999) for the unnamed *B. caudalis* (Smith, 1839) species group.

The Berg Adder, *B. atropos* (Linnaeus, 1758) is split three ways, with one population named as a new species *Bitis* (*Calechidna*) *matteoae* sp. nov. and the taxon *B. atropos unicolor* Fitzimons, 1959 elevated to full species status for the third group.

Within the new subgenus *Klosevipera* subgen. nov., the species *B. caudalis* (Smith, 1839) is divided into three, with the variant from Transvaal, Limpopo and nearby parts of South Africa formally named as *Bitis* (*Klosevipera*) *caudalis swileae* subsp. nov. and the variant from the coastal strip of Namibia formally named as *Bitis* (*Klosevipera*) *caudalis kajerikbulliardi* subsp. nov..

The Puff Adder, *Bitis arietans* (Merrem, 1820), as currently recognized is a widespread True Viper from Africa, found in most parts of the continent, except for wettest and driest parts, as well as the lower Arabian Peninsula. While the type specimen population from South Africa and a regional form from Somalia have taxonomic recognition the other regional forms do not.

This paper defines and describes five other regional variants, in effect meaning that *Bitis arietans* (Merrem, 1820) as commonly known to date has been formally divided into seven regionally allopatric species.

The species *Bitis parviocula* Böhme, 1977, divergent from others within *Macrocerastes* is placed in its own monotypic subgenus *Kuekus* subgen. nov.. The other species within *Macrocerastes* are reviewed in a separate paper (Hoser 2013b), the result being four new taxa formally named.

**Keywords:** Taxonomic revision; African Adders; Viperidae; Bitisini; Puff Adder, *Bitis*; *Calechidna*; *Macrocerastes*; *Keniabitis*; New subgenera; *Klosevipera*; *Kuekus*; *arietans*; *somalica*; new species; *tomcottoni*; *oflahertyae*; *brianwallacei*; *lourenceklosei*; *pintaudii*; *matteoae*; new subspecies; *swileae*; *kajerikbulliardi*.

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**INTRODUCTION**

In the 1980's and 1990's trips by myself to view reptile collections the United States and Europe revealed that a number of African Viper species within the genus *Bitis* Gray, 1842 were composite.

In order to complete a proper revision of the *Bitis* group, I visited Africa in 2009 to view further specimens, both in the wild and captivity and to get further supporting data.

In relation to all my investigations, it came to my surprise that several of the so called "amateur" or private reptile keepers did have a good grasp of many regional forms or "races" of viper species that seemed to be either unknown or unreported in the professional literature.

In other cases, variants were reported in the literature, but not given what appeared to be obvious taxonomic recognition.

Furthermore, my own viewing of regional variants of taxa, in

particular the *Bitis gabonica* (Duméril, Bibron and Duméril, 1854) and *Bitis nasicornis* (Shaw, 1802) species groups yielded consistent regional differences worthy of recognition at the species level.

This paper is a partial result of this broad-ranging review of the genus *Bitis*, and deals with those species groups and species outside of the *B. gabonica* and *B. nasicornis* species groups in most urgent need of taxonomic revision.

In summary the following taxonomic acts are made.

This paper follows on from the position of Lenk *et al.* (1999), by retaining the split of the Viper genus *Bitis* Gray, 1842 into four subgenera, being *Macrocerastes* Reuss, 1939 for the *gabonica* group and *Calechidna* Tschudi, 1845 for the *atropos* group. For the species *worthingtoni*, the name *Keniabitis* Lenk *et al.*, 1999 is adopted.

The subgenus *Calechidna* is however herein split with a new name (*Klosevipera subgen. nov.*), allocated according to the Zoological Code (Ride *et al.* 1999) for the unnamed *B. caudalis* (Smith, 1839) species group.

Within the subgenus, *Calechidna* the Berg Adder, *B. caudalis* is split three ways, with one population named as a new species *Bitis (Calechidna) matteoae sp. nov.*

Within the new subgenus *Klosevipera subgen. nov.*, the species *B. caudalis* (Smith, 1839) is divided into three, with the variant from Transvaal, Limpopo and nearby parts of South Africa formally named as *Bitis (Klosevipera) caudalis swileae subsp. nov.* and the variant from the coastal strip of Namibia formally named as *Bitis (Klosevipera) caudalis kajerikbullardi subsp. nov.*

The Puff Adder, *Bitis arietans* (Merrem, 1820), as currently recognized is a widespread True Viper from Africa, found in most parts of the continent, except for wettest and driest parts as well as the lower Arabian Peninsula. While the type specimen population from South Africa and a regional form from Somalia have taxonomic recognition the other regional forms do not.

This paper defines and describes five other regional variants, in effect meaning that *Bitis arietans* (Merrem, 1820) as commonly known to date has been formally divided into seven regionally allopatric species.

All can be readily separated by pattern differences of the head, which can usually be done without the need to take the risk of physically handling or hand-inspecting the snakes, which may compromise safety for inexperienced handlers.

The species *Bitis parviocula* Böhme, 1977, divergent from others within *Macrocerastes* is placed in its own monotypic subgenus *Kuekus subgen. nov.* The other species within *Macrocerastes* are reviewed in a separate paper published at the same time as this (Hoser 2013b), the result of that review is that four new taxa formally named. This in effect means that there are now six recognized species within the subgenus *Macrocerastes*.

#### NEW SUBGENERA

The African Puff Adder, *Bitis arietans* (Merrem, 1820) is the type species for the true Viper genus *Bitis* Gray, 1842.

Until recently the genus included about 17 described and recognized species, although as already inferred in this paper, the number is clearly an under-estimate.

In 1999, Lenk *et al.* (1999) used molecular data (immunological distances and mitochondrial DNA sequences) to estimate the phylogenetic relationships among species of *Bitis*.

They identified four major monophyletic groups within the genus *Bitis sensu lato*. As a result they resurrected the generic names *Macrocerastes* Reuss, 1939 for the *gabonica* group and *Calechidna* Tschudi, 1845 for the *atropos* group.

For the species *worthingtoni*, they erected the name *Keniabitis* Lenk *et al.*, 1999.

All generic names were used to place each group as subgenera.

Hence their species groups for each subgenus were as follows: *Bitis* Gray, 1842, for *B. arietans* (Merrem, 1820):

*Macrocerastes* Reuss, 1939, for *Bitis gabonica* (Duméril, Bibron and Dumeril, 1854), *Bitis nasicornis* (Shaw, 1802), *Bitis parviocula* Böhme, 1977, and *Bitis rhinoceros* (Schlegel, 1855): *Calechidna* Tschudi, 1845, for *Bitis albanica* Hewitt, 1937, *Bitis armata* (Smith, 1826), *Bitis atropos* (Linnaeus, 1758), *Bitis caudalis* (Smith, 1839), *Bitis cornuta* (Daudin, 1803), *Bitis heraldica* (Bocage, 1889), *Bitis inornata* (Smith, 1838), *Bitis peringueyi* (Boulenger, 1888), *Bitis rubida* Branch, 1997, *Bitis schneideri* (Boettger, 1886) and *Bitis xeropaga* Haacke, 1975: *Keniabitis* Lenk *et al.*, 1999, for *Bitis worthingtoni* Parker, 1932.

Of *Calechidna*, Lenk *et al.* said "an apparent evolutionary diversification into two morphological / genetic groups may justify the separation of two subgenera", has been confirmed by studies since then (e.g. Pyron *et al.* 2013). As a result of this increased body of evidence, the subgenus *Calechidna* is split with a new name allocated according to the Zoological Code (Ride *et al.* 1999) for the unnamed species group, this being the so-called *caudalis*-group, herein named *Klosevipera subgen. nov.*

The species *Bitis parviocula* Böhme, 1977, is known from only a handful of specimens (Phelps, 2010), with a distribution centred on the mountains of Southern Ethiopia.

Physically and in habit, the species is widely divergent from the other species within *Macrocerastes* as defined by Lenk *et al.* 1999, this subgenus otherwise including the morphologically similar to one another *Bitis gabonica* and *B. nasicornis* species complexes.

Lenk *et al.* placed this taxon in the subgenus on the basis of the following:

"*Bitis parviocula* is included only tentatively as its extent of nasal-rostral separation is similar to *Macrocerastes* spp. Its allocation was not verified osteologically or biochemically."

After diagnosing the physical attributes of the group of species, Lenk *et al.* wrote: "restricted to wet forest areas of tropical Africa".

I however disagree with Lenk *et al.* on some critically important points.

They used the words "nasal-rostral separation is similar" as a basis for the inclusion of the species *Bitis parviocula*, but my review finds this somewhat misleading. Fact is that by any reasonable viewing of a number of specimens from the *Bitis gabonica* and *B. nasicornis* species groups versus *Bitis parviocula* the inescapable conclusion is that by scale count, the naso-rostral separation is less for the latter species. In terms of the physical difference in distance between the nostril itself and the rostral scale, this would be expected to be similar in view of the fact that both are terrestrial species in the same genus.

Lenk *et al.*'s statement that the subgenus is "restricted to wet forest areas of tropical Africa" is also in my view potentially misleading as it implies all species have near identical climate and habitat preferences, which is in fact not the case.

Fact is the species *Bitis parviocula* is known only from montane grassland and adjacent human plantations and forests in a relatively cool high elevation region (2,000-3,000 metres above sea level).

This is not the same preferred habitat of the other taxa within the subgenus.

Their preferred habitat is humid, warm lowland forests and the like and most definitely not high altitude areas.

While there are obvious physical similarities between the species *B. parviocula* and the others in the subgenus *Macrocerastes* the differences in form, as well as habit, are in my view sufficient to warrant the removal of this species from that subgenus.

It is therefore placed in its own monotypic subgenus *Kuekus subgen. nov.* formally defined below.

**THE BERG ADDER *BITIS ATROPOS* (LINNAEUS, 1758).**

The Berg Adder is an icon species within southern Africa, being sought after by herpetologists. In 2009, I took great pleasure climbing mountains north-east of Cape Town, South Africa searching for these snakes on sunny days in the spring.

For many years the regional variants identified as this species have been well known.

There are three well-known populations, being:

The nominate form (*B. atropos*) (type locality Cape of Good Hope; see McDiarmid *et al.* 1999), usually grey in dorsal body colour distributed across the southern Cape area of South Africa:

A usually reddish form (*B. unicolor* Fitzimons, 1959) (type locality, Witpoort, about 20 miles north of Belfast, eastern Transvaal) from the North-east of South Africa, and,

A usually reddish form (to date unnamed) from the highlands bordering Zimbabwe and Mozambique.

The taxonomy of the three forms has been somewhat unstable (see Phelps 2010, p. 284 for example) due in part to an apparent inability by herpetologists to quantify differences between the three visibly different forms that are widely separated by regions the snakes are absent from.

By way of example for what Fitzimons described as *Bitis atropos unicolor* the diagnosis was:

"Head scaling somewhat similar to that in typical *atropos*, but less strongly keeled and, over back of head, not so markedly elongate; outermost row of scales on body practically smooth anteriorly and but feebly keeled posteriorly; almost uniformly khaki to reddish brown above and apparently a smaller snake than typical *atropos*." (Uetz, 2013).

The problem with the diagnosis for the *unicolor* taxon was that no direct measurable comparison between this taxon and the nominate form was given. To make things more confusing for herpetologists is the little known fact that the difference between a grey snake and red one can be as simple as one single allele on a single chromosome (Hoser, 1985).

This is hardly enough to be able to define a given species, especially when both red and grey alleles may be in a given population.

Overlooked however has been the consistent colour pattern differences between specimens within each of the three populations identified above and it is these that can be used to reliably separate the taxa and without need to compare specimens of each taxon at the same time.

As a result, I herein redefine the three populations herein as full species according to the Zoological Code, assigning the species name "*matteoae*" to the previously unnamed population.

**THE HORNED ADDER *BITIS CAUDALIS* (SMITH, 1839).**

The wide-ranging and regionally variable species taxon *Bitis caudalis* (Smith, 1839), has until now been recognized as a single species taxon. That is, no subspecies have been formally named. This is surprising due to the fact that regional races have been known for many years with most herpetologists readily identifying specimens by colour and location.

The fact that scale counts between regions overlap and base background colour seems to be the result of a "rinse", controlled by only one or a few genes, means that obvious differences between specimens do not necessarily indicate taxonomic difference.

However in the wild state, there is little evidence of any long-distance movements between populations and therefore it is reasonable to conclude that each major grouping should be recognized at the subspecies level. This is especially when one notes that in spite of other character overlaps, patterning on the head and body does in fact vary consistently between regional populations and can therefore be used as a simple basis to taxonomically identify different populations.

While there is little if any evidence of hybridization between regional morphs, with the possible exception of the region at the south-west edge of the Kalahari Desert, I have taken a conservative position and dissected the species three-ways, hereby naming two divergent populations as subspecies.

The holotype for the species "*Vipera caudalis* Smith, 1839" came from an unidentified region north of the Cape Colony, listed as "sandy districts north of the Cape Colony". However in the absence of accurate locality data the provenance of the specimen is known with a reasonable degree of certainty.

The specimen accords closely with the reddish-coloured form from the Kalahari Desert and nearby areas, including all of Botswana, the western part of Namibia, including the Namibia Plateau, inland parts of northern South Africa in the west, including around Namaqualand and into Zimbabwe.

The two unnamed forms are the more drab varieties. The first is the sandy to dark olive-brown or grey form from the higher regions in the north east of South Africa, including most of Limpopo, Mpumalanga and Guateng, and the sandy-coloured, greyish to buff form from the coastal strip of Namibia from the Angola border and into the north of South Africa, extending inland in the north to include the area around the Etosha Pan, Namibia.

Thus the outcome of this paper in this regard is that the species *B. caudalis* (Smith, 1839) is divided into three, with the variant from Transvaal, Limpopo and nearby parts of South Africa formally named as *Bitis (Klosevipera) caudalis swileae* subsp. nov. and the variant with a distribution centred on the coastal strip of Namibia formally named as *Bitis (Klosevipera) caudalis kajerikbulliardi* subsp. nov.

**THE PUFF ADDERS *BITIS ARIETANS* (MERREM, 1820).**

This paper also forms the culmination of a study of the *Bitis arietans* species group undertaken during a visit to Africa in 2009 and via data collection since. An illegal armed raid on my Melbourne, Australia facility on 17 August 2011 resulted in the loss of images, records and an early draft of this paper and delayed publication of this paper by almost two years.

The Puff Adder, *Bitis arietans* (Merrem, 1820), as currently recognized is a widespread True Viper from Africa, found in most parts of the continent, except for wettest and driest parts, as well as the lower Arabian Peninsula.

This range includes most of sub-Saharan Africa south to the Cape of Good Hope, including southern Morocco, Mauritania, Senegal, Mali, southern Algeria, Guinea, Sierra Leone, Ivory Coast, Ghana, Togo, Benin, Niger, Nigeria, Chad, Sudan, Cameroon, Central African Republic, northern, eastern and southern Democratic Republic of the Congo, Uganda, Kenya, Somalia, Rwanda, Burundi, Tanzania, Angola, Zambia, Malawi, Mozambique, Zimbabwe, Botswana, Namibia, South Africa. The taxon as recognized also occurs on the Arabian Peninsula, where it is found in southwestern Saudi Arabia, Oman and Yemen.

The type specimen is from South Africa and one regional form is also recognized taxonomically, namely *Bitis arietans somalica* Parker, 1949.

However the most divergent form, that which is found on the Arabian Peninsula, has not been formally recognized taxonomically.

This paper defines and describes this taxon as a new species, *Bitis tomcottoni* sp. nov. in accordance with the Zoological Code as well as four other distinct regional forms on the basis of consistent phenotypic differences based on the inspection of over 100 live specimens and more than 300 images of specimens with accurate locality data from relevant locations at the species level.

Recent molecular studies on these snakes (*Bitis arietans sensu lato*) from across Africa and the Arabian Peninsula have indicated several clades warranting specific recognition (Barlow

*et al.* 2013) and these species as diagnosed here broadly conform to the clades defined by Barlow *et al.* (2013) as indicated herein.

However I should note that the diagnosis of these species groups was obtained prior to the publication of (Barlow *et al.* 2013), of which I was unaware of until after publication.

By way of example, the geological history of the Arabian Peninsula has been known from some time and that the local population of *Bitis arietans sensu lato* must have been isolated from the others from Africa is a matter of simple logic, noting the snakes in this genus cannot cross large bodies of water by swimming or rafting. The divisions of the other biomes within Africa as centres for diversification are also well known (see for example, Bosworth *et al.* (2005), Chorowicz (2005), Davison *et al.* (1994), Ghebreab (1998), Šmíd *et al.* (2013) and sources cited therein).

This is all noted as one of the listed co-authors of Barlow *et al.* (2013) is the serial truth-hater and taxonomic vandal Wolfgang Wüster, who will most likely make the stupid claim that this paper is "evidence free" (see for example Kaiser *et al.* (2013), of which Wüster was clearly the main instigator) and advocate a global boycott of the use of the names proposed within it. Of course such a claim must by logical deduction mean both the sources just cited and their own paper Barlow *et al.* (2013) are also "evidence free".

In terms of Barlow *et al.* (2013), I have ethically cited the date timeline they proposed from within that paper (noting it does in fact match the geological data) and other data they obtained that corroborates my own general position, as I do not commit the act of plagiarism as does Wüster, or be seen to do so, and while citing the data from that paper, I do note that it had no bearing on the conclusions within this paper other than as perhaps adding weight to the conclusions and confirming that Wüster himself has publicly co-published findings consistent with the taxonomy I propose herein.

However I must stress that in the absence of firm evidence from other sources, I would never be placing any faith in material that may potentially have been generated by Wüster alone, noting his previous acts of fabrication and fraud (see Hoser, 2012a and Hoser 2013a for some of many examples).

As a result of previously published material (as cited herein), *Bitis arietans somalica* Parker, 1949 is herein elevated to full species status.

It is according to these sources, separated from other all other *Bitis arietans (sensu lato)* by their subcaudal scales, which are distinctly keeled in *Bitis somalica* and not in other African or Arabian *Bitis arietans* (Spawls and Branch 1995).

#### KEY RELEVANT LITERATURE

Key published studies relevant to the taxonomy of the genus *Bitis sensu lato* and *Bitis arietans* as generally recognized as of 2013 and including the species taxa defined herein include and relied upon in whole or in part to support the taxonomic judgements within this paper include: Barlow *et al.* (2012, 2013), Boulenger (1897), Branch (1999a, 1999b), Broadley and Howell (1991), Broadley and Parker (1976), Chiririo and Ineich (2006), Chiririo and Lebreton (2007), Egan (2007), Geniez *et al.* (2004), Girard (1998), Hoser (1985, 2012b, 2013a, 2013b), Largen and Spawls (2010), Linder *et al.* (2012), Loveridge (1929, 1936), Menzies (1966), Merrem (1920), Pauwels (2002), Pitman (1974), Pook *et al.* (2009), Razzetti and Msuya (2002), Spawls and Branch (1995), Schleich *et al.* (1996), Spawls *et al.* (2001), Pyron *et al.* (2011, 2013), van der Kooij (2001), and sources cited therein.

Additional key published studies in relation to the taxonomy of the snakes of the subgenus *Klosevipera* as defined herein additionally include: Auerbach (1987), Barts (2004), Bauer and Branch (1993), Bauer *et al.* (2003), Boettger (1886), Boulenger (1888), Branch (1993), Broadley (1959), Calvete *et al.* (2007), Conradie *et al.* (2011), Dobiey and Vogel (2007), Douglas

(1981), Duméril *et al.* (1854), Fitzsimons and Brain (1958), Herrmann *et al.* (1999), Lenk *et al.* (1999), Loveridge (1936), Mallow *et al.* (2003), Marias (2004), Mattison (2007), McDiarmid *et al.* (1999), Mertens (1954), Phelps (2010), Robinson and Hughes (1978), Šmíd *et al.* (2013), Smith (1838, 1839, 1849), Sternfeld (1910), Wagner and Wilms (2010), and sources cited therein.

The body of published literature in terms of the *B. gabonica* and *B. nasicornis* species group is vast and summarized in a separate paper (Hoser 2013b).

Additional key published studies or accounts in relation to the taxonomy of *B. parviocula* Böhme, 1976 include, Böhme (1977) and Spawls (1994).

Additional references relevant to the taxonomy of *B. atropos* and including the taxa, *B. unicolor* and *B. matteoae sp. nov.* as identified herein include: Anonymous (1984), Botha (1986), Boycott (1992), Broadley (1962), Fitzsimons (1959), Linnaeus (1758), Smith (1826), Ulber (1995) and sources cited therein.

Below is (in order) the following is published: A formal description of the subgenus *Klosevipera subgen. nov.*, then a redescription of *Calechidna Tschudi*, 1845, then followed by dissection of *Bitis (Calechidna) atropos* into three species and then *Bitis (Klosevipera) caudalis* Smith, 1839 into three subspecies, all formally described and named (including the nominate forms redescribed as required for clarity).

Following this is the dissection of *Bitis arietans* (Merrem, 1820) as currently known into a total of seven species (two with pre-existing and available names), the division based on consistent morphological differences and pattern traits of the relevant snakes which in fact corroborates with the molecular data published by a number of studies (e.g. Barlow *et al.* 2013 and others).

While each species is diagnosed in its own right, each description should be read in conjunction with the others here in order to make a full diagnosis, thereby eliminating possible (mis) identifications of similar taxa.

#### THE BERG ADDER *BITIS ATROPOS* (LINNAEUS, 1758).

**Type locality:** Cape of Good Hope (Fitzsimons 1962).

**Diagnosis:** *Bitis atropos* and the other two species described herein and formerly treated as *B. atropos* have the following traits in common:

All are small species of Adder (Viper) averaging between 35-50 cm in total length. Colour and markings are variable, but there are features unique to each species described herein. The scalation is similar between each of the regional taxa and are as follows: Body scales are strongly keeled and most pointed on the top of the head, which is elongate for a viper, but still distinct from the neck which is usually half to two thirds as wide. There are 25-33 dorsal mid-body scale rows, 118-144 ventrals and 15-31 divided subcaudals. There are 10-16 scales around the eye, 9-13 upper labials and 10-16 lower labials.

The three species formerly treated as *Bitis atropos* are best identified by colouration differences and can be identified by one of the following three sets of traits:

1/ *Bitis atropos* is greyish to dark brown or black in dorsal colour. There is a silvery-white dorsolateral line on either side from behind the head to the tail, which completely divides the large dorso-lateral blotches on either side of this line (diagnostic for this species), in effect meaning that each row of such blotches running down either side of the spine is in fact a pair of rows.

Hence each row of blotches presents as follows: Above each line is a series of dark subtriangular to semicircular pale-edged markings and below these are a series of similar but usually slightly smaller markings. These markings are in a geometric pattern but of somewhat irregular outline, being etched by lighter scales. The lighter background colour is of similar intensity dorsally and on the flanks.

The head has a dark arrow-shaped mark on the crown and two

pale stripes on either side both being of irregular, but symmetrical outline.

The venter is off-white to dark grey with dusky infusions, or less often slate-grey to black.

In *B. atropos*, *B. unicolor* and *B. matteoae sp. nov.* there is a white patch on each side of the snout occupying the upper labials (usually at the fourth labial) and extending to the adjoining scales, in turn surrounded by coloured pigmented scales. In both *B. atropos* and *B. unicolor* this patch is noticeably higher than wide (taken from the widest point) whereas in *B. matteoae sp. nov.* the patch is as wide as high (taken from the widest point), or:

2/ *Bitis unicolor* Fitzsimons, 1959 is reddish or orangeish in dorsal colour. *B. unicolor* is diagnosed by the faint dorsal markings (as opposed to strong the other two species), although the (indistinct) dorsal pattern is the same for this species as seen in *B. atropos*.

Due to the colour rinse (red versus grey) in this taxon, the ventral colouration is also different, being off-white to pinkish with dusky infusions or less often salmon pink to red.

In *B. atropos*, *B. unicolor* and *B. matteoae sp. nov.* there is a white patch on each side of the snout occupying the upper labials (usually at the fourth labial) and extending to the adjoining scales, in turn surrounded by coloured pigmented scales. In both *B. atropos* and *B. unicolor* this patch is noticeably higher than wide (taken from the widest point) whereas in *B. matteoae sp. nov.* the patch is as wide as high (taken from the widest point).

Additionally, Fitzsimons diagnosed *B. unicolor* as follows: "Head scaling somewhat similar to that in typical *atropos*, but less strongly keeled and, over back of head, not so markedly elongate; outermost row of scales on body practically smooth anteriorly and but feebly keeled posteriorly; almost uniformly khaki to reddish brown above and apparently a smaller snake than typical *atropos*."

or:

3/ The species *B. matteoae sp. nov.* in common with *unicolor* is reddish in colour (usually, but not always) and in common with *B. atropos* has distinct markings.

In the species *B. matteoae sp. nov.* there is not a silvery-white, or whiteish dorsolateral line on either side from behind the head to the tail. Instead each large dorsolateral blotch (broken by the line in the other two species) in fact presents as a single blotch and each in turn is separated by normal lighter scales as opposed to being joined by the dorsolateral lines (as seen in the other two species). The patterning just described for *B. matteoae sp. nov.* applies for the first 2/3 of the body length.

In *B. matteoae sp. nov.* the dorsolateral blotches are nearly rectangular at the forebody and for the first 2/3 of the body, as opposed to being broken diamonds or triangles (as split) in the other two species.

The darker blotches are medium to dark brown in colour (etched with orangeish brown), with creamy white patches in the centre of each blotch and the lighter areas of the upper body are a beige colour.

The last third to quarter of the snake's length is similar to the other two species in that a pair of white dorsolateral lines form that breaks the dark dorsolateral blotches.

In summary, *B. matteoae sp. nov.* is alternatively defined by the following: Well defined white blotches within the dark brown dorso-lateral blotches on the first two thirds of the body, forming a pair of whitish dorso-lateral stripes at the rear of the body. A similar pattern sometimes seen in *B. atropos* on a greyish background or with orange edged dark blotches has the same spots being in the form of broken lines to break up each of the dorsolateral spots (into two) and of similar grey colour to the rest of the dorsum of the snake. There are no such lines or patches in the taxon *unicolor*.

In *B. atropos*, *B. unicolor* and *B. matteoae sp. nov.* there is a white patch on each side of the snout occupying the upper labials (usually at the fourth labial) and extending to the adjoining scales, in turn surrounded by coloured pigmented scales. In both *B. atropos* and *B. unicolor* this patch is noticeably higher than wide (taken from the widest point) whereas in *B. matteoae sp. nov.* the patch is as wide as high (taken from the widest point).

Due to the colour rinse (red or grey) in this taxon, the ventral colouration is one of any of the following: Off-white to dark grey with dusky infusions, or less often slate grey to black, or alternatively off-white to pinkish with dusky infusions or less often salmon pink to red.

*B. matteoae sp. nov.* and *B. atropos* are separated from *B. unicolor* by the fact that the dark patch posterior to the eye on the top of the head is separated by lighter scales from a second dark area that extends to the back of the head or neck. In *B. unicolor* these patches are merged to form a single darker area.

**Distribution:** *B. atropos* is found on the southern part of the Cape of Good Hope, South Africa in hilly areas close to the coast.

**BITIS UNICOLOR FITZSIMONS, 1959.**

**Type locality:** Witpoort, about 20 miles north of Belfast, eastern Transvaal, South Africa.

**Diagnosis:** See the preceding diagnosis for *B. atropos* (Linnaeus, 1758), which diagnoses this taxon as well, being incorporated in the same diagnosis.

**Distribution:** North-east South Africa.

**BITIS MATTEOAE SP. NOV.**

**Holotype:** A specimen number: M 1702 at the National Museum of South Africa at Bloemfontein, South Africa. The snake is a 347 mm total length (310 SV) male collected from the Chinanimani Mountains in Zimbabwe, Southern Africa. The National Museum of South Africa at Bloemfontein, South Africa is a government-owned facility that allows access to its specimens by researchers.

**Paratype 1:** A specimen number: M 1704 at the National Museum of South Africa at Bloemfontein, South Africa. The snake is a 288 mm total length (268 SV) female collected from the Chinanimani Mountains in Zimbabwe, Southern Africa. The National Museum of South Africa at Bloemfontein, South Africa is a government-owned facility that allows access to its specimens by researchers.

**Paratypes 2-3:** Specimen numbers: M 1701 and M1703 at the National Museum of South Africa at Bloemfontein, South Africa, collected from the Chinanimani Mountains in Zimbabwe, Southern Africa. The National Museum of South Africa at Bloemfontein, South Africa is a government-owned facility that allows access to its specimens by researchers.

**Diagnosis:** *Bitis matteoae sp. nov.* and the other two species described herein and formerly treated as *B. atropos* have the following traits in common:

All are small species of Adder (Viper) averaging between 35-50 cm in total length. Colour and markings are variable, but there are features unique to each species described herein. The scalation is similar between each of the regional taxa and are as follows: Body scales are strongly keeled and most pointed on the top of the head, which is elongate for a viper, but still distinct from the neck which is usually half to two thirds as wide. There are 25-33 dorsal mid body scale rows, 118-144 ventrals and 15-31 divided subcaudals. There are 10-16 scales around the eye, 9-13 upper labials and 10-16 lower labials.

The three species formerly treated as *Bitis atropos* are best identified by colouration differences and can be identified by one of the following three:

1/ *Bitis atropos* is greyish to dark brown or black in dorsal

colour. There is a silvery-white dorsolateral line on either side from behind the head to the tail, which completely divides the large dorso-lateral blotches on either side of this line (diagnostic for this species), in effect meaning that each row of such blotches running down either side of the spine is in fact a pair of rows.

Hence each row of blotches presents as follows: Above each line is a series of dark subtriangular to semicircular pale-edged markings and below these are a series of similar but usually slightly smaller markings. These markings are in a geometric pattern but of somewhat irregular outline, being etched by lighter scales. The lighter background colour is of similar intensity dorsally and on the flanks.

The head has a dark arrow-shaped mark on the crown and two pale stripes on either side both being of irregular, but symmetrical outline.

The venter is off-white to dark grey with dusky infusions, or less often slate grey to black.

In *B. atropos*, *B. unicolor* and *B. matteoae sp. nov.* there is a white patch on each side of the snout occupying the upper labials (usually at the fourth labial) and extending to the adjoining scales, in turn surrounded by coloured pigmented scales. In both *B. atropos* and *B. unicolor* this patch is noticeably higher than wide (taken from the widest point) whereas in *B. matteoae sp. nov.* the patch is as wide as high (taken from the widest point), or:

2/ *Bitis unicolor* Fitzsimons, 1959 is reddish or orangeish in dorsal colour. *B. unicolor* is diagnosed by the faint dorsal markings (as opposed to strong the other two species), although the (indistinct) dorsal pattern is the same for this species as seen in *B. atropos*.

Due to the colour rinse (red versus grey) in this taxon, the ventral colouration is also different, being off-white to pinkish with dusky infusions or less often salmon pink to red.

In *B. atropos*, *B. unicolor* and *B. matteoae sp. nov.* there is a white patch on each side of the snout occupying the upper labials (usually at the fourth labial) and extending to the adjoining scales, in turn surrounded by coloured pigmented scales. In both *B. atropos* and *B. unicolor* this patch is noticeably higher than wide (taken from the widest point) whereas in *B. matteoae sp. nov.* the patch is as wide as high (taken from the widest point).

Additionally, Fitzsimons diagnosed *B. unicolor* as follows: "Head scaling somewhat similar to that in typical *atropos*, but less strongly keeled and, over back of head, not so markedly elongate; outermost row of scales on body practically smooth anteriorly and but feebly keeled posteriorly; almost uniformly khaki to reddish brown above and apparently a smaller snake than typical *atropos*."

or:

3/ The species *B. matteoae sp. nov.* in common with *unicolor* is reddish in colour (usually, but not always) and in common with *B. atropos* has distinct markings.

In the species *B. matteoae sp. nov.* there is not a silvery-white, or whiteish dorsolateral line on either side from behind the head to the tail. Instead each large dorsolateral blotch (broken by the line in the other two species) in fact presents as a single blotch and each in turn is separated by normal lighter scales as opposed to being joined by the dorsolateral lines (as seen in the other two species). The patterning just described for *B. matteoae sp. nov.* applies for the first 2/3 of the body length.

In *B. matteoae sp. nov.* the dorsolateral blotches are nearly rectangular at the forebody and for the first 2/3 of the body, as opposed to being broken diamonds or triangles (as split) in the other two species.

The darker blotches are medium to dark brown in colour (etched with orangeish brown), with creamy white patches in the centre of each blotch and the lighter areas of the upper body are a beige colour.

The last third to quarter of the snake's length is similar to the other two species in that a pair of white dorsolateral lines form that breaks the dark dorsolateral blotches.

In summary, *B. matteoae sp. nov.* is alternatively defined by the following: Well defined white blotches within the dark brown dorso-lateral blotches on the first two thirds of the body, forming a pair of whitish dorso-lateral stripes at the rear of the body. A similar pattern sometimes seen in *B. atropos* on a greyish background or with orange edged dark blotches has the same spots being in the form of broken lines to break up each of the dorsolateral spots (into two) and of similar grey colour to the rest of the dorsum of the snake. There are no such lines or patches in the taxon *unicolor*.

In *B. atropos*, *B. unicolor* and *B. matteoae sp. nov.* there is a white patch on each side of the snout occupying the upper labials (usually at the fourth labial) and extending to the adjoining scales, in turn surrounded by coloured pigmented scales. In both *B. atropos* and *B. unicolor* this patch is noticeably higher than wide (taken from the widest point) whereas in *B. matteoae sp. nov.* the patch is as wide as high (taken from the widest point). Due to the colour rinse (red or grey) in this taxon, the ventral colouration is one of any of the following, off-white to dark grey with dusky infusions, or less often slate grey to black, or alternatively off-white to pinkish with dusky infusions or less often salmon pink to red.

*B. matteoae sp. nov.* and *B. atropos* are separated from *B. unicolor* by the fact that the dark patch posterior to the eye on the top of the head is separated by lighter scales from a second dark area that extends to the back of the head or neck. In *B. unicolor* these patches are merged to form a single darker area.

Recorded scale counts for *B. matteoae sp. nov.* are within the ranges reported for *B. atropos*, and are: 29-31 dorsal midbody scale rows, 121-134 ventrals, single anal, 18-25 divided subcaudals, 11-12 upper labials.

**Distribution:** Eastern Zimbabwe at high altitude in the Chimanimani Mountains and Inyanga District.

**Etymology:** Named in honour of Catherine Matteo of Hawthorn, Victoria, Australia, for numerous contributions to herpetology in Australia and elsewhere, including through logistical and IT support for myself, the reptile education business Snakebusters and similar unpaid for assistance's for others working for public benefit causes.

#### **KLOSEVIPERA SUBGEN. NOV.**

**Type species:** *Vipera caudalis* Smith, 1839.

**Diagnosis:** All are small to medium Vipers, maximum length of 750 mm, but usually much less; no anterolateral pocket in the (right) lung. A gap is present between the heart and liver. Angular and splenial bones are united in a single, much reduced bone lacking a close approach to the dentary (Groombridge 1980), which is as for the subgenus *Calechidna* Tschudi, 1845.

The subgenus *Klosevipera subgen. nov.* is separated from *Calechidna* Tschudi, 1845 by one or other of the following three suites of characters:

A/ 21-31 keeled dorsal mid-body scale rows, 120-155 ventrals, single anal plate and 16-40 divided subcaudals; 10-14 supralabials with none entering the orbit; 9-18 scales around the eye and 10-15 lower labials, usually but not always with a prominent horn above each eye. Variable colour ranging through shades of grey, brown and olive brown. There are 3 series of spots; a median row of dark brown to blackish elongate quadrangular blotches, which may or may not be pale edged and pale centered; this being flanked by two dorsolateral rows of smaller dark blotches which are usually pale centered and sometimes pale edged. Females are less colourful than males and often have indistinct markings. The top of the head has a U-shaped or hour-glass marking. Dark bars may extend from the eye to the angle of the jaw. Below it is uniform white to buff or yellowish white, usually with scattered dark markings on the chin or throat (*B. caudalis*), or:



B/ 23-31 keeled dorsal mid-body scale rows, 117-144 ventrals, single anal plate and 15-30 divided subcaudals; 10-14 supralabials; 10-13 scales around the eye and 10-13 lower labials. Dorsally the colour is orange-brown to pale sandy brown or grayish black spots; the spots on the sides are often pale centred. Most of the body has faint irregular stippling. The venter is uniform white or white with dark reddish brown spots on the sides. The tip of the tail may be black. Eyes on the top of the head, as opposed to being on the side of the head (*B. peringueyi*), or:

C/ 21-27 keeled dorsal mid-body scale rows, 104-129 ventrals, single anal plate and 17-27 divided or single subcaudals; 9-13 supralabials; 14-18 scales around the eye and 9-15 lower labials. Dorsally the colour is grey to brownish grey with 3 series of dark brown to black but pale-centered blotches right down the back. The back is speckled and the belly grayish to dirty yellow, speckled with black. Where found in red sand regions the body may be orange-red. The tip of the tail is often dark. Eyes are on the side of the head as opposed to being on top and has a rounded flat head with slightly raised scales (*B. schneideri*).

**Distribution:** Confined to southern Africa.

**Etymology:** Named in honour of Lourence Klose, of Blouberg Sands, Cape Town, South Africa in recognition for his excellent work with reptiles in Africa, including with taxa as diverse as Cobras (*Uraeus* and *Spracklandus*), Vipers (*Bitis*), Mambas (*Dendroaspis*), and other venomous taxa.

**Content:** *Bitis (Klosevipera) caudalis* (Smith, 1839) (type species); *B. (Klosevipera) peringueyi* (Boulenger, 1888); *B. (Klosevipera) schneideri* (Boettger, 1886).

#### SUBGENUS CALECHIDNA TSCHUDI, 1845.

**Type species:** *Coluber Atropos* Linnaeus, 1758.

**Diagnosis:** Small to medium Vipers, maximum length of 750 mm, but usually much less; no anterolateral pocket in the (right) lung. A gap is present between the heart and liver. Angular and splenial bones are united in a single, much reduced bone lacking a close approach to the dentary (Groombridge 1980).

See the diagnosis for *Klosevipera subgen. nov.* preceding this diagnosis in order to separate *Calechidna* from that subgenus.

**Distribution:** Confined to southern Africa.

**Content:** *Bitis (Calechidna) atropos* (Linnaeus, 1758) (type species); *B. albanica* Hewitt, 1937; *B. (Calechidna) armata* (Smith, 1826); *B. (Calechidna) cornuta* (Daudin, 1803); *B. (Calechidna) heraldica* (Bocage, 1889); *B. (Calechidna) inornata* (Smith, 1838); *B. (Calechidna) xeropaga* Haacke, 1975; *B. (Calechidna) rubida* Branch, 1997.

#### BITIS (KLOSEVIPERA) CAUDALIS (SMITH, 1839).

**Diagnosis:** 21-31 keeled dorsal mid-body rows, 120-155 ventrals, single anal plate and 16-40 divided subcaudals; 10-14 supralabials with none entering the orbit; 9-18 scales around the eye and 10-15 lower labials, usually but not always with a prominent horn above each eye. Variable colour ranging through shades of sandy yellow, grey, brown, red, orange, buff and olive brown, although in the nominate subspecies generally orangeish or red in base colour. There are 3 series of spots; a median row of dark brown to blackish elongate quadrangular blotches or patches, which may or may not be pale edged and pale centered; this being flanked by two dorsolateral rows of smaller dark blotches which are usually pale centered and sometimes pale edged. In the nominate form and *B. caudalis kajerikbulliardi subsp. nov.* the median row of blotches extend to the flanks, but this is not the case in *B. caudalis swilae subsp. nov.*

Females are usually less colourful than males and often have relatively indistinct markings. The top of the head has various markings that vary between individuals, but usually includes a U-shaped or hour-glass marking based on the rear of the skull, or alternatively a dark bar between the eyes and a semicircle of dark at the back of the head. Dark bars extend from the eye to the angle of the jaw, one from the front of the eye, down and the

rear one as a triangle shape from the rear of the eye to include most of the rear labials to the back of the jawline. In some specimens of the nominate race, one or two extra dark bars running up from the labials may be seen, giving a total of up to four. The venter in this taxon (including all subspecies) is uniform white to buff or yellowish white, usually with scattered dark markings on the chin or throat.

The nominate form just described is separated from the two newly described subspecies as follows:

The subspecies *B. caudalis kajerikbulliardi subsp. nov.* is typically, sandy, brownish-grey or a buff ground colour as viewed at a distance, in contrast to the nominate form which is invariably, orange or red in ground colour with markings that blend into this colour at a distance.

In the subspecies *B. caudalis kajerikbulliardi subsp. nov.* the dark markings on the top and side of the head differ consistently from those in the nominate form. In *B. caudalis kajerikbulliardi subsp. nov.* there are two thick dark "lines" running from the eye to the labials. The anterior one is set to the front of the eye and relatively even in width. Behind this is formed a lighter area in an inverted "U-shape" above the labials, or sometimes a "Y-shape" but not reaching the eye. This is followed by an elongated triangular patch running to the eye from the labials, and with a base occupying the labials to the back of the jawline. This patch merges with the dark strip anterior to this and below the front part of the eye, meaning no lighter pigment reaches the lower orbit. Behind the second dark patch is another light area, occupying the back/side area of the skull, but not the dorsal area, which is occupied in the immediately adjacent area by dark scales.

In the nominate form, the dark scaled area at the rear of the top of the skull is seen on the upper side of the head when viewed from side on. This is not the case in *B. caudalis kajerikbulliardi subsp. nov.*, where instead the darker area noticeably curves in (concave) to prevent this view.

In *B. caudalis swilae subsp. nov.* the darker area at the rear of the head/skull is so reduced as to prevent it being seen when the head is viewed side on.

In the nominate form the first dark strip running between the front of the eye and the labials is usually broken to create two such bars or blotches, where only one is seen in *B. caudalis kajerikbulliardi subsp. nov.* However some specimens of the nominate form do not have such a split of first dark strip running between the front of the eye and the labials, but these specimens invariably have some lighter scales at the point of such a split on the labials (at the centre of the bar), these scales with lightening along the split line being obvious at a glance.

In aberrant specimens of the nominate form, including the holotype of the nominate form, a similar split occurs in the rear dark band, in effect creating four such "bars" where only two would otherwise be present.

The subspecies *B. caudalis kajerikbulliardi subsp. nov.*, *B. caudalis swilae subsp. nov.* and the nominate form have an average of 24-28 darker cross-bands or blotches on the dorsal surface, either as single bars or blotches across the dorsum, or less often as blotches or irregular markings running along the body. Hence while the dorsal pattern in individual snakes will take on radically different appearances due to variations in colour scheme, the number of bands cannot be used to differentiate regional subspecies.

In the subspecies *B. caudalis kajerikbulliardi subsp. nov.* the dorsal dark patches each have a pair of white patches, consisting one, or more often two white coloured scales, surrounded in full by the darker scales, but importantly showing as small but elongate markings, running in an anterior-posterior direction.

Similar markings, when present in the nominate form present as spots only and not elongate markings or running in an anterior-posterior direction.

The subspecies *B. caudalis swilae subsp. nov.* lacks any white speckles, spots or tiny bars within the dorsal dark patches.

The subspecies *B. caudalis swilae subsp. nov.* is the sandy to dark olive-brown or grey form (when viewed at a distance) from the higher regions in the north east of South Africa, including most of Limpopo, Mpumalanga and Guateng.

The subspecies *B. caudalis swilae subsp. nov.* is readily separated from both other subspecies by the size and position of the darker markings at the rear of the dorsal skull surface.

In this taxon, this is greatly reduced in size and set further back on the skull. As a result more than half of the skull's dorsal surface, when measured from behind the eyes is of lighter pigment, versus the reverse ratio in the other two subspecies.

In *B. caudalis swilae subsp. nov.* no dark pigment from the dark patch at the rear of the skull/head is seen when the head is viewed side on (in contrast to the nominate form).

In the subspecies *B. caudalis swilae subsp. nov.* there are never white spots or patches as pairs inside the dorsal dark patches on the body. The darker, as in darkest (brown) patches (etched at the front and back with blackened tipped scales) do not extend onto the flanks in *B. caudalis swilae subsp. nov.* as seen in the other two subspecies. The equivalent patches (markings) are enlarged in the other two forms.

In *B. caudalis swilae subsp. nov.* the rear of the two dark patches running from the eye down to the labials is greatly reduced in size and effectively terminates about 2-3 scales posterior to the orbit. It is joined to the orbit by a sliver of black or dark pigment, less than a scale wide.

**Distribution:** Kalahari Desert and nearby areas, including all of Botswana, the western part of Namibia, including the Namibia Plateau, inland parts of northern South Africa in the west, including around Namaqualand and in the east into lower and middle Zimbabwe.

#### **BITIS (KLOSEVIPERA) CAUDALIS SWILAE SUBSP. NOV.**

**Holotype:** Specimen number: 191167 at the Field Museum of Natural History, 1400 S Lake Shore Dr, Chicago, IL 60605, United States of America, collected from Waterpoort, Limpopo, South Africa. The Field Museum of Natural History, 1400 S Lake Shore Dr, Chicago, IL 60605, United States of America is a government-owned facility that allows access to its collection holdings by researchers.

**Diagnosis:** For many years, people have been able to identify regional forms of the species *B. caudalis* (Smith, 1839) on the basis of colour and to a lesser extent morphology. In terms of the latter attribute in particular, while there is local variation, there are common overlaps in scale counts in particular between regional variants, making it an unreliable indicator of provenience. Notwithstanding this difficulty, colour and pattern differences in these snakes do have consistent regional differences and are therefore relied upon for this diagnosis in order to accurately define each subspecies and separate them both from the nominate form.

The subspecies *B. caudalis kajerikbulliardi subsp. nov.* is typically, sandy, brownish-grey or a buff ground colour as viewed at a distance, in contrast to the nominate form which is invariably, orange or red in ground colour with markings that blend into this colour at a distance.

In the subspecies *B. caudalis kajerikbulliardi subsp. nov.* the dark markings on the top and side of the head differ consistently from those in the nominate form. In *B. caudalis kajerikbulliardi subsp. nov.* there are two thick dark "lines" running from the eye to the labials. The anterior one is set to the front of the eye and relatively even in width. Behind this is formed a lighter area in an inverted "U-shape" above the labials, or sometimes a "Y-shape" but not reaching the eye. This is followed by an elongated triangular patch running to the eye from the labials, and with a base occupying the labials to the back of the jawline. This patch merges with the dark strip anterior to this and below the front

part of the eye, meaning no lighter pigment reaches the lower orbit. Behind the second dark patch is another light area, occupying the back/side area of the skull, but not the dorsal area, which is occupied in the immediately adjacent area by dark scales.

In the nominate form, the dark scaled area at the rear of the top of the skull is seen on the upper side of the head when viewed from side on. This is not the case in *B. caudalis kajerikbulliardi subsp. nov.*, where instead the darker area noticeably curves in (concave) to prevent this view.

In *B. caudalis swilae subsp. nov.* the darker area at the rear of the head/skull is so reduced as to prevent it being seen when the head is viewed side on.

In the nominate form the first dark strip running between the front of the eye and the labials is usually broken to create two such bars or blotches, where only one is seen in *B. caudalis kajerikbulliardi subsp. nov.*. However some specimens of the nominate form do not have such a split of first dark strip running between the front of the eye and the labials, but these specimens invariably have some lighter scales at the point of such a split on the labials (at the centre of the bar), these scales with lightening along the split line being obvious at a glance.

In aberrant specimens of the nominate form, including the holotype of the nominate form, a similar split occurs in the rear dark band, in effect creating four such "bars" where only two would otherwise be present.

The subspecies *B. caudalis kajerikbulliardi subsp. nov.*, *B. caudalis swilae subsp. nov.* and the nominate form have an average of 24-28 darker cross-bands or blotches on the dorsal surface, either as single bars or blotches across the dorsum, or less often as blotches or irregular markings running along the body. Hence while the dorsal pattern in individual snakes will take on radically different appearances due to variations in colour scheme, the number of bands cannot be used to differentiate regional subspecies.

In the subspecies *B. caudalis kajerikbulliardi subsp. nov.* the dorsal dark patches each have a pair of white patches, consisting one, or more often two white coloured scales, surrounded in full by the darker scales, but importantly showing as small but elongate markings, running in an anterior-posterior direction.

Similar markings, when present in the nominate form present as spots only and not elongate markings or running in an anterior-posterior direction.

The subspecies *B. caudalis swilae subsp. nov.* lacks any white speckles, spots or tiny bars within the dorsal dark patches.

The subspecies *B. caudalis swilae subsp. nov.* is the sandy to dark olive-brown or grey form (when viewed at a distance) from the higher regions in the north east of South Africa, including most of Limpopo, Mpumalanga and Guateng

The subspecies *B. caudalis swilae subsp. nov.* is readily separated from both other subspecies by the size and position of the darker markings at the rear of the dorsal skull surface.

In this taxon, this is greatly reduced in size and set further back on the skull. As a result more than half of the skull's dorsal surface, when measured from behind the eyes is of lighter pigment, versus the reverse ratio in the other two subspecies.

In *B. caudalis swilae subsp. nov.* no dark pigment from the dark patch at the rear of the skull/head is seen when the head is viewed side on (in contrast to the nominate form).

In the subspecies *B. caudalis swilae subsp. nov.* there are never white spots or patches as pairs inside the dorsal dark patches on the body. The darker, as in darkest (brown) patches (etched at the front and back with blackened tipped scales) do not extend onto the flanks in *B. caudalis swilae subsp. nov.* as seen in the other two subspecies. The equivalent patches (markings) are enlarged in the other two forms.

In *B. caudalis swilae subsp. nov.* the rear of the two dark

patches running from the eye down to the labials is greatly reduced in size and effectively terminates about 2-3 scales posterior to the orbit. It is joined to the orbit by a sliver of black or dark pigment, less than a scale wide.

Further diagnostic of this subspecies taxon is the following: 21-31 keeled dorsal mid-body scale rows, 120-155 ventrals, single anal plate and 16-40 divided subcaudals. 10-14 supralabials with none entering the orbit. 9-18 scales around the eye and 10-15 lower labials, usually but not always with a prominent horn above each eye. There are 3 series of spots; a median row of dark brown to blackish elongate quadrangular blotches or patches, which may or may not be pale edged and pale centered; this being flanked by two dorsolateral rows of smaller dark blotches which are usually pale centered and sometimes pale edged. In the nominate form and *B. caudalis kajerikbulliardi subsp. nov.* the median row of blotches extend to the flanks, but this is not the case in *B. caudalis swilae subsp. nov.*

Females are usually less colourful than males and often have relatively indistinct markings. The top of the head has various markings that vary to a limited extent between individuals, but with consistent differences across subspecies and regions, but usually includes a U-shaped or hour-glass marking based on the rear of the skull, or alternatively a dark bar between the eyes and a semicircle of dark at the back of the head, which may or may not be joined depending on the subspecies (see elsewhere in this description). Dark bars extend from the eye to the angle of the jaw, one from the front of the eye, down and the rear one as a triangle shape from the rear of the eye to include most of the rear labials to the back of the jawline. In some specimens of the nominate race, one or two extra dark bars running up from the labials may be seen, giving a total of up to four. The venter in this taxon (including all subspecies) is uniform white to buff or yellowish white, usually with scattered dark markings on the chin or throat.

**Distribution:** Known from Transvaal, Limpopo and nearby parts of South Africa and potentially immediately adjacent countries.

**Etymology:** Named in honor of Marlene Swile of Mitchell's Plain, Cape Town, South Africa in recognition of various contributions to the herpetology of southern Africa. Swile is a native African word for "hairy feet".

***BITIS (KLOSEVIPERA) CAUDALIS KAJERIKBULLIARDI SUBSP. NOV.***

**Holotype:** Specimen number 165119 from Arandis, Namibia (about 40 km north-east of Swakopmund), held at the USNM (Smithsonian Institution), Washington, DC, USA.

This is a government-owned facility that allows access to its collection holdings by researchers.

**Diagnosis:** For many years, people have been able to identify regional forms of the species *B. caudalis* (Smith, 1839) on the basis of colour and to a lesser extent morphology. In terms of the latter attribute in particular, while there is local variation, there are common overlaps in scale counts in particular between regional variants, making it an unreliable indicator of provenience. Notwithstanding this difficulty, colour and pattern differences in these snakes do have consistent regional differences and are therefore relied upon for this diagnosis in order to accurately define each subspecies and separate them both from the nominate form.

The subspecies *B. caudalis kajerikbulliardi subsp. nov.* is typically, sandy, brownish-grey or a buff ground colour as viewed at a distance, in contrast to the nominate form which is invariably, orange or red in ground colour with markings that blend into this colour at a distance.

In the subspecies *B. caudalis kajerikbulliardi subsp. nov.* the dark markings on the top and side of the head differ consistently from those in the nominate form. In *B. caudalis kajerikbulliardi subsp. nov.* there are two thick dark "lines" running from the eye to the labials. The anterior one is set to the front of the eye and relatively even in width. Behind this is formed a lighter area in an

inverted "U-shape" above the labials, or sometimes a "Y-shape" but not reaching the eye. This is followed by an elongated triangular patch running to the eye from the labials, and with a base occupying the labials to the back of the jawline. This patch merges with the dark strip anterior to this and below the front part of the eye, meaning no lighter pigment reaches the lower orbit. Behind the second dark patch is another light area, occupying the back/side area of the skull, but not the dorsal area, which is occupied in the immediately adjacent area by dark scales.

In the nominate form, the dark scaled area at the rear of the top of the skull is seen on the upper side of the head when viewed from side on. This is not the case in *B. caudalis kajerikbulliardi subsp. nov.*, where instead the darker area noticeably curves in (concave) to prevent this view.

In *B. caudalis swilae subsp. nov.* the darker area at the rear of the head/skull is so reduced as to prevent it being seen when the head is viewed side on.

In the nominate form the first dark strip running between the front of the eye and the labials is usually broken to create two such bars or blotches, where only one is seen in *B. caudalis kajerikbulliardi subsp. nov.*. However some specimens of the nominate form do not have such a split of first dark strip running between the front of the eye and the labials, but these specimens invariably have some lighter scales at the point of such a split on the labials (at the centre of the bar), these scales with lightening along the split line being obvious at a glance.

In aberrant specimens of the nominate form, including the holotype of the nominate form, a similar split occurs in the rear dark band, in effect creating four such "bars" where only two would otherwise be present.

The subspecies *B. caudalis kajerikbulliardi subsp. nov.*, *B. caudalis swilae subsp. nov.* and the nominate form have an average of 24-28 darker cross-bands or blotches on the dorsal surface, either as single bars or blotches across the dorsum, or less often as blotches or irregular markings running along the body. Hence while the dorsal pattern in individual snakes will take on radically different appearances due to variations in colour scheme, the number of bands cannot be used to differentiate regional subspecies.

In the subspecies *B. caudalis kajerikbulliardi subsp. nov.* the dorsal dark patches each have a pair of white patches, consisting one, or more often two white coloured scales, surrounded in full by the darker scales, but importantly showing as small but elongate markings, running in an anterior-posterior direction.

Similar markings, when present in the nominate form present as spots only and not elongate markings or running in an anterior-posterior direction.

The subspecies *B. caudalis swilae subsp. nov.* lacks any white speckles, spots or tiny bars within the dorsal dark patches.

The subspecies *B. caudalis swilae subsp. nov.* is the sandy to dark olive-brown or grey form (when viewed at a distance) from the higher regions in the north east of South Africa, including most of Limpopo, Mpumalanga and Guateng

The subspecies *B. caudalis swilae subsp. nov.* is readily separated from both other subspecies by the size and position of the darker markings at the rear of the dorsal skull surface.

In this taxon, this is greatly reduced in size and set further back on the skull. As a result more than half of the skull's dorsal surface, when measured from behind the eyes is of lighter pigment, versus the reverse ratio in the other two subspecies.

In *B. caudalis swilae subsp. nov.* no dark pigment from the dark patch at the rear of the skull/head is seen when the head is viewed side on (in contrast to the nominate form).

In the subspecies *B. caudalis swilae subsp. nov.* there are never white spots or patches as pairs inside the dorsal dark patches on the body. The darker, as in darkest (brown) patches (etched

at the front and back with blackened tipped scales) do not extend onto the flanks in *B. caudalis swilae subsp. nov.* as seen in the other two subspecies. The equivalent patches (markings) are enlarged in the other two forms.

In *B. caudalis swilae subsp. nov.* the rear of the two dark patches running from the eye down to the labials is greatly reduced in size and effectively terminates about 2-3 scales posterior to the orbit. It is joined to the orbit by a sliver of black or dark pigment, less than a scale wide.

Further diagnostic of this subspecies taxon is the following: 21-31 keeled dorsal mid-body scale rows, 120-155 ventrals, single anal plate and 16-40 divided subcaudals. 10-14 supralabials with none entering the orbit. 9-18 scales around the eye and 10-15 lower labials, usually but not always with a prominent horn above each eye. There are 3 series of spots; a median row of dark brown to blackish elongate quadrangular blotches or patches, which may or may not be pale edged and pale centered; this being flanked by two dorsolateral rows of smaller dark blotches which are usually pale centered and sometimes pale edged. In the nominate form and *B. caudalis kajerikbulliardi subsp. nov.* the median row of blotches extend to the flanks, but this is not the case in *B. caudalis swilae subsp. nov.*

Females are usually less colourful than males and often have relatively indistinct markings. The top of the head has various markings that vary to a limited extent between individuals, but with consistent differences across subspecies and regions, but usually includes a U-shaped or hour-glass marking based on the rear of the skull, or alternatively a dark bar between the eyes and a semicircle of dark at the back of the head, which may or may not be joined depending on the subspecies (see elsewhere in this description). Dark bars extend from the eye to the angle of the jaw, one from the front of the eye, down and the rear one as a triangle shape from the rear of the eye to include most of the rear labials to the back of the jawline. In some specimens of the nominate race, one or two extra dark bars running up from the labials may be seen, giving a total of up to four. The venter in this taxon (including all subspecies) is uniform white to buff or yellowish white, usually with scattered dark markings on the chin or throat.

**Distribution:** The coastal strip of Namibia from slightly north of the Angola border and south through Namibia and into the north of South Africa, extending inland in the north to include the area around the Etosha Pan, Namibia, but not including the main part of the Namibia Plateau.

**Etymology:** Named in honour of Kaj-erik (usually known as Kai) Bulliard, formerly of Sydney, NSW, Australia, now of Perth, Western Australia for his valuable contribution to herpetology and wildlife conservation in Australia. At one time in the 1990's, he had an excellent reptile collection and breeding facility in Sydney, at 83 Fingal Avenue, Glenhaven, New South Wales, where he was doing valuable research on the breeding of little-known reptile species. However he was illegally shut down in the early 1990's when officers of the NSW National Parks and Wildlife Service (NPWS) did an armed raid and stole all the reptiles.

Some of these reptiles were passed to the State government-owned Taronga Zoo, at Mosman, NSW, an animal collection where parasitic mite infestations are endemic and have been for decades. Other reptiles taken from Bulliard were illegally sold outside of Australia (Bennett 1994a, 1994b, 1994c).

#### **KUEKUS SUBGEN. NOV.**

**Type species:** *Bitis parviocula* Böhme, 1977.

**Diagnosis:** The diagnosis for this subgenus, *Kuekus subgen. nov.* is as for *Macrocerastes* Reuss, 1939 as given by Lenk *et al.* minus the habitat description, which now is true for the subgenus as defined herein (that is, only including the species complexes known as the *Bitis gabonica* and *B. nasicornis* species complexes, minus *Bitis parviocula*) and the account of the scales on the head, including the other diagnostic characters as follows:

This subgenus (*Kuekus subgen. nov.*) is separated from *Macrocerastes* by the absence of crossbands on the tail. It is further separated by an absence of prominent spines on the snout. In *Macrocerastes* (as defined herein) the nasal is separated from the first supralabials by four or more scales, as opposed to 3-4 in *Kuekus subgen. nov.*

*Kuekus subgen. nov.* is further separated from *Macrocerastes* by the following suite of characters: The head is long, flat, triangular and covered with small, strongly keeled scales. Both the eyes and the nostrils are large, with the latter set well forward. The head is distinct from the thin neck and the snake is large for a Viper (up to a meter in length) and stoutly built. The body is cylindrical with a slight vertebral ridge, while the tail is short. The dorsal scales are keeled and number 37-39 at midbody. The color pattern consists of a light brown to dark brown ground color overlaid with a series of black hexagons or diamonds that run down the center of the back. The black hexagons may have paler crossbars, while being separated from each other by a chain of yellow butterfly shapes. A series of black triangular or subtriangular spots, each with a white center, run down the upper flanks. The lower flanks have a series of greenish-gray triangles, pointing upwards, with yellow edges, especially the tips. The flanks between these triangles are a mottled green color. The head is brown with a dark triangle between the eyes and a dark hammer shape just behind it that extends onto the nape of the neck. The iris is brown. The side of the head is dark, but with a pale stripe that runs from the eye down to the labials. The upper labial scales are white. The chin and throat are white with black speckling. The belly is greenish-gray and may be clear, or with black speckling.

*Kuekus subgen. nov.* and *Macrocerastes* are also defined and separated from other *Bitis* subgenera by the following characters: Nasal separated from rostral by 2-5 scales; lateralmost body scales in oblique rows, with downward pointing keels; dorsal scale rows often duplicated; prootic modified in relation to the origin of the *Musculus retractor pterygoideus* (see Groombridge 1980). Camouflage body pattern characterized by generally symmetrical blotches along the back, being either rhomboidal, rectangular or of similar geometric shape, with blotches or wave-like pattern laterally.

**Distribution:** Known only from five localities in Southern Ethiopia, Africa.

It is found on both sides of the Rift Valley, both in the Bale Mountains to the east and between Bonga and Jimma to the west. It has been collected at altitudes of 1,700-2,800 metres (5,600-9,200 ft). The type locality was "Doki River bridge (8°20'N 35°56'E), bei Yambo (=Yembo), an der Straße von Metu nach Bedelle, Provinz Illubabor, SW-Äthiopien" [Ethiopia].

Of the three specimens known in 1995, two were found in forested areas west of the Rift Valley and one was found in grassland to the east. Of the two western specimens, one was caught in a forest clearing in an old coffee plantation, while the other was found in a forest town, hiding in grass of the grounds of a brewery. The eastern specimen was found in high grassland near a rocky stream.

**Etymology:** Named in honor of Gabriel Kuek, a lawyer with Access Law in Brunswick, Victoria, Australia for his excellent work in combating police corruption through his representation of whistleblowers facing fabricated police and government criminal charges.

Railroading of whistleblowers on fabricated charges to bankrupt and discredit them is standard and common practice of government in Australia. In a legal system where the law is sometimes practiced as "innocent until proven bankrupt" Kuek has stepped in to assist innocent people to clear their name of improperly laid claims and charges.

Breaking away from the stereotype of lawyers with no interest in anything besides money, Kuek is a shining example of the best possible kind of person and is a lawyer who uses his profession to try to make the world a fairer place.

Noting the widespread legal and other injustices in Africa in the present century, it is appropriate that a subgenus of snake carry the name of one man who has done his best to make his corner of the world a better place.

**BITIS ARIETANS (MERREM, 1820).**

**Type Locality:** Cape of Good Hope, South Africa.

**Diagnosis:** *Bitis arietans* is a relatively large, stout viper, rarely exceeding 1 m in total length but occasionally reaching almost 2 m. Its head is broad, flat, and subtriangular with small, imbricate rostral scales. The nostrils face vertically upwards. There is a circumorbital ring of 10-16 scales, and there are 3-4 scale rows between the suborbital and the 12-17 supralabials (Mallow *et al.* 2003). The nasal and the rostral are separated by 2-3 scale rows, and there are 13-19 sublabials, the first 3-5 of which border the chin shields. The anal plate is single (Broadley 1983). There are 29-41 dorsal mid-body scale rows, the inner rows of which are strongly keeled. There are 123-147 ventral scales, and 14-38 subcaudals (no more than 24 in females) (Mallow *et al.* 2003). Two long, hollow, and recurved fangs are present at the anterior end of the substantially shortened maxillary. These fangs articulate with the shortened maxilla, which in turn articulates with the palatamaxillary arch (Pough *et al.* 2004). When not in use, the fangs fold up against the roof of the mouth into a protective fleshy sheath. The palatines and pterygoids bear small recurved teeth, which decrease in size posteriorly (Broadley 1983). This species as recognized to date, exhibits geographic variation in coloration, that correlates with phylogenetic clades. However in general in the nominate form the colour is as follows: there is a dark patch on the crown of the head and a bar running across the front of the head more-or-less though the eyes and scales between the upper lip. Two oblique bars extend from at or near the eye to the lip separated by lighter areas, and the eye itself may be gold to silver gray. Dorsally, the coloration ranges from straw yellow to reddish brown, with a pattern of 22-24 dark chevrons extending along the back and continuing as 2-6 dark crossbands on the tail, although abundant brown or black speckles may obscure this pattern in some individuals. Coloration on the ventral surfaces is white to yellow, usually with several dark spots (Spawls and Branch 1995, Mallow *et al.* 2003). Juveniles tend to have golden markings on the head, and their lateral ventral plates are pinkish to reddish. (Mallow *et al.* 2003). Coloration is somewhat variable within this species complex, with individuals of the nominate form from the eastern part of its range tending to be more brightly colored than individuals from western habitats, which are paler and more drab. Males in general tend to be more brightly colored than females (Broadley 1983, Branch 1988). Unusual color patterns, including a light vertebral stripe, have also been observed in the species (Branch 1988, Mallow *et al.* 2003). The oblique bars that extend from at or near the eye to the lip, fade with age and the lighter areas also darken, but leaving well-defined light markings forming narrow stripe-like markings on the head at the original boundary of the lighter patches.

In this species, the darker oblique bar that runs from labials, up and through eye, across the head and down the other side sits marginally to the front of the orbit with the rear of the orbit being bound by the white etching of the bar.

On the crown of the head is five light "spots" not of even size or shape, with one in the centre of the crown and the others forming the points of a square around this middle spot, covering an area, about four fifths that of the length between the eyes.

The coloration is sufficient to distinguish *Bitis arietans sensu lato* (including taxa described within this paper for the first time) from all other large species of African adders, which have more "complex, geometric colour patterns" (Spawls and Branch 1995). Additionally, this species can be differentiated from the other members of the genus *Bitis (sensu lato)* by the presence of 1-3 scales between the nasal and the first supralabial, 1-2 scales between the nasal and the rostral scales, and molecularly by differences in cytochrome b as described in Mallow *et al.* (2003).

Until now, *Bitis arietans* has been divided into two subspecies, namely, *B. a. arietans* and *B. a. somalica*: these can be distinguished by their subcaudal scales, which are keeled in the latter and not in the former (Spawls and Branch 1995).

A molecular study published by Barlow *et al.* (2013) indicated that species-level recognition for *B. a. somalica* is almost certainly appropriate, even though it is not even certain on their own evidence if this taxon was tested by the authors. Hence and on the basis of the other molecular evidence these authors presented over and above the cited morphological differences (significant in their own right), it is recognized as a full species herein.

That species is known only from Somalia and nearby parts of Kenya and based on the evidence of Barlow *et al.* (2013) it is unlikely to range much further, if at all.

The nominate form of *Bitis arietans* is a smaller taxon than all species described below from regions north of Southern Africa. In terms of the former, specimens in excess of a metre are uncommon. In terms of the latter specimens in excess of 1.5 metres are reasonably common. This difference in average length also is indicative of the considerably greater body mass of the more northern taxa.

Also seen in the nominate species *B. arietans*, is an unusual mutant form which is characterized by partially broken dorsolateral stripes, one on the mid dorsal line and the other two a third of the way down each flank. The base colour is greyish brown and the stripes yellowish. On the sides of the front of the head, dark pigment is reduced, resulting in the stripe running from the eye to the labials being reduced to form a triangle, with the narrow apex stopping within the scale above the labials, meaning no labials have dark pigment.

**Distribution:** Based on the molecular evidence of Barlow *et al.* (2013) *Bitis arietans* is in fact now restricted to southern Africa, being within the seven countries of South Africa, Lesotho, Swaziland, Mozambique, Zimbabwe, Botswana and Namibia, being only found in the southern parts of the latter four countries.

**BITIS OFLAHERTYAE SP. NOV.**

**Holotype:** Specimen number: 1930.87 at the Muséum national d'Histoire naturelle in Paris, France, collected from Nova Chuponga près Chemba, Mozambique, Africa.

The Muséum national d'Histoire naturelle is the National Museum of Natural History in Paris, France and is a government-owned facility that allows access to its collection by scientific researchers.

**Diagnosis:** *Bitis oflahertyae sp. nov.* is separated from *Bitis arietans* by having less than 20 cross-bands forming chevrons on the body (as opposed to over 22 in *Bitis arietans*). On the latter half of the body, the lighter parts of the mid-dorsal chevrons are completely encircled with dark blackish scales and separated from the nearby white flashes at the rear of the darker irregular crossbands.

Unlike in *Bitis arietans*, there are not five light "spots" on the crown of the head of uneven size or shape, with one in the centre of the crown and the others forming the points of a square around this middle spot, covering an area, about four fifths that of the length between the eyes.

In this taxon, with the possible exception of a small white line at the centre of the neck, there are no light markings on the top of the back of the head or neck. The dark pigment in this region is nearly black in juveniles and similar but faded somewhat in adults.

In rare cases of "spots" on the rear of the head in juveniles, at the top of the rear of the head (the crown) are five irregular shaped "spots", in a configuration of a single spot in the centre at the front with four positioned in a square behind this central spot. The two rear "spots" are not elongate running across the back of the head being twice as long (wide) as deep as seen in *Bitis brianwallacei sp. nov.* (described herein, below).

The nominate form of *Bitis arietans* and this species are additionally defined as follows: It is a relatively large, stout viper, rarely exceeding 1 m in total length but occasionally reaching almost 2 m. Its head is broad, flat, and subtriangular with small, imbricate rostral scales. The nostrils face vertically upwards. There is a circumorbital ring of 10-16 scales, and there are 3-4 scale rows between the suborbital and the 12-17 supralabials (Mallow *et al.* 2003). The nasal and the rostral are separated by 2-3 scale rows, and there are 13-19 sublabials, the first 3-5 of which border the chin shields. The anal plate is single (Broadley 1983). There are 29-41 dorsal mid-body scale rows, the inner rows of which are strongly keeled. There are 123-147 ventral scales, and 14-38 subcaudals (no more than 24 in females) (Mallow *et al.* 2003). Two long, hollow, and recurved fangs are present at the anterior end of the substantially shortened maxillary. These fangs articulate with the shortened maxilla, which in turn articulates with the palatamaxillary arch (Pough *et al.* 2004). When not in use, the fangs fold up against the roof of the mouth into a protective fleshy sheath. The palatines and pterygoids bear small recurved teeth, which decrease in size posteriorly (Broadley 1983). This species as recognized to date, exhibits geographic variation in coloration, that correlates with phylogenetic clades. However in general in the nominate form the colour is as follows: there is a dark patch on the crown of the head and a bar running across the front of the head more-or-less though the eyes and scales between the upper lip. Two oblique bars extend from at or near the eye to the lip separated by lighter areas, and the eye itself may be gold to silver gray. Dorsally, the coloration ranges from straw yellow to reddish brown, with a pattern of 22-24 dark chevrons extending along the back and continuing as 2-6 dark crossbands on the tail, although abundant brown or black speckles may obscure this pattern in some individuals. Coloration on the ventral surfaces is white to yellow, usually with several dark spots (Spawls and Branch 1995, Mallow *et al.* 2003). Juveniles tend to have golden markings on the head, and their lateral ventral plates are pinkish to reddish. (Mallow *et al.* 2003). Coloration is somewhat variable within this species complex, with individuals of the nominate form from the eastern part of its range tending to be more brightly colored than individuals from western habitats, which are paler and more drab. Males in general tend to be more brightly colored than females (Broadley 1983, Branch 1988). Unusual color patterns, including a light vertebral stripe, have also been observed in the species *B. arietans* (Branch 1988, Mallow *et al.* 2003).

The oblique bars that extend from at or near the eye to the lip, fade with age and the lighter areas also darken, but leaving well-defined light markings forming narrow stripe-like markings on the head at the original boundary of the lighter patches.

In this species, the darker oblique bar that runs from labials, up and through eye, across the head and down the other side sits marginally to the front of the orbit with the rear of the orbit being bound by the white etching of the bar.

On the crown of the head is five light "spots" not of even size or shape, with one in the centre of the crown and the others forming the points of a square around this middle spot, covering an area, about four fifths that of the length between the eyes.

The coloration is sufficient to distinguish *Bitis arietans sensu lato* (including taxa described within this paper for the first time) from all other large species of African adders, which have more "complex, geometric colour patterns" (Spawls and Branch 1995). Additionally, this species can be differentiated from the other members of the genus *Bitis (sensu lato)* by the presence of 1-3 scales between the nasal and the first supralabial, 1-2 scales between the nasal and the rostral scales, and molecularly by differences in cytochrome b as described by Mallow *et al.* (2003).

Until now, *Bitis arietans* has been divided into two subspecies, namely, *B. a. arietans* and *B. a. somalica*: these can be distinguished by their subcaudal scales, which are keeled in the

latter and not in the former (Spawls and Branch 1995).

A molecular study published by Barlow *et al.* (2013) indicated that species-level recognition for *B. a. somalica* is almost certainly appropriate, even though it is not even certain on their own evidence if this taxon was tested by the authors. Hence and on the basis of the other molecular evidence these authors presented, it is recognized as a full species herein.

That species is known only from Somalia and nearby parts of Kenya and based on the evidence of Barlow *et al.* (2013) it is unlikely to range much further if at all.

*Bitis brianwallacei sp. nov.* is diagnosed by the following trait: Many dorsal scales on the darker areas are characterized by a large yellow dot in the centre forming a pattern of crossbands (usually but not always of three rows at a time) on the darker regions.

*Bitis brianwallacei sp. nov.* is separated from *Bitis arietans* by having less than 20 cross-bands forming chevrons on the body (as opposed to over 22 in *Bitis arietans*).

Specimens of *Bitis brianwallacei sp. nov.* commonly have chevrons that give an appearance of ovoid blotches. Dorsally there is an absence of white blotches or markings commonly seen in other species in the *Bitis arietans* species group.

In both *Bitis arietans* and *Bitis Oflahertyae sp. nov.* the darker oblique bar that runs from labials, up and through eye, across the head and down the other side sits marginally to the front of the orbit with the rear of the orbit being bound by the white etching of the bar. In *Bitis brianwallacei sp. nov.* the darker bar running from the lip through the eye sits further forward so that the lighter area at the rear forms a large triangle from the labial to the top of the eye (as opposed to a near triangular thick bar), and most importantly runs to either the bottom of the eye or slightly behind this (more than 2/3 the way to the bottom of the eye), whereas the lower eye is met by darker scales in both *Bitis arietans* and *Bitis Oflahertyae sp. nov.*. In common with both *Bitis arietans* and *Bitis Oflahertyae sp. nov.* the top of this lighter bar or triangle forms a usually unbroken line, about a scale thick, running across the head between the upper rear of each eye.

At the top of the rear of the head (the crown) in *Bitis brianwallacei sp. nov.* are five irregular shaped "spots", in a configuration of a single spot in the centre at the front with four positioned in a square behind this central spot. The two rear "spots" are elongate running across the back of the head being twice or three times as long (wide) as deep, consisting of individually marked scales in most cases or in a few cases light pigment running into the adjacent scales. In rare cases the "rear" spots are broken, by consisting of three scales, the middle being normal (darker) pigment.

*Bitis lourenceklosei sp. nov.* is readily separated from all others in the *Bitis arietans* species group by the unusually thick dark band that runs from the labials through the front of the eye and across the head.

In this taxon, the band is of even thickness from the labials into the eye (unique for this taxon), where it runs across the front of the eye and over the head. The rear third of the eye is abutted by pale scales being the top of a triangular-shaped light patch.

In front of the darker band running through the orbit, the lighter cross-band is reduced at the labials, making it distinctly narrower than the broad dark band that follows it, making this a unique colour variation in this species in the *Bitis arietans* species group.

The white cross-band running across the rear of the head is broken in middle. There are four single light scales on the crown in a diamond pattern.

Also characterized by less than 20 cross-bands forming chevrons on the body (as opposed to over 22 in *Bitis arietans*).

*Bitis tomcottoni sp. nov.* is separated from all others in the *Bitis arietans* species group by the unusually thick dark band that runs from the rear of the head (temple region) into the orbit. In

all other species this narrows considerably to either run into the eye as a sliver (less than a scale wide), or alternatively not at all, being blocked by some lighter scales (part of a lighter marking).

In *Bitis tomcottoni* sp. nov. this dark band is typically 2-3 scales wide when it runs into the eye (rarely 1.5 scales wide), as opposed to usually less than a scale thick at the point near the eye and not more than a scale thick in all others in the *Bitis arietans* species group.

The light band across the head at the rear of the eyes is thick, being at least a scale thick, and there is a second similar light band that runs across the back of the head 4 scales anterior to the rear of the head.

*Bitis pintauidii* sp. nov. is separated from all others in the *Bitis arietans* species group by the excess of lighter pigment on the top of the head. The lighter temporal streak running from the rear of the head to the top of the eye is an average of 3 scales wide in this taxon, as opposed to two wide in all others in the *Bitis arietans* species group. The lighter bar across the top of the head at the rear of the eyes is thickened slightly and has a noticeable backwards expansion at the centre of the head.

The light patch at the rear of the side of the head behind the darker cross-band that runs from labials through the eye is noticeably squarish at the top (with an even line), giving the patch the appearance of a skewed square, as opposed to the normal triangular appearance of the patch in all others in the *Bitis arietans* species group. This is largely caused by the fact that the dark patch at the rear of and above of this light region, while triangular in shape (as opposed to elongate in some others in the *Bitis arietans* species group), actually terminates 4 scales to the rear of the orbit and is connected to the eye by a well-defined but narrow dark line of less than a scale wide.

The dorsal surface of this taxon is characterised by large white blotches not seen in any other species in the *Bitis arietans* species group. These commence about a third of the way down the body and end shortly before the tail, which resumes a more-or-less banded appearance as seen in most specimens in the *Bitis arietans* species group.

In terms of chevrons or the equivalent (as measured) this taxon is characterised by no more than 18 on the body (usually 17).

*Bitis somalica* Parker, 1949 is unique in the *Bitis arietans* species group in that their subcaudals are keeled (Spawls and Branch 1995).

**Distribution:** Currently known only from Mozambique, but may also occur in immediately adjacent parts of other countries.

**Etymology:** Named in honour of Julia O'Flaherty of Grafton, NSW, for her valuable contributions to herpetology including by assisting, well-known Australian taxonomist, Richard Wells including helping with his landmark reclassifications of Australian skinks and other taxa.

**BITIS BRIANWALLACEI SP. NOV.**

**Holotype:** Specimen number: 134470 at the Smithsonian Institution, Washington, DC, USA, from Western Equatoria, South Sudan, Africa.

The Smithsonian Institution, Washington, DC, USA is a government-owned facility that allows access to its collection by scientific researchers.

**Paratypes:** Specimen numbers: 134467, 134468, 134471 and 134459, from Western Equatoria, South Sudan, Africa, at the Smithsonian Institution, Washington, DC, USA.

The Smithsonian Institution, Washington, DC, USA is a government-owned facility that allows access to its collection by scientific researchers.

**Diagnosis:** *Bitis brianwallacei* sp. nov. is diagnosed and separated from others in the *Bitis arietans* species group by the following trait: Many dorsal scales on the darker areas are characterized by a large yellow dot in the centre forming a pattern of crossbands (usually but not always of three rows at a time) on the darker regions.

*Bitis brianwallacei* sp. nov. is separated from *Bitis arietans* by having less than 20 cross-bands forming chevrons on the body (as opposed to over 22 in *Bitis arietans*).

Specimens of *Bitis brianwallacei* sp. nov. commonly have chevrons that give an appearance of ovoid blotches. Dorsally there is an absence of white blotches or markings commonly seen in other species in the *Bitis arietans* species group.

In both *Bitis arietans* and *Bitis Oflahertyae* sp. nov. the darker oblique bar that runs from labials, up and through eye, across the head and down the other side sits marginally to the front of the orbit with the rear of the orbit being bound by the white etching of the bar. In *Bitis brianwallacei* sp. nov. the darker bar running from the lip through the eye sits further forward so that the lighter area at the rear forms a large triangle from the labial to the top of the eye (as opposed to a near triangular thick bar), and most importantly runs to either the bottom of the eye or slightly behind this (more than 2/3 the way to the bottom of the eye), whereas the lower eye is met by darker scales in both *Bitis arietans* and *Bitis Oflahertyae* sp. nov.. In common with both *Bitis arietans* and *Bitis Oflahertyae* sp. nov. the top of this lighter bar or triangle forms a usually unbroken line, about a scale thick, running across the head between the upper rear of each eye.

At the top of the rear of the head (the crown) in *Bitis brianwallacei* sp. nov. are five irregular shaped "spots", in a configuration of a single spot in the centre at the front with four positioned in a square behind this central spot. The two rear "spots" are elongate running across the back of the head being twice or three times as long (wide) as deep, consisting of individually marked scales in most cases or in a few cases light pigment running into the adjacent scales. In rare cases the "rear" spots are broken, by consisting of three scales, the middle being normal (darker) pigment.

The nominate form of *Bitis arietans* and this species are additionally defined as follows: It is a relatively large, stout viper, rarely exceeding 1 m in total length but occasionally reaching almost 2 m. Its head is broad, flat, and subtriangular with small, imbricate rostral scales. The nostrils face vertically upwards. There is a circumorbital ring of 10-16 scales, and there are 3-4 scale rows between the suborbital and the 12-17 supralabials (Mallow *et al.* 2003). The nasal and the rostral are separated by 2-3 scale rows, and there are 13-19 sublabials, the first 3-5 of which border the chin shields. The anal plate is single (Broadley 1983). There are 29-41 dorsal mid-body scale rows, the inner rows of which are strongly keeled. There are 123-147 ventral scales, and 14-38 subcaudals (no more than 24 in females) (Mallow *et al.* 2003). Two long, hollow, and recurved fangs are present at the anterior end of the substantially shortened maxillary. These fangs articulate with the shortened maxilla, which in turn articulates with the palatomaxillary arch (Pough *et al.* 2004). When not in use, the fangs fold up against the roof of the mouth into a protective fleshy sheath. The palatines and pterygoids bear small recurved teeth, which decrease in size posteriorly (Broadley 1983). This species as recognized to date, exhibits geographic variation in coloration, that correlates with phylogenetic clades. However in general in the nominate form the colour is as follows: there is a dark patch on the crown of the head and a bar running across the front of the head more-or-less though the eyes and scales between the upper lip. Two oblique bars extend from at or near the eye to the lip separated by lighter areas, and the eye itself may be gold to silver gray. Dorsally, the coloration ranges from straw yellow to reddish brown, with a pattern of 22-24 dark chevrons extending along the back and continuing as 2-6 dark crossbands on the tail, although abundant brown or black speckles may obscure this pattern in some individuals. Coloration on the ventral surfaces is white to yellow, usually with several dark spots (Spawls and Branch 1995, Mallow *et al.* 2003). Juveniles tend to have golden markings on the head, and their lateral ventral plates are pinkish to reddish. (Mallow *et al.* 2003). Coloration is somewhat variable within this species complex, with individuals of the nominate

form from the eastern part of its range tending to be more brightly colored than individuals from western habitats, which are paler and more drab. Males in general tend to be more brightly colored than females (Broadley 1983, Branch 1988). Unusual color patterns, including a light vertebral stripe, have also been observed in the species (Branch 1988, Mallow *et al.* 2003).

The oblique bars that extend from at or near the eye to the lip, fade with age and the lighter areas also darken, but leaving well-defined light markings forming narrow stripe-like markings on the head at the original boundary of the lighter patches.

In this species, the darker oblique bar that runs from labials, up and through eye, across the head and down the other side sits marginally to the front of the orbit with the rear of the orbit being bound by the white etching of the bar.

On the crown of the head is five light "spots" not of even size or shape, with one in the centre of the crown and the others forming the points of a square around this middle spot, covering an area, about four fifths that of the length between the eyes.

The coloration is sufficient to distinguish *Bitis arietans sensu lato* (including taxa described within this paper for the first time) from all other large species of African adders, which have more "complex, geometric colour patterns" (Spawls and Branch 1995). Additionally, this species can be differentiated from the other members of the genus *Bitis (sensu lato)* by the presence of 1-3 scales between the nasal and the first supralabial, 1-2 scales between the nasal and the rostral scales, and molecularly by differences in cytochrome b as described by Mallow *et al.* (2003).

Until now, *Bitis arietans* has been divided into two subspecies, namely, *B. a. arietans* and *B. a. somalica*: these can be distinguished by their subcaudal scales, which are keeled in the latter and not in the former (Spawls and Branch 1995).

A molecular study published by Barlow *et al.* (2013) indicated that species-level recognition for *B. a. somalica* is almost certainly appropriate, even though it is not even certain on their own evidence if this taxon was tested by the authors. Hence and on the basis of the other molecular evidence these authors presented, it is recognized as a full species herein.

That species is known only from Somalia and nearby parts of Kenya and based on the evidence of Barlow *et al.* (2013) it is unlikely to range much further if at all.

*Bitis offahertyae sp. nov.* is separated from *Bitis arietans* by having less than 20 cross-bands forming chevrons on the body (as opposed to over 22 in *Bitis arietans*). On the latter half of the body, the lighter parts of the mid-dorsal chevrons are completely encircled with dark blackish scales and separated from the nearby white flashes at the rear of the darker irregular crossbands.

Unlike in *Bitis arietans*, there are not five light "spots" on the crown of the head of uneven size or shape, with one in the centre of the crown and the others forming the points of a square around this middle spot, covering an area, about four fifths that of the length between the eyes.

In this taxon, with the possible exception of a small white line at the centre of the neck, there are no light markings on the top of the back of the head or neck. The dark pigment in this region is nearly black in juveniles and similar but faded somewhat in adults.

In rare cases of "spots" on the rear of the head in juveniles, at the top of the rear of the head (the crown) are five irregular shaped "spots", in a configuration of a single spot in the centre at the front with four positioned in a square behind this central spot. The two rear "spots" are not elongate running across the back of the head being twice as long (wide) as deep as seen in *Bitis brianwallacei sp. nov.* (described below).

*Bitis lourenceklosei sp. nov.* is readily separated from all others in the *Bitis arietans* species group by the unusually thick dark band that runs from the labials through the front of the eye and across the head.

In this taxon, the band is of even thickness from the labials into the eye (unique for this taxon), where it runs across the front of the eye and over the head.

The rear third of the eye is abutted by pale scales being the top of a triangular-shaped light patch.

In front of the darker band running through the orbit, the lighter cross-band is reduced at the labials, making it distinctly narrower than the broad dark band that follows it, making this a unique colour variation in this species in the *Bitis arietans* species group.

The white cross-band running across the rear of the head is broken in middle. There are four single light scales on the crown in a diamond pattern.

Also characterized by less than 20 cross-bands forming chevrons on the body (as opposed to over 22 in *Bitis arietans*).

*Bitis tomcottoni sp. nov.* is separated from all others in the *Bitis arietans* species group by the unusually thick dark band that runs from the rear of the head (temple region) into the orbit. In all other species this narrows considerably to either run into the eye as a sliver (less than a scale wide), or alternatively not at all, being blocked by some lighter scales (part of a lighter marking).

In *Bitis tomcottoni sp. nov.* this dark band is typically 2-3 scales wide when it runs into the eye (rarely 1.5 scales wide), as opposed to usually less than a scale thick at the point near the eye and not more than a scale thick in all others in the *Bitis arietans* species group.

The light band across the head at the rear of the eyes is thick, being at least a scale thick, and there is a second similar light band that runs across the back of the head 4 scales anterior to the rear of the head.

*Bitis pintauidii sp. nov.* is separated from all others in the *Bitis arietans* species group by the excess of lighter pigment on the top of the head. The lighter temporal streak running from the rear of the head to the top of the eye is an average of 3 scales wide in this taxon, as opposed to two wide in all others in the *Bitis arietans* species group. The lighter bar across the top of the head at the rear of the eyes is thickened slightly and has a noticeable backwards expansion at the centre of the head.

The light patch at the rear of the side of the head behind the darker cross-band that runs from labials through the eye is noticeably squarish at the top (with an even line), giving the patch the appearance of a skewed square, as opposed to the normal triangular appearance of the patch in all others in the *Bitis arietans* species group. This is largely caused by the fact that the dark patch at the rear of and above of this light region, while triangular in shape (as opposed to elongate in some others in the *Bitis arietans* species group), actually terminates 4 scales to the rear of the orbit and is connected to the eye by a well-defined but narrow dark line of less than a scale wide.

The dorsal surface of this taxon is characterised by large white blotches not seen in any other species in the *Bitis arietans* species group. These commence about a third of the way down the body and end shortly before the tail, which resumes a more-or-less banded appearance as seen in most specimens in the *Bitis arietans* species group.

In terms of chevrons or the equivalent (as measured) this taxon is characterised by no more than 18 on the body (usually 17).

*Bitis somalica* Parker, 1949 is unique in the *Bitis arietans* species group in that their subcaudals are keeled (Spawls and Branch 1995).

**Distribution:** North central Africa from Uganda and South Sudan, west into Congo and the Central African Republic.

**Etymology:** Named in honour of Brian Wallace of Cranbourne, Victoria, Australia, for his long-term work with Australian herpetology and herpetoculture, including breeding diverse taxa such as pythons, monitors and elapid snakes and providing data for others to use in their book and paper publications.



**BITIS LOURENCEKLOSEI SP. NOV.**

**Holotype:** Specimen number 18527 at the Field Museum of Natural History (FMNH), 1400 S Lake Shore Drive, Chicago, IL 60605, United States of America, from Angola, Africa. The Field Museum of Natural History is a government-owned facility that allows access to its collection by scientific researchers.

**Paratype:** Specimen number 74238 at the Field Museum of Natural History (FMNH), 1400 S Lake Shore Drive, Chicago, IL 60605, United States of America, from Angola, Africa. The Field Museum of Natural History is a government-owned facility that allows access to its collection by scientific researchers.

**Diagnosis:** *Bitis lourenceklosei sp. nov.* is readily separated from all others in the *Bitis arietans* species group by the unusually thick dark band that runs from the labials through the front of the eye and across the head.

In this taxon, the band is of even thickness from the labials into the eye (unique for this taxon), where it runs across the front of the eye and over the head. The rear third of the eye is abutted by pale scales being the top of a triangular-shaped light patch.

In front of the darker band running through the orbit, the lighter cross-band is reduced at the labials, making it distinctly narrower than the broad dark band that follows it, making this a unique colour variation in this species in the *Bitis arietans* species group.

The white cross-band running across the rear of the head is broken in middle. There are four single light scales on the crown in a diamond pattern.

Also characterized by less than 20 cross-bands forming chevrons on the body (as opposed to over 22 in *Bitis arietans*).

The nominate form of *Bitis arietans* and this species are additionally defined as follows: It is a relatively large, stout viper, rarely exceeding 1 m in total length but occasionally reaching almost 2 m. Its head is broad, flat, and subtriangular with small, imbricate rostral scales. The nostrils face vertically upwards. There is a circumorbital ring of 10-16 scales, and there are 3-4 scale rows between the suborbital and the 12-17 supralabials (Mallow *et al.* 2003). The nasal and the rostral are separated by 2-3 scale rows, and there are 13-19 sublabials, the first 3-5 of which border the chin shields. The anal plate is single (Broadley 1983). There are 29-41 dorsal mid-body scale rows, the inner rows of which are strongly keeled. There are 123-147 ventral scales, and 14-38 subcaudals (no more than 24 in females) (Mallow *et al.* 2003). Two long, hollow, and recurved fangs are present at the anterior end of the substantially shortened maxillary. These fangs articulate with the shortened maxilla, which in turn articulates with the palatamaxillary arch (Pough *et al.* 2004). When not in use, the fangs fold up against the roof of the mouth into a protective fleshy sheath. The palatines and pterygoids bear small recurved teeth, which decrease in size posteriorly (Broadley 1983). This species as recognized to date, exhibits geographic variation in coloration, that correlates with phylogenetic clades. However in general in the nominate form the colour is as follows: there is a dark patch on the crown of the head and a bar running across the front of the head more-or-less though the eyes and scales between the upper lip. Two oblique bars extend from at or near the eye to the lip separated by lighter areas, and the eye itself may be gold to silver gray. Dorsally, the coloration ranges from straw yellow to reddish brown, with a pattern of 22-24 dark chevrons extending along the back and continuing as 2-6 dark crossbands on the tail, although abundant brown or black speckles may obscure this pattern in some individuals. Coloration on the ventral surfaces is white to yellow, usually with several dark spots (Spawls and Branch 1995, Mallow *et al.* 2003). Juveniles tend to have golden markings on the head, and their lateral ventral plates are pinkish to reddish. (Mallow *et al.* 2003). Coloration is somewhat variable within this species complex, with individuals of the nominate form from the eastern part of its range tending to be more brightly colored than individuals from western habitats, which are

paler and more drab. Males in general tend to be more brightly colored than females (Broadley 1983, Branch 1988). Unusual color patterns, including a light vertebral stripe, have also been observed in the species (Branch 1988, Mallow *et al.* 2003).

The oblique bars that extend from at or near the eye to the lip, fade with age and the lighter areas also darken, but leaving well-defined light markings forming narrow stripe-like markings on the head at the original boundary of the lighter patches.

In this species, the darker oblique bar that runs from labials, up and through eye, across the head and down the other side sits marginally to the front of the orbit with the rear of the orbit being bound by the white etching of the bar.

On the crown of the head is five light "spots" not of even size or shape, with one in the centre of the crown and the others forming the points of a square around this middle spot, covering an area, about four fifths that of the length between the eyes.

The coloration is sufficient to distinguish *Bitis arietans sensu lato* (including taxa described within this paper for the first time) from all other large species of African adders, which have more "complex, geometric colour patterns" (Spawls and Branch 1995). Additionally, this species can be differentiated from the other members of the genus *Bitis (sensu lato)* by the presence of 1-3 scales between the nasal and the first supralabial, 1-2 scales between the nasal and the rostral scales, and molecularly by differences in cytochrome b as described by Mallow *et al.* (2003).

Until now, *Bitis arietans* has been divided into two subspecies, namely, *B. a. arietans* and *B. a. somalica*: these can be distinguished by their subcaudal scales, which are keeled in the latter and not in the former (Spawls and Branch 1995).

A molecular study published by Barlow *et al.* (2013) indicated that species-level recognition for *B. a. somalica* is almost certainly appropriate, even though it is not even certain on their own evidence if this taxon was tested by the authors. Hence and on the basis of the other molecular evidence these authors presented, it is recognized as a full species herein.

That species is known only from Somalia and nearby parts of Kenya and based on the evidence of Barlow *et al.* (2013) it is unlikely to range much further if at all.

*Bitis offahertyae sp. nov.* is separated from *Bitis arietans* by having less than 20 cross-bands forming chevrons on the body (as opposed to over 22 in *Bitis arietans*). On the latter half of the body, the lighter parts of the mid-dorsal chevrons are completely encircled with dark blackish scales and separated from the nearby white flashes at the rear of the darker irregular crossbands.

Unlike in *Bitis arietans*, there are not five light "spots" on the crown of the head of uneven size or shape, with one in the centre of the crown and the others forming the points of a square around this middle spot, covering an area, about four fifths that of the length between the eyes.

In this taxon, with the possible exception of a small white line at the centre of the neck, there are no light markings on the top of the back of the head or neck. The dark pigment in this region is nearly black in juveniles and similar but faded somewhat in adults.

In rare cases of "spots" on the rear of the head in juveniles, at the top of the rear of the head (the crown) are five irregular shaped "spots", in a configuration of a single spot in the centre at the front with four positioned in a square behind this central spot. The two rear "spots" are not elongate running across the back of the head being twice as long (wide) as deep as seen in *Bitis brianwallacei sp. nov.* (described below).

*Bitis brianwallacei sp. nov.* is diagnosed by the following trait: Many dorsal scales on the darker areas are characterized by a large yellow dot in the centre forming a pattern of crossbands (usually but not always of three rows at a time) on the darker regions.

*Bitis brianwallacei* sp. nov. is separated from *Bitis arietans* by having less than 20 cross-bands forming chevrons on the body (as opposed to over 22 in *Bitis arietans*).

Specimens of *Bitis brianwallacei* sp. nov. commonly have chevrons that give an appearance of ovoid blotches. Dorsally there is an absence of white blotches or markings commonly seen in other species in the *Bitis arietans* species group.

In both *Bitis arietans* and *Bitis Oflahertyae* sp. nov. the darker oblique bar that runs from labials, up and through eye, across the head and down the other side sits marginally to the front of the orbit with the rear of the orbit being bound by the white etching of the bar. In *Bitis brianwallacei* sp. nov. the darker bar running from the lip through the eye sits further forward so that the lighter area at the rear forms a large triangle from the labial to the top of the eye (as opposed to a near triangular thick bar), and most importantly runs to either the bottom of the eye or slightly behind this (more than 2/3 the way to the bottom of the eye), whereas the lower eye is met by darker scales in both *Bitis arietans* and *Bitis Oflahertyae* sp. nov.. In common with both *Bitis arietans* and *Bitis Oflahertyae* sp. nov. the top of this lighter bar or triangle forms a usually unbroken line, about a scale thick, running across the head between the upper rear of each eye.

At the top of the rear of the head (the crown) in *Bitis brianwallacei* sp. nov. are five irregular shaped "spots", in a configuration of a single spot in the centre at the front with four positioned in a square behind this central spot. The two rear "spots" are elongate running across the back of the head being twice or three times as long (wide) as deep, consisting of individually marked scales in most cases or in a few cases light pigment running into the adjacent scales. In rare cases the "rear" spots are broken, by consisting of three scales, the middle being normal (darker) pigment.

*Bitis tomcottoni* sp. nov. is separated from all others in the *Bitis arietans* species group by the unusually thick dark band that runs from the rear of the head (temple region) into the orbit. In all other species this narrows considerably to either run into the eye as a sliver (less than a scale wide), or alternatively not at all, being blocked by some lighter scales (part of a lighter marking). In *Bitis tomcottoni* sp. nov. this dark band is typically 2-3 scales wide when it runs into the eye (rarely 1.5 scales wide), as opposed to usually less than a scale thick at the point near the eye and not more than a scale thick in all others in the *Bitis arietans* species group.

The light band across the head at the rear of the eyes is thick, being at least a scale thick, and there is a second similar light band that runs across the back of the head 4 scales anterior to the rear of the head.

*Bitis pintauidii* sp. nov. is separated from all others in the *Bitis arietans* species group by the excess of lighter pigment on the top of the head. The lighter temporal streak running from the rear of the head to the top of the eye is an average of 3 scales wide in this taxon, as opposed to two wide in all others in the *Bitis arietans* species group. The lighter bar across the top of the head at the rear of the eyes is thickened slightly and has a noticeable backwards expansion at the centre of the head.

The light patch at the rear of the side of the head behind the darker cross-band that runs from labials through the eye is noticeably squarish at the top (with an even line), giving the patch the appearance of a skewed square, as opposed to the normal triangular appearance of the patch in all others in the *Bitis arietans* species group. This is largely caused by the fact that the dark patch at the rear of and above of this light region, while triangular in shape (as opposed to elongate in some others in the *Bitis arietans* species group), actually terminates 4 scales to the rear of the orbit and is connected to the eye by a well-defined but narrow dark line of less than a scale wide.

The dorsal surface of this taxon is characterised by large white blotches not seen in any other species in the *Bitis arietans* species group. These commence about a third of the way down

the body and end shortly before the tail, which resumes a more-or-less banded appearance as seen in most specimens in the *Bitis arietans* species group.

In terms of chevrons or the equivalent (as measured) this taxon is characterised by no more than 18 on the body (usually 17).

*Bitis somalica* Parker, 1949 is unique in the *Bitis arietans* species group in that their subcaudals are keeled (Spawls and Branch 1995).

**Distribution:** Angola and Zambia.

**Etymology:** Named in honour of Lourence Klose, of Blouberg Sands, Cape Town, South Africa in recognition for his excellent work with reptiles in Africa, including with taxa as diverse as Cobras (*Uraeus* and *Spracklandus*), Vipers (*Bitis*), Mambas (*Dendroaspis*), and other venomous taxa.

#### **BITIS TOMCOTTONI SP. NOV.**

**Holotype:** Specimen number 66143 at the Field Museum of Natural History (FMNH), 1400 S Lake Shore Drive, Chicago, IL 60605, United States of America, from Yemen, Collected by Harry Hoogstraal and Robert E. Kuntz in 1951. The Field Museum of Natural History is a government-owned facility that allows access to its collection by scientific researchers.

**Paratype:** Specimen number 66144 at the Field Museum of Natural History (FMNH), 1400 S Lake Shore Drive, Chicago, IL 60605, United States of America, from Yemen, Collected by Harry Hoogstraal and Robert E. Kuntz in 1951. The Field Museum of Natural History is a government-owned facility that allows access to its collection by scientific researchers.

**Diagnosis:** *Bitis tomcottoni* sp. nov. is separated from all others in the *Bitis arietans* species group by the unusually thick dark band that runs from the rear of the head (temple region) into the orbit. In all other species this narrows considerably to either run into the eye as a sliver (less than a scale wide), or alternatively not at all, being blocked by some lighter scales (part of a lighter marking).

In *Bitis tomcottoni* sp. nov. this dark band is typically 2-3 scales wide when it runs into the eye (rarely 1.5 scales wide), as opposed to usually less than a scale thick at the point near the eye and not more than a scale thick in all others in the *Bitis arietans* species group.

The light band across the head at the rear of the eyes is thick, being at least a scale thick, and there is a second similar light band that runs across the back of the head 4 scales anterior to the rear of the head.

*Bitis oflahertyae* sp. nov. is separated from *Bitis arietans* by having less than 20 cross-bands forming chevrons on the body (as opposed to over 22 in *Bitis arietans*). On the latter half of the body, the lighter parts of the mid-dorsal chevrons are completely encircled with dark blackish scales and separated from the nearby white flashes at the rear of the darker irregular crossbands.

Unlike in *Bitis arietans*, there are not five light "spots" on the crown of the head of uneven size or shape, with one in the centre of the crown and the others forming the points of a square around this middle spot, covering an area, about four fifths that of the length between the eyes.

In this taxon, with the possible exception of a small white line at the centre of the neck, there are no light markings on the top of the back of the head or neck. The dark pigment in this region is nearly black in juveniles and similar but faded somewhat in adults.

In rare cases of "spots" on the rear of the head in juveniles, at the top of the rear of the head (the crown) are five irregular shaped "spots", in a configuration of a single spot in the centre at the front with four positioned in a square behind this central spot. The two rear "spots" are not elongate running across the back of the head being twice as long (wide) as deep as seen in *Bitis brianwallacei* sp. nov. (described below).

The nominate form of *Bitis arietans* and this species are

additionally defined as follows: It is a relatively large, stout viper, rarely exceeding 1 m in total length but occasionally reaching almost 2 m. Its head is broad, flat, and subtriangular with small, imbricate rostral scales. The nostrils face vertically upwards. There is a circumorbital ring of 10-16 scales, and there are 3-4 scale rows between the suborbital and the 12-17 supralabials (Mallow *et al.* 2003). The nasal and the rostral are separated by 2-3 scale rows, and there are 13-19 sublabials, the first 3-5 of which border the chin shields. The anal plate is single (Broadley 1983). There are 29-41 dorsal mid-body scale rows, the inner rows of which are strongly keeled. There are 123-147 ventral scales, and 14-38 subcaudals (no more than 24 in females) (Mallow *et al.* 2003). Two long, hollow, and recurved fangs are present at the anterior end of the substantially shortened maxillary. These fangs articulate with the shortened maxilla, which in turn articulates with the palatamaxillary arch (Pough *et al.* 2004). When not in use, the fangs fold up against the roof of the mouth into a protective fleshy sheath. The palatines and pterygoids bear small recurved teeth, which decrease in size posteriorly (Broadley 1983). This species as recognized to date, exhibits geographic variation in coloration, that correlates with phylogenetic clades. However in general in the nominate form the colour is as follows: there is a dark patch on the crown of the head and a bar running across the front of the head more-or-less through the eyes and scales between the upper lip. Two oblique bars extend from at or near the eye to the lip separated by lighter areas, and the eye itself may be gold to silver gray. Dorsally, the coloration ranges from straw yellow to reddish brown, with a pattern of 22-24 dark chevrons extending along the back and continuing as 2-6 dark crossbands on the tail, although abundant brown or black speckles may obscure this pattern in some individuals. Coloration on the ventral surfaces is white to yellow, usually with several dark spots (Spawls and Branch 1995, Mallow *et al.* 2003). Juveniles tend to have golden markings on the head, and their lateral ventral plates are pinkish to reddish. (Mallow *et al.* 2003). Coloration is somewhat variable within this species complex, with individuals of the nominate form from the eastern part of its range tending to be more brightly colored than individuals from western habitats, which are paler and more drab. Males in general tend to be more brightly colored than females (Broadley 1983, Branch 1988). Unusual color patterns, including a light vertebral stripe, have also been observed in the species (Branch 1988, Mallow *et al.* 2003).

The oblique bars that extend from at or near the eye to the lip, fade with age and the lighter areas also darken, but leaving well-defined light markings forming narrow stripe-like markings on the head at the original boundary of the lighter patches.

In this species, the darker oblique bar that runs from labials, up and through eye, across the head and down the other side sits marginally to the front of the orbit with the rear of the orbit being bound by the white etching of the bar.

On the crown of the head is five light "spots" not of even size or shape, with one in the centre of the crown and the others forming the points of a square around this middle spot, covering an area, about four fifths that of the length between the eyes.

The coloration is sufficient to distinguish *Bitis arietans sensu lato* (including taxa described within this paper for the first time) from all other large species of African adders, which have more "complex, geometric colour patterns" (Spawls and Branch 1995). Additionally, this species can be differentiated from the other members of the genus *Bitis (sensu lato)* by the presence of 1-3 scales between the nasal and the first supralabial, 1-2 scales between the nasal and the rostral scales, and molecularly by differences in cytochrome b as described by Mallow *et al.* (2003).

Until now, *Bitis arietans* has been divided into two subspecies, namely, *B. a. arietans* and *B. a. somalica*: these can be distinguished by their subcaudal scales, which are keeled in the latter and not in the former (Spawls and Branch 1995).

A molecular study published by Barlow *et al.* (2013) indicated

that species-level recognition for *B. a. somalica* is almost certainly appropriate, even though it is not even certain on their own evidence if this taxon was tested by the authors. Hence and on the basis of the other molecular evidence these authors presented, it is recognized as a full species herein.

That species is known only from Somalia and nearby parts of Kenya and based on the evidence of Barlow *et al.* (2013) it is unlikely to range much further if at all.

*Bitis brianwallacei sp. nov.* is diagnosed by the following trait: Many dorsal scales on the darker areas are characterized by a large yellow dot in the centre forming a pattern of crossbands (usually but not always of three rows at a time) on the darker regions.

*Bitis brianwallacei sp. nov.* is separated from *Bitis arietans* by having less than 20 cross-bands forming chevrons on the body (as opposed to over 22 in *Bitis arietans*).

Specimens of *Bitis brianwallacei sp. nov.* commonly have chevrons that give an appearance of ovoid blotches. Dorsally there is an absence of white blotches or markings commonly seen in other species in the *Bitis arietans* species group.

In both *Bitis arietans* and *Bitis Oflahertyae sp. nov.* the darker oblique bar that runs from labials, up and through eye, across the head and down the other side sits marginally to the front of the orbit with the rear of the orbit being bound by the white etching of the bar. In *Bitis brianwallacei sp. nov.* the darker bar running from the lip through the eye sits further forward so that the lighter area at the rear forms a large triangle from the labial to the top of the eye (as opposed to a near triangular thick bar), and most importantly runs to either the bottom of the eye or slightly behind this (more than 2/3 the way to the bottom of the eye), whereas the lower eye is met by darker scales in both *Bitis arietans* and *Bitis Oflahertyae sp. nov.*. In common with both *Bitis arietans* and *Bitis Oflahertyae sp. nov.* the top of this lighter bar or triangle forms a usually unbroken line, about a scale thick, running across the head between the upper rear of each eye.

At the top of the rear of the head (the crown) in *Bitis brianwallacei sp. nov.* are five irregular shaped "spots", in a configuration of a single spot in the centre at the front with four positioned in a square behind this central spot. The two rear "spots" are elongate running across the back of the head being twice or three times as long (wide) as deep, consisting of individually marked scales in most cases or in a few cases light pigment running into the adjacent scales. In rare cases the "rear" spots are broken, by consisting of three scales, the middle being normal (darker) pigment.

*Bitis lourenceklosei sp. nov.* is readily separated from all others in the *Bitis arietans* species group by the unusually thick dark band that runs from the labials through the front of the eye and across the head.

In this taxon, the band is of even thickness from the labials into the eye (unique for this taxon), where it runs across the front of the eye and over the head. The rear third of the eye is abutted by pale scales being the top of a triangular-shaped light patch.

In front of the darker band running through the orbit, the lighter cross-band is reduced at the labials, making it distinctly narrower than the broad dark band that follows it, making this a unique colour variation in this species in the *Bitis arietans* species group.

The white cross-band running across the rear of the head is broken in middle. There are four single light scales on the crown in a diamond pattern.

Also characterized by less than 20 cross-bands forming chevrons on the body (as opposed to over 22 in *Bitis arietans*).

*Bitis pintauidii sp. nov.* is separated from all others in the *Bitis arietans* species group by the excess of lighter pigment on the top of the head. The lighter temporal streak running from the rear of the head to the top of the eye is an average of 3 scales wide in this taxon, as opposed to two wide in all others in the *Bitis arietans* species group. The lighter bar across the top of the

head at the rear of the eyes is thickened slightly and has a noticeable backwards expansion at the centre of the head. The light patch at the rear of the side of the head behind the darker cross-band that runs from labials through the eye is noticeably squarish at the top (with an even line), giving the patch the appearance of a skewed square, as opposed to the normal triangular appearance of the patch in all others in the *Bitis arietans* species group. This is largely caused by the fact that the dark patch at the rear of and above of this light region, while triangular in shape (as opposed to elongate in some others in the *Bitis arietans* species group), actually terminates 4 scales to the rear of the orbit and is connected to the eye by a well-defined but narrow dark line of less than a scale wide.

The dorsal surface of this taxon is characterised by large white blotches not seen in any other species in the *Bitis arietans* species group. These commence about a third of the way down the body and end shortly before the tail, which resumes a more-or-less banded appearance as seen in most specimens in the *Bitis arietans* species group.

In terms of chevrons or the equivalent (as measured) this taxon is characterised by no more than 18 on the body (usually 17).

*Bitis somalica* Parker, 1949 is unique in the *Bitis arietans* species group in that their subcaudals are keeled (Spawls and Branch 1995).

**Distribution:** The southern end of the Arabian Peninsula, including Oman, Yemen and South-west Saudi Arabia.

**Etymology:** Named in honour of Thomas (Tom) Cotton of Ringwood, Victoria, Australia in recognition of many years service to herpetology and wildlife education in his role as manager at Snakebusters reptile education.

**BITIS PINTAUDII SP. NOV.**

**Holotype:** Specimen number 1912.250 at the the Muséum national d'Histoire naturelle in Paris, France, collected from Agadir, Morocco, North Africa.

The Muséum national d'Histoire naturelle is the National Museum of Natural History in Paris, France and is a government-owned facility that allows access to it's collection by scientific researchers.

**Paratypes:** Specimen numbers 1916.8, 1961.336, 1961.335 all from Morocco in North Africa at the the Muséum national d'Histoire naturelle in Paris, France.

Specimen number 1906.10.31.14 at the British Museum of Natural History, London, UK, from Morocco.

The Muséum national d'Histoire naturelle is the National Museum of Natural History in Paris, France and the British Museum of Natural History, London, UK are government-owned facilities that allow access to their collections by scientific researchers.

**Diagnosis:** *Bitis pintaudii sp. nov.* is separated from all others in the *Bitis arietans* species group by the excess of lighter pigment on the top of the head. The lighter temporal streak running from the rear of the head to the top of the eye is an average of 3 scales wide in this taxon, as opposed to two wide in all others in the *Bitis arietans* species group. The lighter bar across the top of the head at the rear of the eyes is thickened slightly and has a noticeable backwards expansion at the centre of the head.

The light patch at the rear of the side of the head behind the darker cross-band that runs from labials through the eye is noticeably squarish at the top (with an even line), giving the patch the appearance of a skewed square, as opposed to the normal triangular appearance of the patch in all others in the *Bitis arietans* species group. This is largely caused by the fact that the dark patch at the rear of and above of this light region, while triangular in shape (as opposed to elongate in some others in the *Bitis arietans* species group), actually terminates 4 scales to the rear of the orbit and is connected to the eye by a well-defined but narrow dark line of less than a scale wide.

The dorsal surface of this taxon is characterised by large white

blotches not seen in any other species in the *Bitis arietans* species group. These commence about a third of the way down the body and end shortly before the tail, which resumes a more-or-less banded appearance as seen in most specimens in the *Bitis arietans* species group.

In terms of chevrons or the equivalent (as measured) this taxon is characterised by no more than 18 on the body (usually 17).

*Bitis ollahertyae sp. nov.* is separated from *Bitis arietans* by having less than 20 cross-bands forming chevrons on the body (as opposed to over 22 in *Bitis arietans*). On the latter half of the body, the lighter parts of the mid-dorsal chevrons are completely encircled with dark blackish scales and separated from the nearby white flashes at the rear of the darker irregular crossbands.

Unlike in *Bitis arietans*, there are not five light "spots" on the crown of the head of uneven size or shape, with one in the centre of the crown and the others forming the points of a square around this middle spot, covering an area, about four fifths that of the length between the eyes.

In this taxon, with the possible exception of a small white line at the centre of the neck, there are no light markings on the top of the back of the head or neck. The dark pigment in this region is nearly black in juveniles and similar but faded somewhat in adults.

In rare cases of "spots" on the rear of the head in juveniles, at the top of the rear of the head (the crown) are five irregular shaped "spots", in a configuration of a single spot in the centre at the front with four positioned in a square behind this central spot. The two rear "spots" are not elongate running across the back of the head being twice as long (wide) as deep as seen in *Bitis brianwallacei sp. nov.* (described below).

The nominate form of *Bitis arietans* and this species are additionally defined as follows: It is a relatively large, stout viper, rarely exceeding 1 m in total length but occasionally reaching almost 2 m. Its head is broad, flat, and subtriangular with small, imbricate rostral scales. The nostrils face vertically upwards. There is a circumorbital ring of 10-16 scales, and there are 3-4 scale rows between the suborbital and the 12-17 supralabials (Mallow *et al.* 2003). The nasal and the rostral are separated by 2-3 scale rows, and there are 13-19 sublabials, the first 3-5 of which border the chin shields. The anal plate is single (Broadley 1983). There are 29-41 dorsal mid-body scale rows, the inner rows of which are strongly keeled. There are 123-147 ventral scales, and 14-38 subcaudals (no more than 24 in females) (Mallow *et al.* 2003). Two long, hollow, and recurved fangs are present at the anterior end of the substantially shortened maxillary. These fangs articulate with the shortened maxilla, which in turn articulates with the palatomaxillary arch (Pough *et al.* 2004). When not in use, the fangs fold up against the roof of the mouth into a protective fleshy sheath. The palatines and pterygoids bear small recurved teeth, which decrease in size posteriorly (Broadley 1983). This species as recognized to date, exhibits geographic variation in coloration, that correlates with phylogenetic clades. However in general in the nominate form the colour is as follows: there is a dark patch on the crown of the head and a bar running across the front of the head more-or-less though the eyes and scales between the upper lip. Two oblique bars extend from at or near the eye to the lip separated by lighter areas, and the eye itself may be gold to silver gray. Dorsally, the coloration ranges from straw yellow to reddish brown, with a pattern of 22-24 dark chevrons extending along the back and continuing as 2-6 dark crossbands on the tail, although abundant brown or black speckles may obscure this pattern in some individuals. Coloration on the ventral surfaces is white to yellow, usually with several dark spots (Spawls and Branch 1995, Mallow *et al.* 2003). Juveniles tend to have golden markings on the head, and their lateral ventral plates are pinkish to reddish. (Mallow *et al.* 2003). Coloration is somewhat variable within this species complex, with individuals of the nominate form from the eastern part of its range tending to be more

brightly colored than individuals from western habitats, which are paler and more drab. Males in general tend to be more brightly colored than females (Broadley 1983, Branch 1988). Unusual color patterns, including a light vertebral stripe, have also been observed in the species (Branch 1988, Mallow *et al.* 2003).

The oblique bars that extend from at or near the eye to the lip, fade with age and the lighter areas also darken, but leaving well-defined light markings forming narrow stripe-like markings on the head at the original boundary of the lighter patches.

In this species, the darker oblique bar that runs from labials, up and through eye, across the head and down the other side sits marginally to the front of the orbit with the rear of the orbit being bound by the white etching of the bar.

On the crown of the head is five light "spots" not of even size or shape, with one in the centre of the crown and the others forming the points of a square around this middle spot, covering an area, about four fifths that of the length between the eyes.

The coloration is sufficient to distinguish *Bitis arietans sensu lato* (including taxa described within this paper for the first time) from all other large species of African adders, which have more "complex, geometric colour patterns" (Spawls and Branch 1995). Additionally, this species can be differentiated from the other members of the genus *Bitis (sensu lato)* by the presence of 1-3 scales between the nasal and the first supralabial, 1-2 scales between the nasal and the rostral scales, and molecularly by differences in cytochrome b as described by Mallow *et al.* (2003).

Until now, *Bitis arietans* has been divided into two subspecies, namely, *B. a. arietans* and *B. a. somalica*: these can be distinguished by their subcaudal scales, which are keeled in the latter and not in the former (Spawls and Branch 1995).

A molecular study published by Barlow *et al.* (2013) indicated that species-level recognition for *B. a. somalica* is almost certainly appropriate, even though it is not even certain on their own evidence if this taxon was tested by the authors. Hence and on the basis of the other molecular evidence these authors presented, it is recognized as a full species herein.

That species is known only from Somalia and nearby parts of Kenya and based on the evidence of Barlow *et al.* (2013) it is unlikely to range much further if at all.

*Bitis brianwallacei sp. nov.* is diagnosed by the following trait: Many dorsal scales on the darker areas are characterized by a large yellow dot in the centre forming a pattern of crossbands (usually but not always of three rows at a time) on the darker regions.

*Bitis brianwallacei sp. nov.* is separated from *Bitis arietans* by having less than 20 cross-bands forming chevrons on the body (as opposed to over 22 in *Bitis arietans*).

Specimens of *Bitis brianwallacei sp. nov.* commonly have chevrons that give an appearance of ovoid blotches. Dorsally there is an absence of white blotches or markings commonly seen in other species in the *Bitis arietans* species group.

In both *Bitis arietans* and *Bitis Oflahertyae sp. nov.* the darker oblique bar that runs from labials, up and through eye, across the head and down the other side sits marginally to the front of the orbit with the rear of the orbit being bound by the white etching of the bar. In *Bitis brianwallacei sp. nov.* the darker bar running from the lip through the eye sits further forward so that the lighter area at the rear forms a large triangle from the labial to the top of the eye (as opposed to a near triangular thick bar), and most importantly runs to either the bottom of the eye or slightly behind this (more than 2/3 the way to the bottom of the eye), whereas the lower eye is met by darker scales in both *Bitis arietans* and *Bitis Oflahertyae sp. nov.* In common with both *Bitis arietans* and *Bitis Oflahertyae sp. nov.* the top of this lighter bar or triangle forms a usually unbroken line, about a scale thick, running across the head between the upper rear of each eye.

At the top of the rear of the head (the crown) in *Bitis*

*brianwallacei sp. nov.* are five irregular shaped "spots", in a configuration of a single spot in the centre at the front with four positioned in a square behind this central spot. The two rear "spots" are elongate running across the back of the head being twice or three times as long (wide) as deep, consisting of individually marked scales in most cases or in a few cases light pigment running into the adjacent scales. In rare cases the "rear" spots are broken, by consisting of three scales, the middle being normal (darker) pigment.

*Bitis lourenceklosei sp. nov.* is readily separated from all others in the *Bitis arietans* species group by the unusually thick dark band that runs from the labials through the front of the eye and across the head.

In this taxon, the band is of even thickness from the labials into the eye (unique for this taxon), where it runs across the front of the eye and over the head. The rear third of the eye is abutted by pale scales being the top of a triangular-shaped light patch.

In front of the darker band running through the orbit, the lighter cross-band is reduced at the labials, making it distinctly narrower than the broad dark band that follows it, making this a unique colour variation in this species in the *Bitis arietans* species group.

The white cross-band running across the rear of the head is broken in middle. There are four single light scales on the crown in a diamond pattern.

Also characterized by less than 20 cross-bands forming chevrons on the body (as opposed to over 22 in *Bitis arietans*).

*Bitis tomcottoni sp. nov.* is separated from all others in the *Bitis arietans* species group by the unusually thick dark band that runs from the rear of the head (temple region) into the orbit. In all other species this narrows considerably to either run into the eye as a sliver (less than a scale wide), or alternatively not at all, being blocked by some lighter scales (part of a lighter marking).

In *Bitis tomcottoni sp. nov.* this dark band is typically 2-3 scales wide when it runs into the eye (rarely 1.5 scales wide), as opposed to usually less than a scale thick at the point near the eye and not more than a scale thick in all others in the *Bitis arietans* species group.

The light band across the head at the rear of the eyes is thick, being at least a scale thick, and there is a second similar light band that runs across the back of the head 4 scales anterior to the rear of the head.

*Bitis somalica* Parker, 1949 is unique in the *Bitis arietans* species group in that their subcaudals are keeled (Spawls and Branch 1995).

**Distribution:** Morocco. Specimens previously assigned to *Bitis arietans* in sub-Saharan West Africa east to Cameroon are tentatively assigned to this species.

**Etymology:** Named in honour of Vince Pintaudi of Narre Warren, Melbourne, Victoria, Australia for his many years of work with reptiles, including as an emergency snake catcher and manager at Amazing Amazon, Springvale Road, Glen Waverley, one of Melbourne's few specialist stores dealing with reptiles and their care.

#### **BITIS SOMALICA PARKER, 1949.**

**Diagnosis:** Unique in the *Bitis arietans* species group in that their subcaudals are keeled (Spawls and Branch 1995).

**Distribution:** Known only from Somalia and allegedly found in nearby parts of Kenya.

#### **FURTHER INFORMATION RELEVANT TO THE PRECEDING DESCRIPTIONS**

As further diagnostic information that should be treated as being within each of the *Bitis* species descriptions above, the species newly described herein can also be assigned to some of the phylogenetic clades as identified by Barlow *et al.* 2013.

*Bitis oflahertyae sp. nov.* corresponds with Clade 6 as described by Barlow *et al.* 2013 (Fig 1 and text). *Bitis brianwallacei sp. nov.*

corresponds with Clade 4 as described by Barlow *et al.* 2013 (Fig 1 and text). *Bitis loureceklosei sp. nov.* corresponds with Clade 8 as described by Barlow *et al.* 2013 (Fig 1 and text). *Bitis tomcottoni sp. nov.* corresponds with Clade 1 as described by Barlow *et al.* 2013 (Fig 1 and text). *Bitis pintauidii sp. nov.* corresponds with Clade 2 as described by Barlow *et al.* 2013 (Fig 1 and text). *Bitis arietans* corresponds with one of five unnumbered subclades (as a single clade) from South Africa and adjoining states described by Barlow *et al.* 2013 (Fig 1 and text). *Bitis somalica (terra typica)* from Somalia was not sampled by Barlow *et al.* 2013 or identified in either Fig 1 and the paper's text, so is presumed here to represent a separate species level clade.

#### FIRST REVISOR'S NOTE.

In the event that any subsequent worker seeks to merge taxa described within this paper, in terms of conflict with names and taxa, the order of priority of retention should be that published within this paper. That is the taxon names named first used within this paper have nomenclatural priority over later names.

#### ACKNOWLEDGEMENTS.

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**A formal five-way division of the Gaboon Viper Species Complex: *Bitis (Macrocerastes) gabonica* (Duméril, Bibron and Duméril, 1854) and a two-way division of the Nose-horned Viper species complex *Bitis (Macrocerastes) nasicornis* (Shaw, 1802) (Serpentes:Viperidae:Bitisini).**

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**ABSTRACT**

The Gaboon Viper *Bitis gabonica* (Duméril, Bibron and Duméril, 1854) as a species complex has had a fairly stable taxonomic history since being described at the species level, although the species as generally recognized was transferred to the genus *Bitis* Gray, 1842 shortly after the original description. Likewise for the Nose-horned Viper species complex *Bitis (Macrocerastes) nasicornis* (Shaw, 1802).

The species known as the Rhinoceros Viper *Bitis rhinoceros* (Schlegel, 1855) was synonymised with *Bitis gabonica* by virtually all herpetologists beyond 1855 until 1999 (see McDiarmid *et al.* 1999), when Lenk *et al.* (1999) provided a molecular basis to recognize the western population, (then known as *Bitis gabonica rhinoceros*) identified in 1999 on the basis of allopatric distribution as opposed to any consistent morphological divergence.

Chippaux (2006), showed that consistent differences in the markings on the side of the head could be used to identify and separate *Bitis rhinoceros* from the nominate species.

Meanwhile the Gaboon Viper as popularly recognized since 1999 comprises the main population centred on the wetter parts of west-central Africa (the type locality Gabon) including several countries and then three quite distant and unconnected outlier populations.

These are each centred on eastern Tanzania along the coastal strip and hills nearby, the eastern escarpments of Zimbabwe and KwaZulu-Natal, north-east South Africa.

Like the disjunct West African population now identified as *B. rhinoceros*, specimens within the three other outlier populations also have consistent phenotypic differences to the main group making them worthy of taxonomic recognition. As all have been reproductively isolated for a long time and clearly form evolutionary species units, each are formally described herein as new species and named according to the Zoological Code.

The species known as the *Bitis (Macrocerastes) nasicornis* (Shaw, 1802), has had a stable taxonomic history at the species level. However phenotypic differences between the nominate western form and that from east of the Dahomey Gap are well known (Phelps 2010), but have not been properly and consistently identified. As they have been reproductively isolated for a long time and clearly form evolutionary species units, the eastern form is described and named according to the Zoological Code.

**Keywords:** Taxonomic revision; Gaboon Vipers; *Bitis*; *Macrocerastes*; *gabonica*; *rhinoceros*; *nasicornis*; new species; *funki*; *wellsi*; *wellingtoni*; *hoserae*.

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**INTRODUCTION**

The Gaboon Viper *Bitis gabonica* (Duméril, Bibron and Duméril, 1854) is one of the world's icon snakes.

Reputed to be the world's heaviest True Viper, large specimens also have the longest fangs (up to 2 inches or 5.5 cm), and

reputedly the highest venom yield of any venomous snake (Mallow *et al.* 2003).

The Gaboon Viper *Bitis gabonica* as a species complex has had a fairly stable taxonomic history since being described at the species level, although the species as generally recognized was

transferred to the genus *Bitis* Gray, 1842 shortly after the original description.

The species known as the Rhinoceros Viper *Bitis rhinoceros* (Schlegel, 1855), the taxon found west of the Dahomey Gap was synonymised with *Bitis gabonica* by virtually all herpetologists beyond 1855 until 1999 (as indicated by McDiarmid *et al.* 1999).

However in that year Lenk *et al.* provided a molecular basis to recognize the population, apparently identified by these authors in 1999 on the basis of allopatric distribution as opposed to any identified consistent morphological divergence.

Chippaux (2006), showed that consistent differences in the markings on the side of the head could be used to identify and separate *Bitis rhinoceros* from the nominate species (see below for detail).

Meanwhile extensive collecting by herpetologists in Africa over the past 150 years has shown that the Gaboon Viper as popularly recognized comprises the main population centred on the wetter parts of west-central Africa (the type locality Gabon) including several countries and then three quite distant and unconnected outlier populations.

These are each centred in distinct habitat regions, being in eastern Tanzania along the coastal strip and hills nearby, the high rainfall eastern escarpments of Zimbabwe and forested parts of KwaZulu-Natal, north-east South Africa.

Like the disjunct East African population now identified as *B. rhinoceros*, specimens within the three other outlier populations also have consistent phenotypic differences to the main group making them worthy of taxonomic recognition. As all have been reproductively isolated for a long time and clearly form evolutionary species units, each are formally described herein as new species and named according to the Zoological Code (Ride *et al.* 1999).

In terms of diagnosing and describing the new species taxa according to the Zoological Code the process (or "materials and methods") was in fact quite simple and straight forward. In fact I am amazed that the division of the Gaboon Vipers into five species groups hasn't been done earlier.

Live specimens with accurate locality information were inspected by myself during a trip to Africa in 2009 and earlier visits to Europe and the United States. Visually they differed by location, but these differences were hard to quantify using the usual characteristics of scalation and the like due to variability in individuals and overlaps between specimens from different regions. But because specimens were photographed as well, I was able to revisit these and ascertain consistent regional differences in markings and the like which indicated taxonomic divergence.

Due to the small size of the sample, I was not confident that the differences I observed were consistent and so I then sought and got numerous images of specimens from throughout the known range of the species group, which had accurate locality data.

This included all taxa identified herein as new species as well as the two forms already with available names.

This material was provided by both herpetologists and non-herpetologists, none of whom sought any payment or gratitude for the time and effort expended by them.

Once the consistent differences were known, it was possible to ascertain the origin of a given specimen based on the head markings even without direct reference to the locality information on hand.

An almost identical situation is seen in the species complex, known as *Bitis (Macrocerastes) nasicornis* (Shaw, 1802). It has had a stable taxonomic history at the species level. However phenotypic differences between the nominate western form and that from east of the Dahomey Gap are well known (Phelps 2010), but have not been properly and consistently identified. As they have been reproductively isolated for a long time and clearly form evolutionary species units, the eastern form is

described and named according to the Zoological Code.

In terms of the nominate form and holotype material the following is noted:

The nominate form of *B. nasicornis* probably comes from Ghana (Hughes and Barry, 1969), meaning that the population east of the Dahomey Gap is that which is unnamed to date.

That the holotype snake is of the western form (that west of the Dahomey Gap) is confirmed by the drawing that accompanies Shaw's original descriptions of the taxon in 1792 and 1802, noting that his written description was vague in terms of the head markings and so reference must be made to the accompanying drawing. The depicted specimen has a distinct white band running along the border of the upper labials. This feature is diagnostic of the western population, but absent in the snakes east of the Dahomey Gap. That the Shaw animal was of the Western form is also confirmed by the presence of the dark patch extending well anterior of the eye, as opposed to only slightly, as seen in the eastern species (see the formal diagnosis for *B. hoserae* sp. nov. below).

The holotype for the species *Vipera hexacera* Duméril, Bibron and Duméril, 1854 is also assignable to the named western species of *B. nasicornis* and is therefore not an available name for the eastern population.

The materials and methods of gathering data for the snakes hitherto known as *B. nasicornis* was as for the *B. gabonica* species group as already outlined. In summary and notwithstanding a range of means to separate the two separate taxa within the *B. nasicornis* group, it was found to be easiest to separate the taxa based on consistent marking differences on the head, as indicated in the relevant description below.

The body of published literature in terms of the *B. gabonica* and *B. nasicornis* species group/s is vast, due to the icon nature of the snakes themselves. Put bluntly, they are large colourful vipers sought after by reptile hobbyists and zoos everywhere.

Important and relevant material published to date includes: Böhme *et al.* (2011), Boulenger (1896), Branch (1993), Broadley and Cock (1975), Broadley and Howell (1991), Broadley and Parker (1976), Broadley *et al.* (2003), Calvete *et al.* (2007), Chippaux (2006), Chirio and Ineich (2006), Chirio and Lebreton (2007), Cope (1859), Critchlow (1998), Daudin (1802), Ditmars (1933), Dobiey and Vogel (2007), Duméril *et al.* (1854), Gray (1842), Hallowell (1847, 1857), Herrmann *et al.* (1999), Hoser (2012), Lenk *et al.* (1999), Linder *et al.* (2012), Loveridge (1936), Mallow *et al.* (2003), Marias (2004), Marsh and Whaler (1984), Marx (1988), Mattison (2007), McDiarmid *et al.* (1999), Mehrtens (1987), Menzies (1966), Mertens (1951), Pauwels and Vande weghe (2008), Peters (1882), Phelps (2010), Pitman (1974), Pyron *et al.* (2011, 2013), Schlegel (1855), Segniagbeto *et al.* (2011), Shaw and Nodder (1792), Shaw (1802), Spawls and Branch (1995), Spawls *et al.* (2004), Sweeney (1971), Warner and Kyle (2010), Wood (1996) and sources cited therein.

#### GENERAL DESCRIPTION OF ALL SPECIES WITHIN THE *BITIS GABONICA* SPECIES COMPLEX

As a description, these snakes are typical of the True Viper's, the most notable feature being their massive adult size.

Adults average 122-152 cm (4 to 5 feet) in length with a maximum of 205 cm (81 in) reported a specimen collected in Sierra Leone. The sexes are most readily distinguished by the length of the tail in relation to the total length of the body: approximately 12 percent for males and 6 percent for females, with males having a considerably larger tail by mass. Sexual dimorphism is obvious with females being considerably heavier and more stout in build.

Mallow *et al.* (2003) reported that a particularly large female had the following dimensions: Total length 174 cm (69 in); Head width 12 cm (4.7 in); Girth 37 cm (14.65 in); Weight (empty stomach) 8.5 kg (19 lbs).

In their description of "*B. gabonica*", Spawls *et al.* (2004) give

an average length of 80-130 cm (32 to 51.5 in), with a maximum size of 175 cm (69.3 in), saying the species may possibly grow larger still. They acknowledged reports of specimens over 1.8 m (6 ft), or even over 2 m (6.5 ft) in length, but claim they had no evidence to support this. A large specimen of exactly 1.8 m (5.9 ft), caught in 1973, was reported to have weighed 11.3 kg (25 lb) with an empty stomach (Wood, 1983). Very large specimens may possibly weigh up to 20 kg (44 lb), which would rank them as the world's heaviest venomous snake ahead of the Eastern diamondback Rattlesnake *Hoserea (Edwardsus) adamanteus* (Palisot de Beauvois, 1799) of the United States of America, but these masses are not known to have been verified (Wood, 1983).

In form the head is large and triangular, while the neck is greatly narrowed: almost one-third the width of the head. A pair of horns is present between the raised nostrils and these regionally vary in size and by individual specimen. As a rule these horns are tiny in all snakes referred to *B. gabonica* (including outlier populations), but much larger in most but not all snakes herein referred to as *B. rhinoceros*. The species *B. (Macrocerastes) nasicornis* is sometimes confused with *B. gabonica* (including *B. rhinoceros*), but is most readily identified by the large lance-shaped marking on the head and neck, not seen in the other species.

In terms of the *B. gabonica* species group, the eyes are large and moveable, set well forward, and surrounded by 15-21 circumorbital scales. There are 12-16 interocular scales across the top of the head. Four or five scale rows separate the suboculars and the supralabials. There are 13-18 supralabials and 16-22 sublabials. The fangs may reach a length of 55 millimetres (2.2 in), believed to be the longest of any venomous snake.

There are 28-46 dorsal mid-body scale rows, all of which are strongly keeled except for the outer rows on each side. The lateral scales are slightly oblique. The ventral scales number 124-140, rarely more than 132 in males, rarely less than 132 in females. The anal scale is single. There are 17-33 paired subcaudals, males have no fewer than 25, females no more than 23.

The color pattern consists of a series of pale, subrectangular blotches running down the center of the back, interspaced with dark, yellow-edged hourglass markings. The flanks have a series of fawn or brown rhomboidal shapes, with light vertical central bars. The belly is pale with irregular brown or black blotches.

The head is white or cream often with a fine, dark central line commencing from the back of the eyes and running to the top of the neck, black markings or spots on the rear corners, and a dark blue-black bar, triangle or diamond behind and below each eye, the front one being absent in *B. rhinoceros* and diagnostic for that taxon (see detail below). The iris color is cream, yellow-white, orange or silvery.

The species group is found in the following places: Guinea, Ghana, Togo, Sierra Leone, Liberia, Nigeria, Cameroon, Democratic Republic of Congo, Central African Republic, South Sudan, Uganda, Kenya, eastern Tanzania, Zambia, Malawi, eastern Zimbabwe, Mozambique, and northeast KwaZulu-Natal Province in South Africa.

In terms of preferred habitat, these snakes are typically found in rainforests, similar wet habitats and nearby woodlands and the edges of them, mainly at low altitudes, but sometimes as high as 1500 m. Spawls *et al.* (2004) mention a maximum altitude of 2100 m. Broadley and Cook (1975), mentioned the well-known fact that this species group is generally found in environments that are parallel to those occupied by the considerably more widespread Puff Adders (Subgenus *Bitisin*), which are normally found in drier and more open habitats.

Due to their cryptic colouration and lack of movement by day in warm weather they are generally hard to find. Most are caught

by herpetologists when crossing roads at night using the collecting methods described by Hoser (1989).

In cool weather, snakes are more likely to be seen by day either on top of ground cover or moving about, although never as easy to find in numbers as in perfect conditions in warm weather by road cruising.

While physically slow-moving and placid they can strike at speed and are typical in form for ambush predators.

As a rule, they are good captives choosing not to strike when handled. They should not be handled with so-called "snake tongs" as they have been known to fatally injure these snakes by breaking bones or damaging internal organs.

As a rule, locomotion is mostly rectilinear, in a sluggish "walking" motion of the ventral scales, the scales and venter giving a similar appearance at a distance to the legs of a millipede as it moves forward. They may writhe from side to side when alarmed, but only for short distances. Ditmars (1933) even described them as being capable of sidewinding, but this is in fact the case only in small and young specimens and again for only a very short distance.

Usually, these snakes give birth in late summer or at the end of the wet season, with an average litter of about 20 young. In line with other snakes, larger individuals are prone to having litters considerably larger than the average.

Neonates are reported by Spawls and Branch (1995), to be 25-32 cm in length and weigh 25-45 g.

The venom of these snakes is not particularly toxic, but due to volume released, the snakes are dangerous to humans.

#### THE SEPARATION OF EACH OF THE GABOON VIPER TAXA

Preceding the formal descriptions of the three new species taxa according to the Zoological Code (Ride *et al.* 1999), I herein give an overview of how the regional species of the *Bitis gabonica* species complex are separated from one another most easily.

Diagnosis of each species level taxon is most easily done by viewing the black to dark brown markings on the head that run from the eye to the (supra) labials, which are distinct from the otherwise lighter scales (pigment) on the rest of the head, which are a creamish-white to yellowish in colour. In the nominate form from central-west Africa (Type locality Gabon, Africa), there are two such lines, one running from the front of the eye to the labials (more-or-less running straight down, though angled slightly backwards) and the other from the rear of the eye in an expanding and descending triangle to the labials and back of the head. The size, shape and configuration of these bars (or their absence) and the white bar between them are diagnostic for the regional species within this species complex.

Of note is that many specimens (in particular younger ones) have a mid-dorsal stripe running from behind the nostrils to the beginning of the neck, but this is not diagnostic of any forms, although is by far most prevalent in nominate species *B. gabonica* and *B. wellingtoni sp. nov.* from Tanzania.

The diagnostic characters of the nominate form *Bitis gabonica* are as follows: The front stripe or bar running down from the eye to the labials has a thick zone of contact with the eye (giving it a distinctive U-shaped appearance), and always includes more than 2 labials wide of dark pigment at the base (on the bottom of the labials), the light bar behind this is irregular edged and is not in a straight line.

*Bitis rhinoceros* is diagnosed by the fact that it lacks a front stripe down from eye. The pigment where this would be is all light coloured as for the rest of the head. There is occasionally a small black "tear drop" seen running down from the eye.

In specimens of the species *B. funki sp. nov.* from north-east South Africa, the black bar at the front is narrow at the labials and two or less labials wide, in most cases being 2 labials wide with lightening apparent at the edge of one or other of the darkened labials. This species is the only one in the complex that has such a reduced width in the base of the front black bar.

The front stripe down from eye has a narrow zone of contact with the eye, occasionally not quite making it to the eye (giving it an inverted "V" shape). In some specimens this anterior dark bar also reduces at the bottom, giving it a diamond-shaped or oversized "tear drop" shape/appearance (not to be confused with the small tear drop-sized marking sometimes seen in *B. rhinoceros*). Occasionally no dark pigment reaches the bottom of the supralabials (the jawline). Due to reduction of black pigment at the base of the labials, the irregular white bar running from the labials to the eye has a distinctly triangular appearance with a wider base at the labials.

In specimens of *B. wellsi* sp. nov. from Zimbabwe, the black of the front and rear bars is so great as to merge, so that the front bar is usually 3 labials wide at the base and the white between the front and back bars forms a line up from the labials, but does not meet the eye, this being surrounded at the bottom with black pigment, or if it does contact the eye, does so as a tiny white line only (a sliver). Young specimens may have tiny black specks in front of the eye, which become indistinct with age.

In *B. wellingtoni* sp. nov. from eastern Tanzania, the first black bar from the eye is triangular in appearance, is at least 2.5 labials wide at the base (the bottom of the supralabials) and up to 3.5 labials wide; the white line between the two dark bars is of even thickness along its length, or rarely widens slightly at the labials and there is an elongate black bar in front of each eye that is not seen in any other species in the complex.

#### **BITIS FUNKI SP. NOV.**

**Holotype:** Specimen number FMNH no. 205789 from Natal, Zululand District, South Africa, (Collected by John Visser in 1973), held at the Field Museum of Natural History at 1400 S Lake Shore Drive, Chicago, IL 60605, United States of America. This is a government-owned facility that allows access to its material by scientists.

**Paratype No. 1:** Specimen number FMNH no. 205790 from Natal, Zululand District, South Africa, (Collected by John Visser in 1973), held at the Field Museum of Natural History at 1400 S Lake Shore Drive, Chicago, IL 60605, United States of America. This is a government-owned facility that allows access to its material by scientists.

**Paratype No. 2:** A specimen number: CM Herps 69392 obtained from St. Lucia, Dukuduku Forest, KwaZulu-Natal, South Africa held at the Carnegie Museum of Natural History, 4400 Forbes Avenue, Pittsburgh, PA 15213, United States of America. This is a facility that allows access to its material by scientists.

**Diagnosis:** Diagnosis of each species level taxon in the *Bitis gabonica* species complex is most easily done by viewing the black to dark brown markings on the head that run from the eye to the (supra) labials, which are distinct from the otherwise lighter scales (pigment) on the rest of the head, which are a creamish-white to yellowish in colour. In the nominate form from central-west Africa (Type locality Gabon, Africa), there are two such lines, one running from the front of the eye to the labials (more-or-less running straight down, though angled slightly backwards) and the other from the rear of the eye in an expanding and descending triangle to the labials and back of the head. The size, shape and configuration of these bars (or their absence) and the white bar between them are diagnostic for the regional species within this species complex.

Of note is that many specimens (in particular younger ones) have a vertebral stripe running from behind the nostrils to the beginning of the neck, but this is not diagnostic of any forms, although is by far most prevalent in nominate species *B. gabonica* and *B. wellingtoni* sp. nov. from Tanzania.

The diagnostic characters of the nominate form *Bitis gabonica* are as follows: The front stripe or bar running down from the eye to the labials has a thick zone of contact with the eye (giving it a distinctive U-shaped appearance), and always includes more than 2 labials wide of dark pigment at the base (on the bottom of the labials), the light bar behind this is irregular edged and is not in a straight line.

*Bitis rhinoceros* is diagnosed by the fact that it lacks a front stripe down from eye. The pigment where this would be is all light coloured as for the rest of the head. There is occasionally a small black "tear drop" seen running down from the eye.

In specimens of the species *B. funki* sp. nov. from north-east South Africa, the black bar at the front is narrow at the labials and two or less labials wide, in most cases being 2 labials wide with lightening apparent at the edge of one or other of the darkened labials. This species is the only one in the complex that has such a reduced width in the base of the front black bar. The front stripe down from eye has a narrow zone of contact with the eye, occasionally not quite making it to the eye (giving it an inverted "V" shape). In some specimens this anterior dark bar also reduces at the bottom, giving it a diamond-shaped or oversized "tear drop" shape/appearance (not to be confused with the small tear drop-sized marking sometimes seen in *B. rhinoceros*). Occasionally no dark pigment reaches the bottom of the supralabials (the jawline). Due to reduction of black pigment at the base of the labials, the irregular white bar running from the labials to the eye has a distinctly triangular appearance with a wider base at the labials.

In specimens of *B. wellsi* sp. nov. from Zimbabwe, the black of the front and rear bars is so great as to merge, so that the front bar is usually 3 labials wide at the base and the white between the front and back bars forms a line up from the labials, but does not meet the eye, this being surrounded at the bottom with black pigment, or if it does contact the eye, does so as a tiny white line only (a sliver). Young specimens may have tiny black specks in front of the eye, which become indistinct with age.

In *B. wellingtoni* sp. nov. from eastern Tanzania, the first black bar from the eye is triangular in appearance, is at least 2.5 labials wide at the base (the bottom of the supralabials) and up to 3.5 labials wide; the white line between the two dark bars is of even thickness along its length, or rarely widens slightly at the labials and there is an elongate black bar in front of each eye that is not seen in any other species in the complex.

**Distribution:** KwaZulu-Natal, South Africa and nearby areas.

**Etymology:** Named in honour of Mesa, Arizona, USA based herpetologist and veterinary surgeon, Dr. Richard Funk, (formerly of Florida USA), in recognition of a lifetime's service to herpetology and reptile medicine and surgery in a career spanning more than 60 years and starting as a child.

#### **BITIS WELLSI SP. NOV.**

**Holotype:** Specimen number, YPM HERR 006212 at the Yale University Peabody Museum, 170 Whitney Ave, New Haven, Connecticut, United States of America, collected from Zimbabwe. This is a facility that allows access to its material by scientists.

**Paratypes:** Three specimen numbers, YPM HERR 006213, YPM HERR 006214, YPM HERR 000020 at the Yale University Peabody Museum, 170 Whitney Ave, New Haven, Connecticut, United States of America, collected from Zimbabwe. This is a facility that allows access to its material by scientists.

**Diagnosis:** Diagnosis of each species level taxon in the *Bitis gabonica* species complex is most easily done by viewing the black to dark brown markings on the head that run from the eye to the (supra) labials, which are distinct from the otherwise lighter scales (pigment) on the rest of the head, which are a creamish-white to yellowish in colour. In the nominate form from central-west Africa (Type locality Gabon, Africa), there are two such lines, one running from the front of the eye to the labials (more-or-less running straight down, though angled slightly backwards) and the other from the rear of the eye in an expanding and descending triangle to the labials and back of the head. The size, shape and configuration of these bars (or their absence) and the white bar between them are diagnostic for the regional species within this species complex.

Of note is that many specimens (in particular younger ones) have a vertebral stripe running from behind the nostrils to the

beginning of the neck, but this is not diagnostic of any forms, although is by far most prevalent in nominate species *B. gabonica* and *B. wellingtoni* sp. nov. from Tanzania.

The diagnostic characters of the nominate form *Bitis gabonica* are as follows: The front stripe or bar running down from the eye to the labials has a thick zone of contact with the eye (giving it a distinctive U-shaped appearance), and always includes more than 2 labials wide of dark pigment at the base (on the bottom of the labials), the light bar behind this is irregular edged and is not in a straight line.

*Bitis rhinoceros* is diagnosed by the fact that it lacks a front stripe down from eye. The pigment where this would be is all light coloured as for the rest of the head. There is occasionally a small black "tear drop" seen running down from the eye.

In specimens of *B. wellsi* sp. nov., from Zimbabwe, the black of the front and rear bars is so great as to merge, so that the front bar is usually 3 labials wide at the base and the white between the front and back bars forms a line up from the labials, but does not meet the eye, this being surrounded at the bottom with black pigment, or if it does contact the eye, does so as a tiny white line only (a sliver). Young specimens may have tiny black specks in front of the eye, which become indistinct with age.

In specimens of the species *B. funki* sp. nov. from north-east South Africa, the black bar at the front is narrow at the labials and two or less labials wide, in most cases being 2 labials wide with lightening apparent at the edge of one or other of the darkened labials. This species is the only one in the complex that has such a reduced width in the base of the front black bar. The front stripe down from eye has a narrow zone of contact with the eye, occasionally not quite making it to the eye (giving it an inverted "V" shape). In some specimens this anterior dark bar also reduces at the bottom, giving it a diamond-shaped or oversized "tear drop" shape/appearance (not to be confused with the small tear drop-sized marking sometimes seen in *B. rhinoceros*). Occasionally no dark pigment reaches the bottom of the supralabials (the jawline). Due to reduction of black pigment at the base of the labials, the irregular white bar running from the labials to the eye has a distinctly triangular appearance with a wider base at the labials.

In *B. wellingtoni* sp. nov. from eastern Tanzania, the first black bar from the eye is triangular in appearance, is at least 2.5 labials wide at the base (the bottom of the supralabials) and up to 3.5 labials wide; the white line between the two dark bars is of even thickness along its length, or rarely widens slightly at the labials and there is an elongate black bar in front of each eye that is not seen in any other species in the complex.

**Distribution:** Restricted to the moister parts of the eastern escarpments of Zimbabwe and immediately adjacent Mozambique.

**Etymology:** Named in honour of Richard Wells, now of Grafton, New South Wales, Australia in recognition of a lifetime's valuable contributions to herpetology that go well beyond the various taxonomic works he is most famous for, many of which were co-authored with Ross Wellington (see below).

#### **BITIS WELLINGTONI SP. NOV.**

**Holotype:** Specimen number R-54449 at the MCZ (Museum of Comparative Zoology, Harvard University, USA), collected from Mtwara, Tanzania, Lat 10.933333, Long 39.3. This is a facility that allows access to its material by scientists.

**Paratype:** Specimen number R-53980 at the MCZ (Museum of Comparative Zoology, Harvard University, USA), from Mtwara, Tanzania, Lat 10.933333, Long 39.3. This is a facility that allows access to its material by scientists.

**Diagnosis:** Diagnosis of each species level taxon in the *Bitis gabonica* species complex is most easily done by viewing the black to dark brown markings on the head that run from the eye to the (supra) labials, which are distinct from the otherwise lighter scales (pigment) on the rest of the head, which are a creamish-white to yellowish in colour. In the nominate form from

central-west Africa (Type locality Gabon, Africa), there are two such lines, one running from the front of the eye to the labials (more-or-less running straight down, though angled slightly backwards) and the other from the rear of the eye in an expanding and descending triangle to the labials and back of the head. The size, shape and configuration of these bars (or their absence) and the white bar between them are diagnostic for the regional species within this species complex.

Of note is that many specimens (in particular younger ones) have a vertebral stripe running from behind the nostrils to the beginning of the neck, but this is not diagnostic of any forms, although is by far most prevalent in nominate species *B. gabonica* and *B. wellingtoni* sp. nov. from Tanzania.

The diagnostic characters of the nominate form *Bitis gabonica* are as follows: The front stripe or bar running down from the eye to the labials has a thick zone of contact with the eye (giving it a distinctive U-shaped appearance), and always includes more than 2 labials wide of dark pigment at the base (on the bottom of the labials), the light bar behind this is irregular edged and is not in a straight line.

*Bitis rhinoceros* is diagnosed by the fact that it lacks a front stripe down from eye. The pigment where this would be is all light coloured as for the rest of the head. There is occasionally a small black "tear drop" seen running down from the eye.

In *B. wellingtoni* sp. nov. from eastern Tanzania, the first black bar from the eye is triangular in appearance, is at least 2.5 labials wide at the base (the bottom of the supralabials) and up to 3.5 labials wide; the white line between the two dark bars is of even thickness along its length, or rarely widens slightly at the labials and there is an elongate black bar in front of each eye that is not seen in any other species in the complex.

In specimens of the species *B. funki* sp. nov. from north-east South Africa, the black bar at the front is narrow at the labials and two or less labials wide, in most cases being 2 labials wide with lightening apparent at the edge of one or other of the darkened labials. This species is the only one in the complex that has such a reduced width in the base of the front black bar. The front stripe down from eye has a narrow zone of contact with the eye, occasionally not quite making it to the eye (giving it an inverted "V" shape). In some specimens this anterior dark bar also reduces at the bottom, giving it a diamond-shaped or oversized "tear drop" shape/appearance (not to be confused with the small tear drop-sized marking sometimes seen in *B. rhinoceros*). Occasionally no dark pigment reaches the bottom of the supralabials (the jawline). Due to reduction of black pigment at the base of the labials, the irregular white bar running from the labials to the eye has a distinctly triangular appearance with a wider base at the labials.

In specimens of *B. wellsi* sp. nov. from Zimbabwe, the black of the front and rear bars is so great as to merge, so that the front bar is usually 3 labials wide at the base and the white between the front and back bars forms a line up from the labials, but does not meet the eye, this being surrounded at the bottom with black pigment, or if it does contact the eye, does so as a tiny white line only (a sliver). Young specimens may have tiny black specks in front of the eye, which become indistinct with age.

**Etymology:** Named in honour of Cliff Ross Wellington now of Woy Woy, New South Wales, Australia in recognition of a lifetime's valuable contributions to herpetology that go well beyond the various taxonomic works he is most famous for which were co-authored with Richard Wells (see previous).

#### **BITIS HOSERAE SP. NOV.**

**Holotype:** A specimen number: SMNS 8360 at the Staatliches Museum Fur Naturkunde Stuttgart, Germany, from the Democratic Republic of Congo. This is a facility that allows access to its material by scientists.

**Paratype:** A specimen number: SMNS 4852 at the Staatliches Museum Fur Naturkunde Stuttgart, Germany, from Congo. This is a facility that allows access to its material by scientists.

**Diagnosis:** The species taxon *Bitis hoserae* sp. nov. has until now been identified by herpetologists as the eastern form of *Bitis* (*Macrocerastes*) *nasicornis* (Shaw, 1802) and the diagnosis for that taxon applies to this new species in addition to the characters identified herein that separates the two taxa.

*Bitis hoserae* sp. nov. is most easily separated from *B. nasicornis* by the markings on the head. In *B. nasicornis* there is a semicircular dark brown patch running from at or near the bottom of the supralabials to just below the eye, but with the lighter white marking bordering the semi-circle separating the eye from the brown patch below. At the level of the eye, there is the dark bottom of a dark stripe or bar (indistinct at the top boundary) that runs from the snout to the back of the head.

This bar does cut under the eye (just) and means that the scales beneath the eye are usually also dark.

At the bottom of the dark semicircle and along the line of the bottom of the upper labials is a continuous and narrow white strip connecting lighter areas to the front and rear of the dark semicircle.

Of note in terms of *B. nasicornis* is that the bottom dark semicircle does not connect with the eye or dark region that runs across or through it.

In very unusual cases, the dark semicircle may connect with either the eye or the dark bar running through it, but this is never more than a single dark scale in width.

*Bitis hoserae* sp. nov. is separated from *B. nasicornis* by the fact that the dark patch below the eye is not of an obvious semicircle in shape, being effectively an irregular band instead, running from the eye down, being marginally wider at the labials, and effectively merging with the area of dark pigment, defined here as a dark stripe or bar, that runs through the eye and side of the head. The narrowest point of where the dark bar from the labials joins the dark patch or eye above is at least three scales wide, averages 5-7 scales wide and may be up to 9 scales wide. This feature enables the two species to be separated with ease, including from photographs.

Along the line of the upper labials there is as a rule, little if any white pigment forming a line bordering the darker pigment patch running down from the eye, as seen in *B. nasicornis*.

There are however some specimens of *Bitis hoserae* sp. nov. which do have some white marks on the upper labials and in some cases partial formation of a white strip as seen in *B. nasicornis*, however it is never a continuous strip as seen in *B. nasicornis*.

Also of note is that the dark patch under the eye of *B. nasicornis* advances considerably anterior to the eye, as opposed to only slightly forward of the eye in *Bitis hoserae* sp. nov..

It should also be noted that *Bitis hoserae* sp. nov. from Nigeria sometimes have a triangular patch under the eye (not the semicircle of *B. nasicornis*), the base of the triangle being at the labials, but with the dark upper tip intersecting the orbit and dividing lighter areas into two. At the labials, there may be some lighter scales, but these do not form a continuous strip as seen in *B. nasicornis*.

*Bitis hoserae* sp. nov. has on average a greater preponderance of green and yellow through the scales than seen in *B. nasicornis*, which in turn has a greater preponderance of blue and red, however this is both hard to quantify and use for diagnostic purposes when one factors in such variables as age and shedding cycle.

*Bitis hoserae* sp. nov. also tend to have longer horns than seen in *B. nasicornis* but this trait is not diagnostic as it also varies both with age and with individual snakes.

Both *B. hoserae* sp. nov. and *B. nasicornis* are diagnosed as follows: They are a large and stout True Viper, similar in many respects to *B. gabonica* as already described above.

*B. hoserae* sp. nov. and *B. nasicornis* range in length from 72 cm to 107 cm. Spawls *et al.* (2004) mentioned a maximum

length of 120 cm, but admitted this is exceptional, quoting an average length of 60-90 cm. Females grow larger than males.

The head is narrow, flat, triangular and relatively small compared to the rest of the body. The neck is thin. These snakes have a distinctive set of two or three horn-like scales on the end of their noses, the front pair of which may be quite long. The eyes are small and set well forward. The fangs are not large, in contrast to the *B. gabonica* species complex and are rarely more than 1.5 cm in length.

There are 31-43 dorsal midbody scale rows. These are so rough and heavily keeled that they occasionally inflict cuts on handlers when the snakes struggle. There are 117-140 ventrals, single anal and 16-32 subcaudals, with males having a higher count (25-30) than females (16-19).

The distinct dorsal color pattern consists of a series of 15-18 blue or blue-green, oblong markings, each with a lemon-yellow line down the center. These are enclosed within irregular, black, rhombic blotches. A series of dark crimson triangles run down the flanks, narrowly bordered with green or blue. Many of the lateral scales have white tips, giving the snake a velvety appearance. The top of the head is blue or green, overlaid with a distinct black arrow mark. The belly is dull green to dirty white, strongly marbled and blotched in black and gray.

**Distribution:** *Bitis hoserae* sp. nov. occurs in eastern, central and western Africa, from southern Sudan, western Kenya, Uganda, Rwanda, Burundi, Democratic Republic of Congo, across to Nigeria to the Dahomey Gap. The populations east of the Dahomey Gap, from Ghana, west to Guinea are of the species *B. nasicornis*.

**Etymology:** Named in honour of my mother, Katrina Hoser, now of Lane Cove, New South Wales, Australia in recognition of many contributions to herpetology spanning more than 40 years as well as her great support for the footwear industry world-wide.

#### FIRST REVISOR NOTE:

In the event that two or more of the new species level taxa described herein are sought to be merged by a later author, the name to be taken and used is in the order as described within this paper, (*funki*, *wellsi*, *wellingtoni*, *hoserae*). That is the first printed name takes priority over a later one in event of conflict involving two names for allegedly one taxon.

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**CONFLICT OF INTEREST**

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

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# **A new species of Night Adder (Serpentes: Viperidae) from central Africa.**

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## **ABSTRACT**

The six species of snake within the genus *Causus* Wagler, 1830 are all superficially morphologically similar and have therefore until now had a relatively stable taxonomic history at the genus level.

While six species are presently recognized (Uetz 2013), some of these are known to be composite (Ineich *et al.* 2006, Phelps 2010) and do in fact have available names for the relevant populations (McDiarmid *et al.* 1999).

The only exception to this is in terms of the species *Causus lichtensteini* Jan, 1859, which consists of two geographically separated populations. Inspection of specimens from both groups, including the relevant type material shows that the differences between the two populations are consistent and worthy of taxonomic recognition. As a result, the eastern population, that which is found east of the Dahomey Gap is herein formally described as *Causus perkinsi* sp. nov. in accordance with the Zoological Code (Ride *et al.* 1999).

**Keywords:** Viper; taxonomy; *Causus*; new species; *perkinsi*.

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## **INTRODUCTION**

The so-called Night Adders, genus *Causus* Wagler, 1830 are a pan-African group of vipers, divergent from the normal viperine body form.

Being of more slender colubrid-like physical attributes, the genus *Causus* as defined was long thought of as basal to the more typical vipers.

However several recent phylogenetic studies have found them to be rooted within the Viperinae (e.g. Pyron *et al.* 2011, 2013) and therefore recognized as a group within the Viperinae, defined as unique at the tribe level (Hoser, 2012).

While all species are morphologically similar in habit and form, one form is in fact divergent, this being *C. lichtensteini* Jan, 1859 as defined to date.

While all others have their distributional centres and preferred habitat in drier savannah zones of Africa, this species is primarily a wet forest inhabitant or alternatively found in very humid microhabitats.

It is also divergent from the others in *Causus* morphologically, the most obvious and easily seen divergence being the fact that the subcaudals are all single, or nearly so, in this species versus divided in all the others.

As a result of these differences, I do, as a matter of course propose separate recognition for the taxon group including *C. lichtensteini* Jan, 1859 at the genus or subgenus level as part the conclusion of a review of the genus.

Doing the ethical and correct thing, I hereby resurrect the available name *Dinodipsas* Peters, 1882 for this species group, recognizing them at the subgenus level within this paper.

However I do also note that it is highly likely that molecular studies, not yet done, will in fact show full generic recognition of

this taxon group may be more appropriate.

Because the genus name is in effect already "available", there is no formal need for me to redefine it here.

However as it was originally proposed in an old publication and not diagnosed in terms of other members of the genus *Causus* Wagler, 1830, I present a diagnosis for the genus name, recognized herein as a subgenus below.

Following on from a Field trip to Africa in 2009, it was decided to undertake an audit for the true Vipers on the continent to see if there were any obviously unnamed species level taxa.

The decision was made because of the number of allegedly undescribed species that were widely known to herpetologists and regularly appearing in the literature as "unnamed species" (e.g. Ineich *et al.* 2006, Phelps 2010).

Unnamed taxa within the large and diverse genus *Bitis* are dealt with in two other papers published at the same time as this.

In terms of the genus *Causus* as generally known, there are as of early 2013, just six species widely recognized (Uetz 2013).

With some of these are known to be composite (Phelps 2010), an audit was done to see which were in actual fact unnamed versus those which had been named previously and then relegated to synonymy.

It turned out that all supposedly undescribed species within Africa that I was readily able to identify, either by direct inspection or from statements in the literature, do in fact have available names for the relevant populations (McDiarmid *et al.* 1999).

In summary, there are in fact considerably more than six valid species of *Causus*!

The only exception to the above is in terms of the species



*Causus lichtensteini* Jan, 1859, not previously recognized by others as consisting more than one species, but which in my view does consist of two separate species level taxa.

These are two geographically separated populations.

Inspection of specimens from both, including the relevant type material, shows that the differences between the two populations are consistent and worthy of taxonomic recognition and at the species level. As a result, the eastern population, that which is found east of the Dahomey Gap is herein formally described as *Causus perkinsi* sp. nov. in accordance with the Zoological Code (Ride *et al.* 1999).

It is also noted that other barely distinguishable rainforest taxa of common ancestry separated by the Dahomey Gap have in the recent past been shown to be of different species by morphological and molecular data (Lenk *et al.* 1999 and sources cited therein).

I also note herein that inspection of the available type material publications for the taxa *C. lichtensteini* Jan, 1859 and "*Dinodipsas angulifera* Peters, 1882" showed that both were one and the same taxon.

Both conformed to the species from west of the Dahomey Gap in West Africa (*C. lichtensteini*) as evidenced by the size and shape of the supraoculars and parietal scales as well as a subcaudal count of 15 for the Peters animal, which fits within the range for the western species (*C. lichtensteini* Jan, 1859) but not the newly described species herein (*C. perkinsi* sp. nov.), which has a range of 17-22.

The configuration of dark and light scales in front of the eye in the Peters animal also conforms to the western species.

Published material relevant to the subgenus *Dinodipsas* Peters, 1882 as defined herein and the species *C. lichtensteini* and *C. perkinsi* sp. nov. including the taxonomic conclusions made within this paper include, Boulenger (1896), Branch (1993), Broadley (1991), Broadley and Cock (1971), Broadley and Cotterill (2004), Broadley and Howell (1991), Broadley *et al.* (2003), Burger *et al.* (2004), Chifundera (1990), Chirio and Lebreton (2007), Cope (1883), Corti *et al.* (2001), Dobiey and Vogel (2007), Duméril (1859), Hoser (2012), Hughes and Barry (1969), Ineich *et al.* (2006), Jacobsen (2009), Jan (1859), Lenk *et al.* (1999), Loveridge (1936, 1956), Mallow *et al.* (2003), McDiarmid *et al.* (1999), Pauwels and Vande weghe (2008), Pauwels *et al.* (2002), Peters (1882), Phelps (2010), Pitman (1974), Pyron *et al.* (2011, 2013), Rödel and Mahsberg (2000), Schmidt (1923), Spawls *et al.* (2001), Trape and Roux-Esteve (1995), Uetz (2013) and sources cited therein.

#### SUBGENUS *DINODIPSAS* PETERS, 1882

**Type species:** *Dinodipsas angulifera* Peters, 1882.

**Diagnosis:** A medium-sized (to 70 cm) but usually averaging 35-60 cm as adults, snake from Africa. Dorsal body colour ranges from bright leaf green to olive green, yellowish, brown or even dull orange, with some well-spaced chevron-like markings on the dorsum which may appear indistinct in some (usually older) specimens. There is a white inverted "V" marking on the posterior dorsum of the head extending well back on the neck and this is most visible in younger specimens. The scales on the first third of the body are usually edged with white to varying degrees giving a stippled effect. The venter is yellowish or cream with two or three distinct black crossbars across the throat region. The head is somewhat elongated with a rounded snout and nine large scales on the dorsum and when compared to members of the nominate subgenus *Causus* is more distinct from the neck. The body scales are velvety and feebly keeled with 15 dorsal mid-body scale rows. There are 135-156 ventrals, single anal and 15-24 single subcaudals.

The rostral is a little broader than deep, obtuse angled above and well visible from above, its upper portion not half as long as its distance from the frontal. Internasals are longer than the praefrontals, separated from the loreal, frontal is one and a third times as long as broad as long as its distance from the end of

the snout, as long as the parietals; two praeoculars, two postoculars and one or two suboculars separating the eye from the labials; 2+3 temporals, upper two of similar size, six upper labials (rarely, 7), 8-9 lower labials with four lower labials in contact with the anterior chin shields; posterior chin shields are very small. Two rows of elongate narrow shields separates the first ventrals and the labials.

**Distribution:** Africa, essentially in the sub-Saharan west and not in the far east or south of the continent.

**Content:** *Causus (Dinodipsas) angulifera* Peters, 1882 (type species) and *C. (Dinodipsas) perkinsi* sp. nov. (see below).

#### **CAUSUS PERKINSI SP. NOV.**

**Holotype:** Specimen number 11788 from Medje, Democratic Republic of Congo 2° 25' 0N, Long (DMS), 27° 18' 0E held at the American Museum of Natural History (AMNH). This is a government owned facility that allows access to its collection by scientists.

**Paratypes:** Specimen numbers: 11780-11787 from Medje, Democratic Republic of Congo 2° 25' 0N, Long (DMS), 27° 18' 0E held at the American Museum of Natural History (AMNH).

This is a government owned facility that allows access to its collection by scientists.

**Diagnosis:** *Causus perkinsi* sp. nov. is separated from the species *Causus lichtensteini* Jan, 1859, which it formerly would have been identified as, by the fact that at the anterior and posterior ends (excluding the tips), the supraocular scales are of equal width, rather than being noticeably wider at the rear. In *Causus perkinsi* sp. nov. the parietals are considerably longer than wide, versus as wide as long, or only minutely marginally longer than wide in *C. lichtensteini*.

The scalation in *Causus perkinsi* sp. nov. is essentially similar to *C. lichtensteini* in most respects, but does also have some consistent trend differences. In this species further diagnostic characters are as follows: 139-149 ventrals, 17-22 single subcaudals, dorsal scale row count of 15-15-11, with the only deviation from this number being 10 or 9 scale rows above the base of the tail. 6 Supralabials, 9 lower labials. 5-7 (usually 6) oculars, 2+3 temporal formula, 1-1 loreals, though rarely 2 on one or other side. The first and second upper temporals are as long combined as the first lower one.

The species *Causus perkinsi* sp. nov. is further diagnosed as follows: It is a medium-sized (to 70 cm total length) but usually averaging 35-60 cm as adults, snake from Africa found east of the Dahomey Gap. Dorsal body colour ranges from bright leaf green to olive green, yellowish, brown or even dull orange, with some well-spaced chevron-like markings on the dorsum which may appear indistinct in some (usually older) specimens. There is a white inverted "V" marking on the posterior dorsum of the head extending well back on the neck and this is most visible in younger specimens. The scales on the first third of the body are usually edged with white to varying degrees giving a stippled effect. The venter is yellowish or cream with two or three distinct black crossbars across the throat region. The head is somewhat elongated with a rounded snout and nine large scales on the dorsum and when compared to members of the nominate subgenus *Causus* is more distinct from the neck. The body scales are velvety and feebly keeled.

The rostral is a little broader than deep, obtuse angled above and well visible from above, its upper portion not half as long as its distance from the frontal. Internasals are longer than the praefrontals, separated from the loreal, frontal is one and a third times as long as broad as long as its distance from the end of the snout, as long as the parietals; two praeoculars, two postoculars and one or two suboculars separating the eye from the labials; 2+3 temporals, upper two of similar size, six upper labials (rarely, 7), 8-9 lower labials with four lower labials in contact with the anterior chin shields; posterior chin shields are very small. Two rows of elongate narrow shields separates the first ventrals and the labials.

In *Causus perkinsi* sp. nov. there is a slight darkening in colour running from the back of the upper jaw to the lower back of the eye (very indistinct in many specimens). This does not in any way progress beyond the eye to the snout, which is the condition seen in *C. lichtensteini*.

**Distribution:** *Causus perkinsi* sp. nov. is known from Nigeria eastward to western Kenya and south to northern Angola. Also known from scattered localities in Sudan, the Democratic Republic of Congo and northern Zambia.

**Etymology:** Named in honour of David Perkins, barrister and lawyer from Melbourne, Victoria, Australia in recognition of a magnificent career where he specialized in taking on cases that corrupt people in the Victorian government did everything they could to stop him from working on.

In the state of Victoria, corruption whistleblowers are hounded and harassed and forced to face fabricated criminal charges. Being stripped of the right to work, the whistleblowers are then unable to fund a legal defence and so are routinely convicted of offences they have not committed, this heinous act being perpetrated by ruthless government-backed legal teams funded with the limitless funds of the Australian tax-payer to destroy them in the state's courts of law.

In support of the fundamental human right of people to have a fair trial in the court system, Perkins has made huge sacrifices and taken on cases pro bono (without fee) in order to help justice prevail. In short this has meant he has done thousands of hours of mentally difficult legal work on behalf of less fortunate others.

Due to the inherent corruption in the Victorian legal system and the fact that a sizeable part of the judiciary is openly corrupt and has a total disrespect not just for truth, but even the law itself (see Hoser, 1995, 1999a and 1999b), it is not surprising that Perkins has lost more cases on behalf of whistleblowers than he has won.

However his magnificent efforts towards making the world a better place deserve recognition.

#### ACKNOWLEDGMENTS

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#### CONFLICT OF INTEREST

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

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# Two new species of Pitviper from Middle America (Serpentes:Viperidae:Crotalinae).

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## ABSTRACT

The nominal species *Bothrops xanthogrammus* (Cope, 1868), also known as *B. asper* (Garman, 1884) has long been known to be composite. For the first time, this paper gives formal taxonomic recognition to three regional forms.

The population from the Pacific Coast of Costa Rica, long known to be distinct from the nominal form of *B. xanthogrammus* is accorded full species status, described herein as *B. lenhoseri* sp. nov..

The population from Nuclear Central America, mainly near the Atlantic Coast, being the region generally north from Nicaragua to southern Mexico, including the lowland zone adjacent to the Gulf of Mexico and the border with Guatemala and Belize is herein described as *B. mexicoiensis* sp. nov.

The population of snakes north of Mexico City in the area of San Luis de Potosí, Mexico is in turn formally named as a subspecies of *B. mexicoiensis* sp. nov., namely *B. mexicoiensis maccartneyi* subsp. nov..

All are defined according to the Zoological Code (Ride *et al.* 1999) on the basis of consistent colouration and scalation differences between these forms and the nominal form of *B. asper*, herein restricted to the region generally south of Nicaragua, including the Atlantic coast of Costa Rica and including the north of South America.

**Keywords:** Taxonomy; pitviper; nomenclature; *Bothrops*; *xanthogrammus*; *asper*; Costa Rica; new species; *lenhoseri*; *mexicoiensis*; new subspecies; *maccartneyi*.

## INTRODUCTION

The Pitvipers of the genus *Bothrops* Wagler, 1824 have been the subject of intense collecting, research and taxonomic interest over many decades, with new forms being described or validated from older descriptions on a regular basis.

Molecular methods of analysis have been incorporated into morphological studies to confirm differences between populations at various levels, ranging from genera to species and subspecies.

Papers are published on the taxonomy of these snakes on a regular basis and the taxonomy of the genus *Bothrops sensu lato* is anything but stable.

Pitviper genera and species have been recently described by myself (see for example Hoser 2012a, 2012b and 2013) and this paper continues the process of taxonomic recognition of unnamed or improperly classified forms.

At the genus level, further divisions within the subfamily Crotalinae Oppel, 1811 are made in a separate paper

published at the same time as this one.

The species *Bothrops xanthogrammus* also widely known as *B. asper* (Garman, 1884), the latter name being a junior synonym, has long been known to be composite. Widely differing phenotypes are detailed in Campbell and Lamar (2004) and sources cited therein.

In preparing this paper, in excess of 100 specimens were examined from most parts of Middle America and nearby South America.

One of the distinctive regional populations includes the heavily studied and apparently isolated population from the Pacific Coast of Costa Rica. Separated from the main Central American population that is mainly found on the Atlantic Coast, by several physical barriers, studies have shown the Pacific Coast population to have been isolated for about 3.5 million years and therefore worthy of taxonomic recognition (Saldariaga and Sasa, unpublished results as cited by Alape-Giro *et al.* 2008).

Besides the phenotypical differences in specimens of this population as detailed by Campbell and Lamar (2004),

the significant venomous differences have been well detailed in the literature (Alape-Giro *et al.* 2008, Aragon and Gubensek 1981, Jimenez-Porras 1964, Gutierrez *et al.* 1980).

In the absence of an available name for this population, I herein assign a name to this population according to the Zoological Code (Ride *et al.* 1999) at the level of full species, named *Bothrops lenhoseri sp. nov.*

I note herein that Alape-Giro *et al.* (2008) indicated in their paper that they thought a subspecies designation was appropriate.

My difference of opinion is based on the geological evidence cited by these authors in their paper, that being a potential population division in the range of up to 5-8 MYA in line with the uplifting of mountain barriers between the populations and mtDNA results indicating a 3.5 million year separation of the two Costa Rica populations (east and west) (Alape-Giro *et al.* 2008), both time frames being well in excess of that required for full speciation to occur, generally regarded by most authors as being less than 2 million years.

Sasa (2002), provided a body of evidence to suggest that the population of *B. xanthogrammus* from Nuclear Central America, the region generally north of Costa Rica, commencing in Nicaragua has consistent colouration and scalation differences as compared to the nominal form of *B. xanthogrammus* from further south and including the northern part of South America. On that basis, the northern form is herein described as a new species as well, namely, *B. mexicioensis sp. nov.*

Within this species group, the northernmost specimens, those being from the area of San Luis de Potosí, Mexico, do in fact have significant and consistent differences as compared to those from regions immediately south of there.

As a result it is accorded subspecies status within *B. mexicioensis sp. nov.*, being described herein as *B. mexicioensis maccartneyi subsp. nov.*

The body of literature relevant to these new species is significant and the detail is not repeated here.

However it is worth noting that numerous aspects of these newly described species taxa, venom properties and relationship to others in the *B. xanthogrammus* group is well-known.

Key published references in terms of *B. xanthogrammus sensu lato* and the newly described taxa *B. lenhoseri sp. nov.* and *B. mexicioensis sp. nov.* (including *B. mexicioensis maccartneyi subsp. nov.*) described below include the following: Boada *et al.* (2005), Campbell and Lamar (2004), Carrera *et al.* (2009), Castro-Herrera and Vargas-Salinas (2008), Castro-Herrera *et al.* (2005), Cisneros-Heredia and Touzet (2004), Cope (1868), Corteis Goimez *et al.* (2010), Dehling and Dehling (2008), Dempfle (2012), Dixon and Lemos-Espinal (2010), Fenwick *et al.* (2009), Folleco-Fernández (2010), Freire and Kuch (1994), Garman (1884), Garrett (1997), Gutierrez Mayen *et al.* (2007), Hoge (1966), Koller (2005), Leenders (1995), McCranie (2011), McCranie and Castañeda (2005), McDiarmid *et al.* (1999), Monzel and Wüster (2008), Mora and Merchán (2001), Müller (1885), Nicholson *et al.* (2000), Parkinson (1999), Pérez-Santos

and Moreno (1988), Porras and Solórzano (2006), Rivas *et al.* (2012), Saldarriaga-Córdoba *et al.* (2009), Sasa (1996, 2002), Sasa and Barrantes (1998), Savage (2002), Schätti and Kramer (1993), Scott and Limerick (1983), Sethao (2008), Taylor (1949), Townsend *et al.* (2012), Urbina-Cardona *et al.* (2006), Wasko and Sasa (2010, 2012), Wirth (2011) and sources cited therein.

#### **BOTHRUPS LENHOSERI SP. NOV.**

**Holotype:** A specimen held at the Texas Cooperative Wildlife Collection (TCWC), specimen number: TCWC Herps 83385, collected from 1.9 mi S Rio Tarcoles, Hwy 34, north branch of Quebrada Bonita, Puntarenas, Costa Rica. The Texas Cooperative Wildlife Collection allows access to its collection by scientists.

**Paratypes:** Two more specimens held at the Texas Cooperative Wildlife Collection (TCWC), specimen numbers: TCWC Herps 83386 and 83387, collected from 1.9 mi S Rio Tarcoles, Hwy 34, north branch of Quebrada Bonita, Puntarenas, Costa Rica. The Texas Cooperative Wildlife Collection allows access to its collection by scientists.

**Diagnosis:** The species *Bothrops lenhoseri sp. nov.* would until now have been diagnosed as *Bothrops xanthogrammus* (Cope, 1868), also known as *B. asper* (Garman, 1884), the species *Bothrops lenhoseri sp. nov.* being the form restricted to the northern region of the Pacific Coast (west coast) region of Costa Rica, Central America, and separated by habitat from the main population of *B. xanthogrammus* to the north, south and east.

All species within the *B. xanthogrammus* species group are strongly sexually dimorphic.

Females of the species *Bothrops mexicioensis sp. nov.* are readily separated from *B. xanthogrammus* and *B. lenhoseri sp. nov.* by their consistently higher average number of dorsal blotches (triangles), being 23 with an SD of 2.0 versus, 17 with an SD of 1.4 in *B. lenhoseri sp. nov.* and 19.2 with an SD of 2.8 in *B. xanthogrammus*. The only exception to this is for females of the subspecies *B. mexicioensis maccartneyi subsp. nov.* which has an average of 20 with an SD of 1.4.

Female *B. mexicioensis sp. nov.* are also separated from *B. xanthogrammus* and *B. lenhoseri sp. nov.* by their consistently higher average number of ventrals being an average of 209 with an SD of 5, versus 197 with an SD of 8.7 in *B. xanthogrammus* and 196 with an SD of 4 in *B. lenhoseri sp. nov.*

*B. mexicioensis sp. nov.* females usually have 10-11 interoculars, versus 8-9 in *B. xanthogrammus* and 9 in *B. lenhoseri sp. nov.*

Males of the species *Bothrops mexicioensis sp. nov.* are readily separated from *B. xanthogrammus* and *B. lenhoseri sp. nov.* by their consistently higher average number of dorsal blotches (triangles), being 23 with an SD of 1.5 versus, 19.6 with an SD of 1.5 in *B. lenhoseri sp. nov.* and 19.0 with an SD of 2.1 in *B. xanthogrammus*. The only exception to this is in males of the subspecies *B. mexicioensis maccartneyi subsp. nov.* which has an average of 20.5 dorsal blotches with an SD of .47.

Male *Bothrops mexicioensis sp. nov.* average 209 ventrals, SD4, versus 196 SD6 in *B. xanthogrammus* and

186 SD23 in *B. lenhoseri* sp. nov..

*B. mexicioensis* sp. nov. males usually have 10 interoculars, versus 8-9 in both *B. xanthogrammus* and *B. lenhoseri* sp. nov..

In terms of scalation characters, *B. mexicioensis maccartneyi* subsp. nov. approaches the characteristics of both *B. xanthogrammus* and *B. lenhoseri* sp. nov. but can be separated from both by the fact that the dorsal blotches do not as a rule merge on the mid-dorsal line, with the potential exception of a small number on the neck, versus a sizeable number of blotches merging along the body *B. lenhoseri* sp. nov., and occasionally in specimens of *B. xanthogrammus*.

The top of the head of *B. xanthogrammus* and *B. lenhoseri* sp. nov. is mainly a dark chocolate brown in colour, whereas the same markings are a light brown colour in Mexican *B. mexicioensis* sp. nov. including for the subspecies *B. mexicioensis maccartneyi* subsp. nov.. On the lower flanks of Mexican *B. mexicioensis* sp. nov. there is a greater amount of white as opposed to darker scales as viewed from the side. This is not the case in either *B. xanthogrammus* and *B. lenhoseri* sp. nov. where the reverse is the case.

This enables one to separate *B. mexicioensis maccartneyi* subsp. nov. from *B. xanthogrammus* and *B. lenhoseri* sp. nov. in the absence of accurate locality data.

In all three species (and the subspecies), the dorsal body pattern consists of a series of pale edged, dark brown to blackish triangles on each side with their wide bases directed ventrally and their apices either opposite or juxtaposed at the vertebral line, generally joining in *B. lenhoseri* sp. nov. to form X-like markings along most of the body. In the other species only a small number of blotches merge, this usually being restricted to the forebody region. Exceptionally, *B. xanthogrammus* may have a similar dorsal pattern to *B. lenhoseri* sp. nov. however the two can be separated by other means as described herein.

In *B. xanthogrammus* and *B. mexicioensis* sp. nov. these triangles are invaded by a light ash gray ground colour. By contrast in *B. lenhoseri* sp. nov. these markings are a distinctive pinkish grey, readily separating this taxon from the other two species.

A detailed diagnosis of the three species *Bothrops mexicioensis* sp. nov., *B. lenhoseri* sp. nov. and *B. xanthogrammus* described singly as *B. xanthogrammus* is provided by Campbell and Lamar (2004), on pages 371-376, as part of Volume 1, with further diagnostic information on the taxon group elsewhere in the same volume.

**Distribution:** *B. lenhoseri* sp. nov. is restricted to the Pacific Coast (west coast) region of Costa Rica, Central America, and separated by habitat from the main population of *B. xanthogrammus* to the north-east, south and east.

The most obvious physical barrier is the central cordillera of Costa Rica.

**Etymology:** Named in honour of my now deceased father, Len Hoser, born in the UK for many contributions to herpetology.

#### **BOTHROPS MEXICIOENSIS SP. NOV.**

**Holotype:** A specimen at the American Museum of Natural History, (AMNH), New York, USA, specimen number 160653 collected from Quintana Roo, Mexico. The American Museum of Natural History is a facility that allows access to its specimens by scientists.

**Paratypes:** Specimen numbers UTA-R 17031 and UTA-R 17095 held at the University of Texas, Arlington, Texas, USA, collected from Quintana Roo, Mexico. The University of Texas, Arlington is a facility that allows access to its specimens by scientists.

**Diagnosis:** The species *Bothrops lenhoseri* sp. nov. would until now have been diagnosed as *Bothrops xanthogrammus* (Cope, 1868), also known as *B. asper* (Garman, 1884), the species *Bothrops lenhoseri* sp. nov. being the form restricted to the northern region of the Pacific Coast (west coast) region of Costa Rica, Central America, and separated by habitat from the main population of *B. xanthogrammus* to the north, south and east.

All species within the *B. xanthogrammus* species group are strongly sexually dimorphic.

Females of the species *Bothrops mexicioensis* sp. nov. are readily separated from *B. xanthogrammus* and *B. lenhoseri* sp. nov. by their consistently higher average number of dorsal blotches (triangles), being 23 with an SD of 2.0 versus, 17 with an SD of 1.4 in *B. lenhoseri* sp. nov. and 19.2 with an SD of 2.8 in *B. xanthogrammus*. The only exception to this is for females of the subspecies *B. mexicioensis maccartneyi* subsp. nov. which has an average of 20 with an SD of 1.4.

Female *B. mexicioensis* sp. nov. are also separated from *B. xanthogrammus* and *B. lenhoseri* sp. nov. by their consistently higher average number of ventrals being an average of 209 with an SD of 5, versus 197 with an SD of 8.7 in *B. xanthogrammus* and 196 with an SD of 4 in *B. lenhoseri* sp. nov..

*B. mexicioensis* sp. nov. females usually have 10-11 interoculars, versus 8-9 in *B. xanthogrammus* and 9 in *B. lenhoseri* sp. nov..

Males of the species *Bothrops mexicioensis* sp. nov. are readily separated from *B. xanthogrammus* and *B. lenhoseri* sp. nov. by their consistently higher average number of dorsal blotches (triangles), being 23 with an SD of 1.5 versus, 19.6 with an SD of 1.5 in *B. lenhoseri* sp. nov. and 19.0 with an SD of 2.1 in *B. xanthogrammus*.

The only exception to this is in males of the subspecies *B. mexicioensis maccartneyi* subsp. nov. which has an average of 20.5 dorsal blotches with an SD of .47.

Male *Bothrops mexicioensis* sp. nov. average 209 ventrals, SD4, versus 196 SD6 in *B. xanthogrammus* and 186 SD23 in *B. lenhoseri* sp. nov..

*B. mexicioensis* sp. nov. males usually have 10 interoculars, versus 8-9 in both *B. xanthogrammus* and *B. lenhoseri* sp. nov..

In terms of scalation characters, *B. mexicioensis maccartneyi* subsp. nov. approaches the characteristics of both *B. xanthogrammus* and *B. lenhoseri* sp. nov. but can be separated from both by the fact that the dorsal blotches do not as a rule merge on the mid-dorsal line, with the potential exception of a small number on the

neck, versus a sizeable number of blotches merging along the body *B. lenhoseri sp. nov.*, and occasionally in specimens of *B. xanthogrammus*.

The top of the head of *B. xanthogrammus* and *B. lenhoseri sp. nov.* is mainly a dark chocolate brown in colour, whereas the same markings are a light brown colour in Mexican *B. mexicoiensis sp. nov.* including for the subspecies *B. mexicoiensis maccartneyi subsp. nov.*

On the lower flanks of Mexican *B. mexicoiensis sp. nov.* there is a greater amount of white as opposed to darker scales as viewed from the side. This is not the case in either *B. xanthogrammus* and *B. lenhoseri sp. nov.* where the reverse is the case.

This enables one to separate *B. mexicoiensis maccartneyi subsp. nov.* from *B. xanthogrammus* and *B. lenhoseri sp. nov.* in the absence of accurate locality data.

In all three species (and the subspecies), the dorsal body pattern consists of a series of pale edged, dark brown to blackish triangles on each side with their wide bases directed ventrally and their apices either opposite or juxtaposed at the vertebral line, generally joining in *B. lenhoseri sp. nov.* to form X-like markings along most of the body. In the other species only a small number of blotches merge, this usually being restricted to the forebody region. Exceptionally, *B. xanthogrammus* may have a similar dorsal pattern to *B. lenhoseri sp. nov.* however the two can be separated by other means as described herein.

In *B. xanthogrammus* and *B. mexicoiensis sp. nov.* these triangles are invaded by a light ash gray ground colour. By contrast in *B. lenhoseri sp. nov.* these markings are distinctive pinkish grey, readily separating this taxon from the other two species.

A detailed diagnosis of the three species *Bothrops mexicoiensis sp. nov.*, *B. lenhoseri sp. nov.* and *B. xanthogrammus* described singly as *B. xanthogrammus* is provided by Campbell and Lamar (2004), on pages 371-376, as part of Volume 1, with further diagnostic information on the taxon group elsewhere in the same volume.

**Distribution:** *Bothrops mexicoiensis sp. nov.* is found in Central America from Nicaragua (on the east coast), as far north as Mexico.

The nominate form of *B. xanthogrammus* occurs in the region from Costa Rica or slightly north in Nicaragua, along the Atlantic coast south through Costa Rica's eastern side and then south through the Panama Isthmus and into northern South America. *B. lenhoseri sp. nov.* is found in the north-west section of Costa Rica along the Pacific Coast and nearby areas.

*B. mexicoiensis maccartneyi subsp. nov.* is restricted to the area of San Luis de Potosí, Mexico.

**Etymology:** Named in reflection of where the taxon occurs noting it is the only *Bothrops* species or subspecies known from that country (Mexico).

**BOTHRUPS MEXICOIENSIS MACCARTNEYI SUBSP. NOV.**

**Holotype:** A specimen at the American Museum of Natural History, New York, USA, specimen number: AMNH 67315 from Chapulhuaco, Hidalgo, Mexico. The

American Museum of Natural History is a facility that allows access to its specimens by scientists.

**Paratype:** A specimen at the American Museum of Natural History, New York, USA, specimen number: AMNH 93434 from 2 miles west of Tamuin, Mexico. The American Museum of Natural History is a facility that allows access to its specimens by scientists.

**Diagnosis:** The species *Bothrops lenhoseri sp. nov.* would until now have been diagnosed as *Bothrops xanthogrammus* (Cope, 1868), also known as *B. asper* (Garman, 1884), the species *Bothrops lenhoseri sp. nov.* being the form restricted to the northern region of the Pacific Coast (west coast) region of Costa Rica, Central America, and separated by habitat from the main population of *B. xanthogrammus* to the north, south and east.

All species within the *B. xanthogrammus* species group are strongly sexually dimorphic.

Females of the species *Bothrops mexicoiensis sp. nov.* are readily separated from *B. xanthogrammus* and *B. lenhoseri sp. nov.* by their consistently higher average number of dorsal blotches (triangles), being 23 with an SD of 2.0 versus, 17 with an SD of 1.4 in *B. lenhoseri sp. nov.* and 19.2 with an SD of 2.8 in *B. xanthogrammus*. The only exception to this is for females of the subspecies *B. mexicoiensis maccartneyi subsp. nov.* which has an average of 20 with an SD of 1.4.

Female *B. mexicoiensis sp. nov.* are also separated from *B. xanthogrammus* and *B. lenhoseri sp. nov.* by their consistently higher average number of ventrals being an average of 209 with an SD of 5, versus 197 with an SD of 8.7 in *B. xanthogrammus* and 196 with an SD of 4 in *B. lenhoseri sp. nov.*

*B. mexicoiensis sp. nov.* females usually have 10-11 interoculars, versus 8-9 in *B. xanthogrammus* and 9 in *B. lenhoseri sp. nov.*

Males of the species *Bothrops mexicoiensis sp. nov.* are readily separated from *B. xanthogrammus* and *B. lenhoseri sp. nov.* by their consistently higher average number of dorsal blotches (triangles), being 23 with an SD of 1.5 versus, 19.6 with an SD of 1.5 in *B. lenhoseri sp. nov.* and 19.0 with an SD of 2.1 in *B. xanthogrammus*. The only exception to this is in males of the subspecies *B. mexicoiensis maccartneyi subsp. nov.* which has an average of 20.5 dorsal blotches with an SD of .47.

Male *Bothrops mexicoiensis sp. nov.* average 209 ventrals, SD4, versus 196 SD6 in *B. xanthogrammus* and 186 SD23 in *B. lenhoseri sp. nov.*

*B. mexicoiensis sp. nov.* males usually have 10 interoculars, versus 8-9 in both *B. xanthogrammus* and *B. lenhoseri sp. nov.*

In terms of scalation characters, *B. mexicoiensis maccartneyi subsp. nov.* approaches the characteristics of both *B. xanthogrammus* and *B. lenhoseri sp. nov.* but can be separated from both by the fact that the dorsal blotches do not as a rule merge on the mid-dorsal line, with the potential exception of a small number on the neck, versus a sizeable number of blotches merging along the body *B. lenhoseri sp. nov.*, and occasionally in specimens of *B. xanthogrammus*.

The top of the head of *B. xanthogrammus* and *B.*

*lenhoseri* sp. nov. is mainly a dark chocolate brown in colour as a distinct large blotch, whereas the same markings are a light brown colour in *B. mexicoiensis* sp. nov. including for the subspecies *B. mexicoiensis maccartneyi* subsp. nov..

On the lower flanks of Mexican *B. mexicoiensis* sp. nov. there is a greater amount of white as opposed to darker scales as viewed from the side. This is not the case in either *B. xanthogrammus* and *B. lenhoseri* sp. nov. where the reverse is the case.

This, along with the scalation and dorsal blotches characters just outlined, enables one to separate *B. mexicoiensis maccartneyi* subsp. nov. from *B. xanthogrammus* and *B. lenhoseri* sp. nov. in the absence of accurate locality data.

In all three species (and the subspecies), the dorsal body pattern consists of a series of pale edged, dark brown to blackish triangles on each side with their wide bases directed ventrally and their apices either opposite or juxtaposed at the vertebral line, generally joining in *B. lenhoseri* sp. nov. to form X-like markings along most of the body. In the other species only a small number of blotches merge, this usually being restricted to the forebody region. Exceptionally, *B. xanthogrammus* may have a similar dorsal pattern to *B. lenhoseri* sp. nov. however the two can be separated by other means as described herein.

In *B. xanthogrammus* and *B. mexicoiensis* sp. nov. these triangles are invaded by a light ash gray ground colour. By contrast in *B. lenhoseri* sp. nov. these markings are distinctive pinkish grey, readily separating this taxon from the other two species.

A detailed diagnosis of the three species *Bothrops mexicoiensis* sp. nov., *B. lenhoseri* sp. nov. and *B. xanthogrammus* described singly as *B. xanthogrammus* is provided by Campbell and Lamar (2004), on pages 371-376, as part of Volume 1, with further diagnostic information on the taxon group elsewhere in the same volume.

**Distribution:** *Bothrops mexicoiensis* sp. nov. is found in Central America from Nicaragua (on the east coast), as far north as Mexico.

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*B. mexicoiensis maccartneyi* subsp. nov. is restricted to the area of San Luis de Potosí, Mexico.

**Etymology:** Named in honour of Peter McCartney, from Doncaster, Victoria, Australia, at times an office bearer at the public interest organisations "Whistleblowers Australia" and "Law Watch", both of whom seek to expose and correct corruption in government in Australia. In the 1990's in particular, after exposing severe judicial corruption involving corrupt County Court Judge and former police prosecutor, Thomas Neesham in 1995, McCartney was exposed to intense harassment by the Victoria Police and other arms of government. The

harassment included bashing, fines and all the usual stuff they get up to. Further relevant details can be found in Hoser (1999).

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#### CONFLICT OF INTEREST

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

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# A review and rearrangement of Pitviper genera (Serpentes: Viperidae: Crotalinae).

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## ABSTRACT

The generic arrangement of the Vipers has been subject of considerable change in recent years. The majority of reviews in the period 1990-2013 have tended to divide formerly large genera along phylogenetic lines.

Most recently erected genera have had widespread acceptance within the herpetological community.

A review of the Viperidae has shown inconsistent treatment of species groups, with some accorded recognition at the genus level, while others of similar divergence remain subsumed within larger paraphyletic genera.

In order to make the treatment of Viper species at the genus level consistent, a review was undertaken including checking all relevant published literature, descriptions and phylogenies as well as direct inspection of specimens, including live, photos and museum specimens.

As a result of earlier published papers by myself (including a paper published simultaneously to this one) (Hoser 2013c) and papers by others, the taxonomy and nomenclature of the True Vipers (Viperinae) appears to be consistent, based on this review. However, within the Pitvipers a very different picture emerged with several groups (clades) requiring formal taxonomic recognition at the genus or subgenus level.

This was most notably the case for the deeply divergent and morphologically convergent Asian taxa.

As a result, these unnamed groups are formally described for the first time, according to the Zoological Code (Ride *et al.* 1999).

All groups are named on the basis of robust morphological and molecular data (refer to Hoser 2013b) and as identified in this paper.

These are 8 newly named genera and 8 newly named subgenera.

At the subfamily level, two morphologically divergent Tribes, namely Calloselasmiini Hoser, 2013 (Hoser 2013a) and Tropicolaemusini Hoser, 2012 are each placed in newly defined subfamilies on the basis of recent phylogenetic studies and published results which shows their continued placement within Crotalinae to be problematic.

An updated list of Viper subfamilies, tribes and genera is presented.

**Keywords:** Taxonomy; Pitvipers; new subfamilies; Tropicolaemusiinae; Calloselasmiinae; new genera; *Sloppvipera*; *Conantvipera*; *Katrinahoservipera*; *Ninvipera*; *Ryukyuvipera*; *Cummingvipera*; *Crottyvipera*; *Swilevipera*; new subgenera; *Blackleyvipera*; *Pughvipera*; *Davievipera*; *Cottonvipera*; *Lowryvipera*; *Simpsonvipera*; *Yunnanvipera*; *Borneovipera*.

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## INTRODUCTION

The generic arrangement of the Vipers has been subject of considerable change in recent years as detailed by Hoser (2012c) and sources cited therein.

The majority of reviews in the period 1990-2013 have tended to divide formerly large genera along phylogenetic lines.

Most of the recently erected genera have had widespread acceptance within the herpetological community, being republished widely (Hoser 2012c).

A review of the Viperidae has shown inconsistent treatment of species groups, with some accorded recognition at the genus level, while others of similar divergence remain

subsumed within larger paraphyletic genera.

In order to make the treatment of Viper species at the genus level consistent both within the group and with reference to other snakes and for that matter other vertebrate groups, a review was undertaken. As a result of other papers by myself, including one published at the same time as this (Hoser 2013c), naming two True Viper subgenera within the genus *Bitis* Gray, 1842, and papers by others (cited below), the taxonomy and nomenclature of the True Vipers (Viperinae) appears to be consistent and is therefore not subject of this paper.

However, within the Pitvipers a very different picture emerged with several groups (clades) requiring formal taxonomic recognition at the genus or subgenus level.

These groups are easily differentiated by both morphological and molecular evidence as cited below.

Hence it has not been a difficult decision to assign names to groups for which no names were available.

The Rattlesnakes (Crotalini Gray, 1825) were dealt with in detail by Hoser (2009) and Hoser (2012d) and have had the generic rearrangements of those papers effectively re-validated by the molecular results of Pyron *et al.* (2011 and 2013), noting both papers specifically endorsed the taxonomic position of the Hoser papers reaffirming the parphyly of the rattlesnake genera (read *Crotalus* Linnaeus, 1758 and *Sistrurus* Garman, 1884).

There is no need to interfere with the taxonomy of that group further, although I maintain full support for the nomenclatural position of Hoser (2012d) in this paper.

Likewise the generic arrangement of species within the tribe Caloselasmaiini Hoser 2013 (Hoser 2013a) does not need rearranging.

The tribe Agkistrodonini Hoser, 2012 is not in need of review or change, save for the fact that the genus *Agkistrodon* Palisot de Beauvois, 1799 should be split into subgenera along obvious morphological lines. The species *A. contortrix* (Linnaeus, 1766), that with the distinctly pointed snout that overshoots the mouth, remains within the subgenus *Agkistrodon* while the other three more bluntly snouted species are within the subgenus *Toxicophis* Troost, 1836, a group originally described as a full genus.

It is of course ethical that I resurrect earlier names, even if unused to date, rather than to destabilize the zoological nomenclature and break the Zoological Code by creating a new junior synonym for the same taxon.

The tribe Trimeresurusini Hoser, 2012, as detailed in Hoser (2012c) contains genera as presently recognized in need of division to maintain consistency in relation to other viper species groups.

This is in spite of the erection of the new genera *Adelynhoserea* Hoser, 2012, and *Oxyus* Hoser, 2012, both being within the tribe.

The same applies for the tribes Jackyhoserini Hoser, 2012, and Adelynhoserserpenini in spite of the erection of the new genera *Jackyhoserea* Hoser, 2012 and *Adelynhoserserpinae* Hoser, 2012 respectively within each genus grouping.

The tribe Lachesini Cope, 1900, as defined by Hoser, 2012 also requires division of genera to make the treatment of species consistent and there are available names for the affected genera.

I also note that Hoser (2012) inadvertently omitted the genus *Mixcoaltus* (Jaden, Smith and Campbell, 2011) containing three species. These should be treated as within Lachesini.

The genus *Peltopelor* Günther 1864, for the species *Trimeresurus macrolepis* Beddome, 1862 was inadvertently omitted from the tribe Trimeresurusini Hoser, 2012.

Likewise for the genus *Ceratimeresurus* Liang and Liu in Liang, 2003, herein recognized and divided into two subgenera within the tribe Trimeresurusini Hoser, 2012.

The genus *Ceratimeresurus* Liang and Liu in Liang, 2003, was originally described as monotypic for the horned viper species *Ceratimeresurus shenlii* Liang and Liu in Liang, 2003, later synonymized with the species *Protobothrops cornutus* (Smith, 1930), by David *et al.* (2008).

This paper formally recognizes the genus *Ceratimeresurus* as being distinct from *Protobothrops* and expands it to include two more species, namely, *Trimeresurus jerdonii* Günther, 1875 and *Trimeresurus xiangchengensis* Zhao, Jiang and Huang, 1979, the inclusion of these taxa being based on both the molecular and morphological studies cited herein.

As a result, I provide a new diagnosis for this genus in this paper.

The genus *Ceratimeresurus* is in turn split two ways to subgenera to divide the species with horns above the eyes (type for the genus) from the others, noting that *Ceratimeresurus jerdonii* (Günther, 1875) as recognized here includes more than one species level taxa.

In the treatment below I do not repeat detailed information in terms of the said snakes repeated elsewhere.

Furthermore I do not rehash the detail of the tribal and subtribe arrangements of the Pitviper genera as this has already been dealt with by Hoser (2012c) and that paper remains widely available, both in hard copy and online as a pdf via links from the internet portal at: <http://www.herp.net>. Instead each species group of relevance and in need of placement in a new genus or subgenus is merely diagnosed and described according to the Zoological Code (Ride *et al.* 1999) and in relation to the genus and species group they were formerly placed within, thereby making the new names available under the Zoological Code.

As a result of this review and on the basis of the evidence within the sources cited, there are 8 new genera and 8 new subgenera formally named for the first time.

On the basis of the evidence within the sources cited, I also note the resurrection of the following:

The genus *Teleuraspis* Cope, 1860 for the species *Teleuraspis schlegeli* Berthold, 1846 and *Bothrops schlegelii supraciliaris* Taylor, 1954, regarded herein as a full species in the same genus:

The genus *Thamnocenchris* Salvin, 1860 (type species: *Thamnocenchris aurifer*) is herein recognized as a subgenus within *Bothriechis* Peters, 1859 and includes the morphologically similar species: *Bothriechis rowleyi* (Bogert, 1968), *B. bicolor* (Bocourt, 1868), *B. thalassinus* Campbell and Smith 2000 and *B. marchi* (Barbour and Loveridge, 1929). As a result the subgenus *Bothriechis* Peters, 1859 is confined to the species *B. nigroviridis* Peters, 1859 and *B. lateralis* Peters, 1862:

The genus *Zhaoermia* Zhang, 1993 is regarded as valid for the species *Trimeresurus mangshanensis* Zhao, 1990 (commonly placed in the genus *Protobothrops* Hoge and Romano-Hoge, 1983 by other recent authors). The recognition of *Zhaoermia* is in line with the view of Hoser 2012c and further validated by the published phylogeny of Pyron *et al.* (2013).

The genus *Craspedocephalus* Kuhl and van Hasselt, 1822 is

resurrected for the species *Cophias punicea* Boie, 1827, better known as *Trimeresurus puniceus* (Boie, 1827) and *T. borneensis* (Peters, 1872) which is herein placed in a newly named subgenus.

The genus *Atropos* Wagler, 1830 is herein treated as junior synonym for *Craspedocephalus* Kuhl and van Hasselt, 1822 as it has the same type species (McDiarmid *et al.* 1999).

All newly resurrected or named genera and subgenera would as a matter of course be placed in the same tribes from where the genus they are derived from came.

The formally named groups are as follows:

**Genera:** *Sloppvipera gen. nov.* for a species formerly placed within *Tropidolaemus* Wagler, 1830: *Conantvipera gen. nov.*, *Katrinahoservipera gen. nov.*, and *Ninvipera gen. nov.* for species formerly within the genus *Gloydus* Hoge and Romano-Hoge, 1981: *Ryukyuvipera gen. nov.* for species formerly within the genus *Ovophis* Burger, 1981; *Cummingvipera gen. nov.* and *Crottyvipera gen. nov.* for species formerly placed within the genus *Protobothrops* Hoge and Romano-Hoge, 1983; and *Swilevipera gen. nov.* for a species formerly placed within the genus *Parias* Gray, 1849.

**Subgenera:** *Blackleyvipera subgen. nov.* for species within the genus *Rhinocerocephalus* Garman, 1881; *Pughvipera subgen. nov.* for a species within the genus *Bothrocophias* Gutberlet and Cambell, 2001; *Davievipera subgen. nov.* for species within the genus *Porthidium* Cope, 1871; *Cottonvipera subgen. nov.* for species within the genus *Ovophis* Burger, 1981; *Lowryvipera subgen. nov.* for two species formerly within the genus *Protobothrops* Hoge and Romano-Hoge, 1983 and herein placed within the genus *Ceratrimeresurus* Liang and Liu in Liang, 2003, in addition to the type species for that genus;

*Simpsonvipera subgen. nov.* and *Yunnanvipera subgen. nov.* each for a single species within the genus *Viridovipera* Malhorta and Thorpe, 2004; *Borneovipera subgen. nov.* for species within the genus *Craspedocephalus* Kuhl and van Hasselt, 1822.

In terms of diagnoses of the original source genera, I rely upon the original diagnosis for each of the relevant genera as cited in the paragraphs above, including as defined in the material cited immediately below.

Published sources of relevant taxonomic data and opinions relied upon include: Beaman and Hayes (2008), Bocourt (1868), Boulenger (1888, 1890, 1892, 1896), Boulenger *et al.* (1907), Boundy (2007), Bourret (1934), Broadley (1996), Bryson *et al.* (2011), Campbell and Lamar (2004), Campbell and Smith (2000), Carrasco *et al.* (2009), Castoe and Parkinson (2006), Castoe *et al.* (2005), Cope (1887), David (1995), David and Tong (1997), David and Vogel (1998, 2012), David *et al.* (2001, 2002a, 2002b, 2006, 2008, 2011), Dawson, *et al.* (2008), De Rooij (1917), Duméril *et al.* (1854), Fenwick, *et al.* (2009), Fernandes (2005), Fernandes *et al.* (2004), Garman (1881), Garrigues *et al.* (2005), Gloyd and Conant (1989), Gong *et al.* (2011), Grismer *et al.* (2006), Gumprecht *et al.* (2004), Groombridge (1986), Gumprecht and Tillack (2004), Gumprecht *et al.* (2004), Günther (1864), Guo *et al.* (1999a, 1999b, 2006, 2007, 2009), Gutberlet and Campbell (2001), Harvey (1994), Heise *et al.* (1995), Herrmann *et al.* (1992, 2002), Hoge and Romano-Hoge (1981, 1983), Hoser (2012a, 2012b, 2012c, 2012d, 2012e, 2012f, 2012g, 2012h, 2013a, 2013b, 2013c), Ineich, *et al.* (2006), Isogawa *et al.* (1994), Jadin *et al.* (2010, 2011), Jan (1859), Jiang and Zhao (2009), Kardong (1986), Kelly *et al.* (2003), Klauber (1972), Koch (2008), Kraus, *et al.* (1996),

Kuch *et al.* (2007), Lawson (1977), Lenk *et al.* (2000), Leviton *et al.* (2003), Lidth de Juede (1886, 1922), Liem *et al.* (1971), Liu *et al.* (1989), Malhorta and Thorpe (2000, 2004, 2005), Marx and Olechowski (1970), McCranie (2011), McDiarmid *et al.* (1999), Mebs *et al.* (1994), Meik and Pires-daSilva (2009), Orlov (1997), Orlov and Barabanov (1999), Orlov *et al.* (2002, 2009), Nutphand *et al.* (1991), Pan *et al.* (2013), Parkinson (1999), Peng and Fuji (2001), Peters (1859, 1872), Pitman (1974), Pyron *et al.* (2011, 2013), Ryabov (2003), Sanders *et al.* (2002), Schätti and Kramer (1993), Schmidt (1925), Schnurrenberger (1959), Sharma (2004), Smith (1941), Smith (1939, 1949), Smith *et al.* (1977), Spawls and Branch (1995), Stejneger (1907), Sterer (1992), Stevens (1973), Stümpel and Joger (2009), Taggart *et al.* (2001), Takahashi (1922, 1930), Taylor (1965), Tillack *et al.* (2003), Toda *et al.* (1999), Toriba (1992), Tu *et al.* (2000), Vidal and Leconte (1998), Vogel (2006), Wall (1906), Wang and Zhao (2006), Werman (1984, 1992), Werner *et al.* (1991), Whitaker and Captian (2004), Wüster and Bérnills (2011), Xu *et al.* (2012), Yang *et al.* (2011), Zamudio and Green (1997), Zhang (1993, 1998), Zhang *et al.* (2011), Zhao (1977, 1995, 1997), Zhao and Adler (1993), Zhao and Zhao (1991) and Ziegler *et al.* (2001) and sources cited therein.

This material provides both a morphological and molecular basis for all the relevant taxonomic judgments herein and are the main body of evidence with which the conclusions can be judged against. Of note is that no genera were erected for species groups that are believed to have diverged less than 6 million years before present as the most conservative of positions, meaning the position taken herein remains more conservative than that used in comparable mammal taxonomy.

The tribe *Trimeresurusini* Hoser, 2012 while defined in terms of the component genera and/or by exclusion of other tribes defined in the same paper did contain errors. Therefore the tribe is redefined herein and including a definition in terms of the diagnostics of the snake species themselves as was done for all the other viper tribes in Hoser (2012).

While listed below as Hoser (2012), in the event that another herpetologist decides for any reason that the description of *Trimeresurusini* Hoser (2012) was not valid under the current zoological code, then the below description must be treated as "*tribe nov.*" in order to maintain nomenclatural stability.

The description of *Trimeresurusini* Hoser, 2012 also made the error of failing to account for the genera placed within the tribe *Tropidolaemusini* Hoser, 2012, even though it was the next listed tribe in the paper and clearly listed in the paper as another tribe with other named genera.

A revisit of the data available shows that both Tribe Calloselasmaiini Hoser, 2013 and *Tropidolaemusini* Hoser, 2012 sit roughly midway between the subfamilies Azemiopinae Liem, Marx and Rabb, 1971 and Crotalinae Opperl, 1811 in terms of their phylogeny (see for example Pyron *et al.* 2013), making their long-term placement within the latter subfamily untenable, unless all are merged into a single subfamily (Crotalinae), or within the Viperidae Opperl, 1811 at the sub-family level (Viperinae Opperl, 1811), which in effect defeats the purpose of having subfamilies.

I regard that as unsatisfactory, especially when compared to mammalian phylogenies and the taxonomy and nomenclature that results, noting the relevant dates of divergence.

Therefore I hereby create two new subfamilies, which in effect t the present time mirror the groups defined by the

tribes Calloselasmiini Hoser, 2013 and *Tropidolaemusini* Hoser, 2012, both defined below according to the Zoological Code.

The tribe *Tropidolaemusini* Hoser, 2012 (and corresponding subfamily) does of course gain the genus *Sloppvipera gen. nov.*, created by a division of the genus *Tropidolaemus* Wagler, 1830, as done at the same time in this paper.

For completeness, this paper ends with a listing of the Viperidae by subfamily, tribal groupings and genera, including subtribes, but excluding subgenera.

#### **CALLOSELASMIINAE SUBFAM. NOV.**

**(Terminal taxon: *Trigonocephalus rhodostoma* Kuhl, 1824)**

Generally currently known as *Calloselasma rhodostoma* (Kuhl, 1824)

**Diagnosis:** This subfamily within the Viperidae, consists of two distinct genera (the tribe Calloselasmiini Hoser, 2013) and they are defined herein separately as a composite diagnosis for the subfamily and its contents.

The species taxon, *Calloselasma rhodostoma*, monotypic for the genus is the only Asian pit viper with large crown scales and smooth dorsal scales.

There are three species within the genus *Hypnale*. All are readily identified by their more-or-less upturned snouts that produce a sort of hump-nosed effect (hence the common name "Humpnosed Vipers"). This separates them from all other vipers.

All taxon within this group are moderately stout snakes. The Malayan Pitviper, *Calloselasma rhodostoma* is found in Southeast Asia from Thailand to northern Malaysia and on the island of Java. Attains an average total body length of 76 cm, with females being slightly larger than males. The largest recorded length is 91 cm. The species is oviparous (lays eggs).

The three species of *Hypnale* occur in South-west India and island Sri Lanka. Members of this genus grow to a maximum total length of 55 cm (for *H. hypnale*). The tail length accounts for 14-18% of the total body length in males, 11-16% in females.

The snout is more or less upturned, with two species having a wart-like protuberance at the tip that is covered with tiny scales.

The anterior head shields are strongly fragmented, but the frontal scale, supraoculars and parietals are complete and quite large. The nasal scale is single, but it may have a groove that extends towards its upper edge. There are two preoculars and 2-4 postoculars.

The loreal scale is single, but extends across the canthus rostralis so that it can be seen from above.

The supralabials and sublabials both number 7-9. Bordering the supralabials are 3-4 enlarged temporal scales, above which are 3-5 irregular rows of temporal scales.

There is one pair of chin shields, each of which is slightly longer than it is wide.

There are 17 dorsal mid-body scale rows, which are weakly keeled.

Apical pits are present, but very difficult to see. The keels are lacking or may be entirely absent on the first two scale rows bordering the ventrals.

There are 120-158 ventrals and 28-48 mainly divided subcaudals.

**Content:** *Calloselasma* Cope, 1860; *Hypnale* Fitzinger, 1843.

#### **TROPIDOLAEMUSIINAE SUBFAM. NOV.**

**(Terminal taxon: *Tropidolaemus wagleri*)**

**Diagnosis:** A subfamily of Asian pitvipers consisting of four genera and herein defined by each genus. This diagnosis should also be treated as a modified diagnosis for the tribe Tropidolaemusini Hoser, 2012.

*Deinagkistrodon* is a monotypic genus for the species *D. acutus*, found in in southern China (Chekiang, Fukien, Hunan, Hupeh, Kwantung), Taiwan, northern Vietnam, and possibly Laos. It is commonly known as the Sharp-nosed Viper.

It is separated from other Asian pitvipers by the following suite of characters:

The back is light brown or greyish brown, with a series of dark brown lateral triangles on each side. The two pointed tops of the two opposite triangles meet each other at the mid-line, forming a series of about twenty light brown, squarish blotches on the back. A row of large black spots extends along each side near the belly. The top and upper sides of the head are uniformly black, with a black streak from the eye to the angle of the mouth; yellowish below, spotted with dark brown. The young are much lighter than the adults with essentially the same pattern.

The head is large, triangular, with an upturned snout. The body is very stout. The tail is short, ending in a compressed, pointed slightly curved cornified scale. The top of the head is covered with nine large plates. Dorsal scales are strongly and tubercularly keeled. Subcaudals are mainly divided, some anterior ones are single. Ranges from 0.8 to 1.0 metre (2.6 and 3.3 ft) in total length, with the longest recorded length being a male of 61 inches or 1.549 metres (5.08 ft).

*Garthius* is monotypic for the species *chaseni*, known as Chasen's mountain pit viper.

It is a small, stocky terrestrial pitviper, not exceeding a metre.

Dorsally it's brownish with irregular blackish, light-edged blotches which become transverse bands posteriorly. The belly is yellow with grey specks. There's an oblique black stripe behind the eye bordered below with white.

Currently known only from Mt. Kinabalu, Borneo (Indonesia).

*Garthius* is separated from other Asian Pitvipers by the following suite of characters: Scalation includes 15-19 dorsal mid-body scale rows, 130-143 ventrals, 20-30 divided subcaudals and 6 supralabials with the third being the highest.

*Tropidolaemus* as defined herein is a genus of four currently described species, commonly known as the Temple Vipers. A fifth species which conforms to the diagnosis immediately below, is now placed in the genus *Sloppvipera gen. nov.*

The two genera are separated from other Asian pitvipers including the superficially similar *Trimeresurus* Lacépède, 1804, by the following suite of characters: absence of a nasal pore, the upper surfaces of the snout and head are covered with distinctly covered small scales, strongly keeled gular scales, second supralabial not bordering the anterior margin of the loreal pit and topped by a prefoveal, and a green colour in juveniles that may or may not change with age.

*Sloppvipera gen. nov.* differ from all other known

*Tropidolaemus* by (1) a higher Tail/Total length ratio, 0.279 vs. 0.179-0.196 in juveniles of *T. wagleri* of same size and sex (David and Vogel, 1998, p. 62); (2) a bright red tip of the snout when the snake is alive, this colouration fading in alcohol but was conspicuous when the live juveniles were collected; and (3) an upturned snout in *S. huttoni* (formerly *T. huttoni*) (not seen to this extent if at all, in all other known

*Tropidolaemus*).

General scale counts such as ventrals and mid-body rows for *Sloppvipera gen. nov.* do sit within the known range for *Tropidolaemus* making separation of the genera by this means problematic.

The two genera are separated by distribution, with *Sloppvipera gen. nov.* found in the District of Madurai, State of Tamil Nadu, South India, as opposed to *Tropidolaemus* which is found in Indonesia, the Philippines and immediately adjacent mainland of South-east Asia only.

Furthermore the known habits of the two genera are strongly contrasted, with *Sloppvipera gen. nov.* clearly a montane genus, as opposed to *Tropidolaemus* being a wet tropics lowland inhabitant.

**Content:** *Deinagkistrodon* Gloyd, 1979; *Garthius* Malhorta and Thorpe, 2004; *Sloppvipera gen. nov.* (this paper); *Tropidolaemus* Wagler, 1830.

#### TRIBE TRIMERESURUSINI HOSER, 2012

(Terminal Taxon: *Trimeresurus gramineus*)

**Diagnosis:** An Asian tribe of pitvipers, it includes all species from Asia and adjacent areas, except those from the genera *Calloselasma* Cope, 1860 and *Hypnale* Fitzinger, 1843, defined under a different tribe name within the tribe Calloselasmaiini Hoser, 2013 and the genera *Deinagkistrodon* Gloyd, 1979, *Garthius* Malhorta and Thorpe, 2004, *Tropidolaemus* Wagler, 1830 and *Sloppvipera gen. nov.*, within the tribe Tropidolaemusini Hoser, 2012 (both latter tribes also being placed in separate subfamilies).

The size and shape of the vipers in the tribe Trimeresurusini varies, but the greatest number are smallish and arboreal. The greatest degree of diversity is in the region of continental south-east Asia.

The species within the tribe Trimeresurusini are separated from other snake taxa and defined as follows: Maxillary bone shortened, movable, with enlarged fang; palatine bone expanded, without a distinct dorsal apophysis; border of cavity of maxillary bone with a slight re-entering curve, forming two distinct curves; head distinct from neck, usually covered with small scales; deep loreal pit present between nostril and eye; pupil of eye vertical; scales smooth or keeled, in 17 to 31 longitudinal rows at midbody; body stout; tail short; ventrals rounded; subcaudals paired, rarely single; hypapophyses present throughout vertebral column; hemipenes forked, ornamentation variable.

In terms of the pitvipers outside this tribe they are as follows: The species taxon, *Calloselasma rhodostoma*, monotypic for the genus is the only Asian pit viper with large crown scales and smooth dorsal scales.

There are three species within the genus *Hypnale*. All are readily identified by their more-or-less upturned snouts that produce a sort of hump-nosed effect (hence the common name Hump-nosed Vipers). This separates them from all other vipers. For further details in terms of the component genera, see within the subfamily Tropidolaemusiinae *subfam. nov.* above.

In terms of the tribe Tropidolaemusini Hoser, 2012, the tribe is best defined by defining each component genus.

*Deinagkistrodon* is a monotypic genus for the species *D. acutus*, found in in southern China (Chekiang, Fukien, Hunan, Hupeh, Kwantung), Taiwan, northern Vietnam, and possibly Laos. It's commonly known as the Sharp-nosed Viper.

It is separated from other Asian pitvipers by the following suite of characters:

The back is light brown or greyish brown, with a series of dark brown lateral triangles on each side. The two pointed tops of the two opposite triangles meet each other at the mid-line, forming a series of about twenty light brown, squarish blotches on the back. A row of large black spots extends along each side near the belly. The top and upper sides of the head are uniformly black, with a black streak from the eye to the angle of the mouth; yellowish below, spotted with dark brown. The young are much lighter than the adults with essentially the same pattern.

The head is large, triangular, with an upturned snout. The body is very stout. The tail is short, ending in a compressed, pointed slightly curved cornified scale. The top of the head is covered with nine large plates. Dorsal scales are strongly and tubercularly keeled. Subcaudals are mainly divided, some anterior ones are single. Ranges from 0.8 to 1.0 metre (2.6 and 3.3 ft) in total length, with the longest recorded length being a male of 61 inches or 1.549 metres (5.08 ft).

*Garthius* is monotypic for the species *chasei*, known as Chasen's mountain pit viper.

It's a small, stocky terrestrial pitviper, not exceeding a metre. Dorsally it's brownish with irregular blackish, light-edged blotches which become transverse bands posteriorly. The belly is yellow with grey specks. There's an oblique black stripe behind the eye bordered below with white.

Currently known only from Mt. Kinabalu, Borneo (Indonesia).

*Garthius* is separated from other Asian Pitvipers by the following suite of characters: Scalation includes 15-19 dorsal mid-body scale rows, 130-143 ventrals, 20-30 divided subcaudals and 6 supralabials with the third being the highest.

*Tropidolaemus* as defined herein is a genus of four currently described species, commonly known as the Temple Vipers. A fifth species which conforms to the diagnosis immediately below, is now placed in the genus *Sloppvipera gen. nov.*

The two genera are separated from other Asian pitvipers including the superficially similar *Trimeresurus* Lacépède, 1804, by the following suite of characters: absence of a nasal pore, the upper surfaces of the snout and head are covered with distinctly covered small scales, strongly keeled gular scales, second supralabial not bordering the anterior margin of the loreal pit and topped by a prefoveal, and a green colour in juveniles that may or may not change with age.

*Sloppvipera gen. nov.* differ from all other known *Tropidolaemus* by (1) a higher Tail/Total length ratio, 0.279 vs. 0.179-0.196 in juveniles of *T. wagleri* of same size and sex (David and Vogel, 1998, p. 62); (2) a bright red tip of the snout when the snake is alive, this colouration fading in alcohol but was conspicuous when the live juveniles were collected; and (3) an upturned snout in *S. huttoni* (formerly *T. huttoni*) (not seen to this extent if at all, in all other known *Tropidolaemus*).

General scale counts such as ventrals and mid-body rows for *Sloppvipera gen. nov.* do sit within the known range for *Tropidolaemus* making separation of the genera by this means problematic.

The two genera are separated by distribution, with *Sloppvipera gen. nov.* found in the District of Madurai, State of Tamil Nadu, South India, as opposed to *Tropidolaemus* which is found in Indonesia, the Philippines and immediately adjacent mainland of South-east Asia only.

Furthermore the known habits of the two genera are strongly contrasted, with *Sloppvipera gen. nov.* clearly a montane genus, as opposed to *Tropidolaemus* being a wet tropics lowland inhabitant.

**SLOPPVIPERA GEN. NOV.**

**Type species:** *Trimeresurus huttoni* Smith, 1949.

**Diagnosis:** The genus *Tropidolaemus* Wagler, 1830 is a pitviper genus defined by the absence of a nasal pore, upper surfaces of the snout and head covered with distinctly keeled small scales, strongly keeled gular scales, the second supralabial not bordering the anterior margin of the loreal pit and topped by a prefoveal and a green coloration in juveniles which may or may not change with growth and age.

The type species for *Sloppvipera gen. nov.* (*Trimeresurus huttoni* Smith, 1949) was placed in the genus *Tropidolaemus* Wagler, 1830 by David and Vogel (1998) on the basis of shared morphological characteristics.

However a revisiting of their published data shows that the species is neither appropriately placed within either of the genera *Trimeresurus* Lacépède, 1804 or *Tropidolaemus* Wagler, 1830.

As there is no available generic name for this taxon, it is entirely appropriate one is defined herein.

*Sloppvipera gen. nov.* is defined and separated from *Trimeresurus* by the following suite of characters (taken from the two known juveniles):

*Sloppvipera gen. nov.* differ from all other known *Tropidolaemus* by (1) a higher Tail/Total length ratio, 0.279 vs. 0.179-0.196 in juveniles of *T. wagleri* of same size and sex (David and Vogel, 1998, p. 62); (2) a bright red tip of the snout when the snake is alive, this colouration fading in alcohol but was conspicuous when the live juveniles were collected; and (3) an upturned snout in *S. huttoni* (formerly *T. huttoni*) (not seen to this extent if at all, in all other known *Tropidolaemus*).

General scale counts such as ventrals and mid-body rows for *Sloppvipera gen. nov.* do sit within the known range for *Tropidolaemus* making separation of the genera by this means problematic.

The two genera are separated by distribution, with *Sloppvipera gen. nov.* found in the District of Madurai, State of Tamil Nadu, South India, as opposed to *Tropidolaemus* which is found in Indonesia, the Philippines and immediately adjacent mainland of South-east Asia only.

Furthermore the known habits of the two genera are strongly contrasted, with *Sloppvipera gen. nov.* clearly a montane genus, as opposed to *Tropidolaemus* being a wet tropics lowland inhabitant.

**Distribution:** Known from only two specimens, both from "The high Wavy Mountains", Varushanad Hills, District of Madurai, State of Tamil Nadu, South India at an elevation of about 5200 feet.

**Conservation Implications:** The species *Sloppvipera huttoni* (Smith, 1949), is known from just two specimens and is monotypic for the new genus and likely to remain that way on the assumption no similar species are discovered.

The two known specimens were collected from beneath leaves of a Hill Bamboo (*Ochlandra travancorica*) clump, locally known as "Eeta" in Tamil. Diet and other aspects of the snake are effectively unknown and can only be inferred from the reported morphological features as published by David and Vogel (1998). According to Hutton's description, only a small area on the plateau was cultivated at the time. This cultivation has greatly expanded and means that the species *Sloppvipera huttoni* (Smith, 1949) could be threatened or perhaps extinct.

Noting the continued environmental pressures within the region and the ease with which Pitvipers breed in captivity. I

strongly recommend that specimens be removed from the wild (if able to be located) and bred for zoo exhibits and private herpetoculture.

I also strongly recommend that bureaucratic impediments to the collection and transport of specimens to places where people are willing and able to keep and breed the species are removed.

**Etymology:** Named in honour of our pet Great Dane, Slopp, who has successfully guarded the Snakebusters research and education facility from several attacks by police-protected criminals and thieves.

In response to widely published complaints both in hard copy and online by serial liars and truth haters Wolfgang Wüster, Mark O'Shea (both of the UK), Hinrich Kaiser (of the USA) and Wulf Schleip (of Germany) and other ratbags associated with them who allege it is inappropriate to use a dog's name for an etymology, I make no apology for taking the opportunity to honour a four-legged co-inhabitant of our planet.

I pride myself as an animal lover, who always puts animal welfare as the highest priority and strongly resent the gross mistreatment of mammals and reptiles by the likes of Wüster and O'Shea who routinely attack snakes with brutal metal tongs whose main function is to break the delicate rib bones and spinal cords of snakes held in these devices.

While the appropriate placement of the species *Trimeresurus huttoni* Smith, 1949 into a new (presently monotypic) genus is in effect a "no-brainer" based on the publicly available evidence, there is little doubt that Wüster and O'Shea will break all rules and ethics to sabotage the use of the name and act in breach of the Zoological Code (Ride *et al.* 1999) to improperly create nomenclatural instability, as they have done in the past (see Hoser 2013b and sources cited therein).

**BLACKLEYVIPEREA SUBGEN. NOV.**

**Type species:** *Bothrops alternatus* Duméril, Bibron and Duméril, 1854.

**Diagnosis:** The genus *Rhinocerocephis* Garman, 1881 which is where this subgenus is contained, is diagnosed as follows:

*Rhinocerocephis* differs from all other South American pitvipers in 27 mitochondrial characters, and in having few (1 or 2) palatine teeth (versus 3-6 teeth in all others), which is a morphological synapomorphy. Distribution is in southern South America, combined with terrestrial habitat in open areas, grasslands, swamps, or broad-leaf and Araucaria forests, and further distinguishes this genus from others.

*Rhinocerocephis* individuals have the maxillary fang shorter than the height of the maxilla, and show black bars on the gular scales of some species (*R. alternatus*, *R. cotiara*, *R. fonsecai*, and *R. jonathani*). *Rhinocerocephis* have fewer subcaudals (25-55) than the other genera (31-86), and some specimens have high numbers of supralabials (7-10, also seen in *Bothropoides*; other South American genera have 7-8). *Rhinocerocephis* differs from *Bothrops* and *Bothriopsis* (as defined until now and including new genera split from them) in having the prelacunal scale separated from the second supralabial. It differs from *Bothriopsis* in the lack of green coloration and in the lack of a prehensile tail. It differs from *Bothrocophias* in the lack of tuberculate keels on posterior dorsal scales. Almost all species differ from *Bothrocophias* in colour pattern: whereas *Bothrocophias* species have spade-shaped dorsal markings lacking spots between the spades, *Rhinocerocephis* species have spots between the spades (*R. alternatus*, *R. cotiara*, and *R. fonsecai*), have trapezoidal markings with spots between them (*R. itapetingae*), or have



a checkered pattern (*R. ammodytoides*). Only *R. jonathani* lacks spots between spades, but it can be distinguished by the presence of black bars on the gular scales, as mentioned above.

All species within the genus *Rhinocerophis* Garman, 1881 are in the subgenus *Blackleyviperea subgen. nov.* except for the type for the genus *Rhinocerophis*, namely *R. ammodytoides* (Leybold, 1873).

Therefore all snakes within the subgenus *Blackleyviperea subgen. nov.* are separated most easily from the nominate subgenus by the absence of a dorsal checkered pattern. Campbell and Lamar (2004), pages 368-369, give a full diagnosis of the species *R. ammodytoides* (Leybold, 1873), enabling further separation of the subgenera. The same text contains a key to relevant species in both subgenera and also diagnostic information for each species.

**Distribution:** Southern South America.

**Etymology:** Named in honour of Caroline Blackley of Romford, London, UK, for contributions to herpetology.

**Content:** *Rhinocerophis (Blackleyviperea) alternatus* (Duméril, Bibron and Duméril, 1854) (type species); *R. (Blackleyviperea) cotiara* (Gomes, 1913); *R. (Blackleyviperea) fonsecai* (Hoge and Belluomini, 1959); *R. (Blackleyviperea) itapetiningae* (Boulenger, 1907); *R. (Blackleyviperea) jonathani* (Harvey, 1994).

#### **PUGHVIPERA SUBGEN. NOV.**

**Type species:** *Bothrops campbelli* Freire-Lascano, 1991.

**Diagnosis:** The subgenus *Pughvipera subgen. nov.* is contained within the genus *Bothrocophias* Gutberlet and Cambell, 2001 and is restricted to the type species and the similar species *B. myersi* Gutberlet and Campbell, 2001. The other four described and recognized species remain in the nominate subgenus *Bothrocophias* Gutberlet and Cambell, 2001, those being *Bothrocophias colombianus* (Rendahl and Vestergren, 1940), *B. hyoprora* (Amaral, 1935), *B. microphthalmus* (Cope, 1876) and *B. rhombeatus* Garcia, 1896.

The genus *Bothrocophias* Gutberlet and Cambell, 2001 is defined herein based on the original description and as follows: Members of the six species included in this lineage are of moderate length, relatively stout-bodied, and terrestrial, lacking a prehensile tail. Females attain greater size than do males. The snout is weakly elevated in (*B. campbelli* and *B. myersi*) and strongly elevated in the four species remaining in the nominate subgenus.

The rostral scale is approximately as high as broad or distinctly higher than broad.

Dorsal coloration within the genus consists mainly of darker shades of brown and reddish-brown. A pattern of dorsal banding may be clearly evident or subdued, and in some specimens the bands do not meet evenly at the middorsal line and are staggered as large lateral blotches.

Derived characteristics shared by the six species of *Bothrocophias* include small, smooth intersupraocular scales; distinctive white spots on gular and infralabial scales; and tuberculate keels on scales on the caudal portion of the dorsum. Many, though not all, specimens of *B. hyoprora* and *B. microphthalmus* exhibit tiny scales between the rostral and internasals that have not been observed in any other New World pitviper.

There are 124-177 ventrals; 38-64 subcaudals, most of which are entire in *B. hyoprora*, but mostly divided in the other species; 21-25 mid-dorsal scale rows; 2-9 smooth intersupraoculars; 7-8 supralabials; 8-11 infralabials; 1-11

prefoveals; 1-3 canthals; and 3-4 interoculabials.

Species of *Bothrocophias* have 4-5 palatine teeth, 12-15 pterygoid teeth, and 14-16 dentary teeth.

The maxillary fang is approximately 1.5 times longer than the height of the maxilla.

Hemipenes of these species are calyculate distally. Walls of the more proximal calyces are spinulate. Proximal to the calyces, small mesial spines and a moderate number (ca. 18-30 per lobe) of lateral spines are present.

Though some lateral spines are noticeably larger than the mesial spines, none can be characterized as basal hooks. The hemipenes of *B. hyoprora* differ slightly from those of the new subgenus in having longer and more slender lateral spines.

The following combination of characters diagnoses *Bothrocophias* from all other New World pitviper genera: (1) 7-8 supralabials; (2) small but unkeeled dorsal head scales, not arranged in a nine-plate, colubrid-like pattern; (3) tubercular keels on dorsal scales on posterior half of body; (4) white spots with dark borders on some gulars and infralabials; (5) 124-177 ventrals; (6) 4-5 palatine teeth; (7) 12-15 pterygoid teeth; (8) 14-16 dentary teeth; (9) maxillary fang approximately 1.5 times longer than height of maxilla; (10) mesial spines present on hemipenial lobes; (11) moderate number (ca. 18-30 per lobe) of lateral spines on hemipenes; (12) hemipenial lobes only slightly longer than organ's base; (13) choanal process of palatine attenuate distally; (14) ectopterygoid and base of pterygoid approximately equal in length; (15) dorsal surface of frontal bones predominantly flat; (16) postfrontal bones large, contributing more to dorsal perimeter of orbit than does parietal; (17) tail not prehensile and lacks a rattle.

Snakes in the subgenus *Pughvipera subgen. nov.* are separated from those in the nominate subgenus by the presence of a lacunolabial (versus an absence) and no cathrostrals (versus presence in the nominate subgenus).

**Distribution:** Northern South America.

**Content:** *Bothrocophias (Pughvipera) campbelli* (Freire-Lascano, 1991) (Type species); *B. (Pughvipera) myersi* Gutberlet and Campbell, 2001.

**Etymology:** Named in honour of Mick Pugh of Geelong, Victoria, Australia, a past president of the Victorian Association of Amateur Herpetologists (VAAH) for his numerous contributions to herpetology in Australia spanning some decades.

#### **DAVIEVIPERA SUBGEN. NOV.**

**Type species:** *Bothrops ophryomegas* Bocourt, 1868.

**Diagnosis:** The genus *Porthidium* Cope, 1871 includes nine described and recognized species of terrestrial snakes ranging collectively from Mexico to Ecuador. In addition to a well defined canthus rostralis, members of *Porthidium* possess a rostral that is higher than it is wide, and the snout is usually attenuate and may be elevated either moderately or greatly, this suite of characters separating them from all other New World Pitvipers. They are terrestrial, less than a meter in overall length, are medium to moderately stout in build, and inhabit xeric or transitional forest (Lawson 1997).

The subgenus *Davievipera subgen. nov.* is most easily diagnosed by the separation of the two component species.

(1) *Porthidium (Davievipera) ophryomegas* (Bocourt, 1868) (the type species) is the only species in the genus with two canthals per side:

(2) *P. (Davievipera) dunni* (Hartweg and Oliver, 1938), is the only species in the genus with the following suite of

characters: The snout is moderately upturned, without a conspicuous nasal appendage; ventrals are variable but usually in excess of 145; there are 19 dorsal scale rows one head length anterior from the vent and 23 dorsal midbody scale rows; a middle preocular that reaches the orbit and is separated from the supralacunal by a vertical suture; 2-3 intercatchals and elevated internasals; the lateral surfaces of the head are mostly dark in colour, with light speckling.

The species remaining within the nominate subgenus *Porthidium* Cope, 1871 are: *Porthidium arcossae* Schatti and Kramer, 1993; *Porthidium hespere* (Campbell, 1976); *Porthidium lansbergii* (Schlegel, 1841); *Porthidium nasutum* (Bocourt, 1868); *Porthidium porrasi* Lamar, 2003; *Porthidium volcanicum* Solorzano, 1995; *Porthidium yucatanicum* (Smith, 1941).

**Distribution:** *Davievipera* subgen. nov. is found in southern Mexico and areas to the south in Middle America.

**Etymology:** Named in honour of Neil Davie formerly of West Geelong, Victoria, Australia, now of Lara, Victoria, Australia a past president of the Victorian Association of Amateur Herpetologists (VAAH) for his numerous contributions to herpetology and herpetological taxonomy in Australia spanning some decades.

**Content:** *Porthidium* (*Davievipera*) *ophryomegas* (Bocourt, 1868) (type species); *P. (Davievipera) dunni* (Hartweg and Oliver, 1938).

#### CONANTVIPERA GEN. NOV.

**Type species:** *Ancistrodon strauchi* Bedraiga, 1912.

Currently most widely known as *Gloydus strauchi* (Bedraiga, 1912).

**Diagnosis:** This paper effectively splits the genus *Gloydus* Hoge and Romano-Hoge, 1981 as defined by them in their paper and popularly recognized by herpetologists since, into four well-recognized species groups, as defined by authors including, Xu *et al.* (2012) and others cited within the paper.

*Gloydus* with the type species of *Trionocephalus halys* Boie, 1827 also known as *Coluber halys* Pallas, 1776, retains the following species: *G. halys* (Pallas, 1776); *G. intermedius* (Strauch, 1868); *G. shedaoensis* (Zhao, 1979) and *Gloydus saxatilis* (Emelianov, 1937).

Snakes in the genus *Gloydus* are separated from the other three genera defined herein (below) by the possession of 23 dorsal mid-body scale rows and having 3 palatine teeth.

Snakes in the new genus *Conantvipera* gen. nov. are separated from the other three genera by the possession of 19 or 21 dorsal mid-body scale rows, having 4 palatine teeth and lower temporals that are separate from the supralabials (fused in *Ninvipera* gen. nov.). The snout is rounded and the head is relatively small and not sharply wider than the neck. The canthus rostralis is well defined but somewhat rounded. The genus is further diagnosed by having 6-7 supralabials, all dorsal scale rows keeled or with keels that are missing on the lowermost rows; inconspicuous paired apical pits, 145-175 ventrals, 34-44 subcaudals and a distinctive body pattern consisting of four irregular dark longitudinal strips that may sometimes form a zig-zag pattern or alternatively some specimens may be melanistic but with whitish borders on the labials along the mouth-line. Alternatively markings may include a dark more-or-less V-shape on the head and irregular small spots on the body. This genus includes the following species: *Conantvipera strauchi* (Bedraiga, 1912) (type species); *C. monticola* (Werner, 1922), *C. liupanensis* (Liu, Song and Luo, 1989); and *C. qinlingensis* (Song and Chen, 1985).

Snakes in the new genus *Katrinahoservipera* gen. nov. are separated from the other three genera by the following suite of characters: Having obvious paired apical pits, 21 dorsal midbody rows and markings consisting of large dark, rounded or squarish blotches on a pale ground colour. Some of the blotches may meet their partners of the opposite side of the body to form dark crossbands, mainly near the tail; 135-146 ventrals (both sexes).

This genus includes the following species:

*Katrinahoservipera blomhoffii* (Boie, 1826) (type species) *K. brevicaudus* (Stejneger, 1907); *K. ussuriensis* (Emelianov, 1929); *K. tsushimaensis* (Isogawa, Moriya and Mitsui, 1994) and *K. lijianlii* (Jiang and Zhao, 2009).

The genus *Ninvipera* gen. nov. is monotypic for the type species *Halys himalayanus* Günther, 1864.

It is separated from the other genera by the following suite of characters: it is a brownish snake with a body pattern of variable dark markings, but invariably consisting of 23-45 crossbands distinguishable from the ground colour by their dark edges; cheek stripe diffuse dorsally, bordered below by a narrow dark streak extending posteriorly from the eye onto the neck. Unlike snakes in the other three genera, the head has large prefrontals that are somewhat pointed in front and rounded at the rear and the fusion of the last two or three supralabials with the temporals to form two or three exceptionally large scales along the commissure. The tip of the snout is slightly upturned and it extends further forward than the lower jaw; 146-170 ventrals (both sexes) or 149-170 in females (a number not seen in *Katrinahoservipera* gen. nov.); apical pits are present but easily missed as they are inconspicuous.

**Distribution:** China.

**Etymology:** Named in honour of Roger Conant, of the USA, co-author of the monograph *Snakes of the Agkistrodon complex*, (Gloyd and Conant 1989) cited as a valuable source in this paper, in recognition for his excellent scholarship in relation to this very genus of snakes that laid a good foundation for later workers.

**Content:** *Conantvipera strauchi* (Bedraiga, 1912) (type species); *C. monticola* (Werner, 1922); *C. liupanensis* (Liu, Song and Luo, 1989) and *C. qinlingensis* (Song and Chen, 1985).

#### KATRINAHOSERVIPERA GEN. NOV.

**Type species:** *Trionocephalus Blomhoffii* Boie, 1826.

**Diagnosis:** This paper effectively splits the genus *Gloydus* Hoge and Romano-Hoge, 1981 as defined by them in their paper and popularly recognized by herpetologists since into four well-recognized species groups, as defined by authors including, Xu *et al.* (2012) and others cited within the paper. *Gloydus* with the type species, of *Trionocephalus halys* Boie, 1827 also known as *Coluber halys* Pallas, 1776, retains the following species: *G. halys* (Pallas, 1776); *G. intermedius* (Strauch, 1868); *G. shedaoensis* (Zhao, 1979); *Gloydus saxatilis* (Emelianov, 1937).

Snakes in the genus *Gloydus* are separated from the other three genera defined herein (below) by the possession of 23 dorsal mid-body rows and having 3 palatine teeth.

Snakes in the new genus *Conantvipera* gen. nov. are separated from the other three genera by the possession of 19 or 21 dorsal mid-body rows, having 4 palatine teeth and lower temporals that are separate from the supralabials (fused in *Ninvipera* gen. nov.). The snout is rounded and the head is relatively small and not sharply wider than the neck. The canthus rostralis is well defined but somewhat rounded.

The genus is further diagnosed by having 6-7 supralabials, all dorsal scale rows keeled or with keels that are missing on the lowermost rows; inconspicuous paired apical pits, 145-175 ventrals, 34-44 subcaudals and a distinctive body pattern consisting of four irregular dark longitudinal strips that may sometimes form a zig-zag pattern or alternatively some specimens may be melanistic but with whitish borders on the labials along the mouth-line. Alternatively markings may include a dark more-or-less V-shape on the head and irregular small spots on the body. This genus includes the following species: *Conantvipera strauchi* (Bedraiga, 1912) (type species); *C. monticola* (Werner, 1922); *C. liupanensis* (Liu, Song and Luo, 1989) and *C. qinlingensis* (Song and Chen, 1985).

Snakes in the new genus *Katrinahoservipera gen. nov.* are separated from the other three genera by the following suite of characters: Having obvious paired apical pits, 21 dorsal midbody rows and markings consisting of large dark, rounded or squarish blotches on a pale ground colour. Some of the blotches may meet their partners of the opposite side of the body to form dark crossbands, mainly near the tail; 135-146 ventrals (both sexes).

This genus includes the following species:

*Katrinahoservipera blomhoffii* (Boie, 1826) (type species)  
*K. brevicaudus* (Stejneger, 1907); *K. ussuriensis* (Emelianov, 1929); *K. tsushimaensis* (Isogawa, Moriya and Mitsui, 1994) and *K. lijianlii* (Jiang and Zhao, 2009).

The genus *Ninvipera gen. nov.* is monotypic for the type species *Halys himalayanus* Günther, 1864.

It is separated from the other genera by the following suite of characters: in that it is a brownish snake with a body pattern of variable dark markings, but invariably consisting of 23-45 crossbands distinguishable from the ground colour by their dark edges; cheek stripe diffuse dorsally, bordered below by a narrow dark streak extending posteriorly from the eye onto the neck. Unlike snakes in the other three genera, the head has large prefrontals that are somewhat pointed in front and rounded at the rear and the fusion of the last two or three supralabials with the temporals to form two or three exceptionally large scales along the commissure. The tip of the snout is slightly upturned and it extends further forward than the lower jaw; 146-170 ventrals (both sexes) or 149-170 in females (a number not seen in *Katrinahoservipera gen. nov.*); apical pits are present but easily missed as they are inconspicuous.

**Distribution:** The region centered on north-east China, but extending to include a sizeable section of eastern China, the Korean Peninsula, Japan, parts of Mongolia and adjacent parts of the former USSR.

**Etymology:** Named in honour of my wife, Katrina Hoser, for a contribution to global herpetology spanning decades as well as contributions to the manufacturing and sale of shoes in various places.

**Content:** *Katrinahoservipera blomhoffii* (Boie, 1826) (type species); *K. brevicaudus* (Stejneger, 1907); *K. ussuriensis* (Emelianov, 1929); *K. tsushimaensis* (Isogawa, Moriya and Mitsui, 1994) and *K. lijianlii* (Jiang and Zhao, 2009).

#### **NINVIPERA GEN. NOV.**

**Type species:** *Halys himalayanus* Günther, 1864.

**Diagnosis:** This paper effectively splits the genus *Gloydius* Hoge and Romano-Hoge, 1981 as defined by them in their paper and popularly recognized by herpetologists since into four well-recognized species groups, as defined by authors including, Xu *et al.* (2012) and others cited within the paper.

*Gloydius* with the type species, of *Trigonocephalus halys* Boie, 1827 also known as *Coluber halys* Pallas, 1776, retains the following species: *G. halys* (Pallas, 1776); *G. intermedius* (Strauch, 1868); *G. shedaoensis* (Zhao, 1979); *Gloydius saxatilis* (Emelianov, 1937).

Snakes in the genus *Gloydius* are separated from the other three genera defined herein (below) by the possession of 23 dorsal mid-body rows and having 3 palatine teeth.

Snakes in the new genus *Conantvipera gen. nov.* are separated from the other three genera by the possession of 19 or 21 dorsal mid-body rows, having 4 palatine teeth and lower temporals that are separate from the supralabials (fused in *Ninvipera gen. nov.*). The snout is rounded and the head is relatively small and not sharply wider than the neck. The canthus rostralis is well defined but somewhat rounded.

The genus is further diagnosed by having 6-7 supralabials, all dorsal scale rows keeled or with keels that are missing on the lowermost rows; inconspicuous paired apical pits, 145-175 ventrals, 34-44 subcaudals and a distinctive body pattern consisting of four irregular dark longitudinal strips that may sometimes form a zig-zag pattern or alternatively some specimens may be melanistic but with whitish borders on the labials along the mouth-line. Alternatively markings may include a dark more-or-less V-shape on the head and irregular small spots on the body. This genus includes the following species: *Conantvipera strauchi* (Bedraiga, 1912) (type species); *C. monticola* (Werner, 1922); *C. liupanensis* (Liu, Song and Luo, 1989); and *C. qinlingensis* (Song and Chen, 1985).

Snakes in the new genus *Katrinahoservipera gen. nov.* are separated from the other three genera by the following suite of characters: Having obvious paired apical pits, 21 dorsal midbody rows and markings consisting of large dark, rounded or squarish blotches on a pale ground colour. Some of the blotches may meet their partners of the opposite side of the body to form dark crossbands, mainly near the tail; 135-146 ventrals (both sexes).

This genus includes the following species:

*Katrinahoservipera blomhoffii* (Boie, 1826) (type species)  
*K. brevicaudus* (Stejneger, 1907); *K. ussuriensis* (Emelianov, 1929); *K. tsushimaensis* (Isogawa, Moriya and Mitsui, 1994) and *K. lijianlii* (Jiang and Zhao, 2009).

The genus *Ninvipera gen. nov.* is monotypic for the type species *Halys himalayanus* Günther, 1864.

It is separated from the other genera by the following suite of characters: in that it is a brownish snake with a body pattern of variable dark markings, but invariably consisting of 23-45 crossbands distinguishable from the ground colour by their dark edges; cheek stripe diffuse dorsally, bordered below by a narrow dark streak extending posteriorly from the eye onto the neck. Unlike snakes in the other three genera, the head has large prefrontals that are somewhat pointed in front and rounded at the rear and the fusion of the last two or three supralabials with the temporals to form two or three exceptionally large scales along the commissure. The tip of the snout is slightly upturned and it extends further forward than the lower jaw; 146-170 ventrals (both sexes) or 149-170 in females (a number not seen in *Katrinahoservipera gen. nov.*); apical pits are present but easily missed as they are inconspicuous.

**Distribution:** Known only from far northern India, Nepal and adjacent parts of Pakistan

**Etymology:** Named in honour of Dara Nin, of Ringwood, Victoria, Australia in recognition of his excellent work educating people about reptiles and wildlife conservation

through his working with Snakebusters, Australia's best reptiles shows, displays and educational incursions.

**Content:** Monotypic for the type species *Ninvipera himalayanus* (Günther, 1864).

#### **RYUKYUVIPERA GEN. NOV.**

**Type species:** *Trimeresurus okinavensis* Boulenger, 1892.

**Diagnosis:** The genus *Ryukyuvipera gen. nov.* monotypic for the type species is separated from other *Ovophis* Burger, 1981 and all other old-world pitvipers by the following suite of characters:

Snout short, obliquely truncate, with sharp raised angle all round; eye rather small. Rostral deeper than broad; nasal divided; upper head-scales small, subimbricate, smooth on the snout and vertex; 6 to 9 scales in a transverse series between the supraoculars, which are large, larger than the eye; a pair of scales separating the internasals in front; three series of scales between the eye and the labials; temporal scales obtusely keeled; 7 or 8 upper labials, second entering the loreal pit, third largest. Scales strongly keeled, in 21 or 23 dorsal mid-body rows. Ventrals 129-130; anal entire; subcaudals 43-47 all divided: Colouration is brown above, with darker cross-bands or alternating large quadrangular blotches; upper surface of the head is dark brown, sides blackish, with a lighter streak along the temple; lower parts brown, with a series of blackish blotches on each side, partly on the ventrals, partly on the two lower rows of scales. Total length under 400 mm; tail under 60 mm. (adapted from Boulenger, 1896):

The other three species of snake currently within the genus *Ovophis* Burger, 1981, (namely, *O. monticola* (Günther, 1864) (type species), *O. tonkinensis* (Bourret, 1934) and *O. zayuensis* (Jiang, 1977), the type species being *Trimeresurus monticola* Günther 1864 (including the subgenus described within this paper) are separated from the genus *Ryukyuvipera gen. nov.* and all other Asiatic Pitvipers by the following suite of characters:

The second upper labial shield forms the front part of the facial pit; a pair of small shields behind the rostral. Scales on the head smooth, those of the body slightly but distinctly keeled, in twenty-three dorsal mid-body rows. 137 or more ventrals (vs 129-130 in *Ryukyuvipera gen. nov.*); approximately 41 subcaudals. Males are a blackish ash colour dorsally, females and young are a pale brown; two series of square black spots along the back: the spots of the two series are either placed alternately with each other, or they are confluent into a single series of large quadrangular spots; sides with small, rounded black or brown spots; a white or yellow streak runs from the back edge of the eye to the side of the neck; the middle of the neck with a Y-like yellow or whitish mark, more distinct in the male than in the female; belly densely marbled with brown.

A molecular phylogeny by Pyron *et al.* (2013) showed *Ryukyuvipera gen. nov.* to be most closely related to the Taiwanese genus *Oxyus* Hoser, 2012, but with a divergence estimated at about 7 million years BP or more, warranting division at the genus level.

**Distribution:** *Ryukyuvipera gen. nov.* is known only from Ryukyu Island, Japan.

**Etymology:** Named in relation to the location where the genus and species are found.

**Content:** Monotypic for the species *Ryukyuvipera okinavensis* (Boulenger, 1892).

#### **COTTONVIPERA SUBGEN. NOV.**

**Type species:** *Trimeresurus monticola zayuensis* Jiang, 1977.

**Diagnosis:** The three species of snake currently within the genus *Ovophis* Burger, 1981, (namely, *O. monticola* (Günther, 1864) (type species), *O. tonkinensis* (Bourret, 1934) and *O. zayuensis* (Jiang, 1977), the type species being *Trimeresurus monticola* Günther 1864 (including the subgenus described within this paper) are separated from the genus *Ryukyuvipera gen. nov.* and all other Asiatic Pitvipers by the following suite of characters:

The second upper labial shield forms the front part of the facial pit; a pair of small shields behind the rostral. Scales on the head smooth, those of the body slightly but distinctly keeled, in twenty-three dorsal mid-body rows. 137 or more ventrals (vs 129-130 in *Ryukyuvipera gen. nov.*); approximately 41 subcaudals. Males are a blackish ash colour dorsally, females and young are a pale brown; two series of square black spots along the back: the spots of the two series are either placed alternately with each other, or they are confluent into a single series of large quadrangular spots; sides with small, rounded black or brown spots; a white or yellow streak runs from the back edge of the eye to the side of the neck; the middle of the neck with a Y-like yellow or whitish mark, more distinct in the male than in the female; belly densely marbled with brown.

The subgenus *Cottonvipera subgen. nov.* is separated from the subgenus *Ovophis* Burger, 1981 by the following suite of characters: the largest supralabial is the third one, whereas in the subgenus *Ovophis* it is the fourth one; the number of ventral scales of the new subgenus is greater than 145, (versus 137-141 in the subgenus *Ovophis*); the subcaudal scales are single or mainly single in the new subgenus, with a few exceptions, whereas in subgenus *Ovophis* these scales are paired or mainly paired, with at most, only a few being single.

**Distribution:** *Cottonvipera subgen. nov.* is found in Vietnam and nearby China.

The subgenus *Ovophis* is believed to occur in South-east Asia in the area bounded by India/Nepal to the west, Taiwan/Mainland China in the east and Sumatra to the south.

**Etymology:** *Cottonvipera subgen. nov.* is named in honour of Tom Cotton, of Ringwood, Victoria, Australia in recognition for his excellent work in terms of wildlife research, conservation and education, with the company, Snakebusters, Australia's best reptiles educational shows and displays over a period of nearly a decade predating 2013.

**Content:** *Ovophis (Cottonvipera) zayuensis* (Jiang, 1977) (type species) and *O. (Cottonvipera) tonkinensis* (Bourret, 1934).

#### **CUMMINGVIPERA GEN. NOV.**

**Type species:** *Trimeresurus kaulbacki* Smith, 1940.

**Diagnosis:** The genus *Cummingvipera gen. nov.* has until now been placed in the genera *Trimeresurus* Lacépède, 1804, or more recently *Protobothrops* Hoge and Romano-Hoge, 1983. However *Cummingvipera gen. nov.* is separated from all other pitvipers (including others in the two genera *Trimeresurus* and *Protobothrops*) by the following suite of characters: 23-25 dorsal mid-body scale rows; elongate body, head long, massive, with narrow snout; canthus rostralis sharp; a single large, squarish loreal; first upper labial completely separated from nasal by a suture; second upper labial anteriorly bordering facial pit; 8-10 scales in line between supraoculars; supraoculars usually

single, flat, without a vertical projection; dorsally dull grayish or olive green with large, blackish rhombohedral dorsal blotches, either distinct or united to one another; smaller spots on the sides; symmetrical yellow lines on the head; 201-212 ventrals; 66-78 divided subcaudals although some of the anterior scutes may be single, others paired; hemipenes with spines. In total length the males get to 1,340 mm, and females 1,410 mm; with tail length in males to 225 mm, and females to 230 mm.

A molecular phylogeny produced by Pyron *et al.* (2013) showed the genus *Cummingviperea* *gen. nov.* to be most closely related to the genus *Triceratolepidophis* Ziegler *et al.*, 2000.

The genus *Protobothrops sensu lato* (including this new genus) is defined as follows:

Two large solenoglyphic teeth and a loreal pit present; dorsal head covered with very small scales; body and tail elongated, thin and cylindrical; dorsal scales keeled except the outermost; and distinct transverse bands found across the body and tail.

**Distribution:** Known only from upper Burma and nearby China and India.

**Etymology:** In honour of leading Australian journalist Fia Cumming, who over a 20 year period was often the only news reporter employed with the mainstream media with the courage to take on the corruption and lies from government officials who sought to outlaw all private ownership of reptiles in Australia.

Without her efforts, including her being the first and main reporter to break the news story of the illegal banning of the book *Smuggled: The Underground Trade in Australia's Wildlife* (Hoser 1993) in May 1993, there would be no person in Australia allowed to have contact with reptiles in any way, save for a handful of privileged persons in government run zoos and the like or similarly protected individuals.

That was the legal situation in most of Australia before the publication of the *Smuggled* books in 1993 and 1996 (Hoser 1993, 1996). See also for the etymology for *Piersonus* Hoser 2009 (type species: *Crotalus ravus* Cope, 1865), in Hoser, 2009.

**Content:** *Cummingviperea kaulbacki* (Smith, 1940) (type species) and *C. himalayanus* (Pan *et al.* 2013).

#### **CERATRIMERESURUS, LIANG AND LIU IN LIANG, 2003**

**Type species:** *Ceratrimeresurus shenlii* Liang and Liu in Liang, 2003.

**Diagnosis:** The genus *Ceratrimeresurus* Liang and Liu in Liang, 2003, was originally described as monotypic for the horned viper species *Ceratrimeresurus shenlii* Liang and Liu in Liang, 2003, later synonymized with the species *Protobothrops cornutus* (Smith, 1930), by David *et al.* (2008).

This paper formally recognizes the genus *Ceratrimeresurus* as being distinct from *Protobothrops* and expands it to include two more species, namely, *Trimeresurus jerdonii* Günther, 1875 and *Trimeresurus xiangchengensis* Zhao, Jiang and Huang, 1979.

Snakes within the genus *Ceratrimeresurus* Liang and Liu in Liang, 2003 are separated from other *Protobothrops (sensu lato)* by the following suite of characters, being one or other of the following three combinations of characters:

1/ The presence of a horn-shaped projection on the supraocular and 187-193 ventrals and 71-78 pairs of subcaudals (versus 228-235 ventrals and 79-82 pairs of subcaudals in *Triceratolepidophis sieversorum* Ziegler *et al.* 2000), this being diagnostic for the subgenus *Ceratrimeresurus subgen. nov.*, or:

2/ No horn-shaped projection on the supraocular; the outermost row of dorsal squamae are smooth; 21 or less dorsal mid-body rows; the fourth supralabial squama is separated from subocular by only one squama or no squama; the tip of tail is not orange and is a similar colour to the body colour; snout length a little more than twice the diameter of the eye; head above, except for large internasals and supraoculars, covered by small, unequal, smooth scales that are feebly imbricate or juxtaposed; first labial completely separated from nasal by a suture; internasals separated by 1-2 small scales; 6-9 small scales in line between supraoculars; 7-8 upper labials, third and fourth beneath the eye, in contact with the subocular or separated by at most a single series of small scales; ventrals: Males 164-188, females 167-193; subcaudals all divided: Males 50-78, females 44-76. Total length: Males 835 mm, females 990 mm; tail length: Males 140 mm, females 160 mm, the preceding being diagnostic for *Ceratrimeresurus jerdonii* (Günther, 1875) within the subgenus *Lowryvipera gen. nov.* or:

3/ No horn-shaped projection on the supraocular; the outermost row of dorsal squamae are smooth; 10-12 squamae between supraoculars, 23-25 dorsal mid-body scale rows, 175-194 ventrals, and 44-66 pairs of subcaudals and 7-8 (rarely 9 or 10) supralabial scales; the tip of tail is not orange, and is similar to the body colour; the preceding being for *Ceratrimeresurus xiangchengensis* (Zhao, Jiang and Huang, 1979).

Of note is that the species *Ceratrimeresurus shenlii* Liang and Liu, 2003 was synonymized with *Protobothrops cornutus* (Smith, 1930), by David *et al.* (2008). However a paper by Gong *et al.* 2011 provided molecular evidence to suggest that *Ceratrimeresurus shenlii* Liang and Liu, 2003 may in fact be taxonomically distinct at either subspecies or species level.

The genus *Protobothrops sensu lato* (including the genus *Ceratrimeresurus*) is defined as follows:

Two large solenoglyphic teeth and a loreal pit present; dorsal head covered with very small scales; body and tail elongated, thin and cylindrical; dorsal scales keeled except the outermost; and distinct transverse bands found across body and tail.

**Distribution:** South-east Asia in the region bound by India/ Nepal in the west, Southern China in the east and Vietnam in the south.

**Content:** *Ceratrimeresurus cornutus* (Smith, 1930) (the senior species-level synonym for the type species for the genus); *C. jerdonii* (Günther, 1875) and *C. xiangchengensis* (Zhao, Jiang and Huang, 1979).

#### **LOWRYVIPERA SUBGEN. NOV.**

**Type species:** *Trimeresurus jerdonii* Günther, 1875.

**Diagnosis:** Snakes within the genus *Ceratrimeresurus* Liang and Liu in Liang, 2003 are separated from other *Protobothrops (sensu lato)* by the following suite of characters, being one or other of the following three combinations of characters:

1/ The presence of a horn-shaped projection on the supraocular and 187-193 ventrals and 71-78 pairs of subcaudals (versus 228-235 ventrals and 79-82 pairs of subcaudals in *Triceratolepidophis sieversorum* Ziegler *et al.* 2000), this being diagnostic for the subgenus *Ceratrimeresurus subgen. nov.*, or:

2/ No horn-shaped projection on the supraocular; the outermost row of dorsal squamae are smooth; 21 or less dorsal mid-body scale rows; the fourth supralabial squama is separated from subocular by only one squama or no

squama; the tip of tail is not orange and is similar to the body colour; snout length a little more than twice diameter of eye; head above, except for large internasals and supraoculars, covered by small, unequal, smooth scales that are feebly imbricate or juxtaposed; first labial completely separated from nasal by a suture; internasals separated by 1-2 small scales; 6-9 small scales in line between supraoculars; 7-8 upper labials, third and fourth beneath the eye, in contact with the subocular or separated by at most a single series of small scales; ventrals: Males 164-188, females 167-193; subcaudals all divided: Males 50-78, females 44-76. Total length: Males 835 mm, females 990 mm; tail length: Males 140 mm, females 160 mm being diagnostic for *Ceratrimeresurus jerdonii* (Günther, 1875) within the subgenus *Lowryvipera gen. nov.* or:

3/ No horn-shaped projection on the supraocular; the outermost row of dorsal squamae are smooth; 10-12 squamae between supraoculars, 23-25 dorsal mid-body scale rows, 175-194 ventrals, and 44-66 pairs of subcaudals and 7-8 (rarely 9 or 10) supralabial scales; the tip of tail is not orange and is similar to the body colour; this being diagnostic for *Ceratrimeresurus xiangchengensis* (Zhao, Jiang and Huang, 1979), within the subgenus *Lowryvipera gen. nov.*

The diagnosis for the nominate subgenus *Ceratrimeresurus* Liang and Liu in Liang, 2003 is effectively contained within this diagnosis.

The diagnosis for *Lowryvipera gen. nov.* is encapsulated within 2 and 3 above, being the diagnosis for the two component species.

The genus *Protobothrops sensu lato* (including the genus *Ceratrimeresurus*) is defined as follows:

Two large solenoglyphic teeth and a loreal pit present; dorsal head covered with very small scales; body and tail elongated, thin and cylindrical; dorsal scales are keeled except the outermost; and distinct transverse bands found across the body and tail.

**Distribution:** South-east Asia in the region bound by India/Nepal in the west, Southern China in the east and Vietnam in the south.

The nominate subgenus *Ceratrimeresurus* is restricted to North Vietnam and nearby Southern China and presently only known from a limited number of specimens.

**Etymology:** Named in honour of Andrew Lowry, a herpetologist formerly from Mentone, Victoria, Australia, now living in Cheltenham, Victoria, Australia in recognition for his largely unrecognized contributions to herpetology in Australia, in particular that relating to venomous elapid snakes (Elapidae).

**Content:** *Ceratrimeresurus (Lowryvipera) jerdonii* (Günther, 1875) (type for subgenus) and *C. (Lowryvipera) xiangchengensis* (Zhao, Jiang and Huang, 1979).

#### **CROTTYVIPERA GEN. NOV.**

**Type species:** *Trionocephalus mucrosquamatus* Cantor, 1839.

**Diagnosis:** *Crottyvipera gen. nov.* is separated from all other *Protobothrops sensu lato* and diagnosed as follows: one or other of:

Rostral slightly broader than deep; nasal divided or semidivided; upper head-scales extremely small, granular, smooth or obtusely keeled; supraocular large, or rather narrow; 2 or 3 scales separating

the internasals in front; 10 to 15 scales on a line between the supraoculars; three to five minute postoculars and a subocular, which is separated from the labials by one, two, or

three series of scales; temporal scales smooth; 7 to 11 upper labials, second forming the anterior border of the loreal pit. Scales strongly keeled, in 25 or 27 rows. Ventrals 183-218; anal entire; subcaudals 72-92 pairs. Brownish grey above, with a dorsal series of large blackish spots and a lateral series of smaller ones; a blackish streak from the eye to the angle of the mouth; lower parts brownish, spotted with white, being diagnostic for *Crottyvipera mucrosquamatus* (Cantor, 1839), or:

Rostral broader than deep; nasal divided; upper head-scales very small, flat, juxtaposed, smooth on the snout and vertex; supraocular large; no internasals; 12 or 13 scales on a line between the supraoculars; two or three small postoculars and a subocular, which is separated from the labials by two series of scales; temporal scales keeled; 7 or 8 upper labials, second forming the anterior border of the loreal pit, third and fourth large. Scales strongly keeled, in 23 or 25 mid-body rows. Ventrals 181-186; anal entire; subcaudals 72-74.

Yellow above, with a dorsal series of rhomboidal dark, black-edged spots partly confluent into a zigzag band; a lateral series of small spots; a blackish streak on each side of the head behind the eye; yellowish beneath, spotted and clouded with grey being diagnostic for *Crottyvipera elegans* (Gray, 1849).

The genus *Protobothrops sensu lato* (including the genus *Crottyvipera gen. nov.*) is further defined as follows:

Two large solenoglyphic teeth and a loreal pit present; dorsal head covered with very small scales; body and tail elongated, thin and cylindrical; dorsal scale keeled except the outermost; and distinct transverse bands found across body and tail.

**Distribution:** Southern Asia from India to Southern China and including Taiwan and Ryukyu Island, Japan and including Bangladesh, Burma and Vietnam, but not including Malaysia/Indonesia or the Philippines.

**Etymology:** Named after a pet Great Dane/Rottweiler Cross (named himself in honour of the Pitviper genus *Crotalus* Linnaeus, 1758) who guarded the house and research facility of our family from 1989 to 2001 from break-ins and thefts.

In reference to a large number of "hate posts" on internet chat forums by so-called "Twitter taxonomists" Mark O'Shea, Darren Naish and Wolfgang Wüster of the UK, I make no apologies for naming a genus of snake in honour of a four-legged co-inhabitant of our wonderful and biodiverse planet. By the way, "Twitter", "Facebook" and "Wikipedia" are NOT peer reviewed scientific publications!

**Content:** *Crottyvipera mucrosquamatus* (Cantor, 1839) (type species); *C. elegans* (Gray, 1849).

#### **SWILEVIPERA GEN. NOV.**

**Type species:** *Bothrops hageni* Lidth De Juede, 1886.

**Diagnosis:** The genus *Swilevipera gen. nov.* was until now included within *Parias*, Gray, 1849.

However it is readily separated from this genus by the fact that the fifth supralabial scale is separated from the subocular by a scale and a lack of dorsal cross-bands. This is not the case in *Parias* species. *Swilevipera gen. nov.* usually lacks an internasal, whereas this is usually present in *Parias* species. *Swilevipera gen. nov.* also has fewer supralabials in contact with the subocular scale than is seen in *Parias* species (Sanders *et al.* 2002).

Both the species *Swilevipera hageni* (Lidth De Juede, 1886) and the morphologically similar species *Parias sumatranus* (Raffles, 1822) are separated from all other south and south-east Asian species of pitviper by the following suite of characters:

Head rather elongate. Rostral as deep as broad or a little broader than deep; the nasal is entire or divided; upper head-scales rather large, flat, smooth, imbricate or subimbricate, largest on the snout, 4 to 9 in a transverse series between the supraoculars, which are large; two or three postoculars and a subocular, which is in contact with the third or third and fourth labials (and fifth in *P. sumatranus*, and not fifth in *S. hageni*); temporal scales smooth; 9 to 11 upper labials, second forming the anterior border of the loreal pit, third largest. Scales feebly keeled, in 21 dorsal mid-body rows. Ventrals 180-191; anal entire; subcaudals 58-82. Tail prehensile. Colour is a bright green above, the scales usually black-edged, with or without black cross-bands (with in *P. sumatranus*, and without in *S. hageni*); two series of small whitish spots may be present along the back; a more or less distinct whitish or yellow streak is usually present on each side, along the outer row of scales; ventrals yellowish or green, with or without fine black edges; end of the tail is red.

**Distribution:** Currently only known from Peninsula Malaysia, Singapore, Southern Thailand and Sumatra.

**Etymology:** Named in honour of Benjamin Swile of Athlone, Cape Town, South Africa, in recognition for his contributions to the herpetology of South Africa.

**Content:** Monotypic for *Swilevipera hageni* (Lidth De Juede, 1886).

#### **SIMPSONVIPERA SUBGEN. NOV.**

**Type species:** *Trimeresurus medoensis* Zhao, 1977.

Currently most widely known as *Viridovipera medoensis* (Zhao, 1977).

**Diagnosis:** This subgenus *Simpsonvipera subgen. nov.* within *Viridovipera* is separated from the rest of the genus and other Asian pitvipers by the following suite of characters: 17 dorsal mid-body scale rows, dorsal rows 7-11 slightly keeled; 8 upper labials, first upper labials separated from nasals by a distinct suture; green or bluish green above, yellowish white below, the two separated by a bright bicolored red (below) and white (above) ventrolateral stripe (in both males and females), which occupies the whole of the outermost scale row and a portion of the second row; ventrals less than 150; hemipenes short, thick and spinose. Total length in males is 671 mm, females 650 mm; tail length in males is 125 mm, females 115 mm.

**Distribution:** Burma, east India and Tibet (China).

**Etymology:** Named in honour of Neil Simpson of East Hills, of Sydney, New South Wales, Australia for a valuable contribution to Australian herpetology spanning two decades, including for a short time, a fantastically well-produced magazine publication called *Reptiles Australasia*.

**Content:** Monotypic for the species *Viridovipera (Simpsonvipera) medoensis* (Zhao, 1977).

#### **YUNNANVIPERA SUBGEN. NOV.**

**Type species:** *Trimeresurus yunnanensis* Schmidt, 1925.

Currently most widely known as *Viridovipera yunnanensis* (Schmidt, 1925).

**Diagnosis:** *Yunnanvipera subgen. nov.* is monotypic for the species *Viridovipera (Yunnanvipera) yunnanensis* Schmidt, 1925. It is separated from all other *Viridovipera* and all other Asian pitvipers by the following suite of characters: 19 or rarely 21 dorsal mid-body rows and 19 or rarely 21 rows on the neck; 9-10 (rarely 11) upper labials, first upper labials are separated from nasals by a distinct suture; a single narrow supraocular, sometimes divided by a transverse suture; 11-16 scales in a line between the supraoculars; the colour above is bright to dark green, below the colour is pale green

to whitish, the two separated by a bicolored orange or brown (below) and white (above) in males, or white only or absent in females, ventrolateral stripe, which occupies the whole of the outermost scale row and a portion of the second row; ventrals 155-165, rarely to 170; subcaudals 58-68, all divided; hemipenes short and spinose beyond the bifurcation. Total length to 750 mm, tail length to 145 mm.

**Distribution:** Known only from Southern China (Yunnan and southwestern Sichuan), at elevations up to 2,845 metres.

**Etymology:** Named in reflection of the type locality Tengyueh, Yunnan, China.

**Content:** Monotypic for the species *Viridovipera (Yunnanvipera) yunnanensis* (Schmidt, 1925).

#### **BORNEOVIPERA SUBGEN. NOV.**

**Type species:** *Atropophis borneensis* Peters, 1872.

Currently widely known as either *Craspedocephalus borneensis* (Peters, 1872) or *Trimeresurus borneensis* (Peters, 1872)

**Diagnosis:** *Borneovipera subgen. nov.* are separated from all other *Craspedocephalus* and all other Asian pitvipers by the following suite of characters:

(1) an overall grey, brown or ochre pattern with 20-30 darker crossbands, distinctly related to the sex: in males, background colour in various shades of greyish-brown or yellowish-grey, with darker dorsolateral blotches, sometimes horizontally divided into two distinct blotches, separated darker areas and powdered with both cream and dark dots, giving a rather confused pattern; in females, pattern less contrasted, in shades of ochre or yellowish-brown with more or less brown subrectangular dorsolateral blotches, often with broad darker edges and a wide lighter centre, producing a "saddle-like" pattern; males have a more complex pattern, but are especially much darker than females; (2) a distinctly projected and raised snout, strongly obliquely truncated when seen from the side, subrectangular seen from above (as opposed to a short obliquely truncate snout in snakes of the *Craspedocephalus puniceus* complex)(subgenus *Craspedocephalus*); (3) internasals projected, strongly spatulate and bilobate, distinctly upturned; (4) 19 or usually 21 (rarely 20) dorsal mid-body scale rows; (5) first supralabial distinct from nasal; (6) Second supralabials bordering the whole of the anterior margin of the loreal pit; (7) 1 to 3 moderate, narrow supraoculars, usually flat, rarely convex; (8) 149-166 ventrals, 41-67 subcaudals; (9) occipital and temporal scales distinctly keeled in both sexes in adults, less so in juvenile specimens; (10) IL of the first pair not in contact each with the other; (11) hemipenes short, reaching the eleventh subcaudal, entirely spinose; and (12) adult females usually light colored (13) In *Borneovipera subgen. nov.* the second supralabial borders the loreal pit, as opposed to not so in the morphologically similar *Craspedocephalus puniceus* complex (subgenus *Craspedocephalus*). (14) In *Borneovipera subgen. nov.* there are 1 to 3 moderate, narrow supraoculars, usually flat, rarely convex, whereas in the *Craspedocephalus puniceus* complex there are 2 to 5 small, distinctly raised supraoculars.

**Distribution:** Borneo, Sumatra, West Malaysia and Thailand.

**Etymology:** Named in reflection of the type locality Sarawak, on the island of Borneo, East Malaysia.

**Content:** *Craspedocephalus (Borneovipera) borneensis* (Peters, 1872) (type species); *C. (Borneovipera) andalasensis* (David, Vogel, Vijayakumar and Vidal 2006), *C. (Borneovipera) brongersmai* (Hoge, 1969); *C. (Borneovipera) wiroti* (Trutnau, 1981).

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**CONFLICT OF INTEREST**

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



**ARRANGEMENT OF GENERA WITHIN THE FAMILY VIPERIDAE OPPEL, 1811****(Terminal Taxon: *Vipera aspis*)****SUBFAMILY VIPERINAE OPPEL, 1811 (PITLESS VIPERS)****(Terminal Taxon: *Vipera aspis*)**

Content: See for each tribe.

Tribe Atherini Groombridge 1986

**(Terminal Taxon: *Atheris chlorechis*)**Content: *Adenorhinos* Marx and Rabb, 1965; *Atheris* Cope, 1862; *Montatheris* Broadley, 1996; *Proatheris* Broadley, 1996.

Tribe Bitisini Hoser, 2012

**(Terminal Taxon: *Bitis arietans*)**Content: *Bitis* Gray, 1842 (including all six subgenera as defined by Hoser (2013c).

Tribe Causini Cope 1860

**(Terminal Taxon: *Causus maculatus*)**Content: *Causus* Wagler, 1830.

Tribe Cerastini Hoser, 2012

**(Terminal Taxon: *Cerastes cerastes*)**Content: *Cerastes* Laurenti, 1768.

Tribe Echiini Hoser, 2012

**(Terminal Taxon: *Echis carinatus*)**Content: *Echis* Merrem, 1820.

Tribe Proatherini Hoser, 2012

**(Terminal Taxon: *Proatheris superciliaris*)**Content: *Proatheris* Broadley, 1996.The genus is monotypic for the species: *Proatheris superciliaris*.

Tribe Pseudocerastini Hoser, 2012

**(Terminal Taxon: *Pseudocerastes persicus*)**Content: *Eristicophis* Alcock and Finn, 1897; *Pseudocerastes* Boulenger, 1896.

Subtribe Pseudocerastina Hoser, 2012

**(Terminal Taxon: *Pseudocerastes persicus*)**Content: *Pseudocerastes* Boulenger, 1896.

Subtribe Eristicophina Hoser, 2012

**(Terminal Taxon: *Eristicophis macmahonii*)**Content: *Eristicophis* Alcock and Finn, 1897.

Tribe Viperini Laurenti, 1768.

**(Terminal Taxon: *Vipera aspis*)**Content: *Daboia* Gray 1842; *Maxhoservipera* Hoser, 2012; *Macrovipera* Reuss, 1927; *Montivipera* Nilson et. al., 1999; *Vipera* Laurenti, 1768.

Subtribe Maxhoserviperina Hoser, 2012

**(Terminal Taxon: *Maxhoservipera palaestinae*)**Content: *Daboia* Gray, 1842; *Maxhoservipera* Hoser, 2012.

Subtribe Montiviperina Hoser, 2012

**(Terminal Taxon: *Montivipera xanthina*)**Content: *Macrovipera* Reuss, 1927; *Montivipera* Nilson et. al., 1999.

Subtribe Viperina Laurenti, 1768.

**(Terminal Taxon: *Vipera aspis*)**Content: *Vipera* Laurenti, 1768.

**SUBFAMILY AZEMIOPINAE LIEM, MARX AND RABB, 1971****(Terminal Taxon: *Azemiops feae*)**Content: *Azemiops* Boulenger, 1888.**Tribe Azemiopini Liem, Marx and Rabb 1971.****(Terminal Taxon: *Azemiops feae*)**Content: *Azemiops* Boulenger, 1888.**SUBFAMILY CALLOSELASMIINI FAM. NOV.****(Terminal taxon: *Calloselasma rhodostoma*)**Content: *Calloselasma* Cope, 1860; *Hypnale* Fitzinger, 1843.**Tribe Calloselasmiini Hoser, 2013****(Terminal taxon: *Calloselasma rhodostoma*)**Content: *Calloselasma* Cope, 1860; *Hypnale* Fitzinger, 1843.**SUBFAMILY TROPIDOLAEMUSIINAE FAM. NOV.****(Terminal taxon: *Tropidolaemus wagleri*)**Content: *Deinagkistrodon* Gloyd, 1979; *Garthius* Malhorta and Thorpe, 2004; *Sloppvipera* gen. nov. (this paper); *Tropidolaemus* Wagler, 1830.**Tribe Tropidolaemusini Hoser, 2012****(Terminal taxon: *Tropidolaemus wagleri*)**Content: *Deinagkistrodon* Gloyd, 1979; *Garthius* Malhorta and Thorpe, 2004; *Sloppvipera* gen. nov. (this paper); *Tropidolaemus* Wagler, 1830.**SUBFAMILY - CROTALINAE OPPEL, 1811 (PITVIPERS)****(Terminal Taxon *Crotalus horridus*)**

Content: See for each tribe.

**Tribe Adelynhoserserpenini Hoser, 2012****(Terminal Taxon: *Adelynhoserserpenae nummifer*)**Content: *Adelynhoserserpenae* Hoser, 2012; *Atropoides* Werman, 1992; *Cerrophodion* Campbell and Lamar, 1992; *Porthidium* Cope, 1871.**Subtribe Porthidiumina Hoser, 2012****(Terminal Taxon: *Porthidium ophryomegas*)**Content: *Porthidium* Cope, 1871.**Subtribe Cerrophodionina Hoser, 2012****(Terminal Taxon: *Cerraphodion godmanni*)**Content: *Cerraphodion* Campbell and Lamar, 1992; *Atropoides* Werman, 1992.**Subtribe Adelynhoserserpenina Hoser, 2012****(Terminal Taxon: *Adelynhoserserpenae nummifer*)**Content: *Adelynhoserserpenae* Hoser, 2012.**Tribe Akistrodonini Hoser, 2012****(Terminal Taxon *Agkistrodon contortrix*)**Content: *Agkistrodon* Palisot de Beauvois, 1799.**Tribe Crotalini Gray, 1825****(Terminal Taxon *Crotalus horridus*)**Content: *Aechmophrys* Coues, 1875; *Caudisona* Laurenti, 1768; *Crotalus* Linnaeus, 1758; *Cummingea*, Hoser 2009; *Hoserea* Hoser, 2009; *Mattea* Hoser, 2009; *Piersonus* Hoser, 2009; *Sistrurus* Garman, 1883; *Uropsophus* Wagler, 1830.

**Subtribe Crotalina Hoser, 2012****(Terminal Taxon *Crotalus horridus*)****Content:** *Aechmophrys* Coues, 1875; *Caudisona* Laurenti, 1768; *Crotalus Linnaeus*, 1758; *Cummingea*, Hoser 2009; *Hoserea* Hoser, 2009; *Matteoa* Hoser, 2009; *Sistrurus* Garman, 1883; *Uropsophus* Wagler, 1830.**Subtribe Piersonina Hoser, 2012****(Terminal Taxon *Piersonus ravus*)****Content:** *Piersonus* Hoser, 2009.**Tribe Jackyhoserini Hoser, 2012****(Terminal Taxon: *Jackyhoserea pictus*)****Content:** *Bothriopsis* Peters, 1861; *Bothrocophias* Cutberlet and Cambell, 2001; *Bothropoides* Fenwick, et. al., 2009; *Bothrops* Wagler, 1824; *Jackyhoserea* Hoser, 2012; *Rhinocerophis* Garman, 1881.**Subtribe Bothropina Hoser, 2012****(Terminal Taxon: *Bothrops lanceolatus*)****Content:** *Bothriopsis* Peters, 1861; *Bothrops* Wagler, 1824.**Subtribe Bothropoidina Hoser, 2012****(Terminal Taxon: *Bothropoides neuwiedi*)****Content:** *Bothropoides* Fenwick, et. al. 2009.**Subtribe Rhinocerophiina Hoser, 2012****(Terminal Taxon: *Rhinocerophis nasus*)****Content:** *Rhinocerophis* Garman, 1881.**Subtribe Jackyhoserina Hoser, 2012****(Terminal Taxon: *Jackyhoserea pictus*)****Content:** *Jackyhoserea* Hoser, 2012 (See Hoser 2012c).**Subtribe Bothrocophiina Hoser, 2012****(Terminal Taxon: *Bothrocophias hyopora*)****Content:** *Bothrocophias* Cutberlet and Cambell, 2001.**Tribe Lachesini Cope, 1900.****(Terminal Taxon *Lachesis muta*)****Content:** *Bothriechis* Peters, 1859; *Lachesis* Daudin, 1803; *Ophryacus* Cope, 1887; *Teleuraspis* Cope, 1860.**Subtribe Bothriechisina Hoser, 2012****(Terminal Taxon *Bothriechis nigroviridis*)****Content:** *Bothriechis* Peters, 1859; *Teleuraspis* Cope, 1860.**Tribe Lachesina Cope 1900.****(Terminal Taxon *Lachesis muta*)****Content:** *Lachesis* Daudin, 1803; *Ophryacus* Cope, 1887.**Tribe Trimeresurusini Hoser, 2012****(Terminal Taxon: *Trimeresurus gramineus*)****Content:** *Adelynhoserea* Hoser, 2012; *Ceratrimeresurus* Liang and Liu in Liang, 2003; *Conantvipera* gen. nov. (this paper); *Craspedocephalus* Kuhl and van Hasselt, 1822; *Crottyvipera* gen. nov. (this paper); *Cryptelytrops* Cope, 1860; *Cummingvipera* gen. nov. (this paper); *Gloydus* Hoge and Romano-Hoge, 1981; *Himalayophis* Malhorta and Thorpe, 2004; *Katrinahoservipera* gen. nov. (this paper); *Ninvipera* gen. nov. (this paper); *Ovophis* Burger, 1981; *Oxyus* Hoser, 2012; *Parias* Gray, 1849; *Peltopelor* Günther, 1864; *Popeia* Malhorta and Thorpe, 2004; *Protobothrops* Hoge and Romano-Hoge, 1983; *Ryukyuvipera* gen. nov. (this paper); *Swilevipera* gen. nov. (this paper); *Triceratolepidophis* Ziegler et al., 2000; *Trimeresurus* Lacépède, 1804; *Viridovipera* Malhorta and Thorpe, 2004; *Zhaoermia* Zhang, 1993.

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