

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*.

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 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 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 lourencecklosei 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.

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