Supplement to *Koedoe* 1984: 171-186

THE HERPETOLOGY OF THE SOUTHERN KALAHARI DOMAIN

W. D. HAACKE

Department of Lower Vertebrates
Transvaal Museum
P.O. Box 413
Pretoria
0001

Abstract – The herpetofauna of the southern Kalahari has mixed affinities, as this area lies on a rainfall gradient in a critical area where a transition between the arid south-west and the moister north-east takes place. As the variation in substrate type is relatively limited, the effect of the rainfall gradient appears to influence and determine the range limits of many taxa in both directions, resulting in an area in which of 55 recorded reptiles, 11 western taxa overlap or form a parapatric zone with 25 eastern taxa, while the remaining taxa are endemic or wide-ranging.

Introduction

Geologically speaking the "Kalahari" is that sandy expanse covering the central depression of the southern African plateau, extending from just north of the Orange River in the Cape Province into the Congo basin of Zaire. As such it is considered the largest continuous body of sand in existence (Leistner 1967). Biologically it shows great diversity, mainly due to the effect of a rainfall gradient on this area which ranges from about 28°S to the proximity of the equator.

Various biogeographical analyses have been attempted in the past (*cf.* Werger 1978a) but in general it has been difficult to define the Kalahari as a unit. However, it has been found that, based on botanical evidence, it is acceptable, to refer to the "Southern Kalahari Domain" as part of the Karoo-Namib Region (Werger 1978a) while the "Central Kalahari" forms part of the huge "Sudano-Zambezian Region".

The southern Kalahari lies south of the "Bakalahari Schwelle" or "Bakalahari Rise" (*cf.* Passarge 1904 and Wellington 1955, quoted in Leistner 1967) which is a slight rise in terrain extending roughly from Kanye in the south-east to the watershed between the Nossob and Epukiro Rivers in the north-west. According to Werger (1978a) this area is botanically not well defined as the floras of the adjacent areas interdigitate to some extent, but he considers that the 250 mm isohyete coincides satisfactorily with a chorological boundary and thus accepts it as an arbitrary border line. In fact the 300 mm isohyete appears to match his limits better, and as will be shown, is also of some significance in the distribution of cer-

tain reptile taxa with arid area affinities (Figs 3 and 4). Accordingly, in this study the "Southern Kalahari Domain" is considered to be that area of the Kalahari sand as outlined by Du Toit (1954) which extends into the below 300 mm average annual rainfall area (*cf.* Figs 1 to 5).

In the past some attempts have been made to analyse the reptile fauna of southern Africa and to define zoological regions according to the distribution of the lizards (Hewitt 1909). That author already mentions evidence for a western and an eastern subdivision although his distribution records are still very scanty and practically non existent for the Kalahari. In a later study (Hewitt 1914) on the distribution and discontinuities of ranges, several references are made to species occurring in the "Kalahari". While analysing the composition of the reptile fauna of Maputaland (Bruton & Haacke 1980) reference to zoogeographical zones in a wider sense was made during which the reptile fauna of the southern Kalahari was classed as belonging to an overlap zone between a south-western "Temperate-transitional" and "Tropical Wide Ranging" fauna. Although the present author's ideas now differ on western detail, the basic idea concerning the herpetofauna of the southern Kalahari still applies.

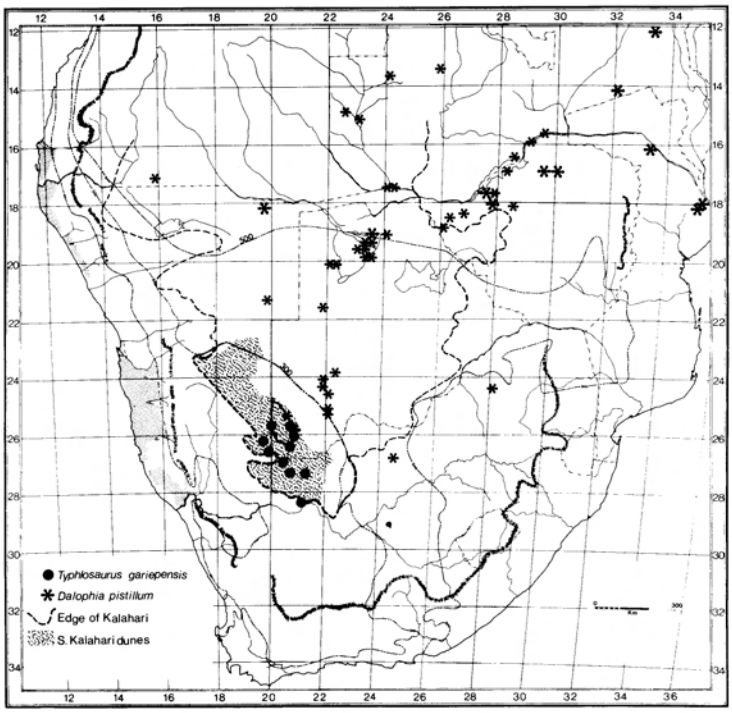

Fig. 1. Distribution of two legless burrowing reptiles of which one is a skink, endemic to the dune-fields of the Southern Kalahari Domain, while the other is an amphisbaenian, wide-ranging in the Sudano-Zambezian Region, which marginally enters the southern Kalahari.

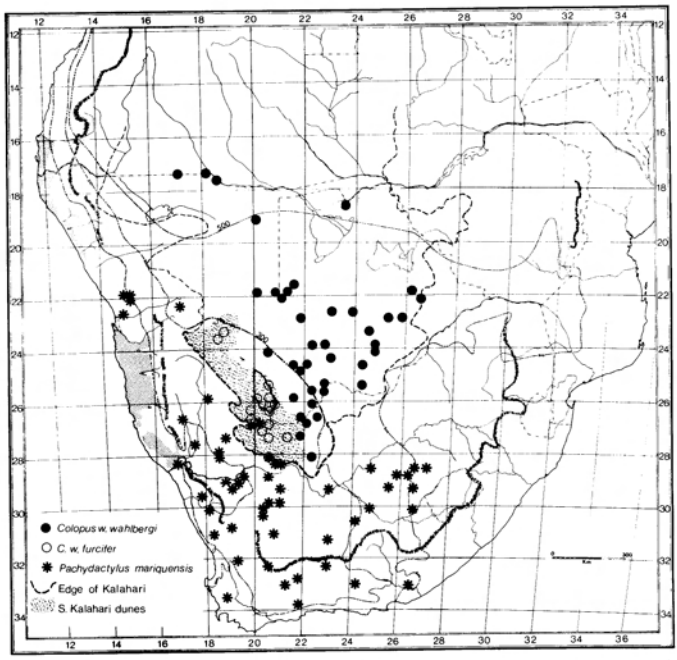

Fig. 2. Distribution of two nocturnal terrestrial geckos of which the one avoids Kalahari sand while the other occurs only on Kalahari sand. The latter has a subspecies endemic to the southern Kalahari dune-fields.

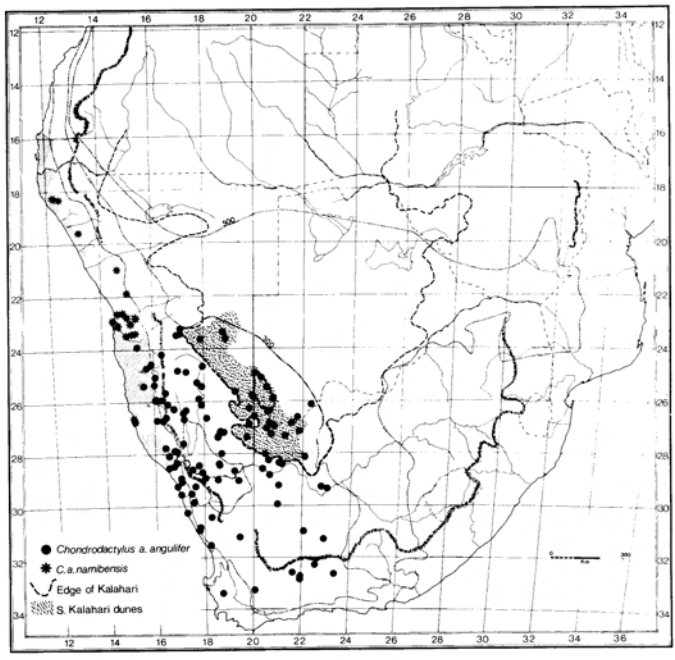

Fig. 3. Distribution of a nocturnal terrestrial gecko typical of the south-western arid area of southern Africa, of which the range limit appears to be determined by increasing rainfall.

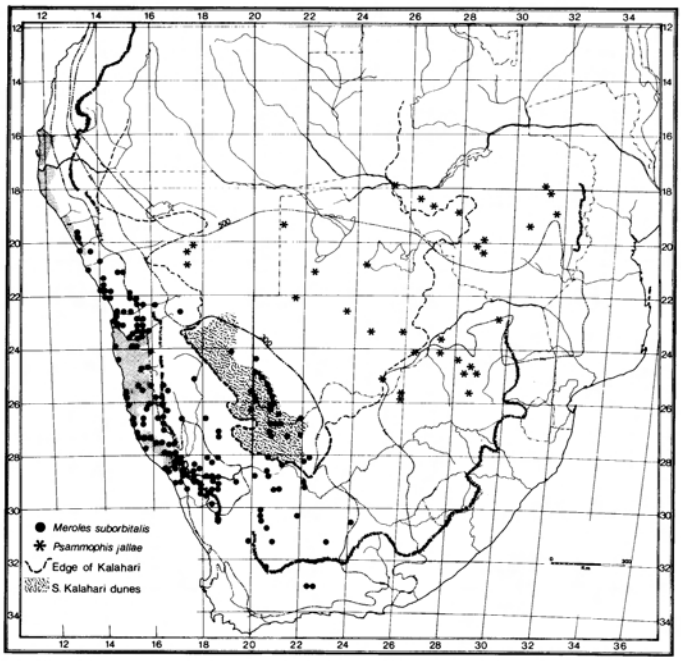

Fig. 4. Distribution of two diurnal terrestrial reptiles of which the range limits appear to be determined by rainfall gradient, as the lacertid is restricted to the below 300 mm average annual rainfall zone while the sand snake avoids this region.

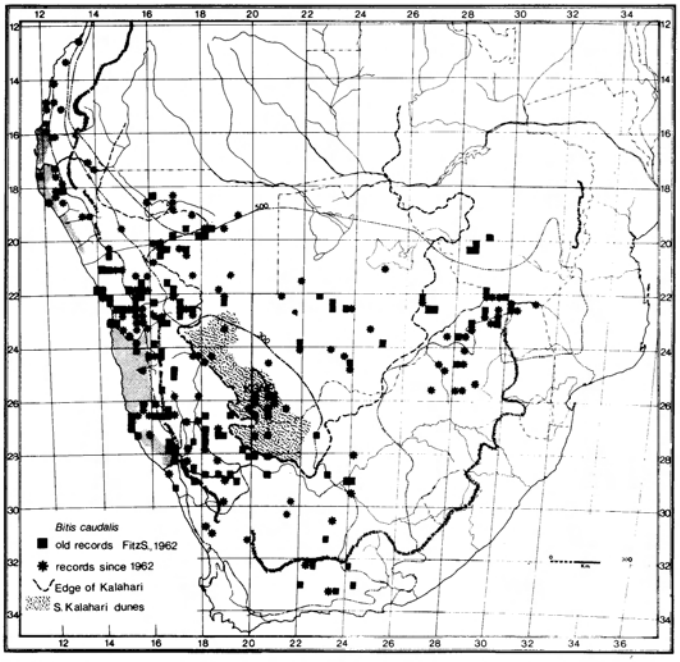

Fig. 5. Distribution of a wide-ranging snake which has strong affinities with the Karoo-Namib Region.

The "Southern Kalahari" with its dune-fields as its heartland (Leistner *op. cit.*) is the most arid part of the huge sandy depression of the central plateau of southern Africa, often referred to with journalistic passion as the "Kalahari Desert" ever since the nineteenth century adventurer Farini (1895, in Leistner *op. cit.*) put this area on the map. In combination with a sandy substrate and a low average annual rainfall it also is part of the hottest area of the subcontinent with the mean daily maximum for January in excess of 35 °C (Schulze & McGee 1978) which may affect the range of some reptiles.

Herpetologically this is an interesting area as it coincides with a number of range limits, thereby forming a transition-zone between certain western arid-adapted forms and some eastern tropical- or more mesic-adapted taxa with a small degree of endemicity. As the term "Kalahari" implies a sandy substrate, rupicolous species are non-significant, and the reptile fauna consists of a few arboreal taxa and some widespread generalists but mainly of psammophilous taxa, many of which are burrowers. Although amphibians experience severe limitations, a few species do manage to exist.

The Kalahari Gemsbok National Park in the Cape Province is the obvious centre of interest in this area. Herpetologically it is not as well known as might be expected. An initial provisional checklist (FitzSimons & Brain 1958) records 16 lizards, one amphisbaenian and nine snake taxa from the park, although the occurrence of the brown house snake (*Lamprophis fuliginosus*) has not been substantiated yet. Of the other two lizards, one amphisbaenian and eight snakes, which were listed as probably occurring in the park, only the occurrence of the amphisbaenian and two blind burrowing snakes have been substantiated. Since 1958 a further five lizard, three amphisbaenian and four snake taxa have been documented while another two snakes and a terrapin have been verbally reported from the park. According to records from the Southern Kalahari Domain and the Kalahari in the wider sense, it is obvious that a few more reptile taxa may be found inside this park in the future. The vast tracts of the Gemsbok National Park in Botswana are as yet herpetologically unexplored, but will in future, without doubt, also contribute further information to this preliminary study.

Material and methods

This analysis is based on published records of lower vertebrate distributions by various authors (*e.g.* FitzSimons 1943, 1962; FitzSimons & Brain 1958; Brain 1959; Broadley 1966, 1967, 1968, 1969, 1972, 1975, 1977 and 1983; Broadley, Gans & Visser 1975; Poynton 1964; Haacke 1975, 1976a, 1976b and others) but much of the information, especially from the Kalahari Gemsbok National Park (KGNP) is based on material in the Transvaal Museum, Pretoria. A few recent additions are based on unconfirmed verbal reports of National Parks Board staff.

The first specimens from this area were apparently collected in 1929 by Power (1933) and FitzSimons (1938). In 1956 FitzSimons collected the first specimens in the KGNP and from 1957 to 1960 Brain made several collections there before the author visited there twice in 1967 and 1970. The intensive ecological work on lizards in the southern Kalahari by Pianka (1971) and Huey, produced a number of

records, including some from the KGNP. A variety of other people, such as the late Dr Charles Koch, former ranger J. Clarke, the present Head Warden Mr Elias le Riche, and others, produced some of the rarer records. In recent years Huey (1982) utilized the facilities of the park to continue his ecological studies of lizards in arid areas.

Results

The amphibians and reptiles of the Southern Kalahari Domain are listed in Table 1, indicating whether they have been recorded from the KGNP and from which of the adjacent areas, thereby indicating what geographic affinity the taxa have.

Table 1

Amphibians and reptiles of the Southern Kalahari Domain and their occurrence in adjacent areas. Brackets indicate sight records

	Southern Kalahari Domain	KGNP	FitzSimons & Brian (1958)	Central Kalahari	Karoo and/or Namaqualand Domain
AMPHIBIA					
Pipidae					
Xenopus l. laevis (Daudin)	X	X			X
Microhilidae					
Breviceps a. adspersus Peters	X	X		X	
Ranidae					
Pyxicephalus a. adspersus Tschudi	X	X		X	
Tomopterna cryptotis (Boulenger)	X	X		X	
Cacosternum boettgeri (Boulenger)	X	X			X
Bufonidae					
Bufo garmani Meek	X	?		X	
CHELONIA					
Testudinidae					
Geochelone pardalis babcocki Loveridge	X	X		X	X
Psammobates oculifer (Kuhl)	X	X		X	
Pelomedusidae					
Pelomedusa subrufa (Lacépède)	X	(X)		X	
LACERTILIA					
Gekkonidae					
Ptenopus garrulus garrulus (A. Smith)	X	X	X	X	
Chondrodactylus angulifer angulifer Peters	X	X	X		X
Colopus wahlbergii wahlbergii Peters	X		X	X	
C. w. furcifer Haacke	X	X			
Pachydactylus punctatus Peters	X			X	X
P. rugosus rugosus A. Smith	X	X	X		X
P. capensis capensis A. Smith	X	X	X	X	X
P. bibronii A. Smith	X	X	X	X	X
Lygodactylus capensis capensis (A. Smith)	X	X		X	X

Table 1 (cont.)

	Southern Kalahari Domain	KGNP	FitzSimons & Brian (1958)	Central Kalahari	Karoo and/or Namaqualand Domain
Chamaelenonidae					
Chamaeleo dilepis dilepis Leach	X	X		X	
Varanidae					
Varanus exanthematicus albigularis (Daudin)	X	(X)		X	X
Agamidae					
Agama aculeata aculeata Merrem	X	X	X	X	X
Lacertidae					
Nucras tessellata tessellata (A. Smith)	X	X	X		X
Eremias lugubris A. Smith	X	X	X	X	
E. namaquensis Dumeril & Bibron	X	X	X	X	X
E. lineoocellata lineoocellata Dumeril & Bibron	X	X	X	X	
Ichnotropis squamulosa Peters	X	X	X	X	
Meroles suborbitalis (Peters)	X	X	X		X
Scincidae					
Typhlosaurus lineatus lineatus Boulenger	X	X	X	X	
T. gariepensis FitzSimons	X	X			
Lygosoma sundevallii (A. Smith)	X	X		X	
Mabuya capensis (Gray)	X			X	
M. occidentalis (Peters)	X	X	X	X	X
M. variegata punctulata (Bocage)	X	X	X	X	
M. striata punctatissimus (A. Smith)	X			X	
M. striata sparsa Mertens	X	X			X
M. spilogaster (Peters)	X	X			X
AMPHISBAENIA					
Amphisbaenidae					
Monopeltis leonhardi Werner	X	X	X	X	
M. capensis capensis A. Smith	X	X		X	X
M. sphenorhynchus mauricei Parker	X	X	X	X	
Dalophia pistillum Loveridge	X	X		X	
Zygaspis quadrifrons Peters	X	X		X	X
OPHIDIA					
Typhlopidae					
Typhlops schinzi Boettger	X	X	?	X	X
Typhlops boylei FitzSimons	X	X		X	
Leptotyphlopidae					
Leptotyphlops scrutifrons scrutifrons (Peters)	X	X	X	X	
Boidae					
Python sebae natalensis A. Smith	(X)			X	

Table 1 (cont.)

	Southern Kalahari Domain	KGNP	FitzSimons & Brian (1958)	Central Kalahari	Karoo and/or Namaqualand Domain
Colubridae					
Lamprophis fuliginosus (Boie)	X		X	X	X
Lycophidion capense capense (A. Smith)			?	X	
Pseudaspis cana (Linnaeus)	X	X	X	X	X
Dipsina multimaculata (A. Smith)	X	X	X		X
Psammophis notostictus Peters	X	X	X		X
P. leightoni trinasalis Werner	X	X	X	X	X
Xenocalamus bicolor bicolor Günther	X	X		X	
Atractaspis bibronii A. Smith	X		?	X	
Prosymna sundevallii sundevallii (A. Smith)	X	X			X
Prosymna bivittata Werner	X	X		X	
Philothamnus semivariegatus semivariegatus (A. Smith)			?	X	X
Telescopus semiannulatus semiannulatus A. Smith	X		?	X	
T. beetzi (Barbour)	X				X
Dispholidus typus typus (A. Smith)			?	X	X
Dasypeltis scabra (Linnaeus)			?	X	X
Elapidae					
Elapsoidea sundevallii fitzsimonsi Loveridge	X	X	X	X	
Naja nivea (Linnaeus)	X	X	X	X	X
Aspidelaps scutatus scutatus (A. Smith)			X	X	?
Dendroaspis polylepis (Günther)	(X)	(X)		X	X
Viperidae					
Bitis caudalis (A. Smith)	X	X	X	X	X
B. arietans arietans (Merrem)	X	X	X	X	X

Since there are no natural permanent water bodies, the variety of amphibians is relatively limited and largely restricted to such forms which are independent of open water for reproduction, such as *Breviceps adspersus*, or opportunists which can cope with ephemeral pools, such as *Pyxicephalus adspersus*, *Tomopterna cryptotis* and *Cacosternum boettgeri*. The presence of *Bufo garmani* is suspected in the KGNP, but awaits confirmation. The purely aquatic *Xenopus laevis laevis* has been found in the rivers and their pools during and after flooding. It is highly likely that this adaptable pioneer is present in some of the reservoirs or wells that exist along the drainage courses. A specimen from Grootkolk in the Nossob River in the northern KGNP was found dead after it half swallowed a young barbel (*Clarias gariepinus*) which was larger than it could accommodate. Barbels apparently come down the river with the floods from farm dams in Namibia higher upstream, from where the clawed frogs or platannas probably also originated.

The Chelonia are represented by three taxa. The above remarks about the origin of the platanna and the barbel probably also apply to the Cape terrapin *Pelome-*

dusa subrufa, which appears temporarily after floods (G. Mills, *pers. comm.*). As it is more resistant to desiccation than the frogs and fish, it can probably spend longer periods brumating than either of these, while being buried in the ground. The leopard tortoise *Geochelone pardalis* which is widespread over the Ethiopian region (Loveridge & Williams 1957) occurs in low concentrations, while the small Kalahari serrated tortoise *Psammobates oculifer* is relatively common. The latter's range closely coincides with the distribution of Kalahari sand as far north as northern Botswana and probably southern Angola, while it has not been recorded from south of the Orange River (Greig & Burdett 1976).

The Squamata are represented by six families of Lacertilia, one of the Amphisbaenia and six families of Ophidia (Table 2).

Table 2

Number of taxa per family of amphibians and reptiles of the Southern Kalahari Domain and their occurrence in adjacent areas. Brackets indicate sight records

		Southern Kalahari Domain	KGNP	Central Kalahari	Karoo-and/or Namaqualand Domain
Pipidae		1	1		1
Microhilidae		1	1	1	
Ranidae		3	3	2	1
Bufonidae		1	?	1	
	AMPHIBIA	6	5+?	4	2
Testudinidae		2	2	2	1
Pelomedusidae		1	(1)	1	1
	CHELONIA	3	2+(1)	3	2
Amphisbaenidae	AMPHISBAENIA	5	5	5	2
Gekkonidae		9	7	6	6
Chamaeleonidae		1	1	1	
Varanidae		1	(1)	1	1
Agamidae		1	1	1	1
Lacertidae		6	6	4	3
Scincidae		9	7	6	3
	LACERTILIA	27	22+(1)	19	14
Typhlopidae		2	2	2	1
Leptotyphlopidae		1	1	1	1
Boidae		(1)		1	
Colubridae		10	7	8	12
Elapidae		3+(1)	2+(1)	4	1
Viperidae		2	2	2	2
	OPHIDIA	18+(2)	14+(1)	18	17
		50+(2)	41+(2)	42	33
	ALL REPTILIA	53+(2)	43+(3)	45	35

Amongst the lizards the Gekkonidae are represented by nine taxa of which some have not been recorded from the KGNP yet. The extremely common barking gecko *Ptenopus garrulus garrulus* is characteristic of Kalahari sands within the below 500 mm average annual rainfall area, while the other subspecies *P. g. maculatus* occurs west and south of the Kalahari sand (Haacke 1975). *Chondrodactylus angulifer,* the large ground gecko, is a classic example of a south-west arid area representative as its entire range is restricted to the below 300 mm rainfall area (Fig. 3, Haacke 1976b). *Colopus* is another monotypic genus, in this case endemic to Kalahari sand as far north as southern Angola. Within this range, the subspecies *C. wahlbergii furcifer* is endemic to the dune-fields of the Southern Kalahari Domain (Fig. 2, Haacke 1976a). *Pachydactylus punctatus*, which has not been documented from within the KGNP yet, but occurs in a broad band from the Namib to the Mozambique coast, reaches its southern limits in the southern Kalahari. Of the other three listed *Pachydactylus* species, *P. rugosus* is also restricted to the below 300 mm rainfall area (McLachlan 1979), while both *P. bibronii* and *P. capensis* range widely over southern Africa. The diurnal, tropical, arboreal dwarf gecko *Lygodactylus* reaches its southern range limits in the northern Cape Province.

A single specimen of the wide-ranging flap-necked chameleon (*Chamaeleo dilepis*) from Nossob Camp indicates that it reaches its range limits in the southern Kalahari. Of the varanids only *Varanus exanthematicus albigularis* occurs in the area, but has not been documented. It is rare in the KGNP with only a few sightings over the past 20 years (E. le Riche *pers. comm.*) while this species is known to the author from near Leonardville further upstream on the Nossob River.

Two agamids occur, of which the rock-living *Agama atra* marginally enters the region from the south-west, extending onto the large rock outcrops on farm Schanzkolk and vicinity and possibly those at Eierdopkoppies. The terrestrial, partly arboreal, *A. aculeata* is wide-ranging over southern Africa and is common in the Southern Kalahari Domain and the KGNP (McLachlan 1981).

Of the lacertids the genus *Meroles* is typical for the Karoo-Namib Region as of its six species only one extends into the Capensis Region. All others are restricted to the Namib Desert except for *M. suborbitalis* of which the range limits coincide closely with the 300 mm isohyete and it extends as far as the Southern Kalahari Domain but not beyond it (Fig. 4). Although the genus *Eremias (sensu lato)* is better represented, the three recorded species, extend from the Namib into the Transvaal lowveld. Of the tropical savanna genus *Ichnotropis* only one species marginally reaches the KGNP. The wide-ranging genus *Nucras* is represented by *N. t. tessellata*, the only arid area form while *N. intertexta* approaches the 300 mm isohyete from the east apparently without crossing it (Broadley 1972).

The nine recorded taxa of the Scincidae fall into two basic groups, *viz.* largely nocturnal burrowers and diurnal terrestrial to arboreal forms. The great diversity of *Mabuya* taxa is increased by the fact that an intergrade zone between two subspecies of *M. striata* exists in this area (Brain 1959; Broadley 1969, 1977). The western *M. spilogaster* reaches its eastern range limits along the 300 mm isohyete. The range of the terrestrial *M. occidentalis*, as the name implies, also a western arid form, extends beyond the Namib-Karoo Region into the Central Kalahari but does

not exceed the area considered to be the "South West Arid Area" (Keay 1959; Davis 1962; Meester 1965; Rautenbach 1978). The subfossorial, tropical *Lygosoma sundevallii* reaches its southern range limit in the KGNP. Of the two legless burrowing skinks the range of *Typhlosaurus lineatus* coincides with the presence of Kalahari sand as far north as southern Angola and Barotseland in Zambia, while *T. gariepensis* is endemic to the dune-fields of the southern Kalahari (Broadley 1968) (Fig. 1).

In general the Amphisbaenia tend to have a tropical affiliation, illustrated by the fact that of the five taxa recorded from the KGNP, three only marginally reach the park from the north-east (*cf.* Fig. 1) and only two species, *viz. Zygaspis quadrifrons* and *Monopeltis capensis* extend beyond the Southern Kalahari Domain into slightly more western and southern areas of the Karoo-Namib Region (Saiff 1970; Broadley & Gans 1975; Broadley, Gans & Visser 1976).

Amongst the snakes recorded from the area under discussion, two typhlopids are known to occur, *viz.* the poorly known *Typhlops boylei*, which appears to be restricted to the south-western Kalahari and adjacent central Namibia, and *T. schinzi* which occurs mainly in the Karoo-Namib Region with slight overlap into the western and southern Kalahari (Broadley 1983).

So far only a single leptotyphlopid, *Leptotyphlops scutifrons* has been recorded. Ranging widely through northern and eastern southern Africa it is the only member of the family which occurs throughout most of the Kalahari, reaching its south-western range limit in the area of the KGNP (TM specimen from Nossob Camp).

Although known records do not suggest the occurrence of pythons in the southern Kalahari (Broadley 1983), Mr E. le Riche, head ranger of the KGNP, recently saw a specimen killed on a farm just south of Twee Rivieren.

Due to a lack of records, information on the colubrid snake fauna consists to a large extent of assumptions and deductions. While in several cases records from the Southern Kalahari Domain exist, some of these taxa have not yet been confirmed for the KGNP. This includes generally common taxa such as *Lamprophis fuliginosus, Dasypeltis scabra, Lycophidion capense, Telescopus* spp. and *Atractaspis bibronii*. Although indications suggest their presence, an intensive long-term study of sociable weavers in the park never produced evidence of *Dasypeltis* (E. McLain *pers. comm.*). Most of the colubrids listed in Table 1 are wide-ranging, but the following taxa, *i.e. Dipsina multimaculata, Psammophis notostictus* and *Telescopus beetzi* are more or less restricted to the below 300 mm rainfall area (Broadley 1983).

The elapids are poorly represented. Only *Naja nivea* is fairly common, while of the burrowers only *Elapsoidea sundevallii fitzsimonsi* has been recorded from the park while *Aspidelaps s. scutatus* is only known from further east. The marginal presence of *Dendroaspis polylepis*, the black mamba, was recently confirmed when a large specimen was killed at Union's End (E. le Riche *pers. comm.*).

Two species of Viperidae occur. The common *Bitis a. arietans* has a nearly Pan-African distribution, while the smaller *Bitis caudalis* is relatively common over most of the below 500 mm rainfall area outside the winter rainfall zone (Broadley 1983) (Fig. 5).

Discussion and summary

The Southern Kalahari Domain (*sensu* Werger 1978b) with the Kalahari Gemsbok National Park in the northern Cape Province of the Republic of South Africa as its popular and scientific focal centre, forms an interesting transition area within a rainfall gradient between the arid south-western Karoo-Namib Region and the moister Central Kalahari area of the Sudano-Zambezian Region. The extent of this area is roughly defined by the sands of the southern part of the Kalahari Basin (Du Toit 1954) which extend into the below 300 mm rainfall area (Figs 1 to 5). The southern Kalahari dune-belt (Leistner *op cit.*) covers the greater part of this area and botanically it is considered to be "open *Acacia* Savannah" (Werger & Coetzee 1978).

The basic habitat types determining reptile distributions are thus a sandy substrate which may be compacted and flat or loose and undulating dunes, with or without trees, shrubs and grass in the presence of a rainfall gradient. The rock outcrops along the south-western edge are not considered in this study nor are the associated rupicolous species. Table 2 is a summary of Table 1 and allows the following deductions in association with their known ranges. Of the anuran amphibians, *Xenopus* and probably *Bufo garmani* only manage to enter the area downstream along the main river courses, *Cacosternum* is found on hard ground and the river valleys, avoiding Kalahari sand, while the remaining taxa have wide-ranging north-eastern distributions which reach their south-western range limits in the southern Kalahari (Poynton 1964).

Table 3

Affinities of reptile taxa recorded from the Southern Kalahari Domain with adjacent areas. Brackets indicate sight records

	Southern Kalahari Domain	Karoo-Namib	Widespread	Central Kalahari Sud.-Zambe. Reg.	Endemic
Testudinidae	2		1	1	
Pelomedusidae	1		1		
Gekkonidae	9	2	4	2	1
Chamaeleonidae	1			1	
Varanidae	1		1		
Agamidae	1		1		
Lacertidae	6	3		3	
Scincidae	9	2	2	4	1
Amphisbaenidae	5		2	3	
Typhlopidae	2	1		1	
Leptotyphlopidae	1		1		
Boidae	(1)			1	
Colubridae	10	2	4	4	
Elapidae	3+(1)	1		3	
Viperidae	2		2		
	53+(2)	11	19	23	2

The reptiles recorded for the southern Kalahari can be roughly grouped into four distribution groups (Table 3) according to their geographical affinities. a) Wide ranging, *i.e.* extending across the Southern Kalahari Domain into the Central Kalahari part of the Sudano-Zambezian Region and Karoo and/or Namaqualand Domain of the Karoo-Namib Region. b) Western arid, *i.e.* the entire range lies within the Karoo-Namib Region and the eastern limits do not exceed or closely coincide with the 300 mm isohyete. c) Eastern, *i.e.* the main distribution lies in the Sudano-Zambezian Region, but extends through the central Kalahari to beyond the 300 mm isohyete thereby entering the Southern Kalahari Domain. d) Endemic. Of the two taxa listed, *Typhlosaurus gariepensis* is the only species qualifying (Fig. 1), as *Colopus wahlbergii furcifer* is only a subspecies restricted to the dune-belt, while the rest of the range of this monotypic genus is restricted to Kalahari sand as far north as southern Angola (Fig. 2). *Mabuya striata sparsa*, an arboreal skink, nearly qualifies, but its range extends into the Namaqualand Domain of southern Namibia and the adjacent Cape.

In addition to the ranges of reptiles and amphibians recorded from the area under discussion, the ranges of taxa which actually or apparently avoid this area, must also be considered (Fig. 4). For example, the common egg-eater *Dasypeltis scabra* (Broadley 1983: 264 map 64) and the cape skink *Mabuya capensis* (TM records) although wide ranging, appear to avoid the main area of the Southern Kalahari Domain, while others such as *Pachydactylus bibronii* appears to be absent from large areas extending from the northern KGNP into the central Kalahari and *Lamprophis fuliginosus*, the common brown house snake is unrecorded from most of the south-western Kalahari and the adjacent Namaqualand Domain.

The causes determining range limits are not always clear but in many cases range limits strongly suggest a correlation with certain ecological factors, such as rainfall regimes, substrate types or combinations of factors. Some of the wide-ranging forms do not provide a clear picture which might suggest ecological causes that limit their range. Good examples of habitat or substrate determined ranges are those of *Typhlosaurus gariepensis* (Fig. 1) and *Colopus wahlbergii furcifer* which are restricted to the dune-belt while typical *Colopus w. wahlbergii* is associated with Kalahari sand as far as southern Angola (Fig. 2). In contrast to this situation the terrestrial gecko *Pachydactylus mariequensis*, which is morphologically very similar to *Colopus*, prefers harder soil types, avoids Kalahari sand and therefore the Southern Kalahari Domain (Fig. 2). For similar reasons all rupicolous species are excluded from this area.

In several cases rainfall appears to determine range limits, as in the case of the diurnal lacertid *Meroles suborbitalis* (Fig. 4) and the nocturnal, terrestrial gecko *Chondrodactylus* (Fig. 3). Both are wide ranging within the Karoo-Namib Region on a variety of substrate types. They are common in the southern Kalahari indicating that the substrate and vegetation density is agreeable. However, existing records show that their ranges terminate abruptly along a line closely coinciding with the 300 mm isohyete, suggesting that the higher rainfall regime is avoided. No ecological equivalents which might fill their vacated niche, thereby preventing their eastward expansion, are known from the central Kalahari. Some snakes such as

Dipsina multimaculata and *Psammophis notostictus* have a very similar distribution pattern. Other western arid area species extend right across the southern Kalahari as their range limits show a strong association with the 500 mm isohyete (Fig. 5). As these range limits are nowhere near the area under discussion, they are here considered to be wide ranging. As much as western arid area taxa show rainfall correlated range limits, several eastern taxa have range limits extending across the Kalahari, which suggest a correlation with diminishing rainfall, as for example *Psammophis jallae* (Broadley 1983; and Fig. 4) and *Dalophia pistillum* (Fig. 1) (Broadley, Gans & Visser 1976).

Table 3 provides a summary of the 55 reptile taxa within their families as recorded from the Southern Kalahari Domain and their affinity to adjacent areas. Of these, two are considered to be endemic and 17 are wide ranging to an extent that their possible basic affinity loses its significance in this analysis. The remaining 36 taxa have their main range elsewhere, but marginally extend into the Southern Kalahari Domain from various directions in such a way that their ranges overlap to a greater or lesser extent or occasionally create parapatric zones. Of these 11 are of western origin and 25 have their main range to the north-east, suggesting that the affinities of the herpetofauna of the Southern Kalahari Domain are biased towards the more mesic Sudano-Zambezian Region although there are obvious and strong links with the arid south-west Karoo-Namib Region.

Acknowledgements

I am indebted to Dr G. de Graaff and the National Parks Board of Trustees for permission to collect in the Kalahari Gemsbok National Park and to Mr E. A. N. le Riche, Dr M. G. L. Mills and Mr J. Clarke for providing specimens and information. Miss L. Wessels assisted in the production of the maps.

REFERENCES

BRAIN, C. K. 1969. Field observations on lizards (Scincidae: *Mabuya*) in the Kalahari Gemsbok National Park. *Koedoe* 12: 1-10.

BROADLEY, D. G. 1966. A review of the *Riopa sundevalli* group (Sauria: Scincidae) in southern Africa. *Arnoldia* (Rhodesia) 2(6): 1-7.

BROADLEY, D. G. 1967. An expedition to the south-western Kalahari, January-March 1967. *J. Herpetol. Assoc. Afr.* 2: 19-30.

BROADLEY, D. G. 1968. A revision of the African genus *Typhlosaurus* Wiegmann (Sauria: Scincidae). *Arnoldia* (Rhodesia) 3(36): 1-20.

BROADLEY, D. G. 1969. Two sympatric species of the *Mabuya striata* complex (Sauria: Scincidae). *Koedoe* 12: 11-14.

BROADLEY, D. G. 1972. A review of the *Nucras tessellata* group (Sauria: Lacertidae). *Arnoldia* (Rhodesia) 5(20): 1-36.

BROADLEY, D. G. 1975. A review of the *Mabuya lacertiformis* complex in southern Africa (Sauria: Scincidae). *Arnoldia* (Rhodesia) 7(18): 1-16.

BROADLEY, D. G. 1977. A review of the *Mabuya striata* complex in South East Africa (Sauria: Scincidae). *Occ. Pap. natn. Mus. Rhod. Ser. B.* 6(4): 130-185.

BROADLEY, D. G. 1983. *FitzSimons' Snakes of Southern Africa.* Johannesburg: Delta Books.

BROADLEY, D. G. and C. GANS. 1975. Additional records for *Zygaspis niger* and *Z. quadrifrons. Herp. Review* 6(1): 21.

BROADLEY, D. G., C. GANS and J. D. VISSER. 1975. Studies on Amphisbaenians (Amphisbaenia, Reptilia). 6. The genera *Monopeltis* and *Dalophia* in southern Africa. *Bull. Am. Mus. nat. Hist.* 157(5): 313-485.

BRUTON, M. N. and W. D. HAACKE. 1980. The reptiles of Maputaland. *In:* BRUTON, M. N. and K. H. COOPER (Eds) *Studies on the Ecology of Maputaland.* Rhodes University, Wildlife Society.

DAVIS, D. H. S. 1962. Distribution patterns of southern African Muridae, with notes on some of their fossil antecedents. *Ann. Cape Prov. Mus.* 2: 56-76.

DU TOIT, A. E. 1954. *The Geology of South Africa.* London: Oliver and Boyd.

FITZSIMONS, V. F. M. 1938. Transvaal Museum Expedition to South West Africa and Little Namaqualand – May to August 1937. Reptiles and Amphibians. *Ann. Transv. Mus.* 19(2): 153-209.

FITZSIMONS, V. F. M. 1943. The lizards of South Africa. *Transv. Mus. Mem.* No. 1.

FITZSIMONS, V. F. M. 1962. *The snakes of southern Africa.* Cape Town: Purnell and Sons.

FITZSIMONS, V. F. M. and C. K. BRAIN. 1958. A short account of the reptiles of the Kalahari Gemsbok National Park. *Koedoe* 1: 99-104.

GREIG, J. C. and B. D. BURDETT. 1976. Patterns in the distribution of southern African terrestrial tortoises (Cryptodira: Testudinidae). *Zool. afr.* 11(2): 249-273.

HAACKE, W. D. 1975. The burrowing geckos of southern Africa. (Reptilia: Gekkonidae) 1. Introduction. *Ptenopus. Ann. Transv. Mus.* 30(2): 13-28.

HAACKE, W. D. 1976a. The burrowing geckos of southern Africa (Reptilia: Gekkonidae) 3. *Colopus. Ann. Transv. Mus.* 30(3): 29-39.

HAACKE, W. D. 1976b. The burrowing geckos of southern Africa (Reptilia: Gekkonidae) 4. *Chondrodactylus. Ann. Transv. Mus.* 30(5): 52-70.

HEWITT, J. 1909. The zoological region of southern Africa as deduced from the composition of its Lacertilia. *Ann. Transv. Mus.* 2(2): 56-71.

HEWITT, J. 1914. Notes on the distribution and character of reptiles and amphibians in South Africa, considered in relation to the problem of discontinuity between closely allied species. *S. Afr. J. Sci.* 10(9): 238-253.

HUEY, R. B. 1982. Phylogenetic and ontogenetic determinants of sprint performance in some diurnal Kalahari lizards. *Koedoe* 25: 43-48.

KEAY, R. W. J. 1959. Vegetation map of Africa south of the Tropic of Cancer. L'Association pour l'Etude Taxonomique de la Flore d'Afrique Tropicale. Oxford Univ. Press.

LOVERIDGE, A. and E. E. WILLIAMS. 1957. Revision of the African tortoises and turtles of the suborder Cryptodira. *Bull. Mus. comp. Zool.* 115(6): 163-557.

LEISTNER, O. A. 1967. The plant ecology of the southern Kalahari. *Mem. bot. Surv. S. Afr.* 38: 1-172.

MEESTER, J. 1965. The origins of the southern African mammal fauna. *Zool. afr.* 1: 87-95.

McLACHLAN, G. R. 1979. The taxonomy of *Pachydactylus rugosus*. *J. Herpetol. Assoc. Africa.* 21: 4-8.

McLACHLAN, G. R. 1981. Taxonomy of *Agama hispida* (Sauria: Agamidae) in southern Africa. *Cimbebasia* A 5(6): 219-227.

POWER, J. H. 1933. Herpetological notes and records. 1. *Trans. roy. Soc. S. Afr.* 21(3): 211-220.

POYNTON, J. C. 1964. The Amphibia of southern Africa. *Ann. Natal Mus.* 17: 1-134.

PIANKA, E. R. 1971. Lizard species density in the Kalahari desert. *Ecology* 52(6): 1024-1029.

RAUTENBACH, I. L. 1978. A numerical re-appraisal of the southern African biotic zones. *Bull. Carnegie Mus. nat. Hist.* 6: 175-187.

SAIFF, E. I. 1970. Geographical variation in the genus *Zygaspis* (Amphisbaenia: Reptilia). *Herpetologica* 26(1): 86-119.

SCHULZE, R. E. and O. S. McGEE. 1978. 2. Climatic indices and classification in relation to the biogeography of southern Africa. *In:* WERGER, M. J. A. (Ed.) *Biogeography and ecology of southern Africa* 1: 19-52. The Hague: Junk.

WERGER, M. J. A. 1978a. 7. Biogeographical divisions in southern Africa. *In:* WERGER, M. J. A. (Ed.) *Biogeography and ecology of southern Africa.* 1: 145-170. The Hague: Junk.

WERGER, M. J. A. 1978b. 9. The Karoo-Namib Rigion. *In:* WERGER, M. J. A. (Ed.) *Biogeography and ecology of southern Africa* 1: 231-299. The Hague: Junk.

WERGER, M. J. A. and B. J. COETZEE. 1978. 10. The Sudano-Zambezian Region. *In:* WERGER. M. J. A. (Ed.) *Biogeography and ecology of southern Africa* 1: 301-462. The Hague: Junk.