Cimbebasia

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Ser. A - Vol. 4 - No. 5 23 December 1975

DESCRIPTION OF A NEW ADDER (VIPERIDAE, REPTILIA) FROM SOUTHERN AFRICA, WITH A DISCUSSION OF RELATED FORMS

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Transvaal Museum, Pretoria

(with 6 figures and 3 plates)

(Manuscript received 1 October 1974) 1962-1968

ABSTRACT

A new dwarf adder from the lower Orange River system and adjacent arid areas is described. *Bitis schneideri*, which is redescribed here, has priority over *B. paucisquamata*. These two species are then compared with specimens of sympatric populations of *B. caudalis* and *B. cornuta*, as well as the other dwarf species of the genus.

CONTENTS

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I. INTRODUCTION

During two collecting trips to the north-western Cape Province and the south-western corner of South West Africa during 1962 and 1968, several small adders of the genus *Bitis*, belonging to the to the species *caudalis*, *cornuta* and *paucisquamata*, were collected. This provided some information on the ecological separation of these species. On the second trip a hornless *Bitis* specimen was collected on a rocky hillside in the vicinity of the Rosh Pinah Mine. By comparing it with a *B. caudalis* it became apparent that a new form of *Bitis* must be involved. It was felt that a long series of specimens of the new form was required to be able to prove that it is distinct from the very variable sympatric *B. caudalis*. Further material from the Rosh Pinah area was added to the collection of the Transvaal Museum, and the State Museum, Windhoek, also acquired some specimens before an attempt was made to describe it.

While checking literature and museum collections for further records of this undetected form amongst *B. caudalis* and related species, *B. paucisquamata* Mertens (1951), originally described as *Vipera schneideri* Boettger (1886), was also re-investigated. These two species were then compared with the other dwarf forms of this genus, especially those occurring in the same general area of their range. Since *B. caudalis* and *B. cornuta* are very variable snakes with fairly wide distribution, it was decided to use only specimens from the area where these species are sympatric with the new species and *B. schneideri*.

In the text "Range" indicates observed range in samples examined and the following abbreviations are used with specimen numbers:

BM	=	British Museum (Natural History), London.
NMB	=	Naturmuseum, Berlin.
SAM	=	South African Museum, Cape Town.
SMF	=	Senckenberg Museum, Frankfurt/Main.
SMW	=	State Museum, Windhoek.
TM	=	Transvaal Museum, Pretoria.
ZIH	=	Zoologisches Institut und Museum, Hamburg.
ZSM	=	Zoologische Staatsammlung, Munich.

II. DESCRIPTION OF SPECIES

Bitis xeropaga n. sp.

Bitis peringueyi (non Boulenger) Nieden, 1913: 430, Kuibis.
Bitis caudalis caudalis (non A. Smith) Mertens,
1958: 145–148, Fig. 3, SMF 51481 Aus. – Mertens,
1971: 529:102, SMF 49619, 49653, 56651 Farm Plateau, MF 51481 Aus, SMF 5285 Fish River Canyon.

MATERIAL

Twenty-seven specimens: 17 adult and five juvenile males, two adult, one subadult and two juvenile females.

Holotype: TM 42305, male.

Type locality: Dreikammberg on north bank of Orange River, Lüderitz district, South West Africa (16°52′ E, 28°05′ S, alt. about 300 m), leg. A. Maritz, 3.8.1972.

Paratypes:

TM 25747, SMF 51481 (males) Aus; TM 36351, 39498, 39712, 39988, 41337, 42416 (males) Rosh Pinah Mine; TM 36688 (female) Farm Spitskop; TM 36696 (juvenile female) Klein Hellskloof, C.P.; TM 36697 (juvenile male) Aughrabies Falls; TM 37623, SMW 246, 2590 (males) Ai-Ais; TM 41681 (male) Dreikammberg; TM 43911, TM 45038 (juvenile males) Haib River 15 km NE of Vioolsdrift; SMW 5812 (juvenile female) Farm Namuskluft; SMW 2591 (male) Obib Mountain; SMF 49619, 49653 (males), 56651 (female) Farm Plateau; SMF 52852 (male) Fish River Canyon; TM 43982, 43983 (males) nr. Lorelei; NMB 23379 (sub. ad. female) Kuibis.

The types are in the Transvaal Museum, Pretoria, the State Museum, Windhoek, the Senckenberg Museum, Frankfurt/Main and the Naturmuseum of the Humboldt University, Berlin, as indicated by the respective numbers. Of the Transvaal Museum paratypes one each is deposited in the British Museum (Nat. Hist.), London and the Museum of Comparative Zoology, Harvard University, Boston.

DIAGNOSIS

A small adder related to the horned adders of southern Africa, but without horns, subcaudals smooth (rarely faintly keeled distally), with higher average scale counts than sympatric populations of *B. caudalis*, the number of dorsal rows across neck equal to those across middle, a typical colour pattern on a light grey background and a speckled, mottled or otherwise irregularly marked ventrum (plate 1 & 2).

DESCRIPTION

Holotype: TM 42305, adult male, 355 + 40 = 395 mm, percra ratio of tail 11,3, V151, A1, Sc 2 28/28 + 1, dorsals in 27 – 27 – 19 rows, nostril amongst three nasal scales, supranasal large, raised, forming well developed nasal sac, supranasals separated by two scales from one another and by two scales from the rostral and first upper labial, 15 scales between eyes, 16 scales around each eye, left orbit slightly irregular apparently due to old injury, suborbitals separated from upper labials by two rows of scales, upper labials 15/15, lower labials 14/14, first lower labials elongate and in contact with one another behind mental, first three pairs of lower labials in contact with enlarged chin shields.

Head subtriangular with a rounded to slightly squared-off snout, swollen temporal region and covered above with keeled scales which are smaller and less strongly keeled than in *B. caudalis*. Neck distinct and much narrower than width of head, general habitus slightly more slender than *B. caudalis* and *B. cornuta*. Dorsal scales elongate with a rounded free end and the moderately developed keel not extending beyond the tip as in

scales on sides of body of *B. caudalis*. Outer row of lateral scales more or less as wide as long and bluntly rounded, smooth on anterior part of body, but increasingly keeled distally with keel tilting slightly downwards. Ventrals and subcaudals smooth, with the first two subcaudals undivided. Tip of ventricle at ventral 52 and anterior tip of liver at ventral 54, no vestigial left lung, trachea expanded dorsally, but vascularisation not extending forward of the heart.

Hemipenes divided, sulcus spermaticus forks at subcaudal 2 following the branches to the tip, crotch between the lobes at Sc 3 and tip of lobes at Sc 8. There are longitudinal folds on the shaft below the fork with large spines appearing (slightly longer than one subcaudal scale) just proximal to the fork in the sulcus. These spines decrease in size but increase in number towards the tip of the lobes. There is no terminal awn.

Variation in type series: Although the types series originates from a number of localities, there is relatively little variation as shown below.

	Range	N	$\bar{x}$	SD
Ventrals, total	147 – 155	25	151,44	2,18
males	147 – 154	20	151,45	2,30
females	151 – 155	5	152,40	1,52
Subcaudals, male	26 – 33	44	29,36	1,68
female	22 – 25	10	23,70	1,16
Dors.sc.rows, anterior	25 – 27	27	26,37	1,04
middle	25 – 27	27	26,26	0,94
posterior	17 – 21	26	18,46	1,06
Upper labials	13 – 17	54	14,46	0,75
Lower labials	13 – 16	54	14,06	0,76
Orbitals	14 – 18	53	15,49	1,07
Tail percra ratio, male	9,57 – 12,00	19	10,56	0,63
fema	8,29 – 9,32	5	8,81	0,47
Rel. pos. of heart	31,82 – 35,37 %	12	34,11 %	0,98
Rel. pos. of ant. tip of liver	35,76 – 40,00 %	12	37,59 %	1,37

An unexplained aspect is the low incidence of females in the sample (5 in 27) for which reason sexual dimorphism could not be studied satisfactorily.

It is apparent that the amount of individual variation is relatively low. On everted hemipenes the basic structure as described for the holotype in retracted position is confirmed. The shaft is very short and has longitudinal ridges. The sulcus spermaticus forks just below the crotch between the long lobes and each branch extends to the tip of each lobe. The spines appearing just proximal to the fork in the sulcus are relatively large but decrease in size distally although increasing in number. Smaller spines occur between the large spines. The tips of the hemipenial lobes are bluntly rounded, the surface is evenly spined to caliculate with small spines occurring along the ridges between the depressions. No terminal awn was observed.

Although the eyebrows are often raised, no enlarged hornlike scales occur (pl.2). The lateral scale rows adjacent to the ventrals are large, blunt and smooth on the anterior half of the body, becoming faintly keeled towards the back with the keels usually tilting slightly down.

The anal is always undivided while the subcaudals are usually paired and smooth although in four specimens the terminal ones are faintly keeled.

Colour: The ash to dark grey dorsal colour with a pattern of 16 to 34 ($\bar{x} = 27{,}48$; N = 25) transverse bars is quite constant and distinctive (pl.1). These crossbars consist of a median dark brown to blackish, roughly rectangular bar, flanked by whitish dorsolateral spots, which are partly surrounded by a light brownish lateral spot which usually borders onto a pale triangular mark, adjacent to the ventrals.

Occasionally the dark vertebral bars are mesially subdivided forming half patterns which are out of cycle. Laterally between the cross bars the body is marked with dark brown to blackish blotches mixed with paler ones. The tail is marked with dark spots. The ventrum is light grey to dusky, often finely dusted with darker grey speckles and is marked with irregular shaped, diffused dark spots and speckles which may be concentrated along the edge of the ventral scales. Subcaudals irregularly speckled, throat and chin usually unmarked while lower labials are marked as part of facial pattern. Head dorsally without a clear pattern, except for a light anterior patch on the supraorbital ridge and a dark blotch posterior to it. The latter may join to form an angled bar across the top of the head. The side of the head is dark brown to charcoal grey with a well defined upper edge which arches up from the rear angle of the head, through the middle of the eye and then descends towards the rostral. Whitish to pale grey triangular areas occur in this dark lateral area of the face. The first one is below the nostril, a smaller one occurs below the eye, a long pointed triangle passes from the back edge of the eye to the rear third of the mouth and a small light patch marks the angle of the mouth. The iris is marked in similar tones to the face pattern, causing the eye to merge into its background. The entire upper surface is finely peppered with minute dark speckles. The forked part of the tongue is white, while the rest is black.

Size: Largest specimen and largest female SMF 56651, Farm Plateau, 610 (558 + 52) mm. Largest male SMF 52852, Fish River Canyon, 445 (406 + 39) mm.

GENERAL AND FIELD NOTES

Although it appears that *B. xeropaga* and *B. caudalis* are sympatric in certain areas, they seem to be ecologically separated. All the specimens of *B. xeropaga* for which any collecting data exist have been found on sparsely vegetated rocky hillsides and mountain

slopes of the southern transitional Namib and the arid lower Orange River basin, while *B. caudalis* is usually found on the sandy flats around the mountains or at the most on the lower slopes thereof. Except for the Aus area at present no reliable records of sympatric specimens of *B. cornuta* are known. However, since *B. cornuta* is often found on rocky or hard mountain sides, it appears to have similar ecological requirements to this new species, for which reason these species may be mutually exclusive, with *B. xeropaga* being the dominant species within its limited range.

Since most of the specimens were kept alive for some time and either died in captivity or were killed for blood sampling, no stomach contents records exist. In captivity mice were readily taken as well as an occasional skink. The poison appears to be exceptionally effective on small rodents since the mice often dropped more or less instantly, dying much faster than from a cobra bite. Occasionally this might have been due to mechanical damage. These snakes rarely held on to their prey after a strike.

In general this species does not appear to be as irascible as *B. caudalis*, but when disturbed will hiss and strike out in sham attacks as is typical of the rest of the genus. It was never noticed that any specimens tried to bury themselves in sand as is characteristic of *B. peringueyi* and to a lesser degree *B. schneideri*, and of *B. caudalis*. In captivity *B. xeropaga* prefers to rest on stones. Sidewinding locomotion has never been observed during normal undisturbed progression. When sprayed with water the body was not specially flattened and droplets would be sucked up from any impervious object, s.a. stones, sticks, glass sides of terraria, the bodies of other snakes and occasionally their own body. The exceptionally large female SMF 56651 bears five ova. A female from south of Vioolsdrif produced four young during the first week of April 1975 a week after capture.

DISTRIBUTION RANGE

The arid mountains of the lower Orange River basin from below the Aughrabies Falls into the Richtersveld in the Cape Province and northwards

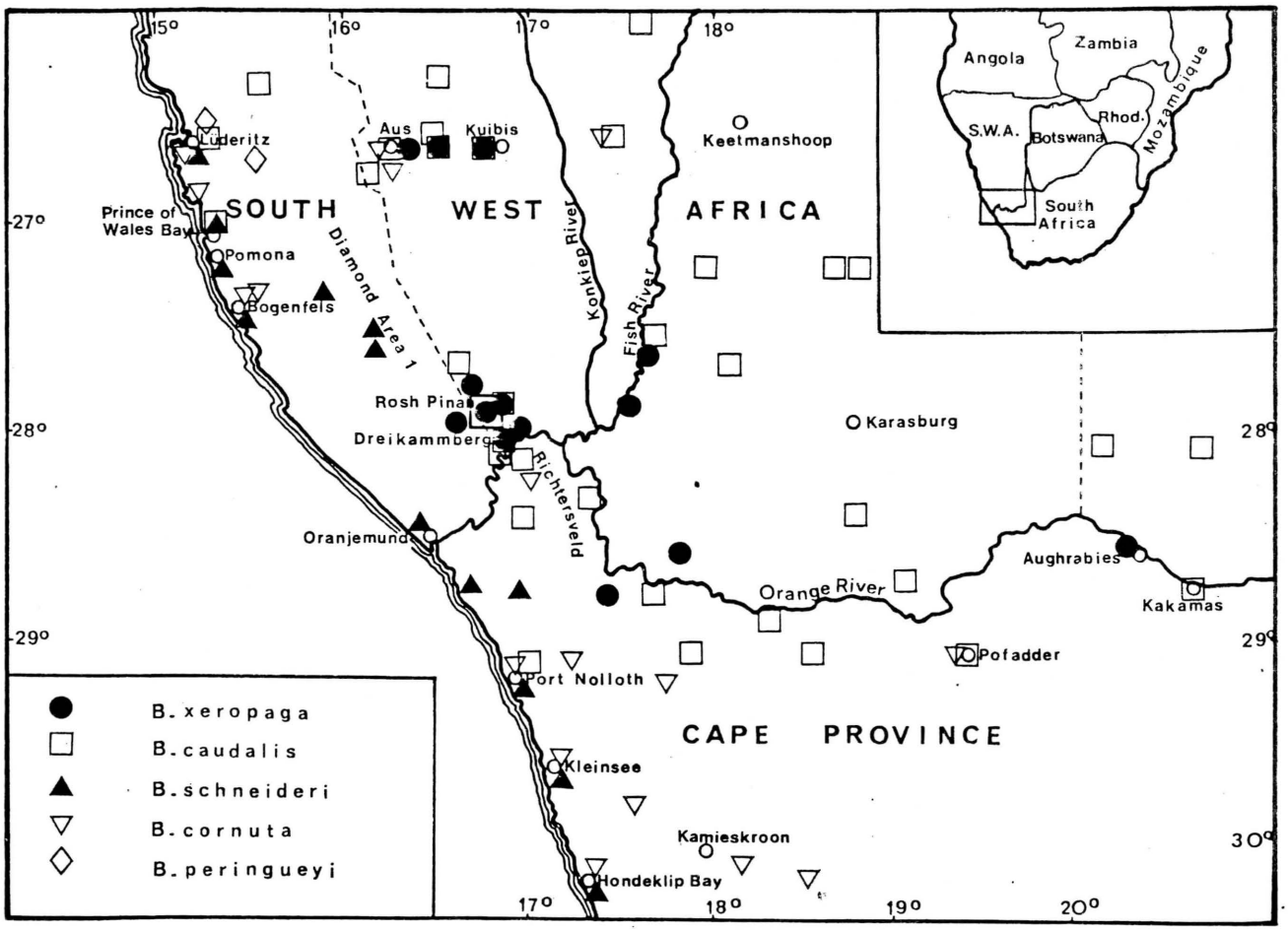

Figure 1. Distribution of the dwarf adders in southern South West Africa and the north-western Cape Province based on examined material as well as literature records (FitzSimons, 1962, Mertens, 1971).

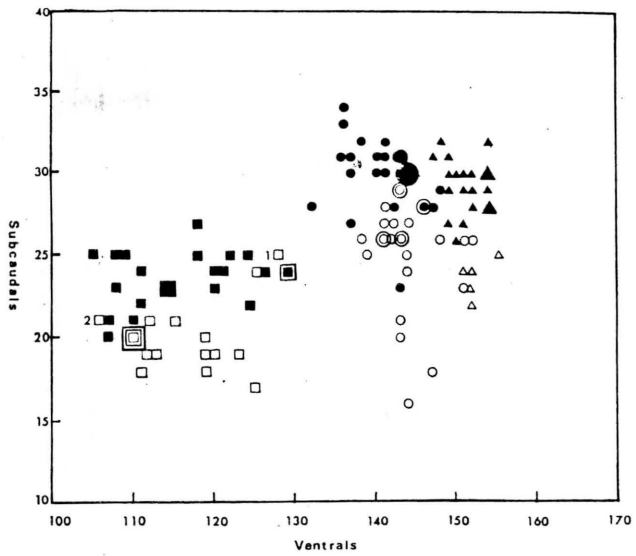

Figure 2. Scatter diagram showing interspecific variation in ventral/subcaudal counts for *B.xeropaga* (triangles), *B.schneideri* (squares) and sympatric specimens of *B.caudalis* (circles). Solid symbols = males, hollow symbols = females. Square 1 = Type of *V.schneideri* Boettger. Square 2 = Paratype of *B.caudalis paucisquamatus* Mertens.

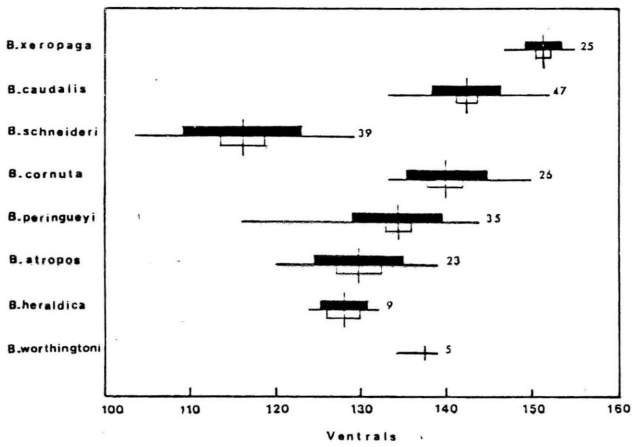

Figure 3. Variation in ventrals of *B.xeropaga, B.schneideri* and specimens from sympatric populations of *B.caudalis* and *B.cornuta*, as well as samples of the other dwarf adders. Horizontal line = range of variation; vertical line = mean; solid bar = one standard deviation; hollow bar = two standard errors; numbers = sample size.

into south-western Great Namaqualand as far as Aus (fig. 1).

Recorded localities (with quarter degree references): Ai-Ais 1727 Cd (SMW, TM); Aughrabies Falls 2028 Cb (TM); Aus 1626 Cb (SMF, TM); Dreikammberg 1628 Bb (TM); Fish River Canyon 1727 Da (SMF); Haib River about 15 km NE of Vioolsdrif 1728 Db (TM); Klein Hellskloof 1728 Cd (TM); Kuibis 1626 Db (NMB); Lorelei 1628 Bb (TM); Farm Namuskluft 1627 Dd (SMW); Obib Mtn 1628 Ba (SMW); Farm Plateau 1626 Cb (SMF); Rosh Pinah Mine 1627 Dc (TM); Farm Spitskop 1627 Dc (TM).

REMARKS

The snake collected by Dr P. Range at Kuibis, which was identified by Nieden (1913) as *Bitis peringueyi* is actually the earliest known specimen of this new species. It is NMB 23379 in the Naturmuseum of the Humbold University, Berlin, and represents the unacceptable inland record for the Namib Sidewinding Adder which has been quoted in the literature since 1913.

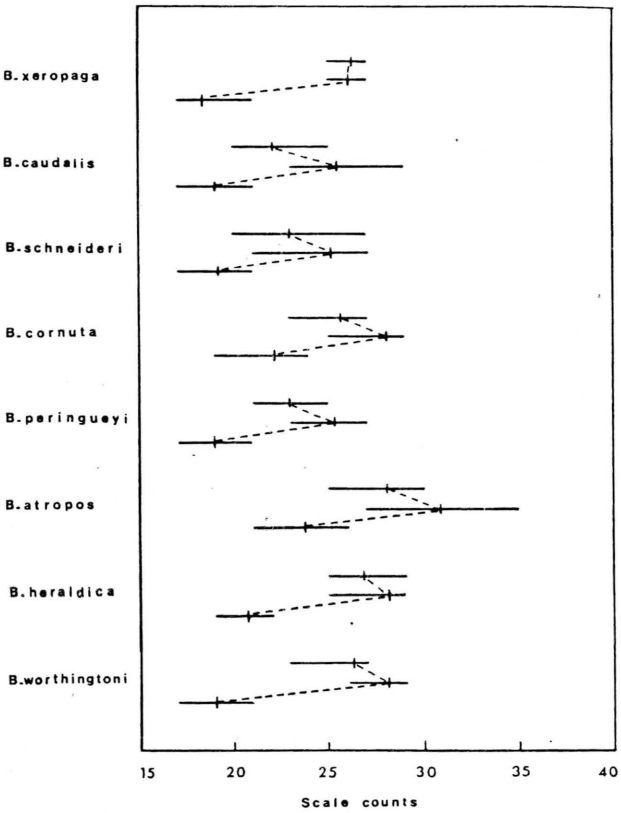

Figure 4. Variation of dorsal scale rows in the dwarf adders. Horizontal line = range of variation, vertical line = mean, top line = number of rows over neck, centre line = number of rows over middle, bottom line = number of rows over back. Dotted lines lines joining means indicate average increase or reduction of scale rows from front to back over body.

Bitis schneideri (Boettger) **n. comb.**

Vipera schneideri Boettger, 1886: 8, Pl. 1, Fig. 1. (Type locality: Angra Pequenia = Lüderitz Bay).

Bitis caudalis Boulenger (*partim*, Port Nolloth only), 1896: 498; FitzSimons (*partim*, Bogenfels, Lüderitzbucht, Pomona), 1962:350; Werner (*partim*, Prince of Wales Bay, male and first female), 1910:368.

Bitis caudalis paucisquamatus Mertens, 1954: 218 (Type locality: Little Namaqualand).

Bitis caudalis paucisquamata Klemmer, 1963:371.

Bitis paucisquamata FitzSimons, 1962:346; Visser, 1966:17; Underwood, 1968:83; FitzSimons, 1970:195.

Bitis paucisquamatus FitzSimons, 1966:78.

Bitis peringueyi FitzSimons (*partim*, Pomona only), 1962:342.

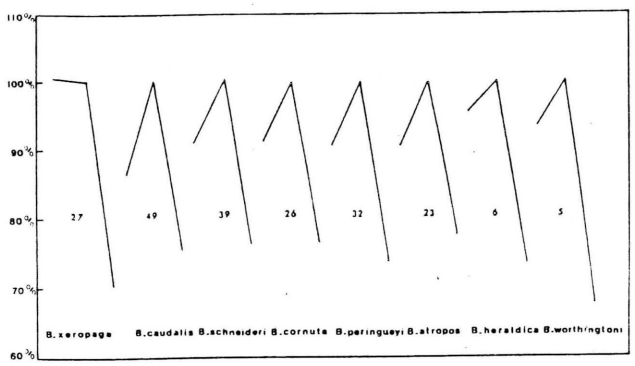

Figure 5. Variation of mean number of dorsal scale rows of the dwarf adders expressed as a percentage of the mean number of rows across the middle. Point on left = mean across neck; centre point = mean across middle (= 100 %); point on right = mean across rear.

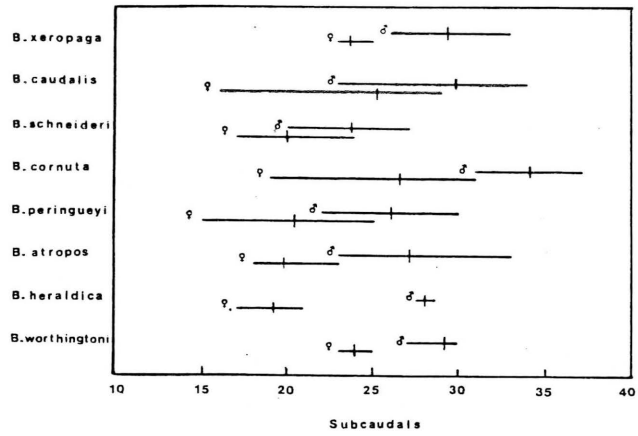

Figure 6. Variation in subcaudal counts in *B.xeropaga*, *B.schneideri* and specimens of roughly sympatric populations of *B.caudalis* and *B.cornuta*, as well as samples of the other dwarf adders.

Vipera schneideri was described on a single specimen donated by Dr O. Schneider from the vicinity of Lüderitz Bay. This species was placed in the synonymy of *B. caudalis* by Boulenger (1896) and was never accredited full species status again, except in an unpublished draft manuscript on small adders by Hewitt when he recognised a specimen in the South African Museum from Kleinsee, as belonging to this species. Mertens (1954) described *B. caudalis paucisquamatus* from Little Namaqualand and FitzSimons (1962) raised this form to species level giving the range as the coastal area from Kleinsee, south of Port Nolloth, to Oranjemund, which lies north of the Orange River in South West Africa. A specimen from Bogenfels was listed as *B. caudalis* while a specimen from the abandoned private museum at the defunct diamond mine at Pomona was referred to as *B. peringueyi* by FitzSimons (1962:342 and 350). This clearly illustrates the fact that this smallest of the adders resembles both *B. peringueyi* and *B. caudalis* in general appearance and colour pattern. A specimen collected about 20 km W of Aurus Mountain, Diamond Area 1, was photographed sidewinding up a dune, tentatively identified as a *B. peringueyi* and unfortunately swallowed by a *B. caudalis*. The photographs were later correctly assigned because of the obvious presence of small horns above the raised eyebrows (Photo by Haacke in FitzSimons 1970, pl. 31, fig. 2). *B. peringueyi*, which looks very similar to this species, has characteristically dorsolaterally placed eyes. FitzSimons (1970:195) mentions that *B. paucisquamata* might occur as far north as Lüderitz. Recent investigations produced the following specimens from this locality, the *terra typica* of *Vipera schneideri:* NMB 22831 in the Naturmuseum, Berlin, registered as having been collected by Professor Leonhard Schultze, which Werner (1910) failed to mention; ZSM 129/1947 in the Zool.Staatssammlung, Munich, collected by Tesdorf in 1927 and TM 44130 and 44131 donated by the Lüderitz Museum. These findings revived the question of the status of *V. schneideri* and an analysis of all the material that became available including the types of *V. schneideri* and *B.c. paucisquamatus* was made.

When analysing the data it became apparent that in the ventrals a clinal tendency exists, with the above types representing more or less the extremes at either end of the range (table 1; fig. 2) The lowest ventral counts *(vide paucisquamata)* are found on the types from Little Namaqualand and the specimen from Kleinsee, while the highest counts are on specimens from the Prince of Wales Bay and Lüderitz, the northern end of the range. It is unfortunate that the actual type of *V. schneideri* appears to be a slightly atypical specimen. It has the highest subcaudal count for females (24/25, range 17-25, $\bar{x} = 20{,}13$, SD = 2,08) (figs 2 + 6) and the highest number of dorsal scale rows over the neck, nl. 27 (range 20-27, $\bar{x} = 23{,}00$, SD = 1,34). Although the ventral count (127) is high it is surpassed by two specimens from the Prince of Wales Bay with 129 each but is still low when compared with the five specimens of *B. caudalis* from the same area (136-144, $\bar{x} = 139{,}2$), all the females (138-152, $\bar{x} =$ 144,13, SD = 3,64) and the total range for both sexes of the latter species (133-152, $\bar{x} = 142{,}4$, SD = 4,08) in the sample used in this study. There is thus no need to doubt the affinities of this specimen.

The illustration of the type in the original description (Boettger, 1886:pl. 1,1a) shows an important characteristic i.e. the spotted ventrals, which are immaculate in *B. caudalis* but spotted to a greater

or lesser degree in *B. schneideri*. The raised eyebrows usually have a single slightly enlarged hornlike scale above each eye although this is often less well developed in specimens from south of the Orange River. The colour pattern as illustrated by Boettger (1886) also fits well into the range observed. Considering the various aspects discussed I conclude that *schneideri* and *paucisquamata* are synonymous, with the former having priority, for which reason *Bitis schneideri* is the correct name for the Spotted Dwarf Adder of the southern and transitional Namib. The view that the difference between *caudalis* and *schneideri* may only be of a subspecific nature was quite justified at the time of the description of *B.c. paucisquamatus*, since their distribution appeared to be completely allopatric. However, sympatry is now apparent at Lüderitz, Prince of Wales Bay and Port Nolloth. Furthermore, the observed ranges of ventral counts of the samples of the two species show no overlap (fig. 3) and the co-efficient of difference between them is 2,39 which is much higher than the conventional level of subspecific difference of 1,28 (Mayer *et.al.*, 1953:146). The statistical difference is highly significant ($t = 21,85$; $P < 0,001$) substantiating that on ventrals alone *B. schneideri* is clearly distinct from *B. caudalis*.

Variation: FitzSimons' (1962:346) description still applies except in the case of some range extensions of scale counts. Since ventral counts were made according to the Dowling method, slight differences from published records may be observed.

	Range	N	$\bar{x}$	SD
Ventrals, total	104 – 129	39	116,28	6,86
male	107 – 129	20	115,35	6,86
female	104 – 129	17	117,16	7,10
Subcaudals, male	20 – 27	40	23,73	1,50
female	17 – 25	38	20,13	2,08
Dors. sc. rows, anterior total	20 – 27	39	23,00	1,34
male	20 – 25	14	22,71	1,33
female	23 – 27	9	24,22	1,39
Dors. sc. rows, middle total	21 – 27	39	25,21	1,32
male	21 – 27	14	24,79	1,42
female	25 – 27	9	26,33	1,00
Dors. sc. rows, posterior total	17 – 21	39	19,21	1,38
male	17 – 21	14	18,50	1,65
female	19 – 21	9	19,66	0,71
Upper labials	9 – 13	78	11,22	0,86
Lower labials	9 – 15	78	11,76	1,10
Orbitals	8 – 14	78	10,98	1,16
Sc. between eyes	11 – 14	35	12,34	1,03
Tail percra ratio, male	10,08 – 14,57	20	12,10	1,40
female	7,34 – 11,20	19	9,48	1,18

The ventral scales show a marked clinal variation in total numbers increasing from low counts in the south to high counts in the north with the types of *B. caudalis paucisquamatus* from "Little Namaqualand" having the lowest to the type of *V. schneideri* from the Lüderitz area and two specimens from the Prince of Wales Bay having the highest (table 1).

Table 1. Ventral counts in relation to geographical distribution.

Males	Females
104	1 L. Namaqual. (Paratype)
105	
106	
107 1 Kleinsee, 1 L. Namaqual. (Type)	
108 2 Port Nolloth	
109 1 Port Nolloth	
110 2 Port Nolloth	2 Port Nolloth, 1 Hondeklip Bay
111 1 Port Nolloth, 1 Alex. B.-Holgat	1 Port Nolloth
112	1 Daberas, 2 Port Nolloth
113	
114 1 Oranjemund, 1 Port Nolloth	
115	1 Port Nolloth
116	
117	
118 1 Oranjemund, 1 Lüderitz	
119	3 Oranjemund
120 1 S.W.A., 1 Oranjemund	1 Oranjemund
121 1 Oranjemund	
122 1 Bogenfels	
123	1 Pomona
124 1 Klinghardt Mtn.	1 Chamnaub Dunes
125	2 Lüderitz
126 1 Lüderitz	
127	1 Lüderitz (Type)
128	
129 1 Pr. of Wales Bay	1 Pr. of Wales Bay

The above list does not indicate any clear sexual dimorphism although when treated as a sample the female average is slightly higher as it is in the dorsal scale rows. In the subcaudals sexual dimorphism is not as well defined as usual in this genus (fig. 6.). To FitzSimons' (1962) colour description must be added that the tail tip may occasionally be dark, as in *B. peringueyi*. This occurrence is unrelated to sex. Size: Largest male TM 45571, Spitzkuppe Süd in Klinghardt's Mtns., 276(250 + 26) mm. Largest female NMB 22831, Pr. of Wales Bay 274 (254 + 20) mm.

FIELD NOTES

Judging from the type of terrain found at the various collecting sites and from the two personal encounters in the field, this snake occurs in low irregular dunes often stabilised by tussocks of coarse dune grass and small xerophytic shrubs. It frequently sidewinds and also buries itself in sand. It is the ecological equivalent of *Bitis peringueyi*, which occupies the windblown sand of the Namib Desert from Lüderitz northwards into south-western Angola. Since FitzSimons' (1962:342) report of *B. peringueyi* from Pomona proved to be *B. schneideri*, on present evidence it appears that the ranges

of these two species do not actually overlap. The southern limit of *B. peringueyi's* range appears to be the southern edge of the southern Namib sand-sea near the Lüderitz-Aus main road. To the south of that line *B. schneideri* occurs, often probably in small pockets, where vegetated sand accumulations or bare dunes are scattered in the rough, broken terrain of Diamond Area No. 1 in South West Africa. Near Oranjemund the sand accumulations become more extensive. South of the Orange River the vegetated sands occur mainly in a coastal strip with inland extensions. In this area the vegetation cover tends to become quite dense, although areas of bare windblown dunes occur as, for example, about eight kilometres north east of Port Nolloth. The vegetated coastal sands continue south of Kleinsee and the most southern recorded locality for this species is Hondeklip Bay.

A female from Port Nolloth (BM 87.6.23.2) contains four fullterm young, three female and one male, varying in total length from 113 to 123 mm. This appears to be the only reproductive information at present.

The main prey animals sharing *B. schneideri* biotope are diurnal lacertids and skinks and nocturnal geckos. From the Holgat River northwards *Palmatogecko rangei* must constitute one of the main prey species. This gecko was found in the stomach of snakes from Lüderitz and Oranjemund. South of the abovementioned river, which appears to be the range limit of *Palmatogecko*, its ecological equivalent *Pachydactylus austeni* Hewitt becomes the most important reptile prey which was confirmed in stomach contents of an adder from Port Nolloth and the one from Kleinsee. Rather interesting is the presence of remains of a short headed frog, presumably *Breviceps macrops* Boulenger, in a snake specimen from Port Nolloth and one from Lüderitz (TM 44131). This frog from Little Namaqualand (Poynton, 1964) has not been recorded from north of the Orange River. The adder from Daberas contained hairs of mammal remains, some head scutes and tail scales of a lacertid, probably *Meroles* sp. and six poison fangs and a few body scales of a small adder, most likely of its own species. Both specimens from the Prince of Wales Bay contain lacertid remains *(Meroles)* while a *Mabuya capensis* juvenile was swallowed by a Port Nolloth specimen.

DISTRIBUTION RANGE

The semi-stable, vegetated sand accumulations of the southern and transitional Namib (*cf.* Koch, 1962) from the vicinity of Lüderitz to at least Hondeklip Bay in Little Namaqualand (fig. 1).

Recorded localities:

Angra Pequenia = Lüderitz Bay; between Alexander Bay and Holgat River 1628 Dc (TM); 20 km W of Aurus 1627 Ca (Photo TM); Bogenfels 1527 Cb (TM); Chamnaub dunes 2615 Cb (TM); Daberas in Holgat River 1628 Dd (TM); Hondeklip Bay 3017 Ad. (BM); Kleinsee 1729 Cc (SAM); Little Namaqualand (SMF); Lüderitz 1526 Ca (SMF, TM); Oranjemund 1628 Cb (TM); Pomona 1527 Ad (TM); Port Nolloth 1929 Bb (BM, TM); Spitzkuppe Süd in Klinghardt's Mtns 2715 Bd (TM); South West Africa (SAM).

Material examined:

Thirty nine specimens. TM 20903, 20910, 20948, 20962, 20963, 32798, 32685, 44132 Oranjemund; TM 22075 Bogenfels; TM 22095 ex Pomona Museum; TM 22271 Alexander Bay to Holgat River; TM 24589, 24590. 24592, 24594 Port Nolloth; TM 33801 Daberas in Holgat River; TM 44130, 44131 Lüderitz area; TM 45571 Spitzkuppe Süd; TM 45572 Chamnaub dunes; SAM 18565 Kleinsee; SAM 20703 South West Africa; SMF 21019 Angra Pequena (Type **V.schneideri);** SMF 21020, 21021 Little Namaqualand (Holo- and Paratype *B.c.paucisquamatus);* ZSM 129/1947 Lüderitz; NMB 22829, 22831 Prince of Wales Bay; NMB 23203 Lüderitz; BM 87.6.23.2 + 3 + 3(a-d), 87.10.6.10, 1905.3.7.163, 1967.594, Port Nolloth; BM 98.2.10.6 Hondeklip Bay.

III. DISCUSSION

The dwarf adders of southern Africa are often rather difficult to distinguish because of general similarity, variability and consequent overlap in morphological characteristics. Although FitzSimons (1962) and Marx and Rabb (1965) provide keys, Underwood (1968:83) found it difficult to confidently separate for example *B. cornuta* from *B. caudalis* and *B. schneideri* on external characteristics but managed to find certain internal aspects which supported conventional taxonomic views.

Consequently, when it was realised that a new species of *Bitis* was involved, it was considered necessary to accumulate a reasonable series to enable adequate comparison with related species. In this connection *B. peringueyi* and *B. worthingtoni* are the best defined and geographically and ecologically separated. Both *B. heraldica* and *B. atropos* are hornless, have a dusky to spotted ventrum and may have phylogenetic relationships. Since the last three mentioned species do not occur in the critical contact area of the other five species in the southern Namib they are not specially listed nor discussed.

Since this new species had previously been confused with *B. caudalis*, the possibility of subspecific differences had to be considered. *B. caudalis* has a wide distribution and consequently a wide range of variation in scutellation which could obscure real differences with sympatric populations of *B. xeropaga* and *B. schneideri*. Although *B. cornuta* has a smaller range similar considerations apply, for which reason only specimens of *B. caudalis* and *B. cornuta* available from the general range of *B. xeropaga* and *B. schneideri*, but all the specimens of *B. peringueyi* in the Transvaal Museum collection were used in this investigation.

Bitis caudalis (A. Smith)

Material examined:

Forty-nine specimens. TM 15362 Pofadder; TM 15898 Kakamas; TM 22274 Vioolsdrif; TM 24595 Goodhouse, TM 24596, 24597 N.W. Cape Province; TM 25746 Aus; TM 35315 Nabas; TM 35397, 39506, 39989, 40008, 41336, 41650, 42330, 42415, 43011, 43142, 43909, 43910, 43981, 44496, 44997 Rosh Pinah Mine; TM 37185 Farm Keimas; TM 37624 32 km N of Steinkopf; TM 42354 Kodas Mine; TM 43012 15 km NE of Sendelingsdrif; SMW 2550 a+b Koichab Pan; SMW 5706 Sendelingsdrif; SMW 5805, 5806, 5877, 5893 Farm Namuskluft; SMW 6013 Neisib; SMF 21017, 21018, 32716, 32717, 43960 Lüderitz; SMF 46775 Farm Augustfelde; SMF 49618, 51712, 55435 Farm Plateau; SMF 52762 Fish River Canyon; SMF 54749 Farm Witputs; NMB 22833 Prince of Wales Bay; BM 87.10.6.9 Port Nolloth; BM 98.5.26.39 Naroep.

Range of variation

	Range	N	$\bar{x}$	SD
Ventrals, total	133 – 152	47	142,40	4,09
male	133 – 148	23	140,78	3,99
female	138 – 152	24	144,13	3,64
Subcaudals, male	23 – 34	46	29,96	2,40
female	16 – 29	48	25,02	3,10
Dors. sc. rows,	20 – 26	49	22,12	3,22
anterior				
middle	23 – 29	49	25,55	1,40
posterior	17 – 23	49	19,10	1,10
Upper labials	10 – 14	92	11,46	0,92
Lower labials	10 – 15	92	12,24	1,14
Orbitals	10 – 16	88	12,75	1,15
Tail percra ratio,				
male	9,55 – 13,75	24	11,48	1,04
female	5,59 – 10,75	24	8,95	1,01

The observed range for ventrals for this species is 120 to 155. The highest range limits occur in the south-western areas of its distribution which overlaps the ranges of *B. xeropaga* and *B. schneideri*, while lower limits are found in Angola, the Kalahari and Transvaal.

Bitis cornuta cornuta (Daudin)

Material examined:

Twenty-six specimens. TM 15338, 33766, 42824, SMW 1525 Lüderitz; TM 18131 S of Kamaggas; TM 22057 Hondeklip Bay; TM 22076 Bogenfels; TM 24588, 24598, 24599 – 24602, 24604-5 Kamiesberg; TM 24591, 24593, BM 1905.3.7.162 Port Nolloth; TM 28706, SMW 1474, 1513 Elizabeth Bay; TM 35115 8 km W of Middelpos; TM 36687 Hellskloof Pass; TM 37092 Uri-Hauchab Mtn.; TM 45567 Mile 70 nr Bogenfels; BM 1905.3.7.161 Klipfontein. For other records from this area check FitzSimons (1962) and Mertens (1971).

Specimens from the western Cape Province have ventral counts as low as 121.

As correctly pointed out by Mertens (1971:104) the records of this species from the Kaokoveld are actually *B. caudalis*. Furthermore, a recent investigation of the collection from colonial times in the Naturmuseum, Berlin, failed to confirm the records from Gobabis and Otjimbingwe. Since no further records from central South West Africa have become known in the past sixty years it appears that

Range of variation:

	Range	N	$\bar{x}$	SD
Ventrals, total	133 – 150	26	139,92	4,94
male	133 – 143	11	136,42	3,09
female	135 – 150	15	142,93	4,21
Subcaudals, male	31 – 37	18	34,28	1,99
female	19 – 31	30	26,57	2,65
Dors. sc. rows,				
anterior	23 – 27	26	25,65	1,09
middle	25 – 29	26	28,00	1,17
posterior	19 – 24	26	21,35	2,13
Upper labials	12 – 15	52	13,52	0,85
Lower labials	11 – 16	52	13,21	1,13
Orbitals	11 – 18	48	14,56	2,17
Tail percra ratio,				
male	12,28 – 14,74	10	13,58	1,06
female	7,90 – 11,19	15	10,00	0,98

the range limits are further south than previously accepted with the specimen from the Uri-Hauchab mountain (TM 37092) being the most northern reliable record at present.

Bitis peringueyi (Boulenger)

Material examined:

Thirty-five specimens. TM 20733, 32037 Rooibank; TM 22272 Rotkuppe near Haalenberg; TM 25015, 25017, 28475-6, 28600, 29133, 31180, 32338 Gobabeb; TM 25101, 25332, 28631, 32348, 33673 Swakopmund; TM 31412 Unjab River Mouth; TM 31676 Sossus Vlei; TM 32506 N W dunefields; TM 36915 Tsondab Plains; TM 37060-2 Between Awasib and Uri-Hauchab; TM 37064-6, 44788-9 Sylvia Hill – Uri Hauchab; TM 37099 16 km W of Awasib. TM 39093 Hoarusib River mouth; TM 44721, 45584 Spencer Bay Water; TM 45585, 45595, 45609 Uri-Hauchab.

Range of variation:

	Range	N	$\bar{x}$	SD
Ventrals, total	117 – 144	34	134,32	5,17
male	117 – 138	15	132,27	5,82
female	125 – 144	19	135,95	4,05
Subcaudals, male	22 – 30	30	26,17	1,82
female	15 – 25	36	20,50	2,21
Dors. sc. rows,				
anterior	21 – 27	33	23,21	1,08
middle	23 – 31	32	25,80	1,63
posterior	17 – 21	34	19,03	0,76
Upper labials	10 – 14	70	11,14	0,89
Lower labials	9 – 14	70	11,29	0,95
Orbitals	10 – 13	70	11,11	0,71
Sc. between eyes	7 – 9	28	8,00	0,72
Tail percra ratio,				
male	9,45 – 12,37	16	10,77	0,98
female	7,37 – 10,53	17	8,40	0,92

A re-examination of old records proved that the most southern record for this species is from Rotkuppe near Haalenberg (TM 22272) since the specimen recorded from Pomona is a *B. schneideri* (TM 22095) and that from Kuibis is a *B. xeropaga* (NMB 23379). The specimen from Konyo, Kalahari, (Werner 1910:366, No. 969) in the Berlin Museum is correctly identified but the locality is unacceptable.

When comparing the scale counts the following points become apparent: *B. xeropaga* has the highest ventral counts, while *B. cornuta* and *B. caudalis* overlap extensively but *B. schneideri* has remarkably low counts although the range of variation is great (fig. 3). The average subcaudal counts of *B.xeropaga* and *B. caudalis* are practically identical for both sexes (fig. 6). Although *B. schneideri* falls within the range of *B. caudalis* it has a much lower mean while *B. cornuta* on average has the highest number of sub-caudals. The number of dorsal scale rows counted one head length behind the head, across the middle of the body and one head length ahead of the cloaca are indistinguishable for *B. caudalis* and *B. schneideri* while the mean counts for *B. cornuta* lie higher for all three counts. In these three species there is an increase in scale rows from front to middle with a strong reduction posteriorly. *B. xeropaga* shows a very significant difference, having on average a slight reduction from the neck towards the middle and from there an even stronger reduction towards the back than in the other species (figs 4 & 5). The labial and orbital counts of *B. caudalis* and *B. schneideri* are similar to one another but lower than those of *B. xeropaga* and *B. cornuta.*

Other external features of importance are hornlike scales above the eyes which usually occur in small tufts with a slightly elongated uppermost orbital scale forming part of the cluster in *B. cornuta*, as a single horn in *B. caudalis*, a minute single horn in *B. schneideri* and are absent in *B. xeropaga*. The subcaudals of *B. caudalis* and *B. schneideri* are strongly keeled in females, while the proximal scales in males are smooth. Those of *B. cornuta* and *B. xeropaga* are smooth, except in a few cases where the most distal subcaudals are faintly keeled. The ventrum of *B. caudalis* is always white and unmarked, in *B. peringueyi* it is usually lightly speckled but occasionally immaculate, while in *B. schneideri* it is always spotted and in *B. xeropaga* and *B. cornuta* it is dusky and speckled to spotted.

When comparing the relative heart and liver position of *B. xeropaga* with Underwood's (1968:84) findings, *B. xeropaga* is practically identical to *B. caudalis* whereas *B. schneideri* and *B. cornuta* are similar by having these organs slightly further forward.

The hemipenis of *B. xeropaga* appears to be very similar to that of *B. cornuta*, having longitudinal folds on the shaft, spines decreasing in size towards the end of the lobes and no terminal awn, while *B. caudalis* and *B. schneideri* show great similarity. In conclusion it appears that the most outstanding characteristics of *B. xeropaga* are the absence of horns, the smooth subcaudals and the high number of scale rows over the neck, of which there are usually as many as over the middle of the body. In all other small adders of this genus the low number of neck scale-rows increases towards the middle (figs 4 & 5).

B. schneideri is well defined by means of its generally low scale counts and the strongly speckled ventrum. Although it shows close affinities to *B. caudalis* in many aspects, no intermediate specimens are represented in the sample studied and therefore the possibility of it being only subspecifically distinct is not accepted.

B. caudalis has an immaculate ventrum with keeled sub-caudals, while *B.cornuta cornuta* has a dusky to spotted ventrum with smooth subcaudals and above each eye several raised elongate hornlike scales which usually incorporate the top orbital scales which are not involved in *B. caudalis.*

Although *B. caudalis*, *B. cornuta*, *B. peringueyi* and *B. schneideri* have all been reported from Lüderitz, it must be remembered that this locality can only be taken as an indication of the general area of origin. These species appear to be ecologically separated. In general it can be assumed that their distribution forms an interdigitating mosaic pattern according to the biotope, with minor areas of overlap along contact zones. *B. peringueyi* is confined to the shifting sands from Rotkuppe near Haalenberg northwards, *B. schneideri* occurs on the semistable, mostly vegetated sands of the southern and transitional Namib south of Lüderitz, *B. caudalis* occupies the sand and gravel flats, while *B. cornuta* apparently prefers the harder substratum of rocky outcrops. To the east on the escarpment, from Aus southwards and eastwards, *B. xeropaga* takes over that niche.

IV. SUMMARY

Bitis xeropaga, a new dwarf adder, is described from the mountains of the arid areas of southern South West Africa and the north-western Cape Province. It is a hornless species, distinguished by a specific colour pattern, a dusky to spotted ventrum, smooth subcaudals and with as many dorsal scale rows over the neck as across the middle of the body. This latter characteristic distinguishes it from all other small *Bitis* species. The type of *Vipera schneideri* is not a *Bitis caudalis*. *V.schneideri* is synonymous with *Bitis paucisquamata*, over which it has priority. *Bitis schneideri* is therefore the correct name for the Spotted or Namaqua Dwarf Adder. The new species and *B.schneideri* are compared with specimens from sympatric populations of *B.caudalis*, *B.cornuta* and *B.peringueyi*, as well as other dwarf adders. They are closely related and differences are not always clear but are substantiated by habitat preferences causing ecological separation among apparently sympatric species.

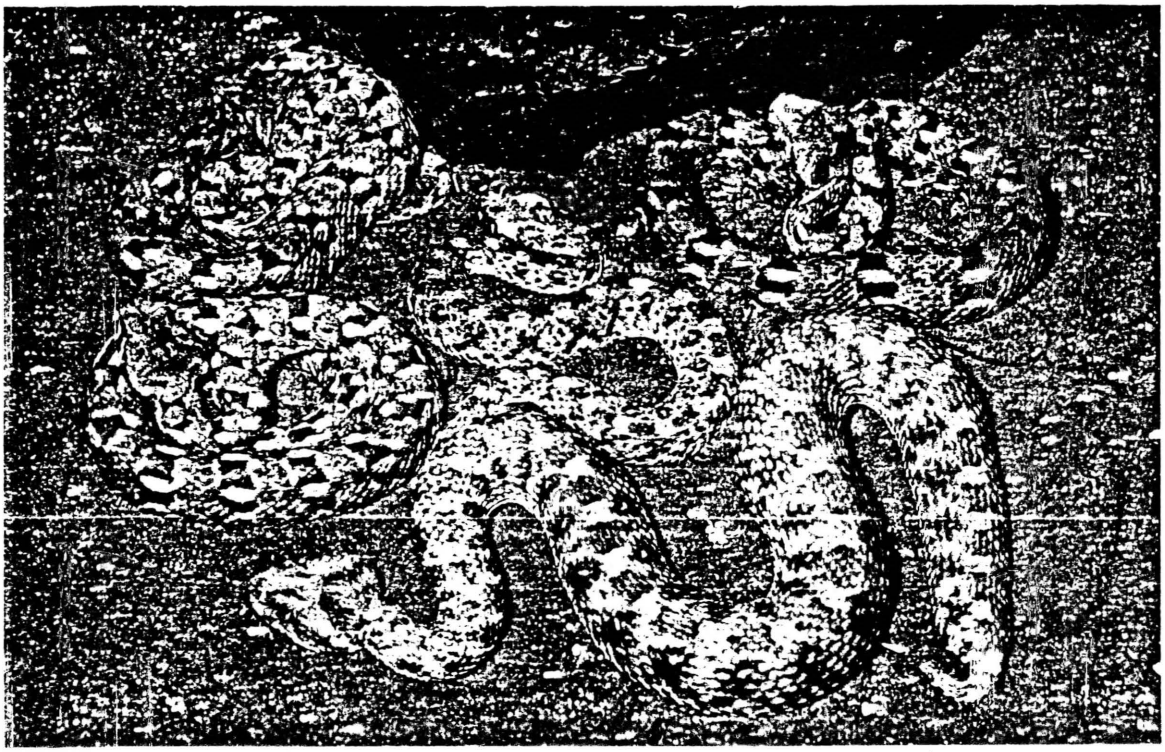

Plate 1. Three specimens of *Bitis xeropaga*,—the two in the rear are from near Lorelei and the one on the left in the centre is from Obib mountain,—next to two specimens of *Bitis caudalis* from the Rosh Pinah Mine, showing differences in colour pattern and general appearance.

Plate 2. Portrait of *Bitis xeropaga* (SMW 2591) from Obib mountain.

ZUSAMMENFASSUNG

Eine neue Zwergpuffotter *(Bitis xeropaga)* aus den Bergen der Trockengebiete des südlichen Südwest-Afrikas und der nord-westlichen Kapprovinz ist beschrieben. Diese hornlose Art wird durch ein typisches Farbmuster, eine dunkele bis gefleckte Unterseite, glatte Subcaudalia und die gleiche Anzahl Schuppenreihen auf dem Hals wie auf der Mitte des Körpers gekennzeichnet. Die letzgenannte Eigenschaft unterscheidet sie von allen anderen kleinen *Bitis*-Arten. Der Typus von *Vipera schneideri* ist keine *Bitis caudalis*. *V.schneideri* hat Priorität über *B.paucisquamata*. *Bitis schneideri* ist deshalb der gültige Name für die Gefleckte oder Namaqua Zwergpuffotter. Die neue Art und *B. schneideri* werden dann mit Exemplaren von sympatrischen Populationen von *B.caudalis* und *B.cornuta* verglichen. Diese Arten sind nahe verwandt und die Unterschiede sind oft nicht sehr deutlich, jedoch verursachen unterschiedliche Habitatvorzüge ökologische Trennungen scheinbar sympatrischer Arten. Zum Vergleiche werden auch sowohl Daten von *B.peringueyi* alsauch von den übrigen Zwergpuffottern angeführt.

V. ACKNOWLEDGEMENTS

I am indebted to the following people: Messrs. J. Botha, A. Maritz and A. Heyns of the Rosh Pinah Mine for providing the bulk of the new material; Dr H. D. Brown for inviting me on to several collecting trips to the western arid areas of southern Africa and providing invaluable live material; Messrs C. G. Coetzee and M. Penrith, State Museum, Windhoek, and Mr R. Rau, South African Museum, Cape Town, for the loan of specimens; Dr K. Klemmer, Senckenberg Museum, Frankfurt/Main, for supplying loan material, for re-examining types on my behalf and for permission and facilities to examine material in his care.

I am grateful for facilities provided by the following colleagues enabling me to study their southern African collections: Dr. U. Gruber, Zoologische Staatssammlung, Munich; Dr G. Peters, Naturmuseum, Berlin; Dr. H. W. Koepke, Zoologisches Institut und Museum, Hamburg and Ms. A. E. Grandison, British Museum (Nat. Hist.) London.

Last but not least I would like to thank the Departments of Nature Conservation of South West Africa and The Cape Province for permission to collect and the Management of the Consolidated Diamond Mines for permission to enter their area.

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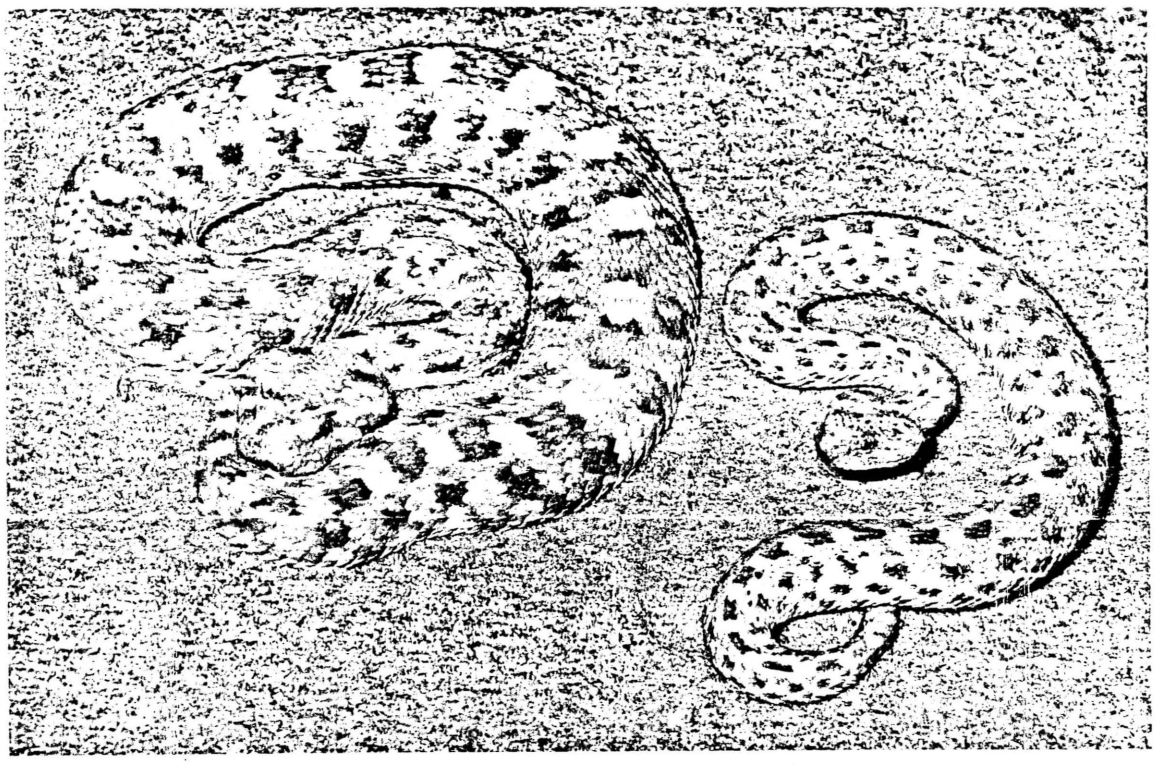

Plate 3: Adult female *B. caudalis* from the Richtersveld next to the largest known specimen of *B. schneideri* showing the size difference and colour patterns.