THE HERPETOFAUNA OF THE ORANGE FREE STATE - WITH SPECIAL EMPHASIS ON BIOGEOGRAPHICAL PATTERNING

by

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PREFACE

The field work described in this thesis was carried out in the Orange Free State province of South Africa during the period January 1983 to December 1992. The examination of specimens and biogeographical analysis was conducted primarily at the National Museum, Bloemfontein during the period October 1991 to December 1992, under the supervision of Professor J.C. Poynton.

These studies represent original work by the author and have not been submitted in any form to another University. Where use was made of the work of others it has been duly acknowledged in the text.

DEDICATION

To

My Mother, Father and late Grandmother

To whom I owe so much.

ACKNOWLEDGEMENTS

I would like to express my gratitude to the following individuals and institutes for their assistance and/or encouragement during the period of study:

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Finally, I thank my wife Andrea and daughter Jessica for tolerating my time-consuming activities while finalizing this thesis.

ABSTRACT

The taxonomic status, distribution and ecology of the herpetofauna of the Orange Free State are discussed, based on the examination of 10 096 specimens housed in various southern African museums. The majority of specimens were collected during the years 1972 - 1978 and 1983 - 1992, and are housed at the National Museum, Bloemfontein. A total of 25 amphibian and 95 reptilian (one translocated species) forms have been determined as occurring in the Orange Free State, 12 (three amphibians, nine reptiles) of which are new (or recently published) records for the province. An additional 10 amphibian and 28 reptilian forms have been determined as occurring nearby but extralimitally to the O.F.S., and several of these forms are expected to occur in the province. New distributional records have resulted in the amendment of the ranges of several species. Detailed taxonomic data on new material, including rare species, have been given. Some problem areas in the taxonomy of O.F.S. taxa have been higlighted.

An analysis of habit utilization indicated that 84,0% of amphibians and 61,1% of reptiles are terricolous, whereas up to 21,5% of reptiles are rupicolous. The majority of snakes (72,2%) are terrestrial in habits, but 13,9% are fossorial. More than half of all lizards (52,8%) are terrestrial, although 34,6% are rupicolous. A total of six amphibian and 27 reptile forms utilize inactive termitaria as a microhabitat, including several basically terrestrial forms. Snake forms were particularly well represented in termitaria, 60,6% of all forms known from the O.F.S. having been recorded from inactive termitaria. General features of the ecology of O.F.S. amphibians and reptiles have also been discussed.

The biogeographical analysis indicated that O.F.S. amphibian forms can be classified into one of nine range clusters (common patterns of distribution), and reptiles into 13 such cluster groups. By testing these classifications by means of a transect through the northern O.F.S. (from eastern to western borders), it was determined that a fairly distinct east-west subtraction of amphibian and reptilian species and subspecies occurs in the O.F.S. Clustering of range boundaries and high species and subspecies diversity at the western and eastern ends of the transect zone suggest dynamic biogeographical situations occurring in those areas - the western group being associated with the transition from grassland to bushveld, and the eastern group associated with the transition from Highveld Grassland to Drakensberg Mountains. The general eastern and western groupings of taxa appear to be associated with the cooler, wetter and mountainous east vs the warmer, drier and lower-lying west, respectively.

Despite a great deal of collecting having been conducted in the O.F.S. from 1972 to 1992, an analysis of the number of taxa collected in each quarter-degree unit in the O.F.S. indicated that additional collecting would be required in order to conduct effectively a mathematically-based biogeographical analysis.

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CHAPTER ONE

INTRODUCTION

Until fairly recently, the most important sources of taxonomic and distributional data on southern African amphibians and reptiles were the works of Poynton (1964, amphibians), FitzSimons (1943, lizards and amphisbaenians) and FitzSimons (1962, snakes). FitzSimons' (1962) book on the snakes of southern Africa was later revised and updated by Broadley (1983, 1990). Field guides to the amphibians (Passmore & Carruthers, 1979), reptiles (Branch, 1988a) and chelonians (Boycott & Bourquin, 1988) were recently published and all of these include generalized distribution maps. During the last 10-15 years or so, a number of important herpetofaunal surveys have been conducted in South Africa, and have added enormously to our knowledge of distribution patterns.

Important surveys of large areas include those for the Kruger National Park, for which the checklists have been updated (amphibians - Pienaar, Passmore & Carruthers, 1976; reptiles - Pienaar, Haacke & Jacobsen, 1983), Cape Province and other parts of South Africa (chelonians - Greig & Burdett, 1976), Orange Free State (squamates - De Waal, 1978; amphibians - De Waal, 1980a; chelonians - De Waal, 1980b), Transvaal (amphibians and reptiles - Jacobsen, 1989) and Natal (amphibians - Lambiris, 1989a). A number of other smaller surveys have also been conducted, including those for Natal Parks Board reserves (see Bourquin, 1989) and Cape Province nature reserves and other areas (see Branch, 1990a).

Currently, the most poorly surveyed area in South Africa is the central and northern Cape Province. However, Branch (1990a) recently provided a number of new records for the central and eastern Cape in particular, and Bauer & Branch (in prep.) are currently surveying the herpetofauna of the Little Karoo. In addition, a herpetological database for the Cape Province is currently being prepared by Baard (1991), and will include all known distribution records for the province.

Until recently, little was known about the herpetofauna of Swaziland. However, a survey of the country's amphibians and reptiles is currently being conducted (see Boycott & Culverwell, 1992).

Another country which has a poorly-known herpetofauna is the mountainous Kingdom of Lesotho. Very few distribution records for this area have appeared in the literature. While the herpetofauna of the Natal Drakensberg is fairly well known (Bourquin & Channing, 1980; Lambiris, 1989a), and is likely to approximate that of western Lesotho, very few specimens have been recorded from Lesotho, especially from the central parts of the country. However, the Department of Mammalogy at the National Museum is currently conducting a survey of the mammals of Lesotho, and has collected occasional frogs, lizards and snakes from various localities (Bates, 1991a). Records have also been

obtained from other museums, and a provisional and annotated checklist of the herpetofauna of Lesotho is currently being prepared (Bates, Lambiris & Haacke, in prep.).

Since the time of V.F.M. FitzSimons, numerous systematic revisions of various southern African reptile taxa have been published, mostly by Broadley (see references in Jacobsen, 1989, p. 1). Far fewer amphibian revisions have been conducted since Poynton's (1964) monumental paper on the amphibians of southern Africa, but these include a revision of southern African *Pyxicephalus adspersus* by Parry (1978) and Lambiris' (1989a) revision of the amphibians of Natal.

The first published records on the occurrence of amphibians in the Orange Free State (O.F.S.) are those of Hewitt & Power (1913), who recorded *Rana fuscigula* (Benauwdheid's Font., Jacobsdal = Benaauwdheidsfontein farm) and *Rana adspersa* (= *Pyxicephalus a. adspersus*) (Moseley, Fauresmith). Hewitt & Power (1913) also recorded a number of species from the Kimberley area on the Cape Province/O.F.S. border.

In the introduction to a paper entitled "A new frog from Thaba 'Nchu", Hoffman (1939) stated the following: "It is a deplorable fact that the Reptilian and Batrachian fauna of the Orange Free State has been largely neglected, and that very little is known as regards occurrence and distribution, not to mention life habits of these animals. Up to about four years ago [1935] the National Museum did very little towards the investigation of the living fauna of the Free State, owing to the lack of a Zoologist on its staff. During the last few months, however, every attempt has been made to enlarge the collections of reptiles and amphibians housed in this institution. Several collecting trips have been undertaken during November and December of 1938, and during the first month of this year [1939], special attention having been paid to the district of Thaba 'Nchu [eastern O.F.S.], where investigations are being made of the differences between the fauna on the flats and those on the mountain tops."

Dr A.C. Hoffman was responsible for what appears to be the first attempts at surveying the amphibian fauna of the O.F.S., as indicated by entries in the National Museum's amphibian catalogue. Several frogs were collected, mostly by Hoffman, in the late 1930's and early 1940's. However, apart from *Semnodactylus thabanchuensis* Hoffman, 1939 (later placed in the genus *Kassina* by Hoffman, 1942) collected on Thaba 'Nchu Mountain in the eastern O.F.S. and *Kassina senegalensis senegalensis* (Duméril & Bibron, 1841) (Hoffman, 1942), Hoffman did not publish any additional information on the distribution of O.F.S. frogs. In his *Investigations on the anatomical characters of the genus* Kassina, *together with descriptions of the different species and of two new subspecies*, Hoffman (1942) represented the distribution of the genus *Kassina* rather crudely on a map of southern Africa. Nevertheless, despite no precise localities being given in the text, it was evident that *Kassina senegalensis* had been collected in the northern and central parts of the O.F.S.

In his monumental work *The Amphibia of Southern Africa: a faunal study*, Poynton (1964) conducted a fundamental and comprehensive revision of all amphibian forms occurring in southern Africa. He examined specimens from all southern African collections as well as nearly all European collections, as well as collecting additional material. In total, 14 500 specimens were examined. Poynton (1964) based his revision on a personal inspection of the animals rather than on a "literature survey". He also noted: "As nearly all the specimens which have been listed in previous papers have been re-examined, it would be superfluous to list the localities more than once; and in any case, records in the literature are frequently based on misidentifications, and it seems pointless to burden this revision with a mass of detailed corrections". Poynton (1964) examined O.F.S. material housed in the National Museum collection and other collections, and recorded 17 forms as occurring in the province. Poynton's (1964) paper was the first significant reference on the status and distribution of O.F.S. frogs, and, importantly, involved an examination of all O.F.S. material available in collections at that time. De Waal (1980a) cited only Poynton (1964) when referring to literature records.

The most comprehensive study dealing with the status and distribution of O.F.S. amphibians was conducted by De Waal (1980a). While surveying the squamate reptiles of the O.F.S., De Waal and his team also collected amphibians. The squamate survey was conducted during the years 1972 to 1974 and the results published in 1978 (De Waal, 1978). However, additional amphibian collecting continued up until 1978. According to Dr C.D. Lynch (Deputy Director at the National Museum) (pers. comm.), De Waal's team did not attempt an intensive programme of amphibian collecting, and obtained most specimens incidentally while looking for reptiles. Despite this, De Waal's (1980a) paper is invaluable in that it adds numerous new distribution records, including five new frog records for the province, and included specimens from localities never before surveyed. Regarding the distribution of amphibian collections, a comparison between Poynton (1964) (Fig. 1) and De Waal (1980a) (Fig. 2; star symbols represent new records) provides an indication as to the significance of De Waal's (1980a) survey.

Recent papers including references on the distribution of O.F.S. frogs include Parry's (1982) revision of the genus *Pyxicephalus* in southern Africa, in which two O.F.S. localities for *P. a. adspersus* are given (Allanridge; Sasolburg), Bates (1988a, 1991b, 1992a) and Bates & Douglas (1991). References on the distribution and status of frogs from the periphery of the O.F.S., and the Kimberley area of the northern Cape Province in particular, include Poynton (1964), Branch (1990a) and Bates (1991c).

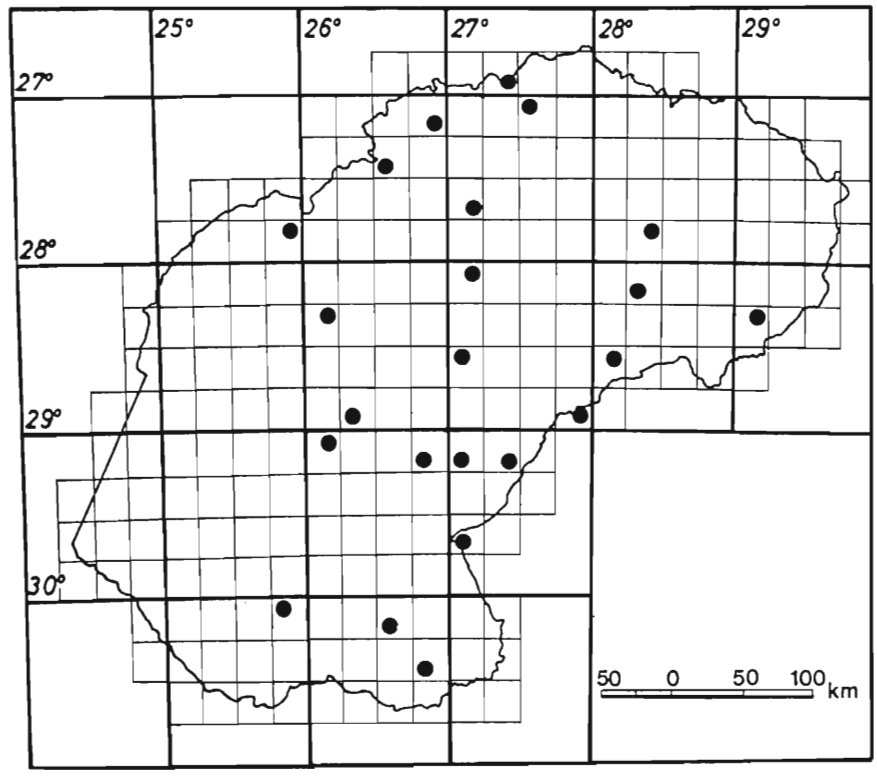


Figure 1: Distribution of amphibian collections (localities sampled) in the Orange Free State, based on Poynton (1964). Each symbol on the map represents the collection of one or more specimens from one or more localities within the eighth-degree unit.

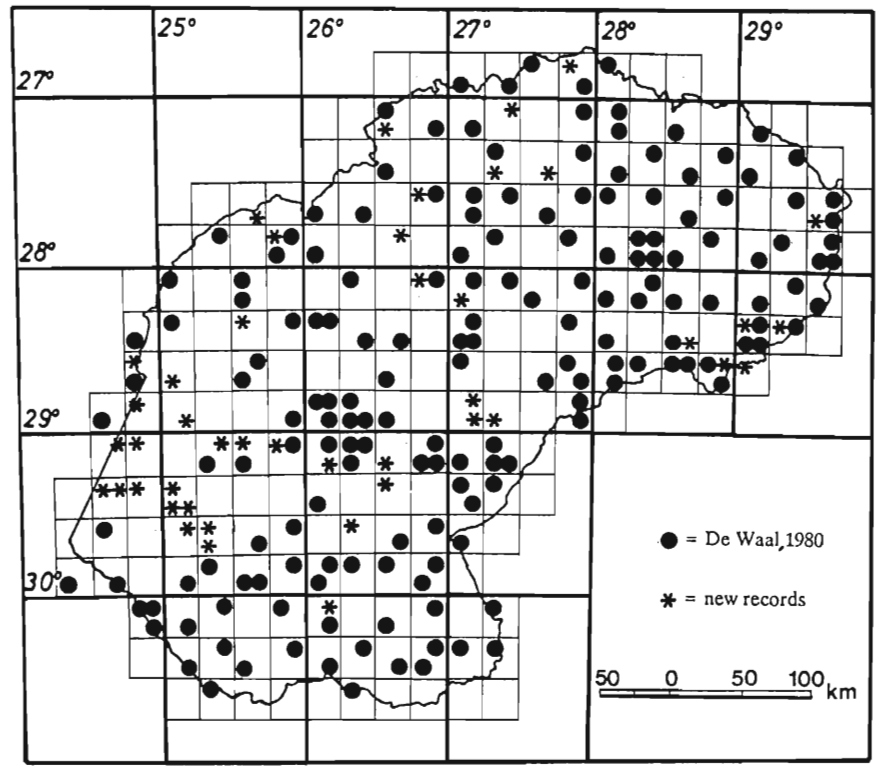


Figure 2: Distribution of amphibian collections (localties sampled) in the Orange Free State, including all known records to date. Each symbol on the map represents the collection of one or more specimens from one or more localities within the eighth-degree unit. Solid circles represent published records, whereas star symbols represent new records - i.e. those not published by De Waal (1980a).

The first contribution to our knowledge of Orange Free State squamates was Boettger's (1883) documentation of four snake and three lizard species from Smithfield (southern O.F.S.). Symonds (1887) later recorded a few snake species from Kroonstad (northern O.F.S.). Following that, and up to 1940, O.F.S. squamates were mentioned in 13 publications, Boulenger's (1910) work being of notable importance (De Waal, 1978). Gough (1908) listed a number of snake species housed at the State Museum, Bloemfontein (now National Museum), but with the exception of a *Homorelaps* (= *Homoroselaps*) *lacteus* record for Bloemfontein, the rest were given the locality "O.R.C." (presumably "Orange River Colony" = Orange Free State), "No record (O.R.C.)" or "No history, O.R.C.". In 1911, Sternfeld described a new gecko species, *Pachydactylus leopardinus*, from Bethanien in the O.F.S., but this form was regarded as a juvenile *P. capensis* by Hewitt & Power (1913) and included in the synonomy of *P. c. capensis* by De Waal (1978). Hewitt & Power (1913) listed several reptiles from the O.F.S., but the Kimberley area in particular, based on specimens in the MacGregor Museum collection. Noteworthy during this period was Hoffman's (1940) description of a new subspecies of *Xenocalamus* (i.e. *X. bicolor concavo-rostralis*) from Kelly's View near Bloemfontein. Although the single type specimen was later shown to be merely an aberrant *X. b. bicolor* (Broadley 1971a; Bates, 1991d), it was and still is the only snake type specimen from the O.F.S. From 1941 to 1977, ten papers contained references to O.F.S. localities, most of which were revisionary studies (De Waal, 1978). The most important contributions were those of FitzSimons (1943) for lizards, and FitzSimons (1962) for snakes.

De Waal's (1978) paper, based on his Ph.D. thesis with the same title (De Waal, 1977), is by far the most important work on O.F.S. squamates, and the intensity and comprehensiveness of his survey is truly commendable. Figure 3 illustrates the distribution of squamate collections (or localities sampled) in the O.F.S. With the exception of a few literature records, all solid circles represent localities at which De Waal (1978) collected material. Records after De Waal (1978), i.e. "new records", are represented by star symbols.

The first reference to a chelonian from the O.F.S. is found in Hewitt's (1935) description of *Pelomedusa galeata orangensis*. Specimens were recorded from Emmaus and Thaba 'Nchu. Loveridge & Williams (1957) later recorded *Psammobates oculifer* from Bothaville and *Homopus femoralis* from Bloemfontein. In a study on distribution patterns of southern African terrestrial tortoises, Greig & Burdett (1976) assessed literature records, examined specimens at museums and conducted a survey of the Cape tortoises. They plotted the occurrence of the various forms in southern Africa using the quarter-degree grid and locus code method, but did not provide a listing of precise localities. Unfortunately it is therefore often impossible to determine into which province certain plotted localities fall - i.e. in the Cape Province or Orange Free State. Nevertheless, in addition to Loveridge & William's (1957) records, they do add at least one, and possibly two or three, additional localities for *Homopus femoralis* in the O.F.S.

By far the most important work on O.F.S. chelonians is that of De Waal (1980b). As was the case with the amphibian collecting (1972 to 1978), De Waal apparently collected tortoises incidentally. However, numerous new records were published, including the first records of *Geochelone pardalis*, a species which, according to De Waal (1980b), was commonly known to occur in the western O.F.S. De Waal (1980b) noted that only four literature records for O.F.S. chelonians existed at that time.

Since De Waal's (1978) paper, O.F.S. snakes have been referred to in two taxonomic revisions by Broadley (1980, 1991) and in his update of *FitzSimons' Snakes of Southern Africa* (1983, 1990), and O.F.S. agamids were studied by McLachlan (1981). New reptilian distribution records were also published by Bates (1988a, 1991b), whereas a number of popular articles also refer to O.F.S. specimens (e.g. Bates, 1988f, 1989c, 1992b).

Since January 1983, a number of additional amphibians and reptiles have been collected in the O.F.S., most of which are housed at the National Museum, Bloemfontein. Virtually all O.F.S. material examined by De Waal (1978, 1980a,b), as well as new material collected, and material in other museums not examined by De Waal (1978), has been examined in order to determine or confirm the identification of specimens. This was followed by the plotting of localities onto maps for each species or subspecies. The correct identification of specimens and the accurate representation of their occurrence on maps are prerequisites for a biogeographical analysis, as conducted in chapter 6. Problems in the taxonomy of various species are discussed in the species accounts.

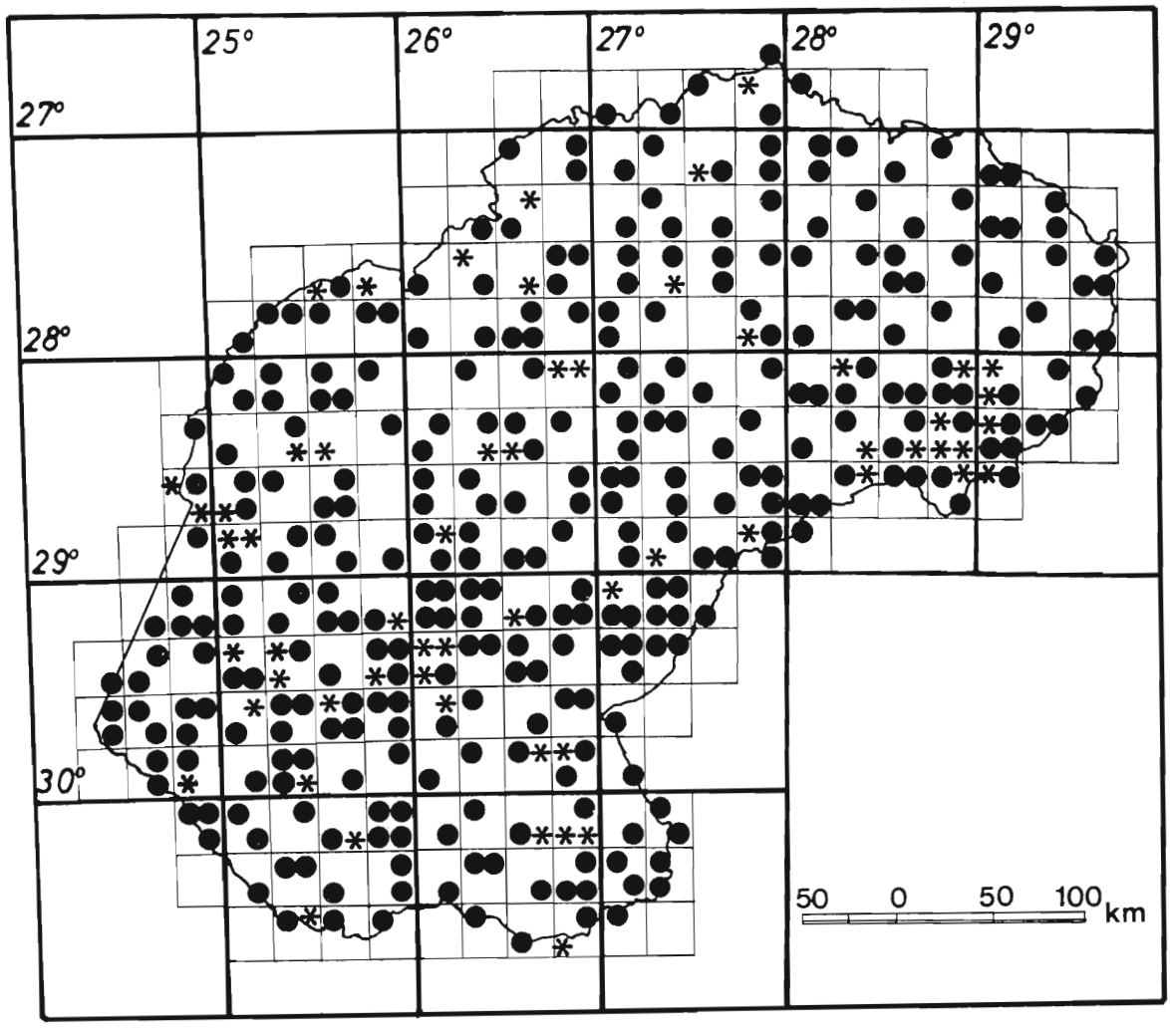


Figure 3: Distribution of reptile collections (localities sampled) in the Orange Free State, including all known records to date. Each symbol on the map represents the collection of one or more specimens from one or more localities within the eighth-degree unit. Solid circles represent published records, whereas star symbols represent new records - i.e. those not published by De Waal (1978; 1980b).

CHAPTER TWO

DESCRIPTION OF STUDY AREA

2.1 Location and size

The Orange Free State province of South Africa comprises an area of 129 152 km^2 (less than 10% of the area of the Republic of South Africa) and is situated between approximately 26°30' and 30°45'S latitude and 24°15' and 29°45'E longitude (Lynch, 1983). With the exception of the south-western border, the study area is delimited by the following natural boundaries: the Vaal River in the north and north-west, the Caledon River in the east, the Drakensberg mountains in the north-east and the Orange River in the south. The main towns are shown in Fig. 4 and administrative districts are shown in Fig. 5.

2.2 Topography

The topographic relief of the O.F.S. is indicated in Fig. 6. Most of the province is typical Highveld, both in topography and vegetation, and lies within altitudes of 1200 to 1500 m a.s.l. The western part of the province is relatively flat in comparison with the primarily mountainous east. The highest point in the province is at Sentinel (3165 m a.s.l.) in the Drakensberg mountains of the north-east, whereas the lowest elevation is 900 m a.s.l. in the Karoo of the south-west.

2.3 Drainage

The major drainage systems are the Vaal and Orange Rivers, whose confluence is in the south-western O.F.S., and which subsume all drainages in the province. All major rivers in the O.F.S., with the exception of the Vaal River, originate in the high eastern parts of the O.F.S. or Lesotho, and flow either north, west or south-west. The most dense drainage systems occur in the moist eastern areas and decrease drastically in the drier west (Fig. 7). Most rivers and streams are ephemeral, flowing only during the rainy season in summer. Most streams do, however, retain some "strips" of water, in the form of pools, throughout the year. Rivers and streams usually support a dense stand of riverine bush and shrubs, usually with correspondingly dense lower storey (Earlé & Grobler, 1987). Typical vlei (marsh) areas occur in the Vrede - Memel - Harrismith region of the eastern O.F.S. The four largest dams in the province are the Vaal, Hendrik Verwoerd, Bloemhof and Sterkfontein dams.

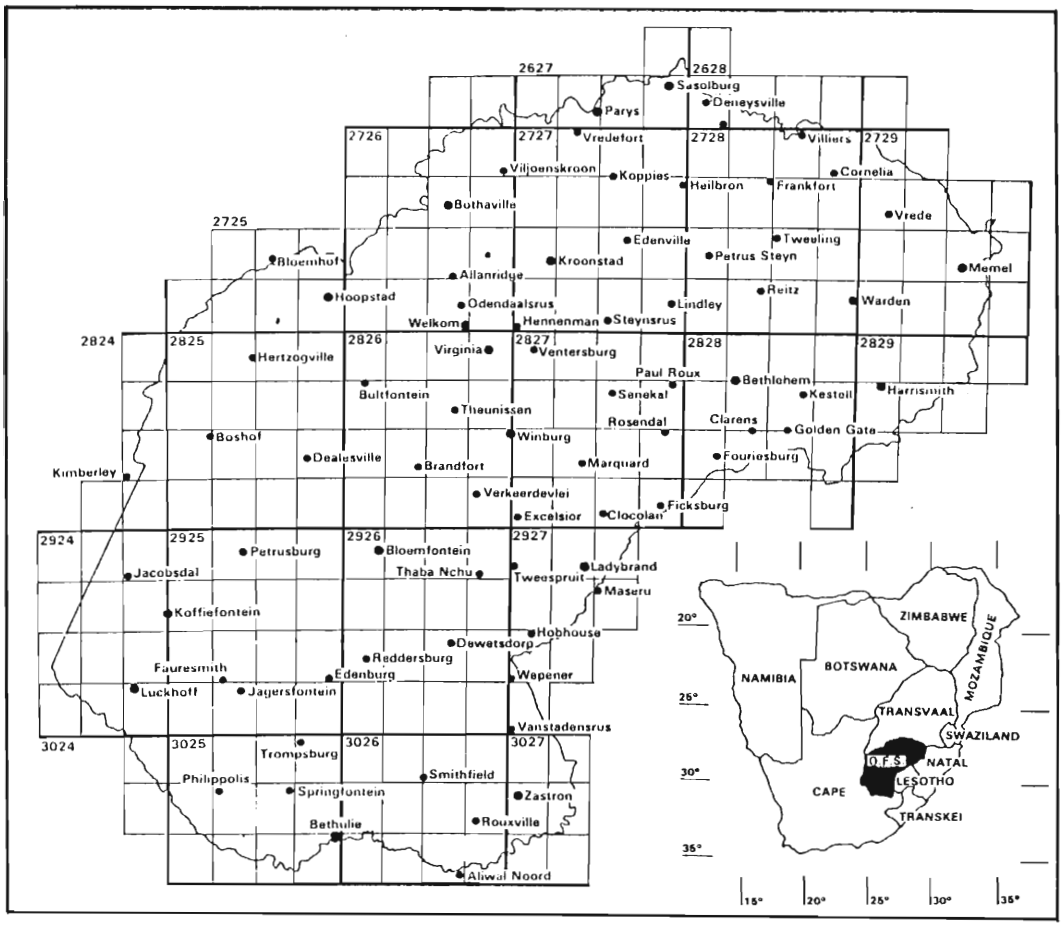


Figure 4: The main towns and cities of the Orange Free State (after Lynch, 1983).

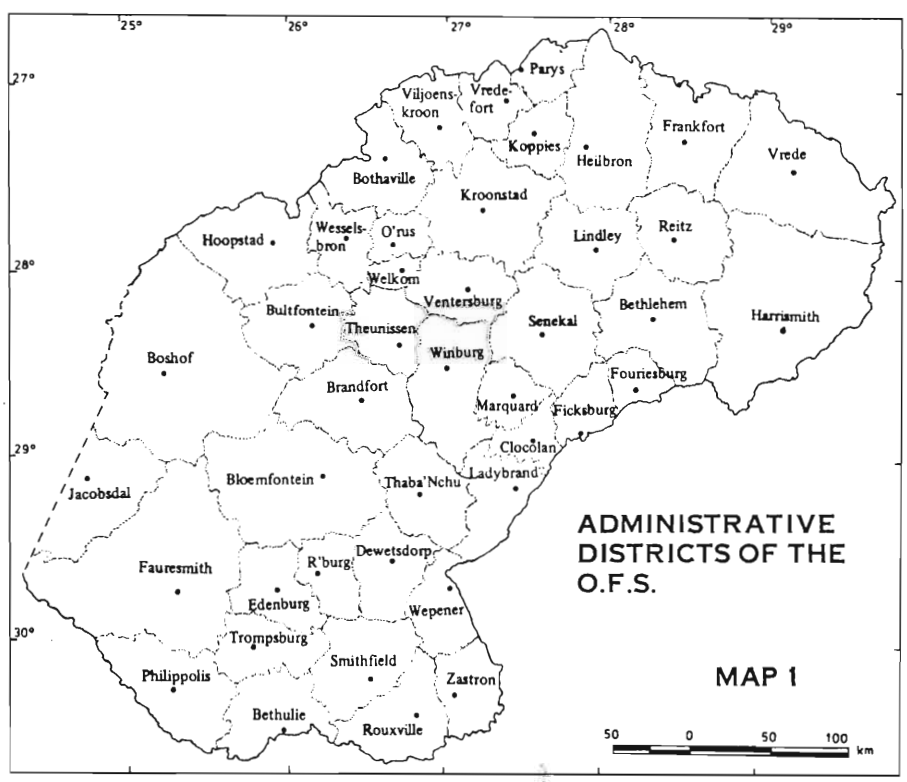


Figure 5: The administrative districts of the Orange Free State (after De Waal, 1978).

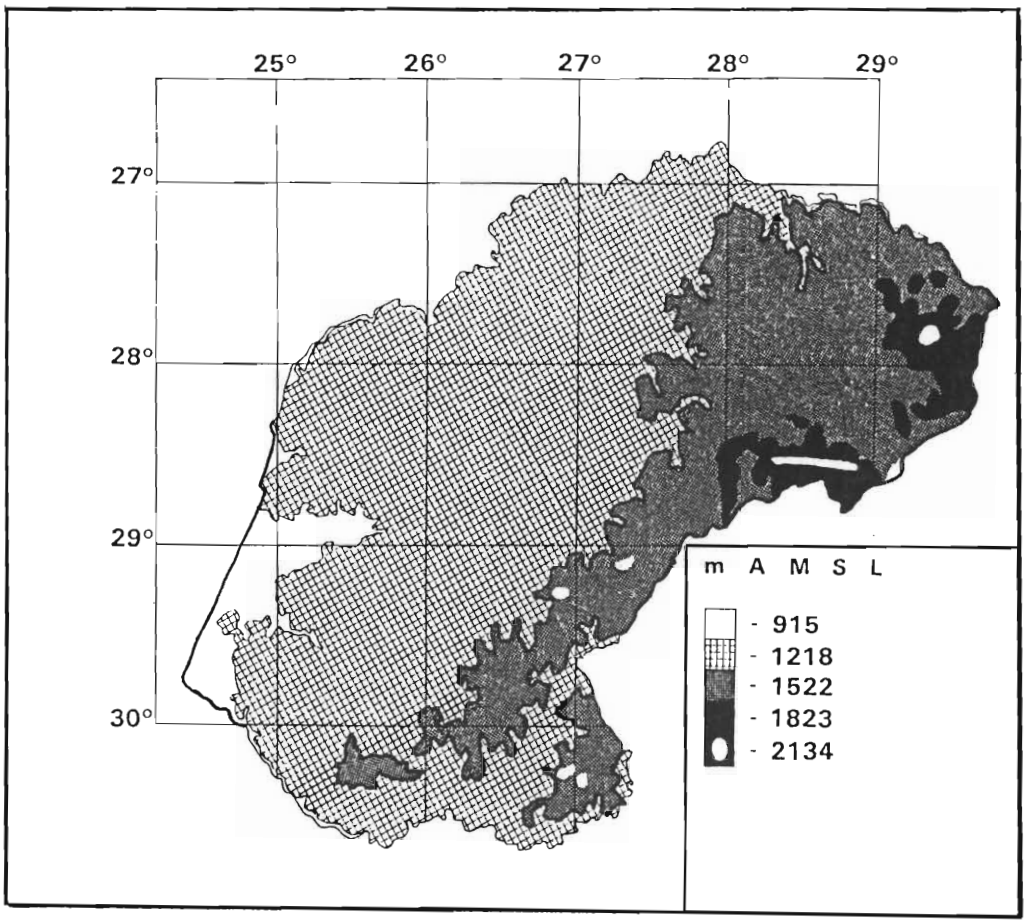


Figure 6: Topographic relief of the Orange Free State (after Earlé & Grobler, 1987).

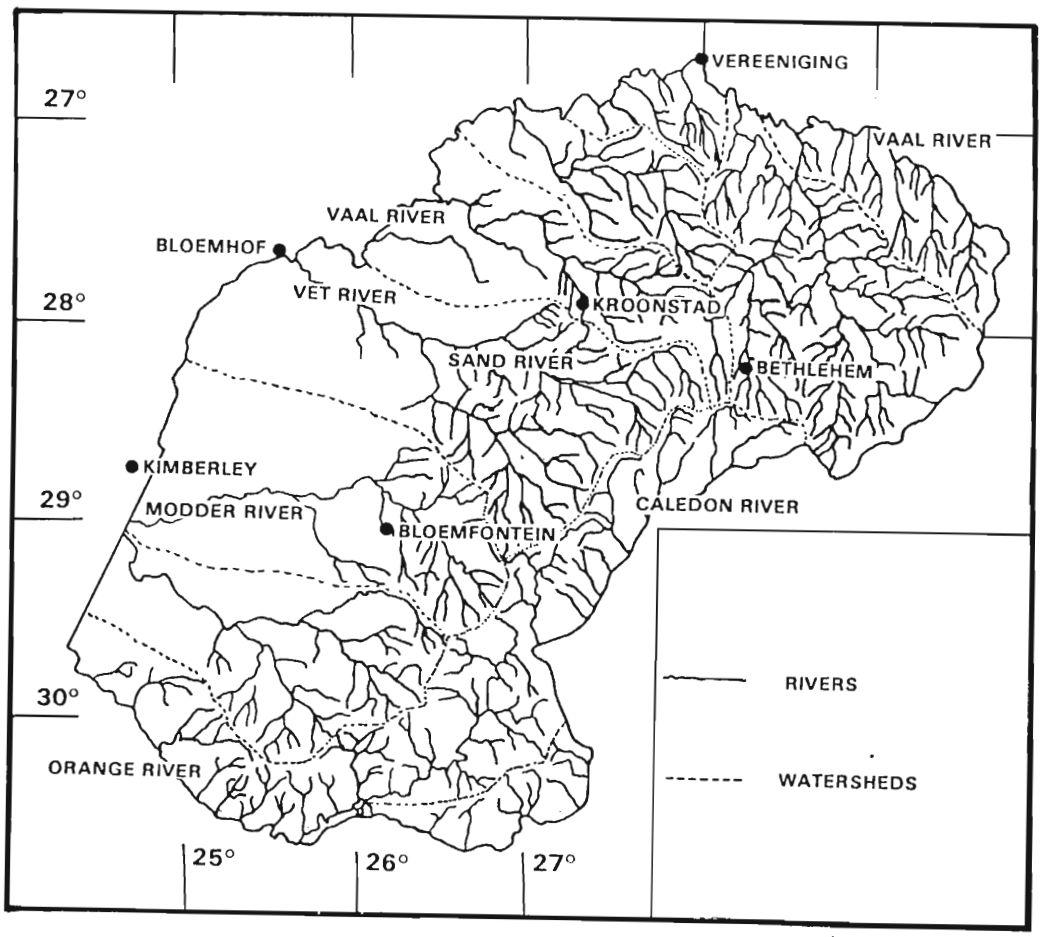


Figure 7: The main rivers and drainage systems of the Orange Free State (after Earlé & Grobler, 1987).

2.4 Climate

2.4.1 Temperature

Figures 8 & 9 show the differentiation of temperature for the warmest (January) and coldest (June) months respectively (after De Waal, 1978). Mean monthly temperatures indicate that temperature increases from east to west in the O.F.S. Harrismith in the east has a mean January temperature of 18°C, whereas Boshof in the west has a mean of 24°C; for July, Harrismith has a mean of 7°C and Boshof 10°C (Lynch 1983). Frost is severe to light during winter throughout the province (Fig. 10). There is a considerable difference between summer and winter temperatures, with hot summer days and very cold winter days, often with severe frost. Snow occurs on high-elevation areas in the east during winter. Most of the O.F.S. is a semi-arid region, but most of the north-east is sub-humid and small parts on the O.F.S./Natal border are humid areas (Fig. 10).

2.4.2 Precipitation

Precipitation in the O.F.S. results from one of three different weather systems, *viz.* orographic, frontal systems and convergence (Louw, 1979 in Earlé & Grobler, 1987). Mean annual rainfall increases from west to east (Fig. 11). Witzieshoek in the east has a mean annual rainfall of 1016 mm, whereas Jacobsdal, which is near the western boundary, has a mean of only 349 mm. Rainfall increases rapidly during October, reaching a peak during February and March, after which it declines rapidly. Three-quarters of the annual precipitation occurs during the summer (October to March). Earlé & Grobler (1987) state that about 80% of the annual rainfall in the east occurs in the January to June period (see Fig. 12). In the western and south-western parts, 70% of the annual rainfall occurs during this period. According to Van der Wal (1977), rainfall also increases with increasing altitude, and there is a positive correlation between topographic relief and mean annual rainfall.

2.5 Vegetation

2.5.1 Natural vegetation

About 75% of the O.F.S. is composed of grassveld, whereas about 20% (south-west) is karoo and 5% (north-west) is bushveld. Figure 13 illustrates Acocks' (1988) five "vegetation units", as found in the O.F.S. Because of regional differences in temperature, altitude, rainfall and soil, a number of variations exist within the five "vegetation units", and Acocks (1988) distinguished 17 veld types in the province (Figs 14a-c). In comparison to the dry, open grassland or karoo areas of the west, the higher, mountainous areas of the north-eastern O.F.S. have higher rainfall, marshy areas and isolated gorges resplendent with dense Afromontane vegetation, including mature riverine forest.

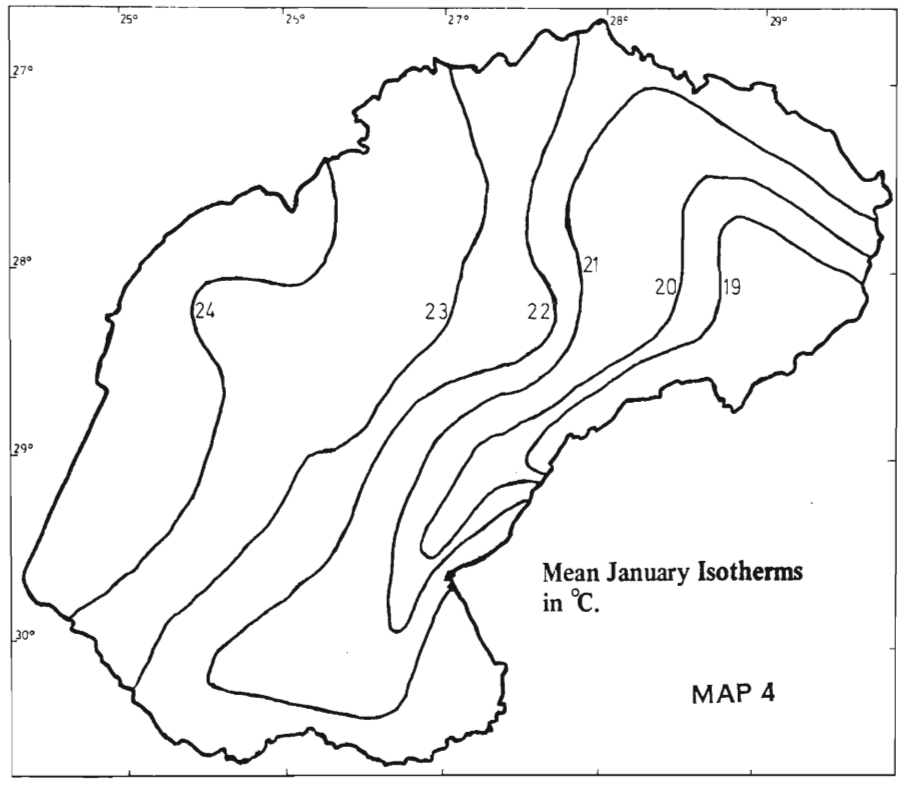


Figure 8: Differentiation of temperature in the Orange Free State - mean January isotherms in °C (after De Waal, 1978).

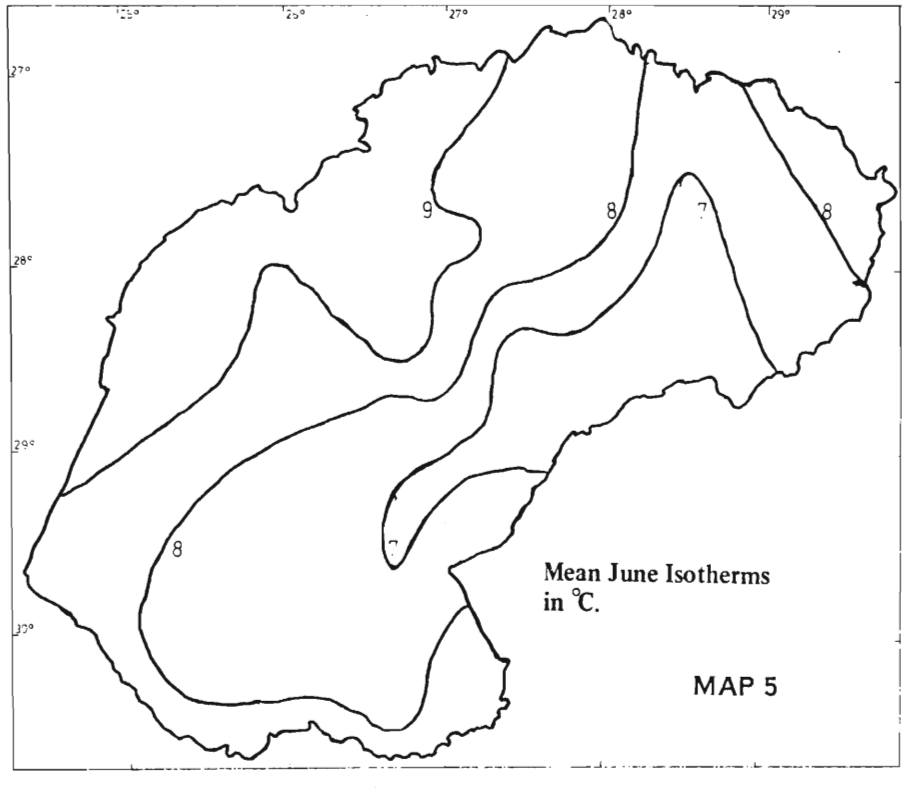


Figure 9: Differentiation of temperature in the Orange Free State - mean June isotherms in °C (after De Waal, 1978).

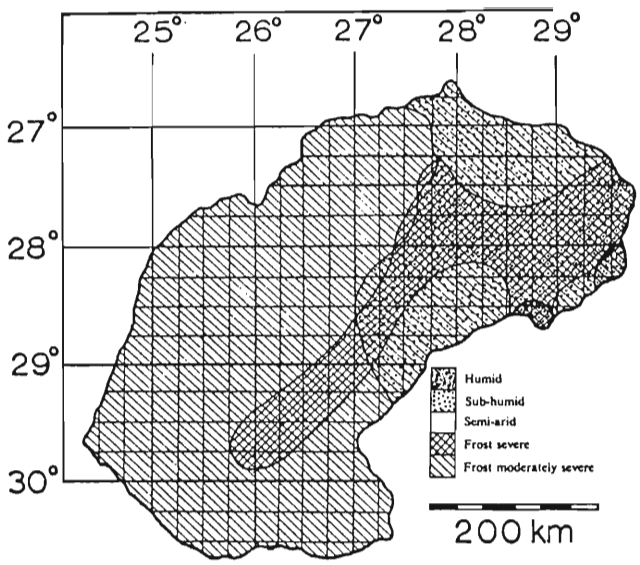


Figure 10: Frost and humidity zones in the Orange Free State (after Lynch, 1983).

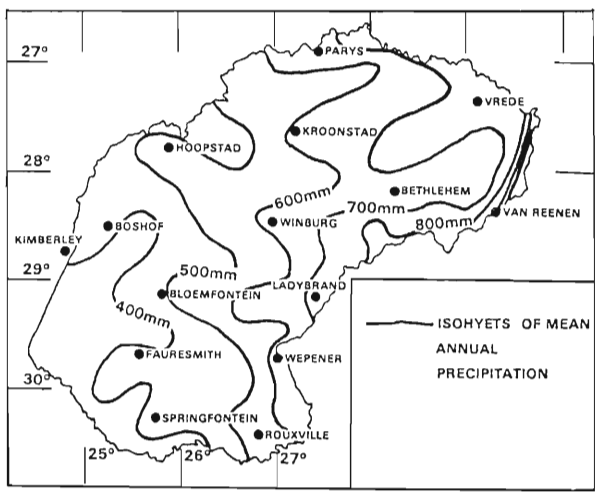


Figure 11: Isohyets of mean annual precipitation in the Orange Free State (after Earlé & Grobler, 1987).

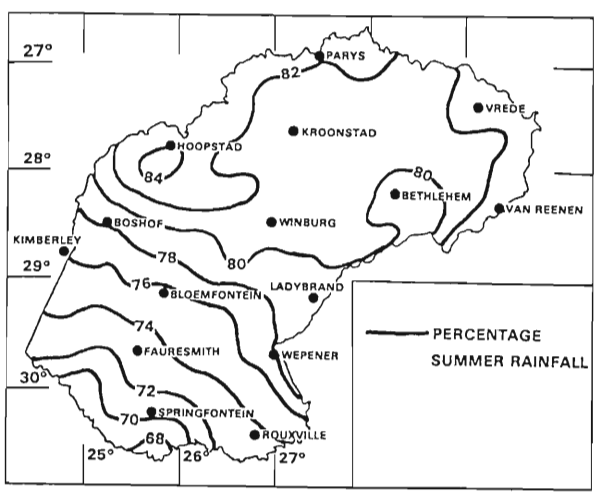


Figure 12: Variation in summer rainfall as a percentage of total annual precipitation (after Earlé & Grobler, 1987).

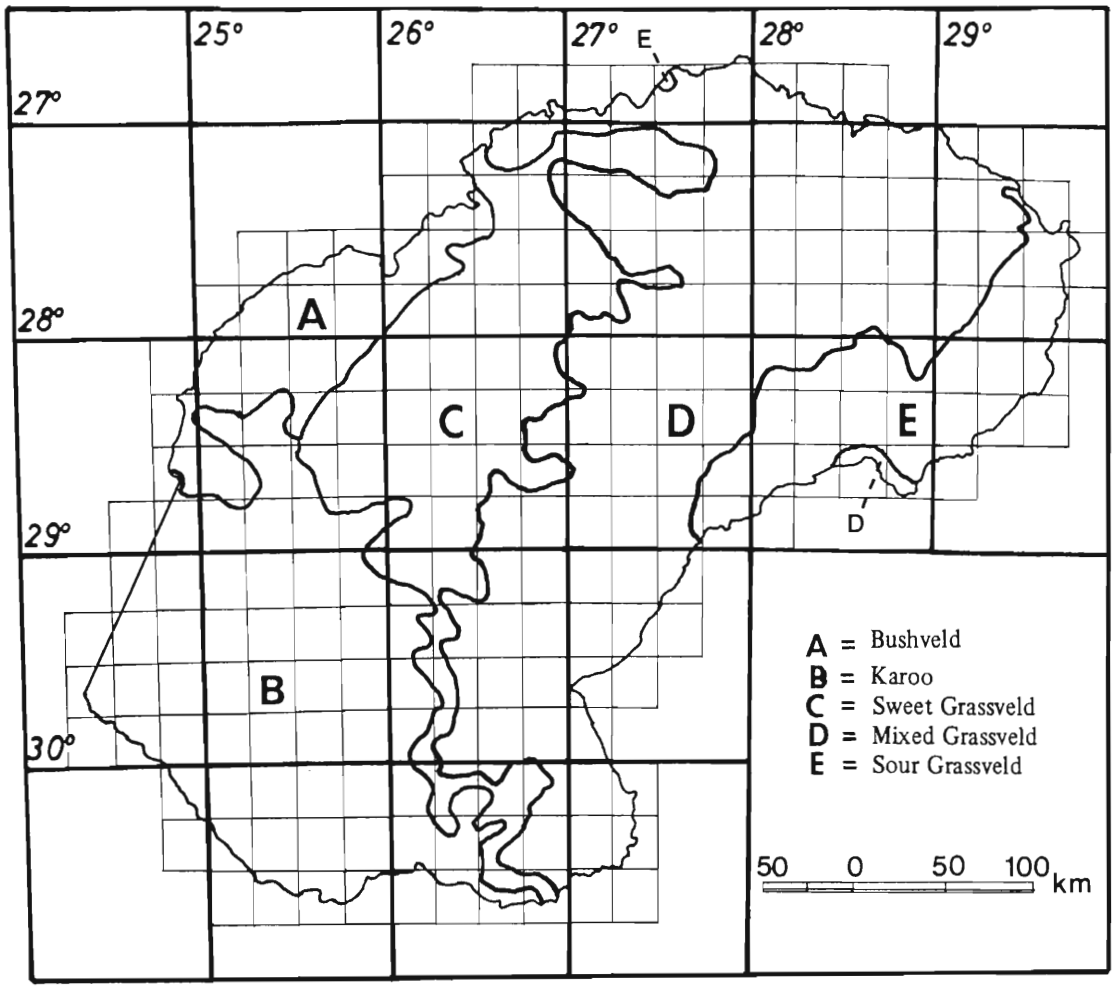


Figure 13: The five vegetation units in the Orange Free State (after Acocks, 1988).

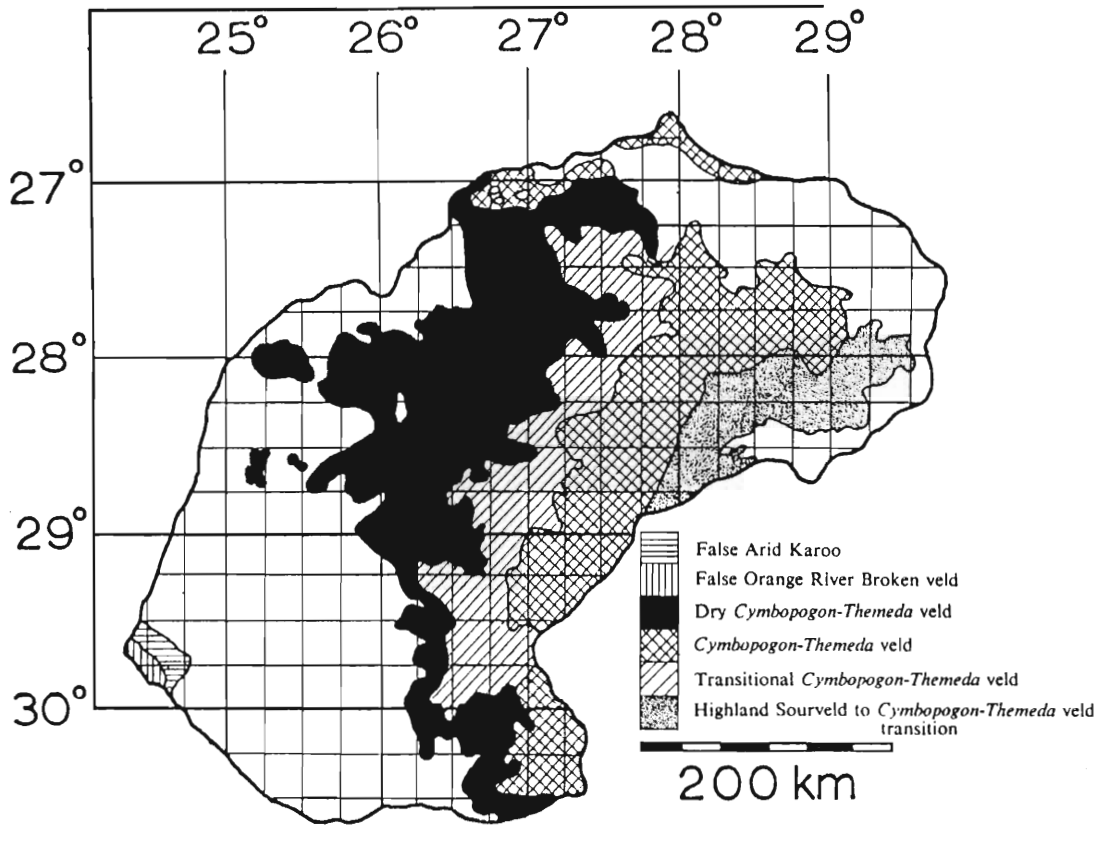
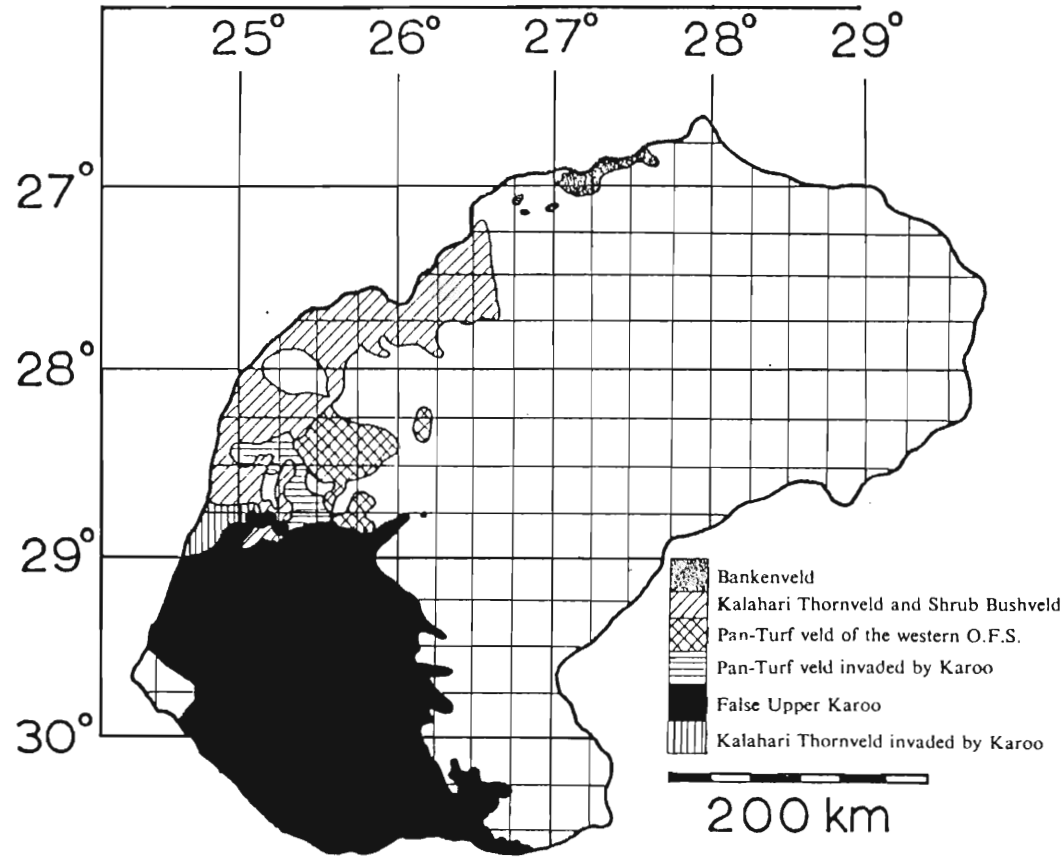


Figure 14a-c: Veld types of the Orange Free State (after Lynch, 1983).



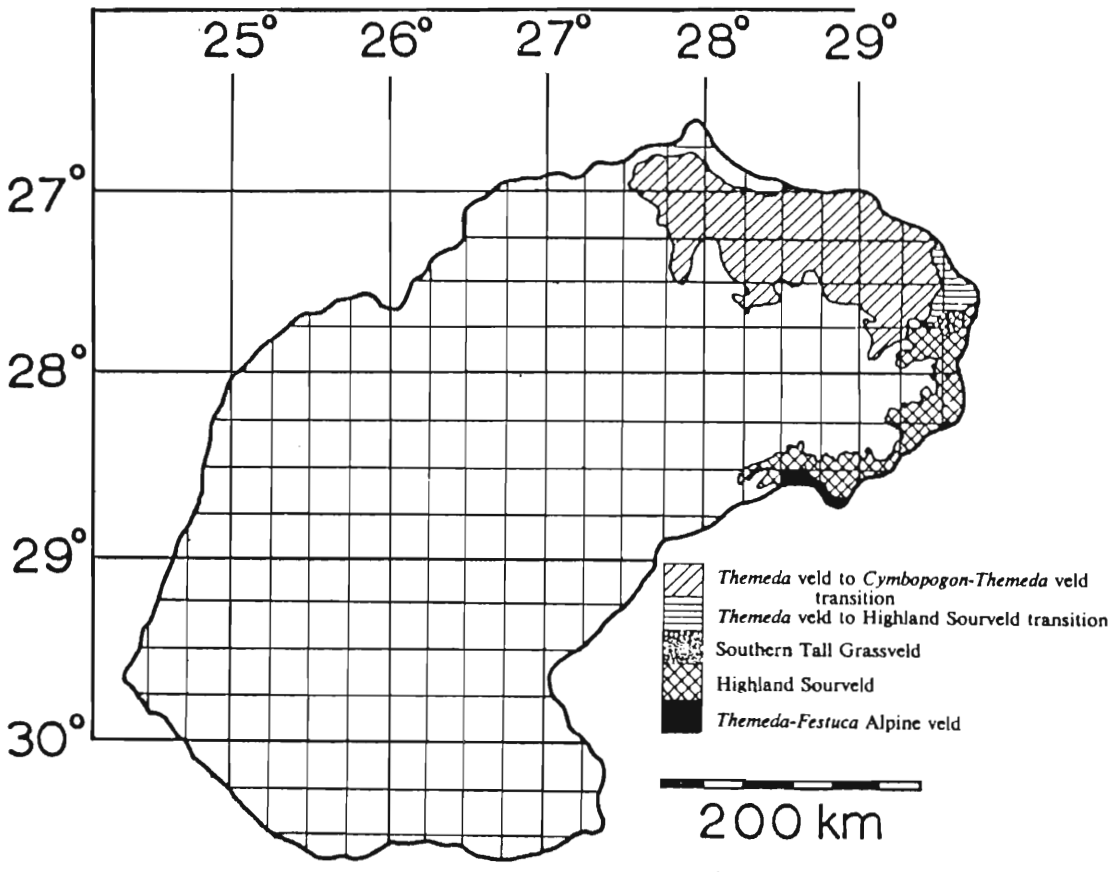


Figure 14a-c: Veld types of the Orange Free State (after Lynch, 1983).

Venter (1976, p. 7) distinguished four major regions of distribution for large, woody plant species in the province:

i) Eastern mountainous region - related to the kloof forest vegetation of Natal.

ii) South-southwestern region - with affinity to the shrubs and trees of the Cape Karoo.

iii) Western region - coinciding with species of the Kalahari Thornveld and Shrub Bushveld of the northern Cape Province.

iv) Northwestern region - having trees and shrubs similar to those of the Bankenveld of the south-western Transvaal.

Only a limited number of large woody plant species have widespread distributions in the O.F.S. (Venter, 1976, p. 7).

2.5.2 Agriculture

Lynch (1983) stated that 44% of wheat, 41% of maize and 30% of grain sorghum produced in the Republic of South Africa is grown in the O.F.S., thus indicating that large areas of the province are intensively farmed for cereals. The main maize yield is from a large area in the north-west (from Vredefort in the north to Hoopstad in the south), but an area centered on Clocolan in the east which stretches along the northern border of Lesotho, is also intensively farmed (Gillooly, 1978, p. 138). Herpetofauna in these areas has probably been severely affected by loss of natural habitat. Earlé & Grobler (1987) also mentioned that the sandveld of the Hoopstad - Wesselbron - Bothaville - Viljoenskroon area, which was originally a Kalahari Thornveld *Acacia* community, is now almost treeless, and has been replaced by extensive ploughed fields.

2.6 Geology

Geological formations of the O.F.S. are shown in Fig. 15. Apart from the mountainous area in the north, formed by rocks of the Witwatersrand Supergroup and the Proterozoic formations of the Vredefort Dome, and the low-lying, rolling topography of the granitic core, the rest of the province is underlain by Karoo Sequence rocks (Earlé & Grobler, 1987). Along the western and northern sides of the O.F.S., flat-lying easily weatherable rocks of the basal Dwyka Formation (glacial deposits) and the Ecca Group (shales) are the cause of a flat to slightly rolling surface, broken only by drainage lines and occasional mesas and buttes (Earlé & Grobler, 1987).

2.7 Soil types

Fig. 16 is a soil map of the O.F.S. Some reptiles and amphibians construct burrows or are fossorial, and soil type may therefore play a role in limiting their distribution. For example, the five fossorial reptiles (see chapter 5) found in the O.F.S. have virtually no records in the sandy area of the south-west.

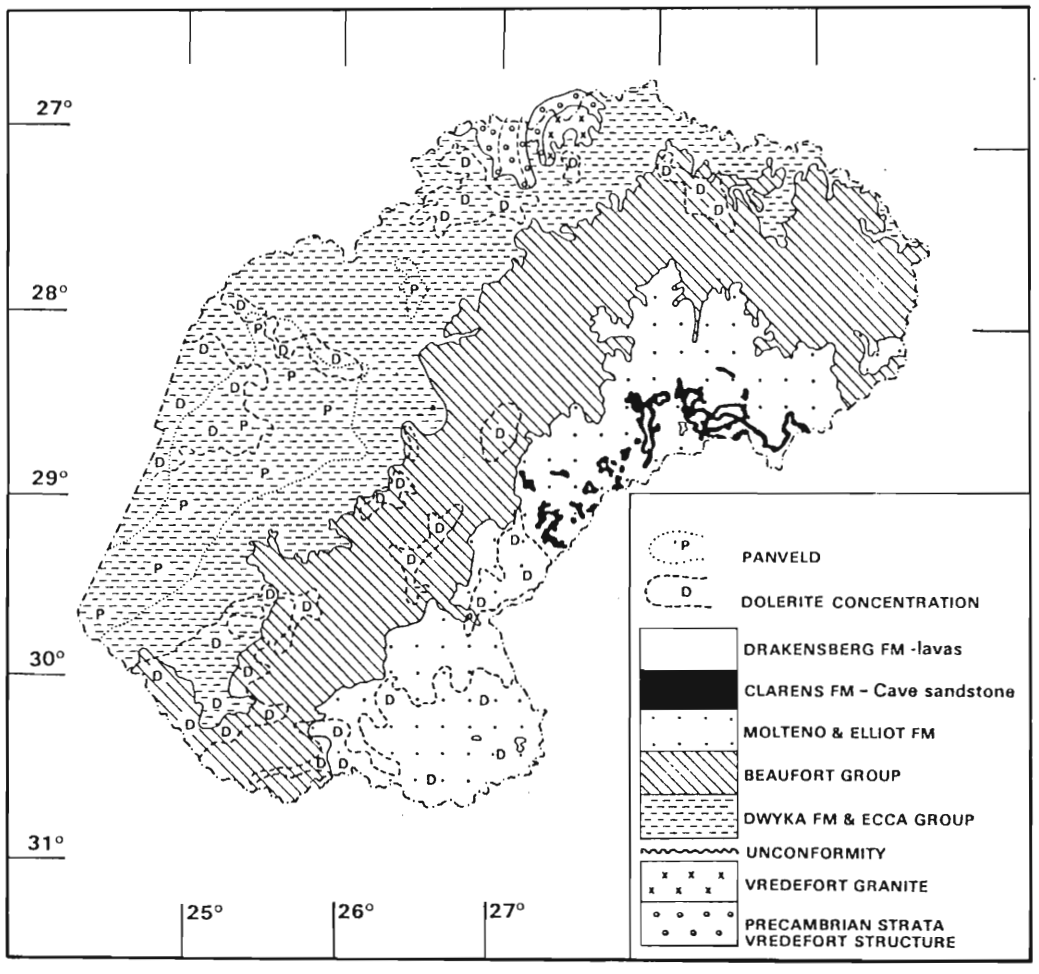
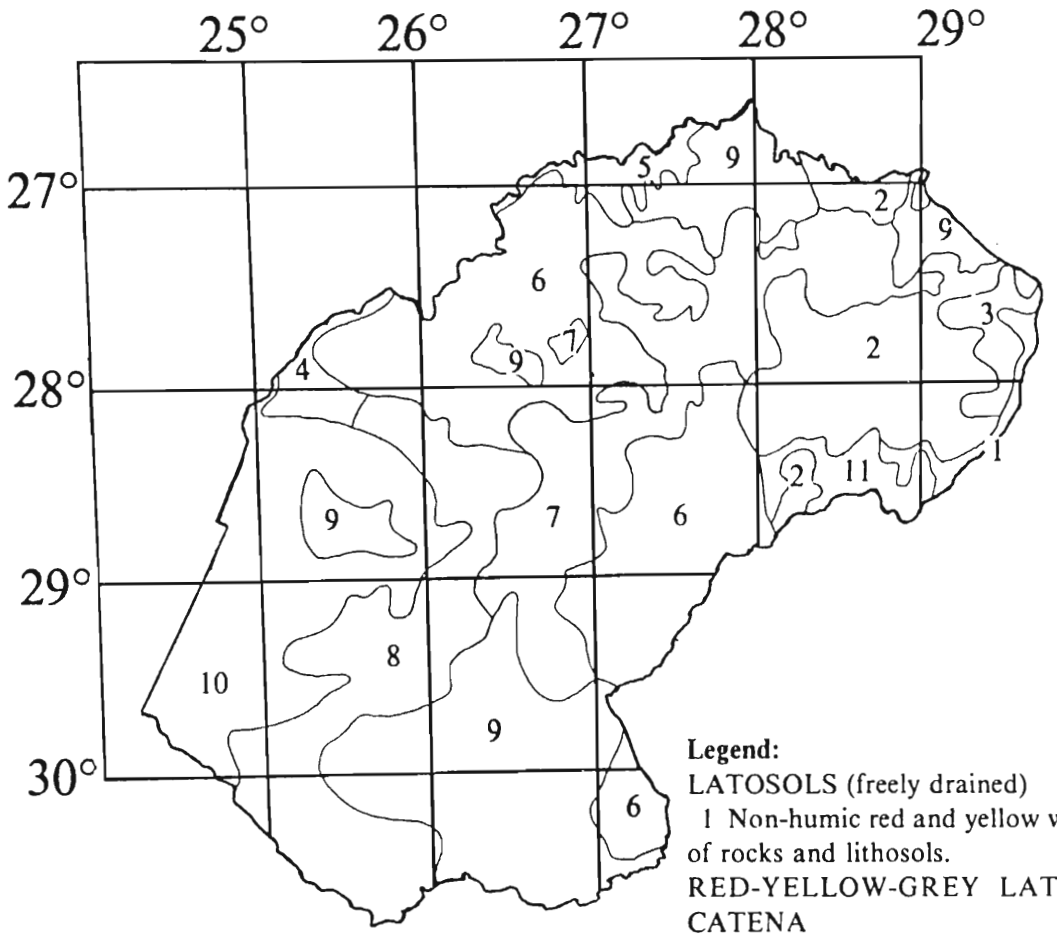


Figure 15: Geological formations of the Orange Free State (after Earlé & Grobler, 1987).



Legend:

LATOSOLS (freely drained)

1 Non-humic red and yellow with varying amounts of rocks and lithosols.

RED-YELLOW-GREY LATOSOL PLINTHIC CATENA

2 Acid, sands/loams, yellow/grey dominant
3 As for 2, but with much rocky land
4 Neutral, sands/loams, red dominant
5 As for 4, but with much rocky land
6 Neutral, sands/loams, yellow/grey dominant

BLACK MONTMORILLONITIC CLAYS, RED CLAYS, SOLONETZIC SOILS

7 Black clays and solonetzic soils
8 Red clays and solonetzic soils
9 Solonetzic soils

SANDS

10 Continental red or brown non-shifting sands with varying amounts of rock and lithosols

ROCK AND LITHOSOLS

11 Undifferentiated.

Figure 16: Soil types of the Orange Free State (after Lynch, 1983).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Material examined

This study is based primarily on specimens collected in the Orange Free State by De Waal (1978, 1980a,b) and his team of collectors during the years 1972-1978, and additional material collected from 1983-92, housed in the collection of the National Museum in Bloemfontein. Several specimens from other southern African museums and private collections were also examined. The Transvaal Museum has the second largest collection of O.F.S. amphibians and reptiles.

O.F.S. material examined during this study comprises 4425 frogs and toads, 3450 lizards, 159 amphisbaenians, 1966 snakes, 82 tortoises and 14 terrapins, a total of 10 096 herptiles. In addition, 105 extralimital frogs, and six lizards and two snakes from over the borders of the O.F.S. were examined, a total of 113 extralimital specimens. The following are the acronyms of institutions from which material was loaned and/or examined, as referred to in the text:

AJL - A.J.L. Lambiris private collection (Pietermaritzburg)
DNSM - Durban Natural Science Museum (Durban)
LR - Lynn Raw private collection (Pietermaritzburg)
MMK - McGregor Museum (Kimberley)
NM - Natal Museum (Pietermaritzburg)
NMB - National Museum (Bloemfontein)
NMZB - Natural History Museum of Zimbabwe (Bulawayo)
SAM - South African Museum (Cape Town)
SMWD - State Museum (Windhoek)
TM - Transvaal Museum (Pretoria)

3.2 Identification of specimens

Adult amphibians were identified mainly according to the criteria given in the diagnostic keys of Poynton (1964) and Lambiris (1989a). The illustrations and descriptions given by Passmore & Carruthers (1979) were also consulted, as was comparative material in the National Museum's amphibian collection. De Waal (1980a) determined the taxonomic status of O.F.S. amphibians according to Poynton's (1964) criteria, but in only one case (*Bufo vertebralis*) did he note morphological variation in O.F.S. populations. Variation in what were considered important taxonomic characters has been given in this manuscript under the heading "Features". Larval amphibians were identified according to the diagnostic keys and descriptions of Wager (1986), Van Dijk (1971a; genus *Bufo*) and Lambiris (1989a).

Chelonians were identified according to the keys and illustrations in Boycott & Bourquin (1988).

Lizards were usually identified according to the diagnostic keys and descriptions in FitzSimons (1943), but as these are in many cases outdated, keys given in later generic and species revisions were also used - Broadley (1972, 1975, 1977a,b), Broadley & Greer (1969), Broadley, Gans & Visser (1976), De Waal (1978), McLachlan (1981) and Jacobsen (1989). Snakes were identified by colour pattern and/or by using the keys in Broadley (1990). Comparative material in the National Museum's collections was also consulted. Variation in important taxonomic characters has also been given for lizards, while in the case of snakes, usually only the size, shape and colour pattern of specimens were examined and are described. This eliminated any obvious descrepencies in specimens identified by other workers. In the case of species represented by only a few specimens from the O.F.S., and material representing a first record for the province, a more detailed description is usually given.

De Waal (1978) did not include a detailed description for each squamate taxon as this was available in the literature. He did, however, note observed variation in important taxonomic characters, based on material collected in the O.F.S. Where differences were noted and in cases where scale counts or measurements on new material had values outside the ranges given by De Waal (1978), these were noted. Recent studies have indicated the need for revising certain species complexes, e.g. *Cordylus vittifer* (see De Waal, 1978), *Agama hispida* (see McLachlan, 1981) and *Pachydactylus capensis* (see Jacobsen, 1989). For this reason, these taxa have received special attention.

3.3 Methods of collecting

De Waal (1978) planned his collecting trips using the index map for the 1 : 250 000 cadastral plan series and the index of O.F.S. farms which provides the farm name and its number, cadastral plan number and the administrative district, as compiled by the Surveyor-General of the O.F.S. in 1970. The above-mentioned index map divides each degree-unit into 32 smaller units (eighth-degree latitudinally and quarter-degree longitudinally). De Waal (1978) therefore collected on one farm in each alternating unit, except for some agricultural areas in the north-west which lack natural habitat; and in some cases collections were made on interjacent units. Specimens were therefore collected from approximately 16 localities per degree-unit. A total of 221 localities was sampled, material being obtained during all seasons of the year and from all parts of the province in both summer and winter. This survey is perhaps the most intensive of its kind conducted to date.

During his recent survey of the amphibians and reptiles of the Transvaal, Jacobsen (1989) collected specimens from at least one locality per quarter-degree unit. Collectors spent only one day in each area, collecting from all major topographic features. Jacobsen (1989) used traplines with funnel traps at the junction of each four quarter-degree units. These traps were left *in situ* for four days. Jacobsen's (1989) findings have been mentioned on many occasions in the species accounts when pertinent to O.F.S.

populations.

Using topo-cadastral maps, De Waal (1978) selected undisturbed habitats in which to collect. All habitats at a particular site were examined. Specimens were captured manually, by searching for free-running animals, opening rock crevices, lifting rocks and excavating disused termite mounds (*Trinervitermes* sp.). Usually three to four persons spent at least one day collecting at each locality.

Since 1983, several additional frogs, lizards, amphisbaenians, snakes and chelonians have been collected in the province. In many cases, field trips aimed at collecting samples of a particular species resulted in the collection of specimens of various species. These were usually rupicolous, or largely rupicolous species, such as *Cordylus p. polyzonus*, *Pseudocordylus m. melanotus*, *Agama a. atra*, *Pachydactylus bibronii*, *P. c. capensis* and *Mabuya* spp. On two occasions, special trips were made to Thaba Phatshwa Mountain in the eastern O.F.S. in order to collect additional *Afroedura karroica halli*. Several attempts were made to collect amphibians, especially from the south-western and eastern O.F.S. Occasional donations of specimens were also received from members of the public. Important collections of amphibians and reptiles from Golden Gate Highlands National Park were independently donated to the National Museum by Mr J. Marais and Mr G. Groenewald (see Bates, 1991b). Lizards and frogs were also collected from bucket traps by staff of the National Museum's Entomology Department while sampling insect populations, and also by staff of the Herpetology Department while sampling local insects during an ecological study on the Giant Girdled Lizard *Cordylus giganteus* in the north-eastern O.F.S. An array trap system (with drift fences, bucket traps and funnels) was used at Florisbad Research Station in the central O.F.S. and proved very successful in collecting grassland herpetofauna (Douglas, 1992). During most field trips subsequent to those of De Waal, squamate reptiles were found by turning over rocks, opening rock crevices (with iron crowbars) and excavating inactive or disused termitaria. Rupicolous lizards were often captured using a tubular pole with fishing gut pushed through to form a noose, but most reptiles were captured by hand.

Adult frogs were collected mainly by lifting stones and rocks on the banks of rivers and dams during daytime. Ranids and bufonids were also collected by torchlight at night on the banks of rivers and dams, and in marshy areas. These specimens were captured either by hand or using a long-handled net. Roadside rain-pools were also inspected, and during the rainy season were often found to contain *Bufo* tadpoles. Tadpoles were collected whenever possible, usually by means of a small net. De Waal (1980b) collected only a few larval amphibians, even though it is an easy procedure and can result in numerous new distribution records. With reference to the "Zambesiaca" area of south-east Africa, Poynton & Broadley (1985) also noted that "virtually no collecting of tadpoles has been done in the area".

Fig. 1 illustrates the O.F.S. localities (eighth-degree units) at which Poynton (1964) recorded amphibians. After De Waal's (1980a) amphibian survey, a significant improvement is shown with

regard to the number of localities sampled (Fig. 2), but it is immediately evident that the south-western part of the province was not well surveyed for amphibians. For this reason, and with the use of 1 : 250 000 topocadastral maps, field trips were undertaken in that region and a special attempt made to obtain specimens (new localities indicated by star symbols in Fig. 2). Prior to De Waal's (1978, 1980b) reptile survey, the O.F.S. had received only a little more attention than in the case of amphibians. Fig. 3 shows that De Waal's (1978, 1980b) survey was extremely comprehensive; records obtained since his survey are indicated by star symbols.

3.4 Processing and preservation techniques

Lizards collected during De Waal's (1978) survey were killed with chloroform and snakes with ethyl acetate; specimens were fixed in 10% formalin and preserved in 70% ethanol. De Waal (1980a-b) gave no particulars as to how chelonians and amphibians were killed or processed, but processing was probably similar to that of squamates, and the specimens are preserved in 70% ethanol.

The following is a summarized account of the process employed since 1983 for processing amphibians and reptiles at the National Museum: After killing the specimen, it is measured and weighed and a numbered field tag is tied to its body. All available information pertaining to it is recorded in a field book. The specimen is then injected hypodermically with 4% formaldehyde solution and positioned in a standard pose in a tray of 4% formaldehyde for 48 hours. After washing in running fresh water for six hours, it is transferred directly into 70% ethanol (ethyl alcohol). Once identified, the species name is entered in the field book, and all pertinent information recorded on a catalogue index card, printed specimen tag (which is tied to the body at the same place as the field tag) and in the permanent catalogue. The specimen can then be deposited in the relevant storage vessel containing 70% ethanol. The catalogue number of the specimen is written on a label taped to the front of the container. After a number of index cards have been completed, selected information is computerized. Permanent, waterproof ink is used on all tags and for all documentation. For a more detailed account, see Bates (1989a).

3.5 Measurements, mass and scale counts

3.5.1 Measurements

Only specimens collected subsequent to De Waal's (1978, 1980a) squamate and amphibian surveys were measured, as De Waal had measured specimens collected during his surveys.

a) Amphibians

Up until 1988, the distance from the tip of the snout to the vent (snout-vent length = SVL) of frogs and toads was measured, using vernier calipers (to 0,02 mm accuracy). However, Prof. J.C. Poynton (pers. comm.) suggested that a snout to urostyle measurement would be preferable, as the position of the vent varies in relation to the urostyle end (which is fixed), and vent position depends on the degree of

hydration of the specimen and the state of fixation (Bates, 1989). Snout-urostyle and/or snout-vent measurements have been taken on specimens since 1988. Snout-urostyle measurements are probably more reliable and accurate, but as size is usually given in terms of SVL, the size of the largest O.F.S. specimen (SVL) of each species/subspecies is given in the text. In some cases, tibia length (with leg flexed; usually right leg) and head width (across top of head at the level of the posterior border of tympanum) were also measured, using vernier calipers (to 0,02 mm accuracy), so as to determine morphometric ratios relevant for diagnosis.

b) Snakes, lizards and amphisbaenians

Snout-vent length and tail length were measured using either a sliding vernier caliper (0,02 mm), a 380-mm or 800-mm stainless-steel rule, depending on the length of the specimen.

c) Chelonians

De Waal (1980b) did not mention size in his treatment of O.F.S. chelonians. The greatest plastron length (after fixation and preservation) for each species was determined using vernier calipers or a 380-mm steel rule and is given in the respective species accounts.

3.5.2 Mass

De Waal (1978, 1980a-b) did not determine the mass of any specimens collected. Since 1988, several freshly collected specimens accessioned into the National Museum's reptile collection (also a few amphibians) were weighed on a Sartorius scale (max. 1000 g) with an accuracy of 0,01 g. A Mettler AE 163 analytical balance was occasionally used for very small specimens. Specimens killed by freezing were first thawed out and excess water droplets dried off using paper toweling. When specimens were to be killed using a method other than freezing (and in order to avoid obtaining exaggerated values), they were weighed while still alive, usually by placing them in a container after zeroing the scale. The mass of specimens can be used in conjunction with SVL to determine growth curves of species (Bates, 1990a).

3.5.3 Scale counts

a) Lizards

Scales across middle of body were counted in a transverse line across the back, midway between fore and hind limbs. Transverse rows of dorsals were counted from first distinct row behind head to row above vent. Transverse rows of ventrals were counted from first row behind forelimb insertion to row anterior to hindlimb insertion. Subdigital lamellae on fourth toe (usually right foot, unless damaged) were counted from basal lamella at junction with adjacent toe, to toe tip (excluding claw). Other scale counts are self-explanatory or explained in the text. Unless otherwise indicated, all counts were taken on the right side of the body.

b) Snakes

Midbody scale rows were counted at a point about halfway between tip of snout and vent. Ventrals were counted using the system of Dowling (1951). Subcaudals, if paired, were counted from the first pair in median contact behind the vent to the pair anterior to the tail tip, i.e. excluding the terminal spine.

3.6 Ecological data

De Waal (1978, 1980a-b) recorded habitat and ecological data (eg. diet, breeding, predators) for several amphibian and reptile species. These data, together with additional ecological data obtained since then, are presented. Data from studies on diet, reproduction and caudal autotomy of O.F.S. species are also included (Van Wyk 1988b, 1989a,b; 1991, Bates, 1989b). Details from other studies and sources have also been included, and are particularly useful when regional differences are apparent or when little or no information is available for O.F.S. populations. In the case of amphibians, De Waal (1980a) did not record many ecological data, and literature sources were therefore usually the main source of ecological data for any particular species or subspecies. It is unfortunate that De Waal (1977, 1978, 1980a,b) did not provide a more detailed account of the habitat at which specimens were collected. However, in the case of several specimens collected during the period 1983-1992, a more detailed description of habitat and microhabitat has been given.

3.7 Listing of locality records

Localities at which O.F.S. material has been collected are listed under "Distribution in the Orange Free State", whereas localities of specimens collected on the periphery of the O.F.S. or near the borders of the O.F.S. are listed under "Extralimital records" (these are usually plotted on the maps, especially in the case of amphibians, and were useful in determining into which range cluster a poorly collected species was best placed - see Chapter 6). Under each of these headings, records have been subdivided into "specimens examined" and "other records". The latter category includes literature records (not examined), records from institutes other than the National Museum (specimens not examined, but for which museum catalogue numbers were usually obtained), sight records (mostly of large, easily identifiable species), photographic records (of which the slides or prints are usually housed at the National Museum) and auditory records (see *Ptenopus g. garrulus*). All literature records are listed even if very vague, e.g. "Modder River", although these "vague" records were not usually plotted on the maps. The record "Vredefort Road" has however, been plotted on the maps (see species accounts). In listing localities, only the town or farm name is given, although the district is added if two synonymous farm names appear in the gazetteer. The farm name and number, district and respective locus code can be found in the Gazetteer.

Sight records serve primarily as an aid for conservationists and future researchers, although in the case of large, easily identifiable species such as monitors, which are difficult to collect and for which few

distribution records exist, and chelonians, which are often not collected for sentimental reasons and are also readily identifiable, they are considered essential for use in biogeographical analyses and are used for that purpose in this study. It should be noted here that Lynch (1983, 1989) made extensive use of sight records of medium to large-sized mammals when plotting mammalian distribution records for the O.F.S. and north-eastern Cape Province respectively. Also, bird atlassing, both in the O.F.S. (Earlé & Grobler, 1987) and elsewhere in southern Africa (Southern African Bird Atlas Project) makes almost exclusive use of sight records, even of the smallest bird species, and although misidentifications are bound to occur, enormous bodies of data are accumulated and prove invaluable in assessing various aspects of distribution patterns. Branch (1990, p. 17) stated that sight records (of reptiles) "should not be used in unqualified distribution maps or ranges, and serve only as aids to future workers for possible localities in which species may be found", but he also noted that sight records by farmers of "very distinctive" and "unlikely to be confused" species "confirm the presence" of certain species in particular areas.

3.8 **Distribution maps**

Maps of the O.F.S., divided into quarter-degree units, were obtained from Dr C.D. Lynch (National Museum, Bloemfontein), who used these maps for plotting the distribution of O.F.S. mammals (Lynch, 1983). For the checking of specific locality records, these maps are an improvement on those used by De Waal (1978, 1980a,b), as his maps were ruled into one-degree units only. The term "degree unit" is preferred to "degree square", as the area formed by two successive degrees of latitude and two (superimposed) successive degrees of longitude is not a square, especially outside the tropics (De Waal, 1978, p. 9).

Distribution maps were compiled from the localities of specimens examined as well as all other records given. The localities plotted on De Waal's (1978, 1980a,b) maps were plotted directly onto the new maps. Locality records for any one species or subspecies were plotted using a maximum of four different symbols, usually the following:

i) A solid circle for localities from which material was personally examined; such localities include virtually all of De Waal's (1978, 1980a,b) records as well as several other previously published records.

ii) A hollow circle for literature records represented by specimens not personally examined.

iii) A solid triangle for personally examined material from localities represented by specimens collected since De Waal's survey and including records published in the literature since De Waal's (1978, 1980a,b) papers.

iv) A hollow triangle for previously unpublished records, including museum records (identified by museum staff members), sight records, photographic records and in one case (*Ptenopus g. garrulus*) a sound record.

This was done so as to indicate the extent to which new records affect the distribution patterns determined by De Waal (1978, 1980a,b), and in the case of sight records, to indicate records which may need confirmation.

Localities were plotted using the eighth-degree grid and locus code method adopted by De Waal (1978, 1980a,b) and illustrated in Fig. 17. This system provides for a more detailed visual impression of distribution patterns than the more commonly used quarter-degree method, and also allows a more accurate determination of ecological correlation with distribution (De Waal, 1978). A comparison between Fig. 18 (eighth-degree units) and Fig. 19 (quarter-degree units), both representing the distribution of the widespread scincid lizard *Mabuya capensis* in the O.F.S., clearly indicates the relative coarseness of the quarter-degree plot when compared to the eighth-degree plot.

Locus codes for new localities were obtained using the index of O.F.S. farms (which gives quarter-degree grid references) in conjunction with 1 : 250 000 and/or 1 : 50 000 topocadastral maps. Locus codes for material recorded by De Waal have been taken from De Waal's (1978, 1980a,b) gazetteers. The publication *Southern African Place Names* (Leistner & Morris, 1976), which gives quarter-degree grid references, was also used in the case of towns or small settlements.

While some workers have represented localities on distribution maps using even smaller "plots" than the eighth-degree (e.g. Pienaar, Passmore & Carruthers, 1976; Pienaar, Haacke & Jacobsen, 1983), the currently accepted carto-zoogeographical practice in southern African herpetology is to use quarter-degree units (see Poynton, 1964; FitzSimons, 1962; Broadley, 1983, 1990; Auerbach, 1987; Lambiris, 1989a; Jacobsen, 1989; Branch, 1990a). The use of eighth-degree plots is realistic only when a thorough survey of a region has been conducted, as was the case with De Waal's (1978, 1980a,b) surveys, where collections were usually made on a farm in each alternating eighth-degree unit. The use of the eighth-degree plot does not present problems when conducting zoogeographical analyses based on quarter-degree plots, as the quarter-degree unit in which the eighth-degree is represented can simply be filled in or readily identified visually, especially when a quarter-degree grid has been ruled or overlaid on the maps.

In most cases, each distribution map represents the occurrence of a single species or subspecies. However, to save space, and in some cases to allow for convenient visual comparison of the distribution of similar or related allopatric species or subspecies, some maps represent the occurrence of more than one form (e.g. *Mabuya variegata variegata* and *M. v. punctulata*). In cases where two forms are indicated on the same map, a six-pointed star symbol is usually used for one form and solid circles for the other; when new records or sight records are involved, the symbols used are explained in the map legend. Instances of sympatry between two forms represented on the same map are indicated by a solid star symbol unless otherwise indicated in the map legend. It should be noted that "sympatry" in terms of two or more forms recorded from the same eighth-degree unit does not necessarily imply microsympatry. For economy of space, maps may represent the distribution of up to five forms, but this is done only when few or no cases of sympatry occur. In all such cases, the symbols used to represent the occurrence of each taxon on the map is clearly indicated. Dotted lines have also been used in some cases to indicate the ranges of forms plotted on the same map.

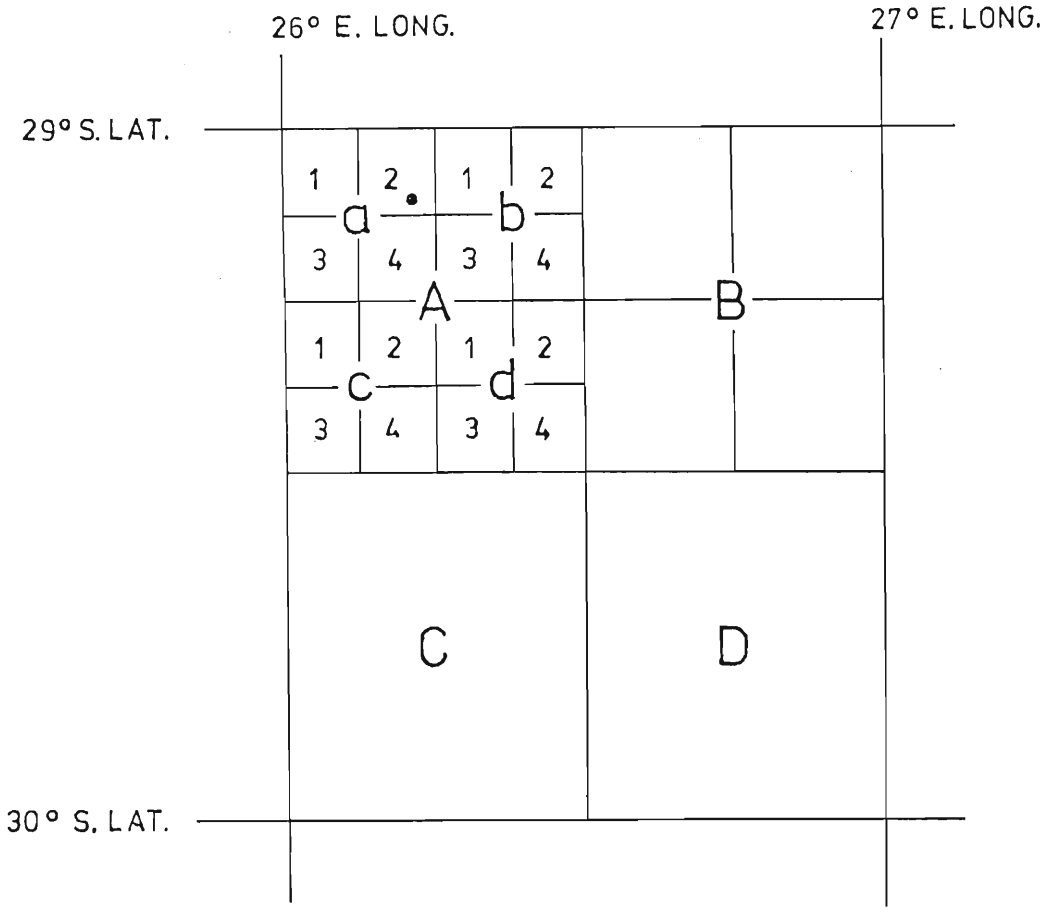


Figure 17: The eighth-degree grid and locus code method, showing the position of Bloemfontein (2926-Aa2) (after De Waal, 1978).

The use of the locus code for plotting localities can be described as follows: Each degree-unit (1 x 1 degree-"square") is designated by a four-figure number, made up of the values of the degrees latitude and longitude as indicated at its north-west corner (i.e. 2926 in fig. 17), followed by the code letter for the given half-degree-unit (i.e. A in fig 17), then the code letter of the given quarter-degree-unit (i.e. a in fig. 17) and finally the code number of the given eighth-degree unit (i.e. 2 in fig. 17). Each degree unit is therefore subdivided into 64 subunits of roughly equal size. (after De Waal, 1978).

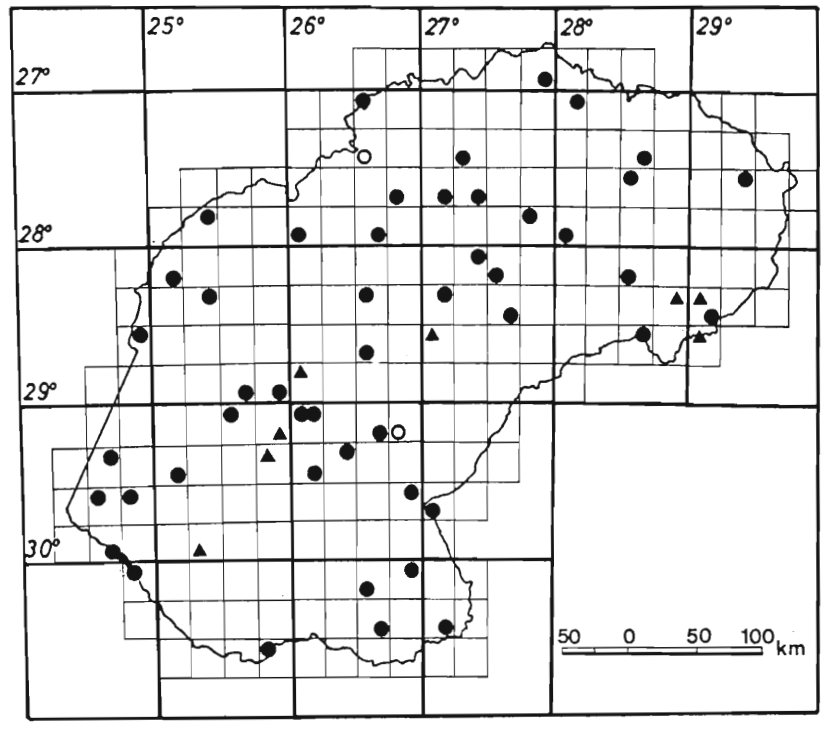


Figure 18: Distribution of *Mabuya capensis* in the Orange Free State - localities plotted on eighth-degree basis.

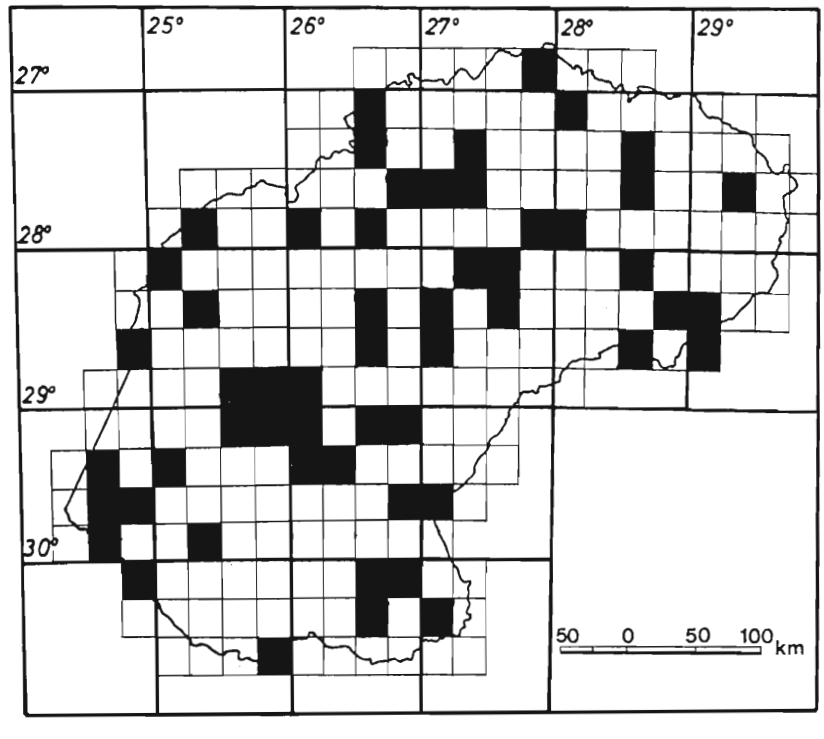


Figure 19: Distribution of *Mabuya capensis* in the Orange Free State - localities plotted on quarter-degree basis.

CHAPTER FOUR

SYSTEMATIC ACCOUNTS

4.1 Introduction

Species accounts begin with a reference to the original description, followed by a list of references specifically related to distribution of O.F.S. taxa. The "Range" includes geographical range, zoogeographical classification (see chapter 6) and range cluster in O.F.S. (see chapter 6). Geographical range was determined using mainly the following references: Poynton (1964, amphibians), Branch (1988a, reptiles), Broadley (1990, snakes) and Greig & Burdett (1976) and Bourquin & Channing (1988) for chelonians. Other references used include those listed in the respective synonymies as well as those cited under "Range". O.F.S. localities and occasionally also extralimital records (mostly for amphibians) are listed. Diagnostic features are also given (under "Features"), followed by notes on habitat and ecology, and finally remarks (especially on taxonomic status). English names used are taken primarily from Passmore & Carruthers (1979) and A.J.L. Lambiris (pers. comm.) for frogs, and Branch (1988a) for reptiles, but in some cases I have used my own names (e.g. *Pyxicephalus a. adspersus, Afroedura karroica halli, Agama aculeata* sspp., *Mabuya variegata* sspp., *Pseudocordylus melanotus* sspp. and *Telescopus beetzii*). In the species accounts the sequence of taxa are essentially in accordance with Poynton (1964, amphibians), FitzSimons (1943, lizards), Broadley (1990, snakes) and De Waal (1980b, chelonians).

4.2 Species and subspecies concepts

For the purposes of this study, species (and subspecies) are understood to be "those samples that a biologist can distinguish, and tell others how to distinguish (diagnose)" (Nelson & Platnick, 1981, p. 11). Poynton & Broadley (1985a, p. 503) also noted that a "species" can be regarded as a hypothesis about the presence of a reproductively inclusive (and perhaps exclusive) group (of amphibians). A subspecies differs morphologically, in terms of its individuals, from members of parapatric or allopatric closely-related populations of the same species, but hybridization in the "transition zone" between parapatric populations results in intergrades (specimens with characters of both subspecies and therefore not clearly assignable to any one subspecies). Individuals from isolated populations representing relics of previously widespread species (achieved during cooler climatic regimes) might be expected to differ morphologically, but this is not always the case (see *Afroedura* spp.). It is possible, however, that biochemical and genetic studies might find differences between such populations. In conclusion, it must be said that as a result of limited ecological data accompanying most museum specimens, the "morphospecies" concept does sometimes play a role during the identification of specimens.

4.3 Doubtful records

The taxa listed below have been recorded from the Orange Free State, but are regarded as of doubtful occurrence, for the reasons given below:

Tetradactylus africanus fitzsimonsi Hewitt, 1915

Hewitt (1915, p. 102) recorded a specimen from Kroonstad, housed at the Port Elizabeth Museum, but regarded the record as of doubtful authenticity; the specimen could not be found and appears to be lost (De Waal, 1978, p. 13). *T. a. africanus* occurs in Natal and the north-eastern O.F.S., whereas *T. a. fitzsimonsi* is restricted to the area around Port Elizabeth, with a single record at George, in the Cape Province. *T. a. africanus* has minute forelimbs, whereas *T. a. fitzsimonsi* lacks forelimbs (Fitzsimons, 1943; Branch, 1988a).

Dalophia pistillum (Boettger, 1895)

Branch (1988a, p. 108) stated that this species occurs in the northern parts of southern Africa, "south to N. Cape and O.F.S." This inaccurate statement was probably based on an examination of Broadley, Gans & Visser's (1976) generalized distribution map for *Dalophia* species in southern Africa (their Fig. 12), which shows a southerly extention to about the northern border of the O.F.S. and extending into the western Transvaal. Broadley *et al.* (1976) in fact list only two South African localities, namely "Zoetvlei near Vryburg" (Cape Province) and "Farm 'Hope' between Nylstroom and Vaalwater, Waterberg District" (Transvaal). No additional specimens were collected in the Transvaal during Jacobsen's (1989) survey.

Prosymna ambigua stuhlmanni (Pfeffer, 1893)

There is a specimen of *P. a. stuhlmanni* recorded from Kroonstad in the Lynn Raw collection (LR 1224). I have examined and confirmed the identification of the specimen (140 ventrals, 25 subcaudals), but as the nearest other record for this subspecies is in northern Natal (Branch, 1988a), the occurrence of this species in the O.F.S. is considered extremely doubtful and the record is therefore rejected. There is also a record of *P. s. sundevallii* from Kroonstad in the Lynn Raw collection (LR 1229).

Dipsina multimaculata (A. Smith, 1847)

This species was recorded from Smithfield (as *Rhamphiophis multimaculatus*) and the specimen was housed in the South African Museum (Boulenger, 1910). According to De Waal (1978, p. 13), the specimen could not be traced, and the species' occurrence in the O.F.S. could not be confirmed. Judging by its distribution, which includes the north-eastern Cape Province, it is not altogether unlikely that this species does occur in the south-eastern O.F.S. (see section 4.4).

Psammophis sibilans sibilans (Linnaeus, 1758)

Loveridge (1940) recorded this species from Kroonstad. De Waal (1978, p. 13) did not examine the material and could not confirm the occurrence of this species in the O.F.S. Following recent taxonomic changes, the only taxon in the *P. sibilans* complex which occurs anywhere near the O.F.S. is *P. s. brevirostris* (Broadley, 1983, 1990). The nearest other record for this taxon is a locality about 100 km north-west in the Transvaal. While it seems unlikely that De Waal (1978) would have failed to collect at least one specimen during his survey, the Kroonstad record and those in the northern Cape and south-western Transvaal suggest that this species may well occur in the O.F.S., at least in the near future (see section 4.4).

Psammophis angolensis (Bocage, 1872)

According to De Waal (1978, p. 13), a specimen from Philippolis in the British Museum (1909.9.3.6) is mentioned and illustrated by Noble (1966). However, the most southerly record of the species is at locus 2527 CA in the southern Transvaal (Jacobsen, 1989), and the Philippolis record (specimen probably mislabelled) is therefore rejected.

Aspidelaps scutatus (A. Smith, 1848)

According to De Waal (1978, p. 13), this species was recorded from Philippolis (Hewitt, 1912, p. 227) and Thaba 'Nchu (FitzSimons, 1962; lost in Port Elizabeth Museum collection), but these records were rejected by Broadley (1968) in a revision of the species. The nearest other record (*A. s. scutatus*) is at locus 2628 AA in the southern Transvaal (Jacobsen, 1989).

4.4 Annotated checklist of herpetofauna which may occur in the Orange Free State

ANURA

Family: **BUFONIDAE** Gray, 1825

Bufo gariepensis nubicolus Hewitt, 1927

This Afromontane subspecies occurs at altitudes of 2100-3000 m a.s.l. in the Natal Drakensberg, and has been recorded at Mont-aux-Sources (2828 DD) and Royal Natal National Park (2828 DB) on the Natal/O.F.S. border (Poynton, 1964; Bourquin & Channing, 1980; Lambiris, 1989a).

Family: **MICROHYLIDAE** Günther, 1859 "1858" (1843)

Phrynomerus bifasciatus bifasciatus (Smith, 1847)

Hewitt & Power (1913, p. 171) recorded this form from Kimberley, but noted that the specimens "no doubt came in firewood from Bechuanaland (= Botswana)". Poynton (1964, p. 86) disputes this, noting that the occurrence of *P. b. bifasciatus* in the northern Cape illustrates a typical tropical distribution pattern (see Poynton, 1962). I have personally examined 11 specimens from Kimberley in the McGregor Museum, collected at various sites in the town - Bultfontein Mine (MMK 964); Winsome Vale, De Beer's (MMK 965); Dutoitspan Mine (MMK 966, two specimens); Kimberley (MMK 967, two specimens); Wesselton Mine (MMK 968, two specimens); De Beer's Mine (MMK 969); Wesselton (MMK 970, two specimens). The specimens exhibited the following features - Dorsum black with wide, pale dorso-lateral bands and a large pale area usually present in region of urostyle; occasionally additional pale spots present on dorsum; pale spots on limbs; ventrum marbled, usually extensively; tips of fingers, but less so for toes, expanded into truncated discs; inner metatarsal tubercle poorly developed and not flanged. This fossorial, savanna species has a tropical distribution and has been recorded at Leeudoringstad, south-western Transvaal (2726 AA) and Kimberley (2824 DD) (Poynton, 1964; Jacobsen, 1989). It may occur in the Kalahari Thornveld of the north-western O.F.S.

Family: **RANIDAE** Gray, 1825

Tomopterna krugerensis Passmore & Carruthers, 1975

This species ranges from north-eastern Namibia, eastwards through Botswana, north-western and south-eastern Zimbabwe, northern half of the Transvaal, southern Mocambique and northern Natal, with an isolated population at Chelmsford Dam in north-western Natal. The latter population occurs at loci 2729 DD and 2829 BB near the north-eastern O.F.S. border (Lambiris, 1989a).

Ptychadena oxyrhynchus (Smith, 1849)

This tropical species has been recorded as far west as locus 2829 BD in Natal (Lambiris, 1989a) and may occur in the north-eastern O.F.S. In Natal, the species occurs mainly in the lower-lying eastern half of the province (Lambiris, 1989a).

Ptychadena porosissima Steindachner, 1876

This species has been recorded at Cathedral Peak (2829 CC) near the Natal/O.F.S. border (Poynton, 1964; Bourquin & Channing, 1980). However, Lambiris (1989a) did not mention this record, his closest Natal record to the O.F.S. border being at Champagne Castle (2929 AB) in the Natal Drakensberg. According to Lambiris (1989a), *P. porosissima* is widespread in Natal, but an apparent "gap" separates upland and lowland populations. This species is probably more likely to occur in the O.F.S. than *P. oxyrhynchus*, as its upland population appears to be typically Drakensberg-associated.

Rana vertebralis Hewitt, 1927

This fully aquatic montane species is currently known only from the Natal and Cape Drakensberg and Lesotho highlands (Bates, Lambiris & Haacke, in prep.). It has been recorded from Mont-aux-Sources (2828 DD) and Royal Natal National Park (2828 DB) on the Natal/O.F.S. border (Poynton, 1964; Bourquin & Channing, 1980; Lambiris, 1989a). According to Bourquin & Channing (1980), specimens have been collected at altitudes of 1800 m and 2800-3000 m a.s.l. in the Natal Drakensberg. If this species does occur in the O.F.S., it would probably be restricted to alpine or high-elevation, cold mountain streams in the Qwa Qwa area.

Strongylopus wageri (Wager, 1961)

This species occurs in Natal and northern Transkei, usually at high altitudes. It has been recorded as far west as Royal Natal National Park (2828 DB and 2828 DD) on the Natal/O.F.S. border (Bourquin & Channing, 1980; Lambiris, 1989a) and is likely to occur in the O.F.S. Drakensberg in the Qwa Qwa region. According to Bourquin & Channing (1980), the species is found at altitudes of 2000 m a.s.l. and lower. Jacobsen (1989) is of the opinion that Poynton's (1964) Sabie record is referrable to the *S. g. grayii* complex, although he did not examine the specimen (Albany Museum).

Phrynobatrachus mababiensis FitzSimons, 1932

This tropical species has been recorded at Syferfontein (13HP) farm (2726 AB) in the south-western Transvaal; this locality represents one of three apparently isolated populations in the western half of the Transvaal (Jacobsen, 1989). The Syferfontein material needs to be re-

examined in order to confirm its taxonomic status (the material may be aberrant *P. natalensis*), as this record appears to be far out of the range of the species. However, if confirmed, the species may occur in the north-western O.F.S.

Cacosternum nanum nanum Boulenger, 1887

Cacosternum nanum parvum Poynton, 1963

Problems in determining the subspecific status of *C. nanum* material has been discussed in the species account (section 4.6). Lambiris (1989a) recorded *C. n. nanum* at Royal Natal National Park (2828 DB) and *C. n. parvum* at Cathedral Peak (2829 CC) and Van Reenen (2829 AD) on the Natal/O.F.S. border. Lambiris (1991) later treated *C. n. parvum* as a valid species.

Family: **HEMISOTIDAE** Cope, 1867

Hemisus guttatus (Rapp, 1842)

Mainly restricted to the Natal lowlands, from middle to northern Natal, with an isolated record from Schaapvlakte farm (2729 DB) in the Newcastle district of the north-west, near the north-eastern O.F.S. border (Poynton, 1964; Lambiris, 1989a); a single record exists for the south-eastern Transvaal at Piet Retief (Poynton, 1964; Jacobsen, 1989). This secretive species may occur peripherally in the north-eastern O.F.S.

SQUAMATA

SAURIA

Family: **AGAMIDAE** Gray, 1827

Agama aculeata armata Peters, 1854

Lambiris (1988b, p. 38) recorded a specimen (AJL 1229; examined by me) from 1 km south of Tiger Falls at Royal Natal National Park on the Natal/O.F.S. border; this form may thus occur in the extreme north-eastern O.F.S. McLachlan (1981, p. 225, Fig. 3) recorded this eastern subspecies from eastern Botswana, Caprivi Strip, Zimbabwe, Mocambique, northern and eastern Transvaal and Natal. Jacobsen (1989), however, recorded *A. a. distanti* from most of the Transvaal, with the exception of the extreme north, where it is replaced by *A. a. armata*. The status of the subspecies of *A. aculeata* is not clear in some areas, and further investigations are required. Jacobsen (in prep.) has reviewed *A. a. armata* in the Transvaal.

Family: **SCINCIDAE** Gray, 1825

Mabuya spilogaster (Peters, 1882)

This skink is arboreal in *Acacia* trees and has been recorded at Kimberley (Broadley, 1977a, pp. 63-64). It may occur in the Kalahari Thornveld of the western O.F.S. Elsewhere, the species occurs in southern Angola, Namibia, western Botswana and the northern Cape Province (Broadley, 1977a).

Acontias breviceps Essex, 1925

This species has been recorded at locus 2730 AC in the south-eastern Transvaal (Broadley & Greer, 1969, p. 18) and may occur in the extreme north-eastern O.F.S. However, it is currently known only from montane areas of the eastern Transvaal and eastern Cape Province (Broadley & Greer, 1969).

Acontias lineatus lineatus Peters, 1879

This species has been recorded at locus 2924 CA in the Cape Province (Broadley & Greer, 1969, pp. 23-24) and may occur in the extreme south-western O.F.S. Elsewhere it is known from southern Namibia, and western and central Cape Province (Broadley & Greer, 1969).

Acontias percivali occidentalis FitzSimons, 1941

This legless skink occurs mainly in the northern half of southern Africa, with an isolated population in the south-western Transvaal, represented by two nearby localities, namely the farms Morakane (1 HN) (2725 AA) and Grootplaats (29 HN) (2724 DD) (Jacobsen, 1989, p. 408). According to Jacobsen (1989, p. 406), considerable morphological variation occurs within the genus *Acontias*. The Grootplaats locality is near the Vaal River, and if the Transvaal material proves to be correctly identified (the material may be aberrant *A. g. gracilicauda*), the species may conceivably occur in the north-western O.F.S.

Family: **CORDYLIDAE** Mertens, 1937

Chamaesaura anguina anguina (Linnaeus, 1758)

This agile lizard is closely related to *C. aenea*, which is known from the north-eastern O.F.S. It occurs in the Cape Fold Mountains, eastern Cape and Natal lowlands, and along the escarpment to the Transvaal Drakensberg (Branch, 1988a; Jacobsen, 1989). Lambiris (1989a) recorded sympatry between *C. aenea* and *C. a. anguina* at Royal Natal National Park on the Natal/O.F.S. border. This indicates that *C. a. anguina* may well occur in at least the mountainous north-eastern O.F.S.

Pseudocordylus microlepidotus fasciatus A. Smith, 1838

This cordylid occurs on the inland mountains of the eastern Cape Province (Branch, 1988a, pp. 171-172). It has been recorded at Colesberg (3025 CA) (FitzSimons, 1943) near the southern border of the O.F.S. and may therefore occur in the extreme southern region of the province.

Pseudocordylus langi Loveridge, 1944

This rupicolous cordylid is found on the summit and upper slopes of the Natal Drakensberg and adjacent areas in Lesotho, and is classified as "Restricted" in the *South African Red Data Book - Reptiles and Amphibians* (Branch, 1988a,b). It has been recorded at Mont-aux-Sources near Qwa Qwa (Loveridge, 1944; Bourquin & Channing, 1980) and may occur on the highest associated peaks in the north-eastern O.F.S.

Family: **LACERTIDAE** Bonaparte, 1831

Tropidosaura cottrelli (Hewitt, 1925)

This monticolous species is found at high elevations in the Natal Drakensberg and Lesotho; the type locality is Nemahedi Camp near Mont-aux-Sources in Lesotho (FitzSimons, 1943; Bourquin & Channing, 1980). The species might occur on the highest peaks in the north-eastern O.F.S.

Pedioplanis lineoocellata pulchella (Gray, 1845)

This lizard occurs in the southern half of the Cape Province (Branch, 1988a, pp. 145-146), with an isolated population in the northern half of the Transvaal (Jacobsen, 1989). It was also recorded at Smithfield by FitzSimons (1943), although De Waal's (1978, pp. 69-70) analysis of O.F.S. material indicated that only *P. l. lineoocellata* occurs in the province. The isolated population in the Transvaal, if truly *pulchella*, is particularly interesting considering its vast separation from Cape populations of *pulchella*. It is possible that *pulchella* occurs in the extreme southern O.F.S.

Pedioplanis laticeps (A. Smith, 1838)

This lacertid has been recorded from Namaqualand, western Cape Province and the central Karoo (Branch, 1988a, p. 145), but its range may extend into the Karoo of the south-western O.F.S.

Meroles suborbitalis (Peters, 1869)

This fast-moving desert lizard occurs in the southern half of Namibia, Little Namaqualand and the central Karoo (Branch, 1988a, pp. 141-142). It may occur in the False Upper Karoo of the south-western O.F.S.

AMPHISBAENIA

Family: **AMPHISBAENIDAE** Gray, 1825

Zygaspis quadrifrons (Peters, 1862)

This worm-lizard is found in Namibia, Botswana, Zimbabwe, northern Transvaal and central Mocambique, then southwards into the northern Cape Province and northwards to Zaire (Branch, 1988a, p. 105; Jacobsen, 1989, p. 726). It has been recorded at locus code 2923 BB (Visser, 1984c, p. 77) near the south-western border of the O.F.S., where it might be found in the future.

SERPENTES

Family: **BOIDAE** Daudin, 1803

Python sebae natalensis A. Smith, 1840

This giant snake is usually found in savanna areas of southern and eastern Africa, although it may occasionally occur in forest. There is a somewhat isolated record in Natal (2729 BD) near the north-eastern O.F.S. border (Broadley, 1990), as well as a record at locus 2725 AD in the south-western Transvaal (Jacobsen, 1989). The species may occur naturally in parts of the Kalahari Thornveld of the north-western O.F.S. Nature Conservation officials at Sandveld Nature Reserve near Hoopstad have informed me that at least one python was introduced into that reserve in recent years.

Family: **COLUBRIDAE** Gray, 1825

Lycodonomorphus laevissimus fitzsimonsi Raw, 1973

This water snake is found in the Natal midlands and Drakensberg (one record) and northwards into the south-eastern Transvaal (one record in the southern Transvaal) and Swaziland highveld (Jacobsen, 1989; Broadley, 1990; Boycott & Culverwell, 1992). It has been recorded from Royal Natal National Park (Bourquin & Channing, 1980) on the Natal/O.F.S. border, as well as at Three Rivers on the northern side of the Vaal River in the Transvaal (Jacobsen, 1989). The species may well occur in the Qwa Qwa area, as well as along the Vaal River in the northern O.F.S. The Three Rivers locality probably represents a specimen washed downstream in the Vaal River, possibly during floods, as it is very isolated from other records for the subspecies. Jacobsen (1989, p. 801) noted the close morphological similarities between the three races of *L. laevissimus*, namely *laevissimus, fitzimonsi* and *natalensis*, and suggested that "a clinal distribution cannot be ruled out, and the species may be in need of revision". The taxonomic status of *L. laevissimus* is currently being reviewed by W.R. Branch & G.V. Haagner (pers. comm.).

Amphlorhinus multimaculatus A. Smith, 1847

This species has an essentially Afromontane distribution in southern Africa. It has been recorded from Mont-aux-Sources (2828 DD) in the Natal Drakensberg (Bourquin & Channing, 1980; Broadley, 1990) and at locus 2730 AC in the south-eastern Transvaal (Jacobsen, 1989; Broadley, 1990). The species is almost certain to occur in the mountainous north-eastern O.F.S., especially in the Qwa Qwa region.

Dipsina multimaculata (A. Smith, 1847)

This rare, diurnal snake occurs in Namibia, south-western Botswana and at several localities in the central Cape Province (Broadley, 1990). It has been recorded at locus 3026 CC in the north-eastern Cape near the border with the southern O.F.S. (Broadley, 1990). The species was recorded from Smithfield by Boulenger (1910), but the specimen (SAM) is apparently lost, and De Waal (1978, p. 13) could not confirm its occurrence in the O.F.S. However, as in the case of *Aspidelaps l. lubricus*, also recorded only at Smithfield in the O.F.S., with a nearby record on the southern bank of the Orange River at Aliwal North (De Waal, 1978, p. 116), this species may well occur in the extreme southern or south-eastern O.F.S.

Psammophis sibilans brevirostris Peters, 1881

This grass snake is found in eastern and western Zimbabwe, south-eastern Botswana, Transvaal and adjacent northern Cape, Swaziland, southern Mocambique, Natal and Transkei (Broadley, 1990). Broadley (1990) plotted a record at locus 2724 DB in the northern Cape, whereas Jacobsen (1989) plotted records at 2724 DD and 2626 DC in the south-western Transvaal. These records appear to represent the southern range limit of inland populations, but are close enough to the north-western border of the O.F.S. to speculate that the species may indeed occur there. If it does not presently occur in the O.F.S., it may occur there soon, considering the possibility of specimens crossing, or being washed into and crossing, the Vaal River. Loveridge (1940, p. 30 & 41) recorded *P. s. sibilans* (Linnaeus, 1758) from Kroonstadt (= Kroonstad). De Waal (1978, p. 13) did not examine Loveridge's material, but, despite his intensive survey, noted that the occurrence of the species in the O.F.S. could not be confirmed. According to Broadley (1990), southern African snakes included by FitzSimons (1962) under *P. s. sibilans* in fact comprise three taxa, namely *P. s. leopardinus, P. s. brevirostris* and *P. phillipsii.* True *P. s. sibilans* reaches its southern limit in central Tanzania (Broadley, 1990), and judging by the distribution of all the forms comprising the *P. sibilans* complex, Loveridge's (1940) Kroonstad record is probably referrable to *P. s. brevirostris*, if indeed accurate. Considering the fact that not a single *P. sibilans* was collected during De Waal's (1978) survey, and the fact that Kroonstad is about 100 km south-east of the closest Transvaal record (2626 DC), it would be premature at the present time to include *P. s. brevirostris* as part of the herpetofauna of the O.F.S.

Philothamnus hoplogaster (Günther, 1863)

This tropical species occurs in east Africa southwards down the eastern half of southern Africa, and is adapted to conditions varying from the coastal plain, inland savanna and even montane forest (Broadley, 1990). There is a record of this species at locus 2729 DD in Natal, near the border with the north-eastern O.F.S. (Broadley, 1990). *P. hoplogaster* may occur in Afromontane forest in this region.

Philothamnus semivariegatus semivariegatus A. Smith, 1840

This arboreal bush snake occurs in the northern and eastern halves of southern Africa (including some arid areas), but is apparently absent from the O.F.S. and Lesotho (see Broadley, 1990). It has been recorded on the western periphery of the O.F.S. at loci 2824 BD and 2824 DB in the Kimberley area (Broadley, 1990) and at loci 2724 BD and 2725 CA slightly north of the north-western O.F.S. border with the south-western Transvaal (Jacobsen, 1989). It could thus be expected to occur in the Kalahari Thornveld of the north-western O.F.S.

Telescopus semiannulatus semiannulatus A. Smith, 1849

This nocturnal tiger snake is found in Kenya and Zaire in the north, southwards to Natal, Transvaal, northern Cape Province, Kalahari and northern Namibia (Broadley, 1990). Its sparse distribution in the northern Cape region indicates the need for more intense surveys in that area. The species has been recorded at Kimberley (2824 DB) and at locus 2924 CA at the periphery of the Cape Province and south-western O.F.S. (Broadley, 1990). It may occur peripherally in the western O.F.S.

Dasypeltis inornata A. Smith, 1849

This egg-eating snake occurs in the south-eastern Transvaal, western Swaziland, Natal and the eastern Cape Province. Broadley (1990) recorded the species at two localities in the vicinity of the Natal/O.F.S. border (2729 DD; 2829 BC), whereas Bourquin (1990a) recorded the species at three localities in the same area, namely loci 2729-Dd2, 2829-Ad3 and 2829-Cc4. Broadley (1990, p. 264) noted that faintly marked or basically uniformly coloured (brown) specimens of *D. scabra* are often misidentified as *D. inornata*, resulting in erroneous locality records. Uniform phase *D. scabra* also occur in the O.F.S. (De Waal, 1978; this study), but scale counts, especially when the sex of the snake has been determined, allow accurate determination of species status. A re-examination of the western Natal specimens from the loci mentioned above is called for to establish whether or not the Natal/O.F.S. border area does indeed represent the western limit of *D. inornata.* If these specimens were correctly identified, it seems likely that *D. inornata* may occur peripherally in the north-eastern O.F.S.

Family: **ELAPIDAE** Boie, 1827

Elapsoidea semiannulata boulengeri Boettger, 1895

This elusive snake is widespread in south-east Africa and also occurs in northern Natal, Swaziland lowveld and the northern half of the Transvaal, with two localities in the Kimberley region which appear to represent an isolated population (Broadley, 1990). The Kimberley locality (2824 DB) suggests that the species might inhabit bushveld in the western O.F.S. However, there is the possibility that material from the above two localities was misidentified as the superficially similar *E. sundevallii media* (subadult colour pattern), which occurs as far west as the Kimberley area.

Elapsoidea sundevallii sundevallii (A. Smith, 1848)

This species occurs in the south-eastern Transvaal, Swaziland highveld and Natal (excluding the north-east), at altitudes from sea level to 1600 m a.s.l. (in western Natal). It has been recorded at two loci near the Natal/O.F.S. border, namely 2729-Dd3 and 2829-Cb3 (Bourquin, 1990; Broadley, 1983, 1990), and may occur peripherally in the north-eastern O.F.S.

Naja mossambica Peters, 1854

This cobra species has a widespread distribution, being found from Pemba Island and south-eastern Tanzania southwards to Natal and westwards to southern Angola and northern Namibia (Broadley, 1990). It has been recorded at locus 2829 BC on the Natal/O.F.S. border, and may occur in the north-eastern O.F.S.; there is also a record at locus 2624 DD in the northern Cape, and there is therefore also the possibility that the species occurs in bushveld in the north-western O.F.S. (see Broadley, 1990).

Family: **VIPERIDAE** Gray, 1825

Bitis caudalis A. Smith, 1839

This small adder is found in south-western Angola, Namibia, the southern halves of Botswana and Zimbabwe, western half of the Transvaal and central Cape Province (Broadley, 1990). Two localities, apparently representing the south-eastern range limit, are close to the south-western O.F.S. border, namely 2924 CA and 2924 AA (Broadley, 1990), and being an arid species, it is likely to occur peripherally in the Karoo of the south-western O.F.S.

CHELONIA

Family: **TESTUDINIDAE** Gray, 1825

Psammobates tentorius tentorius (Bell, 1828)

Psammobates tentorius verroxii (Smith, 1839)

Greig & Burdett's (1976) distribution map for *P. tentorius* (Fig. 7) does not indicate the boundaries between the three subspecies (also *trimeni*), as the same symbol is used on the map for all three subspecies. They do, however, indicate intergrade zones and what could be regarded as areas where "true" forms of any one of the three subspecies occurs. From their map, that of Branch (1988a) and that of Bourquin & Channing (1988), it appears as if the nominate subspecies and *verroxii* occur near the south-western and possibly southern border of the O.F.S. It is not known to what extent the Orange River constitutes a boundary to the movement of tortoises, although it must clearly represent a barrier to short-term range extentions. Tortoises may be dropped by predatory birds and, if surviving, gain "access" north of the river. From the available locality data, it seems probable that *verroxii* may soon be found in the extreme south-western O.F.S., and *tentorius* in the extreme southern part of the province. A presumably translocated female *P. t. tentorius* (plastron length = 73,3 mm) was found in open veld at Rayton near Bloemfontein (2926-Aa2).

4.5 Systematic checklist and index to the amphibians and reptiles of the Orange Free State

AMPHIBIA

Order: **ANURA**

Suborder: **OPISTHOCOELA**

Family: **PIPIDAE** Gray, 1825

Subfamily: **XENOPODINAE** Fitzinger, 1843

Genus: *Xenopus* Wagler, 1827

Family: **HELEOPHRYNIDAE** Noble, 1931

Genus: *Heleophryne* Sclater, 1899

Suborder: **PROCOELA**

Family: **BUFONIDAE** Gray, 1825

Genus: *Bufo* Laurenti, 1768

Genus: *Schismaderma* Smith, 1849

Suborder: **DIPLASIOCOELA**

Family: **MICROHYLIDAE** Gunther, 1859 "1858" (1843)

Genus: *Breviceps* Merrem, 1820

REPTILIA

Order: **SQUAMATA**

Suborder: **SAURIA**

Family: **GEKKONIDAE** Cuvier, 1817

Family: **AGAMIDAE** Gray, 1827

Order: **CHELONIA**

Suborder: **CRYPTODIRA**

Family: **TESTUDINIDAE** Gray, 1825

Genus: *Geochelone* Fitzinger, 1835

G. pardalis (Bell, 1828) 302

Genus: *Psammobates* Fitzinger, 1835

P. oculifer (Kuhl, 1820) 303

Genus: *Homopus* Duméril & Bibron, 1835

H. femoralis Boulenger, 1888 303

Suborder: **PLEURODIRA**

Family: **PELOMEDUSIDAE** Cope, 1868

Genus: *Pelomedusa* Wagler, 1830

P. subrufa subrufa (Lacépède, 1788) 304

4.6 Systematic account of the amphibians of the Orange Free State

(Locality records are based on material in the National Museum, Bloemfontein, unless where otherwise stated.)

(Distribution maps for amphibians, i.e. Figs 20-40, are presented on pages 94 to 104)

Class: **AMPHIBIA** Linnaeus, 1758

Order: **ANURA** Rafinesque, 1815

Family: **PIPIDAE** Gray, 1825

Subfamily: **XENOPODINAE** Fitzinger, 1843

Genus: *Xenopus* Wagler, 1827

Xenopus laevis laevis (Daudin, 1802) Common Clawed Frog

Bufo laevis Daudin, 1802, *His. nat. Rainettes*, p. 85, pl. 30, fig. 1. No type locality, type apparently lost (Poynton & Broadley, 1985a).

Xenopus laevis laevis (Daudin): De Waal, 1980a, p. 95; Bates, 1988a, p. 51; 1991b, p. 153 and 1992a, p. 42, fig.

Range

Throughout southern Africa but excluding most of the Mozambique Plain, most of Botswana, most of the northern Cape Province and northern Namibia; relict populations occur on Inhaca Island and the Shire and Nyika areas of Malawi. Bourquin & Channing (1980) record juveniles being found at an elevation of 1965 m a.s.l.

Zoogeographical classification: Cape Temperate.

Range cluster in O.F.S.: Throughout (T).

Distribution in the Orange Free State (44 localities; Fig. 20)

Specimens examined from: Alma; Arcadia; Babel; Benfontein on Benaauwdheidsfontein (442) (NMB; MMK 1039, ten specimens); Blesbokpan; Boschkop; Constanza; Dam van Trane; Deelfontein; Dundee; Fauresmith; Ferreira School; Florisbad; Geluk; Golden Gate Highlands National Park; Hartenbosch; Heilbron, Phillipolis; Holme's Dale; Klipbankfontein; Klippan; Knellpoort; Kristalpan on Wonderhoek (1698); Lusthof (TM 36669); Mierfontein; Morgenzon, Senekal; Mount Pleasant; Ospoort; Pinekloof

(NMB A5336, two tadpoles); Poortje; Ruigtepoort; Shannon; Smaldeel; Strijdfontein; Sweet Home; Thaba 'Nchu; Thaba Pachoa Berg; Tussen-die-Riviere Game Farm; Uitkijk; Uitzicht; Vissershoek West; Wagenmaker's Drift; Waterval, Winburg; Wesselsdam; Woonhuis near Marah (420); Zandfontein, Smithfield.

Other records: Ngotswane Gorge (sight record, M.F. Bates & R.M. Douglas, 13 November 1990).

Extralimital records (two localities; Fig. 20)

Ten specimens examined from: Kimberley (MMK 1033; MMK 1042, eight specimens); Kimberley (Queens Park) (MMK 1032).

Features (163 specimens examined: 161 frogs, two tadpoles)

Largest specimen (NMB A5195 - Wagenmaker's Drift) 104,2 mm SVL (ex-fix).

Toes fully webbed; inner three toes with black claws; subocular tentacle small. Body flattened, dorsal surface grey to olive brown with dark patches of variable size; ventral surface white to yellowish, often with grey spots or streaks.

Habitat and Ecology

Primarily an aquatic species, found in a variety of water habitats, including streams, pools, dams and even cattle drinking troughs. Specimens have been seen crossing land after rain at Estoire near Bloemfontein and on the farm Arcadia near Lindley (Bates & De Swardt, 1990, p. 46). Jacobsen (1989, p. 1212) observed specimens crossing land during rain showers in Zimbabwe, and collected ten specimens in wire traps set 200 m from the nearest water in the Transvaal. Pienaar, Passmore & Carruthers (1976, p. 12) noted that clawed frogs emerge from water during wet weather and migrate between pools. This phenomenon has also been recorded by Hewitt & Power (1913), Loveridge (1953), Wager (1965, 1986), Passmore & Carruthers (1979) and Bourquin & Channing (1980).

This frog is both a scavenger and a predator (Poynton, 1964, p. 29) and has been recorded as preying on almost anything smaller than itself, including insects and the flesh of carcasses (Jacobsen 1989, p. 1213). Earthworms and adult *Tomopterna natalensis* and *Hyperolius marmoratus taeniatus* were taken in captivity (Hoffman, 1990, p. 58). Enemies include birds such as the Hamerkop *Scopus umbretta bannermani* and Dabchick *Tachybaptus ruficollis* (Wager, 1986, p. 33), and according to Jacobsen (1989), Rowe-Rowe (1977) recorded the Cape Clawless Otter *Anonyx capensis*, Spotted-necked Otter *Lutra maculicollis* and Water Mongoose *Atilax paludinosus* as preying on adults. In a sample of eight Yellowbilled Egrets *Egretta intermedia* from Soutpan in the central O.F.S., one or more adult *X. l. laevis* specimens were found in 50% of bird stomachs; 38 frogs out of a total of 394 prey items in the eight bird stomachs were *X. l. laevis*, representing 9,6% of the birds' diet in terms of the number of prey items eaten by all the birds (Bates, De Swardt & Louw, 1992, p. 44). Jacobsen (1989, p. 1213) noted that Transvaal *X. l. laevis* bred during the summer months, laying several thousand eggs; the tadpoles aggregated in swarms. Eggs are attached to underwater objects (Wager, 1986, p. 52).

Remarks

De Waal (1980a, p. 93) noted that this common frog had not been recorded as occurring in the O.F.S. prior to his paper. Trinomials are needed as the race *X. l. petersii* Bocage, 1895 (syn. = *X. l. poweri* Hewitt, 1927), which occurs to the north of the range of *X. l. laevis* (with some intergradation), is distinguished by a speckled to heavily marked venter (Poynton & Broadley, 1985a, p. 509, Figs 1 & 2).

Family: **HELEOPHRYNIDAE** Noble, 1931

Genus: *Heleophryne* Sclater, 1899

Heleophryne natalensis (Hewitt, 1913) Natal Ghost Frog

Heleophryne natalensis Hewitt, 1913, *Ann. Natal Mus.*, 2, p. 477, pl. 34, figs 1, 3, 5-7. Type locality: "a tributary of the Krantz Kloof River" (probably in the Kranzkloof Nature Reserve, 12 miles north-west of Durban [Poynton, 1964, p. 40]). Holotype in the Mariannhill Monastery Museum, Natal, South Africa. Bates & Douglas, 1991, p. 14; Bates, 1992a, p. 42.

Range

Eastern Transvaal, Natal (excluding the north), north-eastern Lesotho and extreme north-eastern O.F.S.

Zoogeographical classification: Eastern Temperate Transitional.

Range cluster in O.F.S.: Drakensberg (D).

Distribution in the Orange Free State: (three localities; Fig. 21)

Specimens examined from: Mount Pierre (GGHNP) (28° 32'S, 28° 39'E); Stream north of Metsimatsho Dam and east of Phuta-Ditjhaba (28° 35'S; 28° 57'E); Witzieshoek Mountain Resort.

Features (12 specimens examined: three adults, nine tadpoles)

Largest specimen: 47,9 mm SVL (NMB A4719).

Adults with flattish bodies; dorsum olive green to chocolate brown with yellow patches of variable size. Head wide with bulging eyes. Tips of fingers and toes expanded and spatulate, but less so for toes than fingers. Venter white and slightly granular. 1½ phalanges of 3rd toe, three phalanges of 4th toe and 1-1½ phalanges of 5th toe without webbing.

Habitat and Ecology

Four adult *H. natalensis* and a small river crab were found in a horizontal crevice (about 20 cm deep and 10 cm high) formed by large flat rocks situated at the side of a cool, 1-m-deep pool formed by a tributary of the Metsimatsho river (Bates & Douglas, 1991, p. 14). The crevice was about 1 m up from the water surface. Two specimens were collected with some difficulty, the other two jumping into the pool and apparently disappearing under the mud at the bottom. A number of tadpoles were observed further downstream where the water was shallow (about 5 cm deep) and flowed slowly over a substrate composed mostly of large, flat sheets of rock. One tadpole, attached to the rock by means of its huge, sucker-like mouth, was collected. The tadpoles were seen even in the middle of the clear stream and seemed very lethargic. In January 1992, an adult was found in a rock crevice at a waterfall at Mount Pierre in Golden Gate Highlands National Park by L.H. du Preez, whereas four tadpoles of varying sizes were also collected at this site in clear pools measuring about 500 x 500 cm. A further four tadpoles of various lengths were collected at Witzieshoek Mountain Resort by L.H. du Preez on 6 August 1992. While *H. natalensis* is considered to be a forest species, inhabiting bouldery streams, Bourquin & Channing (1980, p. 7) recorded specimens from the Natal Drakensberg which were collected far from streams and forest, i.e. in a soil pit in open grassland and in a hole in a sheer-faced road cutting in open grassland. Lambiris (1989a, p. 46) stated that the breeding habitat appears to be restricted to clear, shallow waters which flow rapidly over rocky substrates, and the tadpoles spend a great deal of time sheltering in underwater rocky crevices. The eggs of *H. natalensis* have never been found, but according Wager (1986, p. 135), they are probably large, few in number, and deposited in a nest deep under a ledge or rock shelf. The tadpole grows to 86 mm in length (Lambiris, 1989a, p. 45) and has a flattened body with a sucker-like mouth used for clinging to rocks, although the mouth can also be used as a locomotory organ (Wager, 1986, p. 135).

Remarks

Five species of *Heleophryne* are recognized, all occurring in South Africa (Boycott, 1988). Four species occur in the southern and/or south-western Cape Province, while *H. natalensis* is found only in the eastern Transvaal, Natal, north-eastern O.F.S. and north-eastern Lesotho. Lambiris (1989a) recorded *H. natalensis* from the same quarter-degree unit (2828 DB) in Natal as the Metsimatsho River locality, and specimens have also recently been collected in north-eastern Lesotho (Bates, Lambiris & Haacke, in prep.).

Family: **BUFONIDAE** Gray, 1825

Genus: *Bufo* Laurenti, 1768

Bufo gariepensis gariepensis Smith, 1848 Karoo Toad

Bufo gariepensis Smith, 1848, *Illus. Zool. S. Afr. Rept.*, pl. 69, fig. 2, 2a. Type locality: "banks of the Orange (Gariep) river". Holotype in the British Museum of Natural History, London.

Bufo gariepensis gariepensis Smith: Poynton, 1964, p. 45, fig. 12; De Waal, 1980a, p. 98; Bates, 1991b, p. 154.

Range

Most of the Cape Province, southern and eastern O.F.S. and Lesotho. Poynton (1964, map 8, p. 265) records this form from a single locality in the south-eastern Transvaal and one in Swaziland. However, Jacobsen (1989, p. 1225) records only the alpine subspecies *B. g. nubicolus* as occurring in the Transvaal, plotting a record at the same locus plotted by Poynton (1964, map 8, p. 265) for *B. g. gariepensis* (2730 AC). The Swaziland specimen may also be *B. g. nubicolus*, but awaits confirmation by Boycott (in prep.).

Zoogeographical classification: Central Temperate Transitional.

Range cluster in O.F.S.: Southern and Eastern (S & E).

Distribution in the Orange Free State (45 localities; Fig. 22)

Specimens examined from: Bachelor's Home; Bergkloof; Blaauwfontein; Boschkloof; Bramley's Hoek; Brightside; Damfontein; Doornhoek; Clarens, 11 miles east of (DNSM 200); Exelsior, Edenburg; Golden Gate Highlands National Park (NMB; TM 64684); Groenekloof; Grootkloof; Harrismith; Harrismith (Botanical Gardens); Heilbron, Philippolis; Hexrivier; Kranskop; Kristalpan on Wonderhoek (1698); La Belle France; Lemoenboord; Luiperfontein; Machbela; Monontsa Pass; Morgenzon, Ficksburg; Morgenzon, Senekal; Noodhulp; Rietfontein; Rouxville; Rohallion; Sentinel; Straalfontein; Thaba 'Nchu; Thaba Pachoa Berg; Thaba Phatshwa Mountain; Tussen-die-Riviere Game Farm; Uitkijk; Verdun, Fouriesburg; Vergaderrand; Waterfall; Weltevreden, Smithfield; Wittepoort; Zandfontein, Smithfield.

Other records: Ficksburg; Smithfield; Wepener (Poynton, 1964).

Extralimital records (one locality; Fig. 22)

Riverton (Poynton, 1964).

Features (206 specimens examined)

Largest specimen: 76 mm SVL.

Dorsum tan to brown, usually with numerous scattered asymmetrical dark patches; in NMB A1822-24 and A1870-71 the dorsum is almost uniform brown with only slight indications of dark patches anteriorly; NMB A913 and A1084 are almost black dorsally, with a few light patches. The dorsa of some specimens from Thaba Phatshwa Mountain are similar to the *B. g. nubicolus* ecomorph. The belly and/or throat are whitish, usually with dark spots or small markings of various sizes. The interorbital bar is divided or undivided. Toes are poorly webbed and parotid glands are visible. NMB A1823 is unusual in having two phalanges of the 3rd toe free of web on both feet (cf. *B. amatolica*).

The following abnormalities were noted:

NMB A2100 has no right eye.

NMB A225 has a deformed left foot with only three toes.

NMB A1073 has a deformed right foot with only one toe.

NMB A1895 has a deformed right hand with only four short fingers.

Habitat and Ecology

Found in mountainous and rocky areas of the eastern and southern O.F.S., usually in burrows under rocks, but also collected from inactive termitaria (De Waal, 1980a, p. 98). Occurs up to an elevation of 2591 m a.s.l. at Sentinel in the eastern O.F.S. Wager (1965, p. 112, 1986, p. 62) stated: "I collected this toad at Riet River, O.F.S., at night while it was calling, a loud 'kwa-kwa' pause 'kwa-kwa' repeated at long intervals". He also noted that eggs and tadpoles of this species are unknown.

Remarks

This form was collected at Sentinel at an altitude of 2591 m a.s.l. (De Waal, 1980, p. 98). According to Lambiris (1989a, p. 49), the monticolous subspecies *B. g. nubicolus* occurs at altitudes of 2300-3000+ m a.s.l. I have examined all O.F.S. *gariepensis* as well as topotypic (TM 13854, 13857, 13859, 21726) and several Lesotho *nubicolus* (NMB and TM collections), and although I found Poynton's (1964, p. 20) character "length of outer metatarsal tubercle greater than ½ length of inner" (*gariepensis*) vs "less than ½ inner" (*nubicolus*) to be variable, in dorsal pattern, size and other characters I am confident that all O.F.S. material examined is referrable to the nominate subspecies.

Poynton (1964, p. 47) noted that specimens from Lesotho and the eastern Transvaal, treated by him as *B. g. gariepensis*, have a similar appearance to *B. g. nubicolus*, with narrower parotid glands, a more pronounced difference between metatarsal tubercles and with a tendency for the dorsal blotches to fuse. Jacobsen (1989, pp. 1224-1227) recorded only *B. g. nubicolus* from the Transvaal, and noted that the pronounced difference in habitat between *B. g. gariepensis* from the Karoo and the montane forms (*B. g. nubicolus* and *B. g. inyangae*) suggests that *B. gariepensis* represents more than one species.

Bufo gutturalis (Power, 1927) Guttural Toad

Bufo regularis gutturalis Power, 1927, *Trans. Roy. Soc. S. Afr.*, 14, p. 416, pl. 21, fig. 2. Type locality: Lobatsi and Kuruman [Botswana-Transvaal border]. Syntypes in McGregor Museum, Kimberley.

Bufo regularis (not Reuss, 1834): Poynton, 1964, p. 51, fig. 15.

Bufo gutturalis Power: De Waal, 1980a, p. 96; Bates, 1988a, p. 51.

Range

Transkei, Lesotho, northern and eastern O.F.S., northern Cape Province, Natal, Swaziland, Transvaal, Mozambique, Zimbabwe, northern and southern Botswana, and northwards to Uganda and Kenya; also two isolated localities in northern Namibia.

Zoogeographical classification: Tropical.

Range cluster in O.F.S.: Non-Southwestern (Non-SW).

Distribution in the Orange Free State (24 localities; Fig. 23)

Specimens examined from: Atalanta; De Brug; De Kiel (393) near De Kiel Oost (101) (23 tadpoles); Deelfontein; Frazer Spruit; Greenlands; La Belle France; Lemoenhoek; Mara, Vredefort; Mecklenburg; Middenspruit; Moirton; Patrijsdraai; Pinekloof; Slangheuvel; Willem Pretorius Game Reserve; Wolvekop; Zion.

Other records: Harrismith; Hoopstad; Kroonstad; Winburg (Poynton, 1964); Bothaville (TM 7991-92, 8016); Smithfield (SAM 10935, 11043).

Extralimital records (one locality; Fig. 23)

Nine specimens examined from: Riverton (MMK 414, seven specimens; MMK 931-32).

Features (51 specimens examined: 26 frogs, 25 tadpoles)

Largest specimen: 72 mm SVL.

Dorsal surface pale to dark brown with dark paravertebral patches and a few additional scattered patches. A thin, pale vertebral stripe always present, starting from just in front of or just behind the light interocular bar. A pale cross is present on the top of the head, formed between a pair of dark markings on the top of the snout and a pair of dark markings situated posteriorly between the eyes. Belly and throat granular and whitish, but throat dark in males. Webbing scanty and parotid glands conspicuous. In live specimens, red infusions are present on the back of the thighs (Passmore & Carruthers, 1979, p. 68).

Habitat and Ecology

Collected mainly under rocks in grassveld and bushveld areas of the northern and eastern O.F.S. (De Waal, 1980a, p. 96). Two specimens (NMB A5513-14) from Greenlands, Harrismith were collected separately from *Cordylus giganteus* burrows on 3 April 1992. Prey includes Isoptera, Hymenoptera, Hemiptera and Coleoptera (Jacobsen, 1982, p. 125). According to Lambiris (1989a, p. 50), their preferred breeding habitat is more or less permanent open pools, dams and streams.

Remarks

Passmore & Carruthers (1979, p. 68) follow Tandy & Keith (1972) and Blair (1972) in using the name *B. gutturalis*, which is separable from the northern form *B. regularis* on the basis of hybridization and call studies.

Bufo poweri Hewitt, 1935 Western Olive Toad

Bufo regularis poweri Hewitt, 1935, *Rec. Albany Mus.*, 4, p. 293. Type locality: Kimberley. Types originally in the Albany Museum, Grahamstown (material from this institution later transferred to Port Elizabeth Museum, Humewood).

Bufo garmani not Meek, 1897: Poynton, 1964, p. 55, fig. 17; De Waal, 1980a, p. 100.

Bufo poweri Hewitt: Channing, 1991, p. 82.

Range

Northern Natal, Swaziland, Transvaal, western O.F.S., northern Cape Province, northern Namibia, Botswana, Mozambique, Zimbabwe and northwards through savannas to Somalia (with disjunctions).

Zoogeographical classification: Tropical.

Range cluster in O.F.S.: Western (W).

Distribution in the Orange Free State (15 localities; Fig. 24)

Specimens examined from: Alwyn; Benfontein on Benaauwdheidsfontein (442) (MMK 1049); Blaauwbank (NMB A5194, 24 tadpoles); Carlie; De Brug; Deelfontein; Holme's Dale; Middenspruit; Moirton; Petrusburg; Richmond West (TM 39659); Sandveld Nature Reserve; Smithskraal; Vet Rivier's Mond.

Other records: Hoopstad (Poynton, 1964).

Extralimital records (two localities; Fig. 24)

Twelve specimens examined from: Kimberley (MMK 457, three specimens); Riverton (MMK 475, nine specimens).

Features (52 specimens examined: 28 frogs, 24 tadpoles)

Largest specimen: 98 mm SVL.

Dorsum olive brown with 3-4 pairs of distinct, dark paravertebral patches (brown with a black border); a thin, pale median line may be present. Venter white, throat darkly pigmented in males. The dark interocular patches converge posteriorly but do not fuse (no distinct dark patches evident in NMB A5176). In NMB A2153, the second pair of paravertebral patches fuse over the midline and represent the first pair on the left side of the body. In life (e.g. NMB A5174-77), red infusions are present on the back of the thighs and extend along the sides of the body to beneath the armpits.

Habitat and Ecology

Found under rocks and in Suricate *Suricata suricatta* burrows in the O.F.S. (De Waal, 1980a, p. 100). Four specimens (NMB A5174-77) were collected together under a large rock near the edge of a dam at Petrusburg, whereas several individuals were found at night on the banks of a river and dam at Sandveld Nature Reserve during late March 1992. The main prey at Nylsvley Nature Reserve in the Transvaal was ants (Hymenoptera) and beetles (Coleoptera) (Jacobsen, 1982, p. 116). The breeding habitat is marshes, pans or dams in open or wooded savanna and males call from exposed positions at the water's edge (Passmore & Carruthers, 1979, p. 72). Up to 20 000 eggs are laid, tadpoles emerging after only 24 hours; metamorphosis occurs after 64 days, at which time froglets measure 9 mm SVL (Taylor, 1982 in Jacobsen, 1989, p. 1241).

Remarks

Poynton (1964) regarded *B. regularis poweri* Hewitt, 1935 as a synonym of *B. garmani* Meek, 1897. Tandy (1972) treated *B. poweri* as distinct from *B. garmani*, based largely on different advertisement calls. Poynton & Broadley (1988, pp. 455-458) treated '*B. garmani*' as a complex within which a southern component, namely *B. poweri*, is partially separable. Poynton & Broadley (1988, p. 457) indicated that *B. pseudogarmani* Hulselmans, 1969 may be a synonym of *B. poweri*, but noted that "the question of synonymy between *pseudogarmani* and *poweri* has to rest on a much more comprehensive analysis of South African and Namibian material than is presently available ..." Channing (1991) found *B. poweri* to be distinguishable from *B. garmani* on the basis of different male advertisement calls and included the O.F.S. in the range of *B. poweri*, to the exclusion of *B. garmani*. However, no sound recordings are available for specimens in the National Museum's collection and the two forms are difficult to separate on the basis of body proportions and colour pattern (Poynton & Broadley, 1988). In his description of *Bufo regularis poweri*, based on five males, Hewitt (1935, p. 293) noted that the dark dorsal blotches do not show a tendency to fuse medially, and no "yellow mid-dorsal stripe" is present. However, in one O.F.S. specimen (see above), the second pair of paravertebral patches fuse over the midline, and a thin, pale median stripe is present in some specimens. I have examined three topotypical specimens from Kimberley and nine from Riverton, a locality nearby, and also in the northern Cape,

and found these to be inseparable from O.F.S. material. The O.F.S. material is thus referred to *B. poweri* Hewitt, 1935, as suggested by Channing's (1991) sonagraphic evidence. Jacobsen (1989, p. 1241) noted that populations from east-central and eastern Transvaal differ from those in the west and south-west of that province in that the former have russet brown markings edged with black paravertebrally and the latter have brown markings which are mostly not highlighted. However, a more intensive investigation of morphological and ecological characters is needed and Jacobsen (1989) therefore decided to incorporate both "forms" under "*garmani*". Lambiris (1989a, p. 52) suggested that "*B. garmani*" comprises three separate taxa, represented by populations in the northern Cape Province and Botswana (probably also O.F.S., i.e. "*poweri*"), Natal and eastern Transvaal, and Zimbabwe respectively. According to Lambiris (1991), laryngeal morphology convincingly demonstrates that *B. garmani* Meek and *B. poweri* Hewitt are separate taxa. However, specimens from the transition zone between *poweri* and *garmani* (an area at the 30°S longitude line according to Channing, 1991, Fig. 2) are needed in order to settle the nomenclature (J.C. Poynton, pers. comm.). Lambiris' (1989a) record of *B. garmani* from western Natal appears to be located in the transition zone.

Bufo rangeri Hewitt, 1935 — Raucous Toad

Bufo regularis rangeri Hewitt, 1935, *Rec. Albany Mus.*, 4, p. 285. Type locality: "Gleniffer", Kei Road, Cape Province. Holotype in the Port Elizabeth Museum, Humewood.

Bufo rangeri Hewitt: Poynton, 1964, p. 57, fig. 18; De Waal, 1980a, p. 101; Bates, 1991b, p. 154.

Range

From the south-western Cape Province and the coastal region of the southern Cape to the north-eastern Cape, O.F.S., Lesotho, Natal, Swaziland and Transvaal, with an apparently isolated population in the Augrabies-Kakamas area of the northern Cape.

Zoogeographical classification: Eastern Transitional.

Range cluster in O.F.S.: Non-Southwestern (Non-SW).

Distribution in the Orange Free State (90 localities; Fig. 25)

Specimens examined from: Allanvale; Annies Rust; Arcadia; Ark; Bergkraal; Bloemfontein; Blydschap; Boschkloof; Caledonspoort; Carlie; Ceylon; Chubani; Dealbata; Deelfontein; De Hague; Doornhoek (22 tadpoles); Falle Grange; Goedetrouw; Golden Gate Highlands National Park; Greylingsfontein; Groenland; Grootkrans; Harrismith (Botanical Gardens); Kalkfontein (677) near Alphaheim; Kalkfontein (677) near Sendelingsfontein; Kalkfontein Dam near Bergfontein (763); Kalkfontein Dam near Kalbasdrift (1017); Kasteelkop; Kromhof; Krugersdrift Dam; Ladybrand; Lang Zeekoegat; Lange Hoek; Lanquedoc; Last Poort; Lemoenhoek; Mecklenburg; Mierfontein; Middenspruit; Monontsa

Pass; Morgenzon, Senekal; Nova; Palmietfontein; Patrijsdraai; Rambouillet; Rhenosterspruit; Rietfontein, Vrede; Rohallion; Roma; Roodekop (15 tadpoles); Rooidraai (four tadpoles); Shannon; Slangheuvel; Smithfield (SAM 10935, 11043); Straalfontein; Sweet Home; Tertia; Thaba 'Nchu; Thaba Pachoa Berg; Tienfontein; Tygerfontein; Uitkijk; Uitzicht; Verdun, Ladybrand; Vergaderrand; Virginia; Vredefort, 18 km east-south-east of (five tadpoles); Welbedacht; Welgegund; Weltevreden, Heilbron; Weltevreden, Smithfield; Willem Pretorius Game Reserve (NMB; TM 29783); Wittepoort; Witzieshoek; Wolvekop; Woonhuis near Marah (420); Woudzicht; Zandfontein, Smithfield; Zion; Zoetbron; Zomervlakte.

Other records: Bethlehem; Bothaville; Ficksburg; Harrismith; Kroonstad; Rouxville; Trompsburg; Tweespruit; Ventersburg; Winburg (Poynton, 1964).

Extralimital records (two localities; Fig. 25)

Ten specimens examined from: Langeberg (NMB A4547); Riverton (MMK 481; 484, three specimens; 494; 496; 515, two specimens; 929).

Features (304 specimens examined: 251 frogs, 53 tadpoles)

Largest specimen: 100 mm SVL.

Dorsum brown with dark paravertebral patches (NMB A38 is a long-preserved specimen of dark colour), the latter of which are occasionally fused across the midline. One or more dark patches are occasionally present on the top of the snout. A pale vertebral line usually present on dorsum. The dark inter-orbital patches (not visible in NMB A38) are fused in about 70% of specimens. Glands under the forearm are in the form of a single row of separate "tubercles" or in a continuous ridge. Venter cream and unmarked; throat dark in males. 3-3½ phalanges of 4th toe free of web; two phalanges (occasionally $1^{3}/_{4}$ phalanges) of 3rd and 5th toes free of web.

The following abnormalities were noted:

NMB A1118 lacks most of the left foot.

NMB A1329 has a deformed right foot.

NMB A1882 has two extra "toes" growing from the sides of a foot.

NMB A2288 lacks toes on the left foot.

NMB A5246 has a retarded, "depressed" left eye.

Habitat and Ecology

Collected mostly from burrows under rocks near water but also found in disused termitaria (De Waal, 1980a, p. 101); also found under rocks on the banks of water bodies and hopping in rocky grassland areas in the O.F.S. These toads rarely shelter in the burrows of other animals, but have twice been found in burrows of the Giant Girdled Lizard *Cordylus giganteus* (Jacobsen, 1989, p. 1246). Breeding occurs in rivers, streams or ponds, in grassland or woodland, providing cover is available (Passmore & Carruthers, 1979, p. 74; Lambiris, 1989a, p. 53).

Remarks

As about 30% of the specimens examined had unfused (constricted or narrowly divided medially) interorbital patches, this character is of limited use in separating preserved specimens of *B. rangeri* from *B. garmani*, as is the red colour on the back of the thighs and sometimes on sides of body of *B. garmani* which fades in alcohol (cf. Poynton 1964, p. 20).

Bufo vertebralis Smith, 1848 Southern Pigmy Toad

Bufo vertebralis Smith, 1848, *Illus. Zool. S. Afr., Rept.*, pl. 68, figs 2, 2a. Type locality: "interior districts of Southern Africa". Types in the British Museum of Natural History, London. Rose, 1950, pp. 107-108, fig. 65.

Bufo vertebralis vertebralis Smith: Poynton, 1964, p. 62, fig. 21; De Waal, 1980a, p. 99.

Range

From the eastern Karoo to the north-eastern Cape Province and southern half of the O.F.S.; also isolated records at "Vredefort Road" and Koppies Dam Nature Reserve (northern O.F.S.), Maseru (western Lesotho), Kimberley (northern Cape Province) and Kareeboomput farm (south-western Transvaal).

Zoogeographical classification: Central Temperate Transitional.

Range cluster in O.F.S.: Southern (S).

Distribution in the Orange Free State (14 localities; Fig. 26)

Specimens examined from: Adonasfontein; Bloemfontein (MMK 525, two specimens); Damfontein; Koppies Dam Nature Reserve; Krugersdrift Dam; Lang Zeekoegat; Lemoenboord; Ospoort; Sweet Home; Vissershoek West; Wonderkop.

Other records: Glen; Smithfield; Thaba 'Nchu; Vredefort Road (Poynton, 1964).

Extralimital records (one locality)

Nine specimens examined from: Wellwood (NMB A2300-05); Maseru (MMK 528, three specimens).

Other records: Kimberley (Poynton, 1964); Kareeboomput farm (Jacobsen, 1989).

Features (41 specimens examined)

Largest specimen: 31,5 mm SVL.

Body depressed and somewhat elongated. Dorsum grey-brown with dark markings (brown with a black outline) of various sizes, more or less symmetrical about the midline. A light scapular patch always

present. A very thin fold of skin runs mid-dorsally, forming a black or white "stripe". Parotid glands inconspicuous; tarsal fold absent; toes feebly webbed. Throat white and usually unmarked (sometimes with a few small dark blotches); belly white and heavily spotted in all except NMB A768, which appears to have only a few markings (but these may have faded, the preserved specimen having been collected in 1926). Poynton (1964, p. 64) stated that the tympanum is distinct and 2½ phalanges of the 3rd toe are free of web. After examining 41 O.F.S. specimens and six Cape Province specimens (see below), I am in agreement with De Waal's (1980a, p. 99) statement that "the diagnosis of *Bufo v. vertebralis* as given by Poynton (1964) should be modified to include the variation shown in Orange Free State series: tympanum distinct or hidden, 2 to 2½ phalanges of 3rd toe free of web".

An additional six specimens (NMB A2300-05) from the farm Wellwood near Graaff Reinet (3124 DC) in the Cape Province were examined in detail. These specimens measured 25,7-32,9 mm SVL, and were collected in pit traps on rocky, grassy slopes and flats (Bates, 1991c, p. 14). They exhibited basically the same variation as did *B. vertebralis* from the O.F.S. (see above), but the throat always had a few dark spots, the tympanum was always inconspicuous and only two specimens had 2½ phalanges of the third toe free of web (both feet examined), the rest having two phalanges free. According to Poynton (1964, p. 62), the skin of the throat is "smooth to slightly granular", but in NMB A2301 it is coarsely granular. The three Maseru specimens (MMK 528) were in poor condition, but had the form typical of *B. vertebralis*, with what appeared to be spotted bellies.

Habitat and Ecology

Specimens were collected from inactive termitaria and under rocks in the O.F.S. (De Waal, 1980a, p. 99). According to Visser (1979, p. 47), specimens at Victoria West "may be seen crossing the national road in literal thousands at night after rain". Wager (1986, p. 65) noted: " I came across a dozen pairs of these Pygmy Toads, and half a dozen spare males early one drizzly afternoon near Bloemfontein, in a slight depression filled with rain water, and miles from the nearest permanent water. The male firmly embraced the female and would not let go when picked up. They were not heard calling, though Hewitt, 1925a, says they have clear castanet-like notes that can be heard from quite a distance". Braack, Boycott & Branch (1990, p. 57) reported that after rain, specimens were heard uttering "an odd cricket-like call" while out of water and hidden amongst vegetation near Beaufort West, while Passmore & Carruthers (1979, p. 80) noted that the breeding habitat is temporary pools in stony, sometimes barren areas, the males calling from exposed sites at the edges of rain pools. Eggs and tadpoles are discussed by Wager (1965, 1986).

Remarks

This form, previously regarded as the nominate subspecies of *B. vertebralis*, is now regarded as a monotypic species following recent taxonomic changes (see Poynton & Broadley, 1988).

Genus: *Schismaderma* Smith, 1849

Schismaderma carens (Smith, 1848) Red Toad

Bufo carens Smith, 1848, *Illus. Zool. S. Afr., Rept.*, pl. 68, fig. 1. Type locality: "interior of Southern Africa". Syntypes in the British Museum of Natural History, London. Poynton, 1964, p. 60, fig. 20; De Waal, 1980a, p. 97.

Schismaderma carens (Smith): Bates, 1988a, p. 51 and 1991b, p. 154.

Range

Natal, northern and north-eastern O.F.S., Transvaal (and its border with the northern Cape Province), Swaziland, Mozambique, Zimbabwe, western Botswana, Caprivi Strip and north to Kenya.

Zoogeographical classification: Tropical.

Range cluster in O.F.S.: Northern and Northeastern (N & NE).

Distribution in the Orange Free State (six localities; Fig. 27)

Specimens examined from: Baltespoort; Lugwijini, Golden Gate Highlands National Park; Mara, Parys; Mara, Vredefort; Middenspruit; Palmietfontein.

Features (21 specimens examined)

Largest specimen: 78,1 mm SVL (ex-fix) (NMB A2655; Lugwijni, Golden Gate Highlands National Park).

Dorsum reddish-brown in colour with pairs of dark paravertebral patches behind the head, in the sacral region and anterior to the joints of the hindlimbs; occasionally other small dark markings present on dorsum. The 3rd pair of markings may be fragmented. Belly and throat whitish with a few to many indefinitely outlined dark flecks. Webbing on toes conspicuous; parotid glands inconspicuous; dorso-lateral glandular line prominent.

Habitat and Ecology

Collected under rocks in the O.F.S. (De Waal, 1980a, p. 97). Breeds in deep pools and dams in grassland or savanna (Lambiris, 1989, p. 57). Calls while floating with one hand or foot clutching a reed (Passmore & Carruthers, 1979, p. 78). According to Wager (1986, p. 59), the string of eggs measures about 12 m and contains about 10 000 eggs, each with a diameter of 24-25 mm; tadpole colonies are 15-35 mm in diameter and metamorphosis occurs after 1-2 months. Prey includes hemipterans, coleopterans and hymenopterans (Jacobsen, 1982, p. 125). Tadpoles are preyed on by dragonfly larvae, Hamerkops *Scopus umbretta* and terrapins (Wager, 1986, p. 60).

Remarks

Poynton & Broadley (1988, p. 448) have discussed recent evidence confirming Tandy & Tandy's (1976, p. 354) separation of *Schismaderma* from *Bufo*. Poynton & Broadley (1988, p. 448-449) and Lambiris (1989, p. 56) are dubious of Dubois's (1986) inclusion of *Schismaderma, Stephopaedes* and *Mertensophryne* into the tribe Stephopaedini.

Family: **MICROHYLIDAE** Günther, 1859 "1858" (1843)
Subfamily: **BREVICIPTINAE** Bonaparte, 1850

Genus: *Breviceps* Merrem, 1820

Breviceps maculatus (FitzSimons, 1947) Plaintive Rain Frog

Breviceps maculatus FitzSimons, 1947, *Ann. Natal Mus.*, 11, p. 134, pl. 3, figs 1-3. Type locality: Bushman's Peak, Drakensberg, Natal. Holotype in the Natal Museum, Pietermaritzburg; paratypes in the Natal Museum, Pietermaritzburg and the Transvaal Museum, Pretoria. Lambiris, 1989a, p. 64; Bates, 1992a, p. 42.

Range

Drakensberg mountains of Natal and Golden Gate Highlands National Park in the north-eastern O.F.S.
Zoogeographical classification: Large Temperate Transitional.
Range cluster in O.F.S.: Drakensberg (D).

Distribution in the Orange Free State (one locality; Fig. 28)

One specimen examined from: Golden Gate Highlands National Park (NM 7003).

Features (one specimen examined)

Largest specimen: 28,8 mm SVL (NM 7003).

Dorsum brown with a wide light-brown median band with slightly serrated edges; band measures more than half the width of the body. Sides of body and rear end with light brown blotches and pale vertical bands. Dorsum densely covered with large, pitted granules. Venter densely granular (but less so centrally) and pale in colour, with little dark pigmentation. Throat also pale but with slightly more dark pigmentation. Tympanum not visible. Feet and hands not webbed. Left foot examined, as first toe of right foot is absent. Fifth toe extends beyond level of basal tubercles of 4th toe; tip of 1st toe reaches basal tubercle of 5th toe; 5th toe longer than 2nd toe; 1st toe half as long as 2nd toe and extending beyond basal tubercle of 2nd toe.

Habitat and Ecology

The Golden Gate specimen was collected on a footpath at high altitude (about 10 000 ft = 3048 m a.s.l.) in a fynbos-type vegetation (cf. Afroalpine Region) on hard, wet, clayey soil in cool, overcast and damp conditions after the previous night's rain (J. Londt, pers. comm. to Lambiris, 1989a, pp. 64-65). As with other *Breviceps*, the breeding habitat is probably in burrows (Passmore & Carruthers, 1979, p. 84; Lambiris, 1989a, p. 65), and the type of amplexus practiced is probably "adhesion", where the smaller male becomes "glued" to the back of the female for the duration of the mating session (Passmore & Carruthers, 1979, p. 15).

Remarks

Poynton (1964, p. 73) listed three localities for *B. maculatus*, but Passmore & Carruthers (1979, p. 84) stated that this taxon is morphologically similar to and has an almost identical mating call to that of *B. v. verrucosus* and therefore treated *B. maculatus* as a junior synonym of *B. v. verrucosus*. However, Lambiris (1989a, p. 65) stated that Passmore & Carruthers' (1979) sonagrams for *B. v. verrucosus* from Port St Johns and Drakensberg Gardens indicated distinct differences in the pattern of intensity within the call. Lambiris (1989a) also noted that the ranges of *B. v. verrucosus* and *B. maculatus* cannot be determined in detail because of the limited material available, and added that no evidence exists of intergradation between the two forms. Lambiris' (1989a) treatment of *B. maculatus* as a valid species is further supported by the distinct laryngeal morphology of specimen NM 656b (Lambiris, 1991, p. 340).

Breviceps adspersus adspersus (Peters, 1882) Bushveld Rain Frog

Breviceps adspersus Peters, 1882, *Reise nach Mossambique*, p. 177. Type localities: Damaraland and Transvaal. Types in the Zoologisches Museum, Berlin.

Breviceps adspersus adspersus Peters: De Waal, 1980a, p. 102; Bates, 1988a, p. 51.

Range

Natal, Swaziland, northern and western peripheries of the O.F.S., Transvaal, southern Mozambique, Zimbabwe, Botswana, northern Namibia and western Zambia.

Zoogeographical classification: Eastern Tropical Transitional.

Range cluster in O.F.S.: Northern and Western (N & W).

Distribution in the Orange Free State (five localities; Fig. 28)

Specimens examined from: Bothaville (TM 7508-10); Inglewood; Rietfontein, Vrede; Sandveld Nature Reserve; Van der Walt's Rust; O.F.S.

Extralimital records (two localities; Fig. 28)

Four specimens examined from: Kimberley (MMK 292-93, 305); Langeberg (NMB A2907).

Features (eight specimens examined)

Largest specimen: 44,1 mm SVL (ex-fix) (NMB A2308; O.F.S.).

Dorsum brown with light spots (usually in paravertebral pairs) on vertebral region, although the vertebral region of NMB A2308 is mottled. Venter white, smooth and unmarked. A series of large white spots, sometimes fused, is also present dorsolaterally. Throat mottled brown laterally (not visible in NMB A920). A thin, pale median stripe is present on the back (not head) of NMB A2308, 2531 and 2567. A dark streak from behind the eye almost reaches the armpit. Throat and side of neck with pale ground colour. Inner metatarsal tubercle massive. Outer toe minute, without a subarticular tubercle and about equal in length to basal tubercle of 4th toe.

Habitat and Ecology

Found under rocks in the O.F.S. (De Waal, 1980a, p. 102). These frogs occur in open or scrubby areas where they shelter in burrows, emerging only after or during heavy rains (Lambiris, 1989a, p. 66). Breeding occurs in burrows of up to 50 cm deep; males call from the burrows or while on the ground; amplexis is by "adhesion", the smaller male becoming "glued" to the female's back (Passmore & Carruthers, 1979, p. 102). According to Jacobsen (1989), Milstein (1967) reported that groups of frogs hibernated under tree roots. Prey includes mostly Hymenoptera (Formicidae) and Isoptera, but also coleopterans, lepidopteran larvae and spiders (Jacobsen, 1982, p. 115). From 20-46 eggs of 7-8 mm diameter are laid in a burrow; metamorphosis occurs within the egg after 4-6 weeks; the fully-developed juveniles measure 6 mm in length and dig themselves out of the nest (Wager, 1986, p. 119-120). Jacobsen (1989, p. 1276) reported that in Transvaal populations, only 17-22 eggs are laid and these take more than 19 days to develop into froglets measuring 8-12 mm SVL and weighing 0,05-0,40g.

Remarks

In the O.F.S. this frog has been collected only on the northern and western periphery. Its distribution here is possibly associated with the Vaal River, suggesting a recent movement of individuals southward across the Vaal River from the Transvaal side. For additional remarks, see under *B. a. pentheri*.

Breviceps adspersus pentheri Werner, 1899 Penther's Rain Frog

Breviceps pentheri Werner, 1899, *Zool. Anz.*, 22, p. 116. Type locality: "Capland, wahrscheinlich Grahamstown". Type not traced (Poynton, 1964, p. 82).

Breviceps adspersus pentheri Werner: De Waal, 1980a, p. 102.

Range

Eastern Transvaal, north-eastern O.F.S., upper eastern plateau slopes of Natal, and after a disjunction, the eastern Cape Province around Port Elizabeth.

Zoogeographical classification: Linkage Zone Transitional.

Range cluster in O.F.S.: Drakensberg (D).

Distribution in the Orange Free State (one locality; Fig. 28)

One specimen examined from: Platberg, Harrismith (NMB A1706).

Features (one specimen examined)

Size: 23 mm SVL (NMB A1706).

Dorsum brown and very warty; venter smooth and marbled (sparse brown flecks). Throat dark with dark streak from eye almost reaching armpit. Inner metatarsal tubercle massive.

Habitat and Ecology

The O.F.S. specimen was found under sandstone on the southern slope of Platberg Mountain, Harrismith district (De Waal, 1980a, p. 102). This form has been collected at altitudes of 1200-2300 m a.s.l. in the Transvaal (Jacobsen, 1989, p. 1279). Specimens were found in soil under rocks on rocky hillsides, usually singly, but sometimes in pairs during the midsummer breeding season (Jacobsen, 1989). According to Lambiris (1989a, p. 67), the preferred habitat is open grassland and open bushveld, sometimes at the margin of closed bush or woodland. These frogs occupy burrows in sandy soils where they lay their eggs (Lambiris, 1989a). Jacobsen (1989) observed "parents with eggs" in January.

Remarks

Jacobsen (1989, p. 1276) noted that "it is likely that the Transvaal and Orange Free State material [of *Breviceps adspersus pentheri*] forms a separate species in its own right". Jacobsen (1989) also questioned De Waal's (1980a, p. 102) identification of Rietfontein, Vrede, material (one specimen) as *B. a. adspersus*, noting that the taxonomic status of this material requires confirmation considering the altitude and habitat at the specific locality. He stated that it "should be a *'pentheri'*". However, my examination of the specimen confirms its status as *B. a. adspersus*. As noted by Jacobsen (1989), a detailed investigation into the status of the forms in the *B. adspersus* complex throughout its range is required; cases of possible sympatry between "*adspersus*" and "*pentheri*" occur in the Transvaal.

Family: **RANIDAE** Gray, 1825

Subfamily: **RANINAE** Gray, 1825

Genus: *Pyxicephalus* Tschudi, 1838

Pyxicephalus adspersus adspersus Tschudi, 1838 — Highveld Bullfrog

Pyxicephalus adspersus Tschudi, 1838, *Classif. Batr.*, pp. 46, 84. Type locality: "Promontorium Bonae Spei" = Cape Peninsula. Syntypes in the Museum National d'Histoire Naturelle, Paris. Poynton, 1964, p. 93, fig. 47; De Waal, 1980a, p. 103.

Rana adspersa (Tschudi): Hewitt & Power, 1913, p. 169; Rose, 1950, pp. 46 & 49, figs 18 & 19.

Pyxicephalus adspersus adspersus Tschudi: Parry, 1982, p. 285, fig. 2; Bates, 1988a, p. 51.

Range

From the central and eastern Cape Province northwards to the O.F.S., northern Natal, Transvaal, Swaziland highveld, Zimbabwe, Botswana and Namibia.

Zoogeographical classification: Tropical.

Range cluster in O.F.S.: Throughout (T).

Distribution in the Orange Free State (25 localities; Fig. 29)

Specimens examined from: Allanridge (TM 26429-30); Bergkraal; Bloemfontein (Raadsaal); Bloemfontein (University of the O.F.S.) (56 tadpoles); Bloemfontein (20 km west of); Dam van Trane; Fauresmith; Florisbad; Frazer Spruit; Glen; Hebron; Houmoed; Krugersdrift Dam; Mimosa, Bloemfontein; Plaatjieskraal; Shannon; Sophiasdal; Spreeuwfontein (MMK 1031); Sweet Home; Thaba 'Nchu; Thaba 'Nchu (Goronyane High School).

Other records: Bloemfontein; Parys; Vredefort Road (Poynton, 1964); Sasol Mine (Parry, 1982).

Extralimital records (one locality; Fig. 29)

Nine specimens examined from: Kimberley (MMK 991, six specimens; 995; 1030, two specimens).

Other records: Kraankuil, east of (Branch, 1990).

Features (1077 specimens examined: 1021 frogs, 56 tadpoles)

Largest specimen: 140 mm SVL.

Dorsum of adults olive green with numerous longitudinal skin folds; venter smooth and cream-yellow, but yellow in life. If present, ventral marbling does not extend well onto pectoral region. Juveniles with dark dorsal spots and a pale vertebral stripe, often with additional pale dorso-lateral stripes. Three toothlike projections always present in lower jaw, but outer two most prominent in large specimens.

Inner metatarsal tubercle massive and flanged. Head width/snout-urostyle length in 12 adults measuring in excess of 68 mm SVL varied from 46-50%, with a mean of 48%.

Habitat and Ecology

Collected near water during summer in the O.F.S. (De Waal, 1980a, p. 103). On two different occasions, during February and March 1984, single juveniles (NMB A2290, 2307) were collected by day in long grass at Frazer Spruit near Harrismith. *P. a. adspersus* is the largest frog species found in southern Africa. These frogs spend most of the year hibernating in cocoons deep underground, emerging only after heavy rains and usually remaining active for only three months of the year (Jacobsen, 1989, p. 1294). Breeding takes place in temporary pans or in marshes, the males calling while in shallow water (Passmore & Carruthers, 1979, p. 114). Females lay 3000-4000 eggs of 2-mm diameter which are encased in jelly capsules with diameters of 4 mm; tadpoles hatch after two days and reach a maximum length of 71 mm (Wager, 1986, pp. 84-85). Males are known to stay with the tadpoles in their pools, and Kok, Du Preez & Channing (1989) showed that males (in an area west of Bloemfontein) occasionally even construct channels in the mud so as to connect isolated pools with a larger water body.

A study conducted by Van Wyk, Kok & Du Preez (1992, p. 56) near Bloemfontein showed that tadpoles aggregate into schools almost immediately after hatching, and the larval phase lasts 20 days. The schools aggregated in shallow, warm water during daytime and moved to deeper water at night, when they sometimes travelled up to 46 m in an hour. One school often stretched over several metres and was composed of over 3000 individuals. Two to three size cohorts were represented in some schools, which suggested that individuals from different clutches, probably laid by different females, were present. The tadpoles fed on debris stirred up by the continuous activity of each school; algae were present in the debris and also the alimentary canals of specimens. Growth of apparently well fed tadpoles in captivity was slow.

The Highveld Bullfrog is an opportunistic feeder, consuming a variety of prey items, including small birds, rats, reptiles, other frogs (including those of their own species), insects, scorpions, crabs and snails (Wager, 1986, pp. 83, 85). Juvenile bullfrogs were found in the stomachs of two out of eight Yellowbilled Egrets *Egretta intermedia* collected at Florisbad, and these frogs represented 1% of the birds' diet (by number of prey items in all eight bird stomachs) (Bates *et al.*, 1992, p. 44).

Remarks

When Parry (1982) revised southern African *Pyxicephalus adspersus*, he examined only two specimens from each of two localities (Allanridge; Sasol Mine) in the O.F.S., and did not examine any of the specimens collected during De Waal's (1980a) survey. All bullfrogs examined from the O.F.S. have the colour pattern of *P. a. adspersus* as defined by Parry (1982). Twelve specimens, all with snout-urostyle

lengths of over 68 mm were examined in detail, and although they agreed with the description provided by Parry (1982) for *P. a. adspersus*, head width/snout-urostyle length ratios varied from 46-50%, with a mean of 48%, and the largest specimen measured only 125,4 mm snout-urostyle length. The values of the last two characters are more typical of *P. a. edulis* (Poynton & Broadley, 1985b). The largest specimen recorded by De Waal (1980a, p. 103) had a snout-vent length of 140 mm, but this specimen (NMB A909) had a post-preservative snout-urostyle length of 125,4 mm. However, the colour pattern and general appearance of all O.F.S. specimens examined leaves me in no doubt that they are *P. a. adspersus*.

Pyxicephalus adspersus edulis Peters, 1854 Lowveld Bullfrog

Pyxicephalus edulis Peters, 1854, *Monatsb. Akad. Wiss. Berlin*, p. 626. Type locality: Boror, Tete and Mozambique Island. Type destroyed, formerly in Zoologisches Museum, Hamburg.

Pyxicephalus adspersus edulis Peters: Lambiris, 1991, pp. 108-109, pl. 22, figs 2a & b.

Range

Northern Natal, Mozambique, Swaziland, eastern and north-western Transvaal, Zimbabwe, eastern and northern Botswana, northern Namibia and Angola; also central, eastern and western Africa to Nigeria; and Bloemfontein (?).

Zoogeographical classification: Tropical.

Range cluster in O.F.S.: ?

Distribution in the Orange Free State (one locality; Fig. 29)

Bloemfontein (Lambiris, 1991).

Habitat and Ecology

According to Lambiris (1989a, p. 74), adults are found on sandier, better drained substrates and in more open wooded grassland or savanna vegetation than *P. a. adspersus*, often in areas with fewer semi-permanent water bodies. A large part of the year is spent in subterranean chambers, where each frog is encased in a cocoon; and specimens emerge during rains (Lambiris, 1989a). Larvae are found in shallow pans or dams with at least some emergent grasses or sedges, or in inundated grassy wetlands on poorly drained clays (Lambiris, 1991, p. 109). Little is known of the autecology of this subspecies (Jacobsen, 1989, p. 1299), but it is probably similar to that of *P. a. adspersus*.

Remarks

Despite Parry's (1982) revision of southern African *Pyxicephalus adspersus*, the status of the three subspecies, namely *adspersus, edulis* and *angusticeps*, remains problematical (Poynton & Broadley, 1985; Lambiris, 1989a, pp. 72-73). According to Poynton & Broadley (1985b), re-examination of material from southern Africa and other parts of Africa showed that the three forms can be distinguished at all ages on the basis of skull width, even though markings show a complexity of geographical variation which makes them of limited taxonomic value. Populations of *adspersus* and *edulis* are largely allopatric and the area of overlap in the ranges of the two forms is not particularly large (Lambiris, 1989a). Lambiris (1989a) stated: "I would be inclined to regard at least *angusticeps* as a full species, and probably *edulis* also; but there is not yet sufficient evidence to justify such an action and I have (with reservations), followed Poynton & Broadley (1985: 122) in accepting Parry's [1982] assignment of southern African material to three subspecies in the interests of taxonomic stability." Lambiris (1991, p. 340) later stated that *adspersus* and *edulis* are "easily identified by differences in laryngeal morphology, and larval buccopharyngeal characters are even more distinctive - these latter differences are undoubtedly reflections of the very different habitats in which the larvae live."

According to Dr A.J.L. Lambiris (pers. comm.), tadpoles and juveniles collected in Bloemfontein by L.H. du Preez in early 1991 are unmistakably *P. a. edulis*. These identifications were subsequently confirmed by internal characters studied by Lambiris (1991, 1992). In my opinion, however, the *P. a. edulis* record for Bloemfontein should at this time be regarded as tentative. No adult bullfrogs from the area have as yet been identified as *edulis*, and the Bloemfontein locality is very isolated from any other records for *edulis*.

Genus: *Tomopterna* Duméril & Bibron, 1841

Tomopterna cryptotis (Boulenger, 1907) Tremolo Sand Frog

Rana cryptotis Boulenger, 1907, *Ann. Mag. nat. Hist.*, (7) 20, p. 109. Type locality: Mossamedes, Angola. Syntypes in the British Museum of Natural History, London.

Pyxicephalus delalandei cryptotis (Boulenger): Poynton, 1964, p. 96, fig. 49.

Tomopterna cryptotis (Boulenger): De Waal, 1980a, p. 104.

Range

Widespread in sub-Saharan Africa, but absent in the south-western and central Cape Province, southern Natal and most of Zambia.

Zoogeographical classification: Tropical.

Range cluster in O.F.S.: Throughout (T).

Distribution in the Orange Free State (53 localities; Fig. 30)

Specimens examined from: Arcadia; Benfontein on Benaauwdheidsfontein (442) (MMK 1004); Bethel; Blaauwfontein; Bloemfontein; Bloemfontein (near Botanical Gardens); Bothaville (TM 7035-39); Bozrah; Constanza; Deelfontein; De Brug; De Hague; Di Poort; Excelsior (20 km south-east of); Excelsior, Edenburg; Florisbad; Frazer Spruit; Glen (TM 12588); Glen Gariff; Golden Gate Highlands National Park (TM 30253); Greenlands; Holme's Dale; Juist Zoo; Ladybrand; Lang Zeekoegat; Lemoenboord; Lusthof (TM 36670, 36673); Michelsohn, Boshof (TM 7069-70); Monontsa Pass; Moreson; Morgenzon; Naval Hill; Richmond West (TM 39656-58); Rusthoff; Sandveld Nature Reserve; Senekal; Sophiasdal; Spreeuwfontein (MMK 987); Stoffelfontein; Sweet Home; Thaba 'Nchu; Veepost; Vergaderrand; Vet Rivier's Mond; Waterbron; Welbedacht; Weltevreden, Smithfield; Wolvenfontein; Wonderkop; Zandfontein, Fauresmith; Zoetbron.

Other records: Bethlehem; Harrismith; Tweespruit (Poynton, 1964).

Extralimital records (five localities; Fig. 30)

Twenty-one specimens examined from: Kimberley (MMK 978, seven specimens); Kimberley, Brickfields (MMK 980); Kimberley, De Beer's Mine (MMK 975, ten specimens); Langeberg (NMB A4545-46); Riverton (MMK 986).

Features (497 specimens examined)

Largest specimen: 47 mm SVL.

Dorsum grey-brown with dark spots and blotches. A pale vertebral stripe, or pale vertebral and dorso-lateral stripes, may be present. Light occipital patch usually discernible. A dark inter-ocular bar often present, but may be divided medially. Inner metatarsal tubercle massive and flanged. NMB A988 has no right hand, whereas the left hand of NMB A2095 is missing. Venter smooth and white in colour.

Habitat and Ecology

Collected from under rocks, in disused termitaria, among grass near water (De Waal, 1980a, p. 104), on the banks of rivers and dams at night and once under a rock on the banks of the Modder River. The breeding habitat is temporary rain pools and marshes in open savanna where males call from exposed positions (Passmore & Carruthers, 1979, p. 120). They may also breed in small dams or rivers with sandy beds, after which they spend much time underground (Lambiris, 1989a, p. 76). They are usually seen only during or after rain (Jacobsen, 1989, p. 1305). Females lay between 2000-3000 eggs, each one separately, in shallow, muddy pools; eggs have a diameter of 1,5 mm and are in jelly capsules of 3-mm diameter (Wager, 1986, p. 87). Eggs hatch after 2-3 days, and tadpoles may reach a length of 37 mm; larval development lasts five weeks, at which time the froglets measure 12 mm in length (Wager, 1986, p. 87). Jacobsen (1982, p. 125) recorded the following prey items: Coleoptera, Isoptera, Araneae and Orthoptera. Auerbach (1987, p. 45) stated that they feed on small invertebrates and possibly small vertebrates, but provided no details.

Remarks

T. cryptotis is a composite form, having a diploid and tetraploid species (see Branch *et al.*, 1988, p. 3).

Tomopterna natalensis (Smith, 1849) Natal Sand Frog

Pyxicephalus natalensis Smith, 1849, *Illus. Zool. S. Afr., Rept.*, App. p. 23. Type locality: "eastward of the Cape Colony". Probable type in the British Museum of Natural History, London.

Strongylopus grayii grayii (not Smith, 1849): Bates, 1991, p. 154 (part).

Tomopterna natalensis (Smith): Bates, 1992a, p. 42.

Range

Eastern Cape Province, Natal, Transvaal and southern tip of Mozambique; also central and eastern O.F.S.

Zoogeographical classification: Eastern Transitional.

Range cluster in O.F.S.: Northern and Northeastern (N & NE).

Distribution in the Orange Free State (four localities; Fig. 31)

Specimens examined from: Golden Gate Highlands National Park (NMB A2657); Krugersdrift Dam (NMB A12); Willem Pretorius Game Reserve (NMB A301-04; TM 29793); Stream north of Metsimatsho Dam and east of Phuta-Ditjhaba (28°35'S, 28°57'E) (NMB A4721).

Features (eight specimens examined)

Largest specimen 30,6 mm SVL (NMB A2657 - Golden Gate Highlands National Park).

Dorsum grey-brown with dark mottling. A dark interorbital bar is present, but is interrupted medially in NMB A12. Indications of a light vertebral line are present in NMB A12 only. A pair of dark paravertebral spots present in the sacral region, while additional dark spots may be present, especially in pairs posteriorly. Top of thigh and lower leg barred. Venter white and smooth; throat dark in males. 2 - 2½ phalanges of 4th toe, 3½ - $3^3/_4$ phalanges of 4th toe and 2 - $2^3/_4$ phalanges of 3rd toe free of web.

Habitat and Ecology

The four specimens from Willem Pretorius Game Reserve were collected in a rocky rain pool, while the specimen collected near Metsimatsho Dam was found hopping on the stony bank of a stream by day. These frogs breed in shallow permanent streams, ponds or marshes in open, grassy areas, or in shallow pools on bare rock beside rivers (Passmore & Carruthers, 1979, p. 126; Lambiris, 1989a, p. 79).

They usually shelter in leaf litter or in holes or burrows (Jacobsen, 1989, p. 1316). Breeding starts after the first spring rains and continues until midsummer; eggs measure 1,2 mm in diameter and are laid singly or in flat groups of 2-6 in shallow water (about 6 mm deep); eggs hatch in two days and tadpoles attain a length of 36 mm (Wager, 1986, p. 88).

Remarks

These are the first fully documented records of *T. natalensis* from the O.F.S. Bates (1992a, p. 42) gave the locus code for the Krugersdrift Dam specimen (NMB A12) as 2826 - Cc1, but as it was collected with other frogs for which the code 2825 - Cd4 was given (see De Waal, 1980a), the latter should be taken as the correct code. There is a batch of tadpoles, collected at Glen in March 1926, in the collection of the Natal Museum (NM 5542), which is documented as *Pyxicephalus natalensis* (= *T. natalensis*), but the specimens are very small and too poorly preserved to confirm the identifications. A tadpole (NMB A2847) collected at Greyvenstein Pan near Bloemfontein and examined by A.J.L. Lambiris (pers. comm.) has webbing which agrees with that of *T. natalensis*, but the characteristic dark sacral patches of this species are not visible. The species is widespread in the Transvaal, including the southern Transvaal/O.F.S. border area (Jacobsen, 1989, map 237, p. 1314), and has also been collected at Royal Natal National Park on the Natal/O.F.S. border (Bourquin & Channing, 1980, p. 8; Lambiris, 1989a, p. 155). Its unusual distribution in the O.F.S. is probably indicative of insufficient collecting. Bates (1991b, p. 154) mistakenly listed a specimen of *Tomopterna natalensis* (NMB A2657) from Golden Gate Highlands National Park as *Strongylopus grayii grayii*.

Rana angolensis Bocage, 1866 — Common River Frog

Rana angolensis Bocage, 1866, *J. Sc. Math. Phys. Nat., Lisboa*, 1, p. 73. Type locality: Duque de Bragança, Angola. Holotype formely in the Museu Bocage, Lisbon, but destroyed in 1978 fire. Poynton, 1964, p. 103, fig. 53; De Waal, 1980b, p. 106; Bates, 1988a, p. 51 and 1991b, p. 154.

Range

Eastern Cape Province, Natal, Lesotho, O.F.S., Transvaal, Swaziland, southern Botswana, Zimbabwe, northern Mozambique and northwards to Ethiopia; also found on the northern bank of the Orange River in southern Namibia (Berger-Dell'mour in Branch [1988, p. 3]).

Zoogeographical classification: Tropical.

Range cluster in O.F.S.: Non-Southwestern (Non-SW).

Distribution in the Orange Free State (46 localities; Fig. 32)

Specimens examined from: Aberdeen; Bachelor's Home; Berlin; Blaauwbank; Bon Haven; Bramley's Hoek; Ceylon; Clarens, 11 miles east of (DNSM 201; 204-14); Constanza; Deelfontein; Diepkloof; Florisbad; Golden Gate Highlands National Park; GGHNP, ± 2 miles east of (TM 30254); Groenland; Hartebeestfontein; Jacobsdal; Klipfontein; Knellpoort; Kromrant; Krugersdrift Dam; La Belle France; Ladybrand; Last Poort; Monontsa Pass; Mount Pleasant; Ngotswane Gorge; Oever; Rhenosterspruit; Smithskraal; Sweet Home; Swinburn; Tafelberg; Waterfall; Waterval, Winburg; Welbedacht; Willem Pretorius Game Reserve; Witzieshoek Mountain Resort; Stream north of Metsimatsho Dam and east of Phuta Ditjhaba (28° 35' S; 28° 57' E).

Other records: Bloemfontein; Ficksburg; Fouriesburg; Kroonstad; Parys; Smithfield; Thaba Putsua (= Thaba Phatshwa Mountain) (Poynton, 1964).

Extralimital records (two localities; Fig. 32)

One specimen examined from: Doorns (NMB A5235).

Other records: Riverton (Poynton, 1964).

Features (148 specimens examined)

Largest specimen: 75 mm SVL.

Dorsum green to grey-brown with dark blotches. A pale vertebral stripe may be present. Throat and belly white, throat sometimes with dark streaks. Usually two phalanges of 4th toe free of web, but sometimes 1, 1½ or 2½ free of web. Head width/tibia length ratio = 45-68% (Lambiris, 1989, p. 88). NMB A1181 (Bramley's Hoek) has two phalanges of 4th toe free of web, but head width/tibia length ratio = 68,4%.

Habitat and Ecology

Found in almost all habitat types where permanent water bodies and fringe vegetation occur, and especially at the sides of streams. Breeds in streams and other permanent water bodies (Passmore & Carruthers, 1979, p. 130). Thousands of eggs are laid in shallow water (about 2,5 cm deep); egg diameter is 1,5 mm and jelly capsule 4 mm; eggs hatch after about seven days, the tadpole growing to 80 mm in length; metamorphosis usually takes place after nine months, but may be delayed by two years (Wager, 1986, p. 68).

Remarks

R. angolensis is sympatric with *R. fuscigula* at 13 localities in the O.F.S., namely Bloemfontein, Bramley's Hoek, Hartebeesfontein, Last Poort, Rhenosterspruit, Smithfield, Sweet Home, Willem Pretorius Game Reserve (see De Waal, 1980a); Blaauwbank, Diepkloof, Florisbad, Knellpoort and Mount Pleasant. This species can often be distinguished from *R. fuscigula* by its less heavily marked ventrum, two rather than one phalanges of the 4th toe free of webbing and a tibia length/SVL ratio of 45-68% rather than 68-85% (Lambiris, 1989a, p. 88), although much variation in these characters occurs in O.F.S. material. De Waal (1980a, p. 106) failed to list or plot Poynton's (1964, p. 104) Parys record.

Rana fuscigula Duméril & Bibron, 1841 Cape River Frog

Rana fuscigula Duméril & Bibron, 1841, *Erpét. Gén.*, 8, p. 386. Type locality: "environs du cap de Bonne-Espérance" (= south-western Cape Province). Holotype in the Museum National d'Histoire Naturelle, Paris; Hewitt & Power, 1913, p. 167; Poynton, 1964, p. 109; De Waal, 1980a, p. 105; Bates, 1991b, p. 154.

Range

Cape Province, western and central Natal, Lesotho, O.F.S. and southern Transvaal, with an isolated population in the south-central part of Namibia.

Zoogeographical classification: Cape Temperate.

Range cluster in O.F.S.: Throughout (T).

Distribution in the Orange Free State (62 localities; Fig. 33)

Specimens examined from: Ararat (18 tadpoles); Arcadia; Babel; Benfontein on Benaauwdheidsfontein (422) (NMB A5501-4; MMK 944, 1045-48); Bergkloof; Bethany; Bethal; Blesbokpan; Bloemfontein; Blaauwbank; Blaauwbanksdrift (3 tadpoles); Bramley's Hoek; De Kiel (393) near De Kiel Oost (101); Diepkloof (1 tadpole); Dundee; Excelsior (13 tadpoles); Florisbad; Fonteintje; Geluk; Giddy's Home; Goedetrouw; Goedgenoeg; Golden Gate Highlands National Park; Groenekloof; Hartebeestfontein; Heilbron, Philippolis; Hoogeveld; Juist Zoo; Klippan; Knellpoort; Lange Hoek; La Riviera; Last Poort; Lessingskop; Mierfontein; Mount Pleasant; Pinekloof; Poortje; Rhenosterspruit; Rohallion; Rondavel; Brandfort; Richmond West (TM 39660-63); Ruigtepoort; Seekoeivleipoort; Strijdfontein; Sweet Home; Swinburn; Tussen-die-Riviere Game Farm; Uitzicht; Verdun, Fouriesburg; Vissershoek West; Wagenmaker's Drift; Weltevreden, Smithfield; Waterval, Vrede (TM 55234); Willem Pretorius Game Reserve; Zandfontein, Smithfield; Zastron.

Other records: Bethlehem; Bultfontein; Smithfield; Viljoenskroon; Winburg (Poynton, 1964).

Extralimital records (one locality; Fig. 33)

Three specimens examined from: Kimberley (MMK 1008, two specimens; 1016).

Features (221 specimens examined: 184 frogs, 37 tadpoles)

Largest specimen: 99 mm SVL.

Dorsum green to grey-brown with dark blotches. Pale vertebral stripe usually present. Dorsal part of limbs also with dark blotches, the upper and lower legs barred. Throat with dark mottling, the latter often present on abdomen and inside of thighs. In large specimens, the venter is nearly always mottled, and markings extend onto the thighs. One to two phalanges (usually one) of 4th toe free of web. Tibial length/SVL = 65-85% (Lambiris, 1989, p. 93).

Habitat and Ecology

This semi-aquatic species breeds in deep, quiet water over sand or silt substrate (Lambiris, 1989, p. 93), and is found among vegetation on the banks of rivers, ponds and even in cement farm dams and cattle drinking troughs. A total of 15 000 or more eggs are laid singly, forming sticky patches which adhere to vegetation or stones in shallow water or slow streams; eggs measure 1,5 mm in diameter in a jelly capsule of 3,5 mm diameter; the tadpole leaves the egg after 7-10 days and may attain a length of 88 mm; metamorphosis may take up to three years to occur (Wager, 1986, pp. 68 & 69). Prey includes crabs (Bourquin & Channing, 1980, p. 9) and insects, but cannibalism is also known to occur (Wager, 1986).

Remarks

With the exception of an isolated population in Namibia, this Cape Temperate species appears to reach its northern limit in the southern Transvaal (Jacobsen, 1989; map 239, p. 1326). For additional comments, see *R. angolensis*.

Genus: *Strongylopus* Tschudi, 1838

Strongylopus grayii grayii (Smith, 1849) Clicking Stream Frog

Rana grayii Smith, 1849, *Illus. Zool. S. Afr., Rept.*, pl. 78, figs. 2a-c. Type locality: "western districts of the Cape Colony". Holotype in the British Museum of Natural History, London.

Rana grayi grayi Smith: Poynton, 1964, p. 113, fig. 57.

Rana grayii grayii Smith: De Waal, 1980a, p. 107.

Strongylopus grayii grayii (Smith): Bates, 1991b, p. 154 (part).

Range

Southern half of the Cape Province, Natal, Lesotho, eastern O.F.S. and Transvaal, with an isolated population at Mariental (Fish River) in central Namibia.

Zoogeographical classification: Cape Temperate.

Range cluster in O.F.S.: Eastern (E).

Distribution in the Orange Free State (16 localities; Fig. 34)

Specimens examined from: Aberdeen; Brandwag Gardens (GGHNP); Brightside; Clarens, 11 miles east of (DNHM 202-03); Doornberg N.W. (384); Golden Gate Highlands National Park (NMB; TM 34630); Klavervlei (TM 55236); La Belle France; Monontsa Pass; Morgenzon, Harrismith; Morgenzon, Senekal; Thaba 'Nchu; Waterfall.

Other records: Clarens (see under Remarks); Ladybrand (Poynton, 1964); Smithfield (SAM 11039).

Features (26 specimens examined)

Largest specimen: 36,5 mm SVL.

Dorsum grey with dark spots and blotches (NMB A650-52 are long-preserved specimens with a uniformly brown dorsum); paravertebral pairs of blotches may be present. A thin, pale vertebral line from tip of snout to axilla is usually present. The legs are barred. The belly is smooth and white. $3^3/_4$ - 4 phalanges of 4th toe free of web.

Habitat and Ecology

Collected in mountainous areas of the O.F.S. They are found in open grasslands near pools and streams, or in gorges and forests (Wager, 1986, p. 70), usually in grass tussocks or the leaf litter of forests (Jacobsen, 1989, p. 1333). Adults prey on aquatic insect larvae and terrestrial insects (Bourquin & Channing, 1980, p. 9). These frogs are active and call throughout the year, even in winter (Wager, 1986). The breeding habitat is virtually any water body with lush vegetation (Passmore & Carruthers, 1979, p. 138), and breeding takes place from early spring to late autumn (Wager, 1986). A few hundred eggs (1,5 mm diameter in jelly capsule of 5 mm diameter) are laid singly or in small groups in shallow water or on a damp surface (e.g. moss or mud) out of, but near to, water (Wager, 1986). Egg masses are sometimes found partly in and partly out of water (Bourquin & Channing, 1980, p. 9). Eggs hatch after 5-10 days, at which time the tadpoles measure 7 mm in length; tadpoles often grow to 60 mm in length and take 3-4 months or more before metamorphosing (Wager, 1986, pp. 70-71).

Remarks

The genus *Strongylopus* was revived by Channing (1979) for the dwarf southern African stream frogs. Poynton (1964) recorded *Rana g. grayi* (= *S. g. grayii*) from Clarens, but this record was overlooked by De Waal (1980, p. 107). Poynton (1964) was probably referring to specimens DNHM 202-03, more correctly given as "11 miles east of Clarence" (see above). The Smithfield specimen listed above was collected about 1909-10 by Dr D.R. Kannemeyer. Bates (1991b, p. 154) mistakenly listed a specimen of *Tomopterna natalensis* (NMB A2657) from Golden Gate Highlands National Park as *Strongylopus grayii grayii*.

Trinomials are needed as the subspecies *S. g. rhodesianus* (Hewitt, 1937) occurs on the eastern highlands of Zimbabwe (Poynton, 1964, pp. 114-115). The two subspecies are separated geographically by the dry Limpopo Basin and exhibit slight differences in morphology and mating calls (Poynton, 1964). Poynton (1964, p. 114) noted that material listed by him as *R. g. grayi* might include more than one taxon, mainly because "lower Natal *grayi*" has a call with a slightly lower pitch and is confined to wooded places, in contrast to the uplands and Cape populations. Jacobsen (1989, p. 1334) is in agreement, noting "definite ecological separation between the forest forms and those occurring in open grassland" in the Transvaal, as well as differences in colour. This could not be confirmed during the present study - all preserved O.F.S. specimens had a basically greyish dorsum with dark blotches.

Strongylopus fasciatus fasciatus (Smith, 1849) Striped Stream Frog

Rana fasciata Smith, 1849, *Illus. Zool. S. Afr., Rept.,* pl. 78, fig. 1a-c. Type locality: "Africa" [i.e. southern Africa, probably the southern Cape (Lambiris, 1989a, p. 100)]. Neotype in the British Museum of Natural History, London (*vide* Opinion 713, *Bull. Zool. Nomencl.* 21, pp. 352-354). De Waal, 1980a, p. 108.

Rana fasciata fasciata Smith: Poynton, 1964, p. 115, fig. 58.

Strongylopus fasciatus fasciatus (Smith): Bates, 1988a, p. 51 and 1991b, p. 154.

Range

Southern and eastern Cape Province, Natal, eastern O.F.S., Transvaal, Swaziland and Zimbabwe. The uplands population in Zimbabwe is separated from other populations by the dry Limpopo Basin.

Zoogeographical classification: Eastern Transitional.

Range cluster in O.F.S.: Eastern (E).

Distribution in the Orange Free State (five localities; Fig. 35)

Specimens examined from: Aberdeen; Bon Haven; Golden Gate Highlands National Park; Rydal Mount (TM 6778).

Other records: Tweespruit (Poynton, 1964).

Features (six specimens examined)

Largest specimen: 45 mm SVL.

Dorsum yellow to tan with dark longitudinal stripes. The paravertebral pair are continuous. Dark markings on lower legs are longitudinal. Venter is smooth and white. Three-and-a-half phalanges of 4th toe free of web.

Habitat and Ecology

These frogs are found on open, grassy hillsides, usually near water, at both high and low altitudes (Wager, 1986, pp. 71-72), and take refuge under grass tussocks and under rocks on soil near water (Jacobsen, 1989, p. 1338). The breeding habitat is grassy margins of water bodies (Passmore & Carruthers, 1979, p. 140). Amplexus was observed during November in the O.F.S. (De Waal, 1980a, p. 108). They call during the night and on cloudy days, even in midwinter; eggs of 1,65-mm diameter in jelly capsules of 5-mm diameter are laid singly; tadpoles attain a maximum length of 70 mm and undergo metamorphosis into adults after 3-4 months or longer (Wager, 1986, p. 72).

Remarks

Trinomials are needed because of the recognition of a northern race, *S. fasciatus fuelleborni* (Nieden, 1910), which occurs in mountainous parts of Malawi, eastern Zambia and southern Tanzania (Poynton & Broadley, 1985b, p. 139). However, Channing (1981) stated that the call of the two subspecies is identical. Poynton (1964, p. 117) recognized a third subspecies, *R. fasciata montana* FitzSimons, 1946. This form was later elevated to species level by Greig, Boycott & De Villiers (1979), whereafter Dubois (1981) used *S. bonaespei* as a replacement name.

Strongylopus hymenopus Boulenger, 1920 — Drakensberg Stream Frog

Rana hymenopus Boulenger, 1920, *Ann. Mag. nat. Hist.*, (9) 6, p. 106. Type locality: South Africa. Holotype in the British Museum of Natural History, London. De Waal, 1980a, p. 109.

Range

Drakensberg mountains on the O.F.S./Lesotho/Natal/north-eastern Cape border.

Zoogeographical classification: Large Temperate Transitional.

Range cluster in O.F.S.: Drakensberg (D).

Distribution in the Orange Free State (one locality; Fig. 36)

Specimens examined from: Sentinel (NMB A1049-68).

Features (20 specimens examined)

Largest specimen: 62,5 mm SVL.

Dorsum grey with dark patches and having a "granular" appearance. Venter smooth and white; throat with very small dark spots which usually extend onto the anterior part of the chest. Two to three phalanges of 4th toe free of web (one phalanx free on left foot of NMB A1052, right foot deformed). The snout is more rounded than that of *S. g. grayii* or *S. f. fasciatus*.

Habitat and Ecology

Collected on a grassy mountain slope at sentinel (2591 m a.s.l.) in the O.F.S. (De Waal, 1980a, p. 109). Lambiris (1989, p. 97) described the habitat of this species as open grassy slopes near streams or other water bodies, and in rocky seepage areas at 2000-3000 m a.s.l. Breeding occurs in shallow pools or shallow fast-flowing water after the rainy season and eggs may be attached to rocks (Bourquin & Channing, 1980, p. 10).

Remarks

De Waal (1980a, p. 109) noted that Poynton (1964, map 35) erroneously plotted the species as occurring at locus 2926BB (Thaba 'Nchu district). Poynton (1964, p. 118-119) was referring to Hewitt's (1927) "Thaba Putsua" locality which is in Lesotho.

Genus: *Phrynobatrachus* Günther, 1862

Phrynobatrachus natalensis (Smith, 1849) Snoring Puddle Frog

Stenorhynchus natalensis Smith, 1849, *Illus. Zool. S. Afr., Rept.,* App. p. 23. Type locality: "the country around Port Natal" (i.e. Durban). Holotype in the British Museum of Natural History, London.

Phrynobatrachus natalensis (Smith): Rose, 1950, p. 74, fig. 39; Poynton, 1964, p. 137, fig. 74; De Waal, 1980a, p. 110.

Range

Widespread over the savanna areas south of the Sahara (i.e. mostly the eastern half of southern Africa), with isolated records in central and north-western Namibia.

Zoogeographical classification: Tropical.

Range cluster in O.F.S.: Non-Southwestern (Non-SW).

Distribution in the Orange Free State (ten localities; Fig. 37)

Specimens examined from: Bergkraal; Ceylon; Deelfontein; Hartebeestfontein; Klipplaat; Lusthof (TM 36671); Stoomhoek; Zoetbron.

Other records: Ficksburg; Winburg (Poynton, 1964).

Extralimital records (one locality; Fig. 37)

Ten specimens examined from: Riverton (MMK 971, five specimens; 972, three specimens; 973, two specimens).

Features (16 specimens examined)

Largest specimen: 28 mm SVL.

Dorsum brown with dark mottling. A light vertebral stripe from tip of snout to axilla present in only two specimens. Venter cream coloured and smooth; throat dark grey in males. In all specimens the throat has mottling of various extent, the latter often extending onto the chest and sometimes the whole venter. A white tubercle is present about midway up on the tarsus. One phalanx of outer toe free of webbing; two phalanges of 4th toe free of webbing.

Habitat and Ecology

Found under rocks and in open grassland near water in the O.F.S. Wager (1986, p. 99) describes the habitat as puddles and shallow, stagnant water, the edge of dams, pools, marshes and in open country. These frogs breed in shallow pools or marshes with aquatic vegetation (Passmore & Carruthers, 1979, p. 166; Lambiris, 1989a, p. 160). A batch of 500-800 eggs is laid; eggs have diameters of 1 mm and each one is in a hard jelly capsule of 2 mm diameter; the eggs are laid on the surface of water where they float; tadpoles hatch after 3-4 days and grow to 35 mm in length; metamorphosis occurs after four weeks (Wager, 1986, p. 100). At the Nylsvley Nature Reserve in the Transvaal, the diet consists of Hymenoptera, Isoptera, Araneae and Orthoptera (Jacobsen, 1982, p. 125).

Remarks

P. natalensis occurs virtually throughout the Transvaal (Jacobsen, 1989) and Natal (Lambiris, 1989a), and is likely to be more widespread in the O.F.S. than indicated in Fig. 37. This again appears to reflect the need for more intense collecting in the O.F.S.

Genus: *Cacosternum* Boulenger, 1887

Cacosternum boettgeri (Boulenger, 1882) Boettger's Dainty Frog

Arthroleptis boettgeri Boulenger, 1882, *Cat. Batr. Sal. Brit. Mus.*, p. 118, pl. 11, fig. 6. Type locality: Kaffraria [i.e. eastern Cape Province]. Holotype in the British Museum of Natural History, London.

Cacosternum boettgeri (Boulenger): Poynton, 1964, p. 146, fig. 79; De Waal, 1980a, p. 111.

Range

Widespread in southern Africa, but excluding most of the northern Cape Province, central Botswana and the Mozambique Plain; also found in southern Zambia and possibly further north to the Shaba province of Zaire and also Ethiopia (Poynton & Broadley, 1985, p. 174).

Zoogeographical classification: Cape Temperate.

Range cluster in O.F.S.: Throughout (T).

Distribution in the O.F.S (91 localities; Fig. 38)

Specimens examined from: Annies Rust; Arcadia; Berlin; Bethel; Biddulphsberg; Blaauwfontein; Blesbokpan; Blaauwbank; Blaauwbanksdrift; Bloemfontein (TM 11379, 14056-59, 14062; MMK 1034); Boschkop; Bothaville (TM 7584-89); Brakfontein; Carlie; Damfontein; Dam van Trane; Dasklip;

Debsie (TM 45026-34); Deelbata; Deelfontein; Die Hoogte; Doornbult; Doornland; Elandsfontein; Elliesdal; Estoire; Excelsior (20 km south-east of); Excelsior, Edenburg; Florisbad; Frazer Spruit; Geluk; Glen (TM 12589, 21872); Glen Gariff; Goedetrouw; Greenlands; Helderfontein; Hitzakker, Petrus Steyn (TM 35768); Holme's Dale; Hoogeveld; Houmoed; Karreeboomsvallei; Klipbankfontein; Klipdrift; Koppiesdam; Krugersdrift Dam; Lange Hoek; La Riviera; Lindesvlei; Loskop; Louis Rust; Lusthof (TM 36672); Mecklenburg; Mimosa, Brandfort; Palm; Poortje; Quaggaspruit; Rambouillet; Reitz (TM 30088-90); Richmond West (TM 39664-74); Rohallion; Rondavel, Kroonstad; Rooidraai; Rusthof; Sophiasdal; Spijtfontein; Smithfield (SAM 11040, 11051-52); Sterkfontein Dam (TM 55240, 55314-18); Stoom Hoek (51 froglets); Sweet Home; Tafelberg; Thaba Pachoa Berg; Three Fountains; Tierfontein, close to (12 froglets); Triangle; Tweefontein; Uitkomst; Uitzicht; Vaalbank; Vergaderrand; Vissershoek West; Wagenmaker's Drift; Wilhelmshohe; Willem Pretorius Game Reserve (NMB; TM 29785-92); Winburg (TM 66809-10, 66812-13); Wolvekop; Wolvenfontein; Wonderkop; Woudzicht; Zwartkoppies.

Other records: Tweespruit; Vredefort Road (Poynton, 1964).

Extralimital records (two localities; Fig. 38)

Seven specimens examined from: Kimberley (MMK 960, 2 specimens; 1035); Langeberg (NMB A4541-44).

Features (1190 specimens examined)

Largest specimen: 26 mm SVL.

Dorsal coloration and pattern very variable but dark patches, often in paravertebral pairs, are usually present. Dorsal colouration in life ranges from dark brown to orange to emerald green (see Passmore & Carruthers 1979, p. 182; pers. obs.). A pale whitish to orange coloured vertebral stripe of various thickness may be present, but vertebral together with dorso-lateral stripes (from armpit to groin) are less commonly present. The venter is white and smooth and almost always with several dark spots, although the latter vary in number and size from numerous large bold spots to one small indistinctly outlined spot, or even a total lack of spots (especially in froglets). The throat of males is orange-brown and lacks spots (Passmore & Carruthers, 1979, p. 183), whereas that of females is faintly spotted.

Habitat and Ecology

In the O.F.S. these frogs have been collected from disused termitaria, in burrows of the large Giant Girdled Lizard *Cordylus giganteus*, under rocks, between cracks of dry mud (De Waal, 1980, p. 111) and in pit traps in open grassland. Newly metamorphosed frogs were observed in large numbers at a stream near Estoire after heavy rains in April 1988 (Bates & De Swardt, 1990, p. 46). One hundred and sixty-one specimens were found in a single disused termitarium on the farm Hoogeveld in the Kroonstad district, and as many as 34 were taken from a single *C. giganteus* burrow (De Waal, 1980a, p. 111). Frogs found in *C. giganteus* burrows in the Harrismith district in 1984 were found to occupy the muddy

ends of the 2-3 m long tunnels (see also Jacobsen, 1989, p. 1380). They are sometimes found together with *Kassina (Kassina) senegalensis* or *Kassina (Semnodactylus) wealii* in these burrows. Several tadpoles were observed (some collected) after rain in April 1992 in what appeared to be a small marsh (possibly a pool in a previously dried-out stream) with a dense stand of *Cyperus fastigiatus* (identified by P.J. du Preez) sedges near Tierfontein. These tadpoles metamorphosed within about a week.

Hewitt & Power (1913, p. 172) noted that young *C. boettgeri* fed on small flies. Wager (1986, p. 28) recorded captive *Cacosternum* specimens (species not given) eating mosquitos. At Nylsvley Nature Reserve in the Transvaal, ants (Hymenoptera - Formicidae) and termites (Isoptera - Termitidae) constituted the diet of this species (Jacobsen, 1982, p. 125). The stomach of a specimen recovered from the stomach of a preserved Spotted Skaapsteker *Psammophylax r. rhombeatus* collected at Heilbron in the O.F.S. contained mainly *Trinervitermes* termites (Termitidae), but also beetles (Coleoptera), bugs (Hemiptera), ants (Formicidae) and leaf beetles (Chrysomelidae) (Douglas, 1990, p. 45). The above data make Jacobsen's (1982) assertion that the species is stenophagous somewhat doubtful.

Cacosternum boettgeri represented nearly 30% of the diet by number of all prey items in eight stomachs of a sample of Yellowbilled Egrets *Egretta intermedia* collected at Soutpan in the central O.F.S. (Bates *et al.*, 1992, p. 44). One bird's stomach contained 104 *C. boettgeri*, 13 *Xenopus l. laevis* and three *Pyxicephalus adspersus*, as well as 12 other prey items. Egrets, herons, Hamerkops and other predaceous aquatic birds probably represent the primary enemies of *C. boettgeri*.

Breeding takes place in marshy areas or shallow pans (Passmore & Carruthers, 1979, p. 182) after heavy rain. Bourquin & Channing (1980, pp. 10-11) noted that these frogs are active by day and night during the breeding season, and can be seen swimming about and attaching eggs to underwater vegetation during the middle of the day. Hewitt & Power (1913, p. 172) found that eggs are laid in masses of 8-20 and attached to plants; when leaving the water, tadpoles measured 14 mm in length. Wager (1986, p. 104) noted that eggs and tadpoles collected in the O.F.S. were indistinguishable from those of *C. n. nanum*.

Remarks

Poynton (1964, p. 147) suggested that southern African material treated by him as *C. boettgeri* may include more than one form, and later noted that the species is probably polytypic (Poynton in Branch *et al.*, 1988, p. 3). *C. striatus* FitzSimons, 1947 was referred to the synonymy of *C. boettgeri* by Poynton (1964, p. 146), but was later treated as a full species by Lambiris (1989a, p. 111), who noted differences in markings, call and call site between *C. boettgeri* and *C. striatus*. Lambiris (1988a) recently described a new species, *C. poyntoni*, from near Pietermaritzburg, based largely on the bold reticulated dorsal and ventral pattern of the single type specimen.

Cacosternum nanum Boulenger, 1887 Bronze Dainty Frog

Cacosternum nanum Boulenger, 1887, *Ann. Mag. nat. Hist.*, (5) 20, p. 52. Type locality: Kaffraria, i.e. eastern Cape Province. Types in the British Museum of Natural History, London.

Cacosternum nanum parvum not Poynton, 1963: De Waal, 1980a, p. 112.

Range

From the southern Cape Province eastwards through the eastern Cape and north to Natal, north-eastern O.F.S., western Swaziland, eastern Transvaal and south-western Mozambique.

Zoogeographical classification: Large Temperate Transitional.

Range cluster in O.F.S.: Drakensberg (D).

Distribution in the Orange Free State (one locality; Fig. 36)

Specimens examined from: Aberdeen (NMB A2117-19).

Features (three specimens examined)

Largest specimen: 16,5 mm SVL (NMB A2119 - Aberdeen).

Dorsum brown with moderately distinct dark lateral stripes and dark spots in the region of the anal-sacral gland; no median stripe present. Throat of NMB A2117 and 2119 dark with tiny pale flecks in between, but central-posterior region paler; in NMB A2118 the throat is pale with large brown spots and blotches. The rest of the venter is mottled with irregular brown patches, less dense mid-ventrally. Inner metatarsal tubercle small and rounded; outer metatarsal tubercle minute or inconspicuous. Metacarpal and palmar tubercles well developed and prominent, larger than tubercles of fingers. Width of head 32-33% of SVL; horizontal diameter of eye 106-117% of inter-orbital distance and 136-154% of eye to nostril distance; inter-orbital distance greater than width of upper eyelid (i.e. 126-152%); foot length 93-103% that of half SVL; and tibia length 39-45% of SVL (Tables 1 & 2).

Table 1: Morphometric data for *Cacosternum nanum* from the Orange Free State (measurements in mm; LHS = left hand side, RHS = right hand side).

NMB A	Width of head at widest points	SVL	Horizontal diameter of eye (RHS)	Inter-orbital distance	Eye to nostril distance (RHS)	Width of upper eyelid			Foot length	Tibia length
						LHS	RHS	mean		
2117	5,3	16,0	1,7	1,45	1,10	1,2	1,1	1,15	7,5	6,5
2118	5,0	15,5	1,7	1,60	1,25	1,1	1,0	1,05	8,0	7,0
2119	5,6	16,5	1,8	1,60	1,20	1,1	1,2	1,15	8,0	6,5

Table 2: Morphometric ratios derived from data in Table 1 for *Cacosternum nanum* from the Orange Free State.

NMB A	Width of head as % of SVL	Horizontal diameter of eye as % of inter-orbital distance	Horizontal diameter of eye as % of eye to nostril distance	Inter-orbital distance as % of width of upper eyelid	Foot length as % of half SVL	Tibia length as % of SVL
2117	33	117	154	126	93	40 c.n.n.
2118	32	106	136	152	103	45 c.n.p.
2119	33	112	150	139	96	39 c.n.n.

Habitat and Ecology

The three Aberdeen specimens were found under rocks (De Waal, 1980a, p. 112). According to Lambiris (1989a, pp. 112-113), the habitat of *C. n. nanum* is grassland or open wooded grassland areas, especially pools with reed beds or tall, dense grass; breeding occurs in dense emergent vegetation in stagnant water bodies, these often deeper than those used by *C. boettgeri*. Poynton & Broadley (1985b, p. 175) stated that this subspecies is normally encountered in the vicinity of grassy or well vegetated streams, and calling often occurs in flooded grassland beside streams. Like *C. boettgeri*, these frogs are probably insectivorous.

Remarks

Poynton (1963, p. 323) distinguished *C. n. parvum* from *C. n. nanum* on the basis of its "smaller size, smaller interorbital distance, and more fully pigmented throat". In the original description of *C. n. parvum*, Poynton (1963, p. 324) gives SVL as 15,5 mm and 14,3 - 15,7 mm (for paratypes); he later gave 16 mm as maximum SVL (Poynton, 1964, p. 150). The largest of the three O.F.S. specimens had a SVL of 16,5 mm (De Waal, 1980a, p. 112), although all three are of similar size.

De Waal (1980a) did not provide a description of the three specimens, and his reasons for assigning them to *C. n. parvum* may have been influenced by the altitude at which they were collected and the known geographical range of the species at that time (see Poynton, 1964). According to Poynton (1963; 1964) and Lambiris (1989a), the size of the largest O.F.S. specimens is slightly in excess of the maximum SVL for *C. n. parvum*.

The inter-orbital distance of the O.F.S. specimens is distinctly greater than the width of the upper eyelid in all specimens, i.e. 126-152%, these values being typical of the nominate subspecies. In fact,

Poynton (1964) and Lambiris (1989a) separate the two subspecies on the basis of "interorbital distance greater than width of upper eyelid" (*C. n. nanum*) or "interorbital distance less than width of upper eyelid" (*C. n. parvum*) in their diagnostic keys.

Regarding the degree of pigmentation on the throat, my examination of the alcohol-preserved specimens indicated that while two frogs had basically dark throats with tiny pale speckles, one specimen had a pale throat with large brown spots and blotches.

Lambiris (1989a), working on Natal specimens of both subspecies, stated (p. 112) that in *C. n. nanum* the "metacarpal and palmar tubercles (are) well developed, conical, prominent", and in *C. n. parvum* the "metacarpal and palmar tubercles [are] feebly developed." Again, the O.F.S. material sorts into *C. n. nanum*.

Poynton & Broadley (1985b, p. 174) commented that Mozambican *C. n. nanum* had "length of foot equal to, to slightly more than half body length" (foot length was 93-103% of half SVL in O.F.S. material), and tibia length not less than 44% body length (= SVL) (this ranges from 39-45% in O.F.S. material).

C. n. nanum apparently occurs below about 4000 ft (= 1219 m a.s.l.) and *C. n. parvum* above 1219 m (Poynton, 1964). The Aberdeen locality lies between altitudes of 1660-1960 m a.s.l., and on the basis of this, the specimens should be *C. n. parvum*. This subspecies has also been recorded at Royal Natal National Park (2828 DB) on the Natal/O.F.S. border (Poynton, 1964, p. 149; Bourquin & Channing, 1980, p. 11). However, Lambiris (1989a, p. 162) recorded only *C. n. nanum* from that locality, based on specimen NM 5827. Bourquin & Channing's (1980) *C. n. parvum* record was also represented by a Natal Museum specimen, possibly the same one examined by Lambiris (1989a). Poynton (1964) and Lambiris (1989a, p. 163) also recorded *C. n. parvum* from Van Reenen (2829 AD) on the Natal/O.F.S. border. Poynton (1964, map 51) recorded both subspecies as occurring in the Transvaal, but Jacobsen (1989, p. 1384) noted that "on a re-examination of the material it was concluded that only *nanum* was present despite the small size of specimens. This was based on the interorbital distance being broader than the upper eyelid which is at best extremely difficult to measure." Lambiris (1989a, pp. 202-203) plotted the two subspecies at three of the same quarter-degree units in the Natal Drakensberg, namely 2929 AB, 2929 BC and 2929 CA. Two adjacent localities were given by Lambiris (1989a), i.e. "Cathkin Peak Forest Reserve" and "Drakensberg Gardens" (see pages 162 and 163). However, some of the Natal Museum catalogue numbers given for the two subspecies are the same! Lambiris' "Drakensberg Gardens" record for *C. n. nanum* was based on three Transvaal Museum specimens, while his *C. n. parvum* record for this locality is in fact a reference to Poynton (1964), who also examined Transvaal Museum specimens from this locality. It seems likely, therefore, that the specimens in question were in fact the same. Jacobsen (1989) also noted that Lambiris (1989a) recorded the two subspecies at some

of the same quarter-degree units, and suggested that this would indicate a degree of sympatry between the two forms. However, he added that "this would be untenable unless the two forms favoured different habitats and/or had different calls to avoid hybridization. In this case they may be different species or they may be conspecific".

The three Aberdeen specimens were sent to Dr A.J.L. Lambiris for examination. Dr Lambiris concluded that NMB A2117 was referrable to *C. n. parvum*, but he questionably placed the other two specimens as *C. n. nanum*, noting that the tubercles on the hands were rather small for the nominate subspecies (A.J.L. Lambiris, pers. comm.).

After examining the laryngeal morphology of representatives of what were considered both subspecies, Lambiris (1991) found marked differences and treated the two "forms" as separate species. Despite this, it is obvious that a detailed review, considering morphological, ecological, call and other factors is called for. The O.F.S. specimens are provisionally referred simply to *C. nanum* on the basis of the conflicting data presented above, but a case could be made for treating them as *C. n. nanum* x *C. n. parvum* intergrades.

Genus: *Arthroleptella* Hewitt, 1926

Arthroleptella hewitti FitzSimons, 1947 Natal Chirping Frog

Arthroleptella hewitti FitzSimons, 1947, *Ann. Natal Mus.*, 11, p. 125, text-figs 4a, 4b. Type locality: Cathedral Peak area, Drakensberg. Holotype in the Transvaal Museum, Pretoria. De Waal, 1980a, p. 112.

Range

Southern half of Natal, i.e. Natal midlands and Drakensberg Mountains (up to an altitude of 2700 m a.s.l.), including Sentinel in the north-eastern O.F.S., and Transkei.

Zoogeographical classification: Large Temperate Transitional.

Range cluster in O.F.S.: Drakensberg (D).

Distribution in the Orange Free State (one locality; Fig. 36)

Specimens examined from: Sentinel (NMB A1045-48).

Features (four specimens examined)

Largest specimen: 29 mm SVL.

Dorsum brown and without a pale vertebral stripe. Venter pale with faint dark speckling. In NMB A1048, the ventral speckling is concentrated mid-ventrally. Outer metatarsal tubercle discernible only in NMB A1046, which also has a more warty dorsum. Webbing absent.

Habitat and Ecology

Collected on a grassy mountain slope at 2439 m a.s.l. at Sentinel in the north-eastern O.F.S. (De Waal, 1980, p. 112). Lambiris (1989a, p. 115) described the habitat as decaying litter on forest floors, in mossy vegetation beside waterfalls, in pools on the walls of gorges and occasionally in rocky streams in open areas; breeding occurs in wet mossy areas on the banks of fast-flowing streams or below waterfalls. Breeding takes place from October to January and females lay 20-40 eggs at a time in an irregularly spaced flattish layer, and deposit them in a hole containing soft wet mud; diameters of eggs and jelly capsules are 3 mm and 5 mm respectively; tadpoles take 17 days to hatch, at which time they measure 9 mm, and metamorphose into tiny frogs of about 3 mm in length after about 21 days; adults feed on jumping crustaceans and wood-lice (Wager, 1986, p. 106).

Family: **HYPEROLIIDAE** Laurent, 1943

Subfamily: **KASSININAE** Laurent, 1972

Genus: *Kassina* Girard, 1853

Kassina (Kassina) senegalensis (Duméril & Bibron, 1841) Senegal Running Frog

Cystignathus senegalensis Duméril & Bibron, 1841, *Erpét. Gen.*, 8, p. 418. Type locality: Galam Lakes, Senegal. Types in the Museum National d' Histoire Naturelle, Paris.

Kassina senegalensis senegalensis (Duméril & Bibron): Hoffman, 1942, p. 148.

Kassina senegalensis (Duméril & Bibron): Poynton, 1964, p. 175, fig. 101; De Waal, 1980a, p. 113; Van Wyk, 1985, p. 26 (part).

Range

Throughout most of southern Africa, excluding most of the Cape Province (but including eastern Cape), Kalahari, southern Namibia and southern Mozambique; northwards in all savanna areas south of the Sahara.

Zoogeographical classification: Tropical.

Range cluster in O.F.S.: Throughout (T).

Distribution in the Orange Free State (43 localities; Fig. 39)

Specimens examined from: Alma (two tadpoles); Alwyn; Annies Rust; Arcadia; Bethel; Bloemfontein; Boschkop; Bothaville (TM 6837-39); Dam van Trane; Damfontein; Dasklip; Dundee; Florisbad; Holme's Dale; Hoogeveld; Kristalpan on Wonderhoek (1698); Ladybrand; Lemoenboord; Moreson; Mount Pleasant (one adult; NMB A5550, one tadpole); Naval Hill; Poortje; Rohallion; Roma; Rusthof; Shannon; Slangheuvel; Sophiasdal; Straalfontein; Sweet Home; Thaba 'Nchu; Thaba Pachoa Berg; Veepost; Verdun, Ladybrand; Welbedacht; Weltevreden, Heilbron; Willem Pretorius Game Reserve (NMB; TM 29779-81); Wolvekop; Wolvenfontein; Zandfontein, Smithfield; Zoetbron; Zwartkoppies.

Other records: Winburg (Poynton, 1964).

Extralimital records (three localities; Fig. 39)

Three specimens examined from: Kimberley (MMK 963, two specimens); Sandfontein (NMB A5316).

Other records: Kraankuil, east of (Branch, 1990).

Features (239 specimens examined: 236 frogs, three tadpoles)

Largest specimen: 46 mm SVL.

Dorsum yellow with a dark vertebral stripe (from inter-orbital area to near urostyle tip) and a pair of dark, broken (two parts) or unbroken lateral stripes. The vertebral stripe is unbroken (broken medially only in NMB A3282) and more or less linear, but may be twisted or contain patches of ground colour (e.g. NMB A5239, light spot in centre of stripe). In NMB A3689 the anterior part of the vertebral stripe is bifurcated posteriorly to form an additional longitudinal "pseudo" stripe. Dark inter-orbital patches may be present, and in NMB A2497 the patch bisects the vertebral stripe, forming a dark "cross" on the top of the head. Venter white, cream or yellow; throat and belly occasionally feebly mottled brown. The gular disc in males is longitudinally oval and grey-brown in colour.

Habitat and Ecology

In the O.F.S. these frogs have been collected from inactive termitaria, under rocks, in the burrows of *Cordylus giganteus* (De Waal, 1980a, p. 113) and in grassland when calling at night. They may be found together with *Cacosternum boettgeri* in *C. giganteus* burrows, but have not been recorded in association with *K. wealii* in these burrows, probably because the two species have largely allopatric distributions in those parts of the range of *C. giganteus* where they occur (see also distribution maps in Jacobsen, 1989). These frogs breed in shallow temporary pools with short grassy banks; eggs are laid singly or in small clumps in submerged grass or reed stalks (Lambiris, 1989a, p. 126). Prey includes mostly Araneae, Orthoptera and Coleoptera, although lepidopterous larvae, Hymenoptera, Hemiptera and other invertebrates are also eaten (Jacobsen, 1982, p. 121).

Remarks

Van Wyk (1985, p. 26) recorded this species at Greenlands near Harrismith, but the specimen (NMB 2361) referred to is in fact a *Kassina* (*Semnodactylus*) *wealii*.

Kassina (*Semnodactylus*) *wealii* Boulenger, 1882 — Weale's Running Frog

Cassina wealii Boulenger, 1882, *Cat. Batr. Sal. Brit. Mus.*, 2nd ed., p. 131, pl. 11, fig. 3. Type locality: Kaffraria. Types in the British Museum of Natural History, London.

Semnodactylus thabanchuensis Hoffman, 1939, *Soöl. Navors. nas. Mus., Bloemfontein*, 1, p. 90, figs 1-5. Type locality: Summit of Thaba 'Nchu Mountain, Orange Free State. Holotype in the National Museum, Bloemfontein (NMB A1908).

Kassina thabanchuensis (Hoffman): Hoffman, 1942, p. 161, fig. 38.

Kassina wealei Boulenger: Poynton, 1964, p. 178, fig. 102.

Kassina wealli Boulenger: De Waal, 1980a, p. 114.

Kassina senegalensis (not Duméril & Bibron, 1841): Van Wyk, 1985, p. 26 (part).

Kassina (*Semnodactylus*) *wealii* Boulenger: Jacobsen, 1989, pp. 1423 & 1425, map 262.

Range

Southern and eastern Cape Province, Natal, Lesotho, eastern and north-eastern O.F.S., south-eastern Transvaal and eastern Transvaal Drakensberg.

Zoogeographical classification: Cape Temperate.

Range cluster in O.F.S.: Eastern (E).

Distribution in the Orange Free State (20 localities; Fig. 40).

Specimens examined from: Aberdeen; Alma (six tadpoles); Berlin; Elandsfontein; Frazer Spruit; Glen Gariff; Goedetrouw; Greenlands; Ladybrand; Lange Hoek; Loskop; Mount Pleasant; Oorsprong; Reitz (TM 46241); Tertia (four adults, 25 tadpoles); Thaba 'Nchu; Three Fountains; Woudzicht.

Other records: Fouriesburg; Tweespruit (Poynton, 1964).

Features (129 specimens examined: 96 frogs, 33 tadpoles)

Largest specimen: 44,5 mm SVL (NMB A2589).

Dorsum yellowish-brown to grey; vertebral stripe divided longitudinally and wider posteriorly; dorso-lateral stripes also divided longitudinally, with ground colour in centre; anterior part of stripe linear, followed by diverging branches which may or may not meet posteriorly to enclose the band of ground colour; a pair of dark lateral stripes, usually with branches running downward along the flanks also present. In NMB A813 the vertebral stripe is interrupted along its length, whereas in some other

specimens (e.g. NMB A2398, 2436 and 2441) the vertebral stripe has a light patch or patches. Venter cream to pale yellowish; gular disc in males is transversely oval and may be black in colour. Snout proportionally shorter than that of *K. senegalensis*.

Habitat and Ecology

Found in *Cordylus giganteus* burrows, under rocks (De Waal, 1980a, p. 114) and clinging to grass stalks in open grassland while calling at night; one specimen was found by day under the leaves of a small herb, the leaves of which grew almost flush to the ground. Occurs in the company of *Cacosternum boettgeri* (apparently not with *K. senegalensis*) in *C. giganteus* burrows. When active, they are often found near small streams or marshes (Jacobsen, 1989, p. 1426). Breeding takes place in pools and pans with emergent grass (Lambiris, 1989a, p. 128). Jacobsen (1989) commented on the curious "curled up in a little ball" posture adopted by these frogs when hibernating. I have observed the "running" behaviour of this species and also the "curling-up" of specimens after being handled. The "curling-up" is probably a "last resort" defence mechanism.

Remarks

Hoffman (1939) described a new genus and species, namely *Semnodactylus thabanchuensis*, from a single specimen collected on the summit of Thaba 'Nchu Mountain. He later referred *Semnodactylus* to the synonomy of *Kassina* (Hoffman, 1942). Poynton (1964, p. 179) treated *thabanchuensis* as a junior synonym of *K. wealei* (= *K. wealii*), arguing that Hoffman's diagnosis was based largely on features brought about by desiccation of the specimen. I have examined this specimen and confirm Poynton's observations, although I do not know whether or not the specimen deteriorated further over time. The type locality for *S. thabanchuensis*, given as "Thaba Nchu, O.F.S." by Poynton (1964, p. 178) is more correctly given here as "Summit of Thaba 'Nchu Mountain, Orange Free State".

Semnodactylus Hoffman, 1939 has priority over *Notokassina* Drewes, 1984 (Lambiris, 1989a, p. 127). Jacobsen (1989, p. 1421) treated *Semnodactylus* as a subgenus of *Kassina*, noting that Drewes' separation of *wealii* from the genus *Kassina* (i.e. as *Notokassina wealii*) on the basis of the zygodactylous manus, differences in call and electrophoretic dissimilarities, is provisionally unacceptable. Lambiris (1991, p. 343) noted that the genera *Kassina* and *Semnodactylus* do not exhibit major differences in either adult laryngeal or larval buccopharyngeal characters, apart from those at species level, and added that "the case for retaining *Semnodactylus* as a separate genus needs to be re-evaluated using a larger suite of characters". For the above reasons, as well as my observations of the close similarity in general form and morphology in O.F.S. material of the two species, I concur with Jacobsen (1989, p. 1423) in treating *Semnodactylus* as a subgenus of *Kassina*.

Van Wyk (1985, p. 26) recorded this species from Ladybrand, but gives an erroneous (untraceable) museum catalogue number (*viz.* NMB A23621). Also, Van Wyk's (1985, p. 26) *K. senegalensis* record from Greenlands (i.e. NMB A2361) is referred to *K. wealii*.

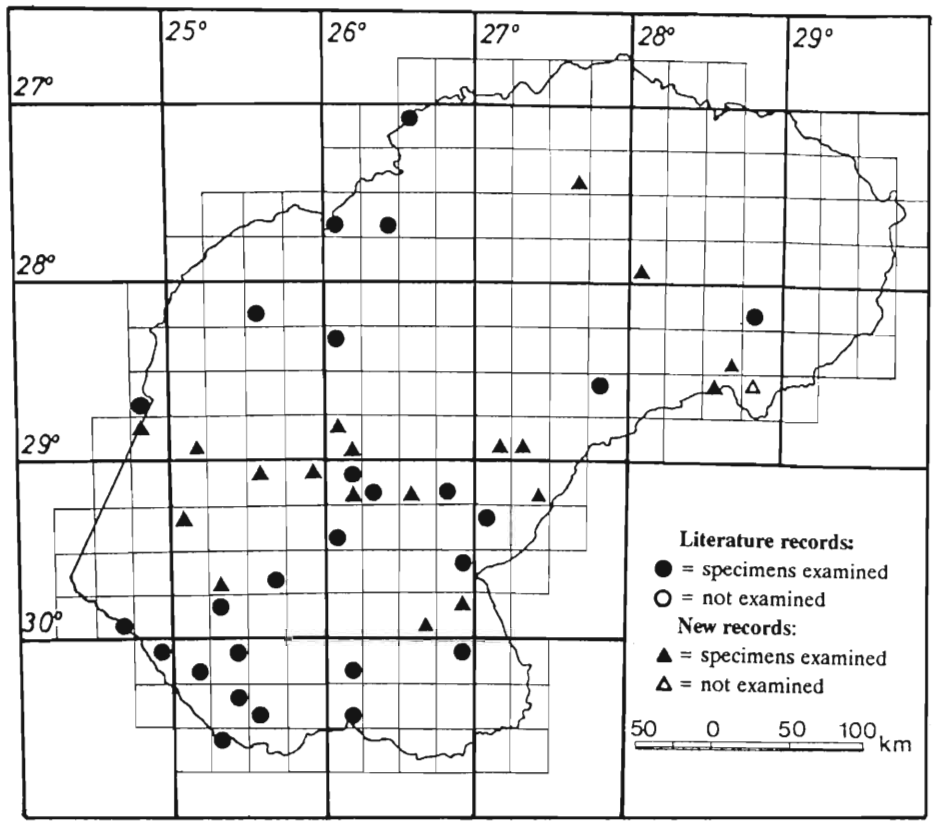


Figure 20: Distribution of *Xenopus laevis laevis* in the Orange Free State and peripheral areas in the northern Cape Province.

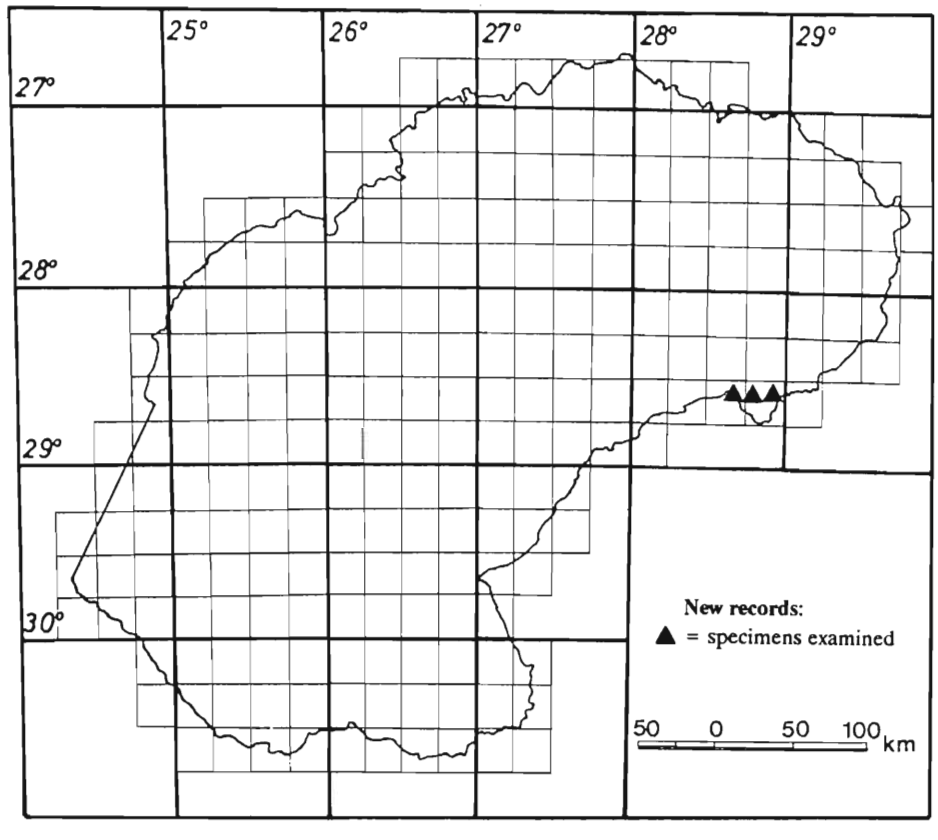


Figure 21: Distribution of *Heleophryne natalensis* in the Orange Free State.

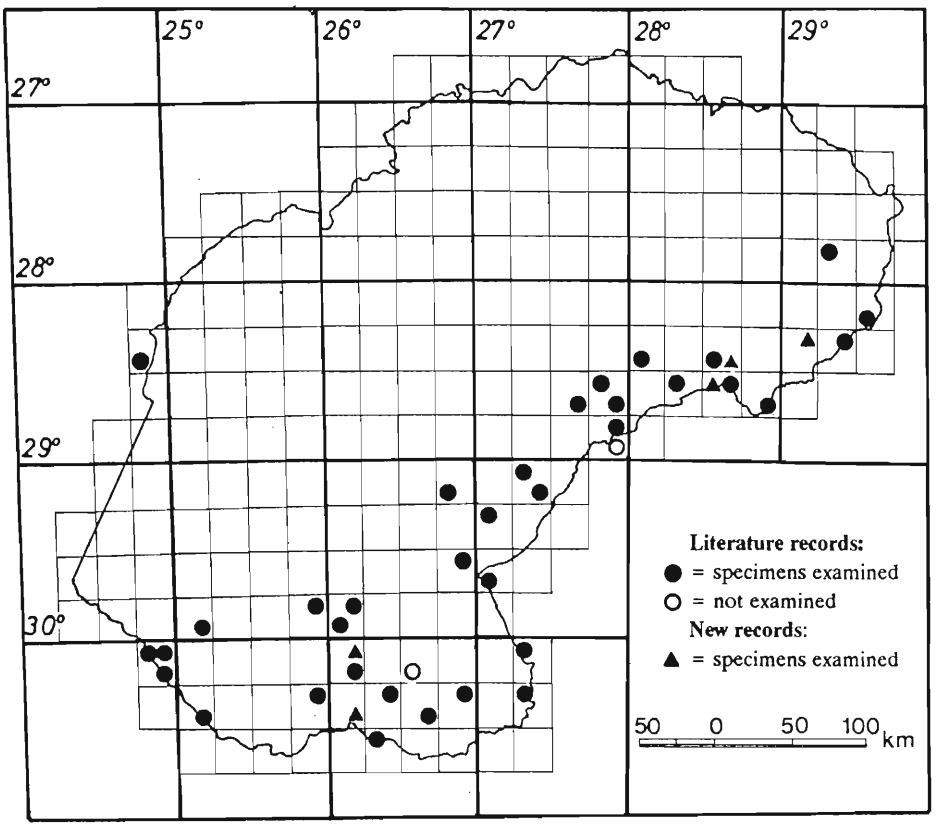


Figure 22: Distribution of *Bufo gariepensis gariepensis* in the Orange Free State and peripheral areas in the northern Cape Province.

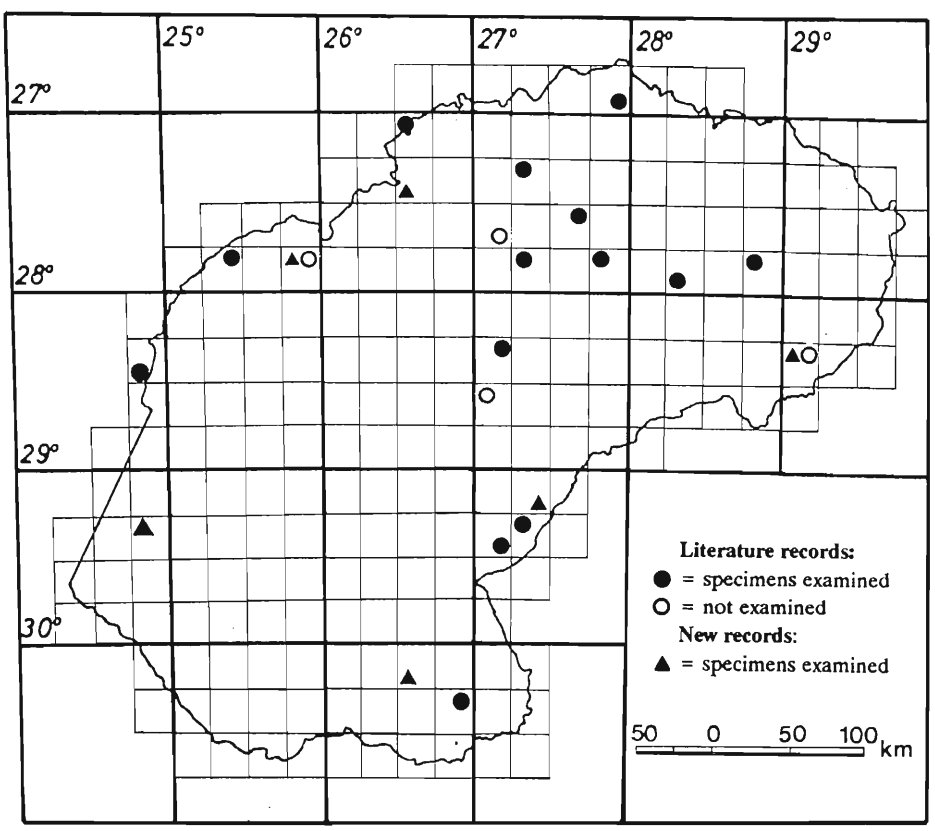


Figure 23: Distribution of *Bufo gutturalis* in the Orange Free State and peripheral areas in the northern Cape Province.

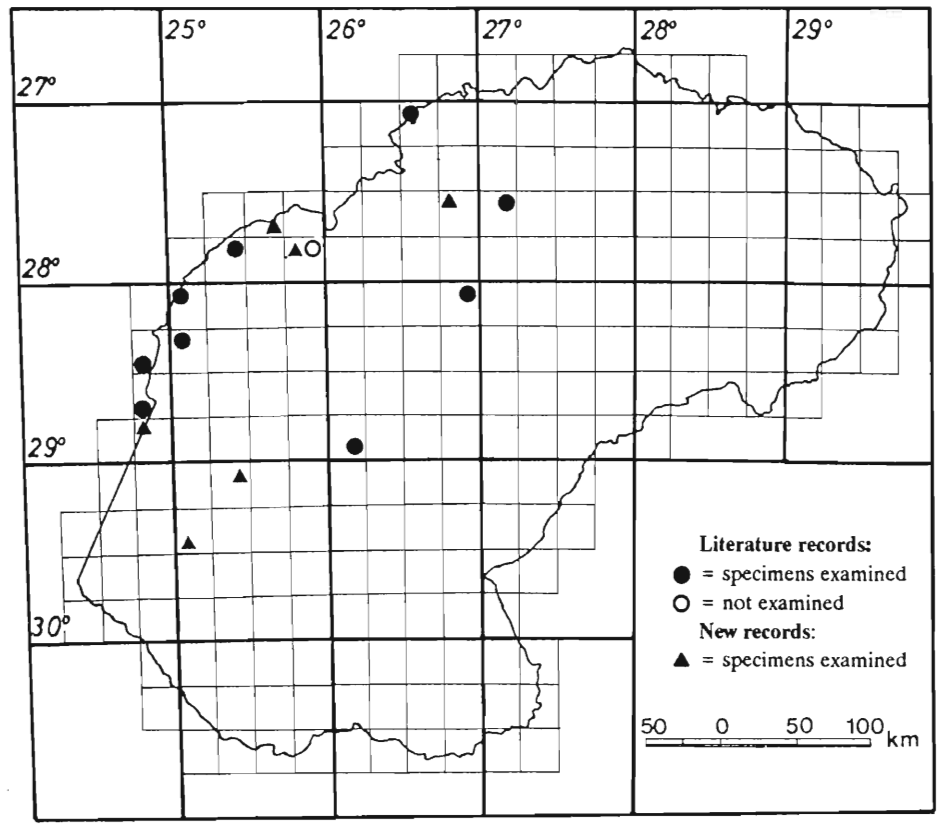


Figure 24: Distribution of *Bufo poweri* in the Orange Free State and peripheral areas in the northern Cape Province.

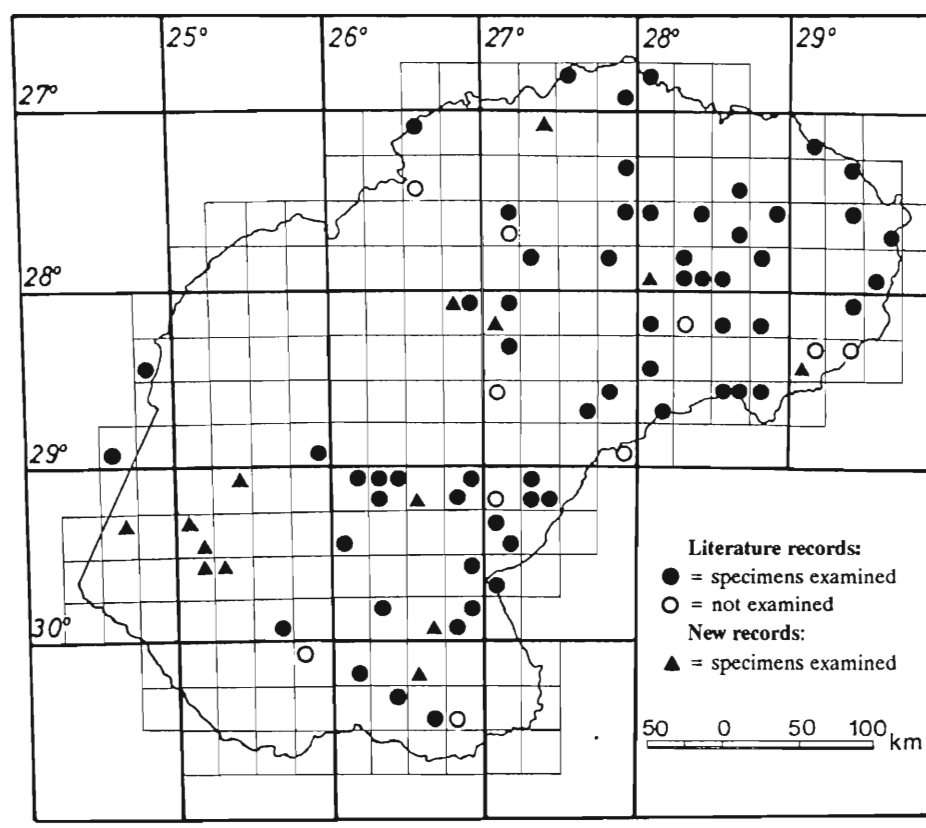


Figure 25: Distribution of *Bufo rangeri* in the Orange Free State and peripheral areas in the northern Cape Province.

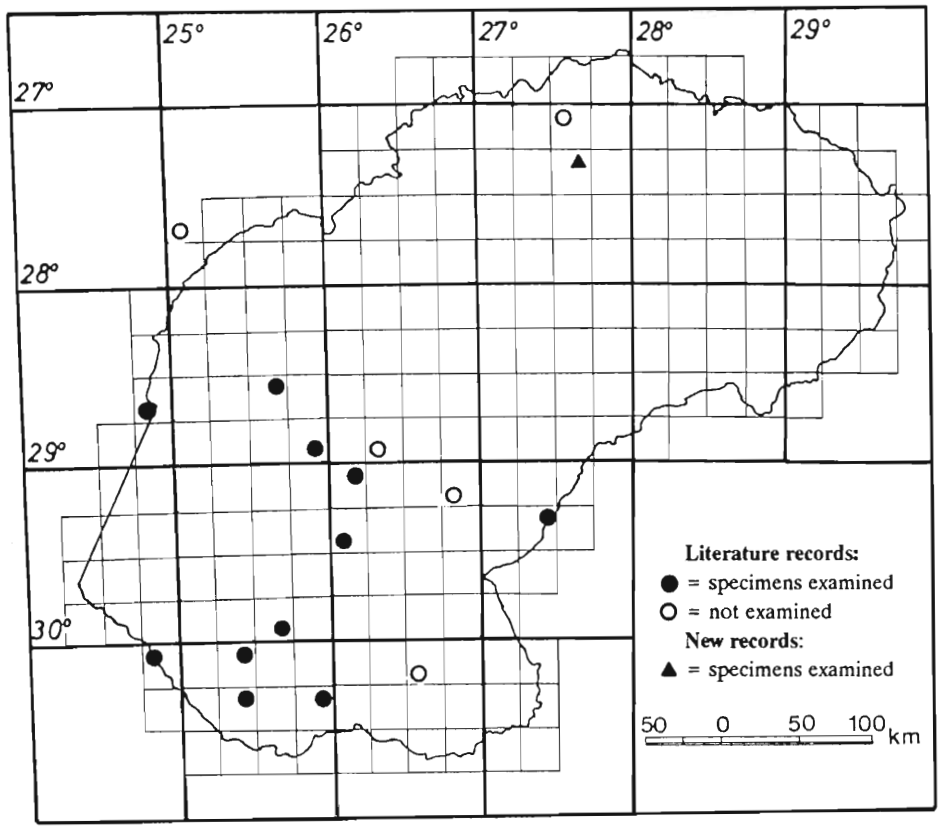


Figure 26: Distribution of *Bufo vertebralis* in the Orange Free State and peripheral areas in the northern Cape Province.

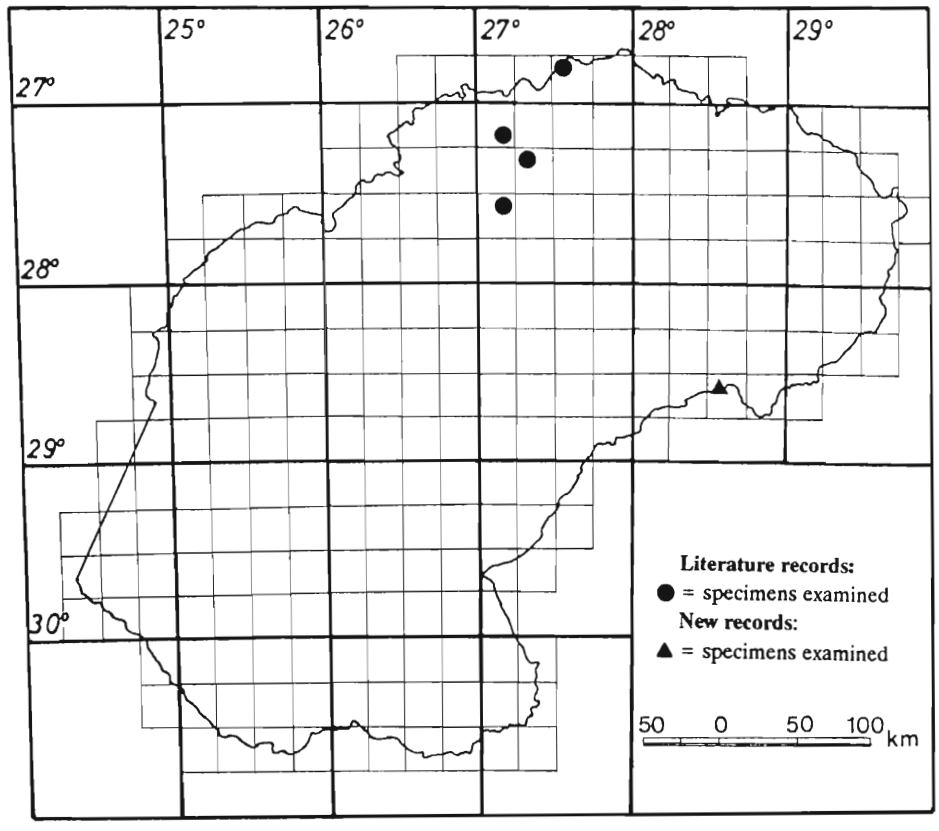


Figure 27: Distribution of *Schismaderma carens* in the Orange Free State.

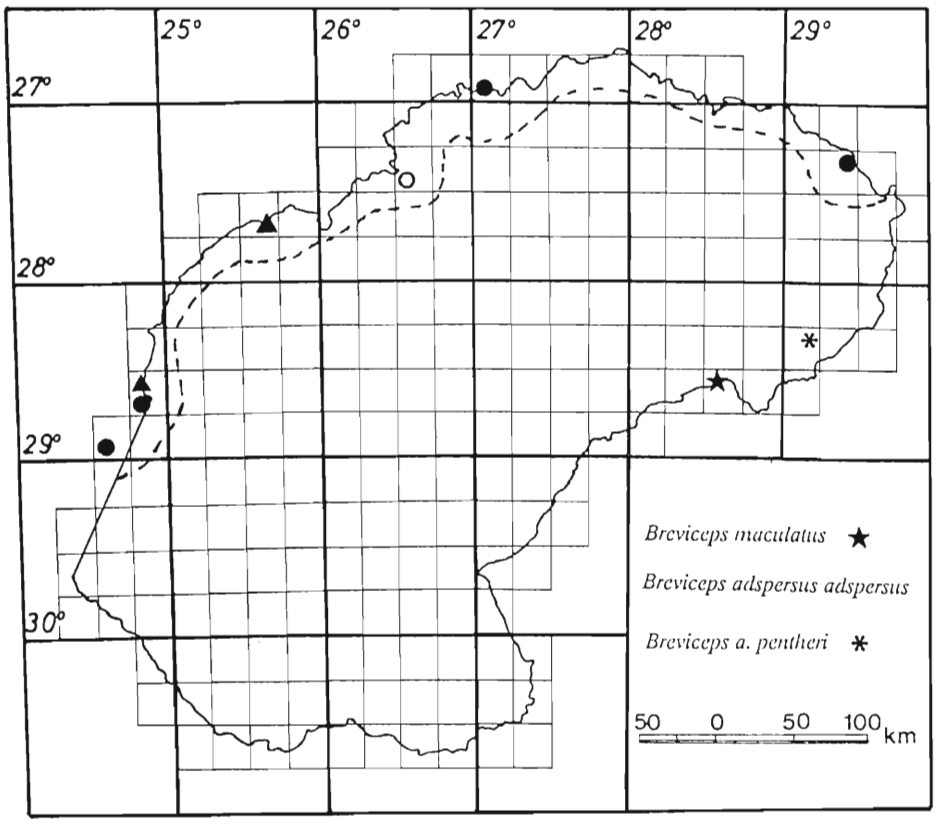


Figure 28: Distribution of *Breviceps maculatus, B. adspersus adspersus* and *B. adspersus pentheri* in the Orange Free State.

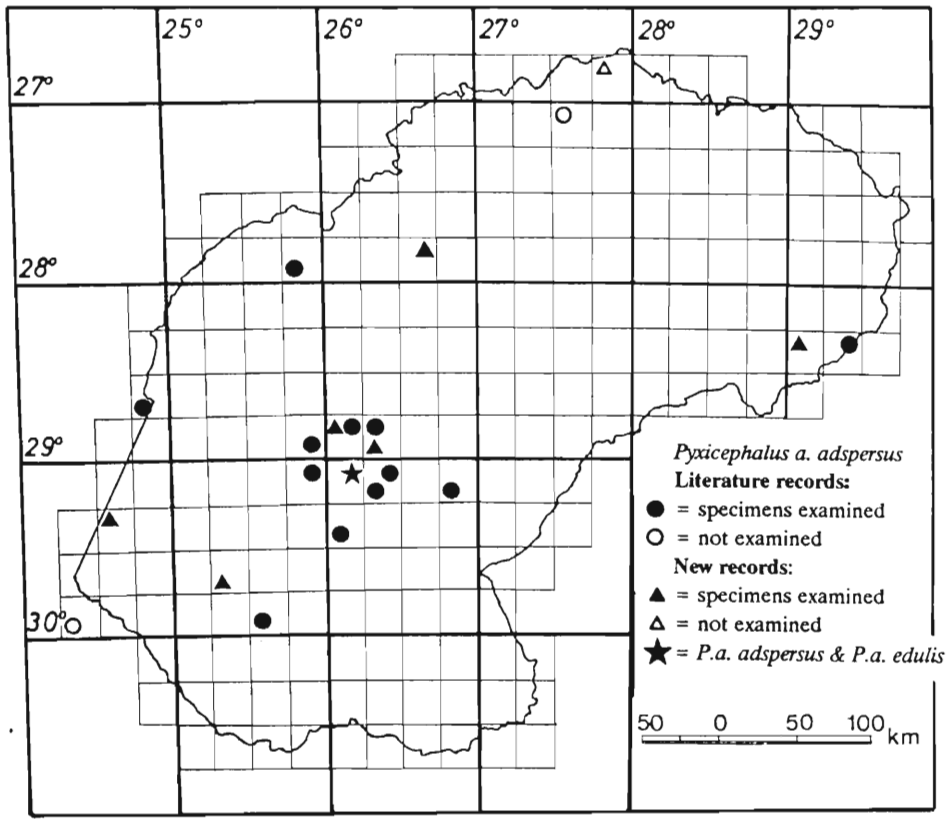


Figure 29: Distribution of *Pyxicephalus adspersus adspersus* and *P. adspersus edulis* in the Orange Free State and peripheral areas in the northern Cape Province.

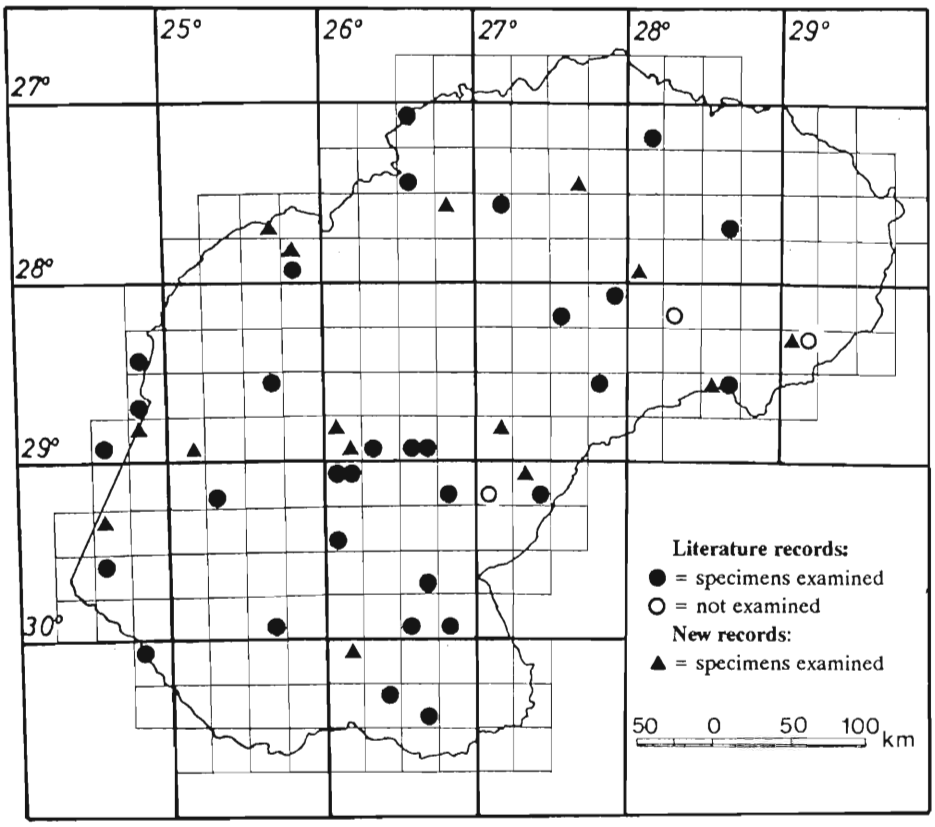


Figure 30: Distribution of *Tomopterna cryptotis* in the Orange Free State and peripheral areas in the northern Cape Province.

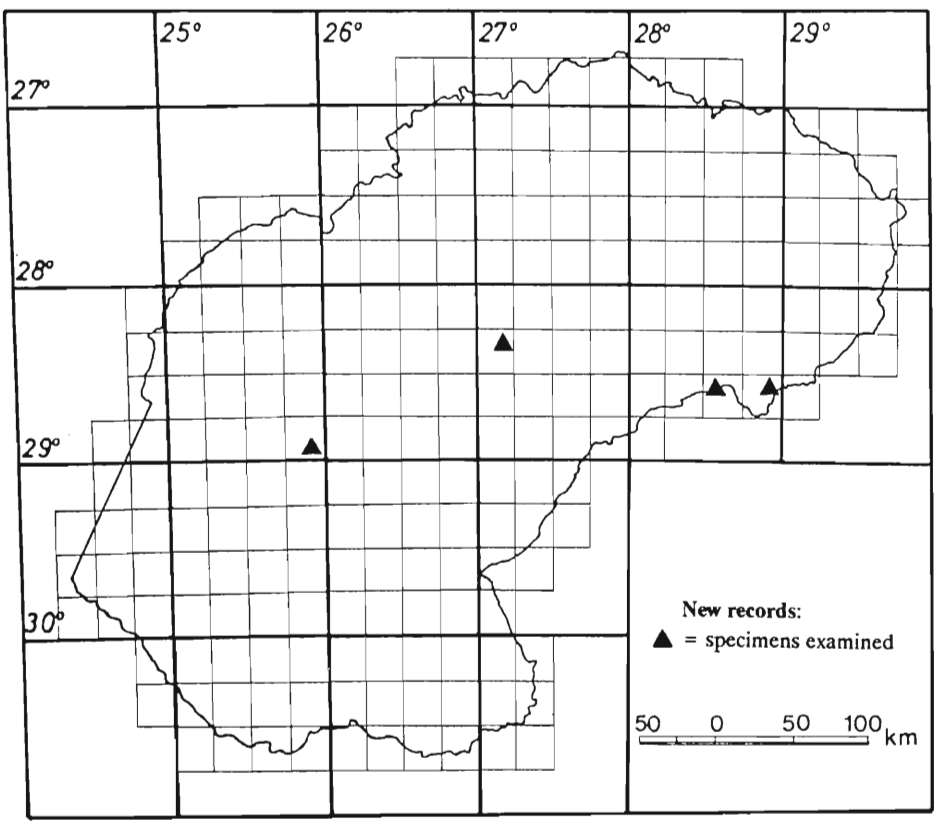


Figure 31: Distribution of *Tomopterna natalensis* in the Orange Free State.

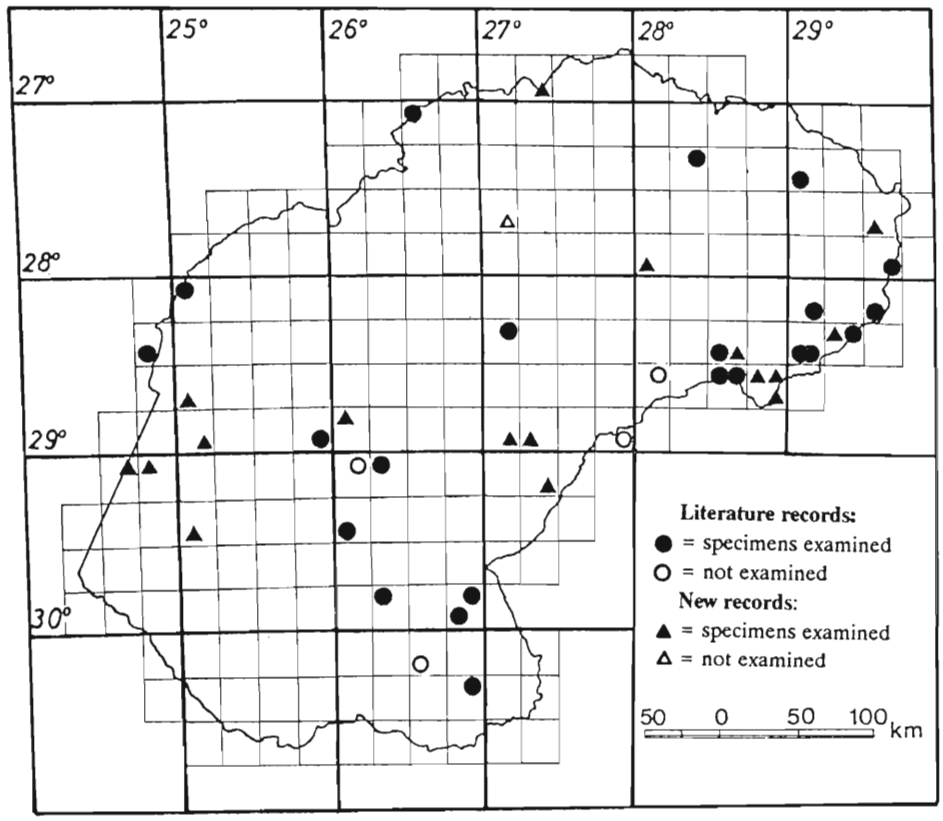


Figure 32: Distribution of *Rana angolensis* in the Orange Free State and peripheral areas in the northern Cape Province.

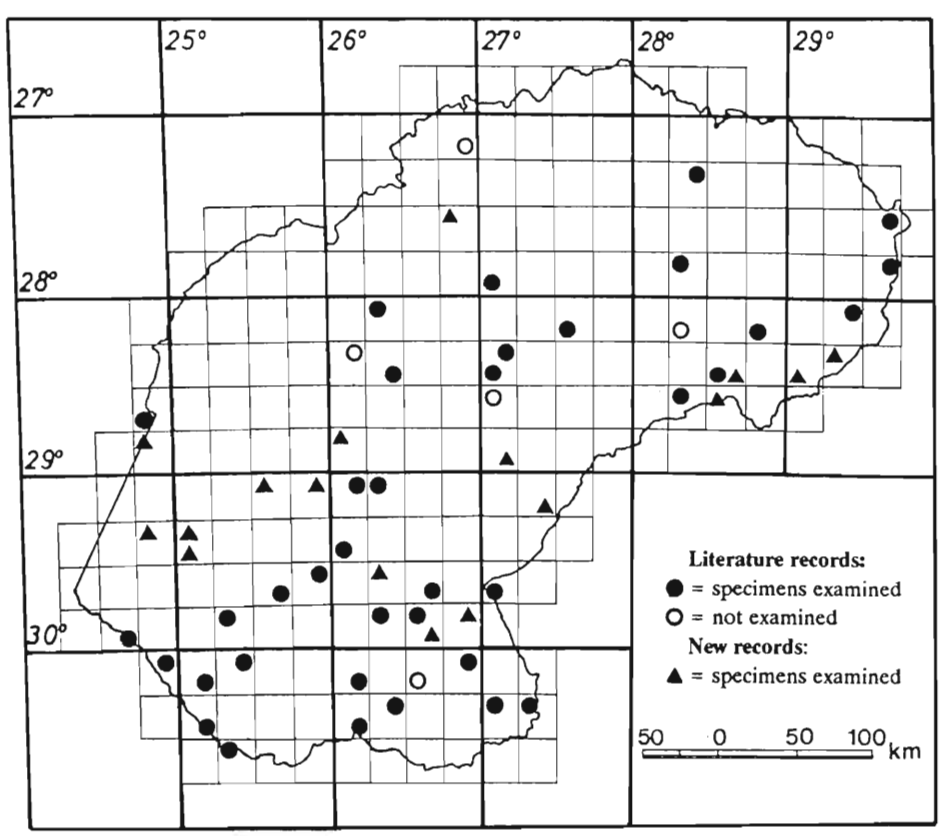


Figure 33: Distribution of *Rana fuscigula* in the Orange Free State and peripheral areas in the northern Cape Province.

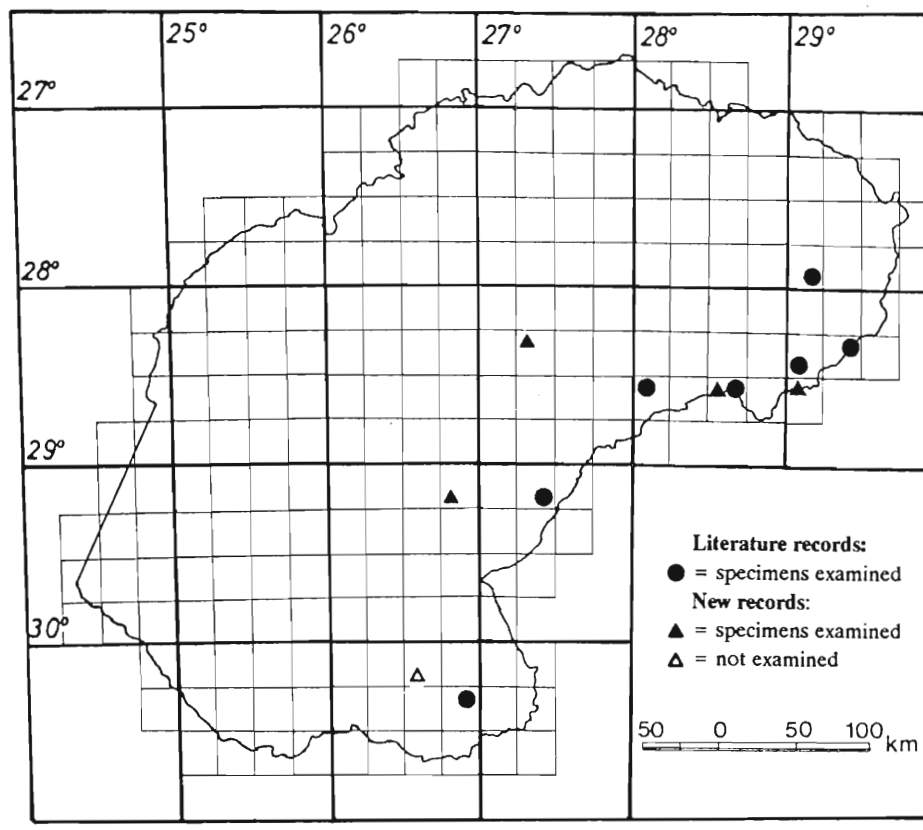


Figure 34: Distribution of *Strongylopus grayii grayii* in the Orange Free State.

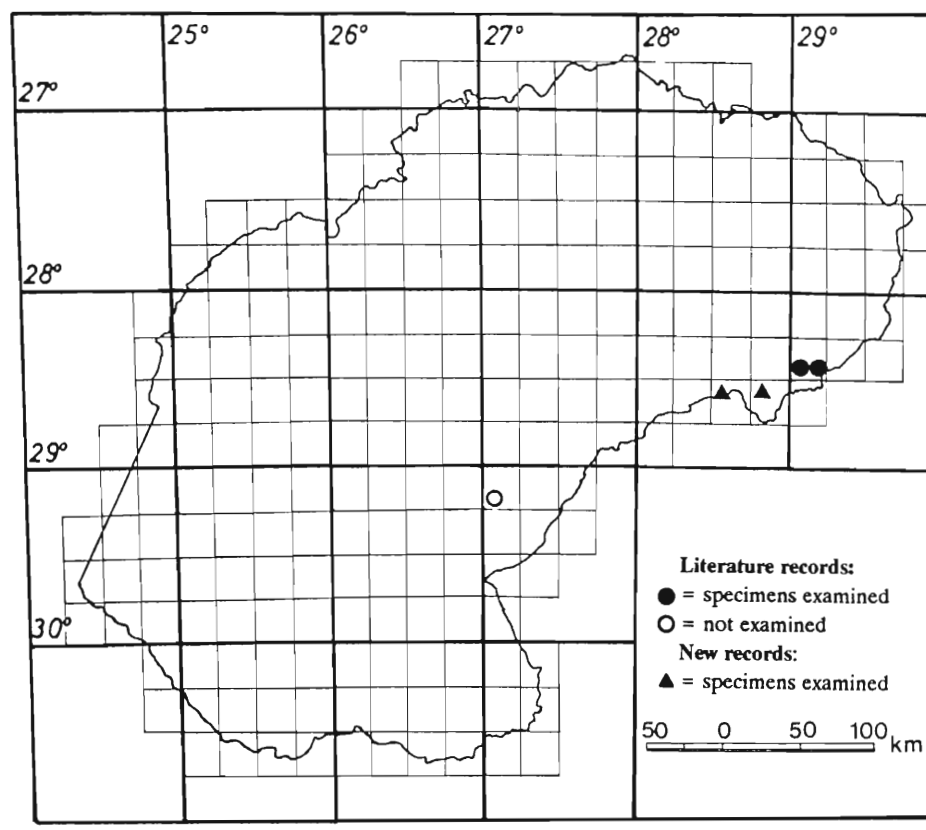


Figure 35: Distribution of *Strongylopus fasciatus fasciatus* in the Orange Free State.

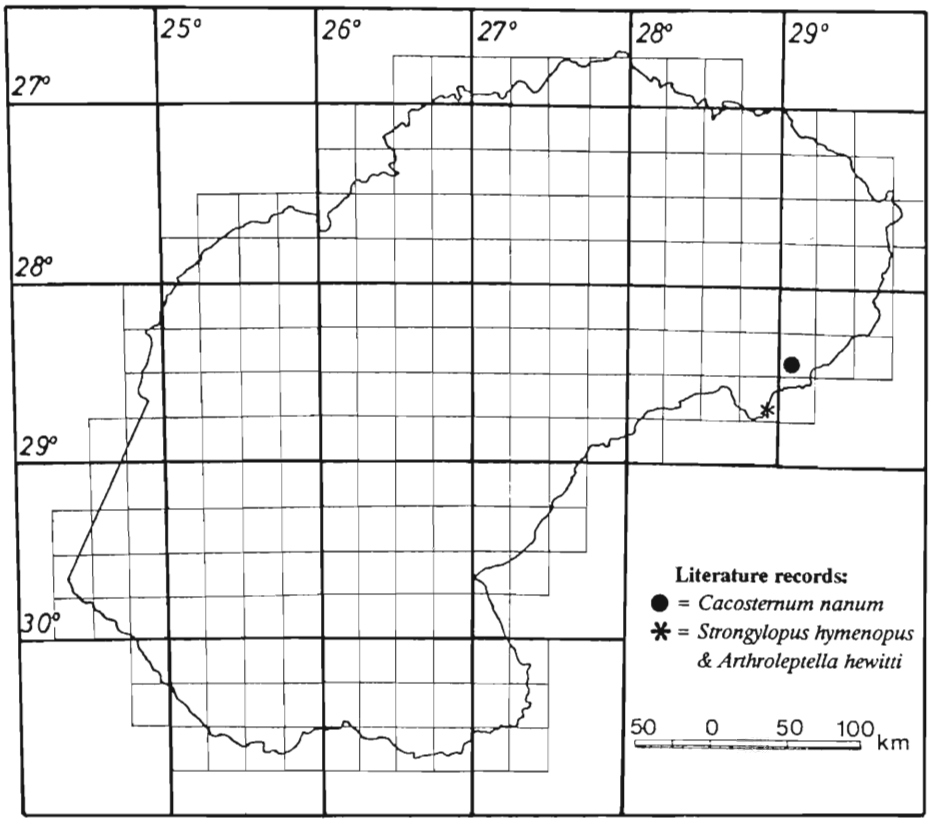


Figure 36: Distribution of *Strongylopus hymenopus, Cacosternum nanum* and *Arthroleptella hewitti* in the Orange Free State.

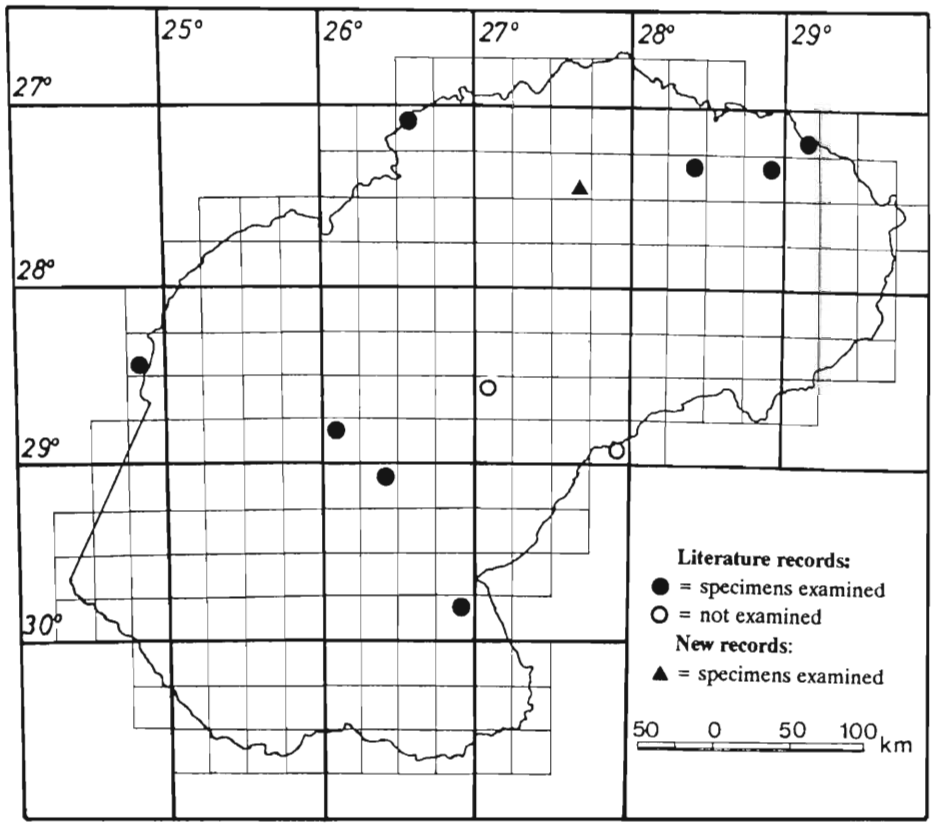


Figure 37: Distribution of *Phrynobatrachus natalensis* in the Orange Free State and peripheral areas in the northern Cape Province.

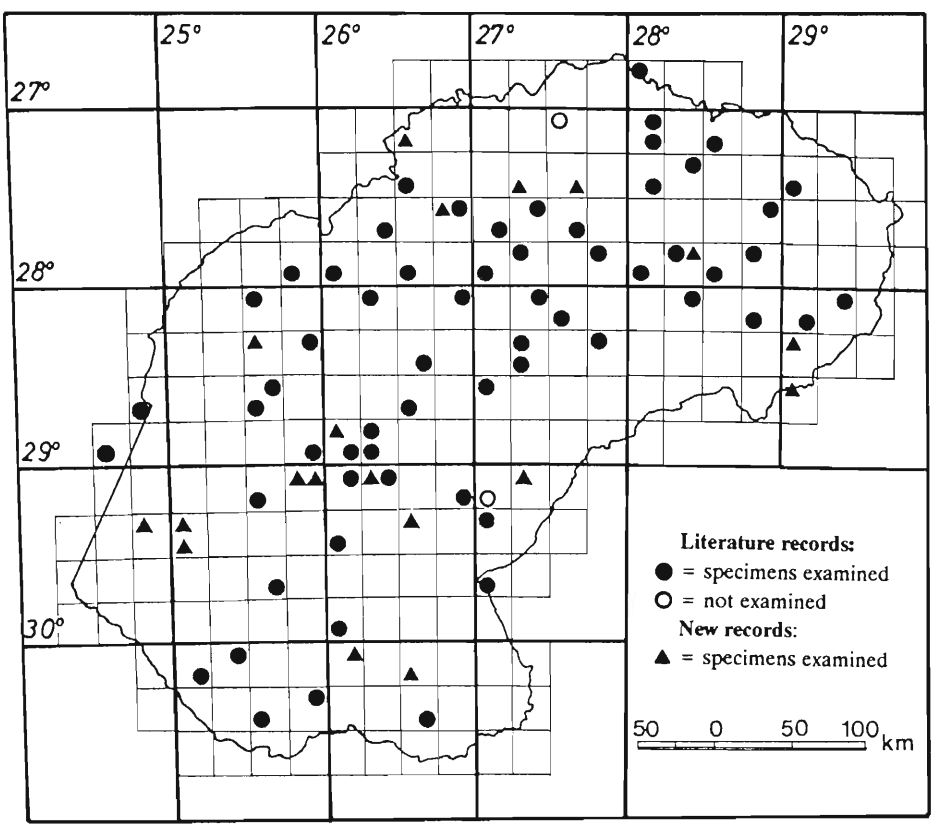


Figure 38: Distribution of *Cacosternum boettgeri* in the Orange Free State and peripheral areas in the northern Cape Province.

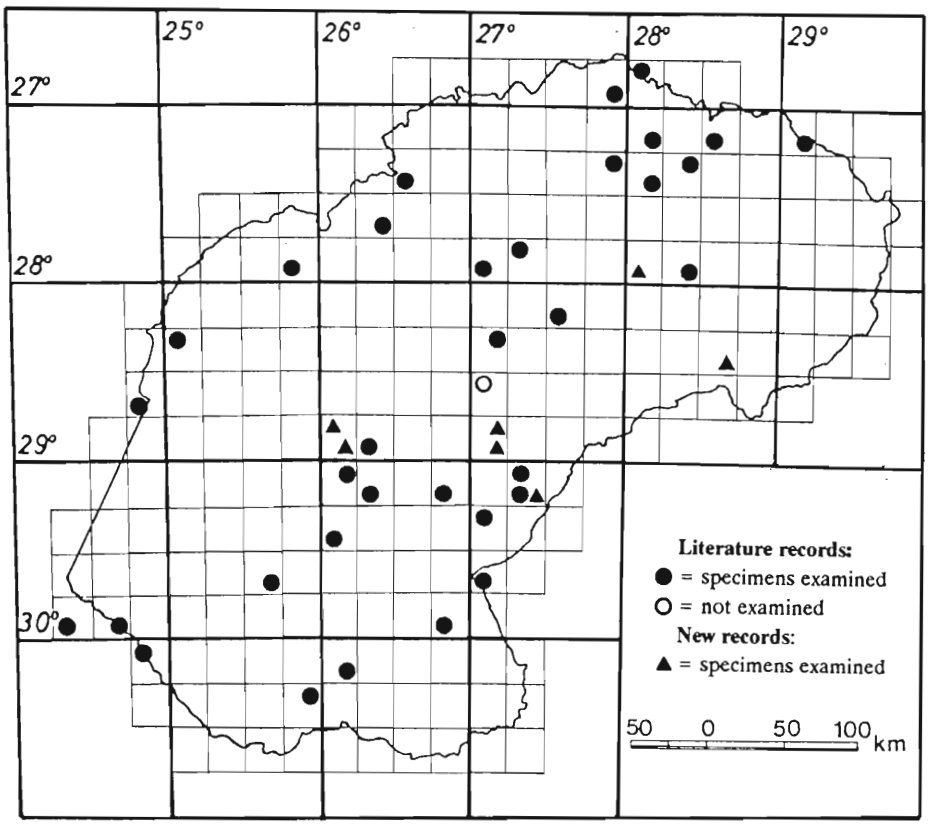


Figure 39: Distribution of *Kassina (Kassina) senegalensis* in the Orange Free State and peripheral areas in the northern Cape Province.

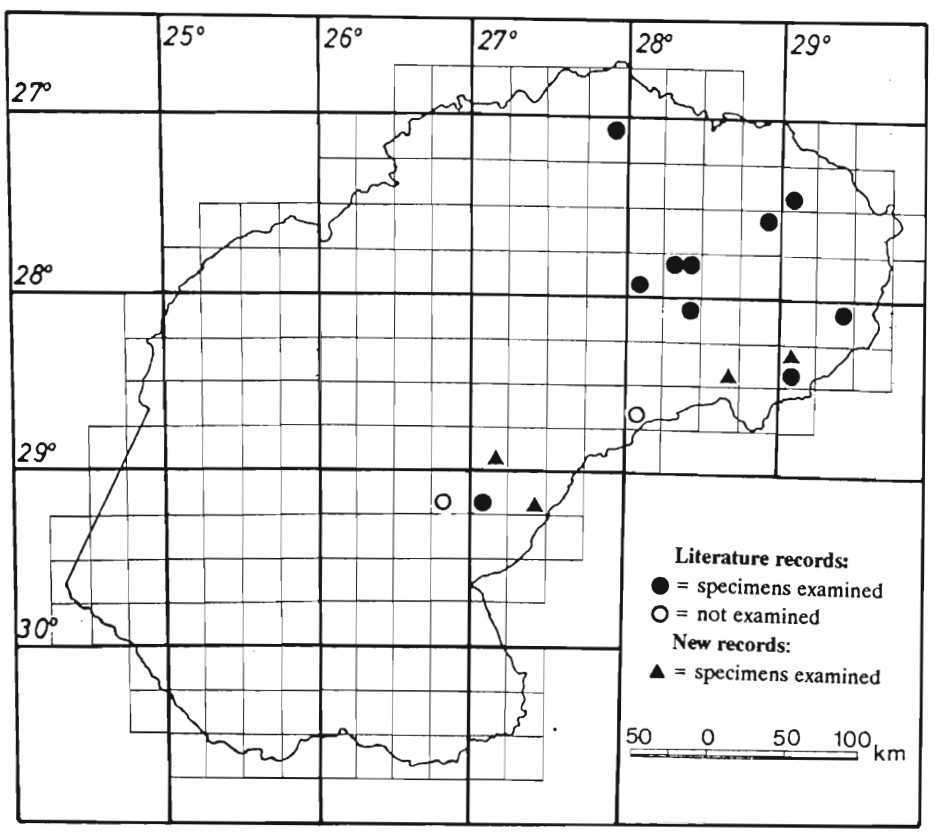


Figure 40: Distribution of *Kassina (Semnodactylus) wealii* in the Orange Free State.

4.7 Systematic account of the reptiles of the Orange Free State

(Locality records are based on material in the National Museum, Bloemfontein, unless where otherwise stated.)

Class: **REPTILIA**

Order: **SQUAMATA** Oppel, 1881

Suborder: **SAURIA** MacCartney, 1802

(Distribution maps and other illustrations for lizards, i.e. Figs 41-77, are presented on pages 200 to 222)

Family: **GEKKONIDAE** Cuvier, 1817

Genus: *Ptenopus* Gray, 1865

Ptenopus garrulus garrulus (A. Smith, 1849) Common Barking Gecko

Stenodactylus garrulus A. Smith, 1849, *Illus. Zool. S. Afr., Rept.,* App. p. 6. Type locality: "Sandy districts in the interior of Southern Africa".

Ptenopus garrulus garrulus (A. Smith): De Waal, 1978, p. 17.

Ptenopus garrulus maculatus (not Gray, 1865): Branch, 1988a, p. 212 (see map).

Range

Eastern half of Namibia, Botswana, extreme northern Transvaal, northern Cape Province and extreme south-western O.F.S.

Zoogeographical classification: Western Tropical Transitional.

Range cluster in O.F.S.: Southwestern (SW).

Distribution in the Orange Free State (one locality; Fig. 41)

Specimens examined from: Lemoenboord (NMB R4648-4774).

Other records: Benfontein on Benaauwdheidsfontein (1442) (auditory record needing confirmation, but plotted in Fig. 41, B.Y. Wilson, A. Anderson & M.F. Bates, 28 January 1992).

Features (49 specimens examined)

Largest male (NMB R4682 - Lemoenboord) 49 + 28 = 77 mm.

Largest female (NMB R4656 - Lemoenboord) 49 + 31 = 80 mm.

Dorsum light brown with small dark streaks. Digits long and strongly clawed, not dilated and without adhesive lamellae or plates, but with narrow transverse scales below. Toes depressed with a well developed lateral fringe of long pointed scales. Thirty-nine specimens (79,6%) had original tails and ten (20,4%) had regenerated tails. Tails were regenerated from various point along their length, from near the base to near the tip. Regenerated tails were of a darker colour than originals, lacked dark markings and banding and had irregularly arranged ventral scales. Four specimens with everted hemipenes (i.e. males) all had regenerated tails.

Habitat and Ecology

All specimens from the O.F.S. were collected on relatively flat, sandy areas covered with grass. They were found in September 1976, after the new P.K. le Roux Dam was completed and water flooded the surrounding land (De Waal, 1978, p. 17). Broadley (1966) reported large numbers of *P. garrulus* flooded out after rain, many specimens having been drowned. These lizards live in self-constructed burrows of up to 35,5 cm in depth in desert or semi-desert areas with sandy soils (Haacke, 1975, p. 217). The common name of this gecko is derived from its habit of producing a clicking sound. Prey consists mainly of termites, but ants, small beetles, hymenopterans and other small insects are also eaten (Haacke, 1975, p. 219). Enemies include snakes, the Ground Gecko *Chondrodactylus*, owls, shrikes and small carnivores (see Haacke, 1975, p. 219). Broadley (1966, p. 95) also recorded specimens of *P. garrulus* from the stomachs of a Bat-eared Fox *Otocyon megalotis* and Genet *Genetta genetta* from the central Kalahari. One or two eggs are produced (Branch, 1988a, p. 212). A detailed description of the habitat and ecology of this species is given by Haacke (1975).

Remarks

The nominate subspecies is distinguished from the western subspecies *P. g. maculatus* Gray, 1865 by its finer lepidosis and a finely speckled, reddish colour pattern (Haacke, 1975, p. 214). De Waal (1978, p. 17) noted that O.F.S. specimens had 168-185 scales around the body. This is in accordance with Haacke's (1975, p. 206) diagnostic key which states that *garrulus* usually has more than 160 scales around the middle and *maculatus* usually has less than 160. Branch (1990a, p. 27) recently recorded *P. g. maculatus* from near Aberdeen, confirming the only other Karoo record (Adendorp) viewed with suspicion by Haacke (1975, p. 225). Branch's (1988a, p. 212) distribution map shows the range of *maculatus*, rather than *garrulus*, extending into the south-western O.F.S.

Genus: *Afroedura* Loveridge, 1944

Afroedura karroica halli (Hewitt, 1935) Lesotho Flat Gecko

Oedura halli Hewitt, 1935, *Rec. Alb. Mus.*, 4, p. 321, pl. XXIX, figs 1 & 2. Type locality: Telle Junction, near Palmietfontein, Herschel District, Cape Province. Holotype (NM 272) and paratypes in the Natal Museum, Pietermaritzburg.

Afroedura karroica halli (Hewitt): Loveridge, 1947, pp. 271-272; De Waal, 1978, p. 19; Branch, 1988a, p. 190; Bates, 1989c, pp. 33-34, fig.

Afroedura nivaria (not Boulenger, 1894): De Waal, 1978, p. 18 (part).

Range

Mountainous regions of western Lesotho (including Drakensberg), north-eastern Cape Province and isolated populations on Thaba Phatshwa and Spitzkop mountains in the eastern and south-eastern O.F.S. respectively.

Zoogeographical classification: Eastern Temperate Transitional.

Range cluster in O.F.S.: Eastern (E).

Distribution in the Orange Free State (four localities; Fig. 42)

Twenty-eight specimens examined from: Ben Nevis; Spitzkop; Thaba Pachoa Berg; Thaba Phatshwa Mountain.

Extralimital records

Three specimens examined from: Half-way up Joubert's Pass; Top of Joubert's Pass.

Features (28 specimens examined: ten males, 14 females, three juveniles, one embryo)

Largest male (NMB R5215 - Ben Nevis) 64,2 + 62,0 r = 126,2 mm.

Largest female (NMB R5216 - Ben Nevis) 58,3 + 56,7 r = 115,0 mm.

A female (NMB R6157) collected half-way up Joubert's Pass near Lady Grey in the north-eastern Cape Province on 8 March 1990 measured 61,3 + 64,3 = 125,6 mm and weighed 6,7 g; another female (NMB R6156) collected at the same time and place measured 60,2 + 55,1 = 115,3 mm and weighed 5,5 g. Dark markings on the back and dorsal side of legs and tail. Dark blotches on back sometimes fused; occasionally 4-5 transverse bands present. Feet and hands with two pairs of digital plates per digit in addition to the terminal pair (right side examined, unless damaged); digits each with a strongly developed claw. Rostral widely separated from nostril on both sides of head. Nasorostrals widely separated, i.e. by a granule about 1½ - 5 times larger than adjoining granules. Preanal pores in males (N = 10) only, usually numbering six, but seven pores in NMB R5223. Out of 10 males, eight had regenerated tails, while the tails of the other two specimens were missing/broken. Out of 14 females,

four had original tails, six had regenerated tails and four specimens had missing/broken tails. Of the three juveniles, two had original tails and one had a missing tail; the embryo's original tail was intact.

Habitat and Ecology

These geckos are found on sandstone rock on the summit and sides of Thaba Phatshwa Mountain in the eastern O.F.S. Specimens were often found under horizontal, exfoliating sandstone flakes under overhanging rocks near the summit. In September 1988, two specimens were collected under a loose flake on a boulder on the western side of the mountain, one of which was a gravid female with two eggs. Hall in Hewitt (1935, p. 323) stated: "I have found this species very scarce: if you get two or three in a day you are lucky". However, they appear to be colonial, and in the O.F.S., large numbers were found occupying sections of sandstone rocks where flakes had formed. Prey includes ants and small beetles (Power, 1939). Enemies probably include snakes such as *Lamprophis guttatus*, also collected on Thaba Phatshwa Mountain (Bates, 1989c, p. 34). De Waal (1978, p. 19) recorded a female collected in November that contained two eggs. Three females collected on 28 September 1988 each contained two eggs; these were laid in October and November in captivity. According to Power (1939), eggs measure 12,5-16 x 10-12 mm and hatch after 6-8 weeks, the hatchlings measuring about 44 mm in length. A juvenile (NMB R6158) collected on 8 March 1990 at the top of Joubert's Pass, north-eastern Cape, measured 34,9 + 37,9 = 72,8 mm and weighed 1,0 g. Large numbers of eggs have been found together, adhering to a rock surface under a flat stone (Power, 1939). The shells of 10-26 eggs (*? A. k. halli*) were found under individual stones on the summit of Thaba Phatshwa Mountain (Bates, 1989c, p. 34). The Cape Thick-toed Gecko *Pachydactylus c. capensis* also occurs on Thaba Phatshwa Mountain, but has never been found in microsympatry with *A. k. halli*. *P. c. capensis* was found under stones, even near the summit, and once between two large boulders near the base of the mountain, but never in sandstone crevices.

Remarks

The first specimen of *A. k. halli* collected on Thaba Phatshwa Mountain was collected by A.C. Hoffman in September 1934, and deposited in the collection of the Museum of Comparative Zoology at Harvard University, United States. The specimen is still in that institution's collection (MCZ 46143) and is accompanied by the following data: "Thebapatchoa [= Thaba Phatshwa Mountain], Theba 'Nchn [= Thaba 'Nchu], Orange Free State. A.C. Hoffman coll. Sept. 1934". (J.P. Rosado, pers. comm., 24 October 1988). A previously misidentified *A. k. halli* specimen was recently discovered in the National Museum's collection, having been collected by A.C. Hoffman in 1938 (Bates, 1989c). Only four more specimens were collected during De Waal's (1978, p. 19) survey. In April 1984, an additional 13 specimens were collected, whereas seven more were collected in September 1988. Three specimens from Spitzkop Mountain in the south-eastern O.F.S., identified as *A. nivaria* by De Waal (1978), were determined to be *A. karroica halli*, mainly on the basis of the rostral being excluded from the nostril in all specimens.

Afroedura nivaria (Boulenger, 1894) Mountain Flat Gecko

Oedura nivaria Boulenger, 1894, *Proc. Zool. Soc. Lond.*, p. 608, 726, pl. XLVII, fig. 1, 1a. Type locality: Summit of Drakensberg Range, Natal. Types in the British Museum of Natural History, London.

Afroedura nivaria (Boulenger): De Waal, 1978, p. 18 (part); Branch, 1988a, p. 191; Bates, 1989c, p. 33; 1991b, p. 154 and 1992a, p. 43.

Range

Mountainous regions of the eastern O.F.S. and Natal Drakensberg, south to Sehlabathebe National Park in Lesotho (Lambiris, 1989b).

Zoogeographical classification: Eastern Temperate Transitional.

Range cluster in O.F.S.: Eastern (E).

Distribution in the Orange Free State (13 localities; Fig. 42)

Specimens examined from: Bosch Kloof, Harrismith; Diepkloof; General Will; Golden Gate Highlands National Park; Klavervlei; Ladybrand; Leliehoek Resort, Ladybrand; Monontsa Pass; Perth; Sentinel; Straalfontein; Tertia; Waterval, Winburg.

Features (43 specimens examined: 16 males, 25 females, two juveniles)

Largest male (NMB R6378 - Bosch Kloof) 58,7 + 64,9 = 123,6 mm; mass 5,8 g; another male (NMB R6379 - Bosch Kloof) measured 58,8 + 47,6r = 106,4 mm and had a mass of 4,9 g.

Largest female (NMB R6380 - Bosch Kloof) 59,6 + 46,0 = 105,6 mm; mass 4,4 g.

Colour pattern similar to that of *A. k. halli.* Digits of hands and feet with two pairs of digital plates in addition to the terminal pair; digits each with a well developed claw (right side examined, unless damaged). Rostral borders nostril, sometimes very narrowly (both sides of head examined). Nasorostrals separated by one (35 specimens) or two (four specimens, NMB R3347, 3348, 3359, 6295) granules or in narrow (one specimen, NMB R5310) to broad (three specimens, NMB R6138, 6139, 6380) contact. The granule/s separating nasorostrals vary in size from minute to about five times larger than adjoining scales. Males (N = 16) have 9-13 preanal pores. Of the total of 43 specimens, nine had original, 23 had regenerated and 11 had missing/broken tails. Therefore, of the 32 tailed specimens, nine (28,1%) had original and as many as 23 (71,9%) had regenerated tails. Of the 16 males, two had original tails, nine had regenerated tails and five had missing/broken tails; of the 25 females, seven had original tails, 14 had regenerated tails and four had missing/broken tails. The two juveniles had missing/broken tails.

Habitat and Ecology

Found in narrow sandstone crevices and under flakes on the mountains of the eastern O.F.S., from 1829-2591 m a.s.l.; at Sentinel it has been found above the snow-line (De Waal, 1978, p. 19). The stomach of one O.F.S. gecko contained coleopteran and orthopteran remains (De Waal, 1978). No detailed information has been recorded regarding enemies, but the Spotted Rock Snake *Lamprophis guttatus* which also occurs in the eastern O.F.S. and Natal Drakensberg, is a likely predator (Bates, 1989c). Little is known about their reproduction, but De Waal (1978) recorded two eggs being laid between January and March, measuring 13 x 9,5 mm. The eggs are firmly attached to rock surfaces and also adhere to one another. After hatching, the egg shells are weathered away, except for that part which adhered to the rock. Other eggs may then be laid on these remains during the same or another season, resulting in the formation of a layer of egg shell remains. One such layer collected at Perth contained at least 16 layers of egg-shell remains (De Waal, 1978). Bourquin & Channing (1980, p. 12) noted that a female collected in January in the Natal Drakensberg contained two eggs with diameters of about 8,0 mm.

Remarks

Three specimens from Spitzkop Mountain in the south-eastern O.F.S., identified as *A. nivaria* by De Waal (1978), were determined to be *A. karroica halli*, mainly on the basis of the rostral being excluded from the nostril in all specimens. The status of the *Afroedura nivaria - karroica - tembulica - amatolica* complex is in need of revision. Certain isolated populations of *Afroedura* in the Transvaal have been found to differ sufficiently in morphological features to suggest specific or subspecific status (Jacobsen, 1989), but the lack of obvious morphological differences in many other populations complications the taxonomy.

Genus: *Hemidactylus* Oken, 1817

Hemidactylus mabouia (Moreau de Jonnes, 1818) Tropical House Gecko

Gecko mabouia Moreau de Jonnes, 1818, *Bull. Soc. Philom. Paris*, p. 138. Type locality: "From Trinidad to Jamaica, in the Antilles, and adjacent mainland". Note: Probably introduced to West Indies from West Africa in slave trading days (FitzSimons, 1943, p.46). Type in the Paris Museum, Paris.

Hemidactylus mabouia mabouia (de Jonnes): Douglas, 1990b, p. 55; Bates, 1992a, p. 43.

Range

From the coastal regions of Natal to the Transvaal Lowveld, Mozambique, border regions of Zimbabwe and in eastern Botswana, with isolated records in northern Namibia and eastern O.F.S. Translocated

populations occur in Bloemfontein, East London, Port Elizabeth and several other areas. The species also occurs on Indian Ocean Islands and the eastern coast of Central and South America.
Zoogeographical classification: Tropical Wide Ranging.
Range cluster in O.F.S.: Eastern (E).

Distribution in the Orange Free State (two localities; Fig. 43)
Specimens examined from: Ben Nevis; Bloemfontein, Dan Pienaar (translocated).

Features (two specimens examined)
Dorsum brown with dark transverse bands; dorsal granules widely spaced. The juvenile Ben Nevis specimen (collected on Thaba Phatshwa Mountain) is similar to the translocated Bloemfontein specimens, which probably originate from the eastern Transvaal (see Remarks).

Habitat and Ecology
Branch (1988a, p. 194) noted that *H. m. mabouia* is primarily arboreal and often found under tree bark, while *H. m. tasmani* from eastern Zimbabwe prefers rock cracks and caves. The Ben Nevis specimen, a juvenile, was found under a stone on the summit of the mountain at about 1827 m a.s.l. The Bloemfontein population inhabit the walls of buildings (R.M. Douglas, pers. comm.). Prey includes moths, beetles, cockroaches and occasionally smaller lizards. Females lay 1-2 eggs measuring 8-10 x 10-13 mm and hatchlings measure 30-32 mm; communal nests with 50-60 eggs are known (Branch, 1988).

Remarks
The occurrence of the Ben Nevis specimen is hard to explain. Despite an intensive search on the mountain on a later occasion, no additional specimens were discovered. It seems unlikely that the specimen, a juvenile, was translocated, as it was found far away from, and at a much greater altitude than, the farmhouse at Ben Nevis. It could, however, have been translocated in camping gear by persons climbing Thaba Phatshwa Mountain subsequent to holidaying in Natal or the eastern Transvaal, where the species is common. The Bloemfontein population is thriving (R.M. Douglas, pers. comm.), the founder stock almost certainly originating from Broedershoek (129), Nelspruit district (2531 AC) (Douglas, 1990).

Broadley (pers. comm. to W.R. Branch) has validated *H. tasmani* as a full species, and *H. mabouia* thus reverts to binomials (see use by Broadley, 1991, p. 522).

Genus: *Lygodactylus* Gray, 1864

Lygodactylus capensis capensis (A. Smith, 1849) Cape Dwarf Gecko

Hemidactylus capensis A. Smith, 1849, *Ill. Zool. S. Afr., Rept.*, pl. LXXV, fig. 3. Type locality: Kaffirland and the districts to the north of the Cape Colony. Types appear to be lost.

Lygodactylus capensis capensis (A. Smith): De waal, 1978, p. 20; Branch, 1988a, p. 197, p. 91; Douglas, 1990b, p. 55; Yeadon, 1991a, p. 19; Bates, 1992a, p. 43.

Range

From Kenya southwards to Botswana, Mozambique, Zimbabwe, eastern Natal, Swaziland, most of the Transvaal (excluding the south-east), extreme western O.F.S. and the Kimberley area of the northern Cape Province. Introduced populations occur in Bloemfontein, Welkom and Kroonstad (O.F.S.) and Port Elizabeth (eastern Cape Province).

Zoogeographical classification: Tropical Wide Ranging.

Range cluster in O.F.S.: Northwestern (NW).

Distribution in the Orange Free State (ten localities, of which four represent translocations; Fig. 44)

Specimens examined from: Bloemfontein (translocation); Inglewood; Leeuwkuil; Moirton; Naudesville (translocation); Platberg, Boshof; Van Aswegenshoek; Welkom (translocation); Zoetvlei.

Other records: Kroonstad (Yeadon, 1991a) (translocation).

Features (19 specimens examined)

Largest male (NMB R2079 - Van Aswegenshoek) 34 + 40 = 74 mm.

Largest female (NMB R1678 - Leeuwkuil) 35 + 37 = 72 mm.

Dorsum grey-brown with pale dorso-lateral stripes visible in some specimens. No distinct markings on throat, but some scales on throat and venter may have one or more dark stipples. Inner digits of hands and feet rudimentary. Mental with slightly inwardly directed lateral clefts. Digits clawed; four pairs of adhesive lamellae under 4th toe of right foot, but three on left foot of NMB R5453. The five males have 4-5 preanal pores each. Of the 19 specimens, seven had original tails, three had regenerated tails and nine had missing/broken tails. Of the five males, four had original tails and one a missing tail. Translocated specimens exhibited the same variation in the features examined that north-western O.F.S. specimens did.

Habitat and Ecology

Collected in *Acacia* trees and on rocks in the Kalahari Thornveld of the western O.F.S. (De Waal, 1978, p. 21). Also found in gardens in Bloemfontein, Kroonstad and Welkom, to which they were almost certainly introduced, probably by means of motor vehicles. These are diurnal, primarily arboreal

geckos. According to Jacobsen (1989, p. 188) it is a sociable species, "living in what appears to be family groups of up to 13 individuals". Males are territorial and breeding apparently occurs throughout the year, with a peak in winter (Jacobsen, 1989, p. 188). Each female lays two eggs, each measuring 5-8 x 5-7 mm (Branch, 1988a, p. 197; Jacobsen, 1989, p. 188). Eggs take 2-5 months to hatch, hatchlings measuring about 25 mm in total length (Branch, 1988, p. 197). Visser (1984a, p. 63) reported on an incubation period of 5 months and 17 days for eggs laid in Swaziland. According to Branch (1988a, p. 197), the diet consists almost exclusively of termites, but Cott (1934, in Loveridge 1947, p. 211) recorded beetles, ants, homopterous bugs, hymenopterans, lepidopterans, cockroaches, caterpillars, spiders and woodlice from 24 *L. capensis* stomachs. Flies and small bees are also eaten (Hoffman, 1990, p. 116). Eggs may be laid in a communal nursery (Auerbach, 1987, p. 87). Broadley (1966, p. 108) recorded individuals of this gecko in the stomachs of a *Thelotornis kirklandii capensis* (= *T. capensis* ssp.) and a *Hemirhagerrhis nototaenia* (= *H. n. nototaenia*) from south-east Africa.

Genus: *Pachydactylus* Wiegmann, 1834

Pachydactylus mariquensis mariquensis A. Smith, 1849 — Marico Gecko

Pachydactylus mariquensis A. Smith, 1849, *Ill. Zool. S. Afr., Rept.*, App., p. 3. Type locality: "Interior of Southern Africa". Types in the British Museum of Natural History, London. Boulenger, 1910, p. 462.

Pachydactylus mariquensis mariquensis A. Smith: FitzSimons, 1943, p. 69, pl. XIV, fig. 2; Loveridge, 1947, p. 346; De Waal, 1978, p. 21; Branch, 1988a, p. 204.

Range

Southern O.F.S. southwards to the eastern, central and western Cape Province.

Zoogeographical classification: Western Temperate Transitional.

Range cluster in O.F.S.: Southern (S).

Distribution in the Orange Free State (ten localities; Fig. 45)

Specimens examined from: Florisbad; Knellpoort; Krugersdrift Dam; Lemoenboord; Sunny Hills.

Other records: Smithfield (Boulenger, 1910); Meadows (FitzSimons, 1943); Glen; Leeuwberg; Mimosa (De Waal, 1978).

Features (21 specimens examined: eight males, 11 females, two juveniles)

Largest male (NMB R371 - Krugersdrift Dam) 52 + 41 = 93 mm.

Largest female (NMB R4707 - Lemoenboord) 57 + 40 = 97 mm.

Dorsum light brown in colour, usually with five (four in NMB R4776) irregular-shaped dark coloured transverse bands from nape of neck to above anterior insertions of hindlimbs. An anteriorly directed dark coloured crescent marking is present on the back of the head. Dorsal bands are either unbroken, separated medially or partly fragmented. Dorsum with subuniform, granular and juxtaposed scales. Nasorostrals usually in contact, but separated by rostral, posterior nasal and a single granule (about 1½ times larger than granules behind) and fragmented into three small granules on left side of head, in NMB R4778; also, under nostril, 1st upper labial on left side "includes" a minute granule in this specimen. First upper labial usually separated from nostril, often very narrowly, but in contact with nostril on left side of NMB R4775; and nostril in contact with rostral on left side of NMB R4782. There are 3-6 (six on one side of NMB R5598 only) well developed conical scales on either side at the base of the tail (both sides examined) in both sexes. These scales are well developed in males (3-6 per side; N = 8) and poorly developed in females (3-5 per side; N = 11) and juveniles (33,2 mm SVL and smaller; 3-5 per side; N = 2). One male (NMB R373) had a clearly evident secondary row of these scales. Males had very well developed hemipenial sacs. Of the total of 22 specimens, nine had original tails, five had regenerated tails and seven had missing/broken tails. In males (N = 8), three had original, two regenerated and three broken tails. In females (N = 11), five had original, three regenerated and three broken tails. In juveniles (N = 2), one had an original and one a broken tail. Regenerated tails were light brown with dark spots but no banding, and in all cases, grew from near the base of the tail.

Habitat and Ecology

Specimens collected at Krugersdrift Dam had been drowned in floods during February of 1972, while those from Lemoenboord were collected when the first waters of the P.K. le Roux Dam flooded the surrounding land (De Waal, 1978, p. 21). A specimen collected at Knellpoort was found under a small stone in a sandy area in short grassland, while one from Florisbad was collected in a bucket trap on a drift fence in open grassland. According to Branch (1988a, p. 204), the species is nocturnal and preys on small insects. Individuals were found in the stomachs of the snakes *Psammophis notostictus* and *P. leightoni trinasalis* (De Waal, 1978, p. 22), while two specimens were recovered from the stomach of an adult Spotted Eagle Owl *Bubo africanus* (Bates, 1988c, p. 49) from the O.F.S. Four gravid females collected in September each contained two well developed eggs, whereas another female collected in September contained three eggs (very unusual for geckos) (De Waal, 1978, p. 22). A female from Victoria West in the Cape Province contained two eggs (Bates, 1991c, p. 15). Branch (1988a, p. 204) reported that in one season females lay 1-2 clutches of two eggs each, and deposit these under a rock slab during October-March; eggs measure 10 x 7,5 mm.

Remarks

FitzSimons (1943) recognized two subspecies, namely *P. m. mariquensis* A. Smith and *P. m. macrolepis* FitzSimons, retaining *P. latirostris* Hewitt as a full species. Loveridge (1947) treated all three forms as subspecies of *P. mariquensis*. McLachlan in Branch *et al.* (1988, p. 6) noted that *P. m. macrolepis* is of doubtful status and probably a synonym of *P. m. mariquensis*, and Bates (1991c, p. 15) recorded both *P. m. mariquensis* and *P. m. latirostris* from the same quarter-degree units at 3123 AC and 3222 BA in the Cape Province. De Waal (1978, p. 22) recorded the localities "Glen", "Leeuwberg" and "Mimosa" for this species, but no *P. m. mariquensis* from these localities could be traced in the National Museum's collection.

Pachydactylus maculatus oculatus Hewitt, 1927 — Golden Spotted Gecko

Pachydactylus capensis oculatus Hewitt, 1927, *Rec. Albany Mus.*, 3, p. 394, pl. xxiii, fig. 1 (given in plate as *Pachydactylus maculatus oculatus*). Type locality: Farm Cyrilhurst, six miles from Tarkastad, Cape Province. Type in Albany Museum, Grahamstown, missing.

Pachydactylus maculatus albomarginatus Hewitt, 1932, *Ann. Natal Mus.*, 7, p. 121, pl. vi, figs 6,7. Type locality: Norvalspont, Cape Province. Types in Albany Museum, Grahamstown, missing.

Pachydactylus maculatus oculatus Hewitt: De Waal, 1978, p. 22.

Pachydactylus oculatus Hewitt: Branch, 1988a, pp. 9 & 204, pl. 81.

Range

Cape inland escarpment northwards to southern O.F.S.

Zoogeographical classification: Eastern Temperate Transitional.

Range cluster in O.F.S.: Southwestern (SW).

Distribution in the Orange Free State (eight localities; Fig. 45)

Specimens examined from: Francis Home; Groenkloof; Houtkoppies (?); Klipbankfontein; Luiperfontein; Middelbron; Ospoort; Hendrik Verwoerd Dam (TM 36709); Vissershoek West.

Features (27 specimens examined)

Largest male (NMB R4107 - Ospoort) 42 + 29r = 71 mm.

Largest female (NMB R2258 - Luiperfontein) 42 mm SVL, tail absent.

Scales on back heterogeneous, with granules intermixed with unkeeled conical tubercles. Four pairs of large, more or less oval-shaped spots in longitudinal series on back, with an additional row of irregular-shaped dark markings on flanks. Each spot is dark brown in colour with a black border and white outline. The white outline may be almost invisible in preserved specimens, and is more prominent in

adults. Spots may be elongated and/or fused together. Usually three conical scales on either side of base of tail, the size of scales decreasing posteriorly, and those of males about twice as large as females. Some specimens have four scales on one side and three on the other (i.e. NMB R561, 565, 1567) and one juvenile (NMB R563) has four on the left side and two on the right. The six males (with everted hemipenes, and large hemipenial sacs) all had missing tails; two out of 11 females had regenerated tails (NMB R2254, regenerated from about midway along the tail; the other from the base, NMB R4906).

Habitat and Ecology

Found in cracks and under rocks on rocky outcrops in the south-western O.F.S. (De Waal, 1978, p. 23). The diet includes grasshoppers (Tasman in Hewitt, 1927). Predators include larger lizards and snakes (Branch, 1988a, p. 204), such as *Trimerorhinus* (Tasman in Hewitt, 1927). Two eggs measuring 10-11 x 8-9 mm are laid in rock cracks (Branch, 1988a, p. 204).

Remarks

The nomenclatural history of this form was discussed by De Waal (1978, pp. 23-24). Branch (1988a, pp. 9 & 204) treats *P. m. oculatus* as a valid species.

Pachydactylus capensis capensis (A. Smith, 1845) Cape Thick-toed Gecko

Tarentola capensis A. smith, 1845, *Ill. Zool. S. Afr., Rept.*, pl. 50, fig. 2. Type locality: Interior of South Africa. Types in the British Museum of Natural History, London. (Note: described under *Tarentola*, but changed to *Pachydactylus* in index).

Pachydactylus capensis (A. Smith): Bocage, 1896, p. 115; Boulenger, 1910, p. 461.

Pachydactylus leopardinus Sternfield, 1911, p. 418, *Mitt. d. Zool. Mus. Berlin*, v, 3, p. 418. Type locality: Bethany, Orange Free State.

Pachydactylus capensis capensis (A. Smith): FitzSimons, 1943, p. 93, figs 27 & 28, pl. 16, fig. 1; De Waal, 1978, p. 24; Branch, 1988a, p. 201, pl. 83.

Range

Southern Angola, eastern half of Namibia, Botswana, Transvaal (excluding the east and south-east), Orange Free State, western Lesotho and northern and central Cape Province.

Zoogeographical classification: Western Tropical Transitional.

Range cluster in O.F.S.: Throughout (T).

Distribution in the Orange Free State (207 localities; Fig. 46)

Specimens examined from: Alpha; Annie's Rust; Atalanta; Babel; Bachelor's Home; Baltespoort; Basberg; Ben Nevis; Bergkloof; Bergplaats, Bloemfontein; Bergplaats, Dewetsdorp; Berlin, Bethlehem (TM 48558); Berlin, Vrede; Bethany; Bethel; Beyersfontein; Biddulphsberg; Bloemfontein, 19 miles west of (TM 27247-48); Bosmansberg; Boschkop; Boskop; Bosmansrust; Brabant; Brakfontein; Brakpan; Bramley; Bramley's Hoek; Brockenhurst; Bultfontein; Caledonspoort; Carlie; Cecilia; Ceylon; Chubani; Cornwall; Damfontein; Dasklip; Deelfontein, Bothaville; De Rust; Die Hoogte; Dipka; Di Poort; Doornlaagte; Edenburg, 4 miles south of (NMZB-UM 814); Elandsfontein; Elim, Vrede; Erinmore; Excelsior, Edenburg; Falle Grange; Fauresmith (NMB; TM 16730); Florisbad (NMB; NMZB-UM 816-17); Francis Home; Geluk, Boshof; Goedehoop; Goedetrouw; Groenekloof; Grootberg on Lemoenshoek (1600); Grootkloof; Grootkrans; Gruiskop; Gruisrand; Haagen's Stad; Hartebeestfontein, Bloemfontein; Heenenweerskop; Holme's Dale; Honingberg; Hoogeveld, Theunissen; Houmoed; Houtkop; Jonkerskraal; Kades; Kafferskop; Kareerand; Karreeboomsvallei; Karreepoort; Kasteelkop; Kestell; Kleinplaas; Klipbankfontein; Klipdrift; Klipfontein; Klippiespan; Klipplaatdrift, Edenburg; Klipplaatdrift, Winburg; Kopjeskraal; Koppiesdam; Kranskop; Krugersdrift Dam; La Belle France; Lange Hoek; Lang Zeekoegat; Lanquedoc; La Riviera; Leeuwberg; Leeuwfontein, Theunissen; Leeuwkop; Leeuwkuil; Leliehoek; Lemoenboord; Lentelus; Lessingskop; Littlecote; Lorenzo; Loskop; Luiperfontein; Luiperskop; Lusthof (TM 36668); Magdalen; Mandyville; Mara, Parys; Mara, Vredefort; Mecklenburg; Merino, Bethlehem; Merriesfontein; Meyerskraal; Middelbron; Middenspruit; Milambi; Mimosa; Moirton; Monontsa Pass; Mooigelegen; Môreson, Marquard; Morgenzon, Ficksburg; Morgenzon, Senekal; Mount Nelson; Noodhulp; Odendaalsrus, near to (TM 27242-46); Ongegund; Onze Rust; Ospoort; Onverwacht (TM 33310-14); Paradys; Patrijsdraai; Petra; Pietersberg; Platberg, Boshof; Poortje, Edenburg; Proces; Quaggaspruit; Ramalitse; Rambouillet; Rietfontein, Rouxville; Riverside; Rohallion; Rondavel; Rorich's Hulp; Rusthof; Sannaspos (TM 48309-10); Schoongezicht; Smithskraal; Spijtfontein; Spitzkop; Stoffelfontein; Straalfontein; Strathearn (TM 55992); Strijdfontein, Heilbron; Strijdfontein, Philippolis; Sussannasfontein; Thaba Pachoa Berg; Trentham (TM 48552); Triangle; Tweefontein; Uitkomst; Uitkyk (486); Uitkyk (614) (TM 41495); Vaalkop; Van Aswegens Hoek; Van der Walt's Rust; Venus; Verdun, Fouriesburg; Vergaderrand; Vredefort, 2 miles north-east of (NMZB-UM 821-22); Waterhoek; Welgegund; Weltevrede; Weltevreden, Heilbron; Weltevreden, Smithfield; Wilhelmshohe; Willem Pretorius Game Reserve (NMB; TM 27322-34, 27336, 29710-35, 29737-52, 29753-34, 29762); Winburg (TM 22008); Wittekopjes; Wittepoort; Witzieshoek; Wolwekop, Fauresmith; Wolvekop, Kroonstad; Wolvenfontein; Wonderkop; Zandfontein; Zoutpan, Jacobsdal; Zuurfontein; Zwartkoppies. Other records: Modder River (Bocage, 1896); Kroonstad; Smithfield (Boulenger, 1910); Bethanien (farm name?, Sternfield, 1911); Avalon; Bloemfontein; Deelfontein, Bethulie; Fauresmith; Ficksburg; Glen; Meadows; Verkeerde Vlei (FitzSimons, 1943).

Features (489 specimens examined)

Largest male (NMB R1943 - Klipfontein) 57 + 48 r = 105 mm.

Largest female (NMB R4033 - Boschkop) 60 + 39r = 99 mm.

Dorsum various shades of brown, usually with small dark spots or blotches, but there may be only a few scattered dark-coloured tubercles. Dorsum may be uniform brown, but usually with black spots or blotches composed of adjoining black tubercles with or without scattered white tubercles, or with scattered single black tubercles only, with or without scattered white tubercles. Tubercles on back either conical and weakly keeled, or less conical and strongly keeled, and separated by small granules. Tubercles in more or less regular longitudinal rows. Vague, thin, wavy transverse white bands very occasionally evident on back, but these bands are not bordered by distinct dark scales or associated with a light vertebral stripe as in *P. vansoni.* Crown of head with large conical tubercles and small granules. Venter cream coloured. Bates (1989b) noted that 68,8% of 247 O.F.S. *P. c. capensis* had shed their tails at least once.

Habitat and Ecology

Found in inactive termitaria and under stones in the O.F.S. (De Waal, 1978, p. 25). One specimen was found hanging vertically in the space formed by two large rocks on the lower slopes of Thaba Phatshwa Mountain, and several others were found under stones near the summit of the mountain. On the farm Lindley, several specimens were collected at night on the walls of a derelict building, but unfortunately none were retained. Two specimens were collected from bucket traps on a drift fence in grassland at Florisbad. Also found in the holes of other animals (e.g. dung beetles), under rotting logs and bark and occasionally in low vegetation (FitzSimons, 1943, p. 95; Jacobsen, 1989, p. 217). *P. c. capensis* was collected at 2073 m a.s.l. in the O.F.S., a record elevation for the subspecies (De Waal, 1978). In the southern Kalahari, 29,2% of first sightings of *P. capensis* were of arboreal (30 cm and less above ground) specimens, whereas 27,7% were terrestrial near a bush or bushes (Pianka & Huey, 1978, p. 694). Prey items include arachnids and insects, especially grasshoppers, crickets, coleopterans and the termite *Hodotermes mossambicus* (Pianka & Huey, 1978). Enemies include genets *Genetta genetta* and mongooses *Paracynictis selousi* (Broadley, 1966, p. 119). Females containing two eggs were collected from September to November, and eggs and juveniles were collected from November to January in the O.F.S.; eggs measuring 10 x 7 mm were deposited in inactive termitaria and under stones (De Waal, 1978). NMB R2521 contains a single egg, as was the case with one out of 15 ovigerous females from the southern Kalahari examined by Pianka & Huey (1978) and one out of ten ovigerous females from the Pretoria area examined by Bates (1991e, p. 7). Bates (1991e) has summarized reproductive data for this subspecies, but some of the specimens (Pretoria area) on which his own study is based may in fact be representative of a *P. affinis* (*vide* Jacobsen, 1989) population; some of the eleven voucher specimens originally confirmed to be *P. c. capensis* by N.H.G. Jacobsen (pers. comm.) were later (1992) identified by him as *P. affinis.* Two juveniles collected at Florisbad measured, respectively, 25,5 mm SVL, tail absent (February) and 22,5 + 17,5 r = 40,0 mm total length (March). De Waal (1978) recorded *P. c.*

capensis from the stomachs of the following snake species from the O.F.S. - *Lamprophis fuliginosus, Lycophidion c. capense, Crotaphopeltis hotamboeia, Psammophylax tritaeniatus, Psammophis notostictus* and *P. leightoni trinasalis.*

Remarks

Considerable confusion has surrounded and in some cases still does surround the taxonomic status of several forms included in the *Pachydactylus capensis* complex (Broadley, 1977b; Jacobsen, 1989). Characters used to distinguish the various forms were based on relative size and arrangement of tubercles on the head, body, limbs and tail, in conjunction with dorsal colour pattern (Broadley, 1977b, p. 2). In separating the various north-eastern forms of the *P. capensis* complex, Broadley (1977b) used, *inter alia*, caudal scale arrangement of the original tail. Despite the usefulness of the latter, its immediate disadvantage lies in the fact that many specimens have tails broken or regenerated, often at or near the base (Bates, 1989b; Jacobsen, 1989, p. 218). The presence or absence of tubercles (of certain size and shape) on the head is very variable and apparently associated with geographical location (Jacobsen, 1989, p. 218). I have found this to be the case with *P. capensis* and *P. vansoni* in the O.F.S., and agree with Jacobsen (1989) in regarding these characters as being of dubious value. Jacobsen (1989) also used the arrangement (number of longitudinal rows) of enlarged tubercles on the back as a diagnostic aid, but I have not attempted to count these in O.F.S. specimens, mainly because of the extreme variation in what would be "longitudinal rows" of these scales. Jacobsen (1989) used morphology, colour, habitat and habitat requirements as aids in sorting material from the Transvaal. My examination involved primarily an attempt to sort typical *capensis* from possible *vansoni* and *affinis* on the basis of colour pattern and general form. The former character was afforded much attention by Jacobsen (1989), and my groupings of *capensis* and *vansoni* are based largely on Jacobsen's descriptions and illustrations of colour patterns. Material included here under *P. c. capensis* includes some specimens which in habitus, and even dorsal markings, resemble *P. affinis* (*vide* Jacobsen, 1989), but as I have not conducted an exhaustive taxonomic study, I leave this for future review. Also, it is felt that despite Jacobsen's (1989) valiant attempts at resolving the *P. capensis* problem in the Transvaal, the situation is still not clear, largely because of to extensive variation in several characters.

Pachydactylus vansoni FitzSimons, 1933 — Van Son's Gecko

Pachydactylus capensis vansoni FitzSimons, 1933, *Ann. Transvaal Mus.*, XV, p. 274. Type locality: Between Entabeni and Lake Fundusi, Zoutpansberg, northern Tansvaal. Types in the Transvaal Museum, Pretoria. Bates, 1992a, p. 43.

Range

South-eastern Zimbabwe, eastern half of the Transvaal, lowveld of Swaziland, southern Mozambique and northern Natal; also north-eastern O.F.S.

Zoogeographical classification: Eastern Temperate Transitional.

Range cluster in O.F.S.: Northeastern (NE).

Distribution in the Orange Free State (13 localities; Fig. 48)

Specimens examined from: Allanvale; Bakerskop; Elim, Vrede; Frazerfield; Harrismith (TM 53526); Kestell; Louisa's Mount; Maanhaar; Machbela; Memel (TM 47538); Morgenzon, Harrismith; Sterkfontein Dam (eastern side of); Tygerfontein.

Features (30 specimens examined)

Largest specimens (N = 28): 55,5 + 40,0 r = 95,5 mm; mass 3,8 g. (NMB R6696, Frazerfield); SVL 51,3 mm + tail 47,2 = 98,5 mm (NMB R 6012, "east of Kestell").

Heaviest specimens (N = 15): 4,3 g; SVL 52,7 (NMB R6698); specimen with greatest SVL that was weighed was NMB R6696, with SVL 55,5 mm and mass 3,8 g.

Lightest specimens (N = 15): 0,35 g, SVL 27,5 mm (NMB R6597); 0,35 g, SVL 28,7 mm (NMB R6375); specimen with smallest SVL that was weighed was NMB R6700, with SVL 24,7 mm and mass 0,41 g.

Dorsum brown to grey-brown wth black spots or scattered black tubercles, with or without occasional white tubercles. Light vertebral stripe present or absent, but usually present at least anteriorly. Belly cream coloured. Dorsum usually with 6-8 narrow, white, black-edged bands, counted from semi circular line behind head to above anterior hindlimb insertions. At least two such bands are always discernible anteriorly. Usually one semicircular white line behind head, but two in NMB R6698 and none in NMB R686, 2973 and 2983. Irregular pattern on head present or absent. Tubercles on back conical and strongly keeled, in more or less regular longitudinal rows; tubercles separated by 1-3 granules. Five lamellae under 4th toe of right foot, the terminal lamella divided medially and often overlapping the adjacent more proximal lamella; forth digits on both feet of NMB R6597 damaged, but there appear to be only four lamellae per digit. The two most proximal lamellae of 4th toe (right side) of NMB R6698 are divided more or less medially, whereas the 4th lamella on both 4th digits of NMB R6699 are divided medially, and the 4th lamella of the 4th toe (right side) of NMB R2973 is divided medially. The feet of NMB R6700 were too damaged to examine properly. *P. vansoni* in the O.F.S. has a generally more robust build that typical *capensis*. Out of 28 NMB specimens, eight had original tails, six had regenerated tails and the tails of 14 others were missing/broken. The tails of most specimens were either regenerated from the base or broken/missing, but examination of the original tails of six specimens, *viz.* NMB R686 (Maanhaar), 3000 (Allanvale), 5264 (Bakerskop), 6012 (Kestell, east of), 6596 (Sterkfontein Dam, east of) and 6700 (Frazerfield) showed that they were moderately to distinctly verticillate with moderately to weakly keeled enlarged tubercles in transverse rows. There were three, sometimes four, scale rows between the enlarged tubercles of each verticel.

Habitat and Ecology

In the O.F.S. this form has been collected only from under or between rocks. Jacobsen (1989, p. 230) noted that the Highveld form of *P. vansoni*, into which grouping the O.F.S. material fits, occurs only between 1500 to 2300 m a.s.l. and is exclusively rupicolous, occurring on rocky outcrops in grasslands. FitzSimons (1943, p. 97) stated that the eggs are laid in pairs and measure 7 x 5,5 mm, whereas Jacobsen (1989) found that Transvaal *P. vansoni* females lay two eggs measuring 10,0 - 11,3 x 7,8 - 9,5 mm and weighing 0,3-0,45 g; hatchlings emerge in late summer and measure 19,0 - 21,0 + 18,0 - 20,5 mm, with masses of 0,15-0,30 g.

Remarks

De Waal (1978) treated all O.F.S. *"Pachydactylus capensis"* as belonging to the nominate subspecies. However, a series of six specimens recently collected at Frazerfield near Harrismith had the distinctive colour pattern of the highveld variety (*vide* Jacobsen, 1989) of *P. c. vansoni* (see Fig. 2(B) in Broadley, 1977c; Fig. 6 (A & C) in Jacobsen, 1989; Plate 11 in Pienaar *et al.*, 1983; and Fig. 48 of this manuscript). This prompted a more detailed examination of colour patterns in O.F.S. material. The specimen illustrated in Fig. 48 exhibits the most typical *vansoni* dorsal colour pattern, but several other specimens have less, and more indistinct, pale stripes, and bands and are less readily "identifiable" as *P. vansoni.* Some specimens treated here as *P. vansoni* (*vide* Jacobsen, 1989) could therefore be regarded as *capensis* x *vansoni* intergrades on account of their relatively indistinct colour patterns. All O.F.S. *"vansoni"* were examined by N.H.G. Jacobsen (pers. comm.), who was in agreement that the material listed here is referable to *vansoni*. Several other O.F.S. specimens were cursorily examined by N.H.G. Jacobsen (pers. comm.), who although not finding additional *vansoni*, noted that some specimens (here treated as *P. c. capensis*) exhibited an affinity with *P. affinis* (*vide* Jacobsen, 1989). The distribution pattern (including sympatry) (see Figs 46 & 47), rupicolous habitat, general form and colour pattern of specimens here treated as *vansoni* form the basis of my decision to treat them as distinct from typical *capensis*. Jacobsen (1989) recorded sympatry between *capensis* and *vansoni* at The Downs (2430 AA) in the Transvaal, and the two forms are sympatric at the locality "east of Kestell" and found in close proximity throughout the north-eastern O.F.S. I therefore concur with Jacobsen (p. 231) in treating *vansoni* as a valid species. However, the status of the forms of the *P. capensis* complex in the O.F.S., and possibly also the Transvaal, is in need of a more detailed revision.

Pachydactylus bibronii (A. Smith, 1845) Bibron's Gecko

Tarentola bibronii A. Smith, 1845, *Ill. Zool. S. Afr., Rept.*, pl. 50, fig. 1. Type locality: Interior of South Africa. Types in British Museum of Natural History, London.

Pachydactylus bibronii A. Smith, 1849, *loc. cit. supra*, correction as footnote to Index of completed Illustrations (1845-1849); Bocage, 1896; FitzSimons, 1943, p. 106, fig. 30, pls III, fig. 2, V, fig. 3, XI, fig. 1 and XVII, fig. 2; Branch, 1988a, p. 200, pl. 84.

Pachydactylus bibronii tumeri (Gray, 1864): Loveridge, 1947, p. 405.

Pachydatylus bibronii (sic.) (A. Smith): De Waal, 1978, p. 26.

Range

Cape Province (excluding the south-west and east), western O.F.S., Namibia, Angola, eastwards to Transvaal, Swaziland, Zululand (northern Natal) and northwards to Botswana (excluding the central Kalahari), Zimbabwe, Malawi, Zambia and Tanzania.

Zoogeographical classification: Tropical Wide Ranging.

Range cluster in O.F.S.: Southwestern (SW).

Distribution in the Orange Free State (49 localities; Fig. 49)

Specimens examined from: Boshof Dorps-Gronden; Bosmansrust; Brakpan; Cornwall; Doornhoek; Dundee; Francis Home; Goede Hoop; Gruisrand; Heenenweerskop; Heilbron, Philippolis; Hendrik Verwoerd Dam (TM 35696-98; 39529-30); Honingberg; Joostenberg; Kades; Kalkfontein (677) near Alphaheim; Kalkplaat; Kleinplaas; Klipbankfontein; Klippiespan; Langehoek; Leeuwberg; Leeuwkuil; Lemoenboord; Lentelus; Lockshoek; Luiperskop; Middelbron; Ospoort; Oudefontein; Platberg, Boshof; Poortje, Fauresmith; Proces; Rietput; Solheim on Aletheim (924); Strijdfontein, Philippolis; Wagenmaker's Drift; Waterhoek; Weltevreden, Jacobsdal; Welverdiend; Wintersdam; Wintershoek; Wolvekop, Fauresmith; Zoutpan, Fauresmith; Zoutpan, Jacobsdal.

Other records: Modder River, O.F.S. (Bocage, 1896); Doornberg near Winburg (see Remarks); Honeynestkloof; Rooilaagte (FitzSimons, 1943); Bloemfontein, National Museum (translocated; sight records, M.F. Bates & R.M. Douglas).

Features (183 specimens examined)

Largest male (NMB R1584 - Kleinplaas) 95 + 96 = 191 mm.

Largest female (NMB R6406 - Winterspoort) 98,3 + 64,2 = 162,5 mm; mass 32,0 g.

Dorsum light to dark brown with 5-7 more or less distinct, irregular, wavy, dark brown to black crossbands; NMB R1584 has a mainly uniform brown dorsum with pale tubercles, dark granules and no crossbands. Isolated white tubercles are occasionally arranged to highlight the margins of dark crossbands. Crown of head paler than rest of dorsum, but with dark spots and streaks. A dark streak is present from behind the nostril, through eye to back of head above ear opening, and sometimes turns

inwards to almost join the stripe on the other side of the head. Dorsal scaling heterogeneous, with small granules intermixed with enlarged, strongly keeled tubercles and more conical, less strongly keeled stellate tubercles laterally. Gular scales subgranular; venter cream. Of the 176 specimens, 63 (41,4% of tailed specimens) had original tails, 89 (58,6% of tailed specimens) had regenerated tails and 25 had broken/missing tails.

Habitat and Ecology

Found in rock crevices and rock piles (especially dolerite) and sometimes on houses, especially in the False Upper Karoo, but also in Kalahari Thornveld. Colonies are typically found in dolerite rock outcrops with associated bushes (Bates, 1992b). The bushes may provide feeding sites for these nocturnal lizards. After examining the stomachs of 114 *P. bibronii* from the southern Kalahari, Pianka & Huey (1978, p. 695) determined that the following prey items are eaten: spiders, scorpions, Formicidae, Blattidae, Coleoptera, Hemiptera, Lepidoptera, Isoptera and small vertebrates. Termites (Isoptera; *Hodotermes mossambicus*) were most commonly eaten and comprised 36,2% (by volume) of the diet. Branch (1988a, p. 200) noted that smaller lizards are also eaten, which probably explains, at least to some extent, why the smaller *P. c. capensis* does not occur in the same rock crevices as *P. bibronii* in the south-western O.F.S. Broadley (1966, p. 125) recorded a specimen from the stomach of a genet *Genetta genetta*, whereas Loveridge (1953a) in Broadley (1966) found remains in the stomachs of the snakes *Telescopus s. semiannulatus, Philothamnus s. semivariegatus* and *Boaedon f. fuliginosus* (= *Lamprophis fuliginosus*). In a sample of 140 specimens from the southern Kalahari, 50,0% had shed their tails (Pianka & Huey, 1978, p. 698), as compared to 58,6% for O.F.S. specimens examined during the present study. A gravid female collected in November in the O.F.S. contained two eggs (De Waal, 1978, p. 27). A juvenile (NMB R6637) measuring 39,5 + 37,0 = 76,5 mm total length and weighing 1,5 g was collected in July. A detailed study on the reproductive cycles of male and female *P. bibronii* from the O.F.S. is currently being conducted by A.F. Flemming and the author.

Remarks

Pachydactylus bibronii tumeri (Gray, 1864) was treated as a variety of *P. bibronii* by FitzSimons (143, p. 109), who noted that "Intermediate specimens in regard to the amount of stellation of the tubercles are frequently encountered, while juveniles are usually indistinguishable on this character". FitzSimons (1943) also noted that the range of typical *bibronii* and that of *tumeri* was largely the same, but with *bibronii* dominant in the east and *tumeri* dominant in the west. Loveridge (1947) recognised three subspecies, namely *P. b. bibronii* (Cape Province), *P. b. tumeri* (most of the current range of *P. bibronii*, including the O.F.S.) and *P. b. pulitzerae* (northern Namibia and Angola). In his key, Loveridge (1947, p. 344) distinguished between *P. b. bibronii* and *P. b. tumeri* on the basis of geographical distribution alone, whereas *P. b. pulitzerae* was separated from the other two races by having fewer and more widely separated tubercles on the head, less strongly keeled dorsal tubercles and "median ventrals subequal to those towards sides" vs "median ventrals smaller than those towards sides". Broadley (1966, p. 125)

treated *P. bibronii* as a monotypic form, an opinion shared by Jacobsen (1989, p. 254) and followed here. De Waal (1978, p. 27) rejected FitzSimons' (1943) Doornberg locality (near Winburg; probably Doornberg N.W.) on account of its being geographically far away from typical *P. bibronii* habitat (i.e. south-western O.F.S.). The specimen is in the National Museum's collection and has been examined. The Winburg area lies within Highveld Grassland and does not provide typical rocky *P. bibronii* habitat. I therefore concur with De Waal (1978) in treating the record with suspicion, and have not plotted it on the distribution map. The following seven NMB specimens are missing and have not been examined: NMB R792, 2272, 3184, 4363, 4548, 4818, 4898. A few specimens of *P. bibronii* excaped from captivity at the National Museum, Bloemfontein in 1983/84 and specimens have been regularly observed on the walls of buildings at the museum up to the present time (1992).

Pachydactylus laevigatus laevigatus Fischer, 1888 — Button-scaled Gecko

Pachydactylus laevigatus Fischer, 1888, *Jahrb. Hamburg, Wiss. Anst.*, V, p. 15, pl. II, fig. 3. Type locality: Aus, Great Namaqualand. Types in Hamburg Museum?

Pachydactylus laevigatus laevigatus Fischer: Bates, 1992a, p. 43.

Range

From the southern O.F.S. and northern Cape Province northwards through western Namibia to the Angolan border.

Zoogeographical classification: Western Tropical Transitional.

Range cluster in O.F.S.: Southwestern (SW).

Distribution in the Orange Free State (one locality; Fig. 49)

One specimen examined from: Hendrik Verwoerd Dam (TM 39922).

Features (one specimen examined)

Similar in appearance to *P. bibronii,* but with a more pointed snout and button-like, unkeeled dorsal scales. The scales above the eye are slightly larger than those of *P. bibronii,* and the scales on the dorsal surface of the head are flatter and not rugose. The dorsal and lateral scales are tubercular, smooth and unkeeled. There are three dark cross-bands on the back (excluding the one between the hind limbs). The original tail has conical tubercles with terminal spines, unlike the keeled and spiny tubercles of *P. bibronii.*

Habitat and Ecology

P. l. laevigatus is very similar in habits and appearance to *P. bibronii,* but less common and gregarious and usually found only in rocky situations where it inhabits loose flakes or rock cracks (FitzSimons, 1943, p. 110). Females lay 2-3 clutches, of two eggs each, per season; eggs measure 18-20 x 14-16 mm and are deposited in a small hole dug into the sand (possibly also in rock cracks); incubation takes 60-80 days, hatchlings of 60-65 mm total length being born in December-March (Branch, 1988a, p. 203).

Remarks

Methuen & Hewitt (1914) treated *P. laevigatus* Fischer, 1988 as a "form" of *P. bibronii*, even though they found it sympatric with *P. b. tumeri* at Narudas Süd. FitzSimons (1943) described a new subspecies from Kaokoveld and north-western Damaraland, namely *P. l. tessellatus*. FitzSimons (1943) synonomized *P. b. laevigatus* with *P. l. laevigatus*, and Loveridge (1947, p. 400) noted that the name *tessellatus* was preoccupied by that of Werner (1910, p. 311) and therefore renamed the form *P. l. fitzsimonsi* in honour of V.F.M. Fitzsimons. *P. l. laevigatus* occurs in sympatry with *P. bibronii* in Namibia (Visser, 1984b, p. 73), with intermediate populations in the central and southern parts of that country (see Branch, 1988a, p. 6). The Hendrik Verwoerd Dam record represents the most south-easterly extension of the species' range (cf. Branch, 1988a).

Family: **AGAMIDAE** Gray, 1827

Genus: *Agama* Daudin, 1802

Agama atra atra Daudin, 1802 — Southern Rock Agama

Agama atra Daudin, 1802, *Hist. Rept.,* III, p. 349. Type locality: South Africa. Types in Paris Museum, Paris?. Boulenger, 1910, p. 465; Hewitt & Power, 1913, p. 152; Boulenger & Power, 1921, p. 273; Fitzsimons, 1943, p. 129, fig. 1, pl. XIX; De Waal, 1978, p. 28.

Agama holubi Bocage, 1896, *J. Sci. Lisb.* (2) IV, p. 115. Type locality: Modder River, Orange Free State.

Agama atra atra Daudin: Branch, 1988a, p. 176, pl. 76; Bates, 1991b, p. 154.

Range

Southern Namibia, south-eastern Botswana and most of South Africa (including Lesotho and the highveld of Swaziland), but absent in the sandy regions of the northern Cape Province.

Zoogeographical classification: Cape Temperate.

Range cluster in O.F.S.: Non-Northeastern (Non-NE).

Distribution in the Orange Free State (178 localities; Fig. 50)

Specimens examined from: Alpha; Annie's Rust; Atalanta; Babel; Baltespoort; Basberg; Ben Nevis; Bergkloof; Bergplaats, Bloemfontein; Bergplaats, Dewetsdorp; Beseva(?); Bethany; Bethel; Beyersfontein; Biddulphsberg; Bloemfontein (MMK 753/2; 754/3; 755/1, four specimens 757/2); Boesmansberg; Boschkloof; Boshof (MMK 755/2, nine specimens; MMK ---); Boskop; Brabant; Brakfontein; Brakpan; Bramley's Hoek; Bultfontein; Caledonspoort; Carlie; Ceylon; Chubani; Clocolan; Deelfontein, Bothaville; Di Poort; Die Hoogte; Donegal A; Doornhoek; Doornplaat; Doornpoort; Dorps Gronden, Fauresmith; Dundee; Francis Home; Fauresmith (TM 16728); Geluk, Philippolis; Goedehoop; Golden Gate Highlands National Park; Groenekloof; Gruiskop; Haagen's Stad; Hagesdam; Hartebeestfontein, Boshof; Hebron; Heenenweerskop; Heilbron, Philippolis; Hendrik Verwoerd Dam (TM 37591-92); Hendrik Verwoerd Dam, 25 miles north of (TM 35737); Holmes Dale; Honingberg; Hoogeveld, Theunissen; Houmoed; Immigrant (MMK 757/6, four specimens; 758/2); Juist Zoo; Kades; Kalkdam; Kareerand; Karreeboomsvallei; Karreepoort; Kleinplaas; Klipbankfontein; Klipdrift; Klipfontein; Klippiespan; Klipplaatdrift, Edenburg; Klipplaatdrift, Winburg; Knoffelfontein; Koortshoek; Kopjeskraal; Koppiesdam; Kraaifontein; Kranskop; La Belle France; Lang Zeekoegat; Last Poort; Leeuwberg; Leeuwfontein, Theunissen; Leeuwkop; Leeuwrant; Leeuwkuil; Lemoenhoek; Lentelus; Lessingskop; Littlecote; Loskop; Luiperfontein; Magdalen; Maghaleen (TM 36039-40); Mara, Parys; Mara, Vredefort; Maseru; Mensvreterberg north of Hillside (617); Merino, Bethlehem; Merriesfontein; Middelbron; Mimosa; Monontsa Pass; Môreson, Marquard; Morgenzon, Ficksburg; Morgenzon, Senekal; Morgenzon, Zastron; Mount Nelson; Naval Hill; Noordhulp; Ongegund; Onze Rust; Op-die-Rivier (TM 37373-74, 37389); Ospoort; Oudefontein; Palmietfontein; Paradys; Parys; Petra; Pietersberg; Platberg, Boshof; Poortje, Edenburg; Poortje, Fauresmith; Proces; Ramalitse; Rietfontein, Rouxville; Riverside; Rohallion; Rondeberg; Roodedraai; Scheerpan Oost (TM 63617-19); Schoongezicht; Smithfield (TM 12565); Smithskraal; Spes Bona; Stoffelfontein; Strijdfontein, Philippolis; Susannasfontein; Thaba 'Nchu (MMK 753/15, two specimens; 754/12, two specimens; 756/14, three specimens; 757/17, four specimens; 758/6; 883/3, six specimens; MMK ---, four specimens); Torbek; Triangle; Tussen-die-Riviere Game Farm; Tweefontein, Winburg; Uitkijk; Uitkyk; Vaalkop; Van Aswegens Hoek; Van der Walt's Rust; Veepost; Verdun, Fouriesburg; Verdun, Ladybrand; Weenkop (TM 37591-92, 37398-401, 38241); Welbedacht; Welgegund; Weltevrede; Weltevreden, Jacobsdal; Wesselsdam (TM 65927); Wilhelmshohe; Willem Pretorius Game Reserve (NMB; TM 27305-17; SMWN 907); Williamstrip; Winterspoort; Wittekopjes; Witzieshoek; Wolvekop, Fauresmith; Wonderkop; Zomervlakte; Zoutpan, Jacobsdal; Zuurfontein; 37 km from Bloemfontein on road to Winburg; 25 km north of Hendrik Verwoerd Dam; Rooilaagte, Honeynest Kloof ? (MMK 753/12); Schoemans Farm, Boshof? (MMK 755/2, three specimens).

Other records: Modder River (Bocage, 1896); Bethulie (FitzSimons, 1943).

Features (395 specimens examined)

Largest male (NMB R1414 - Houmoed) 110 + 152 = 262 mm.

Largest female (NMB R6617 - Grootberg) 105,5 mm, tail absent, mass 40,0 g ; another female (NMB R3207 - Morgenzon, Senekal) measured 98 + 112 = 210 mm.

Dorsum grey to dark brown, usually with a pale vertebral stripe from nape of neck to tail and sometimes continuing onto tail. In some specimens a mere indication of a pale line is evident and even this is absent in a few specimens, the largest being NMB R5480, SVL = 57,1 mm. A few specimens have pale transverse bands on the back and tail. Occipital usually larger than, but may be equal to or smaller than, adjoining scales. Dorsolateral scales on back with keels directed obliquely outwards from the vertebral line. Dorsal scales unequal in size and intermixed with scattered, enlarged single, or small groups of spinose scales (often white in colour). Moderately developed crest of spines at nape of neck, but no vertebral or caudal crest. Gular region unmarked or with a variety of dark lines or flecks which may extend onto the chest (especially in males, which often have a blue throat and/or venter); when the chest is marked, so is the throat. Markings may be absent in specimens preserved for a considerable period of time.

Habitat and Ecology

Occurs on rocky hills and especially in rock piles where numerous crevices are available. They are often found near the faeces of Dassies *Procavia capensis*, to which they are probably attracted by the gathering insects (De Waal, 1978, p. 28). Often found in the same crevices, or near to, *Cordylus p. polyzonus* and *Mabuya* spp. A hatchling was found under a flat rock together with a subadult *Hemidactylus m. mabouia* on the summit of Thaba Phatshwa Mountain in April 1984. During summer the males, which are larger than the females, develop a bright blue throat and chest. This species forms dense colonies of up to 165 lizards per hectare; males and females form hierarchies and are territorial; male territories include those of several females, and polygamy is practised (Branch, 1988a, p. 176). Stomach contents of O.F.S. specimens revealed the following dietary items: Coprinae (Coleoptera), Hymenoptera, Isoptera (soldiers and alates) and lepidopteran larvae (De Waal, 1978), whereas Transvaal specimens also feed on grasshoppers, crickets, millipedes and spiders (Jacobsen, 1989, p. 270), and FitzSimons (1943, p. 132) adds cockroaches, fossorial wasps and also possibly vegetable matter, to the list. Enemies include birds of prey such as Rock Kestrels and snakes such as *Psammophis crucifer* and *Lamprophis guttatus* (Branch, 1988a), and De Waal (1978) recorded a specimen recovered from the stomach of a *Lamprophis fuliginosus. A. a. atra* represented 2,9% by number of all prey items eaten by 94 Spotted Skaapstekers *Psammophylax r. rhombeatus* from the O.F.S. (Van Wyk, 1988b, p. 462). Females lay 7-12 eggs measuring 15-18 x 10-12 mm in a hole of up to 15 cm deep which they dig into the ground; eggs are laid one at a time and then covered until all are thus positioned; incubation by the sun's heat takes 2-3 months, after which the hatchlings dig themselves out (FitzSimons, 1943). Egg development commences in August - September, the first egg clutch being laid in October - November and a second clutch laid in January - February; hatchlings measure 53-59 mm (Branch, 1988a, p. 176).

Jacobsen (1989) recorded gravid females in November and December, and gives total length of hatchlings as 59,0-68,0 mm and mass as 0,4-1,2 g. De Waal (1978) recorded gravid females with 8-10 well developed eggs collected in January in the O.F.S.

Remarks

In the O.F.S. *A. a. atra* has a disjunct distribution, populations absent from most of the northern parts of the province, with the exception of an area at and near the Vredefort Dome. De Waal (1978, p. 29) noted that at the Vredefort Dome there exists rocky habit suitable for the species, and explains its absence from the north-west by the absence of suitable rocky outcrops there. However, there appears to be no explanation for the species' absence from the north-eastern O.F.S., where rocky outcrops and mountains (mostly sandstone) are common features of the landscape. The species is also absent from the extreme south-eastern Transvaal, north of the Vaal River, but has been recorded from virtually every quarter-degree unit on the southern and south-western border of the Transvaal (Jacobsen, 1989, p. 268). Jacobsen (1989, p. 271) also recorded a relict population north of the Soutpansberg which is well separated from other populations. According to Jacobsen (1989), this is the most northerly *A. a. atra* population. A western subspecies, *A. a. knobeli*, occurs in Namaqualand, north and south of the lower Orange River, and is distinguished from the nominate subspecies by a well developed vertebral crest on the neck and keels on the dorsals pointing towards the backbone rather than away from it (Branch, 1988a, pp. 176-177).

Agama hispida hispida (Linnaeus, 1754) Spiny Agama

Lacerta hispida Linnaeus, 1754, *Mus. Adol. Fred.*, p. 44 and 1758, *Syst. Nat.*, Ed. 10, I, p. 205. Type locality: "America australe". Note: obviously incorrect, probably from Cape of Good Hope (FitzSimons, 1943, p. 141).

Agama hispida brachyura (not Boulenger, 1885): FitzSimons, 1943, p. 142 (part, Bothaville).

Agama makarikarika (not FitzSimons, 1932): Steyn & Steyn, 1970; De Waal, 1978, p. 32.

Agama hispida hispida (Linnaeus): McLachlan, 1981, p. 225 (part); Branch, 1988a, p. 177.

Range

Western Cape Province, central Karoo, north-western O.F.S. and south-western Namibia.

Zoogeographical classification: Cape Temperate.

Range cluster in O.F.S.: Northwestern (NW).

Distribution in the Orange Free State (three localities; Fig. 51)

Specimens examined from: Moirton; Roodedraai; O.F.S. (MMK 772/3).

Other records: Bothaville (FitzSimons, 1943).

Features (three specimens examined: two males, one female)

Dorsum either light brown with a pale vertebral band or dark brown with scattered pale scales in rows (long-preserved specimen, MMK 772/3). Occipital about four times larger than adjoining scales on top of head. Diameter of earhole slightly smaller that half eye cleft on both sides. Dorso-lateral scales on back with keels directed obliquely inwards to the vertebral line. Spinose scales on back in eight (MMK 772/3) or ten more or less straight rows, which are more closely spaced than in *A. a. aculeata* or *A. a. distanti*. Crest of spines at nape of neck continuing as a very low vertebral crest which extends onto about the first tenth of the tail. Dorsal head shields rugose, with scales keeled and/or lumpy. Gular with six bold, thick, more or less longitudinal stripes which extend onto the chest and belly; but throat and belly of MMK 772/3 are dark (old specimen). No spots, net-like pattern or gular spot on throat. Ventrals keeled and spiny. Tail about equal in length to SVL, or longer. Fifth toe reaches to middle of first toe on both feet. Third toe half a lamella-length longer than fourth toe on both feet. The two males have 13 lamellae under 4th toe of right foot, whereas the female (MMK 772/3) has 15. Preanal pores in males nine (NMB R700) and 12 (NMB R699).

Habitat and Ecology

This terrestrial agamid was collected amongst loose stones and scattered bushes at Moirton and Roodedraai, near the banks of the Vaal River (De Waal, 1978, p. 33). It occupies short tunnels excavated at the base of bushes, and feeds on ants and beetles; not colonial (Branch, 1988a, p. 177). According to FitzSimons (1943, p. 142), vegetable matter is also consumed by *A. h. hispida*, while ground-running beetles, caterpillars and occasionally centipedes are eaten by *A. h. brachyura* (p. 143). FitzSimons (1943, p. 143) noted that *A. h. brachyura* (see Bothaville locality) females lay "about 18" eggs at a time in holes in the ground; eggs measure 18-20 x 12-13 mm.

Remarks

The Smithfield specimen (SAM 13984) listed by McLachlan (1981, p. 225) under *A. h. hispida* has been examined and found to be *A. aculeata distanti* (see also Remarks for *A. a. distanti*). The *A. h. hispida* population in the north-western O.F.S., treated as *A. makarikarika* by De Waal (1978), is isolated, but intermediate geographically between *A. h. hispida* (Cape Province) and *A. h. makarikarika* (Makarikari Pan in Botswana). De Waal (1978) examined nine specimens (TM 4337-4345) listed under *A. hispida brachyura* by FitzSimons (1943), treating them as *A. makarikarika*. These specimens were not examined, but according to De Waal's (1978) description, are here listed under *A. h. hispida*. Specimen MMK 772/3 from the locality "O.F.S." (= Orange Free State) was listed as *A. h. brachyura* in the McGregor Museum catalogue, but is here treated as *A. h. hispida*; this specimen may well have been collected near Kimberley, considering the fact that many O.F.S. specimens in that collection were collected near Kimberley or in the western O.F.S. The status of *Agama* populations in the north-western O.F.S. require further study, and additional collections are required.

Agama aculeata aculeata Merrem, 1820 Western Ground Agama

? Agama aculeata Merrem, 1820, *Tent. Syst. Amph.*, p. 53. Type locality: "Cape of Good Hope". Types (of Duméril & Bibron) in Paris Museum, Paris.

Agama pulchella Bocage, 1896, *J. Sci. math. phys. nat.*, (2), IV, p. 116. Type locality: Modder River, Orange Free State.

Agama hispida aculeata Merrem: FitzSimons, 1943, p. 146.

Agama hispida (Linnaeus, 1758) "South-western variety" - De Waal, 1978, p. 30.

Agama aculeata aculeata Merrem: McLachlan, 1981, p. 226, fig. 3; Branch, 1988a, p. 175, pl. 78.

Range

Most of the Cape Province (excluding the east and west), northwards through south-western O.F.S., most of Botswana (excluding the east), and Namibia (excluding the west).

Zoogeographical classification: Western Temperate Transitional.

Range cluster in O.F.S.: Southwestern (SW).

Distribution in the Orange Free State (15 localities; Fig. 51)

Specimens examined from: Bozrah; Gruisrand; Heenenweerskop; Hendrik Verwoerd Dam; Langhoek; Lemoenboord; Lentelus; Luiperskop; Schoemansneksfontein (MMK 751/15); Smithfield (SAM 13984); Spreeuwfontein (MMK 750/7); Weltevreden, Jacobsdal; Wolvekop, Fauresmith; Zwartfontein.

Other records: Modder River, O.F.S. (Bocage, 1896).

Features (26 specimens examined: 16 males, eight females, two juveniles)

Largest male (NMB R1166 - Langhoek) 110 + 121 = 231 mm.

Largest female (NMB R2230 - Heenenweerskop) 101 + 107 = 208 mm.

Dorsum light to dark brown with a light vertebral band, usually continuous but sometimes interrupted, usually evident. Occipital usually larger than adjoining scales on head, but smaller in NMB R787 and 5450. Diameter of earhole more than half diameter of eye cleft (right side). Dorsolateral scales on back with keels directed obliquely inwards to the vertebral line. Spinose scales on back covering a wider area of back than in *A. a. distanti*, and usually in six, seven (once) or eight more or less regular longitudinal rows; but in NMB R2230 and a few other specimens, several "rows" are arranged paravertebrally. Crest of spines at nape of neck continuing as a very low vertebral crest which extends $^{1}/_{8}$ - $^{3}/_{4}$ of the tail length. Dorsal head shields generally smooth, but a few scales (especially anteriorly) in some specimens are keeled; weakly keeled and "lumpy" in MMK 756/7 and 751/15. Gular with 7-9 (usually eight) more or less wavy, longitudinal dark stripes, often irregular and/or broken. Males usually have a dark posterior spot (covering up to half of gular in NMB R787), but this is absent in NMB R5002. There is an indication of a dark gular spot in three of the six females (*viz.* NMB R1196, 2230 and 4812). Dark

reticulation may extend onto venter. Ventrals usually smooth and mucronate, but keeled in MMK 751/15 (female) and NMB R2198, and keeled towards the sides in NMB R151. Tail distinctly longer than SVL in males (NMB R4815 has a broken tail) and slightly longer than SVL in females and juveniles, except for NMB R151 which has a tail shorter than SVL. Fifth toe reaches to the end, or almost to the end (i.e. one lamella short) of 1st toe, although the 5th is one lamella longer than the 1st in NMB R5448; both 1st toes of NMB R1166 are damaged. Fourth toe of right foot (left foot of NMB R1126) 1-2 lamellae lengths longer than 3rd toe. There are 15-21 lamellae under 4th toe (right foot). Preanal pores in males 9-15.

Habitat and Ecology

This mainly terrestrial species with cryptic colouration is found in dry and sandy areas of the south-western O.F.S., often taking refuge under *Ziziphus mucronata* bushes (De Waal, 1978, p. 31). A specimen (NMB R5001) from Knoffelfontein was observed in, and under, a small bush; this specimen had a tick under its left armpit. According to Branch (1988a, p. 175), a shallow hole is dug in loose soil at the base of a bush, and is shared by a pair of agamids. The diet consists mainly of termites and ants (Branch, 1988a). Females lay 10-18 eggs measuring 13-15 x 9-10 mm in a sandy hole under a stone or at the base of a bush (Branch, 1988a). Branch's (1988a) life-history data refers to the species *A. aculeata*, and not to any particular subspecies. Auerbach (1987, p. 98) reported a clutch size of 10-14 eggs, these measuring 9,5-14 mm each, hatchlings measuring 30-50 mm; and noted that, apart from ants, many other insects are also eaten.

Agama aculeata distanti Boulenger, 1902 — Eastern Ground Agama

Agama hispida Boulenger, 1892, in *Distant, Naturalist* in the Transvaal, p. 174 (Pretoria). Types in the British Museum of Natural History, London. Sternfeld, 1911, p. 419.

Agama distanti Boulenger 1902: Boulenger, 1910, p. 465 (part, Smithfield, Kroonstad, Vredefort Road).

Agama hispida var. *distanti* Boulenger, 1902: Gough, 1909, p. 189, pl. 21, figs 1-3; Boulenger & Power, 1921, p. 243.

Agama hispida Boulenger, 1892: Boulenger, 1910, p. 464 (part, Kroonstad).

Agama aculeata (not Merrem, 1820): Boulenger, 1910, p. 465 (part, Kroonstad).

Agama hispida distanti Boulenger, 1902: FitzSimons, 1943, p. 143.

Agama hispida Boulenger, 1892: "Eastern variety" - De Waal, 1978, p. 30.

Agama aculeata distanti Boulenger, 1902: McLachlan, 1981, p. 223-225, 227, fig. 1; Branch, 1988a, p. 175, pl. 78.

Agama hispida hispida (not Linnaeus, 1754): McLachlan, 1981, p. 225 (part, Smithfield only).

Range

Transvaal (excluding the extreme north where it is replaced by *A. a. armata*), Swaziland, O.F.S. (excluding the south-west where it is replaced by *A. a. aculeata*) and north-eastern Cape Province.

Zoogeographical classification: Eastern Temperate Transitional.

Range cluster in O.F.S.: Non-Southwestern (Non-SW).

Distribution in the Orange Free State (37 localities; Fig. 51)

Specimens examined from: Alpha; Bloemfontein (NMB; MMK 774/1, two specimens); Brandfort (TM 478); Brandfort, 19 miles north-west of (TM 32970); Evenston A; Genisla; Glen (MMK 766/2); Gruiskop; Hartebeestfontein, Boshof; Klipplaat; Kroonstad (MMK 774/6); Krugersdrift Dam; Leeuwkuil; Littlecote; Mierdam; Morgenzon, Zastron; Odendaalsrus (TM 16735); Parys (TM 1633); Rietfontein, Vrede; Rusthof; Slangheuvel; Smithfield (SAM 13984); Spitzkop; Stoffelfontein; Stoltzkop; Sweet Home; Thaba 'Nchu (MMK 766/9); Uitzicht; Ventersburg (SMWN 1269); Venus; Villiers, 25 km south-east of (TM 53323); Weltevreden, Heilbron; Willem Pretorius Game Reserve (TM 29764); Winburg (TM 22004-05, 24620); Wolvenfontein; Woudzicht; Zoetbron.

Features (50 specimens examined: 20 males, 18 females, 11 juveniles; sex of one adult not determined)

Largest male (NMB R857 - Slangheuvel) 90 + 97 = 187 mm.

Largest female (NMB R856 - Slangheuvel) 96 + 65 = 161 mm.

Dorsum light to dark brown with a light vertebral band, usually continuous but sometimes interrupted, evident in most specimens. Occipital usually larger than adjoining scales on head. Diameter of earhole more than half diameter of eye cleft (right side). Dorsolateral scales on back with keels directed obliquely inwards to the vertebral line. Spinose scales on back as follows: a pair of short lateral rows (sometimes mere bundles of spinose scales), two pairs of increasing length dorsolaterally and 2-3 less distinct rows paravertebrally, i.e. six clear rows, or 8-12 (14 in MMK 766/2) when counting paravertebral rows as one, two or three pairs. Crest of spines at nape of neck continuing as a very low vertebral crest which may continue as an almost invisible crest to a maximum of about one-eighth the length of the tail. Dorsal head shields rugose, i.e. keeled and/or lumpy; not very rugose in NMB R1157. Gular with 8-10 more or less wavy longitudinal dark stripes, often broken and/or difficult to discern. The area between these "lines" is not speckled or spotted; darkish central-posterior marking in SMWN 1269 (male). Dark reticulation may extend onto venter. Ventrals smooth to keeled, those of juveniles being more typically strongly keeled. In males, tail usually longer than SVL, but may be equal to or slightly shorter. Tail slightly shorter than SVL in females and juveniles. On the right foot, the 5th toe usually reaches to the end of 1st, but may be slightly longer or shorter than 1st toe; in NMB R3912, 4175 and SMWN 1269 (all males) the 5th toe reaches to only about half the length of the 1st. Third toe usually longer than 4th (right foot) by one-half to two lamellar lengths (relative to lamellar lengths on 3rd and 4th toes, which are about equal), but of about equal length in NMB R1121 and 1157. On the right foot there are 11-15 lamellae under 4th toe, except for SMWN 1269 which has 17. Preanal pores

in males 9-14 (N = 24; 10 in NMB R2407 and 11 in TM 24620, others have 12-14 pores). NMB 1157 is intermediate between *A. a. aculeata* and *A. a. distanti* in having only slightly rugose head shields, and 3rd and 4th toes of equal length on left foot, but 4th longer than 3rd on right foot.

Habitat and Ecology

Mostly terrestrial, but occasionally basks on poles or termite mounds (De Waal, 1978, p. 31); a specimen (NMB R5172) from Randfontein was found under a stone. According to Jacobsen (1989, p. 275), Transvaal specimens take refuge in rodent and other burrows, in branches of shrubs and in holes in inactive termitaria. The stomachs of O.F.S. specimens contained hymenopterous and isopterous (workers and soldiers) insects, while faeces contained fragmented ants (*Dorylus* sp.) and termites (*Hodotermes* sp.), and curculionid beetles (De Waal, 1978). According to Fitzsimons (1943, p. 144), *A. hispida distanti* also feeds on crickets, grasshoppers and cockroaches. FitzSimons (1943) stated that 14 eggs measuring 15-19 x 10-13 mm are laid during early summer and buried in the ground by the female. Jacobsen (1989) reported that Transvaal females lay 7-18 eggs measuring 11,8 - 14,7 x 9,2 - 10,7 mm in midsummer. One female collected in February in the O.F.S. contained 17 well developed eggs (De Waal, 1978). See also life-history notes for *A. aculeata* (Branch, 1988a, p. 175).

Remarks

Boulenger (1910, pp. 464-465) recorded *Agama hispida*, *A. aculeata* and *A. distanti* from Kroonstad, all collected by Watermeyer. McLachlan (1981, p. 227) examined three specimens (SAM 3535, 3537, 3538) from this locality, listing them all under *A. a. distanti.* Boulenger (1910) also gave Smithfield as a locality for *A. distanti.* McLachlan (1981, pp. 225-227) listed five Smithfield specimens (SAM 13564, 13569, 10993-95) under *A. a. distanti* and one (SAM 13984) under *A. h. hispida.* The last-mentioned specimen has been examined and determined to be an *A. a. distanti*. Boulenger's (1910) "Vredefort Road" *A. distanti* material was not examined or cited by McLachlan (1981), but is here included in the synonomy of *A. a. distanti* (see key in Boulenger, 1910, p. 464).

Family: **CHAMAELEONIDAE** Gray, 1827

Genus: *Chamaeleo* Laurenti, 1768

Chamaeleo dilepis dilepis Leach, 1819 — Flap-neck Chameleon

Chamaeleo dilepis Leach, 1819, *Bowdich, Miss. Ashantee,* App., p. 493. Type locality: Gaboon. Type in the British Museum of Natural History, London. Branch, 1988a, p. 186, pl. 96.

Chamaeleo dilepis dilepis Leach: FitzSimons, 1943, pp. 153 & 155, pl. XX, fig. 1; De Waal, 1978, p. 33; Douglas, 1992a, p. 19.

Range

Tropical Africa, southwards to central Namibia, northern Cape Province, extreme western O.F.S., Transvaal, Swaziland and northern and eastern Natal.

Zoogeographical classification: Tropical Wide Ranging.
Range cluster in O.F.S.: Northwestern (NW).

Distribution in the Orange Free State (five localities, of which two represent translocations; Fig. 52)
Specimens examined from: Moirton; Stowlands; Vet River - Bloemhof Dam junction; also Bloemfontein (St Margaret's Church) and Bloemfontein (Langenhoven Park) (translocations).

Features (five specimens examined)
Largest female (NMB R702 - Moirton) 123 + 100 = 223 mm.
Dark colour in alcohol, but longitudinal brown lateral streak discernible on flank. Parietal narrowed and compressed, not roofing over temporal region. Gular and ventral crest of enlarged white conical tubercles. Soles of feet smooth. Features the same in translocated specimens as in north-western O.F.S. material.

Habitat and Ecology
Recorded from only three localities in the Kalahari Thornveld of the north-western O.F.S., but apparently introduced populations also occur in Bloemfontein and Welkom. Jacobsen (1989, p. 289) noted that, because these chameleons have been extensively transported by man, it is difficult to determine whether or not populations in the south-western Transvaal are natural or a result of translocation. Although they are primarily arboreal, these chameleons do cross open ground when travelling from tree to tree (Jacobsen, 1989). Prey includes grasshoppers, beetles (Branch, 1988a, p. 186), flies, butterflies and other insects (Jacobsen, 1989). Enemies include snakes, especially *Dispholidus t. typus* (sympatric with *C. d. dilepis* at Moirton) and *Thelotornis capensis*, monkeys and birds (e.g. Crowned Hornbill) (Branch, 1988a). Mating may last for up to an hour, after which the eggs take 3-4 months to develop before being laid; 25-50 eggs measuring 13-15 x 8-9 mm are laid in summer in a tunnel of 15-30 cm long, constructed by the female in damp soil (Branch, 1988a). Egglaying may take as long as 24 hours to complete and incubation lasts for about 150 days, but up to 300 days if laying is followed by an extreme winter (Branch, 1988a). Jacobsen (1989) stated that 30-40 (up to 77) eggs measuring 13,5 - 16,0 x 7,0 - 9,1 mm are laid in a hole of about 4 cm deep and take up to a year to hatch; hatchlings measure 28,0 - 29,0 + 25,5 - 28,0 mm = 54,0 - 57,0 mm total length and weigh 0,65-0,75 g. A female collected during February in the north-western O.F.S. contained 36 well developed eggs (De Waal, 1978).

Remarks
FitzSimons (1943, p. 155) treated *C. dilepis quilensis* Bocage 1866 as a variety of *C. dilepis*. Broadley (1966, p. 144) argued that *quilensis* was not a valid subspecies, pointing out several cases of sympatry with typical *dilepis*. However, he retained the trinomial *dilepis* in view of Parker's (1942) acceptance of *C. d. ruspolii* Boettger of Somalia. FitzSimons' (1943) Smithfield record could not be confirmed by De

Waal (1978, p. 34), and can no longer be located in the South African Museum, Cape Town (Cherry in Douglas, 1992a, p. 19). This record is therefore provisionally rejected, although it may represent a translocated specimen. According to Douglas (1992b), reports on the occurrence of *C. d. dilepis* were received from Bothaville, Sandveld Nature Reserve and between Boshof and Kimberley.

Genus: *Bradypodion* Fitzinger, 1843

Bradypodion ventrale cf. *karroicum* (Methuen & Hewitt, 1915) Karoo Dwarf Chameleon

Lophosaura ventralis karroica Methuen & Hewitt, 1915, *Trans. Roy. Soc. S. Afr.*, IV, p. 103. Type locality: Beaufort West. Co-types in Albany Museum, Grahamstown and Transvaal Museum, Pretoria.

Bradypodion sp.: Douglas, 1990c, p. 100 and 1992a, p. 19.

Bradypodion ventrale/karroicum?: Bates, 1992a, p. 43.

Distribution in the Orange Free State (two localities; Fig. 52)

Specimens examined from: Bloemfontein; Welkom.

Remarks

Thirty-three specimens from Bloemfontein, in the National Museum's collection, and probably all representing translocations, appear to be intermediate between *B. v. ventrale* and *B. v. karroicum*. Probable hybridization of specimens from widely separated populations has caused taxonomic confusion in towns like Bloemfontein. Douglas (1992b) noted "records" of *Bradypodion* (possibly *B. v. karroicum*) from Clocolan and Riebeeckstad, north of Welkom.

Bradypodion dracomontanum Raw, 1976 Drakensberg Dwarf Chameleon

Bradypodion dracomontanum Raw, 1976, *Durban Mus. Novit.*, 11(7), p. 157. Type locality: Cathedral Peak, Natal. Holotype in the Natal Museum, Pietermaritzburg.

Range (see Fig. 52 for distribution in O.F.S.)

Natal Drakensberg, including parts of the north-eastern O.F.S.

Zoogeographical classification: Eastern Temperate Transitional.

Range cluster in O.F.S.: Drakensberg (D).

Remarks

Nine specimens have been examined. All specimens have two pairs of paravertebral rows of tubercles, one with small tubercles (inner), one with big. The taxonomic status of this form is currently being studied by Douglas, Bates & Raw (in prep.). Several juveniles were collected on grass stalks near a gorge at Mount Pierre, GGHNP, and an adult was found on the farm Klavervlei. Douglas (1992b) noted that "other sightings of *Bradypodion* have been reported from Virginia" and "along the Caledon river near Clarens".

Bradypodion sp. nov. ("Ngotswane Gorge")

Zoogeographical classification: Eastern Temperate Transitional.
Range cluster in O.F.S.: Drakensberg (D).

Remarks

A specimen from Ngotswane Gorge in Qwa Qwa, together with another from Royal Natal National Park on the Natal/O.F.S. border, appear to represent an undescribed, long-tailed *Bradypodion* species with unique gulars (Douglas, Bates & Raw, in prep.). Three specimens were collected in small cavities on a vertical sandstone rock face at Ngotswane Gorge, but only one was accessioned into the Transvaal Museum collection (see Douglas, 1992a, p. 19). See Fig. 52 for distribution in O.F.S.

Bradypodion sp. nov. ("Zastron")

Zoogeographical classification: Eastern Temperate Transitional.
Range cluster in O.F.S.: Southeastern (SE).

Remarks

Specimens collected in the town of Zastron appear to represent an undescribed species (Raw & Douglas, in prep.). Eight specimens were examined by myself, and the specimens do indeed differ from other described species of *Bradypodion* in the size and shape of their gular scales. See Fig. 52 for distribution in O.F.S.

Family: **SCINCIDAE** Gray, 1825

Genus: *Mabuya* Fitzinger, 1826

Mabuya homalocephala smithii (Gray, 1845) Red-sided Skink

Euprepis smithii Gray, 1845, *Cat. Liz. Brit. Mus.*, p. 112. Type locality: South Africa. Type in British Museum of Natural History, London.

Mabuya homalocephala smithii Gray: De Waal, 1978, p. 35; Branch, 1988a, p. 129, pl. 52.

Range

Eastern Cape Province to southern Natal, with isolated records in the south-eastern and north-eastern O.F.S., and two populations in the eastern half of the Transvaal.

Zoogeographical classification: Eastern Temperate Transitional.

Range cluster in O.F.S.: Eastern (E).

Distribution in the Orange Free State (two localities; Fig. 53)

Specimens examined from: Rietfontein, Vrede; Spitzkop.

Features (seven specimens examined)

Largest male (NMB R808 - Rietfontein, Vrede) 62 + 36r = 98 mm.

Largest female (NMB R890 - Spitzkop) 66 + 85 = 151 mm.

Head and body slightly depressed. Dorsum brown with seven dark longitudinal stripes from nape to tail base (median one present only anteriorly in NMB R890, fading posteriorly), bordered dorso-laterally by a pair of pale stripes extending from behind the eye to base of tail; a pair of well-marked, whiter, lateral stripes of about the same thickness as the dorso-lateral stripe (one-scale wide) extend from behind upper labials to base of tail. Top of head with several scattered black spots. Venter white, underside of tail white in adults, brown in hatchlings. Dorsals weakly tricarinate. Scales on soles of feet non-spinose, smooth and tubercular; subdigital lamellae generally smooth, but may exhibit signs of weak unicarinate keeling. Lower eyelid transparent; subocular narrowed below and in contact with lip, the lower border more than half the length of upper. Ear lobules (both ears) well developed and lanceolate, usually three but four in NMB R890 (most ventral lobule about half the length of third lobule). Centre of nostril posterior to or above rostro-labial suture. Prefrontals separated; frontonasal either narrowly separated from rostral by supranasals (five specimens) or in narrow contact (two specimens); frontonasal in contact with frontal. One of the two adults had an original tail, the other a regenerated tail, whereas the five hatchlings (NMB R833) had intact original tails.

Habitat and Ecology

Collected amongst rocks at an elevation of about 1524 m a.s.l. in the O.F.S. (De Waal, 1978, p. 36). Found on rocky hillsides and rock outcrops at 1550-1800 m a.s.l. in the Transvaal; inhabits crevices between rocks, but also found under rocks which may be buried in soil (Jacobsen, 1989, p. 329). Two specimens collected near Prince Alfred's Pass (eastern Cape Province) were found in a shale bank bordering a road (Branch, 1990a, p. 32). According to FitzSimons (1943, p. 211), specimens are also occasionally found on grassy hillsides near the coast. At Rietfontein, Vrede (north-eastern O.F.S.), 35 eggs were found under stones during December; some of these eggs (measuring 14 x 8 mm) hatched during the same month and produced hatchlings measuring 24 + 25 = 49 mm total length (De Waal, 1978). According to Branch (1988a, p. 129), *M. homalocephala* females (subspecies not specified) lay about six eggs measuring 13-15 x 8-9 mm in November or December in a small chamber which is dug into sandy soil under a boulder or old log; hatchlings measure 65-75 mm. The diet probably consists largely of insects, as is the case with *M. h. homalocephala*, which preys mostly on grasshoppers (FitzSimons, 1943, p. 209).

Remarks

Four subspecies of *M. homalocephala* are currently recognized, namely *homalocephala, peringueyi, depressa* and *smithii* (Branch, 1988a, p. 9), and their status requires reassessment (Branch, 1990a, p. 32). Branch (1990a, p. 31) recently recorded *smithii* from numerous localities in the eastern Cape Province, but few records exist for inland areas. The most northerly localities are those in the Transvaal (Iron Crown is most northerly), and Jacobsen (1989) contended that *M. homalocephala* is a temperate species which has migrated northwards along the inland mountains. He also stated that the two Transvaal populations "are now relict and widely separated from conspecifics and in time may develop into species in their own right". FitzSimons (1943, p. 211) stated that specimens (listed by him under *M. h. smithii*) from Cape St Francis are "more or less intermediate with typical *homalocephala*, but in colour markings resemble *smithii*; and Jacobsen (1989, p. 332) noted that Transvaal populations of *M. h. depressa* differ in colour pattern to Natal populations of this subspecies. Despite the intensive surveys of De Waal (1978) and Jacobsen (1989), few specimens have been collected in either the O.F.S. or Transvaal respectively, despite the widespread use of drift fences in the Transvaal. The use of drift fences is, however, probably the only realistic approach to obtaining larger and more representative samples.

Mabuya capensis (Gray, 1830) Cape Skink

Scincus trivittatus (non Hardwicke & Gray) Cuvier, 1829, *Regne. Anin.*, ed. 2, 2, p. 62. Type locality: Cape of Good Hope, South Africa. Type in Paris Museum, Paris? Reoccupied by *trivittatus* Hardwicke & Gray, 1827, *Zool. Journ.*, 3, p. 227, an Indian species (see FitzSimons, 1943, p. 218).

Tiliqua capensis Gray, 1830, in *Griffith's Anim. King.*, 4, Syn, p. 68 and 1838, *Ann. Nat. Hist* (1) 2, p. 290. Type locality: Cape of Good Hope.

Euprepes (Euprepis) Merremii (not Duméril & Bibron, 1839): Boettger, 1883, p. 156.

Mabuia trivittata (not Harwicke & Gray): Boettger, 1887, p. 149; Boulenger, 1910, p. 484; Sternfeld, 1911, p. 420.

Mabuya capensis (Gray): FitzSimons, 1943, p. 216, figs 94 & 95; De Waal, 1978, p. 36; Branch, 1988a, p. 128, pl. 52.

Range

Widespread in Namibia, much of Botswana and southwards throughout most of the rest of southern Africa, with the exception of the Namib desert and eastern Transvaal lowveld; relict populations on Inyanga mountains of Zimbabwe, and Liuwa Plain in Zambia.

Zoogeographical classification: Cape Temperate.

Range cluster in O.F.S.: Throughout (T).

Distribution in the Orange Free State (59 localities; Fig. 54)

Specimens examined from: Arcadia; Babel; Bethel; Bloemfontein (NMB; MMK 827/1; 828/1, two specimens); Bothaville (TM 4331-32); Bozrah; Doornbult; Doornplaat; Driekloof; Dundee; Elandsfontein; Fauresmith; Florisbad; Frazer Spruit; Glen Gariff; Goedehoop; Greenlands; Hartebeestfontein, Boshof; Hoogeveld, Theunissen; Jonkerskraal; Kasteelkop; Kleinplaas; Krugersdrift Dam; Langhoek; Leeuwkuil; Lemoenboord; Louis Rust; Lovedale; Magdalen; Mara, Vredefort; Middenspruit; Mimosa; Moirton; Monontsa Pass; Morgenzon, Zastron; Naval Hill; Onze Rust; Perth; Platrand; Poortje, Fauresmith; Ramalitse; Rambouillet; Richmond West (TM 39649-50); Rohallion; Slangheuwel; Sterkfontein Dam (TM 55320); Thaba 'Nchu (NMB; MMK 827/7); Triangle; Tygerfontein; Uitkijk; Verdun, Reitz; Vergaderrand; Waterbron; Welgegund; Welkom (TM 27239-40); Weltevrede; Willem Pretorius Game Reserve (TM 27320); Winburg (TM 22006); Wolvekop, Fauresmith.

Other records: Smithfield (De Waal, 1978).

Features (286 specimens examined)

Largest male (NMB R4340 - Welgegund) 108 + 72r = 180 mm.

Largest female (NMB R900 - Jonkerskraal) 120 + 171 = 291 mm.

Dorsum brown with a broad, pale median stripe and a pair of pale dorso-lateral stripes half as wide as

the median one. Stripes sometimes have distinct black border lines and very occasionally a thin black vertebral line is present within the pale median stripe. Dark flecks or bars are present between stripes and on the flanks. Flanks may have white flecks or spots. Belly and throat white to light blue (usually), often with dark-edged scales. Six specimens have uniformly brown dorsa and another has a brown dorsum with a vague median stripe. Dorsals tricarinate, but NMB R5661 has a few bicarinate anterior dorsals. Scales on soles of feet distinctly keeled and spinose, and subdigital lamellae sharply unicarinate in all specimens except NMB R899 which has smooth, convex scales on the soles as well as smooth lamellae, and NMB R2955 which has weakly keeled scales on the soles as well as weakly keeled lamellae. Lower eyelid transparent (N = 271). Subocular not narrowed below and similar to upper labials, although it is usually longer (up to twice as long, e.g. NMB R5138) and slightly wider (N = 272). Scales on anterior border of ear opening not differentiated (N = 272). Of 278 specimens, 168 had original tails, 80 had regenerated tails and 30 had broken/missing tails. Of the 248 tailed specimens examined, 67,7% had original and 32,3% regenerated tails.

Habitat and Ecology

This large, terricolous skink is found in a variety of habitats throughout the O.F.S., including rocky areas, open grassland, holes, inactive termitaria, gardens (De Waal, 1978, p. 36) and under stones in open grassland. Also found in rotting logs in the Transvaal, where specimens were also observed taking refuge in rodent burrows, holes and thick bush (Jacobsen, 1989, p. 346). Jacobsen (1989) also reported that an adult specimen took refuge in a pool of water where it remained for 20 min, after which it was captured. It may bask in shrubs during the late afternoon (Jacobsen, 1989). The stomach of an O.F.S. specimen contained the tail of another skink (De Waal, 1978), but the usual diet is composed mainly of insects (e.g. beetles, grasshoppers, crickets and stinkbugs), although spiders, centipedes and worms are also taken (FitzSimons, 1943, p. 218). A sand snake *Psammophis leightoni trinasalis* from the O.F.S. was found to have eaten a *M. capensis* (De Waal, 1978), whereas a *M. capensis* (about 78,5 mm SVL; together with six [or seven] *M. variegata punctulata*) was recovered from the stomach of a Blackheaded Heron *Ardea melanocephala* from Florisbad (Bates, 1988d,e, p. 48); and a dead and tailless *M. capensis* was discovered in the nest of a Secretarybird *Sagittarius serpentarius* on the farm Leeuwrant (Bates & De Swardt, 1991, p. 23). Domestic cats are important enemies in gardens (Branch, 1988a, p. 129). A female collected in February in the O.F.S. produced eight neonates, each measuring about 60 mm in total length, whereas a female collected in November contained 11 partly developed embryos (De Waal, 1978). The reproductive cycle of males and females from the O.F.S. has been studied by A.F. Flemming at the National Museum (Flemming, in prep.). Flemming (in prep.) found that gravid females were collected from October to February, and parturition occurred from December to February; females produced 8-20 embryos, and clutch size was positively correlated with female SVL. Throughout its range females give birth during late summer to 5-18 neonates measuring 60-75 mm in total length (Branch, 1988a). However, Brown-Wessels (1989, p. 46) has shown that *M. capensis* exhibits a bimodal reproductive strategy, oviparous females being recorded from Pretoria and

Ohrigstad in the Transvaal and ovoviviparous females widespread elsewhere in southern Africa. Branch (1988a) also noted oviparity occurring in Port Elizabeth. Brown-Wessels (1989, p. 47) reported that both oviparous and viviparous females occur in the Pretoria area, but noted that the possibility of two sibling species being involved cannot be discounted. The largest recorded brood was one of 18 neonates born to a female of 111 mm SVL; neonates measured 27-30 + 38-42 mm and weighed 0,5-0,6 g (Branch, 1988c, p. 38).

Remarks

See under *Mabuya occidentalis*.

Mabuya occidentalis (Peters, 1867) Western Three-striped Skink

Euprepes vittatus var. *australis* Peters, 1862, *Monatsb. Ak. Wiss. Berlin*, p. 19 (unacceptable on grounds of stability).

Euprepes occidentalis Peters, 1867, *Monatsb. Ak. Wiss. Berlin*, p. 20. Type locality: Otjimbingue, Hereroland. Types in Berlin Museum, Berlin.

Mabuya occidentalis (Peters): De Waal, 1978, p. 37; Branch, 1988, p. 132, pl. 52.

Range

Karroid areas of the Cape Province and extreme south-western O.F.S., through Namibia and south-western Botswana and north to southern Angola.

Zoogeographical classification: Western Tropical Transitional.

Range cluster in O.F.S.: Southwestern (SW).

Distribution in the Orange Free State (two localities; Fig. 54)

Specimens examined from: Dundee, Fauresmith; Lemoenboord.

Features (12 specimens examined)

Largest male (NMB R4708 - Lemoenboord) 90 + 117 = 207 mm.

Largest female (NMB R4355 - Dundee) 97 + 97r = 194 mm.

Dorsum brown with broad, pale median stripe as well as a pair of pale dorsolateral stripes about half as wide as median stripe, and a pair of pale lateral stripes as wide as median stripe. No black speckles or bars between stripes as in *M. capensis*. Belly and throat white, sometimes with a tinge of light blue. Dorsals tricarinate. Scales on soles of feet keeled and spinose; subdigital lamellae sharply unicarinate; 19-24 lamellae under 4th toe. Lower eyelid transparent. Subocular not narrowed below, similar to upper labials. Two to three enlarged lobules projecting on anterior border of ear opening. Of the 12 specimens, nine had original tails, two had regenerated tails and one had a broken/missing tail.

Habitat and Ecology

Found among rocks or in scant vegetation in the False Upper Karoo of the extreme south-western O.F.S. (De Waal, 1978, p. 38). Similar in habits to *M. capensis*, but more active (FitzSimons, 1943, p. 219). Takes shelter by night in a shallow burrow that it digs in loose soil at the base of a bush; also known to hibernate during winter (Branch, 1988a, p. 132). Preys on invertebrates, especially phasmids and mantids (Huey & Pianka, 1977, p. 125). A female collected in November in the O.F.S. contained seven undeveloped embryos (De Waal, 1978); females collected in February in the Namib Desert also contained seven embryos, whereas Kalahari females lay 5-7 eggs (Branch, 1988a).

Remarks

Power (1939) suggested that *M. occidentalis* be treated as a race of *M. capensis*, but FitzSimons (1943, p. 220), having determined several of the specimens examined by Power (1939) to be *M. capensis*, stated that evidence favouring the relegation of *occidentalis* to subspecific rank was inconclusive. Specimens of *M. capensis* and *M. occidentalis* were sympatric at the only two O.F.S. localities at which *occidentalis* occurred, namely Dundee and Lemoenboord, and although the midbody scale counts of *occidentalis* overlapped those of *capensis*, other characters were typical of *occidentalis* (De Waal, 1978, p. 38). The two forms were collected in microsympatry in the Karoo National Park (Branch & Braack, 1989, p. 30), providing further evidence in support of FitzSimons' (1943) decision to treat the two taxa as separate species. Superficially, *occidentalis* is distinguishable from *capensis* by the lack of brown transverse bands between the pale dorsal stripes.

Mabuya varia (Peters, 1867) Variable Skink

Euprepes (Euprepis) varius Peters, 1867, *Monatsb. Ak. Wiss. Berlin*, p. 20. Type locality: Tete, Mozambique. Types in Berlin Museum, Berlin.

Mabuia varia (Peters): Boulenger, 1910, p. 485 (part, Smithfield).

Mabuya varia (Peters): FitzSimons, 1943, p. 221, figs 98 & 99; De Waal, 1978, p. 38; Branch, 1988a, p. 133, pl. 53; Bates, 1991b, p. 154.

Range

From the south-eastern Cape Province, northwards through most of the eastern half of Africa up to Sudan and Somalia, and west to northern Namibia, Angola and the Congo.

Zoogeographical classification: Tropical Wide Ranging.

Range cluster in O.F.S.: Non-Southwestern (Non-SW).

Distribution in the Orange Free State (72 localities; Fig. 55)

Specimens examined from: Annies Rust; Atalanta; Babel; Baltespoort; Basberg; Ben Nevis; Bergplaats, Bloemfontein; Bergplaats, Dewetsdorp; Bethel; Boskop, Boshof; Brockenhurst; Ceylon; Di Poort; Florisbad; Geluk, Boshof; Golden Gate Highlands National Park; Hartebeesfontein, Boshof; Imperaai; Karreeboomsvallei; Karreepoort; Kasteelkop; Klipplaatdrift, Winburg; Knellpoort; Kraaifontein; Kranskop; Leeuwkop; Leeuwkuil; Leeuwrant; Lemoenhoek; Lorenzo; Mara, Parys; Mara, Vredefort; Mecklenburg; Mensvreterberg north of Hillside (617); Merino, Bethlehem; Meyerskraal; Middenspruit; Mimosa; Monontsa Pass; Môreson, Marquard; Morgenzon, Ficksburg; Morgenzon, Harrismith; Morgenzon, Zastron; Mount Nelson; Naval Hill; Ongegund; Onze Rust; Palmietfontein; Paradys; Platberg, Boshof; Ramalitse; Rambouillet; Riverside; Rohallion; Rondavel; Spijtfontein; Straalfontein; Susannasfontein; Thaba 'Nchu; Thaba Pachoa Berg; Tweefontein; Uitkijk; Uitkyk; Verdun, Fouriesburg; Welbedacht; Willem Pretorius Game Reserve; Wittepoort; Wittekopjes; Witzieshoek; Wolvekop, Kroonstad; Zoetbron.

Other records: Parys (TM 1839); Willem Pretorius Game Reserve (TM 27321, 29761).

Features (115 specimens examined)

Largest male (NMB R4210 - Weltevreden, Smithfield) 47 + 57 = 98 mm.

Largest female (NMB R726 - Noodhulp) 44 + 48 = 92 mm.

Dorsum brown with black spots arranged in more or less longitudinal series (may be absent anteriorly), with a paravertebral series similar to that of *M. variegata*, but seldom forming distinct stripes; a pale vertebral band (one scale wide) may be present; pale dorsolateral stripes (one scale wide) from nape extending onto first fifth of tail; distinct white lateral stripes (one scale wide) from suboculars extending to first fifth of tail; scales on back may be dark-edged, forming very thin longitudinal stripes; a few specimens had scattered pale scales (arranged in longitudinal series) between the dorso-lateral stripes, creating a speckled appearance. Dark spots randomly arranged on top of head in most specimens. Ventrum and underside of tail white, light blue or grey. Dorsals tricarinate. Scales on soles of feet keeled and spinose; subdigital lamellae sharply tricarinate, but most specimens have a few to many lamellae four or/and five-keeled, usually posteriorly. Lower eyelid transparent; subocular narrowed below and in contact with lip, lower border more than half as long as upper (usually about three-quarters the length of upper, occasionally more), less than half in only one specimen (NMB R2596, both sides). One to four (usually 2-3) obtuse, short and bluntly pointed lobes on anterior border of ear opening; when three or four, uppermost or lowest lobe usually small, about half as long as longest lobe. Centre of nostril usually posterior to, sometimes above, rostro-labial suture; nostril separated from 1st upper labial by a distance much less than its own diameter (usually less than half its diameter, seldom more); nostril diameter equal in length to distance from nostril to first upper labial in one juvenile (NMB R4559). Prefrontals usually separated, very narrowly in seven specimens, in narrow contact in eight specimens, in very narrow contact in four other specimens. Frontal, prefrontals and frontonasal separated by a small scale in eight specimens. Seventeen specimens were not examined in detail, as

their museum specimen tags were knotted. Of the 98 specimens examined in detail, 43 had original tails, 20 had regenerated tails and 35 had broken/missing tails. Of the 63 tailed specimens, 68,3% had original and 31,7% had regenerated tails.

Habitat and Ecology

In the O.F.S., these terricolous, diurnal skinks are found in rocky areas associated with bushes and other vegetation (De Waal, 1978, p. 38); also collected from pit traps in grassland. They hunt mostly in the afternoon using the "wait and see" method, preying mainly on grasshoppers, beetles, termites, ants, sucking bugs, lepidopterous larvae and spiders (Jacobsen, 1982). Mantids, cockroaches and centipedes are also taken (FitzSimons, 1943, p. 223). Jacobsen (1982) recorded three instances of *M. varia* preying on *Panaspis wahlbergii* in the central Transvaal; and Broadley (1966) reported one such occurrence by a specimen from Umtali in Zimbabwe. Predators in the O.F.S. include the following snakes: *Lycophidion c. capense*, *Psammophis leightoni trinasalis* and *Psammophis crucifer*. In south-east Africa, the following predators have been recorded: *Felis libyca* (= *F. lybica*), *Lycophidion capense* and *Psammophis s. subtaeniatus* (Broadley, 1966). Although the species is reported to be viviparous throughout most of its range, females in some bushveld areas (e.g. Nylsvley Nature Reserve) lay 6-12 eggs from October to December, which hatch after two months incubation, the hatchlings measuring 40-50 mm in length (Jacobsen, 1982). FitzSimons (1943) noted that 4-12 (usually 4-8) young are born in summer, whereas De Waal (1978) reported that 2-4 young are born to O.F.S. females, also noting that a female collected in November contained four well developed embryos. A female of 62 mm SVL from the Suurberg (Cape Province) gave birth to ten young in February; the latter measured 21-23 + 26-31 mm and weighed 0,09-0,15 g (Branch, 1988d, pp. 38-39). Bates, Haagner & Flemming (in prep.) discuss evidence of asynchronous reproduction in this species.

Remarks

According to Jacobsen (1989, p. 356), the taxonomy of *M. varia* "is still vague". Jacobsen (1989, p. 361) described a sibling species "bridging the gap between *M. lacertiformes* and *M. varia*" in the Transvaal; this form was separated on overlapping morphological features and its wholly rupicolous habits, as opposed to terricolous as is the case with typical *M. varia*.

Mabuya variegata variegata (Peters, 1869) Western Variegated Skink

Euprepes variegatus Peters, 1869, *Oefvers. Vet. Akad. Forhandl.*, p. 660, pl. I. Type locality: "Damaraland". Type in the Zoologisches Museum, Berlin.

Mabuya variegata variegata (Peters): Broadley, 1975, p. 4; De Waal, 1978, p. 40; Branch, 1988a, p. 134, pl. 53.

Range

Central Cape Province and south-western O.F.S., westward to the Namib desert of southern and western Namibia.

Zoogeographical classification: Western Temperate Transitional.

Range cluster in O.F.S.: Southwestern (SW).

Distribution in the Orange Free State (nine localities; Fig. 56)

Specimens examined from: Bozrah; Klipbankfontein; Koortshoek; Langhoek; Luiperfontein; Middelbron; Ospoort; Strijdfontein, Philippolis.

Other records: Lismore (Broadley, 1975).

Features (eight specimens examined)

Largest male (NMB R1573 - Klipbankfontein) 47 + 64 = 111 mm.

Largest female (NMB R4109 - Ospoort) 53 + 66 = 119 mm.

Dorsum brown with small dark spots (often elongate) arranged longitudinally, forming distinct stripes in NMB R1212, 2253 and 4109. A pair of pale dorsolateral stripes extend from nape to anterior insert of hindlimbs, usually extending onto first fifth of tail, and more distinct than in *M. v. punctulata*. The pale lateral stripe extends from the subocular to tail or onto first fifth of tail, and is of about the same width as the dorsolateral stripe, but less distinct. Dark spots or blotches present between dorsolateral and lateral stripes, as well as above (dorsal to) dorsolateral stripe, often bordering it; blotches extend onto tail. The area between paravertebral stripes is always pale, forming a one-scale-wide stripe or band from nape to first fifth of tail. Top of head with a couple to a few scattered dark spots. Venter and throat white-grey with scattered grey scales. Dorsals always tricarinate. Scales on soles of feet keeled and spinose; subdigital lamellae sharply tricarinate, although a few lamellae may have 4-5 keels. Lower eyelid transparent; subocular distinctly narrowed below and in contact with lip; lower border about half (sometimes more than half) the length of upper. Ear lobules large, lanceolate and mostly white, covering most of the ear opening, always three in number (both ears examined), the most ventral being $^{1}/_{2}$ - $^{2}/_{3}$ the length of middle lobule. Centre of nostril always anterior to rostro-labial suture. Prefrontals always well separated. Of the eight specimens, two had original tails, four had regenerated tails and two tails were broken/missing; tails may be regenerated from base of tail to halfway along regenerated tail length.

Habitat and Ecology

In the O.F.S. this subspecies was found among low-lying rocks, often with their burrows under a rock (De Waal, 1978, p. 40). Broadley (1975, p. 6) stated that this form inhabits the Namib Desert, Karoo vegetation and bushveld in the Great Fish River valley; and appears to be both arenicolous and rupicolous. According to Branch (1988a, p. 134), the diet of *M. variegata* consists of beetles and spiders. A female collected in December in the O.F.S. contained three partly developed embryos (De Waal, 1978). Branch (1988a) stated that *M. variegata* females (subspecies not specified) give birth to 2-4 young measuring 48-57 mm from January to March, but also give birth during August in the Namib Desert.

Mabuya variegata punctulata (Bocage, 1872) Eastern Variegated Skink

Euprepes punctulatus Bocage, 1872, *Jorn. Sci. math. phys. nat.* Ser. 1(6), p. 76. Type locality: Rio Coroca, south of Mossamedes, Angola. Syntypes in the Lisbon Museum, Lisbon (Broadley, 1975, p. 7).

Mabuya variegata punctulata (Bocage): De Waal, 1978, p. 41; Branch, 1988a, p. 134, pl. 53; Bates, 1988a, p. 51.

Range

From the O.F.S. (excluding the north) to the western Transvaal, northern Cape Province, eastern and north-western Namibia, southern Angola, Botswana, southern Zimbabwe, Zambia west of the Zambezi, northern Transvaal and southern Mozambique.

Zoogeographical classification: Tropical Wide Ranging.

Range cluster in O.F.S.: Southern (S).

Distribution in the Orange Free State (19 localities; Fig. 56)

Specimens examined from: Alpha; Cornwall; Di Poort; Excelsior, Edenburg; Florisbad (64 specimens); Fraser Spruit; Hebron; Krugersdrift Dam; Lessingskop; Lockshoek; Lovedale; Noodhulp; Rietfontein, Rouxville; Spes Bona; Tweefontein; Waterhoek; Weltevrede; Weltevreden, Smithfield; Zandfontein.

Features (91 specimens examined)

Largest male (NMB R4210 - Weltevreden, Smithfield) 41 + 57 = 98 mm.

Largest female (NMB R726 - Noodhulp) 44 + 48 = 92 mm.

Dorsum brown with dark spots (often elongate) arranged paravertebrally, sometimes forming distinct stripes (NMB R1315, 1317, 2572, 4210, 4403, 5335). A pair of pale dorsolateral stripes from nape to anterior insert of hindlimbs, often extending onto first fifth of tail; pale lateral stripe from upper labials (which may be stippled grey) to tail, often extending onto first fifth of tail. Lateral stripe usually about

twice as wide as dorsolateral stripe. Dark spots or blotches present between dorso-lateral and lateral stripes, and above (dorsal to) dorso-lateral stripe, often bordering stripe; blotches extend onto tail. The area between paravertebral stripes occasionally appears pale, forming a one-scale-wide stripe from nape onto first fifth of tail (particularly well marked in NMB R5242, 5243, 5255, 5567, 5607). In some specimens (NMB R5568, 5578, 5642, 5840) there are several white flecks (scales) between the dorsolateral and lateral stripes. Top of head with a couple to several (usually only a few) small dark spots. Venter usually light blue, sometimes white; two specimens (NMB R5567, 6352) had several distinctly dark-edged scales on their bluish ventres. Dorsals (at least mid-dorsally) of adults usually quinquecarinate, sometimes a mixture of tricarinate, four-keeled and quinquecarinate, or tricarinate only (17 specimens; including all juveniles). Scales on soles of feet keeled and spinose; subdigital lamellae usually sharply tricarinate, sometimes a few lamellae quinquecarinate; first toe often largely bicarinate. Lower eyelid transparent; subocular distinctly narrowed below and in contact with lip, its lower border about half (sometimes more than half) the length of upper. Ear lobules (right ear) large, lanceolate and usually white, covering most of the ear opening; 1-3 (usually two) in number (one lobule in four specimens; three lobules in seven specimens; usually on both ears). When three lobules are present, the uppermost or lowest lobule is usually very small, about half the length of longest other lobule. Centre of nostril usually anterior to, sometimes above, rostro-labial suture. Prefrontals widely separated in all but one specimen, in which they are in narrow contact (NMB R1316). Frontal, prefrontals and frontonasal separated by a small scale in one specimen (NMB R5578). Of the 91 specimens, 53 had original tails, 15 had regenerated tails and 23 had broken/missing tails.

Habitat and Ecology

In the O.F.S. this small skink has been found in rocky areas with small associated bushes and other vegetation (De Waal, 1978, p. 41), as well as in open grassland at Florisbad and Fraser Spruit, where they were collected by means of drift fences with bucket and/or funnel traps. Two Zimbabwean specimens were collected under logs in association with several *M. varia* in *Baikiaea* woodland (Broadley, 1975, p. 10). Broadley (1975) stated that the centre of distribution appears to be the Kalahari Thornveld, and noted that both arenicolous and rupicolous populations occur within the range. This is confirmed by the occurrence of sand as well as rock-dwelling *M. v. punctulata* in the O.F.S. Two to four young are born to O.F.S. females, and a female collected in November contained four well developed embryos (De Waal, 1978). Three specimens (including a hatchling) of *M. v. punctulata* were recovered from the crop of a Cattle Egret *Bubulcus ibis* collected at an unspecified site in the O.F.S., while six (possibly seven as the hindquarters of an additional skink may have been *M. v. punctulata*) specimens were found in the stomach of a Blackheaded Heron *Ardea melanocephala* collected at Florisbad (Bates, 1988e, p. 48). See *M. v. variegata* for other life-history information.

Remarks

Broadley (1975) distinguished between *M. v. variegata* and *M. v. punctulata* on the basis of the dorsal scales of adults having three vs five keels per scale respectively. O.F.S. adults of *M. v. punctulata*, however, occasionally have tricarinate dorsals. De Waal's (1978) key for *M. variegata* separates the subspecies on the basis of dorsal keeling, as mentioned above (although he does not note that juvenile *M. v. punctulata* have tricarinate dorsals [Broadley, 1975; this study]), and 3 vs 1-2 pointed lobules on anterior border of ear opening. However, my examination of a larger sample showed that *M. v. punctulata* had 1-3 such lobules (three in seven specimens). *M. v. punctulata* adults with either tricarinate or quinquecarinate dorsals, and specimens with 1-3 ear lobules, occurred together at Florisbad (64 specimens examined), indicating that both Broadley's (1975) and De Waal's (1978) diagnostic keys should be used with caution when attempting to separate the two subspecies of *M. variegata*.

Mabuya sulcata sulcata (Peters, 1867) Western Rock Skink

Euprepes olivaceus (non-Gray) Peters, 1862, *Monatsb. Ak. Wiss. Berlin*, p. 21.

Euprepes sulcatus Peters, 1867, *Monatsb. Ak. Wiss. Berlin*, p. 20. Type locality: Neu Barmen, Hereroland. Types in the Berlin Museum, Berlin.

Mabuia sulcata (Peters): Hewitt & Power, 1913, p. 158.

Mabuya sulcata (Peters): FitzSimons, 1943, p. 226, figs 102 & 103.

Mabuya sulcata sulcata (Peters): De Waal, 1978, p. 42; Branch, 1988a, p. 133, pl. 54.

Range

Karroid regions of the Cape Province and south-western O.F.S., Namibia and southern Angola.

Zoogeographical classification: Western Tropical Transitional.

Range cluster in O.F.S.: Southwestern (SW).

Distribution in the Orange Free State (33 localities; Fig. 57)

Specimens examined from: Bozrah; Brakpan; Doornhoek; Dundee; Francis Home; Geluk, Philippolis; Groenekloof; Gruisrand; Heenenweerskop; Heilbron, Philippolis; Kalkplaat; Kleinplaas; Klipbankfontein; Klippiespan; Lemoenboord; Lentelus; Luiperfontein; Luiperskop; Middelbron; Ospoort; Poortje, Fauresmith; Proces; Strijdfontein, Philippolis; Uitkyk; Waterhoek; Weltevreden, Jacobsdal; Wintershoek; Wolvekop, Fauresmith; Zoutpan, Fauresmith; Zoutpan, Jacobsdal.

Other records: Hendrik Verwoerd Dam (TM 39503, 39706); Van der Kloof Dam site on Orange River (TM 35545-47); 15 km east of Hendrik Verwoerd Dam wall (TM 37673).

Features (105 specimens examined)

Largest male (NMB R527 - Middelbron) 76 + 108 = 184 mm.

Largest female (NMB R3171 - Brakpan) 76 + 131 = 207 mm.

Head and body somewhat depressed. Males dark brown to black dorsally, sometimes with a russet-brown rump; ventral surfaces black, but area around vent and sometimes most of belly (e.g. NMB R4817, Doornhoek) and underside of tail whitish. Dorsum of females and juveniles olive-brown with six dark brown longitudinal stripes (occasionally somewhat indistinct) which extend onto base of tail; venter cream to pale blue in colour, throat with dark spots and speckles with may extend onto chest. The back of a female from Dundee (NMB R4366; ovaries examined) is uniformly dark brown to black in colour; while a male from Middelbron (NMB R566; testes examined) has the typical female dorsal pattern, but the throat is mostly black and the belly mostly white. Dorsal scales usually quinquecarinate, but occasionally tricarinate, especially in juveniles; in some specimens quinque-and tricarinate scales are present. Scales on soles of feet keeled and usually spinose; subdigital lamellae sharply tri-to quinquecarinate. Eyelids movable, lower with transparent disc; subocular not reaching lip. Nostril pierced in a small nasal shield and well separated from rostral; centre of nostril posterior to rostro-labial suture. Prefrontals and frontoparietals present; prefrontals usually separated, but sometimes in contact; frontoparietals of NMB R2242 (Heenenweerskop) fragmented, as are the prefrontals of NMB R2264 (Luiperfontein). Out of 46 males, 30 had original, seven had regenerated and nine had broken/missing tails; while out of 59 females and juveniles, 42 had original, ten had regenerated and seven had broken/missing tails. For all specimens (N = 105) the ratio was 72:17:16.

Habitat and Ecology

Found on dolerite rock outcrops in the arid western and south-western O.F.S., where specimens can often be observed scrambling up and down large boulders, taking refuge in rock crevices and spaces between boulders. They are often found in association with *Agama a. atra, Cordylus p. polyzonus* and *Pachydactylus bibronii* in these habitats (see also FitzSimons, 1943, p. 228; Bates, 1992b, pp. 6 & 7). *M. s. sulcata* replaces the widespread *M. striata punctatissima* in the south-western O.F.S., with only two confirmed cases of sympatry, one on the farm Kleinplaas (De Waal, 1978, pp. 43 & 44) and another on the farm Kalkfontein, where specimens were collected about 100 m apart and also observed in microsympatry in an open space (not a crevice) between two dolerite rocks. A specimen from the latter locality was collected. On 30 September 1992, what appeared to be a male (all-black) *M. s. sulcata* was observed chasing a *M. striata punctatissima* on the top of a rocky, bush-covered ridge about 200 m from the Nature Conservation Offices at Kalkfontein Dam Nature Reserve (B. Colahan, pers. comm.). This locality falls within the same eighth-degree, unit as the Kalkfontein record. These lizards shelter by night in rock cracks, often in pairs (Branch, 1988a, p. 133). Sexual dichromatism occurs, the males being dark brown or black and females (and juveniles) light brown with six yellow-gold stripes. Prey consists mostly of beetles, grasshoppers, termites, ants and hymenopterans (FitzSimons, 1943). According to De Waal (1978), females with partly to well developed embryos were collected from November to February in the O.F.S., and there were usually five embryos present, two in the left

and three in the right oviduct. However, my examination of the oviducts of all O.F.S. females in the National Museum's collection showed that 13 females, collected from November to February, contained 2-5 (usually three; 2 embryos in one specimen, 3 in seven, 4 in two and 5 in three specimens) partly to well developed embryos. According to FitzSimons (1943), mating occurs in spring and four neonates emerge "some months later towards the end of summer". Branch (1988a) reported that *M. sulcata* females (subspecies not specified) give birth to 3-5 young measuring 58-65 mm from December to February, and noted "informal" reports of egg-laying females.

Remarks

The mostly allopatric distribution of this species and *M. striata punctatissima* in the O.F.S. suggests that interspecific competition of some kind plays a role in separating the two forms, as the habitat on either side of the separation zone appears to be suitable to both species. Two additional subspecies of *M. sulcata* are known, namely *M. s. nigra* (Lüderitz Bay) and *M. s. ansorgii* (Kaokoveld) (see Branch, 1988a, p. 133).

Mabuya striata punctatissima (A. Smith, 1849) Southern Striped Skink

Euprepes punctatissimus A. Smith, 1849, *Ill. Zool. S. Afr., Rept.*, pl. 31, fig. 1. Type locality: "North-eastern districts of the Cape Colony".

Mabuia striata (not Peters, 1844): Hewitt & Power, 1913, p. 158.

Mabuya striata (Peters): FitzSimons, 1943, p. 229, figs 104 & 105.

Mabuya striata punctatissima (Smith): De Waal, 1978, p. 43; Branch, 1988a, p. 132, pl. 54; Bates, 1991b, p. 154.

Range

North-eastern Cape Province, Transkei, western half of Natal, Lesotho, O.F.S., Transvaal (excluding the east), western Swaziland, southern Botswana and adjacent part of the northern Cape Province; also relict populations on the eastern highlands of Zimbabwe and southern highlands of Malawi.

Zoogeographical classification: Western Tropical Transitional.

Range cluster in O.F.S.: Non-Southwestern (Non-SW).

Distribution in the Orange Free State (163 localities; Fig. 58)

Specimens examined from: Allanvale; Alpha; Babel; Bachelors Home; Basberg; Bergkloof; Berlin; Bethany; Bethel; Bon Haven; Bothaville (TM 4334); Boschkop; Boshof (MMK 825/2); Boskop; Brakfontein; Braunzijnkop; Brockenhurst; Caledonspoort; Carlie; Ceylon; Clarens (DNSM 306, 308,

310, 312); Damfontein; Dasklip; Dealbata; De Rust; Die Hoogte; Dipka; Di Poort; Donegal A; Doornbult; Doornplaat; Driekloof Dam (TM 56531); Elandsfontein; Eskol; Exelsior; Falle Grange; Fauresmith; Frazerfield; Geluk, Boshof; Glen Lennie; Goedetrouw; Golden Gate Highlands National Park (TM 30255; 31146); Grootkloof; Grootkrans; Gruiskop; Greenlands; Haagens Stad; Hartebeestfontein, Boshof; Harrismith (TM 53504-05); Hebron; Het Loo; Holmes Dale; Honingberg; Hoogeveld, Theunissen; Houtkop; Juist Zoo; Kades; Kafferskop; Kalkdam; Kareerand; Kasteelkop; Klavervlei; Kleinplaas; Klipfontein; Klipoog; Klipplaat; Klipplaatdrift, Edenburg; Koortshoek; Kopjeskraal; Kranskop; Lange Hoek; Lang Zeekoegat; Lanquedoc; La Riviera; Last Poort; Leeuwberg; Leeuwfontein, Theunissen; Lemoenhoek; Lessingskop; Littlecote; Lomagundi; Lorenzo; Loskop; Louis Rust; Lovedale; Machbela; Magdalen; Mandyville; Maseru; Mecklenburg; Memel (TM 47563); Merriesfontein; Milambi; Moirton; Monontsa Pass; Mooigelegen; Morgenzon, Ficksburg; Morgenzon, Senekal; Noodhulp; Oever; Onverwacht (TM 3315-17); Palmietfontein; Petra; Parys (TM 3317); Pietersberg; Platrand; Quaggaspruit; Rambouillet; Reddersburg, 18 km south of (AJL 859); Rietfontein, Rouxville; Rietfontein, Vrede; Rohallion; Rondeberg; Roodekop (TM 39654-55); Rusthof; Schoongezicht; Sedan; Seekoeivleipoort; Sentinel; Slangheuvel; Smaldeel; Spijtfontein; Spitzkop; Stoffelfontein; Strijdfontein, Heilbron; Susannasfontein; Table Farm (MMK 825/17, two specimens); Tafelberg; Tienfontein; Triangle; Tweefontein; Tygerfontein; Uitkomst; Uitvlugt; Uitzicht; Vaalkop; Verdun, Fouriesburg; Verdun, Reitz; Verdun, Ladybrand; Vergaderrand; Vet River - Bloemhof Dam junction; Virginia; Vissershoek West; Vrede (MMK 825/2, three specimens); Vredefort, 8 miles south of (NMZB 819-20); Waterfall; Weenkop (TM 37507-25); Welgegund; Weltevrede; Weltevreden, Heilbron; Weltevreden, Smithfield; Wilhemshohe; Willem Pretorius Game Reserve (NMB; TM 29759-60); Wittekopjes; Witzieshoek; Wolvenfontein; Woudzicht; Zoetbron; Zwartkoppies.

Other records: Immigrant (Hewitt & Power, 1913); Bloemfontein; Kroonstad; Smithfield (FitzSimons, 1943).

Features (328 specimens examined)

Largest male (NMB R3360 - Sentinel) 70 + 85 = 164 mm.

Largest female (NMB R860 - Slangheuvel) 90 + 85r = 175 mm.

Dorsum black with a pair of white to yellow dorso-lateral stripes (1-2, usually one dorsal scale width wide) which fades posteriorly; small white spots may be present and sometimes form thin longitudinal lines between the dorso-lateral stripes. Pale markings always present on head shields. Throat with black speckling; this varies from only a few poorly defined markings to very bold, large blotches. Speckling on the throat may extend onto the white venter; the venter is well marked in 40 specimens (especially so in NMB R3331). Dorsals tricarinate (some posterior dorsals in NMB R2742 have four keels). Scales on soles of feet keeled and spinose; subdigital lamellae sharply unicarinate, although some lamellae may be tricarinate, especially posteriorly. Lower eyelid transparent; subocular distinctly narrowed below (lower border $^1/_5$ to $^1/_2$ length of upper) and in contact with or excluded from lip (on right side of head, sometimes both sides, in 55 specimens). Ear lobules small, subtriangular or rounded, 2-5 (usually 2-3),

often different in number on either side of head. Centre of nostril above or behind rostro-labial suture. 4-6 (usually five) upper labials anterior to subocular (often differing in number on either side of head). Prefrontals usually well separated by frontonasal and frontal, but in very narrow (15 specimens) to narrow (20 specimens) contact in 32% of specimens; prefrontals and frontal separated by small scale in NMB R3095. Out of 323 specimens, 162 had original tails, 90 had regenerated tails and 71 had broken/missing tails. NMB R4334 had a bifurcated regenerate.

Habitat and Ecology

Found in a variety of ecological conditions in the O.F.S., from sandy river banks to various rocky habitats up to 2591 m a.s.l. (De Waal, 1978, p. 43). Also found on the walls of buildings, on the roofs of houses and in rubbish heaps in Pretoria (pers. obs.). A specimen was found at night under a creeper about 2 m up on the wall of a derelict building on the farm Arcadia (Lindley district); several *Pachydactylus c. capensis* were also found on this and nearby walls. The species is gregarious, and as many as 50 specimens were found under the same large rock slab at Woodbush in the Transvaal (Jacobsen, 1989, p. 376). Specimens are often found in rock crevices or between rocks in association with *Agama a. atra, Cordylus p. polyzonus, Pachydactylus bibronii* and *Pachydactylus c. capensis* in the O.F.S. Sympatric with *M. s. sulcata* at two localities in the O.F.S., *viz.* Kleinplaas and Kalkfontein. Although the species is often associated with rupicolous habitat, populations in the western part of the range are largely arboreal (Broadley, 1977a, p. 67), whereas a specimen was also collected in pit-traps on a drift fence in open grassland about 150 m from the nearest rocky outcrop (where *M. varia* was collected) on the farm Plaat Kop near Aliwal North (Bates & Douglas, *in press*.). According to FitzSimons (1943, p. 232), the diet of South African *Mabuya striata* (*sensu lato*) consists of insects (*viz.* beetles, flies, mantids, ants and termites), other small invertebrates, and occasionally vegetable matter, fruit and carrion. Broadley (1977a, p. 69, pl. II) illustrated a *M. s. striata* capturing a *Hemidactylus m. mabuia*. De Waal (1978) recorded hymenopterans and isopterans (workers and warriors) from the stomachs of O.F.S. specimens. Enemies in the O.F.S. include *Lamprophis fuliginosus, Psammophis leightoni trinasalis* and *P. crucifer*. *M. s. punctatissima* represented 8,5% by number of all prey items eaten by 94 Spotted Skaapstekers *Psammophylax r. rhombeatus* from the O.F.S. (Van Wyk, 1988, p. 462). Females from the O.F.S. contained 3-10 embryos, in various stages of development, from October to March. According to Jacobsen (1989), Transvaal females give birth to 2-7 young in December and January as well as March and April; neonates measured 27,0 - 29,0 + 38,5 - 42,0 = 65,5 - 71,0 mm total length and weighed 0,4 g.

Remarks

Despite careful examination of all O.F.S. *M. s. punctatissima*, none proved to be *M. spilogaster*, which may occur in Kalahari Thornveld in the western O.F.S. The latter species occurs as far east as Kimberley, has a heavily speckled throat and belly and is arboreal in *Acacia* trees (Broadley, 1977a, p. 63; Branch, 1988a, p. 132). Several O.F.S. specimens of *M. s. punctatissima* have extensive speckling on

the throat and belly, but lack numerous large, white flecks or spots on the back, although a few pale spots may be present; none were collected in trees.

Genus: *Panaspis* Cope, 1868

Panaspis wahlbergii (A. Smith, 1849) Wahlberg's Snake-eyed Skink

Cryptoblepharus wahlbergii A. Smith, 1849, *Ill. Zool. S. Afr., Rept.*, App., p. 10. Type locality: "Country to the eastward of the Cape Colony", i.e. Natal. Types in the British Museum of Natural History, London (but neither of the two specimens agree with A. Smith's description [FitzSimons, 1943, p. 238]).

Ablepharus wahlbergii (A. Smith): FitzSimons, 1943, p. 236, figs 106 & 107.

Afroablepharus wahlbergii (A. Smith): De Waal, 1978, p. 45.

Panaspis wahlbergii (A. Smith): Branch, 1988a, p. 134, pl. 51.

Range

From central and eastern Africa southwards to eastern and southern Natal, and from north-eastern Botswana and Zimbabwe south to Transvaal, Swaziland and northern and central O.F.S.; also an isolated population in northern Namibia.

Zoogeographical classification: Tropical Wide Ranging.

Range cluster in O.F.S.: Central (C).

Distribution in the Orange Free State (21 localities; Fig. 59)

Specimens examined from: Bergplaats, Bloemfontein; Bothaville (TM 4333); Cecilia; Deelfontein; Di Poort; Florisbad; Glen; Holme's Dale; Houmoed; Klipdrift; La Riviera; Lorenzo; Middenspruit; Richmond West (TM 41515-16); Spijtfontein; Strathearn (TM 55991); Van der Walt's Rust; Venus; Willem Pretorius Game Reserve (NMB; TM 29763); Wittekopjes; Wolvekop, Kroonstad.

Features (59 specimens examined)

Largest male (NMB R333 - La Riviera) 44 + 64 = 108 mm.

Largest female (NMB R1424 - Houmoed) 45 + 63 = 108 mm.

Dorsum brown with dark lateral streak (occasionally not very dark), with or without distinct dark line between dorsal and lateral areas; dark flecks or distinct to indistinct thin dark stripes on back of some specimens. Five specimens have a distinct white ventro-lateral stripe (i.e. below dark lateral streak) (NMB R333, 1393, 1890, 3291, 4002). Ventrum cream or pale bluish, occasionally greyish in colour; underside of tail cream or greyish. Eyelids immovable, lower lid with a large transparent disc which

completely covers the eye. Dorsal scales smooth. Prefrontals and frontoparietals fused into a single shield (occasionally semi-divided at the top). Nostril pierced in a small or moderate-sized nasal shield and well separated from rostral; nostril situated between two nasals, of which the anterior is twice as large as the posterior. Frontonasal transversely divided in NMB R1923. Specimen NMB R2377 has a crushed head, and the nasal area of NMB R5258 is damaged. Of the 59 specimens, 23 had original tails, ten had regenerated tails and 26 had missing/broken tails.

Habitat and Ecology

Collected in inactive termitaria, under rocks (De Waal, 1978, p. 46) and in open grassland (at Florisbad) in the O.F.S. Also found under rotting logs (FitzSimons, 1943, p. 237) and among leaves or grass tussocks, where it may take shelter (Jacobsen, 1989, pp. 393-394). Auerbach (1987, p. 115) recorded a specimen found under cow dung in Botswana. Feeds mostly on termites, but also takes beetles and their larvae, cockroaches, homopterous bugs, caterpillars, ants, woodlice, spiders and small centipedes (FitzSimons, 1943; Jacobsen, 1982). Arachnid remains were found in the stomach of an O.F.S. specimen (De Waal, 1978). A female collected in September in the O.F.S. contained a record 18 eggs, nine in each oviduct; these were in different stages of development (De Waal, 1978). Mating occurs from August to October, and two clutches of eggs may be produced, the second in late summer; incubation lasts for 40-50 days (Branch, 1988a, p. 135). According to FitzSimons (1943), 2-6 oval, white eggs measuring 6,5 - 9 x 4,8 - 5 mm are laid under stones or logs on moist ground or in roots in spring or early summer; hatchlings measure 30-35 mm in total length. In the Transvaal, females lay 2-6 eggs measuring 6,9 - 8,0 x 3,4 - 3,7 mm from November to January; the incubation period is about 36 days, and hatchlings measure 15,0 - 17,5 + 19,5 - 22,5 = 34,5 - 40,0 mm total length and have masses of 0,1-0,15 g (Jacobsen, 1982). A female of 103 mm total length from Manyeleti Game Reserve laid four eggs on 12 November (the day after capture); these measured 7,1 - 7,4 x 3,6 - 3,8 mm with a combined mass of 0,2 g (25% post-partum mass of female); incubation was unfortunately unsuccessful (Haagner, 1988a, p. 48). Specimens were found in the stomachs of the snakes *Psammophis leightoni trinasalis* and *Lycophidion c. capense* in the O.F.S. (De Waal, 1978), whereas a *L. c. capense* from Owen Sithole College of Agriculture in Natal regurgitated a *P. wahlbergii* after capture (Hoffman, 1990).

Genus: *Acontias* Cuvier, 1817

Acontias gracilicauda gracilicauda Essex, 1925 — Eastern Thin-tailed Legless Skink

Acontias gracilicauda Essex, 1925, *Rec. Alb. Mus.*, 3, p. 334, figs D, E & F. Type locality: Grahamstown. Types in the Albany Museum, Grahamstown.

Acontias meleagris (not Linnaeus, 1758): Boettger, 1883, p. 156.

Acontias plumbeus gracilicauda Essex: FitzSimons, 1943, p. 248, fig. 117, pl. 22, fig. 5.

Acontias gracilicauda gracilicauda Essex: Broadley & Greer, 1969, p. 18, fig. 2, pl. I; De Waal, 1978, p. 46; Branch, 1988a, p. 114, pl. 44.

Range

Eastern Cape Province, northwards to the O.F.S. (excluding the north-east), southern Transvaal and westwards to Kuruman in the northern Cape.

Zoogeographical classification: Eastern Temperate Transitional.

Range cluster in O.F.S.: Non-Southwestern (Non-SW).

Distribution in the Orange Free State (38 localities; Fig. 60)

Specimens examined from: Alpha; Baunton; Bethel; Bethulie (TM 16733); Bloemfontein; Ceylon; Damfontein; Dealbata; Die Hoogte; Doornberg N.W.; Goedehoop; Kalkdam; Klipoog; Kroonstad; Kroonstad district (TM 42892); Krugersdrift Dam; La Belle France; La Riviera; Leeuwkop; Lessingskop; Lindley (TM 36576); Mandyville; Middenspruit; Milambi; Mimosa; Petra; Rouxville; Schutte's Draai Estates (NMZB-UM 12501); Slangheuvel; Tussen-die-Riviere Game Farm; Uitkijk; Vet River - Bloemhof Dam junction; Vrede (TM 43211); Weltevreden, Smithfield; Willem Pretorius Game Reserve (TM 29755-58).

Other records: Smithfield (Boettger, 1883); Doornberg N.W.; Glen (FitzSimons, 1943); Ficksburg; Vredefort Road (Broadley & Greer, 1969).

Features (70 specimens examined)

Largest specimen, a male (NMB R3198 - Vet River - Bloemhof Dam junction) 253 + 42 = 295 mm.

Dorsum olive-green to grey-brown with dorsal scales dark-edged, or with spotted appearance (all juveniles). TM 29758 is grey above, probably in a pre-sloughing condition, while NMB R1076 has a black dorsum and NMB R1334 has brown, black-edged dorsal scales. Venter pale yellow to white, but some specimens have a few dark spots on belly and/or tail. Limbs absent. Dorsal scales smooth. Snout rounded and moderately projecting. Lower eyelid elongate and translucent. Interparietal slightly elongated. Tail cylindrical and gently tapered with obtuse point; median subcaudals not strongly broadened. Only one specimen exhibited signs of tail regeneration.

Habitat and Ecology

This fossorial, legless skink is found in damp spots under rocks or in inactive termitaria (De Waal, 1978, p. 46); one specimen was collected from under a fallen prickly pear tree in grassland. Prey items in the O.F.S. include curculionid beetles and scutigerid chilopods (De Waal, 1978). According to Broadley & Greer (1969, p. 26), beetle larvae, termites and other small invertebrates are eaten. Females collected in October and November in the O.F.S. contained three or four well developed eggs (De Waal, 1978). Branch (1988a, p. 113) stated that *Acontias* spp. are viviparous and give birth to a single brood in late summer.

Remarks

Jacobsen (1989, p. 408) recorded the morphologically similar *A. percivali occidentalis* from the farm Grootplaas (2724 DD) on the south-western Transvaal/O.F.S. border. The isolated nature of this record prompts a re-examination of the specimen, which may be an *A. g. gracilicauda*.

Family: **GERRHOSAURIDAE** Fitzinger, 1843

Subfamily: **GERRHOSAURINAE** Fitzinger, 1843

Genus: *Gerrhosaurus* Wiegmann, 1828

Gerrhosaurus flavigularis flavigularis Wiegmann, 1828 Yellow-throated Plated Lizard

Gerrhosaurus flavigularis Wiegmann, 1828, *Isis Oken*, 21, p. 379. Type locality: "Africa meridionale" (= South Africa). Type specimen in Leipzig Museum?. De Waal, 1978, p. 48; Branch, 1988a, p. 151, pl. 65.

Gerrhosaurus bibronii A. Smith, 1844, *Ill. Zool. S. Afr., Rept.*, pl. 37, fig. 1, pl. 42, figs 9-12. Type locality: Towards the sources of the Caledon River, Quathlamba Mountains, Orange Free State.

Gerrhosaurus flavigularis var. *quadrilineata* Boettger, 1883, *Ber. Tat. offenbach. Ver. Naturk.*, No's 22-23, p. 156. Type locality: Smithfield.

Gerrhosaurus flavigularis flavigularis Wiegmann: Loveridge, 1942, p. 516; FitzSimons, 1943, p. 272, figs 152-154.

Range

From the southern Cape Province eastwards along the coastline to Natal, Lesotho, eastern half of the O.F.S., adjacent northern Cape, Transvaal, Swaziland, southern Mozambique, eastern half of Zimbabwe and adjacent Mozambique, west through central Botswana to eastern Namibia; further north it reaches Ethiopia and Sudan.

Zoogeographical classification: Tropical Wide Ranging.

Range cluster in O.F.S.: Eastern (E).

Distribution in the Orange Free State (26 localities; Fig. 61)

Specimens examined from: Allanvale; Atalanta; Biddulphsberg; Bloemfontein; Boschkloof; Caledonspoort; Dipka; Florisbad; Harrismith (DNSM 1126); Leeuwfontein, Theunissen; Lemoenhoek; Morgenzon, Senekal; Naval Hill; Oliewenhuis Art Museum; Petra; Rietfontein, Vrede; Rohallion; Rondeberg; Rusthof; Rydal Mount (NM 81); Tygerfontein; Verdun, Reitz; Welbedacht; Willem Pretorius Game Reserve; Wittepoort.

Features (39 specimens examined)

Largest male (NMB R3240 - Boschkloof) 108 + 164 = 272 mm.

Largest female (NMB R3015 - Dipka) 144 + 190 = 334 mm.

Dorsum brown with thin (about half a dorsal scale wide) paravertebral stripes (separated by about one scale width) extending from back of head or nape, usually to tail base, where it becomes very pale in colour; a pair of dark-bordered pale stripes (about one scale wide) from 2nd to 4th supraocular extend back onto first quarter to half the tail length; flanks grey, sometimes with indications of light and dark vertical bars (always present in juveniles, NMB R990, 5540, 6370); top of head paler brown than dorsum. Venter white to cream, but light blue in NMB R6449. Dorsals strongly keeled and striated; striations absent in one juvenile (NMB R5540). Scales on soles of feet tubercular and smooth; subdigital lamellae smooth. Lower eyelid scaly and opaque. One large lobe on anterior border of ear, usually covering most of the earhole, but sometimes present as a narrow rim. A pair of frontoparietals is followed posteriorly by a larger pair of parietals (interparietal fragmented in one adult, NMB R3015); parietals and interparietal of another adult (NM 81) also fragmented; a small elongate granule is present between left side frontoparietal and parietal of NMB R3014); prefrontals separated in all but one specimen; frontonasal and rostral separated by nasals. Ventral plates in eight longitudinal series. Femoral pores in both sexes usually 10-12 (nine in one specimen, NMB R3214). Of the 39 specimens, 25 had original tails, nine had regenerated tails and five had broken/missing tails.

Habitat and Ecology

Found on rocky and grassy hillsides where they have their burrows under rocks (De Waal, 1978, p. 49); a juvenile was also collected in a pit trap in open grassland at Florisbad. The holes into which these lizards retire are often of considerable length (FitzSimons, 1943, p. 274), but according to Jacobsen (1989, p. 540), it is uncertain as to whether or not the lizards construct the burrows themselves. The species is common along streams in south-eastern Africa, where specimens readily take to water when pursued (Broadley, 1966, p. 215). De Waal (1978) recorded the following prey items for O.F.S. specimens: insects - Legriidae (Coleoptera), Acrididae (Orthoptera), Blattaria and Arachnida (Aranaeida). According to FitzSimons (1943), grasshoppers, beetles, crickets, cockroaches, ants, myriapods and even vegetable matter are eaten; and Jacobsen (1989, p. 541) also recorded Isoptera and Chilopoda. O.F.S. females lay 5-8 eggs measuring 16 x 13 mm in December; these hatch in February and one hatchling measured was 37 + 58 = 95 mm total length (De Waal, 1978). According to FitzSimons (1943), 4-6 membranous eggs measuring 19-25 x 13-14 mm are laid and buried in the ground, where they are left to incubate, the hatchlings emerging in late summer (Branch, 1988a, p. 151). Transvaal females lay 2-7 eggs measuring 19,2 - 21,6 x 12,6 - 13,7 mm (mass = 1,8-2,1 g) in holes or under a rock on soil from October to December; after 74-86 days, hatchlings measuring 39,0 - 42,0 + 68,0 - 77,0 = 107,0 - 119,0 mm total length and weighing 1,1-1,4 g, are born (Jacobsen, 1989, p. 541).

Remarks

Trinomials are used by Branch *et al.* (1988, p. 11).

Genus: *Tetradactylus* Merrem, 1820

Tetradactylus seps (Linnaeus, 1758) Short-legged Plated Lizard

Lacerta seps Linnaeus, 1758, *Syst. Nat.*, ed. 10, I, p. 204 and 1766, ed. 12, I, p. 363. Type locality: "in meridionalibus", i.e. South Africa. Type in the Transvaal Museum, Pretoria.

Tetradactylus seps laevicauda (not Hewitt, 1915): FitzSimons, 1943, p. 290; Branch, 1988a, p. 154.

Tetradactylus seps seps (Linnaues): De Waal, 1978, p. 12.

Tetradactylus seps (Linnaeus): Branch, 1990b, p. 13.

Range

Found in what appears to be four disjunct populations in South Africa, namely the south-western and southern Cape Province (Cedarberg and Cape Fold Mountains); Amatola Mountain (eastern Cape); Smithfield (south-eastern O.F.S.); and Natal Drakensberg.

Zoogeographical classification: Cape Temperate.

Range cluster in O.F.S.: Southeastern (SE).

Distribution in the Orange Free State (one locality; Fig. 62)

Smithfield (FitzSimons, 1943).

Extralimital records (one locality; Fig. 62)

One specimen examined from: Royal Natal National Park, Natal (LR 1943).

Features (one specimen examined)

Body alongate; limbs short but fully developed and pentadactyl (LR 1943 - Royal Natal National Park).

Habitat and Ecology

These serpentiform lizards are found in small colonies in moist places (Branch, 1990b, p. 13) on mountain plateaux and in coastal forests (Branch, 1988a, p. 154). They occur in marshy seepage zones with scattered rocks and rotting logs in montane grassland, in mountain fynbos and in clearings in coastal forest (Branch, 1990b, p. 13). The diet consists of bees, grasshoppers and other insects, and females lay 2-3 large, oval, creamy-white eggs (14 x 8 mm) among rotting logs or leaf mould (Branch, 1988a, p. 154).

Remarks

De Waal (1978, p. 12) regarded *T. s. laevicauda* as of doubtful occurrence in the O.F.S, with reference to FitzSimons' (1943, p. 290) Smithfield record. After examining the specimen (SAM 11033), De Waal (1978) concluded that it was referrable to the nominate race, at that time known only from the south-western and southern Cape Province. No additional material was collected during De Waal's (1978) survey, and he thus stated that "the occurrence of *T. seps* in the Orange Free State could not be confirmed". Branch (1990b) reported on additional Cape material of *T. seps*, and concluded that intraspecific variation did not confirm the status of *T. laevicauda* as a northern race. Bourquin & Channing (1980, p. 15) recorded *T. s. laevicauda* at four localities in the Natal Drakensberg, including Royal Natal National Park (this specimen has been examined) on the Natal/O.F.S. border. Considering the apparently disjunct distributions of other *Tetradactylus* species in southern Africa, and in the O.F.S., i.e. *T. breyeri* and *T. a. africanus*, and this despite De Waal's (1978) intensive survey, I suggest that *T. seps* be provisionally included in the herpetofauna of the O.F.S. If the Smithfield record did prove to be erroneous, the species is in any case likely to occur in the north-eastern O.F.S., west of Royal Natal National Park. Three *Tetradactylus* species occur in the Qwa Qwa/Royal Natal National Park area, namely *T. breyeri* (see species account), *T. a. africanus* (Hewitt, 1915; De Waal, 1978) and *T. seps* (Bourquin & Channing, 1980). The reason why De Waal (1978) did not collect more *Tetradactylus* material might be explained by the fact that his collecting methods concentrated on termite mounds and rocks, whereas *Tetradactylus* appear to be more common in open grassland areas; also, the species appears to be rare (see remarks for *T. tetradactylus*).

Tetradactylus tetradactylus (Lacépède, 1803) Common Long-tailed Seps

Lacerta tetradactyla Lacépède, 1803, *Ann. Mus. Hist. Nat. Paris*, 2, p. 351, pl. LIX, fig. 2. Type locality: Unknown. Type in Paris Museum, Paris?

Tetradactylus tetradactylus tetradactylus (Lacépède): Bates, 1988a, p. 51 and 1988f, p. 22.

Tetradactylus tetradactylus (Lacépède): Bates, 1992a, p. 43.

Range (Fig. 63)

Cape Fold Mountains and montane grasslands of the Cape Province, from the south-western to north-eastern Cape, with a single record near Rouxville in the south-eastern O.F.S. (FitzSimons, 1943; Bates, 1988a; Branch, 1990; Bates, in prep.; see Fig. 63).

Zoogeographical classification: Cape Temperate.

Range cluster in O.F.S.: Southeastern (SE).

Distribution in the Orange Free State (one locality; Fig. 62)

One specimen examined from: Boschberg (NMB R4885).

Extralimital records (Fig. 63)

One specimen examined from: Plaat Kop near Aliwal North (NMB R5582).

Features

Largest O.F.S. specimen (NMB R4885 - Boschberg) 48,5 + 157 = 205,5 mm.

Body serpentiform; limbs tetradactyl; 3rd finger longer than 2nd. Dorsum grey with distinct brown dorso-lateral stripes; top of head with several brown spots; venter white. Hindlimbs extend over ten caudal scale rows; forelimbs extend backwards over ten ventral scale rows. Dorsal scales in 14 longitudinal series and 61 (Boschberg) to 62 (Plaat Kop) transverse series. Ventral scales in six longitudinal and 47 (Boshberg) to 48 (Plaat Kop) transverse series. Nostril bordered by two nasals and 1st upper labial (Boschberg), or three nasals (left side) and two nasals and 1st upper labial (right side) (Plaat Kop). Four supraoculars, three of which are in contact with frontal; supraciliaries 4-5 (Plaat Kop) and 3-4 (Boschberg); frontoparietals in long contact; supranasals in contact. Upper labials anterior to subocular three (decreasing in size posteriorly), lower labials three (2nd the longest). Preanal plates three; femoral pores five per thigh, but six on right thigh of Boschberg specimen. Subcaudal scale rows 164 (Boshberg) and 172 (Plaat Kop). Number of scales on side of neck dark-edged: nine (Boschberg) and 12 (Plaat Kop).

Habitat and Ecology

T. tetradactylus is a diurnal, serpentiform lizard that hunts small invertebrates in scrub vegetation on mountain plateaux; it has been found in montane *Merxmuellera* grassland with scattered rocks and in sparse restioid mountain fynbos (Branch, 1990b, p. 14). *T. tetradactylus* shelters in tufts of grass by night (Branch, 1988a, p. 155). The Boschberg specimen was found under an orange tree, while a specimen from Plaat Kop near Aliwal North was found dead at the bottom of a cattle drinking trough in open grassland (Bates, 1988a, p. 51, 1988f, p. 22). Drift fences with bucket traps set on Plaat Kop farm for 14 months were unsuccessful in capturing any additional *Tetradactylus* specimens (Bates & Douglas, *in press*.). FitzSimons (1943, p. 293) noted that except for slow movement, the limbs are non-functional, and movement is wholly serpentine. A female from Queenstown, north-eastern Cape Province, contained two "somewhat collapsed eggs" measuring approximately 7 x 13-14 mm, as well as two "smaller" eggs, one per oviduct (Branch, 1990b, p. 14).

Remarks

Until recently, the Common Long-tailed Seps *T. t. tetradactylus* was recorded only from the south-western Cape, and the subspecies *T. t. bilineatus* Hewitt, 1926 was represented by a single specimen collected in 1926, recorded from Burgersdorp in the north-eastern Cape (FitzSimons, 1943). However, in 1978, a specimen was collected on the farm Boschberg near Rouxville in the southern O.F.S. (Bates, 1988a,f). De Waal identified the specimen as *T. tetradactylus* (see National Museum catalogue index

card), but considered it as having been "introduced" and did not publish the record. In January 1988, a dead specimen was found in a water trough in grassland on the farm Plaat Kop near Aliwal North, about 20 km south of the Rouxville locality (Bates, 1988a,f). The two new specimens were collected nearer to the recorded locality of *T. t. bilineatus*, which is about 57 km south-west of the Aliwal North locality, but exhibited the characteristics of the nominate race. Branch (1990b) later recorded the species from a number of localities (most of these specimens have been personally examined) in the Cape Province (the Rouxville locality represents the northernmost limit of the species' range) and found no evidence to justify the continued recognition of *T. t. bilineatus* as an eastern subspecies.

Tetradactylus breyeri Roux, 1907 — Breyer's Long-tailed Seps

Tetradactylus breyeri Roux, 1907, *Zool. Jb. Syst.*, 25, p. 430, pl. 14, fig. 6. Type locality: Transvaal. Type probably in the Amsterdam Museum, Amsterdam.

Tetradactylus breyeri Roux: De Waal, 1978, p. 49; Jacobsen, 1988, p. 107; Branch, 1988a, p. 154, pl. 51; Jacobsen, 1989, p. 526.

Range (Fig. 64)

Three apparently disjunct populations, one in the eastern Transvaal, one at Swartkoppies farm in the north-eastern O.F.S. and a large population in Natal and the Drakensberg region of the O.F.S. (FitzSimons, 1943; De Waal, 1978; Bourquin & Channing, 1980; Lambiris, 1989b; Jacobsen, 1989; Bates, in prep.; see Fig. 64).

Zoogeographical classification: Eastern Temperate Transitional.

Range cluster in O.F.S.: Northeastern (NE).

Distribution in the Orange Free State (one locality; Fig. 62)

Specimens examined from: Sterkfontein Dam Nature Reserve (near Gateman's Quarters) (NMB R6852, 6853); Zwartkoppies (NMB R1073).

Extralimital records (Fig. 64)

Features (three O.F.S. and seven extralimital specimens examined)

NMB R1073 (Zwartkoppies) measured 72 + 135 = 207 mm.

Body serpentiform; dorsum grey with brown dorso-lateral stripes; venter white. Forelimbs didactyle; hindlimbs monodactyl. See Table 3 for variation in O.F.S. and extralimital material, and "remarks" for discussion.

Habitat and Ecology

One specimen of this diurnal, terrestrial species was collected in "grassy veld" at Zwartkoppies in the north-eastern O.F.S. (De Waal, 1978, p. 49), while another two were found on stones in grassland at Sterkfontein Dam Nature Reserve. The habitat of this rare lizard has also been described as "probably open grassland" (Bourquin & Channing, 1980, p. 15) and "montane grassland" (Branch, 1988a, p. 154). In the Transvaal, it inhabits montane and highveld grassland at altitudes of 1700-2000 m a.s.l.; specimens from the escarpment were found under rocks on soil, while another specimen (which escaped) was located at the perimeter of an inactive termitarium in heavily grazed grassland with scattered tussocks of tall "unpalatable" grasses (Jacobsen, 1989, p. 525). Jacobsen (1988, p. 107) stated that the species probably requires extensive stands of grass, and noted that the widespread use of land for crop farming, together with man-made fires, are a possible threat to the survival of this poorly known species. Nothing is known about the life history of *T. breyeri*, but it is likely to be similar to that of other *Tetradactylus* species.

Remarks

De Waal (1978, pp. 49 & 50) collected a single specimen of this species (Zwartkoppies) during his survey. At that time *T. breyeri* was known from only three localities in Natal and the type locality "Transvaal" (FitzSimons, 1943). Since then, only a few additional specimens have been collected (Table 3; Fig. 64), and the species is currently regarded as "Rare" in the *South African Red Data Book - Reptiles and Amphibians* (Branch, ed., 1988b). Data pertaining to specimens examined by me are presented in Table 3. De Waal (1978, p. 50) noted that the Zwartkoppies specimen "probably represents an undescribed subspecies" and listed it as "*Tetradactylus breyeri* ssp." This was based on the fact that the Zwartkoppies specimen "differs from typical *breyeri* in having three femoral pores on either side instead of two; upper head shields smooth instead of ribbed; first two supraoculars instead of first three in contact with frontal; frontoparietals in contact, not separated by interparietal". However, variation occurs in all of these characters, as shown in Table 3, and it is thus apparent that De Waal's (1978) "subspecies" is untenable. Of the two Sterkfontein Dam specimens, one has two and the other three, femoral pores per thigh. Apart from the latter specimen (NMB R6853) and the Zwartkoppies lizard, all other *T. breyeri* have two femoral pores per thigh (FitzSimons, 1943; Table 3).

Table 3: Variation in taxonomic characters in *Tetradactylus breyeri* from southern Africa.

	SVL (mm)	No. femoral pores (per side)	Upper head shields	No. supra-oculars in contact with frontal	Fronto-parietals	Scales at midbody	DORSALS		VENTRALS	
							Longitudinal rows	Transverse rows	Longitudinal rows	Transverse rows
NMB R1073 (Zwartkoppies, Frankfort)	72	3	smooth	2	in contact	22	14	76	8	59
NMB R6852 (Sterkfontein Dam Nature Reserve)	54,0	2	smooth	3	separated	22	14	71	8	56
NMB R6853 (Sterkfontein Dam Nature Reserve)	48,6	3	smooth	3	separated	22	14	75	8	58
NHMZ - UM 3027 "Bushmans Cave, Witzieshoek"	approx. 58	2	smooth	3	separated	21	13	73	8	57
TM 56792 (Mount Sheba, Pilgrims Rest)	59,5	2	smooth	2	separated	21	13	73	8	57
TM 56692 (The Staircase, Lydenburg)	49,8	2	moderately ribbed	2/3	separated	22	14	73	8	55
TM 682 (Weenen, Natal)	62,7 +	2	weakly ribbed anteriorly	2/3	narrow contact	22	14	74	8	52
TM 22674 (Natal)	-	2	weakly ribbed anteriorly	3	separated	22	14	71	8	57
LR 1817 (Highmoor Forestry Reserve, Natal)	-	2	smooth	2	separated	-	-	-	-	-
AJL 2751 (Dargle, Natal)	63,6	2	feebly ribbed	2/3	in contact	22	14	72	8	57

Tetradactylus africanus africanus (Gray, 1838) African Long-tailed Seps

Caita africana Gray, 1838, *Ann. Mag. nat. Hist.*, 1, p. 389. Type locality: "Cape of Good Hope". Whereabouts of type not known.

Tetradactylus africanus (Gray): Hewitt, 1915, pp. 105 & 106.

Tetradactylus africanus africanus (Gray): FitzSimons, 1943, p. 296, figs 181-183; De Waal, 1978, p. 50; Branch, 1988a, p. 153, pl. 50.

Range (Fig. 65)

Pondoland (northern Transkei), Natal, middleveld of Swaziland and Witzieshoek in the north-eastern O.F.S. (Hewitt, 1915; FitzSimons, 1943; Bruton & Haacke, 1980; Lambiris, 1988b; Bates, in prep.; see Fig. 65).

Zoogeographical classification: Eastern Temperate Transitional.

Range cluster in O.F.S.: Drakensberg (D).

Distribution in the Orange Free State (one locality; Fig. 62)

One specimen examined from: Witzieshoek.

Features (one specimen examined)

Serpentiform, fore- and hindlimbs minute and monodactyl. Nostril pierced between two nasals and 1st upper labial. Femoral pores per thigh two and three.

Habitat and Ecology

No ecological data are available for the Witzieshoek specimen, and little is known of the ecology of either subspecies of *T. africanus* (Branch, 1988a, p. 15). *T. a. africanus* is a diurnal, terrestrial, serpentiform species found in montane grassland (Branch, 1988a, p. 154). Hoffman (1990, p. 133) reported on a male, collected at Owen Sithole College of Agriculture in Natal, which had the sides of neck, inferiorly and posteriorly, a "brilliant sky-blue" in colour, and suggested that this represented breeding coloration.

Remarks

The even rarer subspecies *T. a. fitzsimonsi* differs from the nominate subspecies in that it lacks forelimbs (Branch, 1988a, p. 154).

Family: **CORDYLIDAE** Gray, 1837

Subfamily: **CHAMAESAURINAE** Wiegmann, 1834

Genus: *Chamaesaura* Schneider, 1799

Chamaesaura aenea (Wiegmann, 1843) Transvaal Grass Lizard

Cricochalcis aenea (Wiegmann): Fitzinger, 1843, *Syst. Rept.*, p. 21. Type locality: South Africa. Whereabouts of type unknown.

Chamaesaura aenea (Wiegmann): FitzSimons, 1943, p. 409, figs 303-305; Loveridge, 1944, p. 101; De Waal, 1978, p. 13; Bates, 1988a, p. 51; 1991b, p. 154 and 1992, p. 43.

Range (Fig. 66)

Escarpment grasslands of the eastern Transvaal Drakensberg, southern Transvaal highveld, north-eastern O.F.S. and Natal Drakensberg, with an isolated relict population in the Amatola Mountains in the eastern Cape Province (FitzSimons, 1943; Loveridge, 1944; Bourquin & Channing, 1980; Bates, 1988a; Lambiris, 1988b, 1989b; Jacobsen, 1989; Bates, 1991; see Fig. 66).

Zoogeographical classification: Eastern Temperate Transitional.

Range cluster in O.F.S.: Drakensberg (D).

Distribution in the Orange Free State (two localities; Fig. 67)

Specimens examined from: Golden Gate Highlands National Park (NMB R5490, 6264, 6448).

Other records: Lindley (FitzSimons, 1943).

Extralimital records (one locality; Figs 66 & 67)

One specimen examined from: Royal Natal National Park, near Tiger Falls (AJL 2754).

Features (4 specimens examined)

Largest specimen (NMB R6448 - Golden Gate Highlands National Park) 101 + 319,5 = 420,5 mm.

Dorsum brown with pale median and dorsolateral stripes which may be black-edged (not evident in NMB R5490, presloughing ?) and extend onto tail. Dorsal and ventral surfaces of body and tail with regular whorls of lanceolate, strongly keeled scales. Ventral surfaces cream, unmarked. Limbs rudimentary, feet and hands with five clawed digits. Scales around body in 30 or 31 longitudinal rows (30 in NMB R5490, 31 in NMB R6264 and 6448) and 36-39 transverse rows (36 in NMB R5490; 38 in NMB R6448; 39 in NMB R6264) (counted ventrally from first row behind forelimb insertion to row anterior to hindlimb insertion). Femoral pores three on each thigh. Tail more than three times SVL (3,23 in NMB R5490; 3,16 in NMB R6448; NMB R6264 poorly positioned when fixed, not measured). Nasals separated by internasal in NMB R5490 and 6448, but in contact behind rostral in NMB R6264. Specimen AJL 2754 was not examined in as much detail as the other specimens, but according to FitzSimons' (1943) key for the genus, it is undoubtably *C. aenea*.

Habitat and Ecology

No ecological data are available for O.F.S. specimens. *C. aenea* is a diurnal, terrestrial, serpentiform, grassland species adapted for life in thick grass cover; the reduced limbs allow for easy movement between grass culms and the long tail assists in rapid locomotion (Jacobsen, 1989, pp. 555-556). They are found on grass-covered mountain slopes and plateaux (Branch, 1988a, p. 156). Reproduction is probably similar to that of the other two South African *Chamaesaura* species, which are viviparous, namely *C. a. anguina* (6-9 young in April) and *C. m. macrolepis* (6-8 young in March) (Branch, 1988a, p. 156).

Remarks

The Transvaal Grass Lizard *Chamaesaura aenea* was listed by De Waal (1978, p. 13) as being of doubtful occurrence in the O.F.S. FitzSimons (1943) recorded a specimen from Lindley, but it was later lost and no additional specimens were collected during De Waal's (1978) survey. However, three specimens have since been collected at Golden Gate Highlands National Park (GGHNP), on different occasions, confirming the occurrence of this species in the north-eastern O.F.S. (see Bates, 1988a, 1991b). In addition, Lambiris (1989b) recorded sympatry between *C. aenea* and *C. anguina anguina* near Tiger Falls in Royal Natal National Park on the Natal/O.F.S. border. NMB R6448 is a record-sized specimen (total length = 420,5 mm) (cf. Branch, 1988a, p. 156; max. length = 40 cm), although its SVL (101 mm) does not exceed that of a female (SVL = 134 mm) recorded by FitzSimons (1943, p. 410).

Subfamily: **CORDYLINAE** Camp, 1923

Genus: *Cordylus* Laurenti, 1768

Cordylus giganteus A. Smith, 1844 — Giant Girdled Lizard

Cordylus giganteus A. Smith, 1844, *Ill. Zool. S. Afr. Rept.*, pls 35 & 36. Type locality: "Interior districts of Southern Africa, on pinnacles of Quathlamba Mountains" (in error, species not known from mountainous regions - Van Wyk, 1988, p. 78). FitzSimons, 1943, p. 418, figs 307-309, pl. 24, fig. 5; Loveridge, 1944, p. 16, pl. 1, figs 1-2; De Waal, 1978, p. 51; McLachlan, 1986, p. 30 and correction of locality spelling, 1987, p. 30; Van Wyk, 1988a, p. 78; Branch, 1988a, p. 159, pl. 65; Bates, 1991b, p. 155; Groenewald, 1992, p. 76.

Zonurus giganteus (A. Smith): Hewit, 1909, p. 35; Boulenger, 1910, p. 467; Hewitt & Power, 1913, p. 153; Power, 1930, p. 14.

Range

Northern and north-eastern O.F.S., south-eastern Transvaal and adjacent north-western Natal.

Zoogeographical classification: Eastern Temperate Transitional.

Range cluster in O.F.S.: Northeastern (NE).

Distribution in the Orange Free State (65 localities, but four not plotted - see Remarks; Fig. 68)

Specimens examined from: Allanvale; Arcadia, Lindley; Berlin; Bethel; Biddulphsberg; Boshof; Braunzijnkop; Brockenhurst; Campen; Carlie; Dealbata; Doornland; Elandsfontein; Evenston A; Fraser Spruit; Goedetrouw; Grootkrans; Holfontein (TM 39448); Hoogeveld, Kroonstad; Houtkop; Kalkoenkrans; Kroonstad (NM 1072; SMWN 1795, 1796a,b, 3364); Lange Hoek; Lanquedoc; Loskop; Louis Rust; Lusthof; Mecklenburg; Mooigelegen; Morgenzon, Harrismith; Oorsprong; Quaggaspruit; Rambouillet; Reitz (NMZB-UM 6489); Rondebuld; Rusthof; Spijtfontein; Stoffelfontein; Strijdfontein, Heilbron; Triangle; Uitzicht; Vaalbank; Verdun, Reitz; Wolvenfontein; Woudzicht; Zwartkoppies.

Other records: Bloemfontein (Hewitt, 1909); Hoopstad (Boulenger, 1910); Bethlehem (Power, 1930); Bloemfontein District; Boshof; Lindley; Odendaalsrus; Rondebuld - near Meets Siding (FitzSimons, 1943); Geluk, Kroonstad; Harrismith; Ventersburg (Loveridge, 1944); Thesen's Laagte; Willem Pretorius Game Reserve (De Waal, 1978); Zoeten Inval (McLachlan, 1986, 1987); Holfontein (TM 39448); El Bethal (sight record of dead specimen in vicinity of burrow, D.H. de Swardt, 4 May 1992); map in Groenewald (1992, locality names not given, but localities plotted on map in present study).

Features (104 specimens examined)

Largest male (NMB R1059 - Louis Rust) 204 + 172 = 376 mm.

Largest female (NMB R1060 - Louis Rust) 205 + 181 = 386 mm.

This fawn-brown, giant, spiny cordylid is unmistakable in appearance. Juveniles have a more spiny appearance than other *Cordylus* species occurring in the O.F.S.

Habitat and Ecology

These large, diurnal, colonial lizards are found in open grassland where they inhabit burrows dug by themselves or other *C. giganteus* (see De Waal, 1978, p. 51 for details). The diet includes scarabaenid beetles, curculionid beetles, lepidopterous larvae, orthopterans and myriapods (De Waal, 1978). According to Branch (1988a, p. 159), females give birth to one or two young (measuring 130-150 mm) in February - March, possibly only every second season. Van Wyk (1991) showed that reproduction in O.F.S. populations was distinctly seasonal (when females were reproducing), but 53% of females did not reproduce in a given year; reproducing females were gravid for most of the summer, and parturition occurred in January and February. Van Wyk (1991) did not mention how many young were born to females, but Van Wyk (1988a, p. 79) noted that 1-4 young are born.

Remarks

Jacobsen (1989, p. 574) examined specimens from the Transvaal population of *C. giganteus* and stated that "... details of the Orange Free State population [vs Transvaal population] indicates that they are not contiguous". Jacobsen (1989, p. 574) also noted that Transvaal specimens appear to be smaller than those in the O.F.S. Their separation on either side of the Vaal River probably played a major role in this character expression.

Four isolated localities, namely Bloemfontein (Hewitt, 1909), Hoopstad (Boulenger, 1910), Boshof and Colesberg (FitzSimons, 1943), were regarded as "doubtful recordings" by Van Wyk (1988a), who suggested that the specimens may have been confused with *C. polyzonus*. These localities have not been plotted in Fig. 68. However, it seems unlikely that FitzSimons (1943), if he did indeed personally examine the specimens from these localities, would confuse *C. giganteus* with *C. polyzonus*, and the doubtful records may therefore represent incorrectly tagged or documented specimens, rather than misidentifications. One such specimen (labelled "Bloemfontein") in the State Museum, Windhoek collection was examined by me. This specimen had apparently been kept captive at the National Museum, Bloemfontein, and later sent to the State Museum. Its original collecting site is unknown. It should be noted that FitzSimons (1943) gives "Bloemfontein District" as a locality, and not "Bloemfontein" (see De Waal, 1978). McLachlan (1986, 1987) showed that the Hoopstad locality in fact referred to the farm "Zoete Infal" in the Odendaalsrus district. I have checked this, and found that the farm name should in fact be spelled "Zoeten Inval"; its eighth-degree grid reference is 2726-Dc2. This record has been plotted in Fig. 68.

Cordylus polyzonus polyzonus A. Smith, 1838 — Karoo Girdled Lizard

Cordylus polyzonus A. Smith, 1838, *Mag. Nat. Hist.*, (2)2, p. 34. Type locality: South Africa. Types in the British Museum of Natural History, London. FitzSimons, 1943, p. 430, figs 326-328; Branch, 1988a, p. 161, pl. 69.

Zonurus polyzonus (A. Smith): Boulenger, 1910, p. 469; Power, 1930, p. 14.

Cordylus polyzonus polyzonus A. Smith: Loveridge, 1944, p. 60; De Waal, 1978, p. 53.

Range

Central and western Cape Province and southern Namibia, eastwards to western and southern O.F.S. and extreme south-western Transvaal.

Zoogeographical classification: Cape Temperate.

Range cluster in O.F.S.: Southern (S).

Distribution in the Orange Free State (100 localities; Fig. 68)

Specimens examined from: Alpha; Bergplaats, Dewetsdorp; Bethany; Beyersfontein; Boskop, Boshof; Boskop, Bloemfontein; Bozrah; Brakfontein; Brakpan; Ceylon; Chubani; Cornwall; Damfontein; Die Hoogte; Di Poort; Donegal A; Doornplaat; Dundee; Edenburg, 4 miles south of (NMZB-UM 813); Exelsior, Edenburg; Francis Home; Geluk, Philippolis; Groenekloof; Gruiskop; Hagesdam; Hammanskraal West; Hartebeestfontein, Boshof; Hebron; Heenenweerskop; Honingberg; Houmoed; Joostenberg; Juist Zoo; Kades; Kalkdam; Kalkplaat; Kareerand; Kleinplaas; Klipbankfontein; Klipfontein; Klippiespan; Klipplaatdrift, Edenburg; Knellpoort; Koortshoek; Koppiesdam; Lang Zeekoegat; Leeuwberg; Leeuwkuil; Leeuwrant; Lemoenboord; Lentelus; Lessingskop; Loskop; Luiperfontein; Luiperskop; Magdalen; Matjesfontein; Merriesfontein; Middelbron; Middeldeel; Mimosa; Noodhulp; Onze Rust; Ospoort; Pietersberg; Platberg, Boshof; Poortje, Edenburg; Poortje, Fauresmith; Proces; Rietfontein, Rouxville; Ruigtepoort; Strijdfontein, Philippolis; Susannasfontein; Thaba 'Nchu (MMK/F/787); Tienfontein; Torbek; Tussen-die-Riviere Game Farm; Tweefontein; Uitkijk; Uitkyk; Vaalkop; Vergaderrand; Vissershoek West; Waterhoek; Weltevrede; Weltevreden, Jacobsdal; Weltevreden, Smithfield; Wilhelmshohe; Williamstrip; Winterspoort; Wolvekop, Fauresmith; Wonderkop; Zoutpan, Fauresmith; Zuurfontein.

Other records: Smithfield (Boulenger, 1910); Bloemfontein; Boshof; Jacobsdal (Power, 1930); Bethulie (FitzSimons, 1943); Hendrik Verwoerd Dam (TM 36031).

Features (378 specimens examined)

Largest male (NMB R1552 - Strijdfontein, Philippolis) 106 + 141 = 247 mm.

Largest female (NMB R502 - Matjesfontein) 124 + 113r = 237 mm.

A female (NMB R2488 - Hebron) with an original tail measured 111 + 145 = 256 mm.

Dorsum dark brown to black (olive brown in NMB R1646), usually with darker spots irregularly arranged more or less paravertebrally; juveniles with light brown dorsum and several scattered dark spots. Venter is orange-white, sometimes greyish; throat either immaculate or with dark brown spots (which extend onto the chest in one specimen, NMB R2180) or occasionally greyish. Upperside of tail dark brown or a mixture of light and dark brown, underside light to dark brown and usually lighter than dorsal side. Black streak on either side of neck, from behind tympanic opening to anterior part of forelimb, most distinct in juveniles. Dorsals small and smooth, keeled on flanks. First transverse row of dorsals (post-occipital row) usually 1-1½ times longer than second row, very seldom twice as long. Rostral and frontonasals separated by supranasals. Whorls of tail composed of two rows of scales, one small, one large, except for the first few basal rows and the terminal portion, which have a single row; regenerated tails have only one row of scales per whorl. Of the 378 specimens, 162 had original tails, 62 (all adults) had regenerated tails and 154 had broken/missing tails. Tails were regenerated from near the base to near the tip of the total tail length.

Habitat and Ecology

Found in dolerite rock crevices on the lower slopes and bases of hillocks in the O.F.S. The diet in the O.F.S. includes coleopterans, hemipterans, orthopterans and isopterans (see De Waal, 1978, p. 53). A *Psammophis notostictus* from the O.F.S. had consumed a *C. p. polyzonus* (De Waal, 1978). Females from the O.F.S. give birth to 1-5 young in February, the number of young being positively correlated with female SVL (Van Wyk, 1989).

Remarks

O.F.S. specimens are dark brown to black in colour, and, contrary to Branch's (1988a, p. 161) statement that southern O.F.S. individuals are of a "uniform olive" colour, most have at least some dark spots/blotches on the back (not distinct in adults). The north-western subspecies, *C. p. jordani*, is treated as a valid species by Branch (1988a, pp. 9 & 162), who noted that *jordani* differs from *polyzonus* in having only a single row of scales per tail whorl and lacks a dark streak on the side of the neck.

Cordylus cordylus (Linnaeus, 1758) Cape Girdled Lizard

Lacerta cordylus Linnaeus, 1758, *Syst. Nat.*, ed. 10, 1, p. 202. Type locality: "In Africa, Asia" (probably Cape Province). Types in Stockholm Museum, Stockholm?

Cordylus cordylus cordylus (Linnaeus): FitzSimons, 1943, p. 455, figs 363-365; De Waal, 1978, p. 54; Branch, 1988a, p. 158, pl. 66.

Range

South-western, southern and eastern Cape Province, northern Transkei, south-eastern O.F.S. and Natal midlands.

Zoogeographical classification: Cape Temperate.

Range cluster in O.F.S.: Southeastern (SE).

Distribution in the Orange Free State (five localities; Fig. 69)

Specimens examined from: Bergkloof; Littlecote; Maghaleen (TM 36033-38); Morgenzon, Zastron.

Other records: Smithfield (FitzSimons, 1943).

Features (23 specimens examined: seven males, 15 females, one juvenile [31,5 mm SVL])

Largest male (NMB R1241 - Bergkloof) 72 + 72 = 144 mm.

Largest female (NMB R1282 - Morgenzon, Zastron) 74 + 85 = 159 mm.

Dorsum grey-brown with black spots or blotches. No dark temporal streak as in *C. p. polyzonus*. Dorsals with a distinct median keel; first transverse row of dorsals not twice as long as second row, of

about equal length. Venter white or light blue. Upper head shields more or less smooth anteriorly, feebly rugose posteriorly. Occipitals 6-8 (nine in one specimen, NMB R1281), non-spinose. Parietals four; prefrontals separate frontonasal from frontal; frontonasal slightly broader than long and in contact with loreal on both sides (separated from loreal by nasal and prefrontal on both sides of NMB R1239); rostral and frontonasal separated by nasals; a single, large, slightly elongate nasal; nostril pierced in lower posterior part of nasal. Lower eyelid scaly and opaque. Femoral pores 6-7 in males (five in TM 36038); 6-7 in females and juvenile; enlarged femoral scales 3-9 in males, 3-4 in females and juvenile. One scale row to each whorl of tail. Two enlarged, median preanal plates. Of the 23 specimens, five had original tails, two had regenerated tails and 16 had broken/missing tails.

Habitat and Ecology

This small girdled lizard is found in cracks and under stones on mountain slopes in the south-eastern O.F.S. (De Waal, 1978, p. 54), where the species reaches its northern and north-eastern limit. It also occurs at sea level in the Cape Province (FitzSimons, 1943, p. 457). In the Cape, dense colonies of up to 300 individuals per hectare occur; the males are aggressive and territorial (Branch, 1988a, p. 158). The diet consists mostly of insects, but smaller lizards and vegetable matter are also occasionally eaten (FitzSimons, 1943, p. 457). Enemies include snakes, small carnivores and small birds of prey (e.g. owls) (Branch, 1988a, p. 158). Mating occurs in spring and females give birth to 1-3 young during late summer (January and February); hatchlings measure 69-80 mm (FitzSimons, 1943, p. 457; Branch, 1988a, p. 158).

Remarks

Mouton & Van Wyk (1989) elevated *C. cordylus minor* to species rank, leaving *C. cordylus* a monotypic species.

Cordylus vittifer vittifer (Reichenow, 1887) Transvaal Girdled Lizard

Zonurus vittifer Reichenow, 1887, *Zool. Anz.*, p. 372. Type locality: Transvaal. Holotype in the Berlin Museum, Berlin.

Cordylus vittifer vittifer (Reichenow): De Waal, 1978, p. 55 (part, varieties "A" and "B"); Branch, 1988a, p. 163, pl. 67 (part).

Range

Transvaal and adjacent south-eastern Botswana, Swaziland, northern and north-eastern O.F.S. and Natal.

Zoogeographical classification: Eastern Temperate Transitional.

Range cluster in O.F.S.: Northeastern (NE).

Variety "A"

Distribution in the Orange Free State (five localities; Fig. 69)

Specimens examined from: Annies Rust; Baltespoort; Mara, Parys; Mara, Vredefort, Van der Walt's Rust.

Features (19 specimens examined: ten males, nine females)

Largest male (NMB R3772 - Mara, Parys) 87 + 82 = 169 mm.

Largest female (NMB R3412 - Annies Rust) 92 + 85 = 177 mm.

Dorsum light brown with scattered or grouped black scales which extend onto the base of the tail. Dorsum virtually uniform in NMB R3411-13, with only occasional blotches; NMB R3414, 3770 and 3772 had distinct, dark, dorso-lateral stripes from nape to base of tail, but few other dark markings. Venter white. First transverse row of dorsals (post-occipital row) elongate, 2-3 times as long as second row. Upper head shields moderately rugose, largely unmarked, with occasional dark spots; a short, dark temporal streak is present from just anterior to the eye, extending onto , but not reaching, the back of the head. Dorsals small and strongly keeled; lateral scales spiny. Parietals four, anterior pair slightly smaller; occipitals six, non-spinose. Rostral and frontonasal separated by nasals; nasal about as long as prefrontals, longer than frontonasal. Frontonasals may be separated from frontal by prefrontals. Interparietal separates the anterior parietals and makes contact with the frontoparietals in all but NMB R912. Females with 4-7 femoral pores, males with 5-8 femoral pores (five in NMB R4050 only). Whorls of tail composed of only one scale row each. Of the 19 specimens, six had original tails, five had regenerated tails and eight had broken/missing tails. For variation in taxonomic characters, see also Table 4.

Habitat and Ecology

Diurnal and rupicolous in fissures on rocky flats and hills in the northern O.F.S. (De Waal, 1978, p. 56). Dietary items include tenebrionid beetles and Acrididae orthopterans (De Waal, 1978, p. 56). The species also feeds on grasshoppers (Branch, 1988a, p. 163). One to four young measuring 34,0 - 37,0 + 33,0 - 37,0 = 67,0 - 74,0 mm total length and weighing 1,0-1,5 g are born in November or December, and seven days may elapse between the birth of first and second neonates (see Jacobsen, 1989, p. 616).

Remarks

De Waal (1978) separated O.F.S. populations into "three distinct and easily separable forms". These allopatric populations were treated as varieties "A", "B" and "C". De Waal was reluctant to treat varieties "A" and "B" (for "C", see under *Cordylus* sp.) as subspecies on account of "inadequate material", cases of sympatry and variation, including apparent intermediates, in a sample of 106 specimens collected in the Transvaal and Natal. In an analysis of 472 specimens collected throughout

the Transvaal, Jacobsen (1989) found overlaps "in all characters which in the Orange Free State dilineated each form [i.e. 'A' and 'B')". Variation in some characters specifically given by Jacobsen (1989) in comparing "A" and "B" in the Transvaal, as well as those characters regarded by De Waal (1978) as diagnostic, are given in Table 4. Jacobsen (1989) found that variety "A" occurs in the central, southern and most of the south-western Transvaal, whereas variety "B" is found in parts of the northern, much of the eastern and most of the south-eastern part of the Transvaal. Jacobsen (1989) found overlap in colour between "A" and "B" in the south-eastern Transvaal, and recorded sympatry between the two varieties in Sekukhuneland and around the Waterberg; he also recorded three colour phases, i.e. "a", "b" and "c". The situation after De Waal's (1978) and Jacobsen's (1989) studies, as well as my own examination of specimens, suggests that varieties "A" and "B" cannot at this time be treated as subspecies, but merely as infra-subspecific varieties. A more detailed study is needed in order to provide further insight into this complex taxonomic problem.

Table 4: Variation in taxonomic characters in *Cordylus v. vittifer* from the Orange Free State (De Waal, 1978) and Transvaal (Jacobsen, 1989).

	Variety "A"		**Variety "B"**		**Variety "C"**
	O.F.S.	**Tvl**	**O.F.S.**	**Tvl**	
Femoral pores in females:	undeveloped		4-7		5-7
Femoral pores in males:	5-8		6-8		6-9
Glandular femoral scales in males:	13-18	12-28 (18 or more in 77,6%)	11-18	8-24 (17 or less in 82,6%)	9-13
Glandular femoral scales in females:	none		none		3-7
Anterior parietals:	separated in 80,9%	separated in 68,6%	contact in 100%	contact in 70,0%	contact in 100%
Longitudinal ventrals:	16-18	12-18 (16-18 in 90,6%)	14-16	13-20 (14-16 in 81,6%)	14
Maximum SVL:	92 mm		78 mm		77 mm
Stripes:	none		pale vertebral		dark lateral
Loreal/postnasal		in contact with nostril in 91,8%		separated from nostril in 70,6%	

Variety "B"

Distribution in the Orange Free State (six localities; Fig. 69)

Specimens examined from: Berlin; Dipka; Klipplaat; Tygerfontein; Uitvlugt; Woudzicht.

Features (25 specimens examined)

Largest male (NMB R2393 - Klipplaat) 74 + 94 = 168 mm.

Largest female (NMB R2922 - Tygerfontein) 78 + 83 = 161 mm.

Dorsum light brown to grey with numerous scattered or grouped black scales which extend onto the base of the tail. A pale vertebral stripe (sometimes interrupted), from nape onto base of tail, is usually present, but apparently absent in three specimens (i.e. NMB R2394, 2398 and 2400) which have several dark scales, some of which form moderately distinct cross-bands on the back. The dorsum is more heavily spotted than in "variety A". Venter white. Upper head shields moderately rugose and with light and dark blotches; no dark temporal streak. Dorsals small and strongly keeled (weakly keeled in NMB R2393 only); lateral scales spiny. First transverse row of dorsal scales (post-occipital row) elongate, 2-5 times as long as 2nd row. Parietals four, anterior pair slightly smaller; occipitals six, non-spinose. Interparietal more acutely diamond-shaped than in "variety A". Rostral and frontonasal separated by nasals, which are about as long as prefrontals, but longer than frontonasals. Frontonasal usually separated from frontal by prefrontals, but in narrow contact in nine specimens (i.e. NMB R829; 831, 2393, 2420, 2421, 2423, 2451, 2926, 2930). In NMB 2394 and 2449 the frontonasal is divided into two scales, the posterior of which is in narrow contact with the frontal; the same situation occurs in NMB R2421, but the posterior frontonasal is in broad contact with the frontal. In NMB R2422 the frontonasal is divided into three scales, the posterior of which is in broad contact with the frontal. Males and females usually with 6-8 femoral pores, but five pores on both thighs of NMB R2400 (male ?). Whorls of tail composed of one scale row each. Of the 36 specimens, 21 had original tails, two had regenerated tails (i.e. NMB R832, 2452) and 13 had broken/missing tails. For variation in taxonomic characters, see also Table 4.

Habitat and Ecology

Found on sandstone rocks at altitudes of 1524-1829 m a.s.l. in the north-eastern O.F.S. (De Waal, 1978, p. 56). In the Transvaal, variety "B" occurs primarily on the mountains of the eastern part of the province (Jacobsen, 1989, p. 616). This subspecies is found at altitudes of 360-2300 m a.s.l. in the Transvaal (Jacobsen, 1989, p. 616). For additional notes, see under variety "A".

Remarks

See under "variety A".

Cordylus sp. ("Waterfall") *aff. C. v. vittifer* (Reichenow, 1887) Striped Girdled Lizard

Cordylus vittifer vittifer (Reichenow, 1887): De Waal, 1978, p. 55 (part, variety "C" only); Branch, 1988a, p. 163 (part).

Range (Fig. 69)

Known only from the farm "Waterfall" in the Drakensberg mountains on the north-eastern O.F.S./Natal border.

Zoogeographical classification: Eastern Temperate Transitional.

Range cluster in O.F.S.: Drakensberg (D).

Distribution in the Orange Free State (one locality; Fig. 69).

Specimens examined from: Waterfall (NMB R...).

Features (18 specimens examined)

Largest male (NMB R4591 - Waterfall) 68 + 78 = 146 mm; one male with a regenerated tail measured 71 mm SVL.

Largest female (NMB R3077 - Waterfall) 77 + 85 = 162 mm.

Dorsum brown with scattered dark scales; occasional dark streaks on head shields (which are very rugose). A dark streak or band is present (usually continuous) from behind eye to anterior insert of hind limbs (Fig. 70). Venter cream. First transverse row of dorsals 2-5 times longer than following rows. Frontonasal in narrow (NMB R4591, 4596, 4600, 4602) and very narrow (NMB R3086) contact with frontal; a large anterior and tiny posterior frontonasal in NMB R3084, the latter contacting the frontal; frontonasal narrowly separated from frontal by prefrontals in NMB R4598. Femoral pores six or seven (five on right side of juvenile NMB R3090). Flanks without dark scales. Of the 18 specimens, nine had original, one had a regenerated and eight had broken/missing tails. For variation in taxonomic characters, see also Table 4.

Habitat and Ecology

Found in crags on scattered sandstone rocks on a grassy plateau at 1829 m a.s.l. in the north-eastern O.F.S. (De Waal, 1978, p. 56). Dietary items include scarabaeid and chrysomelid beetles and pentatomid hemipterans; females collected in July contained 1-3 well developed eggs with small or undeveloped embryos (De Waal, 1978, p. 56).

Remarks

After examining 106 *C. vittifer* from the Transvaal and Natal, De Waal (1978) found that females did not have differentiated grandular femoral scales. However, these were found in his variety "C" of *C. v. vittifer*. In his study of this species in the Transvaal, based on 472 specimens, Jacobsen (1989) noted that

glandular scales are present on the thighs in varying numbers, ranging from 12-28, but failed to indicate whether this is for males only or for both sexes. De Waal (1978) noted that variety "C" is a localized form, but "due to inadequate material from the entire range of *C. vittifer* a decision to separate variety "C" as a subspecies or even allopatric species would at this stage be premature". De Waal (1978, p. 58) noted that some Transvaal and Natal specimens, treated by him as variety "B", had faint dark lateral stripes, and such specimens are included in Jacobsen's (1989, p. 610) colour phase "b" of *C. v. vittifer*. In the "Waterfall" specimens, the lateral stripe is dark and very distinct, and together with the presence of glandular femoral scales in females, and the isolated habitat of the population, I am led to believe that this population represents a distinct and allopatric species closely related to *C. v. vittifer*. The last-mentioned species was not recorded from the Natal Drakensberg by Bourquin & Channing (1980), and variety "C" was not recorded from the Transvaal by Jacobsen (1989).

Genus: *Pseudocordylus* A. Smith, 1838

Pseudocordylus melanotus melanotus (A. Smith, 1838) Drakensberg Crag Lizard

Cordylus (Pseudocordylus) melanotus A. Smith, 1838, *Ann. Mag. nat. Hist.*, (2), 2, p. 32. Type locality subsequently designated as hills between the main branches of the Orange River east of Philippolis, Orange Free State (Smith, 1843), but restricted to the Ficksburg district, eastern Orange Free State (De Waal, 1978, p. 59).

Pseudocordylus subviridis subviridis (A. Smith): FitzSimons, 1943, p. 467, figs 373 & 374.

Pseudocordylus melanotus melanotus (A. Smith): De Waal, 1978, p. 59; Branch, 1988a, p. 170, pl. 73.

Range

Eastern and south-eastern Transvaal, and north-eastern and south-eastern O.F.S.; possibly also northern Natal.

Zoogeographical classification: Eastern Temperate Transitional.

Range cluster in O.F.S.: Eastern (E).

Distribution in the Orange Free State (39 localities; Fig. 71)

Specimens examined from: Allanvale; Allemans Gras (TM 26229-31); Ark; Bachelors' Home; Berlin, Bethlehem (TM 50096); Berlin, Vrede; Bon Haven; Boschkloof, Harrismith; Ceylon; Elandsfontein; Falle Grange; Frazerfield; Grootkloof; Grootkrans; Harrismith (TM 11245, 47549); Jagersrus, close to Petrus Steyn (SMWN 3365); Langehoek; Lindley (TM 47285-89); Louisa's Mount; Machbela; Monontsa Pass; Mooigelegen; Mooihoek, Harrismith; Mooihoek, Lindley (TM 54769); Morgenzon, Harrismith; Morgenzon, Senekal; Oever; Parva Sed Mea; Petrus Steyn (SMWN 3366); Platberg

Mountain, Harrismith (NMB; TM 55319, 54338); Rambouillet; Reitz (NMZB-UM 10933); Stoffelfontein; Sweetwaters; Tafelberg; Tygerfontein; Uitvlugt; Waterfall; Wodehousekop, GGHNP; Sentinel.

Features (213 specimens examined: 91 males, 109 females, one unsexed adult, 12 juveniles [smallest 56,5 mm SVL; largest 66,5 mm SVL])

Largest male (NMB R1446 - Langehoek) 142 + 175 = 317 mm; another male (NMB R1479 - Bachelor's Home) 136 + 201 = 337 mm; NMB R6311 (Mooihoek) measured 133,3 + 181,1 = 314,4 mm and had a mass of 66,2 g.

Largest female (NMB R3079 - Waterfall) 131 + 170 = 301 mm; NMB R6322 (Louisa's Mount) measured 120,7 mm SVL (tail broken) and had a mass of 38,0 g.

Dorsum of male grey with broad black longitudinal band which extends onto base of tail; the band may have a few light spots or is similar to that of females, but with more dark than light markings; laterally immaculate grey or with dark stripes or blotches, but usually yellow, orange or reddish. Dorsum of female grey with light and dark blotches. Males are stouter with more acutely triangular-shaped heads than females. Top of head with light and dark markings. Venter cream to bluish-grey. Throat with a longitudinal black band medially (sometimes with a pale median stripe); entire throat, including lower labials, may be dark. Upperside of tail with light and dark bands, especially proximally; underside of tail with light and dark banding basally, often almost entirely black, but at least the distal one-third is dark brown to black (darker than in *P. m. subviridis*). Original tails have two scale rows per whorl. In regenerated tails there is only one scale row per whorl, and regenerated tails are usually dark with a pale median stripe ventrally. Dorsum with small scales and intermixed granules. Upper row of temporal scales (usually 3-5) almost always vertically elongate, but may occasionally be similar to lower row. Frontonasal slightly broader than long and usually in contact with loreals (exceptionally separated - e.g. by nasal and prefrontal on left side of NMB R2960); frontonasal usually divided, with left side in contact with rostral in UM 10933, undivided in NMB R663, 3305, 3403, 4609; slightly to partly divided or fragmented in NMB R3052, 6276, 6299, 6234, 6235, 4238, 3404, 3401, 3303, 944, 3406 and SMWN 3365-66. Lateral scales larger than the horizontal spaces between them. According to De Waal (1978, p. 59), males have 6-9 (exceptionally five or ten) femoral pores and 1-17 differentiated glandular femoral scales (N = 81); the ranges for 24 additional males were 6-10 and 0-17 respectively. The ranges for O.F.S. specimens are thus 5-10 and 0-17 respectively. According to De Waal (1978), females have 6-9 shallow femoral pits, but in 28 additional females, the range was 6-11. NMB R3304 is intermediate between *melanotus* and *subviridis* in having an undivided frontonasal, temporals mostly a single row of elongated scales and the tail mostly pale ventrally (some barring on sides of whorls). Of the 213 specimens, 94 had original tails, 64 had regenerated tails and 55 had broken/missing tails; the ratio in males was 39:24:28, in females 48:38:23 and in juveniles 6:2:4.

Habitat and Ecology

These diurnal, strictly rupicolous cordylids are found amongst rocks and in rock crevices in the hills and mountains of the north-eastern O.F.S., up to an altitude of 2379 m a.s.l. (Monontsa Pass), with an apparently isolated population in the south-east (De Waal, 1978, p. 60). Up to six specimens (usually a female with juveniles) have been collected from one crevice in the O.F.S. Usually found singly in the Transvaal, although two or three individuals are occasionally found in the same crevice; however, a rocky outcrop may provide habitat for a family group headed by a single dominant male (Jacobsen, 1989, p. 625). The diet in the O.F.S. is composed of insects (*Smaragdesthes africana, Copris* sp., *Heleronychus* sp., *Gymnopleurus* sp., *Ontophagus* sp. (Scarabaeidae), curculionid beetles, Neuroptera larvae and Hymenoptera; and arachnids (Aranaeida) (De Waal, 1978). The reproductive cycle of this viviparous form in the O.F.S. has been studied in detail by Flemming (1992 and *in press.*), who found that the breeding cycle is distinctly seasonal, females being gravid in November and December and giving birth to 1-6 young in December and possibly also January. Clutch size increased significantly with increasing SVL (Flemming, *in press.*). According to Jacobsen (1989), 1-4 young measuring 46,0 - 48,0 + 64,0 - 65,0 = 110 - 113 mm total length, and with individual masses of 2,3 g, are born in midsummer in the Transvaal.

Remarks

The nomenclatural and taxonomic status of the three subspecies of *P. melanotus* was discussed in detail by De Waal (1978, pp. 60-61). Jacobsen's (1989) analysis of Transvaal *P. melanotus* follows De Waal's (1978) morphological and other criteria, and I have also done so for the most part here. The distribution of *P. m. transvaalensis*, as determined by Jacobsen (1989), differs from that shown in Branch (1988a, p. 170) in that eastern and south-eastern Transvaal *P. melanotus* populations are treated as *melanotus*, not *transvaalensis*, while *transvaalensis* is indicated as occurring only in the north-central Transvaal. Jacobsen (1989, p. 632) suggested that *transvaalensis* be elevated to specific rank, noting distinct differences in colour pattern and considerable variation in morphological characters between *melanotus* and *transvaalensis*.

Pseudocordylus melanotus subviridis (A. Smith, 1838) Drakensberg Crag Lizard

Cordylus (Pseudocordylus) sub-viridis A. Smith, 1838, *Ann. mag. nat. Hist.*, (2), 2, p. 33. Type locality subsequently designated as top of the high mountainous range which extends behind Kafferland and the country of Natal (Smith, 1843), i.e. Drakensberg Range (De Waal, 1978, p. 61).

Pseudocordylus melanotus subviridis A. Smith: De Waal, 1978, p. 61; Branch, 1988a, p. 170, pl. 73; Bates, 1991b, p. 154.

Range

Natal Drakensberg, north-eastern O.F.S. and Lesotho; also an isolated population on Amatola mountains in the eastern Cape Province.

Zoogeographical classification: Eastern Temperate Transitional.

Range cluster in O.F.S.: Drakensberg (D).

Distribution in the Orange Free State (four localities; Fig. 71)

Specimens examined from: Bramley's Hoek; Golden Gate Highlands National Park (NMB; TM 34618-19, 42814, 54653, 54659, 54662); Monontsa Pass; Sentinel; Wodehousekop (GGHNP).

Features (56 specimens examined: 17 males, 25 females, six other adults, eight juveniles [biggest 59,0 mm])

Largest male (NMB R4624 - Sentinel) 108 + 133 = 241 mm; another male with incomplete tail (NMB R3523 - Bramley's Hoek) measured 118 mm SVL.

Largest female (NMB R4616 - Sentinel) 95 + 116 = 211 mm.

Dorsum, venter and throat pattern similar to that of *P. m. melanotus*, but males never with a pure black, broad median band; more pale dorsal markings in both sexes. Underside of tail largely pale whitish, although the base may have barring and the distal third may be dark. Dorsum with small scales and intermixed granules. Upper row of temporal scales always elongate, much longer than lower row (when present). Frontonasal undivided, slightly broader than long and in contact with loreals (separated in NMB R662); two males have partly or largely fragmented frontonasals. Lateral scales smaller than the horizontal spaces between them. According to De Waal (1978, p. 62), males have 7-13 femoral pores and 19-34 (exceptionally 15) differentiated glandular femoral scales; the following values were determined for a sample of seven additional males: 8-10 femoral pores, 18-27 femoral scales (left thigh examined). De Waal (1978) recorded 7-10 well-developed femoral pores in females; the same range was determined for ten additional specimens, but a juvenile (NMB R6445) had 11 pores on the left side (one is very small). Of the 50 NMB specimens, 26 had original tails, 15 had regenerated tails and nine had broken/missing tails; the ratio in males was 4:9:4, females 15:6:4 and juveniles 7:0:1.

Habitat and Ecology

Found amongst rocks and in rock crevices from 1829 m a.s.l. (Bramley's Hoek) to 2622 m a.s.l. (Sentinel) in the north-eastern O.F.S. (De Waal, 1978, p. 62). An adult *P. m. subviridis* was regurgitated by a *Lamprophis guttatus* collected near Ugie at 1900 m a.s.l. in the north-eastern Cape Province (Branch, 1991a, p. 24), while another was recorded from the stomach of a *Bitis atropos* (Bourquin & Channing 1980, p. 15). Both of these snake predators occur in the O.F.S., and in the same general habitat as *P. m. subviridis*, and are probably also important enemies in the region. Females collected in August in the O.F.S. contained 2-4 partly developed embryos (De Waal, 1978, p. 62), and Broadley (1964) recorded 2-4 developing ova and four well developed embryos from April to May. Other aspects of their biology are probably similar to *P. m. melanotus*.

Pseudocordylus spinosus FitzSimons, 1947 — Spiny Crag Lizard

Pseudocordylus spinosus FitzSimons, 1947, *Ann. Natal Mus.*, 11, (1), p. 116, fig. 1, pl. 1, figs 5 & 6. Type locality: Cathkin Peak area, Drakensberg, Natal. De Waal, 1978, p. 63; Branch, 1988a, p. 171 and 1988b, p. 165 & map 69.

Range

Lower slopes (1500-2500 m a.s.l.) of the Drakensberg, from Giant's Castle in Natal to Sentinel Mountain in the north-eastern O.F.S.

Zoogeographical classification: Eastern Temperate Transitional.

Range cluster in O.F.S.: Drakensberg (D).

Distribution in the Orange Free State (one locality; Fig. 71)

Specimens examined from: Sentinel (NMB R3357, 4612-13).

Features (three males examined)

Largest male (NMB R3357 - Sentinel) 86 + 102 = 188 mm.

Dorsum dark brown to black with large white spots and streaks; flanks dark with pale vertical streaks and spots. Top of head dark with occasional light streaks. Venter white; throat with a pair of dark streaks against the lower edges of labials and another pair in the centre of the throat. Upperside of tail with light and dark markings; underside pale, but light brown if tail is regenerated. Dorsum with small, keeled scales and intermixed granules; lateral scales keeled and spinose, separated by minute granules. Parietals four, anterior pair smaller. Nasals in contact, separating rostral and frontonasal; frontonasal undivided, longer than broad and separated from loreals. The three males examined have 3-4 femoral pores; the number of pores may vary from three to four on either thigh of the same specimen, and only

NMB R4612 has four on each thigh; differentiated femoral scales 19-20 (left side) and 16-21 (right side), never equal in number on both thighs of the same animal. Of the three male specimens, one had an original tail, one had a regenerated tail and one had a broken/missing tail.

Habitat and Ecology

Rupicolous at 2439 m a.s.l. at Sentinel in the north-eastern O.F.S. (De Waal, 1978, p. 63). According to Branch (1988e), the diet consists of invertebrates such as beetles, cockroaches, crickets, ants, lepidopterous larvae and millipedes; and females give birth to 1-3 young in late summer. Branch (1988a) noted that 1-4 young are born in late summer.

Family: **LACERTIDAE** Bonaparte, 1831

Genus: *Tropidosaura* Fitzinger, 1826

Tropidosaura essexi Hewitt, 1927 — Essex's Mountain Lizard

Tropidosaura essexi Hewitt, 1927, *Rec. Alb. Mus.* 3, p. 378, pl. 22, fig. 2. Type locality: Mont aux Sources (11 500 ft), Basutoland (= Lesotho). Types in the Albany Museum, Grahamstown. Branch, 1988a, p. 147.

Range

Summit slopes of Natal Drakensberg, adjacent Lesotho and north-eastern Orange Free State.
Zoogeographical classification: Eastern Temperate Transitional.
Range cluster in O.F.S.: Drakensberg (D).

Distribution in the Orange Free State (one locality; Fig. 72)

One specimen examined from: Berlin (TM 48557).

Features (one specimen examined)

Dorsum dark brown with a pair of pale blue paravertebral stripes, and a pair of pale blue dorsolateral stripes which originate behind the head shields and extend onto the base of the tail. A pale blue lateral stripe is visible on the right side, extending from behind the armpit to the anterior hindlimb insertion. Also a short pair of pale blue stripes from posterior part of tympanic opening to forelimb insertion. Upper head shields brown-grey, unspotted. Dorsal surface of the original tail dark brown, ventral surface grey. Dorsals large, elongate, strongly keeled and imbricate. Scales on sides of neck distinctly reduced in size, smooth and granular. Ventral plates in six longitudinal series and 23 transverse series

(counted from posterior part of forelimb insertion to, but not including, the ventral plate). A single distinctly enlarged preanal plate (median scale). Gular scales small and imbricate, gular fold weakly marked across throat; collar absent. Rostral and frontonasal in broad contact. Subocular borders lip; four upper labials anterior to subocular, which is narrowed below (i.e. lower border about 40% length of upper) and there much shorter than adjoining labials. Lower labials six; five pairs of large chin shields, the first three pairs in broad contact. A single large, postnasal scale. First upper labial well separated from nostril, which is pierced between two nasals. Four supraoculars on each side, the first (most anterior) of which is very small. Three upper temporals on each side, the anterior one longer than middle one and in contact with fourth supraocular; a large, elongate shield is present anterior to tympanic opening. Femoral pores - seven on left, five on right thigh. Digits not serrated nor fringed laterally; subdigital lamellae tubercular; digits laterally compressed; 21 lamellae under 4th toe of right foot, left foot damaged. Scales on tail in regular whorls, keeled and mucronate; ventrally they are smooth basally but keeled distally - i.e. keeled virtually throughout. Scales on tibia keeled; elongate scales on upper surface of arms not keeled, but keeling may occur on scales laterally on the arms.

Habitat and Ecology

These fast-moving, apparently rare lacertids inhabit rocky grasslands and wooded, boulder-strewn valleys at altitudes of 1700-3300 m a.s.l. (Bourquin & Channing, 1980, p. 13). They forage (probably for insects) near dense vegetation along mountain streams and at the base of rock faces; females lay two eggs in summer (Branch, 1988a, p. 147).

Remarks

At the time of FitzSimons' (1943) monograph, this form was known only from Hewitt's (1927) type specimen (AM 5227) collected at Mont-aux-Sources. The O.F.S. specimen was collected by A. Harrington on 3 May 1976, but was not examined or recorded by De Waal (1978). The genus *Tropidosaura* is currently being reviewed by Dr W.R. Branch (Port Elizabeth Museum), who is of the opinion that *T. essexi* is of doubtful validity and part of the *T. montana - natalensis - rangeri* complex, all of which probably represent a single monotypic species, namely *T. montana* (W.R. Branch, pers. comm.). Dr Branch also pointed out an error in FitzSimons' (1943, p. 301) key for the genus *Tropidosaura*, namely that *essexi* also has only a single preanal plate; however, this character is very variable (W.R. Branch, pers. comm.).

Genus: *Nucras* Gray, 1838

Nucras lalandii (Milne-Edwards, 1829) Delalande's Sandveld Lizard

Lacerta lalandii Milne-Edwards, 1829, *Ann. Sci. Nat.*, 16, pp. 70 & 84, pl. 5, fig. 5. Type locality: "Cape of Good Hope". Types in the Paris Museum, Paris.

Nucras delalandii (Milne-Edwards): FitzSimons, 1943, p. 312, figs 198-200.

Nucras lalandii (Milne-Edwards): De Waal, 1978, p. 64; Branch, 1988a, p. 143, pl. 61; Bates, 1991b, p. 154.

Range

Eastern Cape Province, south-eastern and north-eastern O.F.S., western Lesotho, southern Natal and the eastern half of the Transvaal, with relict populations in the southern Cape.

Zoogeographical classification: Eastern Temperate Transitional.

Range cluster in O.F.S.: Eastern (E).

Distribution in the Orange Free State (16 localities; Fig. 73)

Specimens examined from: Bachelor's Home; Berlin; Bon Haven; Francina; Golden Gate Highlands National Park; Klipplaat; Kristalpan on Wonderhoek (1698); Machbela; Monontsa Pass; Morgenzon, Zastron; Perth; Rohallion; Tafelberg; Uitzicht; Witzieshoek (NM 1062).

Other records: Rouxville (FitzSimons, 1943).

Features (24 specimens examined)

Largest male (NMB R3320 - Monontsa Pass) 76 + 173 = 249 mm.

Largest female (NMB R3057 - Bon Haven) 107 + 205 = 312 mm.

Dorsum grey-brown with dark spots having pale centers, but pale centers absent in three specimens (i.e. NMB R277, 3057 and 5471). The dorsal pattern generally extends onto the tail and limbs. Juveniles (NMB R750, 3096) have eight somewhat irregular rows of large, white, black-edged spots on the back; these rows are most distinct in subadults. Black and white vertical bars present on sides of head and neck. Venter and most of underside of throat, limbs and original tail are white, usually with heavy (sometimes sparse) black spotting (big and small spots). Ventral spots always present, but may be less intensively distributed and smaller in size (e.g. NMB 2405, R2691); however, at least the first two longitudinal scale rows on either side are always heavily spotted. Dorsals small, smooth and juxtaposed. Transversely enlarged plates under forearm absent or poorly developed. Digits not serrated nor fringed laterally; subdigital lamellae smooth; scales on soles of feet rounded and smooth. Subocular borders lip; nostril pierced between two (seven specimens) or three (16 specimens) nasals and well separated from the first upper labial. Of the 23 NMB specimens, 16 had original tails, five had regenerated tails and two had broken/missing tails.

Habitat and Ecology

N. lalandii is a large, terrestrial, highveld-to-montane grassland species (Jacobsen, 1989, p. 444). It has been found in burrows under rocks or in the ground in sheltered spots in the O.F.S. (De Waal, 1978, p. 64). Also found under stones in open grassland (Branch, 1988a, p. 143). The diet consists of beetles, orthopterans and insect larvae (FitzSimons, 1943, p. 315), as well as spiders (Branch, 1988a, p. 143). A specimen was recovered from the stomach of a Cross-marked Sand Snake *Psammophis crucifer* collected in the O.F.S. (De Waal, 1978, p. 65). Bourquin & Channing (1980, p. 13) recorded a specimen from the stomach of an Egyptian Mongoose *Herpestes ichneumon*. One O.F.S. female laid nine eggs measuring 14 x 9 mm in October while in captivity, and eight eggs measuring 16 x 13 mm were collected from under a rock at Bon Haven in January, which hatched in February, one hatchling measuring 34 + 54 = 88 mm total length (De Waal 1978, pp. 64-65). In the Transvaal, 3-9 eggs measuring 18,5 - 21,0 x 12,0 - 14,5 mm and weighing 1,5-1,8 g are laid in midsummer and hatch mainly in February or March; hatchlings measure 30,0 - 36,0 + 50,0 - 56,0 = 80,0 - 92,0 mm total length with masses of 0,40-0,42 g (Jacobsen, 1989). According to FitzSimons (1943, p. 315), however, only four eggs are laid, in midsummer, and hatchlings measure only 20-25 mm SVL. Yeadon (1991b, p. 22) reported on a record-sized female of 97 + 214 = 311 mm total length from Nottingham Road, Natal, which laid seven eggs on 28 October; and another female from Highmoor (Natal) was found (26 November) with a clutch of seven eggs (16 x 11 mm) which were in a "chamber off a tunnel in the soil beneath the rock." These eggs hatched on 18 January and the hatchlings fed on termites the following day. Boycott (1990, p. 50) reported on a female (98 + 186 = 284 mm total length) from Malolotja Nature Reserve in Swaziland which was collected on 5 October under a large granite slab together with nine eggs measuring 12-14 x 9-10 mm; four of these hatched after 265 days at fluctuating temperatures, producing hatchlings of 74,7-78,0 mm total length. Branch (1988a, p. 143) noted that 4-9 eggs measuring 9-13 x 14-16 mm are laid in a chamber dug under a stone in early summer, hatchlings measuring 70-90 mm.

Remarks

Van Reenen was given as an O.F.S. locality by De Waal (1978, p. 65), but as it is in Natal (see Boulenger, 1917), it has not been listed or plotted here.

Nucras intertexta (A. Smith, 1838) Spotted Sandveld Lizard

Lacerta intertexta A. Smith, 1838, *Ann. Mag. nat. Hist.*, 2(2), p. 93. Type locality: "Country near Latakoo". Types in the British Museum of Natural History, London.

Nucras intertexta intertexta (A. Smith): Broadley, 1972.

Nucras intertexta (A. Smith): De Waal, 1978, p. 65; Branch, 1988a, p. 142, pl. 60.

Range

From the Kaokoveld of northern Namibia south-westerly through the southern half of Botswana and Kalahari of northern Cape Province, then southwards through the extreme south-western Transvaal and western half of the O.F.S. and eastwards through central and northern Transvaal, southern Zimbabwe and southern Mozambique.

Zoogeographical classification: Western Tropical Transitional.

Range cluster in O.F.S.: Non-Northeastern (Non-NE).

Distribution in the Orange Free State (11 localities; Fig. 73)

Specimens examined from: Houmoed; Inglewood; Lake Warden; Mimosa; Onze Rust; Poortje, Edenburg; Strijdfontein, Philippolis.

Other records: Boshof (Broadley, 1972); Odendaalsrus (TM 16731-32); Willem Pretorius Game Reserve (TM 27300); Winburg (TM 22007).

Features (eight specimens examined)

Largest male (NMB R1562 - Strijdfontein, Philippolis) 74 + 162 = 236 mm.

Largest female (NMB R1120 - Onze Rust) 84 + 178 = 262 mm.

Dorsum grey-brown with a series of black-edged pale spots in 3-5 longitudinal rows; the black areas around the spots are sometimes confluent. The shape and size of individual dorsal markings varies considerably, although the basic pattern is similar. Laterally, there are vertically elongated pale markings with distinct black borders. One juvenile (NMB R2091) has almost entirely black flanks with vertically elongated pale markings. Dorsal scales small, smooth and juxtaposed. Digits not serrated nor fringed laterally; subdigital lamellae tubercular. Subocular bordering lip. Nostril pierced between three nasals in all but NMB R2091 (Mimosa), in which it is pierced between two nasals (both sides of head). A series of transversely enlarged plates present under forearm. Ventral surfaces unspotted and white. NMB R1117 was used in a clearing-and-staining procedure and was not examined in detail. Of the other seven specimens, four had original tails, one (NMB R6661) had a regenerated tail (regenerated near tip of tail and paler in colour than rest of tail) and two had missing/broken tails.

Habitat and Ecology

These cursorial, diurnal, terrestrial lacertids are found in the arid sandveld of the western half of the O.F.S., where they have burrows under *Zizyphus mucronata* bushes or under stones (De Waal, 1978, p. 66). The diet of O.F.S. specimens includes Insecta: Lagriidae and Scarabaeidae (Coleoptera), Gryllidae (Orthoptera); lepidopterous larvae; and Myriapoda: Scolopendridae (Chilopoda) (De Waal, 1978). Jacobsen (1989, p. 453) also recorded Araneae and noted that the tail of another large lacertid was found in the stomach of a Transvaal lizard. A lizard from Botswana was found in the crop of a Secretarybird *Sagittarius serpentarius* (Broadley, 1966, p. 242). According to FitzSimons (1943, p. 320), females lay four eggs measuring 12,5 - 12,8 x 7,5 - 8,3 mm. Jacobsen (1989) recorded 2-8 eggs being laid in midsummer in the Transvaal, and noted that the smallest specimen, collected in March, measured 31,0 mm SVL (mass = 0,6 g), thus suggesting that it hatched in February.

Remarks

Broadley (1972) and Jacobsen (1989, p. 453) noted that much variation occurs in colour pattern in this species. However, all O.F.S. specimens have the general appearance of the specimen illustrated in Broadley's (1972) Fig. 2.

Nucras taeniolata holubi (Steindachner, 1882) Lined Sandveld Lizard

Eremias holubi Steindachner, 1882, *Sitz. Ak. Wien.*, 86, p. 83, pl. Type locality: Valley of the Crocodile (Limpopo) River, Transvaal (Broadley, 1972, p. 13).

Nucras tessellata var. *holubi* (Steindachner): Boulenger, 1910, p. 474.

Nucras intertexta var. *holubi* (Steindachner): Boulenger, 1917, p. 208.

Nucras tessellata (not A. Smith, 1838): Boulenger, 1917, p. 212.

Nucras intertexta holubi (Steindachner): FitzSimons, 1943, p. 320 (part, Jacobsdal; Odendaalsrus).

Nucras taeniolata ornata (not Gray, 1864): De Waal, 1978, p. 66; Branch, 1988a, p. 143, pl. 60 (part).

Nucras taeniolata holubi (Steindachner): Jacobsen, 1989, p. 457, map 69.

Range

Northern Cape Province, O.F.S. (excluding the north-east), Transvaal (excluding the south-east), northern Natal, eastern Botswana, Zimbabwe, central Mozambique, Zambia and Malawi, with an isolated population in northern Namibia.

Zoogeographical classification: Eastern Tropical Transitional.

Range cluster in O.F.S.: Non-Northeastern (Non-NE).

Distribution in the Orange Free State (41 localities; Fig. 74)

Specimens examined from: Basberg; Bethel; Bloemfontein; Chubani; Geluk, Boshof; Florisbad; Haagen's Stad; Heenenweerskop; Houtkop; Kafferskop; Klipplaatdrift, Winburg; Kraaifontein; Kromrant; Krugersdrift Dam; Leeuwkop; Leliehoek; Magdalen; Middenspruit; Mount Nelson; Odendaalsrus (TM 16731-32); Platrand; Poortje, Edenburg; Quaggaspruit; Slangheuvel; Smithfield (SAM 13983); Spijtfontein; Susannasfontein; Sweet Home; Triangle; Uitkijk; Uitkomst; Van der Walt's Rust; Vergaderrand; Weltevrede; Winburg (TM 22007); Willem Pretorius Game Reserve (TM 27300); Winterspoort; Zoutpan, Fauresmith; 19 km from Theunissen on Bultfontein Road.

Other records: Vredefort Road; Orange River Colony (Boulenger, 1917); Jacobsdal (FitzSimons, 1943).

Features (86 specimens examined)

Largest male (NMB R2807 - Chubani) 53 + 102 = 155 mm.

Largest female (NMB R361 - Krugersdrift Dam) 64 + 104 = 168 mm.

Dorsum brown with three continuous pale stripes in addition to a pair of more often broken pale stripes on flanks. Two pale stripes extend onto the head, and sometimes the median stripe is present as a spot; in juveniles the median usually forks into two short stripes; the median stripe extends onto the base of the tail, whereas the other two central stripes extend onto the first half of the tail; dorsolateral and usually also lateral stripes may be continuous, wavy, partially broken or present as a series of pale spots or blotches; dorsolateral and lateral stripes extend from behind the upper and lower parts of the ear opening respectively, and reach the base of the tail; there may be additional white spots or blotches on the flanks; the area between the three central stripes is a lighter brown than the rest of the back. Top of head brown with small pale flecks. Dorsal scales small, smooth and juxtaposed; dorsal scales of tail are keeled. A series of 7-10 (usually 8-9) transversely enlarged plates present on inside lateral surface of (right) forearm (Table 5). Ventral surfaces white and unspotted, but the first lateral row of ventral plates has large to medium-sized brown spots and the second row usually has small to medium-sized brown spots (but only the first row spotted in NMB R852-854 [juveniles], 359, 364 and 1033). Digits not serrated nor fringed laterally; subdigital lamellae tubercular; soles of feet rounded and smooth. Subocular borders lip; lower border of subocular more than half length of upper (less than half in NMB R4075 only). Nostril usually pierced between three nasals, but pierced between two nasals in NMB R3701, 5591, 5632; when pierced between three nasals, the anterior one is about as large as the other two nasals put together; nostril well separated from first upper labial. Number of granules between superciliaries and supraoculars varies from two to ten (usually 5-6) (Table 6). NMB R3605 is a decapitated specimen which has been included in the sample. Out of 85 specimens, 63 had original tails, eight had regenerated tails and 14 had broken/missing tails.

Habitat and Ecology

This fast-moving, diurnal, terrestrial lacertid is found on rocky flats with at least some loose rocks, or in open veld with scant vegetation where they usually have burrows under isolated loose rocks (De Waal, 1978, p. 67); also found in open grassland at Florisbad. Jacobsen (1989, p. 458) recorded two Transvaal specimens thermoregulating about 45 cm above ground level; one specimen was hanging by its hindfeet. The diet in the O.F.S. consists of coleopterans (Tenebrionidae, Curculionidae, Chrysomelidae) and isopterans (workers only) (De Waal, 1978). Broadley (1966, p. 245) recorded a scorpion

(*Buthus* sp.) from one stomach, and Jacobsen (1982, p. 111) added Dictyoptera to the list. A Brown House Snake *Lamprophis fuliginosus* from the O.F.S. contained a *N. t. holubi* in its stomach (De Waal, 1978) and Broadley (1966) recorded specimens from the stomachs of the nocturnal snakes *Calamelaps unicolor miolepis* (= *Amblyodipsas p. polylepis*) and *Atractaspis bibronii* in Zimbabwe. A female collected in October in the O.F.S. contained five small eggs (De Waal, 1978). In the Transvaal, 1-7 (usually four or five) eggs are laid in midsummer; the smallest specimens collected measured 27,0-28,5 mm SVL and had masses of 0,3-0,5 g (Jacobsen, 1989).

Remarks

Broadley (1972) reviewed the *Nucras tessellata* complex in southern Africa and distinguished the two subspecies of *N. taeniolata* by the number of pale longitudinal stripes on the dorsum, namely 8-11 in *N. t. taeniolata* and seven in *N. t. ornata*. *N. t. taeniolata* has a relict distribution and is known from only three localities in the eastern Cape Province, i.e. Bushman's River; Grahamstown (Broadley, 1972, p. 13) and Addo Elephant National Park (Branch, 1990a, p. 31). Broadley (1972) discussed two varieties or morphs of *N. t. ornata*, namely *ornata* and *holubi*. The diagram of the *holubi* variety in his Fig. 5 conforms to the appearance of O.F.S. specimens examined, as does the specimen illustrated in Plate 40 of Pienaar *et al.* (1983, p. 103). The ten O.F.S. specimens examined by Broadley (1972) were included as part of a western population of *N. t. ornata*, with maximum SVL of 56-76 mm and retention of the *holubi* dorsal pattern throughout life. The *ornata* morph differs from *holubi* is that the sides of the neck are barred and not striped or spotted (see Fig. 5 & pl. 1 in Broadley, 1972, p. 8). Broadley (1972) therefore treated *N. t. ornata* as a polytypic subspecies, having noted cases of sympatry and parasympatry. Jacobsen (1989, p. 459) also reported cases of sympatry and parasympatry in the Transvaal, and noted that what he regarded as the *ornata* morph was much larger than the *holubi* morph, with *ornata* juveniles having a different colour pattern, as did most adults. The greatest SVL of *ornata* of each sex measured by Jacobsen (1989, p. 462) were 84,0 mm (male) and 94,0 mm (female), while his largest *holubi* were 66,5 mm (male) and 73,0 mm (female). The largest O.F.S. *N. t. ornata* (= *N. t. holubi*) measured by De Waal (1978, p. 67) were 53 mm SVL (male) and 64 mm SVL (female). Tables 5 & 6 provide a comparison between the number of transversely enlarged plates under forearm, and number of granules between superciliaries and supraoculars, in *N. t. holubi* and *N. ornata* from the O.F.S. (this study) and Transvaal (Jacobsen, 1989). Table 5 indicates that O.F.S. *N. t. holubi* are intermediate between Transvaal *N. t. holubi* and *N. ornata* with respect to the number of enlarged plates under forearm, but O.F.S. and Transvaal *holubi* both show distinct separation from *N. ornata* with respect to the number of granules between superciliaries and supraoculars (Table 6). Considering their *holubi* colour pattern and the data presented in Tables 5 & 6, O.F.S. populations are here treated as *N. t. holubi*. Jacobsen (1989) observed only one intergrade, from between Pretoria and Krugersdorp, and contended that two distinct taxa were involved; he treated *N. ornata* as a distinct species and *holubi* as a widespread northern subspecies of *N. taeniolata*. Jacobsen (1989, p. 464) did, however, note that much difficulty is endured in separating some individuals, although "in appearance they can be separated with 95% accuracy". A nomenclatural problem that remains unresolved, however, is whether it is *holubi* or *ornata* that is conspecific with typical *taeniolata*, of which an isolated population occurs in the eastern Cape Province.

Table 5: Number of transversely enlarged plates under one forearm of two species of *Nucras*; for Transvaal samples, see Jacobsen (1989, p. 439).

	2	3	4	5	6	7	8	9	10	11	12	13
Nucras taeniolata holubi (O.F.S.)	0	0	0	0	0	4	39	33	1	0	0	0
Nucras taeniolata holubi (Tvl)	1	1	5	27	50	47	29	7	6	1	1	0
Nucras ornata (Tvl)	0	0	0	3	3	8	12	10	12	7	4	1

N. t. holubi (O.F.S. in NMB collection)	N = 77;	mean = 8,40;	93,0% have 8 - 9; mode = 8/9
N. t. holubi (Tvl)	N = 175;	mean = 6,67;	87,4% have 5 - 8; mode = 6/7
N. ornata (Tvl)	N = 60;	mean = 8,88	81,7% have 7 - 10; mode = 8/10

Table 6: Number of granules between supraciliaries and supraoculars in two species of *Nucras*; for Transvaal samples, see Jacobsen (1989, p. 439).

	0	1	2	3	4	5	6	7	8	9	10
Nucras taeniolata holubi (O.F.S.)	0	0	1	0	4	24	23	11	7	2	2
Nucras taeniolata holubi (Tvl)	0	0	3	12	17	49	70	22	2	1	0
Nucras ornata (Tvl)	1	1	12	26	13	6	0	0	0	0	0

N. t. holubi (O.F.S. in NMB collection	N = 74;	mean = 6,04;	87,0% have 5 - 8; mode = 5/6
N. t. holubi (Tvl)	N = 176;	mean = 5,42;	96,6% have 3 - 7; mode = 6
N. ornata (Tvl)	N = 59;	mean = 3,15	96,6% have 2 - 5; mode = 3

Genus: *Pedioplanis* Fitzinger, 1843

Pedioplanis namaquensis (Duméril & Bibron, 1839) Namaqua Sand Lizard

Eremias namaquensis Duméril & Bibron, 1839, *Erp. Gen.*, V, p. 307. Type locality: "Namaqualand". Types in the British Museum of Natural History, London. De Waal, 1978, p. 146.

Pedioplanis namaquensis (Duméril & Bibron): Branch, 1988a, p. 146, pl. 57.

Range

Eastern Cape Province northwards through the Karoo (including south-western O.F.S.), Namaqualand, Namibia, southern Angola and Botswana.

Zoogeographical classification: Western Temperate Transitional.

Range cluster in O.F.S.: Southwestern (SW).

Distribution in the Orange Free State (seven localities; Fig. 72)

Specimens examined from: Heilbron, Philippolis; Kalkfontein Dam; Kalkplaat; Lemoenboord; Lentelus; Luiperskop; Poortje, Fauresmith.

Features (25 specimens examined)

Largest male (NMB R783 - Kalkplaat) 59 + 137 = 196 mm.

Largest female (NMB R1150 - Lentelus) 50 + 108 = 158 mm.

Dorsum dark to medium-dark brown, usually with 6 or 7 distinct white stripes which barely extend onto the tail. The three median stripes are close-set and this area is often of a lighter brown than the rest of the dorsum. Lateral stripes may be present in the form of closely spaced, usually confluent spots. Upper surfaces of hind limbs black with white spots. The vertebral median stripe may fork on the nape. Venter cream or bluish; underside of tail cream. Dorsals granular and smooth. Digits not serrated nor fringed laterally; subdigital lamellae keeled. Collar well-marked and straight; gular fold faintly to distinctly indicated. Head shields smooth or slightly rugose (e.g. NMB R4367; 4587). Subocular bordering lip. Ventral plates in 8-12 (usually ten) longitudinal series. No upper temporal shield; narrow tympanic shield on upper anterior border of ear opening (formed by two slightly elongated shields in NMB R4785). Lower eyelid semi-transparent. Of the 24 specimens, eight had original tails, four had regenerated tails and 12 had broken/missing tails. Specimen NMB R1179 was used in a clearing-and-staining procedure and was not examined in detail. Tails were regenerated from points throughout their length, and regenerates were of a lighter brown colour than the original tail.

Habitat and Ecology

Found on hard ground with scant vegetation, where they construct burrows (De Waal, 1978, p. 69). Individuals remain dormant in their burrows during winter; the burrows are usually at the base of bushes (Branch, 1988a, p. 146). Females lay 3-5 eggs in November (Branch, 1988a), and De Waal (1978) recorded an O.F.S. female, collected in November, which contained three well developed eggs. The diet consists of dermapteran insects and arachnids (De Waal, 1978). According to FitzSimons (1943, p. 335), the habits of *P. namaquensis* are very similar to those of *P. lineoocellata*.

Remarks

Bocage's (1896) record of "Modder River" (not plotted in Fig. 72) was given as a literature record for the O.F.S. by De Waal (1978, p. 69). However, if this locality is the same as the "Modder River Stn (= Station)" locality given by FitzSimons (1943), it is situated just west of the O.F.S. border near the junction of the Modder and Riet rivers in the northern Cape Province.

Pedioplanis lineoocellata lineoocellata (Dumeril & Bibron, 1839) Spotted Sand Lizard

Eremias lineo-ocellata Dumeril & Bibron, 1839, *Erp. Gen.*, 5, p. 314. Type locality: South Africa. Types in the British Museum of Natural History, London. Hewitt, 1910, pp. 109 & 113; Boulenger, 1910, p. 477; Hewitt & Power, 1913, p. 156; Boulenger, 1918, p. 289.

Eremias lineo-ocellata pulchella part, Gray, 1845: FitzSimons, 1943, p. 341.

Eremias lineoocellata lineoocellata Dumeril & Bibron: De Waal, 1978, p. 69.

Pedioplanis lineoocellata lineoocellata (Duméril & Bibron): Branch, 1988a, p. 145, pl. 59.

Range

Namibia (excluding the west and north-east), Botswana, Transvaal (excluding the east and south-east), northern Cape Province and central and southern O.F.S.; absent from Namib Desert and central Kalahari.

Zoogeographical classification: Western Temperate Transitional.

Range cluster in O.F.S.: Southern (S).

Distribution in the Orange Free State (47 localities; Fig. 75)

Specimens examined from: Alpha; Avalon; Babel; Bergkloof; Bloemfontein; Ceylon; Chubani; Cornwall; Doornplaat; Francis Home; Geluk, Philippolis; Hebron; Heenenweerskop; Kleinplaas; Klipbankfontein; Koortshoek; Koppiesdam; Kraaifontein; Kranskop; Lemoenboord; Lessingskop; Littlecote; Matjesfontein; Middelbron; Rietfontein, Rouxville; Rorich's Hulp; Spitzkop; Strijdfontein, Philippolis; Table Farm; Thaba 'Nchu; Tienfontein; Vaalkop; Vissershoek West; Waterhoek; Weltevrede; Wolvekop, Fauresmith.

Other records: Smithfield (Boulenger, 1910); Emmaus (Hewitt & Power, 1913); Vredefort Road (Boulenger, 1921); Fauresmith; Kroonstad; Meadows (FitzSimons, 1943); Bothaville; Brandfort; Willem Pretorius Game Reserve (De Waal, 1978; TM specimens); Uitkyk (TM 41494).

Features (120 specimens examined)

Dorsum grey-brown with more or less linear series of white, black-edged spots and a series of blue, black-edged spots on the flanks; a pale dorso-lateral and/or lateral (wider) pale stripe usually present. Scattered black patches/spots often present on dorsum; upper surfaces of limbs grey with pale spots. NMB R2224 has numerous bluish blotches on body. Dorsal scales small and keeled (occasionally more or less granular), rhombic and subimbricate. Venter and underside of tail usually white, although venter may be bluish; and faint indications of grey are present on the throat of a few specimens. Digits not serrated nor fringed laterally; subdigital lamellae keeled. Collar well marked and straight; faintly indicated gular fold present. Head shields usually rugose, sometimes very much so, but fairly smooth in NMB R1261 (Bergkloof), 1293 (Kraaifontein) and 2197 (Wolwekop). Scales on back (especially posteriorly) as large, or nearby as large, as scales on tibia. No upper temporal shield; no tympanic

shield. Lower eyelid with a large transparent disc, formed by two large, black-edged scales. Scales on anterior border of ear opening seldom clearly differentiated into lobules, but if so, about 3-6 are present. Specimen NMB R4695 was used in a clearing-and-staining procedure and was not examined in detail. Of the 120 specimens, 51 had original tails, 15 had regenerated tails and 54 had missing/broken tails.

Habitat and Ecology

This active, diurnal, terrestrial species is found in sandy areas or rocky flats with scattered rocks and scant vegetation in the O.F.S. (De Waal, 1978, p. 70). In the Transvaal, they are found in both calcrete and sandy substrates in open scrub and wooded sandveld areas (Jacobsen, 1989, p. 482). According to Branch (1988a, p. 145), *P. lineoocellata* (subspecies not specified) are active even on warm winter days, and shelter in a small burrow dug beneath a flat rock. The burrows are shallow and may be constructed among the roots of small shrubs (FitzSimons, 1943, p. 341). De Waal (1978) recorded tenebrionid beetles, and both worker and soldier isopterans, as part of the diet of O.F.S. specimens. According to FitzSimons (1943), the diet consists mainly of diurnal termites, but ants, small beetles and grasshoppers are also taken. Branch (1988a, p. 145) stated that the species preys on beetles and locusts during summer, while termites are the main prey during winter. Females in the O.F.S. lay 4-8 eggs measuring 10 x 6 mm in February (De Waal, 1978). FitzSimons (1943) stated that about six eggs are laid in early summer, whereas Branch (1988a, p. 146) noted that 4-8 eggs measuring 12-13 x 9-10 mm are laid in November in a small chamber dug in moist soil under a rock; the eggs hatch after 70-80 days, in February, and hatchlings measure 50-55 mm. Jacobsen (1989) recorded 6-9 eggs laid during midsummer in the Transvaal. Baard (1987, pp. 34-35) observed mating between two captive specimens during late October, and noted that towards the end of November the female dug a burrow about 6 cm deep, but died before depositing her clutch.

Remarks

FitzSimons (1943) treated *Eremias pulchella* Gray, 1845 as a subspecies of *E. lineoocellata* Dumeril & Bibron, 1839, from which it differed in the followed characters: dorsal scales over posterior part of back much smaller than scales on tibia, granular, juxtaposed and not or but feebly keeled. De Waal (1978, p. 70) noted that these characters were included in the range of *lineoocellata* in the O.F.S., and he could not separate the two forms in the province. Jacobsen (1989, p. 487) later commented on the similarity in the habitat of *P. l. pulchella* in the Transvaal and De Waal's (1978) habitat description for *P. l. lineoocellata* in the O.F.S. Jacobsen (1989) also stated that "He [De Waal, 1978] did not notice that the head shields of *pulchella* are largely smooth as opposed to notably rugose in typical *lineoocellata*". My examination of 120 specimens from the O.F.S. indicated that the posterior dorsals are moderately keeled and as large, or nearly as large, as scales on tibia; and the head shields were almost always distinctly rugose, being fairly smooth (not distinctly smooth) in only three specimens. I therefore conclude that O.F.S. material is referrable to *P. l. lineoocellata*.

Pedioplanis burchelli (Dumeril & Bibron, 1839) Burchell's Sand Lizard

Eremias burchelli Dumeril & Bibron, 1839, *Erp. Gen.*, 5, p. 303. Type locality: "South Africa". Types in the British Museum of Natural History, London. Bocage, 1896, p. 117; Boulenger, 1910, p. 477; FitzSimons, 1943, p. 346, figs 226-228; De Waal, 1978, p. 71.

Pedioplanis burchelli (Dumeril & Bibron): Branch, 1988a, p. 144, pl. 59; Bates, 1991b, p. 154.

Range

From Cape Agulhas in the south-western Cape Province, through the Cape Fold mountains and inland Cape escarpment, eastern half of the O.F.S., Lesotho and south-eastern Transvaal, with one locality (Little Switzerland) in the Natal Drakensberg.

Zoogeographical classification: Cape Temperate.

Range cluster in O.F.S.: Eastern (E).

Distribution in the Orange Free State (37 localities; Fig. 75)

Specimens examined from: Bachelor's Home; Bon Haven; Boschkloof; Bramley's Hoek; Caledonspoort; Dipka; Elandsfontein; Frazer Spruit; Frazerfield; Golden Gate Highlands National Park; Groenland; Kranskop; Lange Hoek; Leeuwfontein, Theunissen; Machbela; Mecklenburg; Monontsa Pass; Mooigelegen; Morgenzon, Ficksburg; Morgenzon, Harrismith; Oever; Perth; Rietfontein, Vrede; Sedan; Verdun, Fouriesburg; Verdun, Ladybrand; Waterval, Winburg; Welgegund; Wittepoort; Zomervlakte.

Other records: Berlin (TM 48554-55); Brandwag Kop (TM 57394, 57431); Clarens (TM 65272); Harrismith (TM 11246); Maghaleen (TM 38242); Ngotswane Gorge (TM 65282, 65288, 66154); Trentham (TM 48551).

Features (165 specimens examined)

Largest male (NMB R3311 - Monontsa Pass) 63 + 119 = 182 mm.

Largest female (NMB R1438 - Oever) 66 + 108 = 174 mm.

Dorsum grey with light as well as dark spots; pale spots may be in more or less linear series. The extent of dark and pale markings is extremely variable. A pale dorso-lateral stripe is often present from behind upper labials, through tympanum to anterior hindlimb insertion. Upper parts of limbs with pale spots (very prominent in juveniles) which may have dark borders; dark spots may also be present. Top of head of adults with several dark spots. Juveniles dark brown to black dorsally with six or seven pale longitudinal dorsal stripes; a pale, fork-like marking is often present anteriorly. Venter and underside of tail white; two or three lateral ventral scale rows often with dark spots. Dorsal scales small, juxtaposed and granular; occasionally somewhat flattened and closely-spaced in large specimens. Digits not serrated nor fringed laterally; subdigital lamellae of feet keeled; soles of feet spinose, although less

typically so in some specimens, and non-spinose in NMB R5473 (Golden Gate Highlands National Park). Collar well marked and straight; faintly to moderately distinct gular fold present. No upper temporal shield; no distinct tympanic shield, although a somewhat enlarged scale resembling a "tympanic shield" is present in a few specimens. Lower eyelid opaque; subocular borders lip. Specimen NMB R3313 was used in a clearing-and-staining procedure and was not examined in detail. Of the 165 specimens, 89 had original tails, 30 had regenerated tails and 46 had broken/missing tails. Regenerated tails are a lighter, more brownish colour than originals, and may grow from near the base to near the tip of the tail. NMB R1015 (Verdun) had an original tail which appeared to have been injured about half-way down its length, from where a regenerate had grown (i.e. bifurcated tail).

Habitat and Ecology

This diurnal, primarily rupicolous lacertid is usually found on mountain slopes and plateaux up to an elevation of 2378 m a.s.l. in the O.F.S., usually on rocky flats with scant vegetation and scattered loose rocks and stones (De Waal, 1978, p. 72). Up to five adult *P. burchelli* have been found together under one stone in the eastern O.F.S. According to FitzSimons (1943, p. 348), this species inhabits open grassy hillsides and mountain slopes, but has also been recorded near the summit of the Drakensberg. According to Branch (1988a, p. 145), it shelters in a small chamber (in which it hibernates) excavated in soil under a flat rock; it exhibits a sit-and-wait hunting strategy, dashing from behind rocks to catch small insects. Prey items in the O.F.S. include beetles (Scarabaeidae [*Ontophagus* sp.], Tenebrionidae, Curculionidae) and lepidopterous larvae (De Waal, 1978). Gravid females collected in December in the O.F.S. contained 2-6 well-developed eggs measuring 15 x 10 mm; eggs were laid in damp situations beneath rocks and hatched in February and March; one hatchling measured 25 + 41 = 66 mm total length (De Waal, 1978). Jacobsen (1989, p. 491) recorded three "somewhat dehydrated" eggs, laid by a Transvaal female, which measured 11,0 - 12,0 x 6,0 - 7,0 mm, and noted that juveniles measuring 29,0-32,0 mm (mass = 0,45-0,65 g) were collected in April. A female from the Karoo National Park laid five eggs measuring 11,4 - 13,0 x 7,5 - 8,8 mm in January in captivity; four of these eggs hatched 64 days after being incubated at 21-29°C, hatchlings measuring 25-26 + 48-52 = 73-78 mm total length and weighing 0,4-0,5 g (Branch, 1988f, p. 39). According to Branch (1988a, p. 145), 4-6 oval-shaped eggs measuring 9-13 x 7,5-10 mm are laid in moist soil under a rock slab in December or January; these hatch after 60-70 days (February - March), hatchlings measuring 66-78 mm.

Genus: *Ichnotropis* Peters, 1854

Ichnotropis squamulosa Peters, 1854 Common Rough-scaled Lizard

Ichnotropis squamulosa Peters, 1854, *Mber. dt. Akad. Wiss. Berl.*, p. 617 and 1855, *Arch. Naturg.*, 1, p. 46. Type locality: Tete, Mozambique. Types in the Berlin Museum, Berlin. FitzSimons, 1943, p. 350, figs. 229-231; De Waal, 1978, p. 72; Branch, 1988a, p. 139, pl. 61.

Range

Northern Zululand, southern Mozambique, Swaziland, Transvaal (excluding the south and south-east), extreme north-western O.F.S., northern Cape Province, Botswana, north-eastern Namibia, southern Angola, Malawi, Tanzania, Zambia, Zimbabwe and central Mozambique.

Zoogeographical classification: Western Tropical Transitional.

Range cluster in O.F.S.: Northwestern (NW).

Distribution in the Orange Free State (two localities; Fig. 72)

One specimen examined from: Van Aswegenshoek (NMB R2073).

Other records: Bothaville (FitzSimons, 1943).

Features (one male examined)

Largest specimen, a male (NMB R2073 - Van Aswegenshoek) 67 + 130 = 197 mm.

Dorsum brown with paravertebral longitudinal series of white spots and two such rows on each flank. Undersides cream. Digits not serrated nor fringed laterally; subdigital lamellae keeled. No collar or gular fold visible. Dorsals large, imbricate and strongly keeled. Head shields striated and keeled. Subocular excluded from lip. Frontonasal divided longitudinally. One small occipital. Tail original.

Habitat and Ecology

The Van Aswegenshoek specimen was collected in sandveld with scattered rocks (De Waal, 1978, p. 73). According to FitzSimons (1943, p. 352), this large, fast-moving, diurnal lacertid occurs in both sand- and bushveld country. Jacobsen (1989, pp. 498-499) noted that the species forages among grass tussocks or at the fringe of bushes, and lives in holes in the ground. These burrows branch off and are dug in soft sand; they may be shared by several individuals (Branch, 1988a, p. 139). Diurnal termites, beetles, grasshoppers and other orthopterans are eaten (FitzSimons, 1943). According to Pienaar *et al.* (1983, p. 108), solifugids are also eaten. Broadley (1966, p. 252) recorded a specimen from the stomach of a Cape Fox *Vulpes chama*; and showed that *I. squamulosa* emerges from the egg in November or December and reaches maturity after eight months; breeding then occurs, followed by death. The species thus exists within the egg for the months August to October. However, Jacobsen (1987, p. 17) was unable to collect specimens during the months August and September (and November) only.

Reproduction and interspecific competition between the similar-sized *I. squamulosa* and *I. capensis* has been studied by Broadley (1966) and Jacobsen (1987). According to FitzSimons (1943), females lay 10-12 eggs measuring 10-12 x 7 mm; and the largest ova *in situ* examined by Jacobsen (1987, p. 16) measured 10,0 - 11,0 x 5,5 - 6,8 mm. Jacobsen (1987) also stated that clutch size varied from 4-12 (usually eight or more).

Family: **VARANIDAE** Hardwicke & Gray, 1828

Genus: *Varanus* Merrem, 1820

Varanus albigularis albigularis (Daudin, 1802) Rock Monitor

Tupinambis albigularis Daudin, 1802, *Hist. Nat. Rept.*, 3, p. 72, pl. 32. Type locality: "Afrique u de l' Inde". Types in the Paris Museum, Paris.

Varanus albigularis (Daudin): Boulenger, 1910, p. 471.

Varanus albigularis albigularis (Daudin): FitzSimons, 1943, p. 403.

Varanus exanthematicus albigularis (Daudin): De Waal, 1978, p. 74; Branch, 1988a, p. 172, pl. 63.

Range

From the central and eastern Cape Province northwards through most of eastern southern Africa (i.e. excluding western Cape), with a fairly widespread but apparently isolated population in Namibia.

Zoogeographical classification: Tropical Wide Ranging.

Range cluster in O.F.S.: Non-Northeastern (Non-NE).

Distribution in the Orange Free State (18 localities; Fig. 76)

Specimens examined from: Babel; Bloemfontein; Brakfontein; Brandfort; Hartebeestfontein, Boshof; Hertzogville; Koortshoek; Leeuwfontein, Boshof; Leeuwkuil; Mara, Vredefort; Middenspruit; Philadelphia; Uitkyk; Vet River - Bloemhof Dam junction.

Other records: Smithfield (Boulenger, 1910); Fauresmith (FitzSimons, 1943); Merriesfontein (sight record, M.F. Bates); Tussen-die-Riviere Game Farm, western side (sight record, M.F. Bates).

Features (15 specimens examined)

Dorsum grey with black transverse bands. Head grey with a black stripe extending from behind the eye to above the arm and continuing down the flank, often forming a thin black band on the venter. The area between the dorsal black banding is grey with transverse series of indistinct pale spots which also form a "band". Venter cream with narrow dark bands or a network of dark markings. The chin and

gular region is usually black (always in juveniles), but may be only speckled. Nostril oblique, separated from closest part of eye by a distance of about its own length. More robust in build than *V. n. niloticus*.

Habitat and Ecology

De Waal (1978, p. 75) noted that this species is terrestrial and arboreal in the drier parts of the O.F.S. (especially the west), particularly where rocky outcrops provide sheltering sites. Bates (1990, p. 50) recorded a specimen of about 60 cm SVL found in a state of apparent hibernation in a burrow surrounded by rocks during July on the farm Merriesfontein near Boshof. These large diurnal lizards occupy holes in the ground or in trees, and in rock crevices, and are not dependent on permanent water bodies (FitzSimons, 1943, p. 404). Detailed accounts on the behaviour of this species are given by FitzSimons (1943) and Jacobsen (1989, p. 510). Prey includes small mammals, birds and their eggs, reptiles, snails, insects (FitzSimons, 1943, p. 405), decomposing animals, millipedes (Broadley, 1966, p. 262) and scorpions (Jacobsen, 1989). De Waal (1978) noted that the stomach of a specimen collected at Hertzogville in the O.F.S. contained two juvenile Leopard Tortoises *Geochelone pardalis* and one grasshopper. A juvenile collected at Merriesfontein fed on crickets, white mice and *Xenopus l. laevis* while in captivity (Bates, 1990b). Enemies of adults include Martial Eagles and other birds of prey, and Ratels (FitzSimons, 1943; Branch, 1988a), while *V. exanthematicus albigularis* (= *V. a. albigularis*) eggs are eaten by Banded Mongooses (Branch, 1988a) and probably various other small mammals. A female measuring 991 mm, collected in November in the O.F.S., contained 31 eggs measuring 57 x 34 mm, while another female (920 mm SVL) collected in October contained 13 eggs measuring 55 x 30 mm (De Waal, 1978). From 12-40 eggs may be laid, depending on the size of the female, and incubation may take as long as 10 months; a female from the Transvaal laid 28 eggs measuring 61,0 x 35,0 - 38,0 mm (Jacobsen, 1989). According to Branch (1988a, p. 173), 8-37 eggs measuring 53-61 x 35-39 mm, and with masses of 32-46 g, are laid. Eggs are deposited in a hole dug to a depth of about 30 cm (Jacobsen, 1989).

Remarks

Jacobsen (1989, p. 511) noted that to date no formal statement had been made with regard to the adoption of *albigularis* as a valid species, but suggested that this elevation is valid. According to Branch (pers. comm.), formal statements concerning the recognition of *V. albigularis* as a valid species were made by Böhme, Joger & Schätti (1989). Trinomials are now required because the western subspecies *V. albigularis angolensis* Schmidt is recognized as a distinct subspecies on account of its dark throat and a vertebral band of enlarged scales extending from occiput to proximal portion of tail (Broadley, 1991a, p. 525).

This monitor is probably more common in the O.F.S. than has been recorded - the large size of adult *V. a. albigularis* and *V. n. niloticus* make them difficult to capture. A very large specimen was seen on the upper slopes of a hill on the farm Plaat Kop near Aliwal North, north-eastern Cape Province. Despite

the thick undergrowth, the specimen turned and fled with remarkable speed and agility after realizing that its presence had been detected. The same reaction was elicited by a large specimen observed on a footpath at Tussen-die-Riviere Game Farm near Bethulie.

Varanus niloticus niloticus (Linnaeus, 1762) Water Monitor

Lacerta nilotica Linnaeus, 1762, in Hasselquist, *Reise n. Palast.*, p. 361 and 1766, *Syst. Nat.*, Ed. 12, 1, p. 369. Type locality: Egypt. Types in the Paris Museum, Paris?

Varanus niloticus niloticus (Linnaeus): De Waal, 1978, p. 73; Branch, 1988a, p. 173, pl. 63.

Range

Savanna areas of the eastern half of southern Africa, from eastern Cape Province northwards through most of sub-Saharan Africa, from where it extends along the Nile River to Egypt; also west along the Orange River to the Atlantic Ocean; replaced in western rain forests by *V. n. ornatus* (Daudin).

Zoogeographical classification: Tropical Wide Ranging.

Range cluster in O.F.S.: Throughout (T).

Distribution in the Orange Free State (12 localities; Fig. 77)

Specimens examined from: Glen; Krugersdrift Dam; Maselspoort; Mecklenburg; Middelpunt; Rustfontein Dam; Smitherton; Tussen-die-Riviere Game Farm; Willem Pretorius Game Reserve.

Other records: Hoopstad, at Vet River (TM 63610); near Nature Conservation Offices at Kalkfontein Dam Nature Reserve (sight record, M.F. Bates); Kalkfontein (677) near Alphaheim (sight record, M.F. Bates).

Features (six specimens examined)

Dorsum and most of upperparts of limbs and tail mostly black with greyish spots; also a series of clear white spots forming transverse "bands". Top of head black with clear pale spots. Venter with bold transverse bands, usually not confluent. Throat usually with confluent black transverse bands; markings on throat never in the form of black patches as in *V. a. albigularis*. More slender in build than *V. a. albigularis*.

Habitat and Ecology

This large, diurnal lizard is found in and near rivers, dams and other permanent water bodies, provided suitable cover in the form of rocky outcrops, cliffs or large trees is available (Jacobsen, 1989, p. 517). The diet consists of virtually anything it is able to capture, especially crabs and mussels, but also small mammals, frogs, fish, birds and their eggs, crocodile eggs, reptiles, millipedes and snails (Branch,

1988a, p. 172; Jacobsen, 1989). Bourquin & Channing (1980, p. 14) recorded a specimen attacking a juvenile Grey Duiker *Sylvicapra grimmia*. Juveniles occupy marginal reed beds and prey mainly on frogs and insects (Branch, 1988a). Enemies of adults include crocodiles and pythons (Branch, 1988a), while juveniles are probably preyed on by raptors. Females excavate a nest in an active termitarium and lay 20-60 eggs measuring 54-64 x 30-40 mm; the worker termites then repair the termitarium, providing an ideal situation of constant temperature and humidity; incubation may take up to a year, although it lasts for 129-175 days at 30°C in captivity; hatchlings measure 200-300 mm, with masses of 23-32 g (Branch, 1988a). According to FitzSimons (1943, p. 407), incubation takes 9-10 months, and when the hatchlings break out of the termitarium, they disturb the termites which then provide their first meal.

Remarks

Very few specimens, as well as locality records, are available for the O.F.S. However, it is likely that this large monitor is common at suitable sites along, *inter alia*, the Vaal, Modder and Orange Rivers.

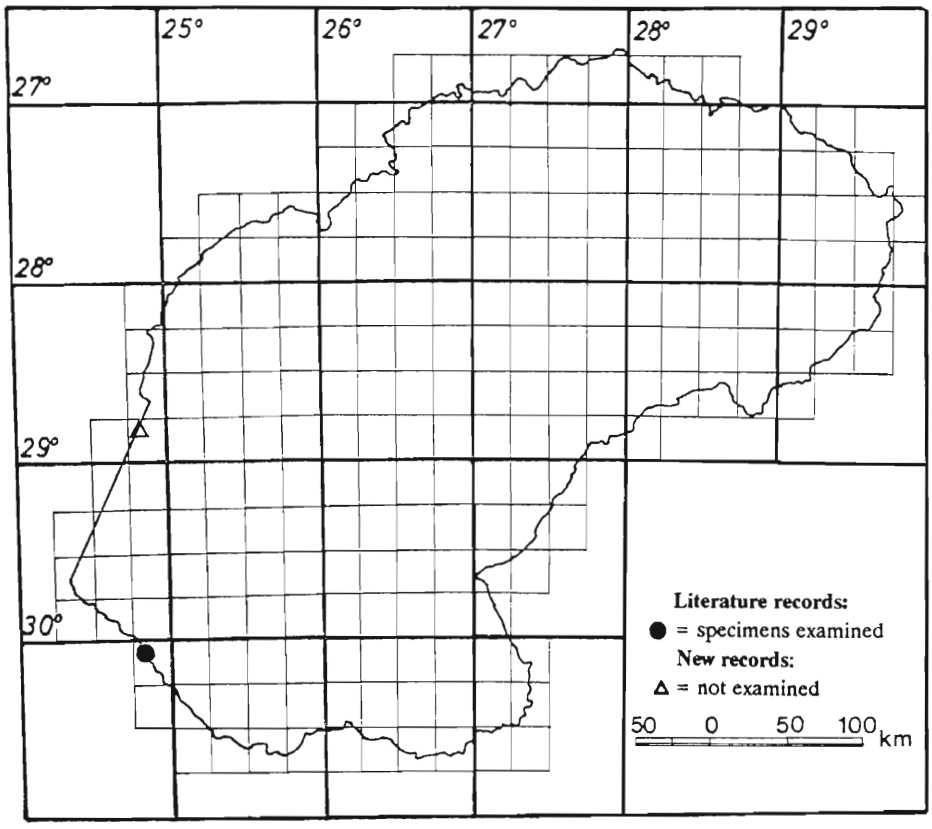


Figure 41: Distribution of *Ptenopus garrulus garrulus* in the Orange Free State.

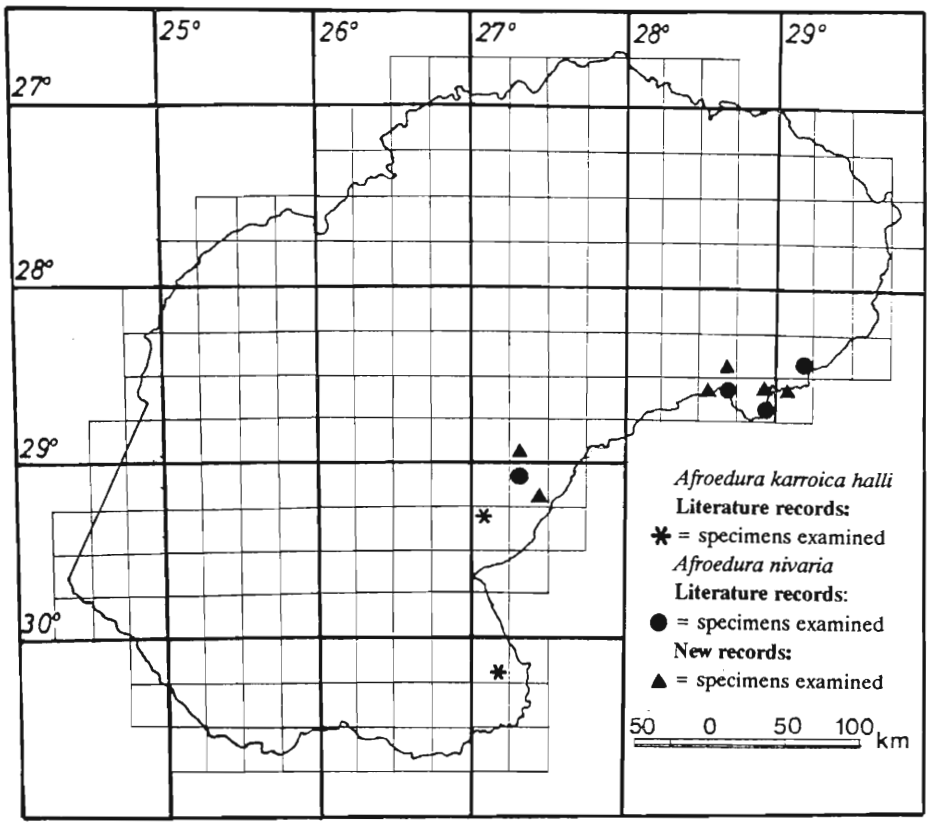


Figure 42: Distribution of *Afroedura karroica halli* and *A. nivaria* in the Orange Free State.

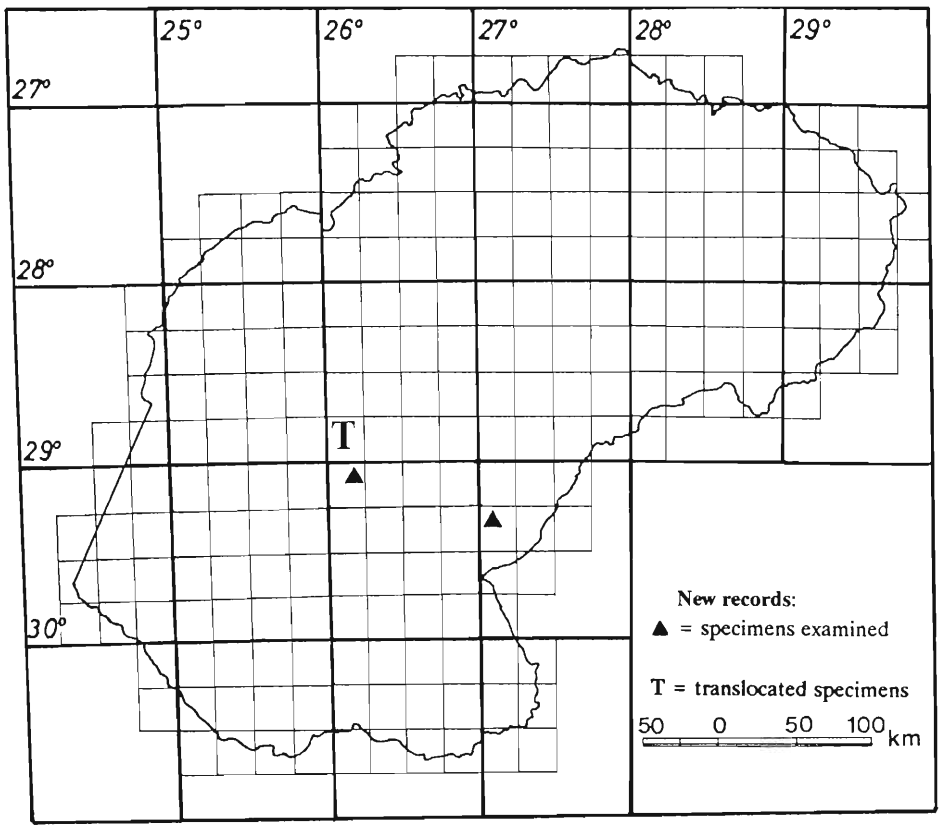


Figure 43: Distribution of *Hemidactylus mabouia mabouia* in the Orange Free State.

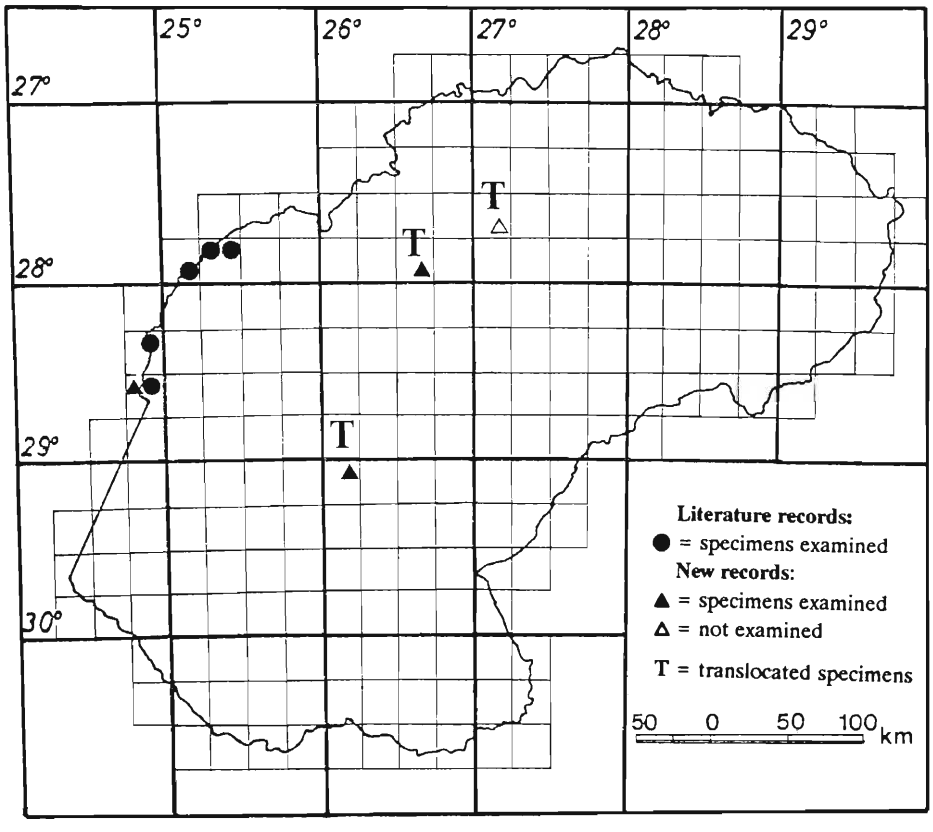


Figure 44: Distribution of *Lygodactylus capensis capensis* in the Orange Free State.

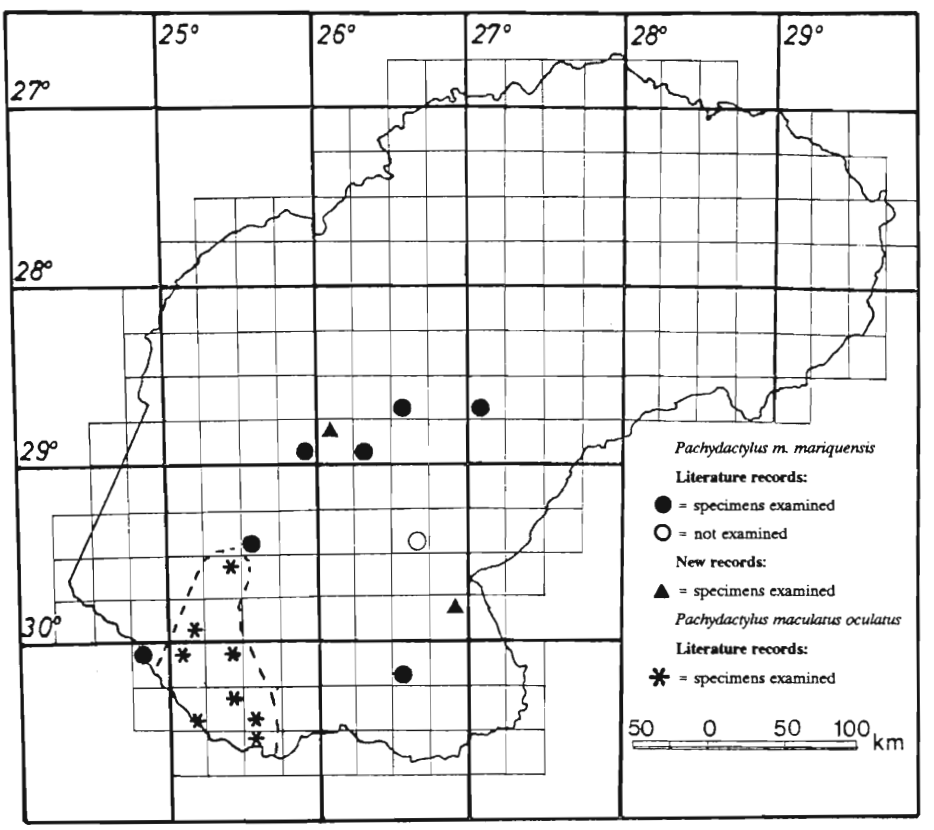


Figure 45: Distribution of *Pachydactylus mariquensis mariquensis* and *P. maculatus oculatus* in the Orange Free State.

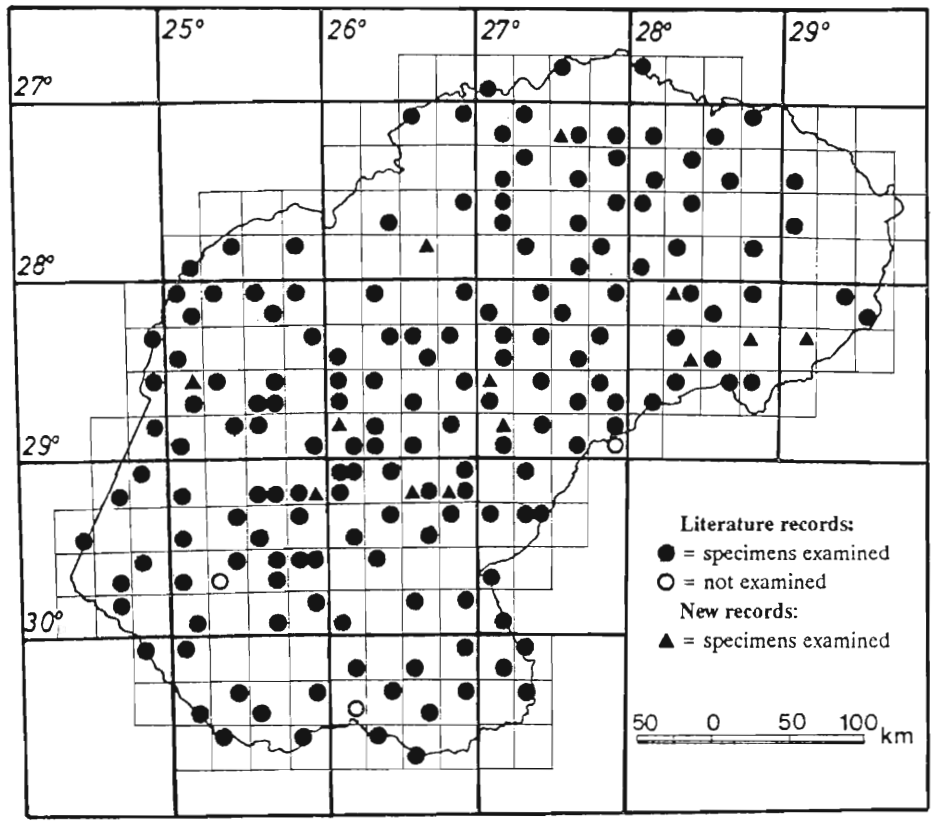


Figure 46: Distribution of *Pachydactylus capensis capensis* in the Orange Free State.

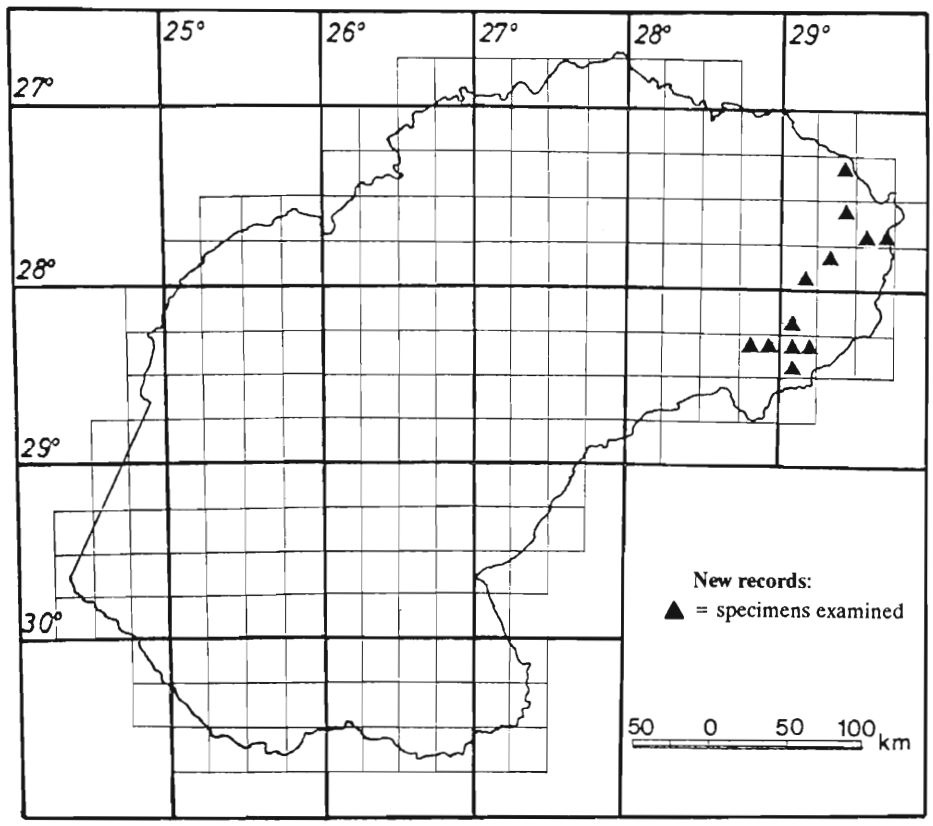


Figure 47: Distribution of *Pachydactylus vansoni* in the Orange Free State.

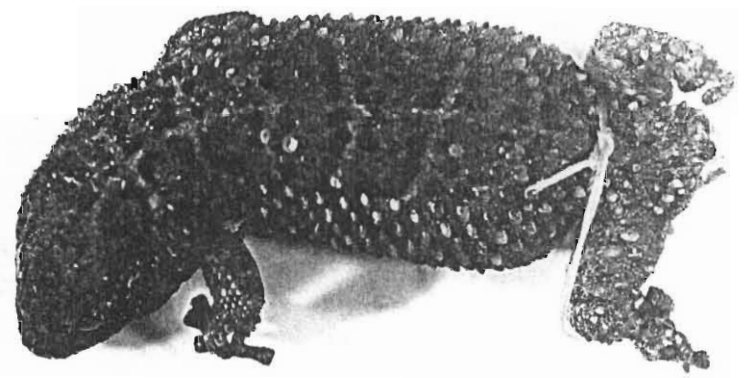


Figure 48: Dorsal patterning of *Pachydactylus vansoni* from Frazerfield, north-eastern Orange Free State.

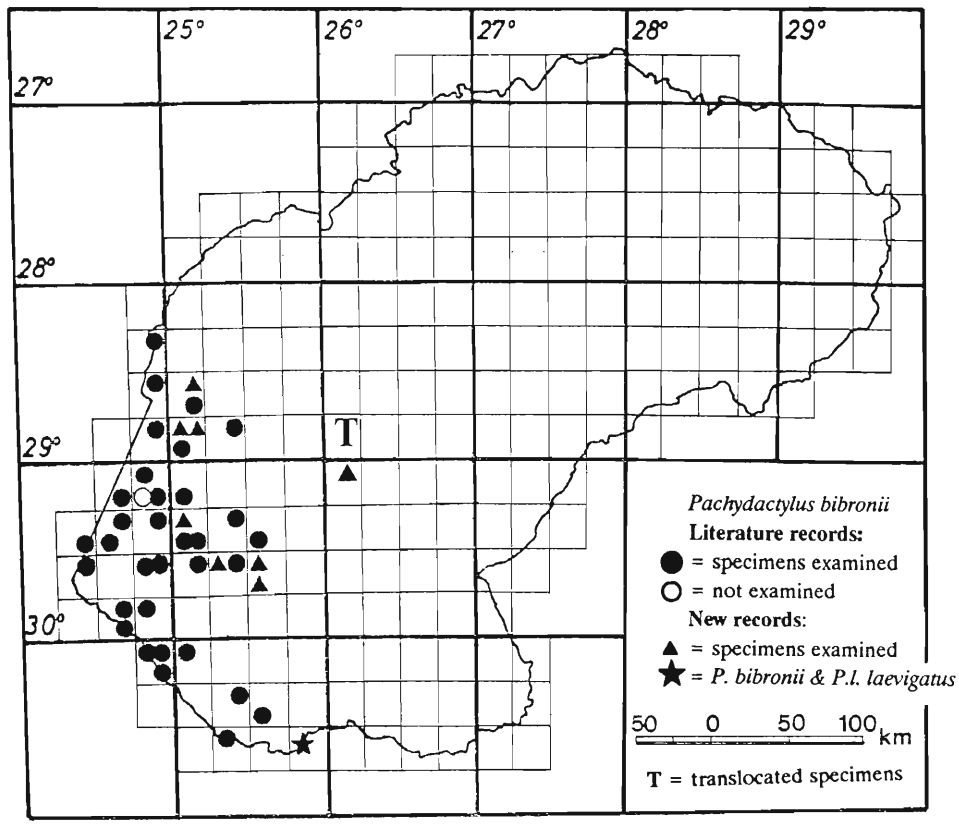


Figure 49: Distribution of *Pachydactylus bibronii* and *P. laevigatus laevigatus* in the Orange Free State.

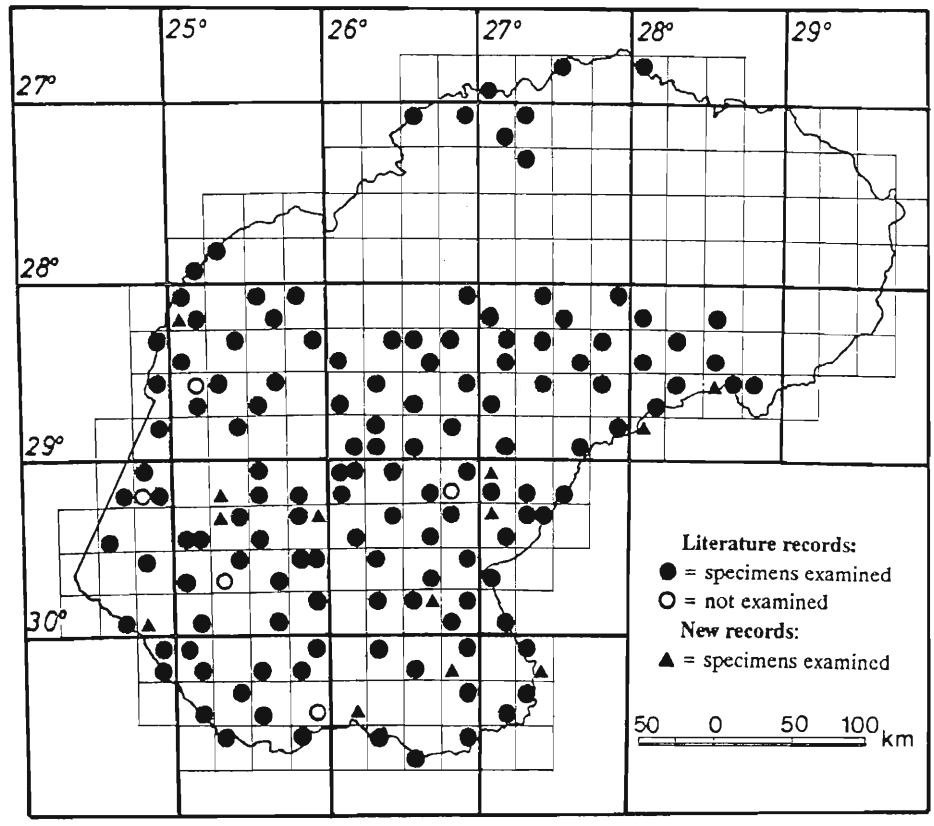


Figure 50: Distribution of *Agama atra atra* in the Orange Free State.

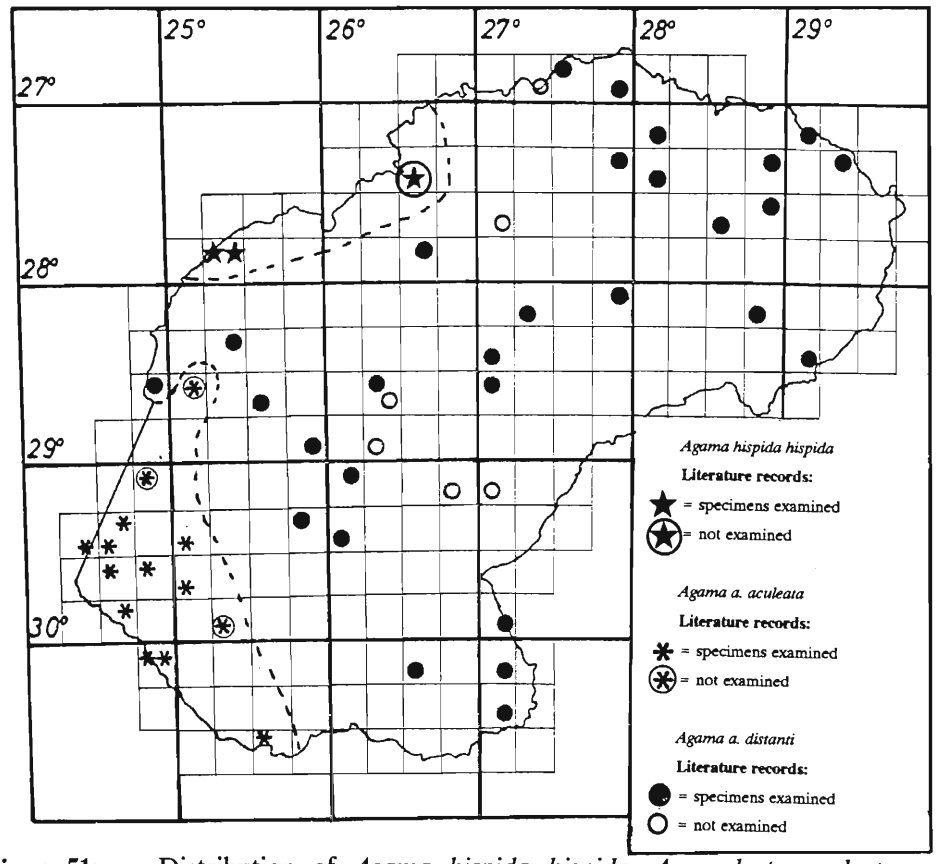


Figure 51: Distribution of *Agama hispida hispida, A. aculeata aculeata* and *A. aculeata distanti* in the Orange Free State.

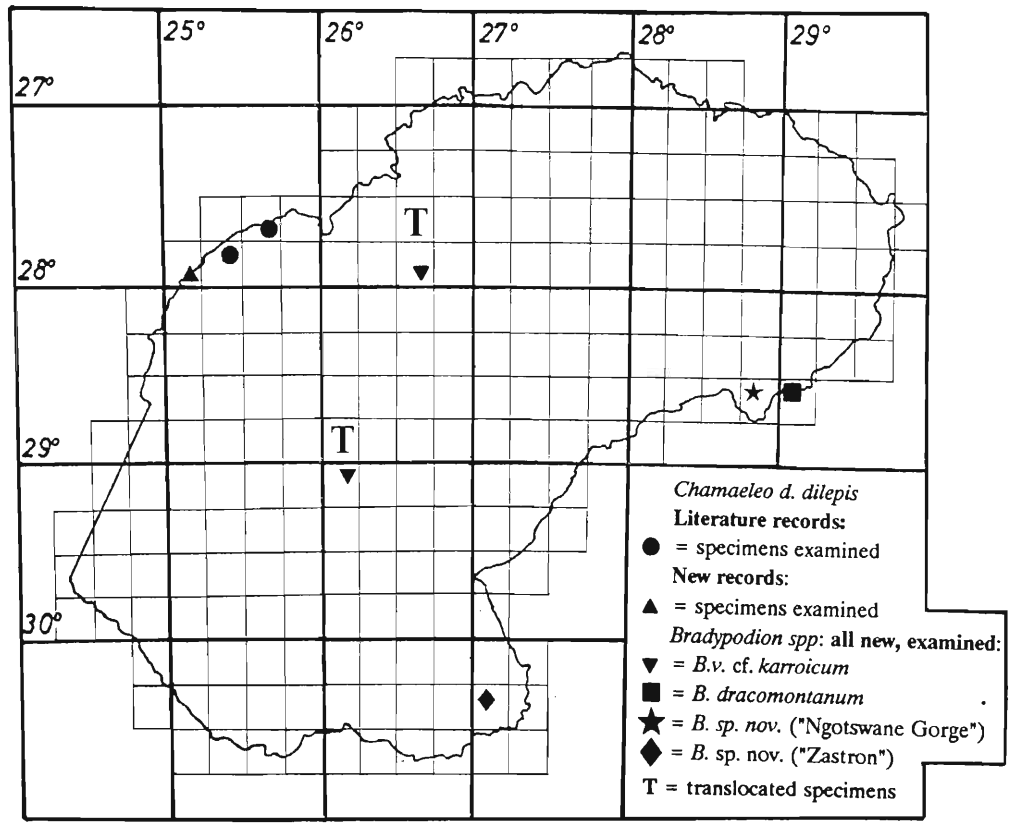


Figure 52: Distribution of *Chamaeleo dilepis dilepis, Bradypodion ventrale* cf. *karroicum, Bradypodion dracomontanum, Bradypodion* sp. nov. ("Ngotswane Gorge") and *Bradypodion* sp. nov. ("Zastron") in the Orange Free State.

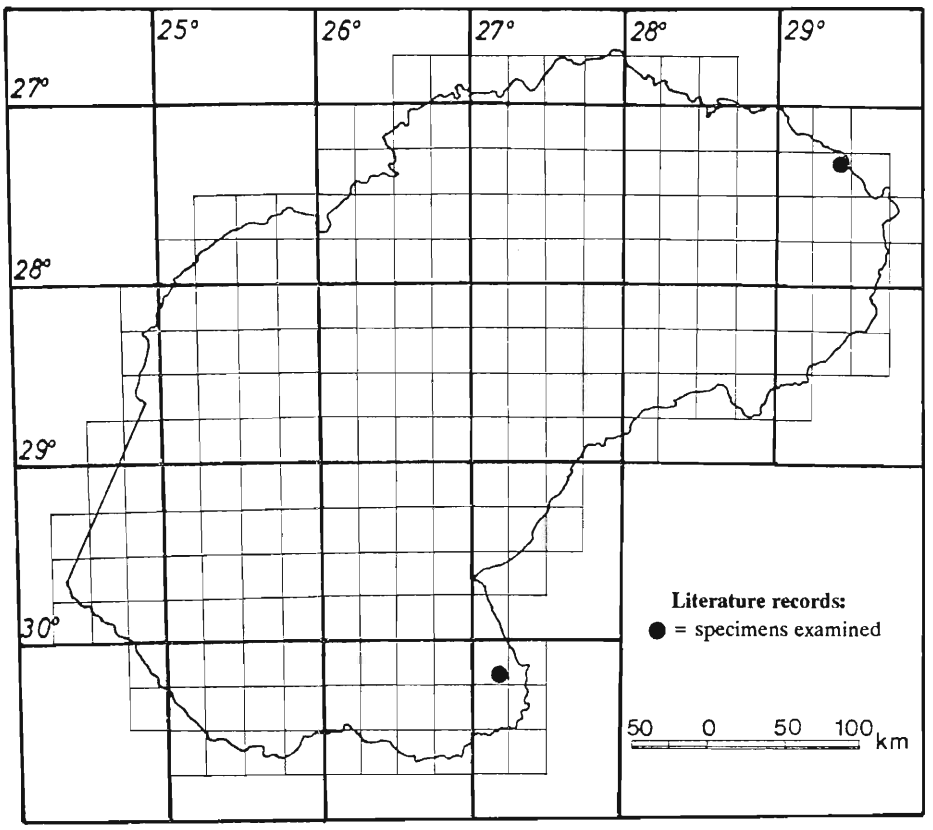


Figure 53: Distribution of *Mabuya homalocephala smithii* in the Orange Free State.

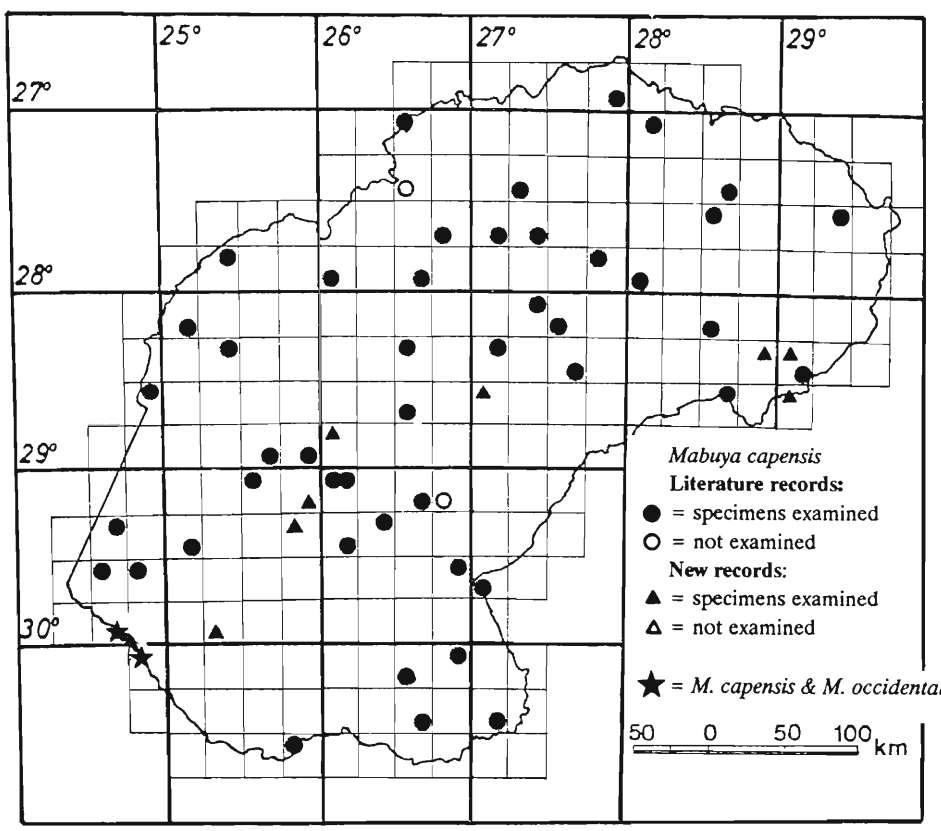


Figure 54: Distribution of *Mabuya capensis* and *M. occidentalis* in the Orange Free State.

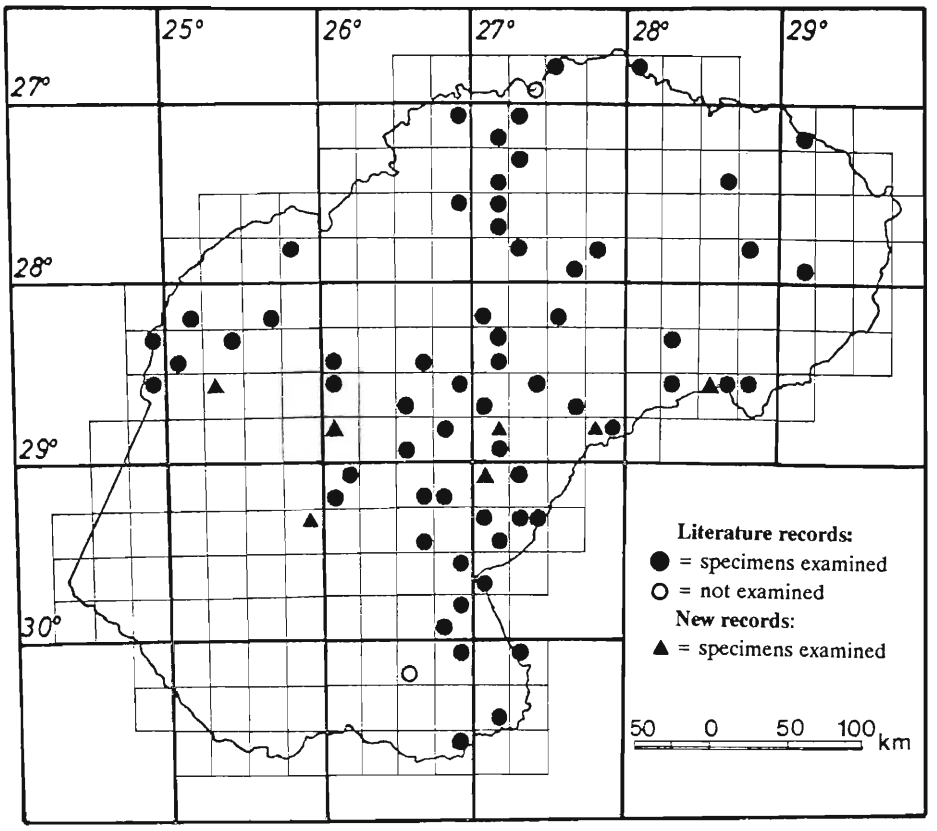


Figure 55: Distribution of *Mabuya varia* in the Orange Free State.

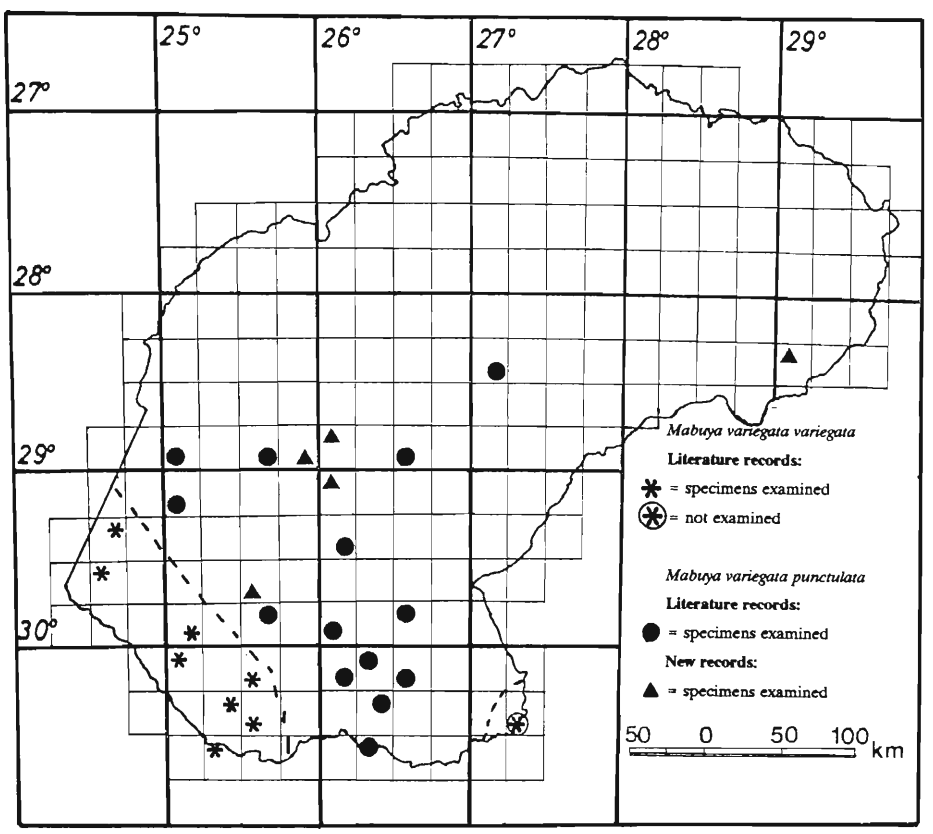


Figure 56: Distribution of *Mabuya variegata variegata* and *M. variegata punctulata* in the Orange Free State.

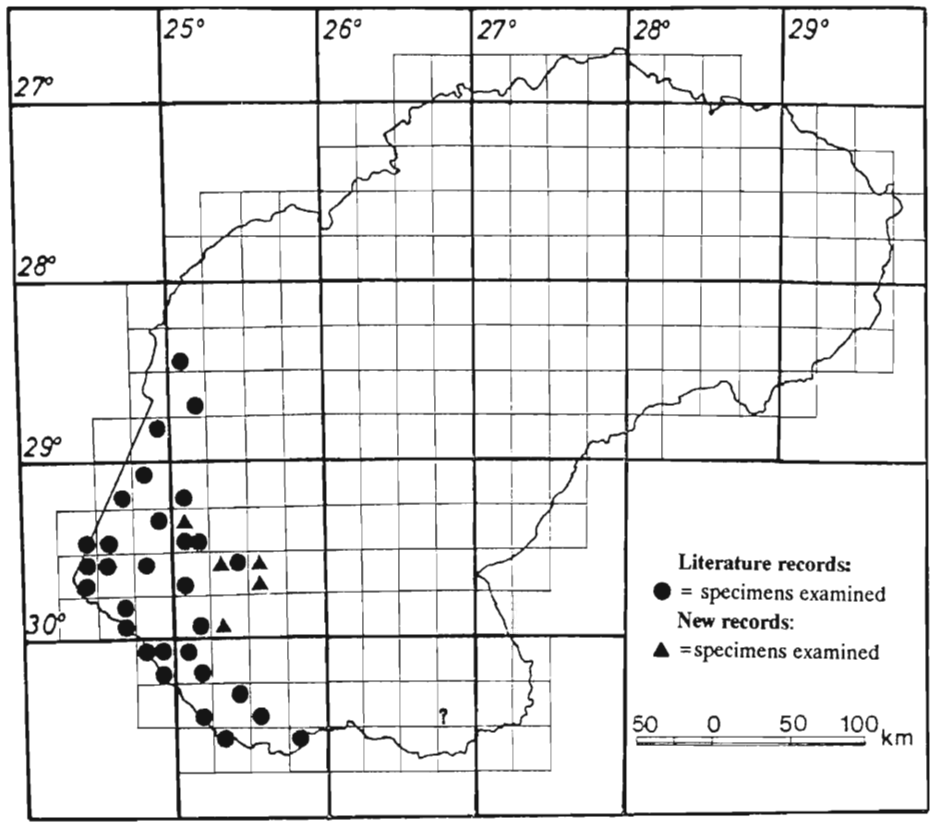


Figure 57: Distribution of *Mabuya sulcata sulcata* in the Orange Free State.

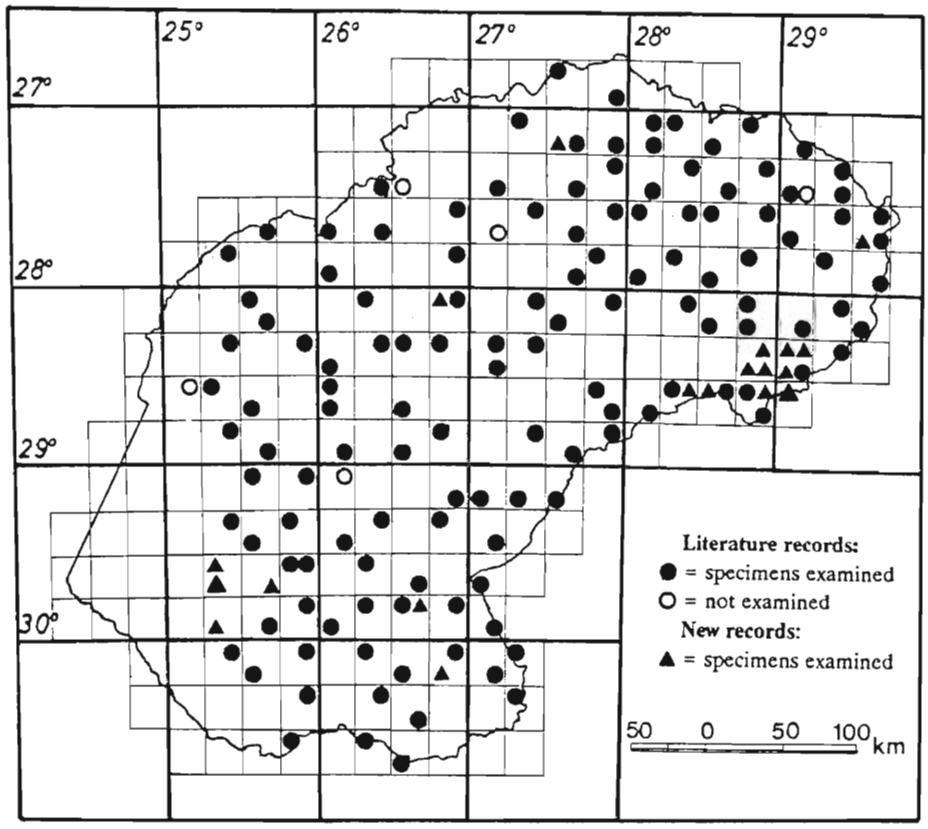


Figure 58: Distribution of *Mabuya striata punctatissima* in the Orange Free State.

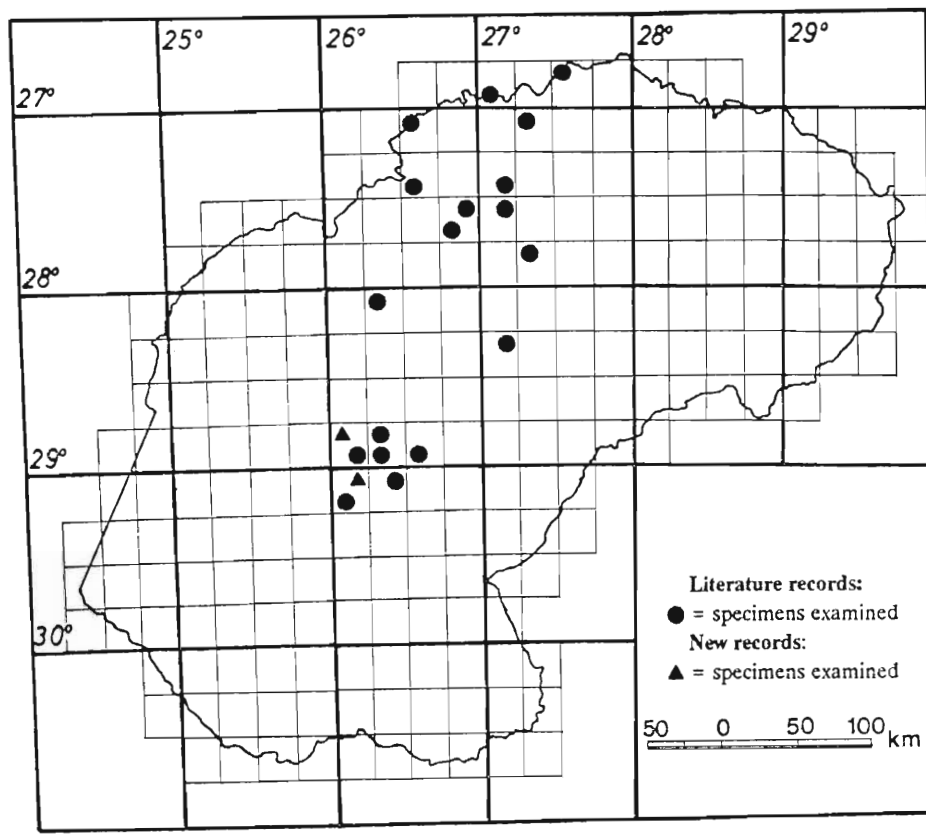


Figure 59: Distribution of *Panaspis wahlbergii* in the Orange Free State.

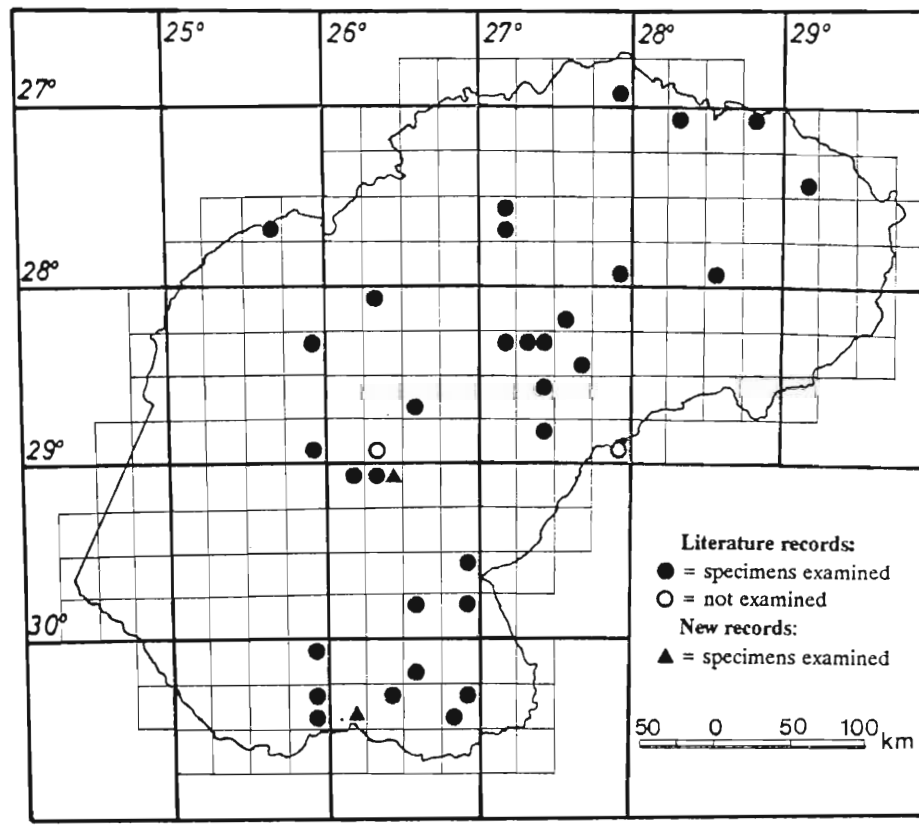


Figure 60: Distribution of *Acontias gracilicauda gracilicauda* in the Orange Free State.

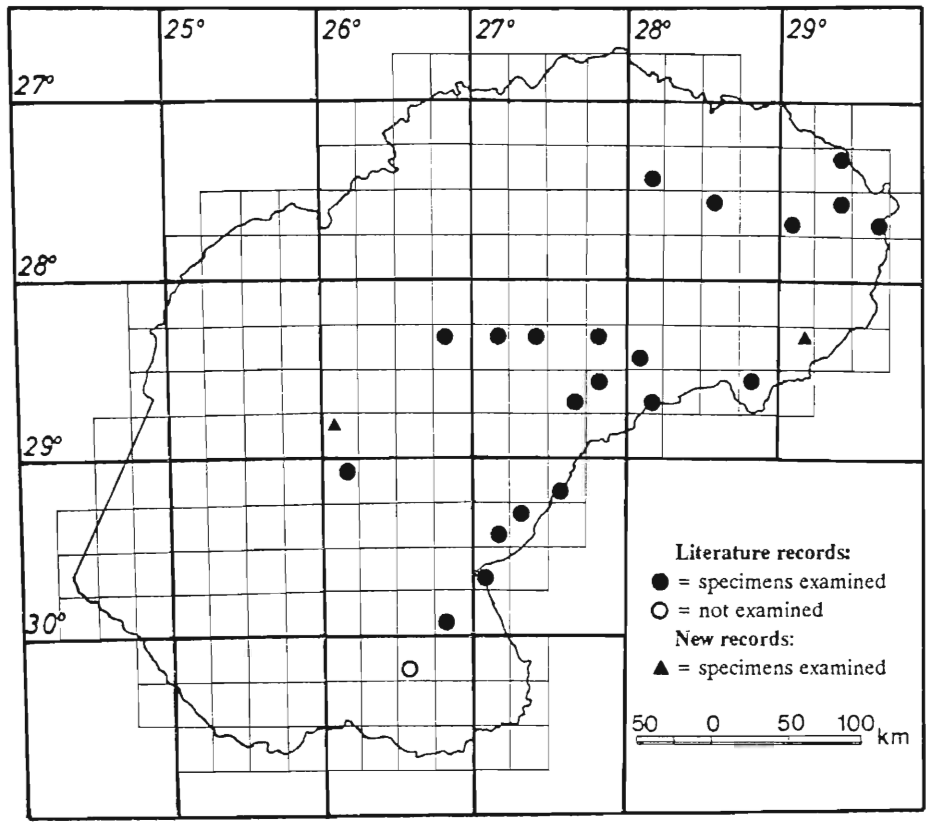


Figure 61: Distribution of *Gerrhosaurus flavigularis flavigularis* in the Orange Free State.

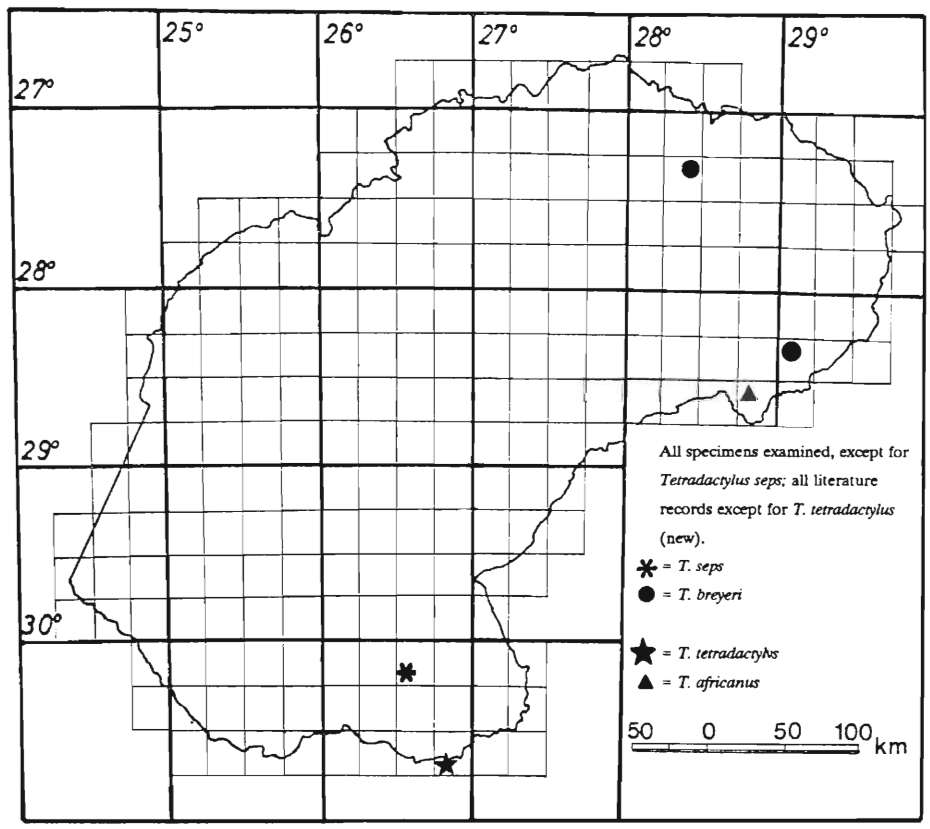


Figure 62: Distribution of *Tetradactylus seps, T. Tetradactylus, T. breyeri* and *T. a. africanus* in the Orange Free State.

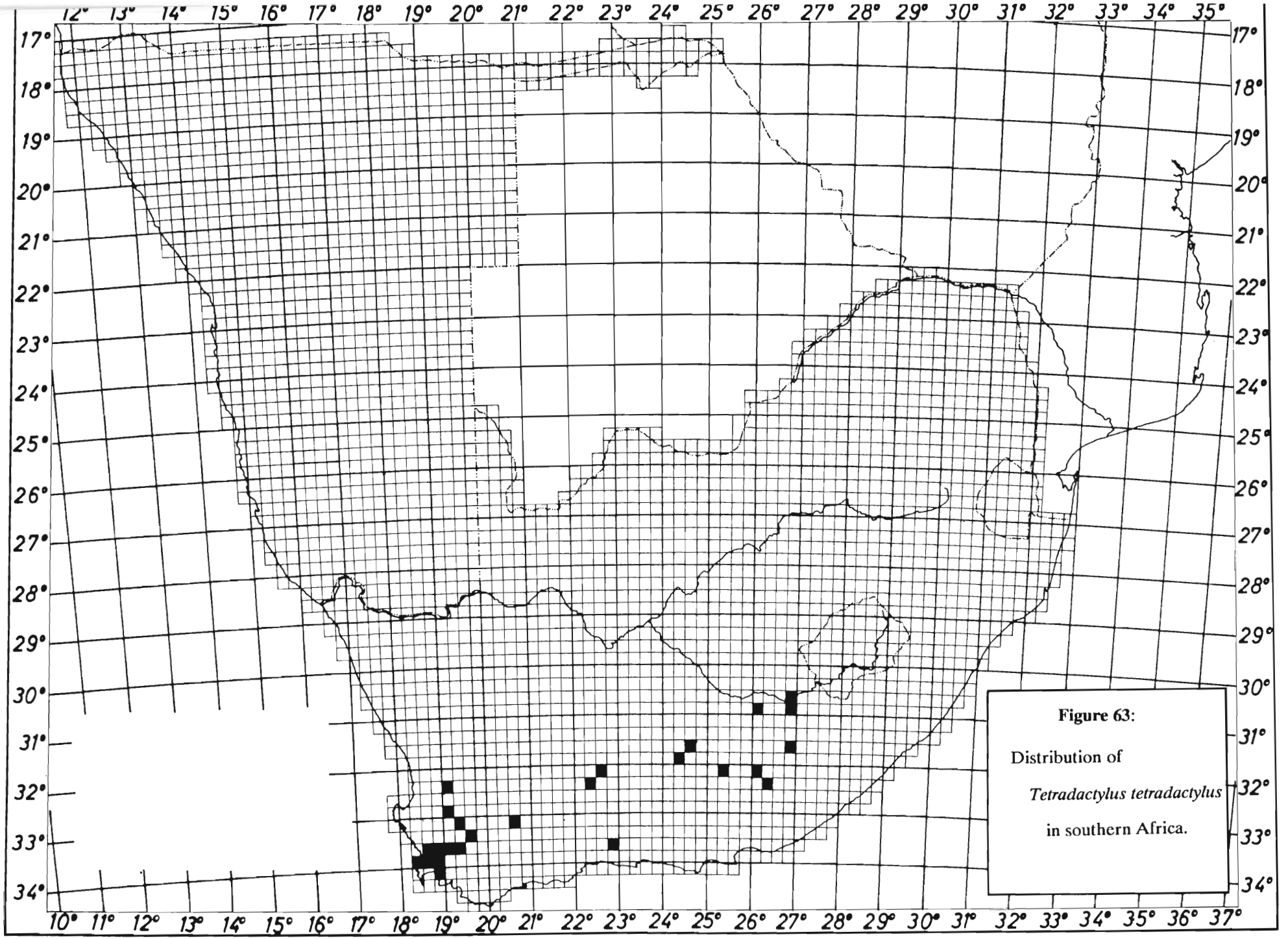


Figure 63:

Distribution of *Tetradactylus tetradactylus* in southern Africa.

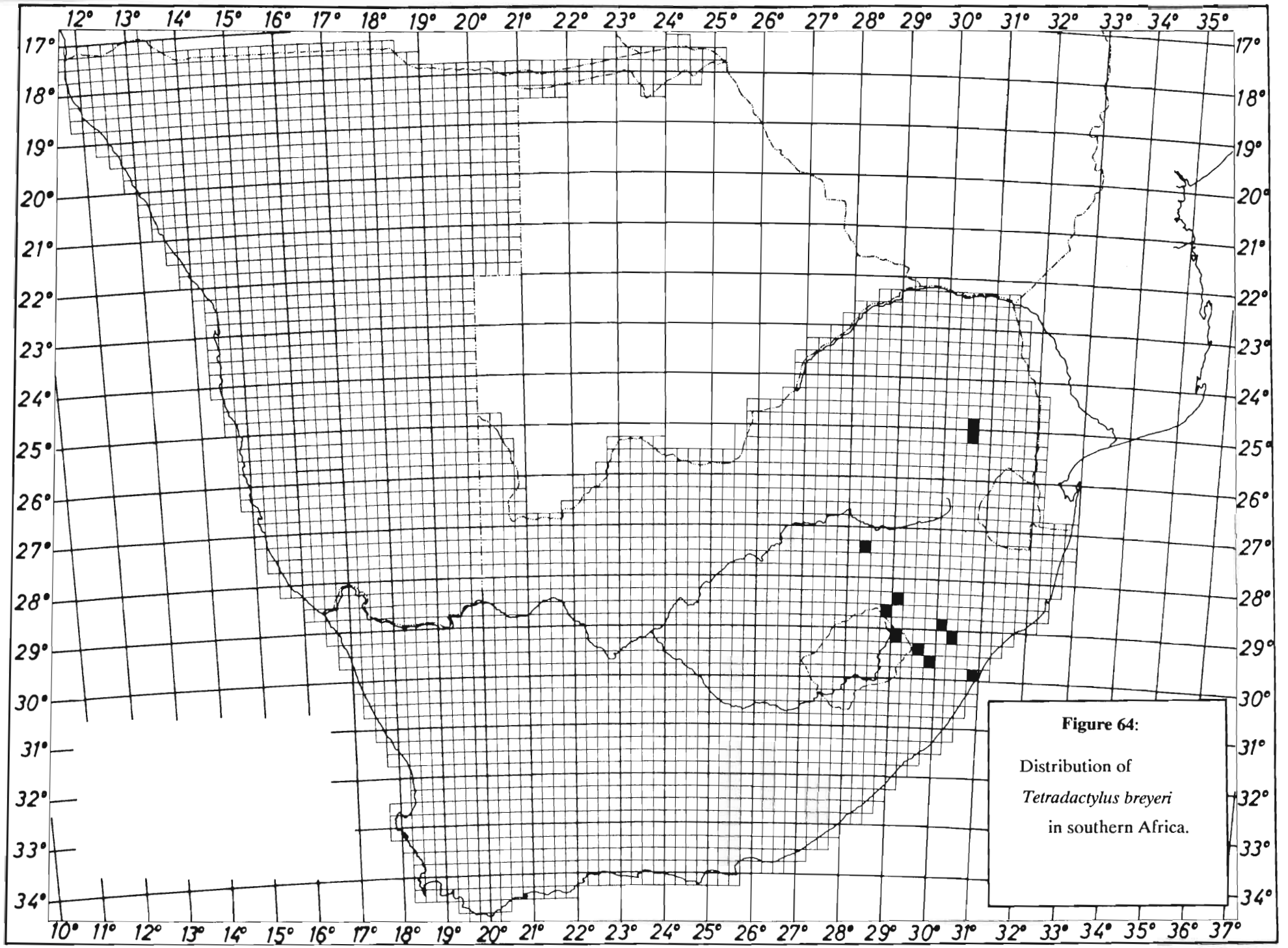


Figure 64:

Distribution of *Tetradactylus breyeri* in southern Africa.

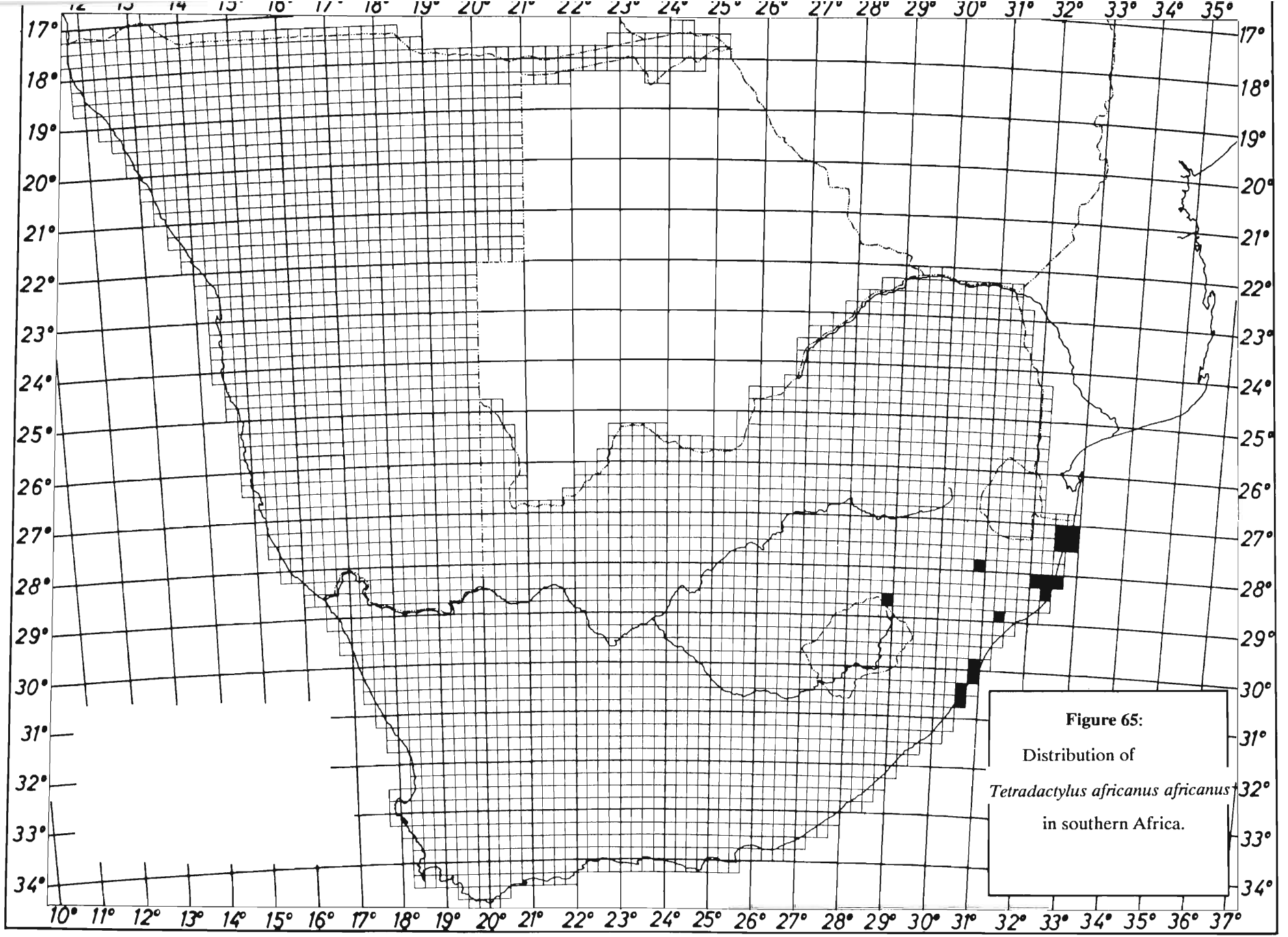


Figure 65:
Distribution of
Tetradactylus africanus africanus
in southern Africa.

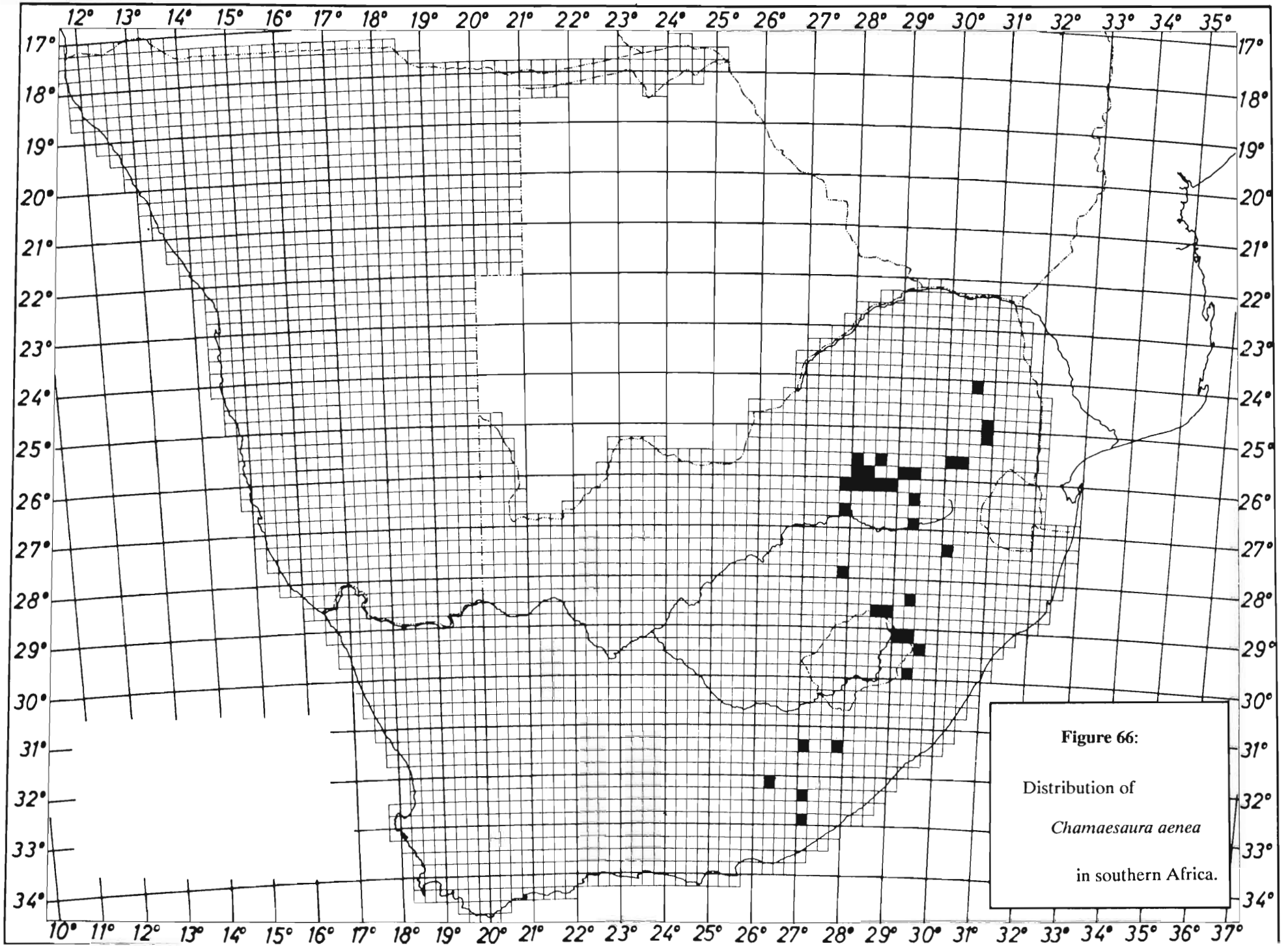


Figure 66:

Distribution of

Chamaesaura aenea

in southern Africa.

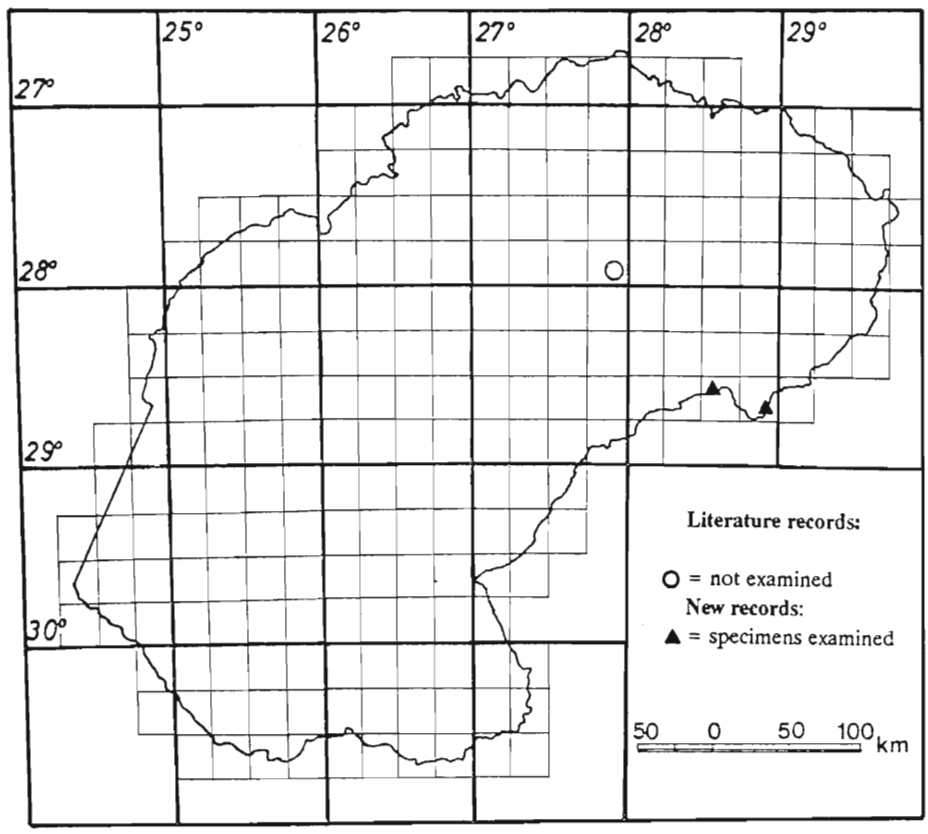


Figure 67: Distribution of *Chamaesaura aenea* in the Orange Free State and peripheral areas on the Natal/O.F.S. border.

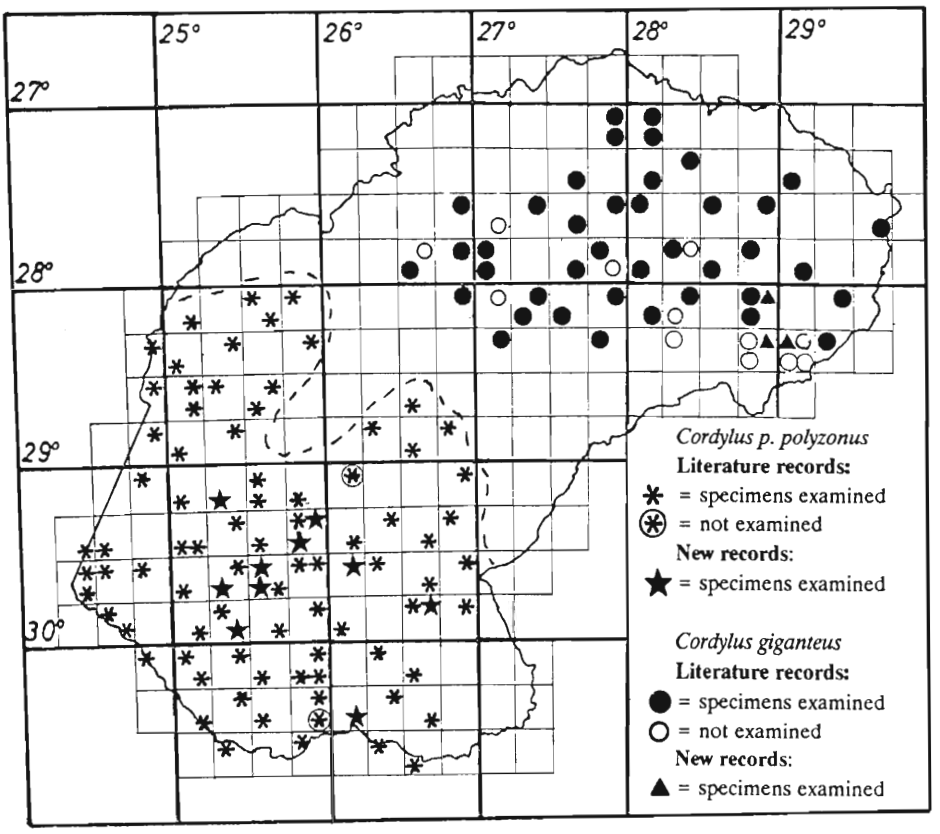


Figure 68: Distribution of *Cordylus giganteus* and *C. polyzonus polyzonus* in the Orange Free State.

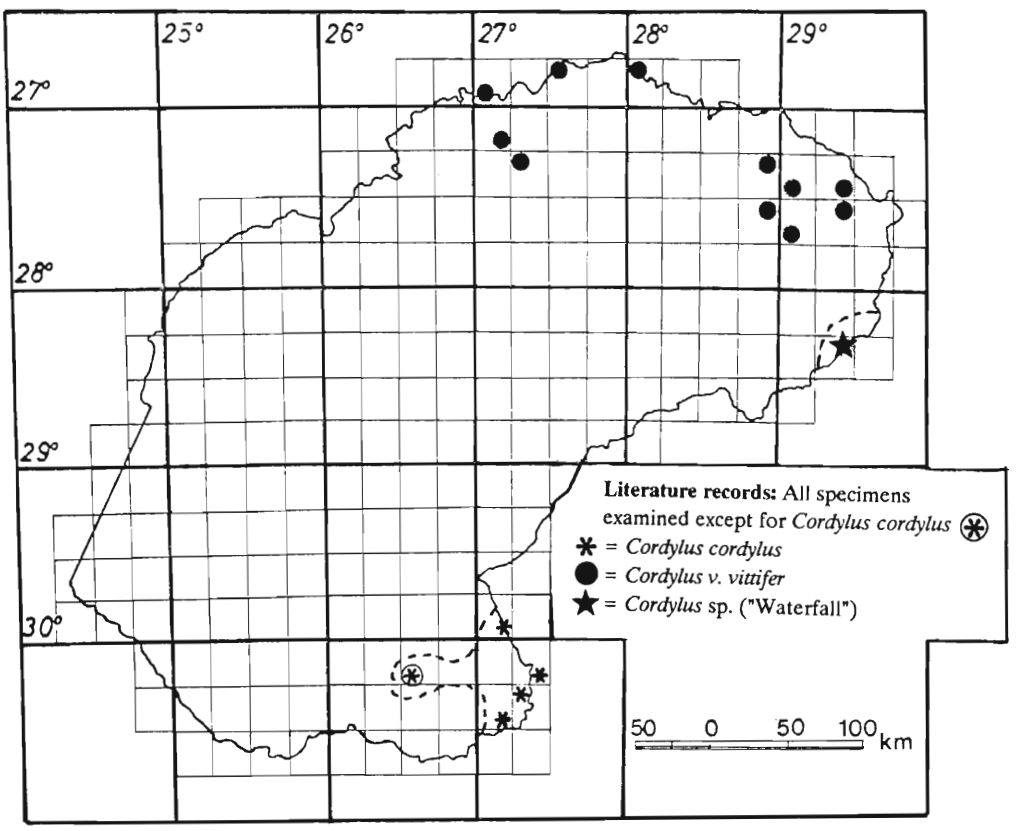


Figure 69: Distribution of *Cordylus cordylus, Cordylus vittifer vittifer* and *Cordylus* sp. ("Waterfall") in the Orange Free State.

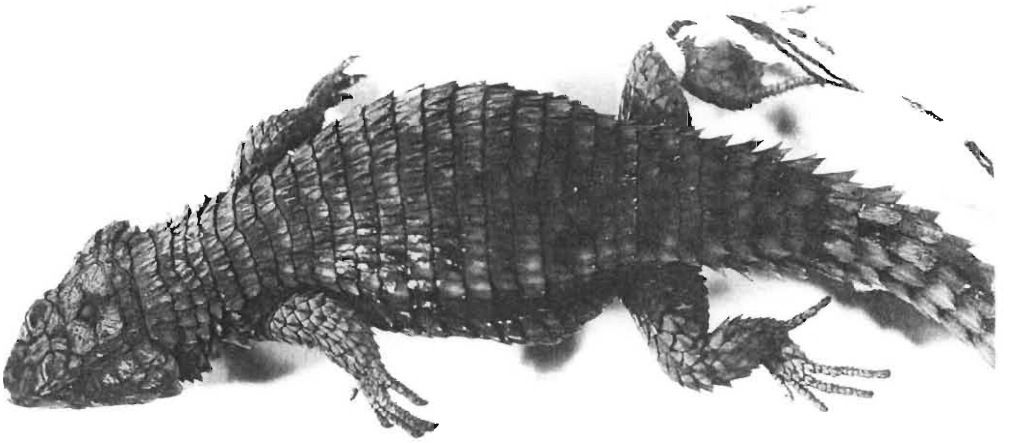


Figure 70: Dorsal view of *Cordylus* sp. ("Waterfall") showing dark lateral streak.

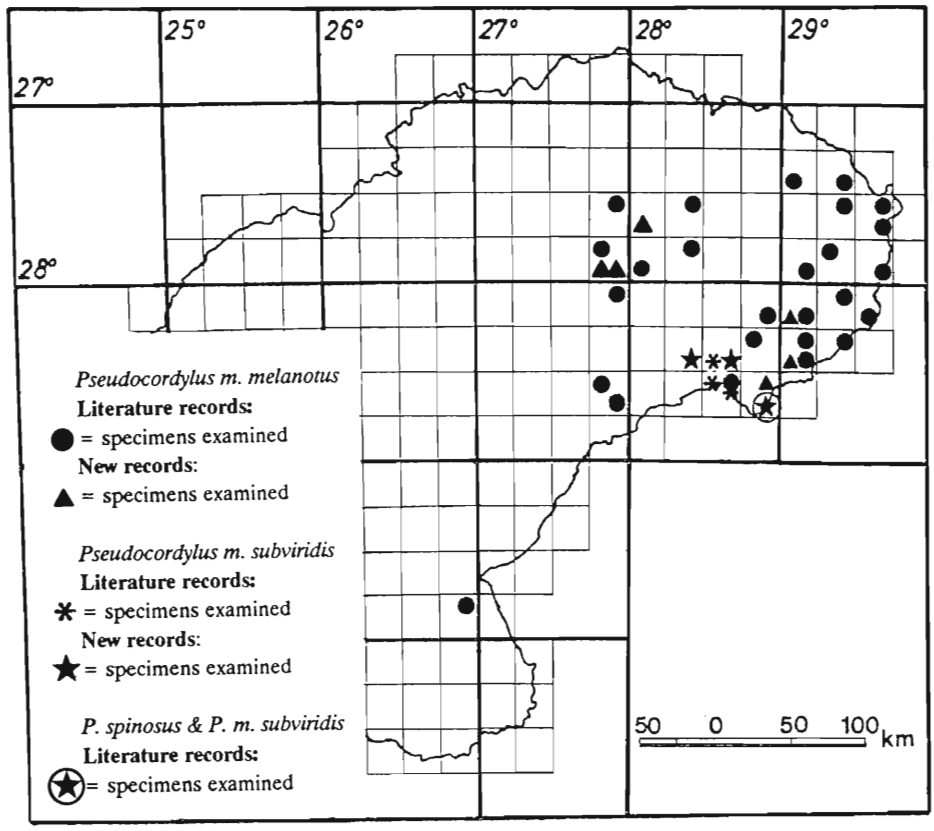


Figure 71: Distribution of *Pseudocordylus melanotus melanotus, P. melanotus subviridis* and *P. spinosus* in the Orange Free State.

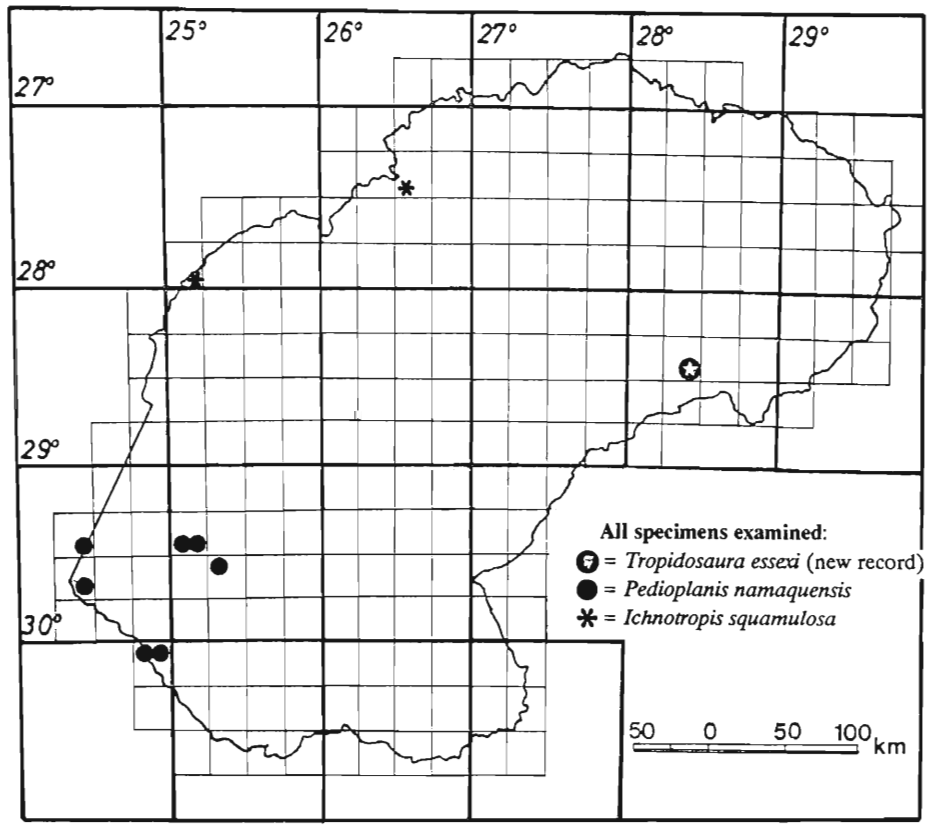


Figure 72: Distribution of *Tropidosaura essexi, Pedioplanis namaquensis* and *Ichnotropis squamulosa* in the Orange Free State.

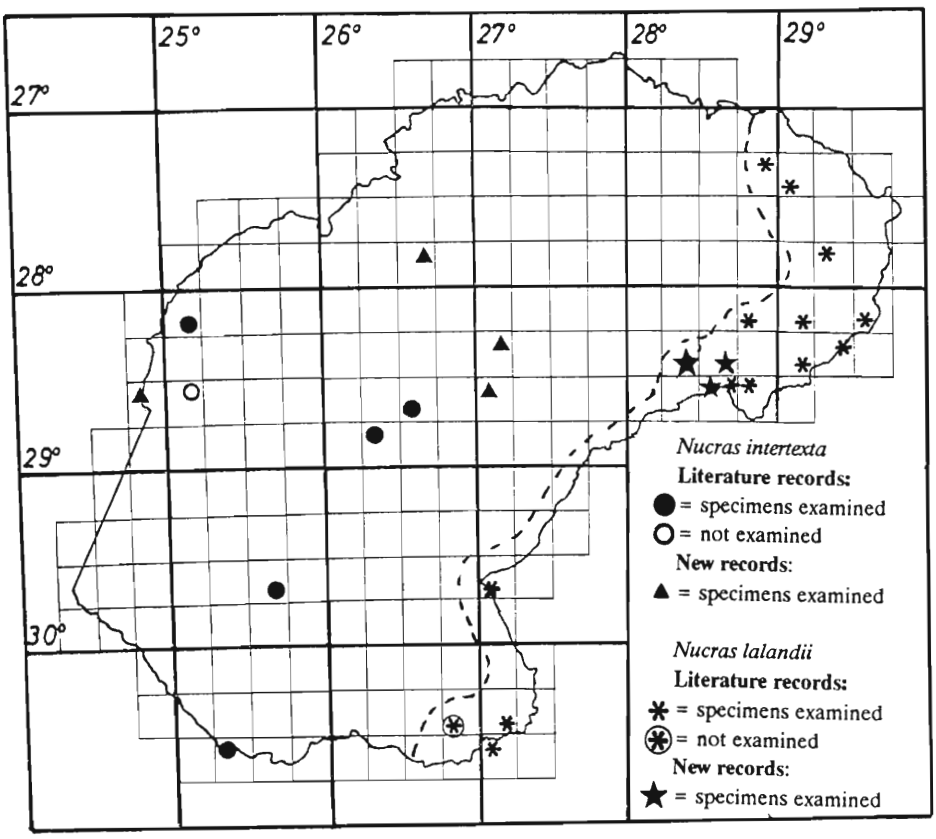


Figure 73: Distribution of *Nucras lalandii* and *N. intertexta* in the Orange Free State.

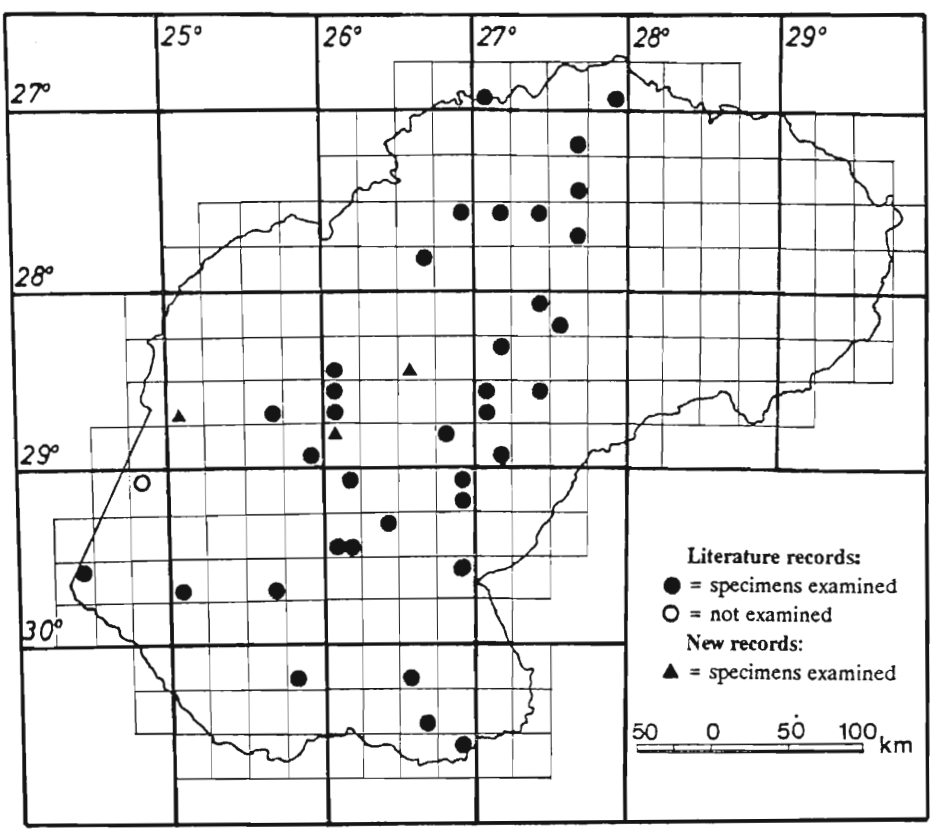


Figure 74: Distribution of *Nucras taeniolata holubi* in the Orange Free State.

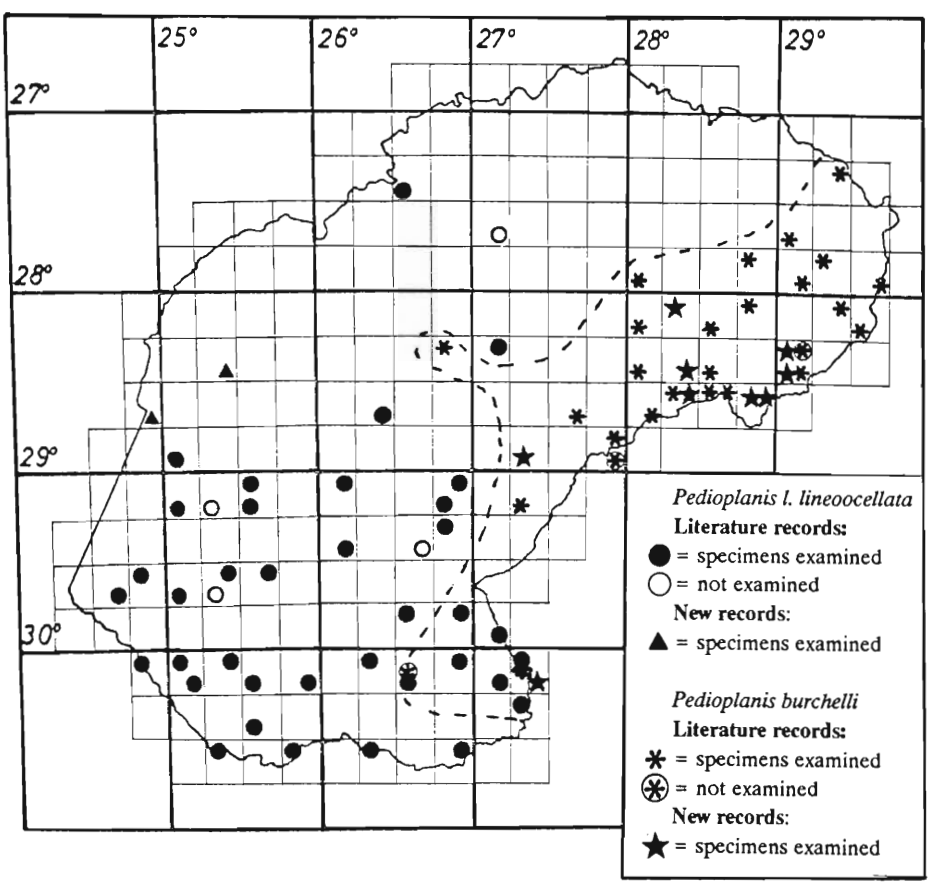


Figure 75: Distribution of *Pedioplanis lineoocellata lineoocellata* and *P. burchelli* in the Orange Free State.

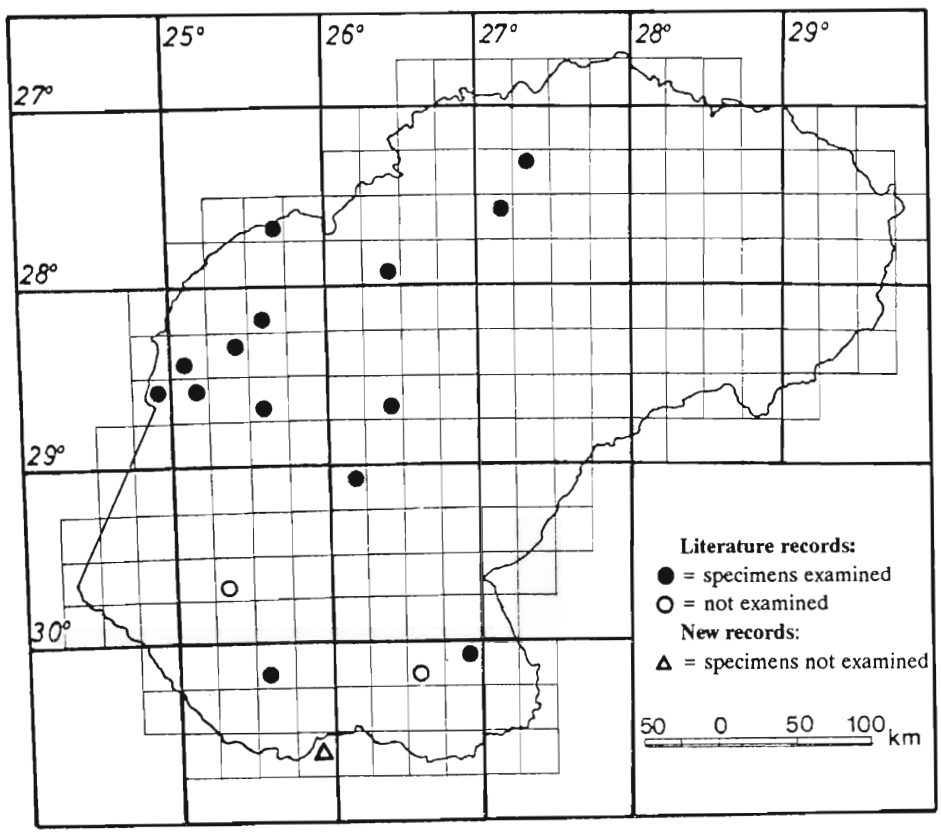


Figure 76: Distribution of *Varanus albigularis* in the Orange Free State.

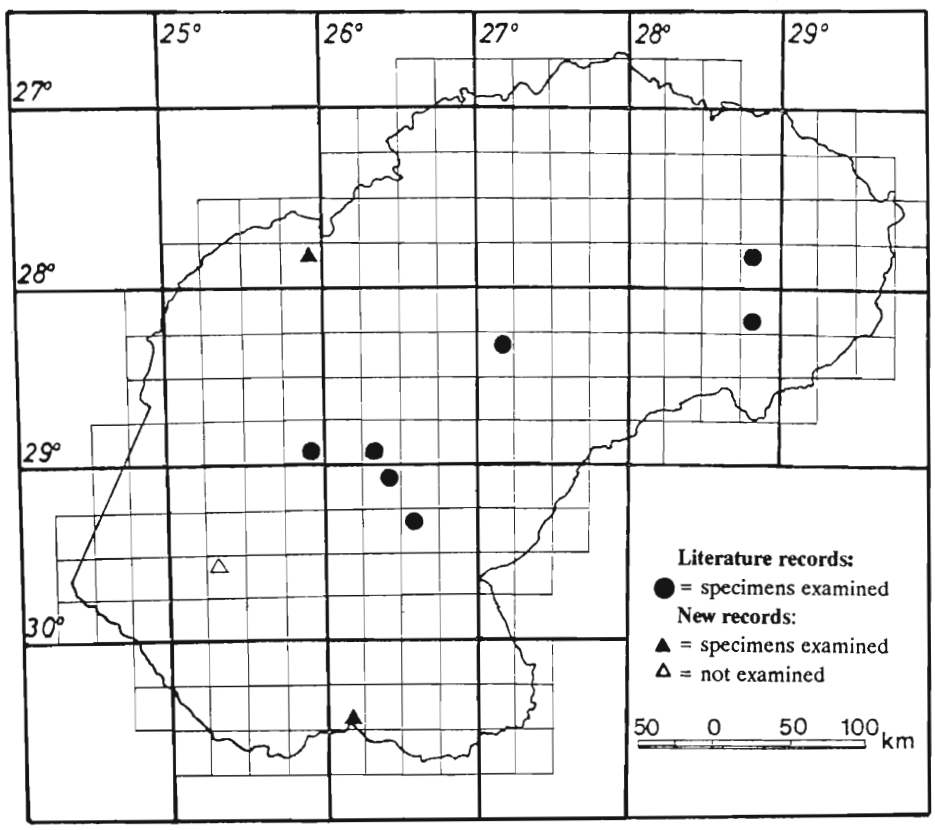


Figure 77: Distribution of *Varanus niloticus niloticus* in the Orange Free State.

Suborder: **AMPHISBAENIA** Gray, 1844

(Distribution map, Fig. 78, is presented on page 225)

Family: **AMPHISBAENIDAE** Gray, 1825

Genus: *Monopeltis* A. Smith, 1848

Monopeltis capensis capensis A. Smith, 1848 Cape Spade-snouted Worm Lizard

Monopeltis capensis A. Smith, 1848, *Ill. Zool. S. Afr., Rept.*, pl. LXVII. Type locality: "Latitude 24 South" (i.e. near junction of Limpopo and Motwan Rivers, western Transvaal [FitzSimons, 1943, p. 391]).

Monopeltis capensis capensis A. Smith: FitzSimons, 1943, p. 391, figs 279-281; Broadley, Gans & Visser, 1976, p. 385, figs 45-47 (var. A); De Waal, 1978, p. 76; Branch, 1988a, p. 107, pl. 41.

Range

Central and eastern Namibia, Kalahari region of the southern half of Botswana and northern Cape Province, O.F.S. (excluding north-east), Transvaal and southern Mozambique Plain.

Zoogeographical classification: Western Temperate Transitional.

Range cluster in O.F.S.: Western (W).

Distribution in the Orange Free State (20 localities; Fig. 78)

Specimens examined from: Bainsvlei; Bloemfontein; Brandfort; Hendrik Verwoerd Dam; Holme's Dale; Lemoenboord; Kelly's View; Krugersdrift Dam; Kwaggafontein; Rhenosterspruit; Rietkuil; Rietspruit; Richmond West (TM).

Other records: Bloemfontein, General de Wet (TM 47634); De Brug (TM 48323); Bothaville; Glen; Odendaalsrus (FitzSimons, 1943); Kroonstad (Broadley, Gans & Visser, 1976).

Features (159 specimens examined)

Body cream coloured in alcohol (pink in life). All O.F.S. specimens lack dark pigmentation. Segments of pectoral region enlarged, forming elongate shields. Snout depressed, with sharp horizontally projecting edge. A single, large shield covers the head. Tail rounded at its termination; enlarged scales in the region of the vent. Three specimens were mutilated, namely NMB R4604 and 5767 (posterior part of body missing) and 5756 (anterior part of body missing).

Habitat and Ecology

This fossorial amphisbaenid was found in damp soil and sand on river banks, and one was collected from a Suricate *Suricata suricata* burrow in the O.F.S. (De Waal, 1978, p. 77). Specimens are often ploughed up or flooded out after rain, when they are forced to the surface for air (FitzSimons, 1943, p. 392). According to Jacobsen (1989, p. 710), they inhabit sandy soils at a depth of 20 cm or less below the soil surface. Several lamellicorn larvae were recovered from the stomach of an O.F.S. specimen (De Waal, 1978). Enemies include Yellowbilled Kites, Bateleurs, hornbills, jackals and snakes (e.g. *Atractaspis* spp., *Xenocalamus* spp.) (Branch, 1988a, p. 107). According to Branch (1988a), *Monopeltis capensis* females give birth to 1-3 young (measuring 90-100 mm in length) during summer.

Remarks

Broadley, Gans & Visser (1976) recognized three varieties (A, B and C) of *M. c. capensis*. Broadley *et al.* (1976, pp. 387-88) listed 13 O.F.S. localities for var. A, illustrating a specimen from Bothaville (their Figs 45-47). My examination of O.F.S. material, based partly on presence/absence of dark pigmentation on the body, indicated that only var. A occurs in the O.F.S. Variety A also occurs in the extreme south-western Transvaal (Jacobsen, 1989, map 113). The species has a patchy distribution in both the O.F.S. and Transvaal, possibly reflective of its fossorial habits and therefore difficulty in collecting, but populations may be associated with specific soil types (although this could not be confirmed in the O.F.S.).

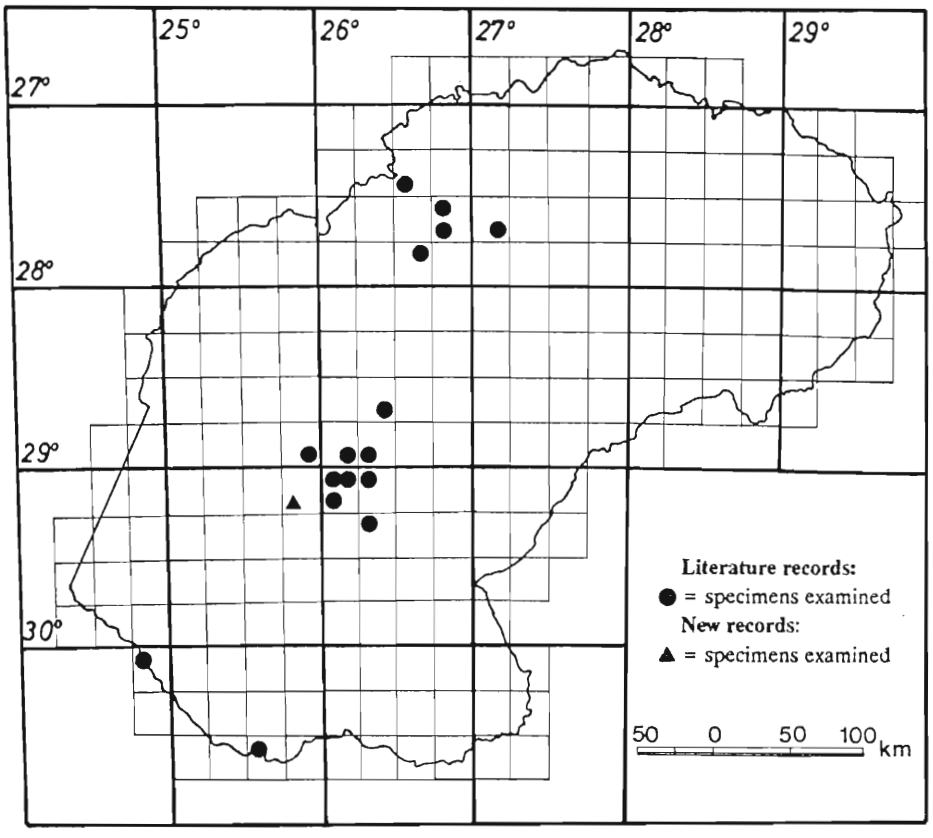


Figure 78: Distribution of *Monopeltis capensis capensis* in the Orange Free State.

Suborder: **SERPENTES** Linnaeus, 1758

(Distribution maps for snakes, represented by Figs 79-108, are presented on pages 286 to 301)

Family: **TYPHLOPIDAE** Gray, 1825

Genus: *Typhlops* Oppel, 1881

Typhlops bibronii (A. Smith, 1846) Bibron's Blind Snake

Onychocephalus bibronii A. Smith, 1846, *Ill. Zool. S. Afr., Rept.*, pl. 1i, fig. 2, pl. 1 iv, figs 5-8. Type locality: North of Latakoo, i.e. Kuruman.

Typhlops bibronii (A. Smith): FitzSimons, 1962, p. 67, figs 2 & 6, pls 1 & I; Roux-Estéve, 1974, p. 138, fig. 90; De Waal, 1978, p. 78; Broadley, 1983/90, p. 40, figs 2 & 5, pl. 1; Branch, 1988a, p. 47, pl. 39; Bates, 1991b, p. 154.

Typhlops bibroni (A. Smith): FitzSimons, 1970/74, p. 66, pl. 2(1).

Range

From the eastern Cape Province northwards to Natal, north-eastern O.F.S., Transvaal, Swaziland and south-eastern Botswana, with isolated records at Morija (western Lesotho), northern Cape and eastern highlands of Zimbabwe.

Zoogeographical classification: Eastern Temperate Transitional.

Range cluster in O.F.S.: Northeastern (NE).

Distribution in the Orange Free State (ten localities; Fig. 79)

Specimens examined from: Arcadia; Clarens (TM 65267); Golden Gate Highlands National Park; Klipplaat; Morgenzon, Harrismith; Op-die-Rivier (TM 37371); Rusthof; Seekoeivlei Nature Reserve (TM 56533); Tafelberg; Tygerfontein.

Features (12 specimens examined)

Largest male (NMB R4300 - Tafelberg) 296 + 6 = 302 mm.

Largest female (NMB R4645 - Rusthof) 389 + 7 = 396 mm.

Dorsum brown, venter cream-yellow. Snout more or less rounded in profile.

Habitat and Ecology

In the O.F.S. this species has been collected in soil under rocks in rocky areas (De Waal, 1978, p. 78), but was also collected in inactive termitaria and under rotting logs in the Transvaal (Jacobsen, 1989, p. 756). Has been collected at an altitude of 2000 m a.s.l. in the Natal Drakensberg (Bourquin & Channing, 1980, p. 15). Prey includes termites and other small invertebrates, including ant eggs (Jacobsen, 1989). Females lay 5-12 thin-walled eggs in late summer (February) and these hatch after 5-7 days (suggesting egg retention), hatchlings measuring 91-124 mm in total length (Erasmus & Branch, 1983). According to these authors, a gravid female (measuring 460 mm total length) from Mbabane, Swaziland, was collected in November and contained eight eggs, two of which measured 21 x 21 mm and 20 x 10 mm respectively. Jacobsen (1989, pp. 756-757) reported finding eggs in hollows under rocks; these varied in size from 16,0 - 20,5 x 11,5 - 13,5 mm to 42,0 - 43,0 x 9,5 - 10,0 mm and weighed 1,40-2,7 g; eggs are retained in the female for almost the duration of the incubation period. Broadley (1990, p. 42) gives egg sizes as 20-30 x 9-12 mm; while FitzSimons (1974, p. 67) stated that up to eight eggs measuring on average 25 x 12 mm are laid at a time. Yeadon (1991c, p. 23) reported on a record-sized specimen (468 + 8 = 476 mm) collected on the farm Rocliffe in Natal which laid 14 "half creamy, half purplish pink" eggs on 15 January.

Remarks

T. bibronii and *T. lalandei* are allopatric in the O.F.S., the former replacing the latter in the north-eastern O.F.S. Jacobsen (1989, p. 257) noted that the taxonomic status of *T. bibronii* requires revision due to anomalies in colour and midbody scale counts in the Transvaal. The "Vredefort Road" record of Roux-Estéve (1974, p. 146) is not plotted on her map (plate VI), but there is a plot in the Bloemfontein area. FitzSimons' (1962) Bloemfontein record is probably erroneous, as two Transvaal Museum specimens (TM 4852, 4954) examined by me were determined to be *T. lalandei*. De Waal (1978) also noted that specimen TM 4954 was a *T. lalandei* and not a *T. bibronii*.

Typhlops lalandei Schlegel, 1844 Delalande's Blind Snake

Typhlops lalandei Schlegel, 1844, *Abbild. Amph.*, p. 38, pl. 32, figs 17-20. Type locality: Cape of Good Hope; FitzSimons, 1974, p. 70; Broadley, 1983/90, p. 43, figs 7 & 8, pl. 4; Branch, 1988a, p. 47, pl. 39.

Typhlops delalandii Schlegel: Boulenger, 1910, p. 498; FitzSimons, 1962, p. 71, fig. 9.

Typhlops bibronii (not A. Smith): Boulenger, 1910, p. 498 (part; Malmesbury only, not Smithfield - *vide* FitzSimons, 1962, p. 73).

Typhlops delalandei Schlegel: FitzSimons, 1970, p. 70.

Typhlops (Onychocephalus) Lalandei var. *paucisquamosa* Schlegel: Boettger, 1883, p. 155.

Rhinotyphlops lalandei (Schlegel): De Waal, 1978, p. 79; Roux-Estéve, 1974, p. 158, fig. 109.

Range

Cape Province (excluding the east), Orange Free State (excluding the north-east), Transvaal, Swaziland, Zimbabwe (excluding the north-east) and eastern Botswana; also southern, central and western Namibia (apart from the southern Namibia record, the other two are apparently isolated).

Zoogeographical classification: Cape Temperate.

Range cluster in O.F.S.: Non-Northeastern (Non-NE).

Distribution in the Orange Free State (59 localities; Fig. 79)

Specimens examined from: Babel; Bainsvlei; Bergkloof; Bergkraal; Bergplaats, Bloemfontein; Bloemfontein (NMB; TM 4852; 4954); Bloemfontein (Langenhoven Park); Bultfontein; Carlie; Cecilia; Ceylon; De Brug; Doornbult; Dundee; Florisbad; Houmoed; Kaffirrivier Dam; Klipdrift; Klipfontein; Klipplaatdrift, Winburg; Knellpoort; Kranskop; Krugersdrift Dam; Leeuwkop; Leliehoek; Lemoenboord; Lessingskop; Littlecote; Middelbron; Milambi; Morgenzon, Senekal; Naval Hill; Newlands A; Ongegund; Petra; Poortje, Edenburg; Rohallion; Roodekop (TM 4862); Spijtfontein; Straalfontein; Tempe; Thaba Pachoa Berg; Triangle; Tussen-die-Riviere Game Farm; Uitkijk; Van der Walt's Rust; Vergaderrand; Vissershoek West; Welbedacht; Weltevreden, Smithfield; Whitehills; Wolvekop, Kroonstad; Zandfontein; Zuurfontein.

Other records: Smithfield (Boettger, 1883); Philippolis; Tweespruit (FitzSimons, 1962); Willem Pretorius Game Reserve (De Waal, 1978).

Features (127 specimens examined)

Largest specimen, unsexed (NMB R4830 - Lemoenboord) 339 + 5 = 344 mm.

Dorsum brown, venter cream-yellow. Snout with a sharply angular, keratinized horizontal edge.

Habitat and Ecology

Usually found in soil under rocks but occasionally also in inactive termitaria in the O.F.S. (De Waal, 1978, p. 80); NMB R5008-09 were collected in a house. Also collected from under rotting logs in the Transvaal (Jacobsen, 1989, p. 761). Found at altitudes of 250-1600 m a.s.l. in the Transvaal (Jacobsen, 1989). One female collected at Willem Pretorius Game Reserve in the O.F.S. contained two eggs (De Waal, 1978), while Branch (1988, p. 47) reported that females lay 2-4 eggs. The diet consists of small subterranean insects, especially termites and their eggs (Broadley, 1990, p. 45). Broadley (1966, p. 282) recorded a specimen from Whitewaters in Zimbabwe which had been swallowed tail first by an *Atractaspis bibronii*.

Remarks

Jacobsen (1989, p. 762) suggested that the taxonomic status of *T. lalandei* requires revision because of the occurrence of two colour forms and variable rostral shields, and their geographical distribution in the Transvaal. The Willem Pretorius record is not plotted on Roux-Estéve's (1974, p. 159) distribution map (plate VII).

Family: **LEPTOTYPHLOPIDAE** Stejneger, 1891

Genus: *Leptotyphlops* Fitzinger, 1843

Leptotyphlops scutifrons scutifrons (Peters, 1854) Peters's Thread Snake

Stenostoma scutifrons Peters, 1854, *Monatsb. Akad. Wiss. Berlin*, p. 621. Type locality: Sena, Mozambique.

Stenostoma nigricans (not Schlegel, 1839): Boettger, 1883, p. 156.

Glauconia conjuncta (not Jan, 1861): Gough, 1908, p. 20 (part).

Leptotyphlops scutifrons (Peters): FitzSimons, 1962, p. 86, fig. 18, pl. VI and 1970/74, p. 74, pl. 2(2) (part).

Leptotyphlops conjuncta (not Jan): FitzSimons, 1962, p. 84, figs 11 & 16, pl. V (part) and 1970/74, p. 74 (part).

Leptotyphlops scutifrons scutifrons (Peters): De Waal, 1978, p. 80; Broadley, 1983, p. 57, fig. 17; Branch, 1988a, p. 49, pl. 40 (part); Bates, 1990c, p. 68 and 1991b, p. 154.

Leptotyphlops conjunctus conjunctus (not Jan): Broadley, 1983, p. 55, figs 13 & 16 (part); Branch, 1988a, p. 49 (part).

Range

Throughout the northern half of southern Africa, from southern Tanzania south to the northern and north-eastern Cape Province and Transkei; absent from southern Namibia and the rest of the Cape Province, and apparently also absent on the southern Mozambique Plain.

Zoogeographical classification: Tropical Wide Ranging.

Range cluster in O.F.S.: Throughout (T).

Distribution in the Orange Free State (45 localities; Fig. 80)

Specimens examined from: Bergkloof; Berlin; Bethlehem, 16 km north of (TM 50790); Bloemfontein (TM 5000, 5010, 5046); Boschkloof; Bramley's Hoek; Dealbata; Dipka; Falle Grange; Frazer Spruit; Goedetrouw; Golden Gate Highlands National Park; Greenlands; Grootkloof; Harrismith (DHSM 1159); Klipoog; Maanhaar; Machbela; Mecklenburg; Milambi; Mooigelegen; Morgenzon, Harrismith; Morgenzon, Senekal; Op-die-Rivier (TM 43175-76); Parys (TM 24632); Rietfontein, Vrede; Rustfontein Dam; Rusthof; Tafelberg; Tweespruit (TM 4969, 4973); Tygerfontein; Van Aswegen's Hoek; Van der Walt's Rust; Viljoens Drift (NMZB-UM 31422-23); Vissershoek West; Waterfall; Waterhoek; Welgegund; Willem Pretorius Game Reserve (TM 29772-73); Wolvenfontein; Woudzicht; Zoetbron; Zomervlakte.

Other records: Smithfield (Boettger, 1883); Vrede (FitzSimons, 1962); Orange River Colony (Gough, 1908).

Features (112 specimens examined)

Largest male (NMB R4094 - Vissershoek West) 145 + 15 = 160 mm.

Largest female (NMB R2889 - Waterhoek) 198 + 15 = 213 mm.

Body very thin, thread-like. Dorsum dark brown to black in colour. Venter a somewhat paler brown.

Habitat and Ecology

In the O.F.S. this species has been found in soil under rocks, in inactive termitaria (De Waal, 1978, p. 81) and in partly dried-out cow dung (Bates, 1990c, p. 68). In the Transvaal, Jacobsen (1989, pp. 784-785) recorded the species from under stones, rotting logs and among grass roots adjacent to rocks or inactive termite mounds; it was occasionally found on the surface of soil during or after heavy rains. Feeds on small invertebrates such as termites (Broadley & Watson, 1976, p. 506). De Waal (1978, p. 81) recorded gravid females with 3-4 eggs in November and December in the O.F.S., the largest intact eggs measuring 14 x 3,5 mm. Jacobsen (1989, p. 785) reported that Transvaal females laid five elongate eggs at a time, whereas Branch (1988a, p. 49) gave clutch size as 3-7 and noted that eggs may remain attached to one another, as in a string of sausages. According to Broadley & Watson (1976), it is possible that *Leptotyphlops* species lay more than one clutch of eggs during summer. Enemies of *L. s. scutifrons* include small mammalian carnivores such as foxes, jackals, genets and mongooses; while a specimen was also found in the stomach of a sand snake, *Psammophis s. sibilans* (Broadley, 1966, p. 290).

Remarks

FitzSimons (1962) recorded both *L. scutifrons* and *L. conjuncta* from Tweespruit (and Ubombo). De Waal (1978) was unable to separate *L. scutifrons* and *L. conjunctus* in the O.F.S., treating all specimens as *L. s. scutifrons*. De Waal (1978) noted that rostral width/supranal width ratio showed a gradient of 1,2-2,4 in the O.F.S., and also noted that other characteristics used by Broadley & Watson (1976) were not suitable for separating *conjunctus* from *scutifrons*. In his examination of Transvaal specimens of the *scutifrons - conjunctus - incognitus* complex, Jacobsen (1989) expressed similar uncertainties, noting that the "size and shape of the rostral and the number of dorsal scales from rostral to caudal spine are not always clear-cut" (p. 776) and "overlaps of most characters occur, making the identification of many specimens difficult" (p. 785). Broadley (1983/90, p. 56) noted that specimens listed by De Waal (1978, p. 81) from Vissershoek West; Morgenzon, Senekal and Dealbata "can be assigned to *L. s. scutifrons*, the others conform to *L. c. conjunctus*, although the rostrals are rather broad in many cases." Broadley (1983/90, p. 57) also noted that although De Waal (1978) indicated that the total length/tail length ratio of 11,5 separates the sexes in O.F.S. populations and De Waal (p. 83) considered *L. conjunctus* (and its subspecies *incognitus*) synonyms of *L. s. scutifrons*, this would imply that some areas are populated only by males and others only by females. Broadley (1990, p. 57) thus suggested that *conjunctus* may be a south-eastern race of *L. scutifrons*, with *L. incognitus* a full species.

As indicated by all of the above authors, a detailed analysis of the taxonomic status of this species complex is urgently required. Such a study was considered beyond the scope of the present one, and as I have myself experienced difficulty in separating O.F.S. material, I have followed De Waal (1978) in treating, at least provisionally, all specimens as *L. s. scutifrons*. Trinomials are required for *L. scutifrons* as *L. s. merkeri* (Werner) is considered a valid northern subspecies (Broadley & Watson, 1976).

Family: **COLUBRIDAE** Gray, 1825

Subfamily: **LYCODONTINAE**

Genus: *Lycodonomorphus* Fitzinger, 1843

Lycodonomorphus rufulus (Lichtenstein, 1823) Common Brown Water Snake

Coluber rufulus Lichtenstein, 1823, *Verz. Dubl. Zool. Mus. Berlin*, p. 105. Type locality: "South Africa".

Ablabophis rufulus (Lichtenstein): Gough, 1908, p. 21.

Lycodonomorphus rufulus rufulus (Lichtenstein): FitzSimons, 1962, p. 106, fig. 22, pl. IX and 1970, p. 83, pl. 5(3).

Lycodonomorphus rufulus (Lichtenstein): FitzSimons, 1974, p. 83, pl. 5(3); De Waal, 1978, p. 85; Broadley, 1983/90, p. 76, figs 32 & 33, pl. 9; Branch, 1988a, p. 58, pl. 32; Bates, 1988a, p. 51 and 1991b, p. 154.

Range

From the south-western Cape Province eastwards along the southern Cape coast and then northwards through the eastern half of southern Africa to southern Mozambique and northern Transvaal; north of the Limpopo Basin there are populations in eastern Zimbabwe and adjacent Mozambique.

Zoogeographical classification: Cape Temperate.

Range cluster in O.F.S.: Eastern (E).

Distribution in the Orange Free State (22 localities; Fig. 81)

Specimens examined from: Bergkraal; Bloemfontein (TM 34952); Golden Gate Highlands National Park (NMB; TM 35685); Laveno; Lusthof (TM 34645); Manchester; Op-die-River (TM 37998); Rietspruit; Rouxville; Rustfontein Dam; Seekoeivleipoort; Shannon; Thaba Pachoa Berg; Tweespruit (TM 6019); Vergaderrand; Welbedacht Dam.

Other records: Harrismith; Heilbron Townlands; Parys; Thaba 'Nchu; Winburg (FitzSimons, 1962); Orange River Colony (Gough, 1908); Bloemfontein, Uitsig (previously captive specimen; J.C.P. van Wyk, pers. comm.).

Features (23 specimens examined)

Largest male (NMB R4452 - Rustfontein Dam) 442 + 150 = 592 mm.

Largest female (TM 37998 - Op-die-Rivier Game Farm) 608 + 146 = 754 mm.

Dorsum light to dark brown. Venter pale yellow, sometimes cream. Upper labials mostly pale (cream to white).

Habitat and Ecology

Found in or near dams and rivers in the O.F.S. (De Waal, 1978, p. 85); one specimen was collected from under a large sheet of rock about 20 metres from the edge of a stream, and another (NMB R5826) was collected in a garden at Welbedacht Dam. The species has also been found in holes near water and in swampy areas, and at altitudes of 1000-2000 m a.s.l. in the Transvaal (Jacobsen, 1989, p. 805). This non-poisonous species is nocturnal and readily enters water in search of frogs, tadpoles and small fish (Broadley, 1990, p. 77) which are taken to the shore before being constricted and swallowed. A specimen was observed in a small dam in Bloemfontein while apparently chasing a *Cacosternum boettgeri* seated on a mat of grass in the dam (J.C.P. van Wyk, pers. comm.). De Waal (1978) recorded a *Xenopus laevis* in the stomach of an O.F.S. specimen. The species is also known to take small rodents in captivity (Marais, 1985, p. 81), although this is probably seldom the case in nature. Although usually solitary, several specimens may be found together in favourable conditions (Jacobsen, 1989), probably

in situations were the food supply is abundant. Two gravid females collected in the O.F.S. in October each contained five eggs (De Waal, 1978), whereas a female captured in Bloemfontein laid six eggs while in captivity, these hatching out about April (J.C.P. van Wyk, pers. comm.). In the Transvaal, 3-10 eggs measuring 36,0 x 14,0 mm are laid during midsummer (Jacobsen, 1989). Jacobsen (1989) reported that four eggs, incubated at 20,7-31,5°C, hatched after 37 days, neonates measuring 161,0-176,0 mm SVL and weighing 2,70-2,75 g; and noted that juveniles of 132,0-173,0 mm SVL were collected from October to May, indicating a lengthy reproductive season. Dyer (1979, p. 6) recorded a clutch of ten eggs laid in midsummer and gave egg sizes (two clutches) as 29,5-30 x 15-17 mm; eight of the ten eggs of one clutch hatched after 46 days, the hatchlings measuring 80-100 mm. According to Broadley (1990, p. 78), 6-10 eggs are laid in midsummer and hatch about after about two months to produce hatchlings measuring about 15 cm in length. Five eggs were found under a rock at Bushman's River in Giants Castle Game Reserve; these hatched on 18 April (Bourquin & Channing, 1980, p. 16).

Genus: *Lamprophis* Fitzinger, 1843

Lamprophis fuscus Boulenger, 1893 — Yellow-bellied House Snake

Lamprophis fuscus Boulenger, 1893, *Cat. Snakes Brit. Mus.*, 1, p. 322, pl. 20, fig. 4. Type locality: "Cape of Good Hope". FitzSimons, 1962, p. 109, fig. 23, pl. X; De Waal, 1978, p. 85; Broadley, 1983/90, p. 80, figs 37 & 38; Branch 1988a, p. 60, pl. 32.

Range

From Cape Town in the south-western Cape Province eastwards through the eastern half of the O.F.S., Natal (including Drakensberg) and eastern Transvaal, in apparently isolated populations.

Zoogeographical classification: Cape Temperate (possibly Afromontane).

Range cluster in O.F.S.: Eastern (E).

Distribution in the Orange Free State (two localities; Fig. 82)

One specimen examined from: Dealbata (NMB R3566).

Other records: Smithfield (FitzSimons, 1962).

Features (one specimen examined)

Largest specimen, a female (NMB R3566 - Dealbata) 178 + 47 = 225 mm.

Dorsum grey-brown; belly and underside of tail cream. Top of head a darker brown than back.

Habitat and Ecology

One of the O.F.S. specimens was collected in an inactive termitarium in open grassland (De Waal, 1978, p. 86), as were two specimens from near Suurberg Pass in the eastern Cape Province (Branch, 1990, p. 37). Specimens from Giants Castle Game Reserve and Cathedral Peak in the Natal Drakensberg were collected in rocky or wooded open grassland at altitudes of 1830 and 2440 m a.s.l. (Bourquin & Channing, 1980, p. 16). Jacobsen (1989, p. 814) recorded the species at altitudes of 1700-1800 m a.s.l. in the Transvaal. A specimen from Kommetjie (Cape Peninsula) was found under a stone in a *Restio* area within 100 m of the sea, while another specimen from Bain's Kloof was collected while moving through *Restio* near a river during mid-day (Visser, 1979, p. 43). The largest recorded specimen, from Hutton Heights in Natal, measured 618 + 118 = 736 mm (Haagner, 1991, p. 24). The diet consists mainly of lizards (Branch, 1988, p. 60), and Marais (1992, p. 138) noted that a *Tropidosaura montana* was recovered from the stomach of a southern Cape specimen. Nothing is known about the reproduction of this rare species, but it is probably oviparous and similar to that of other *Lamprophis* species.

Lamprophis aurora (Linnaeus, 1754) Aurora House Snake

Coluber aurora Linnaeus, 1754, *Mus. Adolph. Frid.*, p. 25, pl. 19, fig. 1. Type locality: "America", in error, from Africa.

Lamprophis aurora (Linnaeus): Symonds, 1887, p. 488; Gough, 1908, p. 21; Boulenger, 1910, p. 504; Bogert, 1940, p. 19; FitzSimons, 1962, p. 112, fig. 25, pl. XI and 1970/74, p. 87, pl. 6(1); De Waal, 1978, p. 86; Broadley, 1983/90, p. 83, fig. 41, pl. 11; Branch, 1988a, p. 59, pls 25 & 32.

Range

South-western, southern and north-eastern Cape Province, Lesotho, Natal, O.F.S., northern Cape and Transvaal (excluding the north-west), with single records near Serowe in south-eastern Botswana and Karoo National Park in central Cape Province.

Zoogeographical classification: Cape Temperate.

Range cluster in the O.F.S.: Non-Southwestern (Non-SW).

Distribution in the Orange Free State (42 localities; Fig. 83)

Specimens examined from: Bachelor's Home; Bethany; Bethel; Bloemfontein; Bon Haven; Boschkloof; Brockenhurst; Cecilia; Die Hoogte; Edenville (TM 36625); Florisbad; Grootkrans; Hoogeveld; Kroonstad; Houtkop; Kasteelkop; Klipoog; Littlecote; Loskop; Milambi; Mooigelegen; Morgenzon, Harrismith; Muller's Rust (TM 62917); Olive Hill; Oorsprong; Rambouillet; Rietspruit; Rouxville; Rusthof; Spijtfontein; Tweespruit (TM 6046); Venus; Verdun, Fouriesburg; Willem Pretorius Game

Reserve (TM 27267-69); Woudzicht; Zandvoort.

Other records: Kroonstad (Symonds, 1887); Smithfield (Boulenger, 1910); Bainsvlei; Shannon; Thaba 'Nchu (FitzSimons, 1962); Orange River Colony (Gough, 1908).

Features (56 specimens examined)

Largest male (NMB R3140 - Bloemfontein) 406 + 96 = 502 mm.

Largest female (NMB R6854 - Thaba 'Nchu, near Selosesha School) 670 + 104 = 774 mm.

Dorsum olive green with orange vertebral stripe from top (centre) of head to tip of tail; belly white.

Habitat and Ecology

Specimens from the O.F.S. were usually collected in inactive termitaria, but were also found under rocks (De Waal, 1978, p. 87). Two specimens were collected in pit traps in open grassland at Florisbad. In the Transvaal this species was found in grassland, often alongside or near streams or under stones, but less commonly in termitaria. This non-poisonous, nocturnal constrictor preys mainly on small rodents, but also takes lizards, particularly skinks and lacertids (Broadley, 1990, p. 84). De Waal (1978, p. 87) recorded rodent remains in the alimentary canals of several O.F.S. specimens, and one snake contained lacertid remains. According to Marais (1985, p. 80), frogs are also taken. Broadley (1990, p. 84) noted that 8-12 oval eggs measuring 35 x 20 mm are laid, and hatchlings measure 200 mm in total length. A juvenile (NMB R5675) measuring 207 + 46 = 253 mm was collected at Florisbad in October. Dyer (1979, p. 6) recorded a clutch of nine eggs with mean dimensions of 41 x 19 mm; the incubation period for eight eggs was 72-78 days and young averaged 100 mm in (total ?) length.

Lamprophis inornatus Duméril & Bibron, 1854 — Olive House Snake

Lamprophis inornatus Duméril & Bibron, 1854, *Erp. Gen.*, 7, p. 464. Type locality: "Environs of the Cape of Good Hope"; FitzSimons, 1962, p. 114, fig. 26, pls. 4 & XII; De Waal, 1978, p. 87; Broadley, 1983/90, p. 84, fig. 42, pl. 12; Branch, 1988a, p. 59, pl. 32; Bates, 1991b, p. 154.

Range

From the south-western Cape Province eastwards along the coastal areas to Natal (excluding the north-east) and northwards through north-eastern O.F.S. to Transvaal (excluding the south-west) and western Swaziland highveld.

Zoogeographical classification: Cape Temperate.

Range cluster in O.F.S.: Drakensberg (D).

Distribution in the Orange Free State: (two localities; Fig. 82)

One specimen examined from: Golden Gate Highlands National Park (NMB R6255).

Other records: Harrismith (FitzSimons, 1962).

Features (one specimen examined)

Largest female (SAM 18029 - Harrismith) 662 + 128 = 790 mm.

Dark coloured, almost black, above and below. Midbody scale rows 22, ventrals 173, subcaudals 62 (Golden Gate specimen). These latter values are 23, 185 and 53 respectively for the Harrismith specimen (De Waal, 1978, p. 88).

Habitat and Ecology

Found under rocks on soil, in or under rotting logs in grassland and occasionally in forests on highveld and escarpment areas of the Transvaal at altitudes of 1500-1800 m a.s.l. (Jacobsen, 1989, p. 821). The diet of this non-poisonous, nocturnal constrictor consists of mice and other small mammals, but lizards and other snakes are also occasionally eaten (Broadley, 1990, p. 86). According to Visser (1972, p. 20), young snakes are partial to lizards, especially geckos. Jacobsen (1989) recorded the skinks *Mabuya varia* and *M. striata punctatissima* being eaten by each of two Transvaal snakes. Broadley (1990, p. 86) noted that 6-12 eggs measuring 38-40 x 24-26 mm are laid during early or midsummer in decaying vegetable matter, and hatch after 4-5 months, the hatchlings averaging 22 cm in length. Jacobsen (1989) collected a clutch of 11 eggs from under a rock in November in the Transvaal; the eggs measured 31,8 - 42,8 x 22,0 - 25,6 mm, with a total mass of 180,0 g (i.e. about 16,36 g per egg). A female from Gravelotte (eastern Transvaal) laid a clutch of five eggs in October while in captivity; eggs measured 35-39 x 20 mm, and one egg, opened after three months, contained a well developed embryo similar in colour to the adult; during October of the following year, a further eight eggs were laid (Bates, 1985, p. 21). The second clutch was also unsuccessfully incubated, and was not checked for embryos. A female from Cato Ridge in Natal laid seven eggs on 5 September; these measured 38,2 - 45,2 x 24,2 - 25,1 mm and hatched on 17/18 November after being incubated at room temperature for 73-74 days; hatchlings measured 206,9-226,5 mm, with individual masses of 4,5-5,1 g (Haagner & Carpenter, 1987, p. 35).

Lamprophis guttatus (A. Smith, 1843) Spotted Rock Snake

Lycodon guttatus A. Smith, 1843, *Ill. Zool. S. Afr. Rept.*, pl. 23. Type locality: "Beyond Kurrichane", i.e. Rustenburg, Transvaal (De Waal, 1978, p. 88), but probably in error for Cape Province (Broadley, 1983/90, p. 86).

Boaedon guttatus (A. Smith): De Waal, 1978, p. 88.

Lamprophis guttatus (A. Smith): Broadley, 1983/90, p. 86, figs 43 & 44, pl. 13; Branch, 1988a, p. 59, pl. 17; Douglas, 1989, p. 20, fig.

Range

South-western Cape Province northwards into Great Namaqualand and southern Namibia, and eastwards through the Cape Fold Mountains to Natal, the mountainous eastern half of the O.F.S., eastern half of Transvaal, Swaziland and adjacent southern Mozambique.

Zoogeographical classification: Cape Temperate (possibly Afromontane).

Range cluster in O.F.S.: Eastern (E).

Distribution in the Orange Free State (six localities; Fig. 84)

Specimens examined from: Ben Nevis; Caledonspoort; Clifford; Kasteelkop; La Belle France; Perth.

Features (six specimens examined)

Largest male (NMB R3410 - Kasteelkop) 394 + 90 = 484 mm.

Largest female (NMB R987 - Perth) 581 + 99 = 680 mm.

Two colour phases occur in the O.F.S. - A: Dorsum sandy-brown with mostly large spots joined at corners, often forming a zig-zag stripe (NMB R987, Perth; 1122, Clifford; 3410, Kasteelkop; these are similar in appearance to the specimen illustrated in plate 17(2) of Branch, 1988a); B: Dorsum greyish with mostly paired paravertebral spots which do not fuse across the midline (NMB R986, Caledonspoort; 4187, La Belle France; 5926, Ben Nevis; [see figure in Douglas, 1989, p. 20]). In all specimens, the spots have brown centres and are black-edged. Additional, smaller dark spots/blotches present on back. Spots extend onto tail. Venter cream with very occasional small dark flecks.

Habitat and Ecology

This secretive, non-poisonous nocturnal constrictor is found under rocks in mountainous or hilly areas of the O.F.S. (De Waal, 1978, p. 89). Found under or between rocks at altitudes of 800-2300 m a.s.l. in the Transvaal (Jacobsen, 1989, p. 825). Preys on lizards such as *Afroedura* spp. , *Pedioplanis burchelli, P. lineoocellata* and *Mabuya varia*, as well as rodents (Jacobsen, 1989). A specimen from Prentjiesberg, Cape Province, regurgitated an adult *Pseudocordylus melanotus subviridis* with a mass 66,43% that of the snake (Branch & Burger, 1991, p. 24). Females lay 3-6 elongate eggs measuring 38x20 mm in midsummer (Branch, 1988a, p. 59). This species may be one of the main predators of *Afroedura nivaria* and *A. karroica halli* in the O.F.S. (Bates, 1989c, p. 34).

Lamprophis fuliginosus (Boie, 1827) Brown House Snake

Lycodon fuliginosus Boie, 1827, *Isis von Oken*, 20, col. 551. Type locality: "Java" - in error for "Africa".

Boodon lineatus (not Duméril & Bibron, 1854): Gough, 1908, p. 22.

Boaedon lineatus mentalis (not Günther, 1888): Bogert, 1940, p. 22.

Boaedon fuliginosus fuliginosus (Boie): FitzSimons, 1962, p. 119, figs. 27 & 29, pls 5 & XIV; 1970, p. 88, pl. 6(2) & 9(2) and 1974, p. 89; De Waal, 1978, p. 89.

Lamprophis fuliginosus (Boie): Broadley, 1983/90, p. 88, figs 36 & 45, pl. 15; Branch, 1988a, p. 58, pl. 28.

Range

Throughout southern Africa, extending northwards to southern Sudan and Ethiopia in the east and Senegal and West Africa (south of the Sahara) in the west.

Zoogeographical classification: Afrotropical (= Ethiopian).

Range cluster in O.F.S.: Non-Northeastern (Non-NE).

Distribution in the Orange Free State (86 localities; Fig. 85)

Specimens examined from: Bergplaats, Bloemfontein; Bethany; Bethel; Beyersfontein; Bloemfontein; Bloemfontein (Dan Pienaar); Bloemfontein (General de Wet); Bloemfontein (Industrial Area); Boschkloof; Boschrand; Boskop; Boshof (TM 6123); Brabant; Carlie; Ceylon; Cornwall; Deelfontein, Bothaville; Di Poort; Doornbult; Florisbad; Geluk, Boshof; Grootkrans; Haagen's Stad; Hendrik Verwoerd Dam wall, 10 km north of (TM 37986); Holme's Dale; Houmoed; Jacobsdal; Kades; Kafferskop; Klipbankfontein; Klipdrift; Klippiespan; Klipplaatdrift, Winburg; Kranskop; La Belle France; Lanquedoc; Leeuwkop; Leeuwkuil; Leliehoek; Lemoenboord; Lemoenhoek; Littlecote; Lorenzo; Lovedale; Mandyville; Merino, Bethlehem; Merriesfontein; Meyerskraal; Morgenzon, Senekal; Mount Nelson; Naval Hill; Patrijsdraai; Petra; Philippolis; Proces; Quaggaspruit; Rohallion; Rondavel; Rondeberg; Spijtfontein; Straalfontein; Strijdfontein, Heilbron; Tempe; Tempe, near to (TM 53305); Triangle; Tweefontein; Uitkijk; Uitkomst; Uitkyk; Vaalkop; Van Aswegen's Hoek; Van der Walt's Rust; Venus; Waterhoek; Welbedacht; Weltevrede; Wilhelmshohe; Willem Pretorius Game Reserve (NMB; TM 27264-66); Wittekopjes; Wolvekop, Kroonstad; Wonderkop; Zoutpan, Fauresmith; O.F.S. ? (MMK 694).

Other records: Brandfort; Luckhoff; Theunissen (FitzSimons, 1962); Kroonstad (Bogert, 1940); Orange River Colony (Gough, 1908).

Features (155 specimens examined)

Largest male (NMB R2821 - Rondeberg) 516 + 101 = 617 mm.

Largest female (NMB R5654 - Dan Pienaar suburb, Bloemfontein) 843 + 131 = 974 mm.

An unsexed specimen (NMB R5271 - Fauna suburb, Bloemfontein) measured 834 + 112 = 946 mm. A specimen (NMB R6735 - Bloemfontein) collected in March measured 393 + 80,5 = 473,5 mm and weighed 22,6 g. Dorsum brown; pale stripe runs from tip of snout, above eye, to back of head. In juveniles this stripe extends (after a break behind the head) onto the anterior part of the body. In NMB R2602, 3225 amd 3646, there is no break in the stripe, which also continues down towards the belly. Juveniles also have pale blotches and occasionally vague pale crossbands anteriorly, as well as vague dark lateral stripes. Dark paravertebral spots may be present anteriorly in juveniles, and NMB R3755 has seven clearly defined pairs of dark paravertebral spots. Belly white.

Habitat and Ecology

A common, non-poisonous, nocturnal constrictor collected from inactive termitaria and under rocks, and also in the vicinity of houses and the ruins of buildings in the O.F.S. (De Waal, 1978, p. 90). Also found under the bark of trees, under logs and debris and in holes in the ground in the Transvaal (Jacobsen, 1989, p. 831), and at altitudes of 400-1800 m a.s.l. Preys mostly on rodents and lizards, but may take birds and their eggs, bats, frogs and other snakes (Broadley, 1966, pp. 300-301; Broadley, 1990, p. 89; Jacobsen, 1989, p. 831; see also references in Haagner, 1987a, p. 9). The following prey were recorded from the stomachs of O.F.S. house snakes: *Pachydactylus c. capensis, Mabuya striata punctatissima, Agama atra (= A. a. atra), Nucras taeniolata ornata (= N. t. holubi), Eptesicus capensis* (bat) and *Suncus* sp. (shrew) (De Waal, 1978, p. 90). A gravid female collected in September in the O.F.S. contained nine small eggs, whereas another female collected in December contained six eggs measuring 43 x 13 mm (De Waal, 1978). According to Broadley (1990, p. 89), up to 16 (usually 8-10) elongately oval eggs measuring 25-50 x 12-24 mm (averaging about 30 x 15 mm) are laid in late spring or early summer in decaying vegetable matter, termitaria or manure heaps; hatchlings emerge in mid- or late summer and measure 220-250 mm in length. Haagner (1987a, p. 9) reported on three clutches laid by wild-caught house snakes. He found that eggs were laid in November and December, the eggs of one clutch hatching in January (after 69 days at 28°C) and producing hatchlings with a mean length of 216,67 mm and a mean mass of 3,81 g. Eggs from the three clutches had mean dimensions of 27,30 x 17,78 mm (mean mass = 4,46 g) (these were successfully incubated), 36,01 x 20,13 mm (mean mass = 7,85 g) and 56,20 x 18,23 mm (mean mass = 9,53) and numbering 18, 11 and 5 respectively. Haagner (1987) also demonstrated that there is a positive correlation between incubation temperature and incubation period, i.e. eggs hatch earlier at higher temperatures. Enemies include cobras, sand snakes, file snakes and birds of prey, especially owls (Pienaar *et al.*, 1983, p. 147).

Remarks

Bogert (1940, p. 22) treated a single specimen of this form from Kroonstad as *Boaedon lineatus mentalis* (Günther, 1888), noting that the snake, a female, had dorsal scale rows of 25-27-19, 211 ventrals, 46 subcaudals, 8 supralabials (4th and 5th entering orbit) and the second pair of chin shields separated by the posterior extension of the anterior pair. However, all of the above values fall into the ranges of *Lamprophis fuliginosus* for the O.F.S. sample examined by De Waal (1978, pp. 90-91), who also noted that four O.F.S. "*L. l. mentalis*" specimens (localities: Lorenzo; Patrijsdraai; Willem Pretorius Game Reserve; Wonderkop) were collected sympatrically with typical *L. fuliginosus* and had posterior sublinguals separated and 4th and 5th supralabials entering the orbit. Broadley (1990, p. 89) noted that *L. lineatus* (Duméril & Bibron, 1854) is currently treated as a valid species, but all citations for southern Africa apparently refer to *L. fuliginosus*.

Genus: *Lycophidion* Fitzinger, 1843

Lycophidion capense capense (A. Smith, 1831) Cape Wolf Snake

Lycodon capensis A. Smith, 1831, *S. Afr. Quart. Journ.*, 1, p. 18 and 1838, *Ill. Zool. S. Afr., Rept.*, pl. v.
Type locality: Restricted to Port Elizabeth by De Waal (1978, p. 91).
Lycophidion capense capense (A. Smith): De Waal, 1978, p. 91; Broadley, 1983/90, p. 92, fig. 48, pl. 16; Branch, 1988a, p. 60, pl. 36.

Range

Eastern Cape Province northwards through most of southern Africa into southern Zambia, but absent from central Botswana, most of the Cape Province, Lesotho and north-eastern O.F.S.; isolated records in the southern Cape.
Zoogeographical classification: Tropical Wide Ranging.
Range cluster in O.F.S.: Non-Northeastern (Non-NE).

Distribution in the Orange Free State (41 localities; Fig. 86)

Specimens examined from: Bergplaats, Bloemfontein; Bethel; Beyersfontein; Boesmansberg; Boschkloof; Boschrand; Boskop; Brabant; Cecilia; Deelfontein, Bothaville; Die Hoogte; Doornplaat; Excelsior; Glen; Hebron; Holme's Dale; Houmoed; Jagersfontein; Klipdrift; Klipplaatdrift, Winburg; Knellpoort; Kraaifontein; Lorenzo; Mara, Vredefort; Meyerskraal; Middeldeel; Middenspruit; Patrijsdraai; Pietersberg; Platberg, Boshof; Proces; Rondeberg; Shannon; Susannasfontein; Tablefarm; Van Der Walt's Rust; Venus; Wilhelmshohe; Willem Pretorius Game Reserve; Wittekopjes; Wonderkop.

Features (80 specimens examined)

Largest male (NMB R3662 - Patrijsdraai) 328 + 50 = 378 mm.
Largest female (NMB R1518 - Pietersberg) 407 + 44 = 451 mm.
Dorsum dark chocolate brown, often almost black (grey in pre-sloughing specimens), usually with scattered white flecks. Venter white, usually with dark spots/patches.

Habitat and Ecology

This slow-moving, mainly nocturnal terrestrial constrictor has been collected primarily from inactive termitaria, but also from under rocks in the O.F.S. (De Waal, 1978, p. 92); a specimen from Tablefarm was collected from under a dead and collapsed prickly pear tree on red Kalahari sand. The species is commonly found in damp situations under stones or vegetable debris (Broadley, 1990, p. 93), but also under logs, and at altitudes of 200-1800 m a.s.l. in the Transvaal (Jacobsen, 1989, p. 842). The teeth of

the upper and lower jaws of this snake are relatively long, needle-sharp and recurved (thus "wolf snake"), and adapted to the snake's main prey of skinks, although rougher-scaled prey such as *Gerrhosaurus* spp. and *Nucras* spp. are also taken (Broadley, 1990, p. 93; Branch, 1976). FitzSimons (1962) also noted that small snakes are occasionally eaten, but this was not confirmed by Branch (1976) in a detailed review of the wolf snake's diet. In the O.F.S., *Panaspis wahlbergii, Mabuya varia* and the gecko *Pachydactylus c. capensis* have been recorded as prey (De Waal, 1978). In a study currently being undertaken, *P. c. capensis* has (so far) been found in as many as five out of 80 O.F.S. *L. c. capense* alimentary canals (Bates, in prep.). Since Branch's (1976) paper, the following additional dietary records have been published - *Panaspis wahlbergii* (regurgitated by a snake from Owen Sithole College, Zululand; Hoffman, 1990, p. 143) and *Mabuya capensis* (in the guts of three specimens from the Cape Province; Branch, 1990a, p. 37). Females usually lay 6-8 eggs measuring 20-24 x 8-10 mm in early summer (Broadley, 1990, p. 93). Broadley (1966, p. 303) recorded 3-7 eggs measuring 22 x 10 mm being laid in November or December in south-east Africa. Auerbach (1987, p. 156) recorded 4-8 eggs measuring 22 x 9 mm being laid in summer in Botswana, and Dyer (1979, p. 6) reported on a clutch of four eggs with mean dimensions of 24 x 12 mm, two of which hatched out after 79 days, producing hatchlings of 68 and 63 mm (total ?) length. Jacobsen (1989, p. 843) noted a clutch of seven Transvaal eggs, laid in midsummer, which measured 19,7 - 22,3 x 9,3 - 10,5 mm; hatchlings measured about 65,0 mm in total length. Broadley (1966, p. 303) recorded a juvenile *L. c. capense* found in the stomach of a snake, *Chilorhinophis g. gerardi*, from Charama Plateau in south-east Africa.

Remarks

This species is apparently absent from the north-eastern O.F.S. and much of the south-eastern Transvaal, although there are records at loci 2729 BC (Broadley, 1990) and 2828 DB (Royal Natal National Park; TM 55454 in Natal).

Genus: *Duberria* Fitzinger, 1826

Duberria lutrix lutrix (Linnaeus, 1758) Southern Slug-eater

Coluber lutrix Linnaeus, 1758, *Syst. Nat.*, ed. 10, 1, p. 216. Type locality: "In Indiis" = South Africa; and 1766, ed. 12, 1, p. 375.

Homalosoma lutrix (Linnaeus): Gough, 1908, p. 25.

Duberria lutrix lutrix (Linnaeus): FitzSimons, 1962, p. 167, fig. 46, pls 10 & XXIII; De Waal, 1978, p. 97; Broadley, 1983/90, p. 104, fig. 58, pl. 19; Branch, 1988a, p. 63, pl. 28; Bates, 1991b, p. 155.

Range

From the south-western Cape Province eastwards to Natal, eastern half of the O.F.S., Transvaal (excluding the west) and Swaziland; replaced in eastern Zimbabwe and adjacent Mozambique by *D. l. rhodesiana*.

Zoogeographical classification: Cape Temperate (possibly Afromontane).

Range cluster in O.F.S.: Eastern (E).

Distribution in the Orange Free State (ten localities; Fig. 87)

Specimens examined from: Bloemfontein; Dasklip; Deelfontein, Bethulie; Ficksburg; Golden Gate Highlands National Park; Heilbron (TM 55386); Leeuwkop; Mooihoek, Lindley (TM 54770-71); Schaapkraal; Thaba 'Nchu (Goronyane High School).

Other records: Orange River Colony (Gough, 1908).

Features (11 specimens examined)

Largest male (NMB R283 - Bloemfontein) 177 + 42 = 219 mm.

Largest female (NMB R6415 - Ficksburg) 290 + 57 = 347 mm (ex-fix.).

An unsexed (damaged) specimen from Goronyane High School in Thaba 'Nchu measured 226 + 35 = 261 mm.

Dorsum with a wide, pale brown longitudinal band which extends to tip of tail; within the band is a thin, dark vertebral stripe from nape which barely reaches base of tail. Flanks grey-brown. Specimens NMB R6254 (GGHNP) and 6415 (Ficksburg) are entirely dark brown above, possibly representing a pre-sloughing condition. Venter mostly white, but lateral edges dark brown. Ventrals in males 108-123 (N = 3), in females 123-130 (N = 4); subcaudals in males 36-41, in females 26-33. Scale counts were not determined for specimens recorded by De Waal (1978, p. 97), but De Waal gave these values as ventrals 119-130, and subcaudals 39-42 (males) and 27 (females). The recorded range of ventrals in thus 108-130, and subcaudals 36-42 (males) and 26-33 (females). Anal single.

Habitat and Ecology

This secretive, slow-moving, nocturnal, non-poisonous snake is of rare occurrence in the O.F.S. It has been found under rocks, in inactive termitaria (De Waal, 1978, p. 98), in a garden about 50 m from natural vegetation (TM 55386) and dead on roads in the eastern half of the province. According to Broadley (1990, p. 106), the species favours damp localities, but has also been collected under stones, rotting logs, building rubble and pieces of iron, as well as under plant litter, though rarely in termite mounds, at altitudes of 1300-2300 m a.s.l. in the Transvaal (Jacobsen, 1989, p. 860). A female (NMB R6415) collected during March in Thaba 'Nchu contained 14 vitellogenic follicles (no signs of embryos), and the undigested soft part of a snail in the stomach. The diet apparently consists exclusively of slugs and snails (e.g. *Sheldonia* spp., *Helix adspersa*); the forepart of a snail is seized and gradually swallowed, excluding the shell (Broadley, 1990). De Waal (1978) recorded a gravid female with eight

small eggs collected in March, and another with eleven well developed eggs collected in October. The species is ovoviviparous, with 6-12 (usually six) young born from October to February (usually in late summer, i.e. February) and hatchlings measure 80-90 mm in total length; the number of young is apparently correlated with the size of the female (Broadley, 1990). Jacobsen (1989, p. 860) reported 5-23 young being born during mid- to late summer in the Transvaal, but noted that these figures refer to embryos at an early stage of development. Dyer (1979, p. 6) reported that a female measuring 600 mm gave birth in mid-February to ten neonates (six males, four females) measuring an average of 100 mm in (total ?) length, and Haagner (1987, p. 36) reported on a female of 342 mm total length which gave birth in December to 15 young measuring 82-102 mm (mean = 94,3 mm) and weighing 0,4-1,0 g. Haagner (1987b) does not support Broadley's (1990) contention that larger females bear more young. Defence reactions begin with the release of the lower intestinal contents, followed by coiling of the body into a tight roll (Visser, 1972, p. 31); the snake does not bite if handled, but may squirm (Broadley, 1990).

Genus: *Pseudaspis* Fitzinger, 1843

Pseudaspis cana (Linnaeus, 1754) Mole Snake

Coluber cana Linnaeus, 1754, *Mus. Adolph. Frid.*, 1, p. 31, pl. xi, fig. 1; 1758, *Syst. Nat.* ed. 10, 1, p. 22 and 1768, *Syst. Nat.*, ed. 12, 1, p. 382. Type locality: "Indiis", i.e. Africa.

Coronella cana (Linnaeus): Symonds, 1887, p. 486.

Pseudaspis cana (Linnaeus): Gough, 1908, p. 23; Boulenger, 1910, p. 506; Hewitt & Power, 1913, p. 162; FitzSimons, 1962, p. 162, fig. 44, pls 8, 9 & XXI; 1970, p. 105, pl. 7(3) and 1974, p. 106; De Waal, 1978, p. 96; Broadley, 1983/90, p. 108, figs 60-63, pl. 20; Branch, 1988a, p. 63, pls 18, 28 & 35; Bates, 1991b, p. 155.

Range

Virtually throughout southern Africa, including Robben Island, extending northwards into Angola in the west and Kenya in the east; apparently absent from most of the central Karoo, Lesotho and most of Mozambique; recently recorded from the north-eastern Transvaal, at Giyani, for the first time (Haagner, 1990a, p. 56).

Zoogeographical classification: Cape Temperate.

Range cluster in O.F.S.: Non-Northeastern (Non-NE).

Distribution in the Orange Free State (57 localities; Fig. 88)

Specimens examined from: Baltespoort; Bloemfontein; Bloemfontein (Pelisier Park); Bloemfontein (Rayton); Dealesgift; De Brug Station; Grasslands; Golden Gate Highlands National Park; Florisbad; Glen; Hartebeestfontein, Bloemfontein; Herzogville; Karreepoort; Kolbe; Krugersdrift Dam; Meriba; Merino, Bloemfontein; Musgrove (near to); Platkop; Rietfontein, Bultfontein; Rietspruit; Sandveld Nature Reserve (SNR 1); Schoongezicht; Somerset; Sweet Home; The Willows; Utopia; Vaalbank Zuid; Vet River - Bloemhof Dam junction; Welgedacht; Welkom; Zandvoort.

Other records: Kroonstad (Symonds, 1887); Smithfield (Boulenger, 1910); Fauresmith (Hewitt & Power, 1913); Bethulie; Bloemfontein; Bothaville; Brandfort; Bultfontein; De Brug; Edenburg; Harrismith; Henneman; Hertzogville; Hoopstad; Karee; Odendaalsrus; Petrusburg; Philippolis; Prior; Thaba 'Nchu; Theunissen; Tweespruit; Viljoenskroon; Winburg; Zastron (FitzSimons, 1962); Orange River Colony (Gough, 1908); Holfontein (TM 24635-6); Mersey (TM 65125); Stoke Farm (TM 57344).

Features (48 specimens examined)

Largest male (NMB R2645 - Karreepoort) 1218 + 253 = 1471 mm.

Largest female (NMB R989 - Somerset) 862 + 135 = 997 mm.

NMB R6787 (Skoongesigt) measured 1045 + 236 = 1281 mm and weighed 729 g.

NMB R6790 (Meriba) measured 1027 + 243 = 1270 mm and weighed 945,5 g.

NMB R6789 (near Musgrove) measured 1070 + 228 = 1298 mm and weighed 652,7 g.

NMB R6786 (Bloemfontein) measured 1000 + 256 = 1256 mm and weighed 814,9 g.

Dorsum usually light brown or grey, sometimes with poorly defined darker patches (always present in juveniles). Six specimens are melanistic (NMB R600, 3047, 4571, 4864, 5258, 5262), although in NMB R5258 some of the throat scales are white. Belly and underside of tail cream, but usually with either a grey centre or dark markings on the lateral parts of the ventrals. The bellies of NMB R6789 and 6790 are pinkish in colour (fresh specimens).

Habitat and Ecology

This non-poisonous, burrowing constrictor is found in open grassland, in rodent burrows and under rocks in the O.F.S. (De Waal, 1978, p. 97). Adults feed mostly on moles, mole-rats, rats, gerbils and other small ground-living mammals, although bird eggs are also taken and swallowed whole; young snakes prey mainly on lizards and are therefore often found in rocky areas providing suitable habitat for such prey (Broadley, 1990, p. 109). De Waal (1978) found the remains of small mammals in the stomachs of several O.F.S. specimens. Symonds (1887, p. 486) noted that a captive specimen from Kroonstad fed on frogs. De Waal (1978) recorded a juvenile *Pseudaspis cana* from the stomach of a Fork-marked Sand Snake *Psammophis leightoni trinasalis* and noted that a captive Cape Cobra *Naja nivea* consumed a *P. cana*. Mating usually occurs in late spring (October) when males become involved in fierce fights, often severely gashing each other (Broadley, 1990, p. 109). Mole snakes are viviparous, giving birth to an average of 30-50 young during March or April; hatchlings measure about 20 cm in length; the number of young may occasionally exceed 50, the record being 95 (Broadley, 1990). Boycott (1990, p. 56) reported on the reproductive behaviour of captive Mole Snakes at the Transvaal Snake Park and found that copulation took place in September, the gestation period was 182 days and 30-40 young were born in February and March; hatchlings measured 254-312 mm total length and weighed 7-10 g; the first slough occurred 12-16 days after birth.

Remarks

De Waal (1978, p. 97) suggested that FitzSimons' (1962) Harrismith record needs confirmation. The Golden Gate specimen confirms it and the occurrence of this species in the extreme north-eastern O.F.S. The species has also been collected near the O.F.S. border at loci 2729-Db3 and 2729-Dd4 in Natal (Bourquin, 1990a, p. 36).

Genus: *Psammophylax* Fitzinger, 1843

Psammophylax rhombeatus rhombeatus (Linnaeus, 1754) Spotted Grass Snake

Coluber rhombeatus Linnaeus, 1754, *Mus. Adolph. Frid.*, p. 27, pl. xxiv, fig. 2; 1758, *Syst. Nat.*, ed. 10, 1, p. 220 and 1766, *Syst. Nat.*, ed. 12, 1, p. 380. Type locality: "In Indiis", i.e. South Africa.

Psammophylax rhombeatus var. *trilineata* Boettger, 1883, *Ber. Tät. offenb. Ver. Naturk.*, p. 156. Type locality: "Smithfield, Transvaal" = Smithfield, Orange Free State.

Trimerorhinus rhombeatus (Linnaeus): Gough, 1908, p. 28; Boulenger, 1910, p. 511.

Psammophis sibilans (not Linnaeus): Symonds, 1887, p. 487.

Cerastes tritaeniatus tritaeniatus (not Günther, 1868): Bogert, 1940, p. 77, fig. 15C.

Psammophylax rhombeatus (Linnaeus): FitzSimons, 1962, p. 210; 1970/74, p. 126/127, pl. 14(1).

Psammophylax rhombeatus rhombeatus (Linnaeus): Broadley, 1977c, p. 21, figs 5A-D, 7 & 8, pl. II; De Waal, 1978, p. 105; Broadley, 1983/90, p. 121, figs 73 & 74, pls 24 & 25; Branch, 1988a, p. 69, pls 17 & 22; Bates, 1991b, p. 155.

Range

From the south-western Cape Province eastwards to Lesotho, Natal, eastern half of the O.F.S., most of the Transvaal (excluding the west) and highveld of western Swaziland; isolated relict populations in western Namibia, Little Namaqualand and northern Cape near Kimberley. Replaced by *P. r. ocellatus* in southern Angola.

Zoogeographical classification: Cape Temperate.

Range cluster in O.F.S.: Eastern (E).

Distribution in the Orange Free State (74 localities; Fig. 89)

Specimens examined from: Aberdeen; Annie's Rust; Ben Nevis; Bergplaats, Dewetsdorp; Berlin; Beth-Aven; Bethel; Bloemfontein; Brakfontein (TM 55232); Brockenhurst; Campen; Carlie; Dealbata; Deelfontein, Bethulie; Dipka; Di Poort; Excelsior, Ladybrand; Franshoek; Goedetrouw; Greenlands; Golden Gate Highlands National Park (NMB; TM 44865); Hammanskraal West; Hebron;

Jagersfontein (TM 27444); Juta (TM 69965); Kestell (east of); Klavervlei (TM 55233); Klipdrift; Klipoog; Knellpoort; Koortshoek; Lanquedoc; Leeuwkop; Loskop; Lindley (TM 35522; 37598-99; 37604-05); Manchester; Mara, Parys; Merino, Bethlehem; Middenspruit (TM 42893); Milambi; Monontsa Pass; Mooigelegen; Moreson; Morgenzon, Harrismith; Op-die-Rivier (TM 37370); Petra; Pietersberg; Quaggaspruit; Rietfontein, Vrede; Rietspruit; Rusthof; Seekoeivlei Nature Reserve (TM 55230); Sentinel; Sterkfontein Dam (TM 55231); Tafelberg; Trentham (TM 48553); Tweefontein; Uitzicht; Venus; Verdun, Reitz; Vaalbank (TM 64796); Vergaderrand; Waterfall; Weenkop (TM 37385); Willem Pretorius Game Reserve (NMB; TM 27272-77; 27299); Wittekopjes; Wittepoort.
Other records: Smithfield (Boettger, 1883); Kroonstad (Symonds, 1887); Harrismith; Heilbron Townlands; Thaba 'Nchu; Vrede (FitzSimons, 1962).

Features (126 specimens examined)
Largest male (NHMZ 1940 - Harrismith) 700 + 225 = 925 mm.
Largest female (NMB 716 - Uitzicht) 630 + 198 + 828 mm.
Dark spots present on sides of neck; these may be clear but are usually blended into one another. NMB R32 and 716 are long-preserved specimens without spots. Occasionally several clear dark spots are present dorsally on the neck, in addition to lateral ones. Venter white, usually with several well defined black markings, but occasionally only a few (e.g. NMB R1167, 3464), or heavily marbled (NMB R3761). The venter of a few specimens (e.g. NMB R341, 553, 716) is bluish-grey. Two specimens (NMB R810 and 3777) have brown backs, i.e. median and dorso-lateral pale stripes absent.

Habitat and Ecology
This agile, diurnal, semi-poisonous, back-fanged snake has neurotoxic venom which, weight for weight, is considered more toxic than that of southern African elapids, although no deaths from its bite have been recorded (Broadley, 1990, p. 123). It is partial to open grassland habitats and is found in inactive termitaria and under rocks up to an altitude of 2591 m a.s.l. in the O.F.S. (De Waal, 1978, p. 105). According to Broadley (1990), it feeds mainly on lizards, frogs and small mammals, such as mice and shrews, whereas Branch (1988a, p. 70) noted that birds and other snakes are also taken. Broadley (1977c, p. 37) reported that the alimentary canal of several specimens contained large *Rana* frogs, including a *R. grayi* (= *Strongylopus grayii*). De Waal (1978) reported that rodent remains were recovered from several stomachs, and one snake contained four new-born mice. Van Wyk (1988b) studied the diet of this snake in detail, reporting on the alimentary canal contents of 94 O.F.S. specimens. Actual mammalian hair found in the alimentary canal was identified, 58% of specimens containing identifiable prey items of some kind. The diet consisted of insectivores (48,6%); rodents (32,8%); lizards (12,9%) - *Mabuya striata punctatissima* 8,5%, *Agama atra* 2,9%, unidentifiable scales 1,5%; frogs (4,3%) - *Cacosternum boettgeri*; and a lepidopterous larva (1,5%). Van Wyk (1988, p. 462) noted a significant difference in dietary composition between snakes smaller than 440 mm SVL, collected primarily in inactive termitaria, and those larger than 440 mm SVL, usually collected from

open grassland or rocky habitats, and never in termitaria. Snakes smaller than 440 mm SVL fed mainly on soricids, reptiles and amphibians, whereas larger snakes preyed mainly on murids. Egg clutches and gravid females with well developed eggs were collected in October and November in the O.F.S (De Waal, 1978, p. 105). Females were usually found coiled around their eggs, which varied in number from 8-17 and measured 21-32 x 14-15 mm; on the farm Mooigelen, 29 eggs and four females (one still gravid) were found under the same rock (De Waal, 1978). The eggs that were collected hatched out in January and February; one hatchling measured 135 + 40 = 175 mm (De Waal, 1978). A juvenile (NMB R5873) measuring 149 + 42 = 191 mm was collected in January while swimming in the newly-filled Knellpoort Dam, whereas a juvenile from Excelsior (NMB R6137), collected in February, measured 187,5 + 55 = 242,5 mm and weighed 2,69 g. Additional information on reproduction is given by Bates (1985), Jacobsen (1989, pp. 883-884) and Broadley (1990, p. 123). Enemies include Secretarybirds *Sagittarius serpentarius* and other snakes, such as the Rinkhals *Hemachatus haemachatus* and cobras (*Naja* spp.) (Broadley, 1990, p. 123). A Rinkhals from the O.F.S. was recorded as preying on a *Psammophylax r. rhombeatus* (De Waal, 1978).

Remarks

Bogert (1940, p. 77) recorded a female *Cerastes t. tritaeniatus* (= *Psammophylax tritaeniatus*) (AMNH 50513) from Kroonstad. Upon re-examination, the specimen proved to be a *P. r. rhombeatus* (Broadley, 1977c, p. 27). Broadley (1977) also recorded another *P. r. rhombeatus* (TM 42893) from Kroonstad, but this locality, with reference to the Transvaal Museum catalogue, is more correctly given as "Middenspruit, 11 km east of Kroonstad", i.e. the farm Middenspruit. In the O.F.S., *P. r. rhombeatus* is sympatric with the western *P. tritaeniatus* only at Bloemfontein (2926-Aa2). For further comments, see under "remarks" for *P. tritaeniatus*.

Psammophylax tritaeniatus (Günther, 1868) Striped Grass Snake

Rhagerrhis tritaeniatus Günther, 1868, *Ann. Mag. Nat. Hist.*, (4), 1, p. 423, pl. xix, fig. H. Type locality: South-east Africa.

Psammophylax tritaeniatus tritaeniatus (Günther): FitzSimons, 1962, p. 213, pls 20 & XXXVI and 1970/74, p. 127/130, pl. 14(2).

Psammophylax tritaeniatus (Günther): Broadley, 1977c, p. 32, fig. 11, pl. iii; De Waal, 1978, p. 106; Broadley, 1983/90, p. 124, pl. 26; Branch, 1988a, p. 70, pl. 22.

Range

From southern Tanzania and Angola southwards into the northern half of Namibia, northern Botswana and Zimbabwe (and adjacent Mozambique) and south to Transvaal, south-eastern Botswana, western half of the O.F.S. and northern Cape Province.

Zoogeographical classification: Tropical Wide Ranging.

Range cluster in O.F.S.: Western (W).

Distribution in the Orange Free State (36 localities; Fig. 89)
Specimens examined from: Beestkraal (TM 24628); Bergplaats, Bloemfontein; Bloemfontein; Bloemfontein (Langenhoven Park); Bloemfontein, 11 km south of (AJL 853); Bloemfontein (15 km south-west of); Boesmansberg; Boskop; Brabant; Die Hoogte; Doornplaat; Florisbad; Francis Home; Geluk, Boshof; Gruiskop; Haagen's Stad; Hartebeestfontein, Boshof; Jagersfontein Road; Kareerand; Klipplaatdrift, Edenburg; Koppiesdam; Krugersdrift Dam; Kwaggafontein; Leeuwberg; Lovedale; Meyerskraal; Middeldeel; Paradys; Smithskraal; Sweet Home; Uitkyk, Boshof (TM 45044); Vet River - Bloemhof Dam junction; Weltevrede; Wilhemshohe; Zandvoort.
Other records: Hoopstad (FitzSimons, 1943) (not plotted on map, see "remarks"); Harrismith (TM 11244) (needs confirmation; not plotted on map).

Features (75 specimens examined)
Largest male (NMB R3122 - Krugersdrift Dam) 739 + 131 = 924 mm.
Largest female (NMB R2320 - Meyerskraal) 518 + 142 = 660 mm.
Dorsum grey with a dark median stripe (in which is located a thin pale median stripe) bordered by a pair of broad grey/brown bands; a dark band is present on the flanks. The dark median stripe extends onto the posterior part of the parietals centrally. The venter is white, sometimes with a thin brown lateral stripe, or small dark lateral spots forming a "pseudo-stripe". Upper and lower labials immaculate white.

Habitat and Ecology
This agile, diurnal, mildly poisonous (neurotoxic) back-fanged snake was found in inactive termitaria and under rocks in open grassland in the O.F.S. (De Waal, 1978, p. 107). According to Jacobsen (1989, p. 890), it occasionally takes refuge in water, where it may remain for over 5 min. Prey includes frogs, lizards (especially skinks), small rodents and nestling birds (Broadley, 1977c, p. 37, 1990, p. 125). De Waal (1978) noted that some O.F.S. specimens contained rodent remains, frogs and geckos (*Pachydactylus c. capensis*) in their stomachs, whereas Broadley (1966, p. 365) reported rats or rodent fur from adult stomachs, and skinks (*Mabuya striata, M. varia*) and frogs from the stomachs of smaller snakes in south-eastern Africa. A snake in captivity ate a juvenile chameleon *Chamaeleo d. dilepis* (Broadley, 1966). A juvenile measuring 201 + 46 = 247 mm (when preserved), collected at Middeldeel in April, twice fed on individuals of *Pachydactylus c. capensis* while in captivity. According to Jacobsen (1989), shrews are also taken. De Waal (1978) noted that a *P. tritaeniatus* was recovered from the stomach of a Cape Cobra *Naja nivea* from the O.F.S. Broadley (1990, p. 125) reported that females lay 6-10 eggs measuring 20-25 x 10-12 mm, whereas Haagner (1986) recorded a clutch of 17 eggs measuring 23,2 - 28,2 x 13,7 - 15,5 mm with individual masses of 2,0-2,9 g; incubation took 43-45 days at 28°C, hatchlings measuring an average of 179,5 mm in length, with a mean mass of 2,15 g. Jacobsen (1989, p. 890) stated that (Transvaal ?) females laid 6-15 eggs under a rock or other suitable cover during the months September to November, and Broadley (1966, p. 364) recorded clutches of 14 and 18 eggs for Zimbabwean females. Broadley (1977c, p. 40) later reported finding 5-18 eggs in Zimbabwean females.

Remarks

Symonds (1887, p. 487) recorded a *Psammophis sibilans* from Kroonstad. Based on Symonds' description (mainly colour pattern), FitzSimons (1962) included this record under *Psammophylax tritaeniatus*. However, the vague description does not allow accurate determination of the specimen's taxonomic status, as pointed out by De Waal (1978, p. 107), and the record was removed from the synonymy of *P. tritaeniatus* by Broadley (1983/90, p. 124). *P. r. rhombeatus* has been recorded at Middenspruit near Kroonstad and to a certain extent the species' colour pattern matches that of the specimen described by Symonds (1887), who also noted that the species he referred to was known by the name "Schaaf-sticker (sheep-sticker)", "was found in the long grass", was "very quick in its movements" and was "said to kill sheep!" This fits Broadley's (1983/90, p. 123) discussion on the habitat and folklore of the Spotted Skaapsteker, suggesting that Symonds' snake was a *P. r. rhombeatus*. Symond's (1887) record has thus been tentatively referred to the synonomy of *P. r. rhombeatus*. Bogert's (1940, p. 77) record of a specimen (*sub. nom. Cerastes t. tritaeniatus*) from Kroonstad is referable to *P. r. rhombeatus* (Broadley, 1977c, p. 27). The Transvaal Museum "Hoopstad" record of FitzSimons (1943) probably refers to a plotted (see Fig. 89) specimen record (TM 24628) for the farm Beestkraal in the Hoopstad district. The specimen (TM 11244) recorded from Harrismith (not examined) should be regarded with suspicion, as the locality is far out of the range of *P. tritaeniatus*, but within the range of *P. r. rhombeatus*.

Genus: *Psammophis* Boie, 1825

Psammophis notostictus Peters, 1867 — Karoo Sand Snake

Psammophis moniliger var. *notostictus* Peters, 1867, *Monatsb. Akad. Wiss. Berlin*, p. 237. Type locality: Otjimbingue, Namibia.

Psammophis notostictus Peters: Boulenger, 1910, p. 513; FitzSimons, 1962, p. 225, pl. XL and 1970/74, p. 136, pl. 17(2); De Waal, 1978, p. 108; Broadley, 1983/90, p. 133, fig. 81, pl. 30; Branch, 1988a, p. 71, pl. 23.

Psammophis sibilans notostictus Peters: Loveridge, 1940, p. 44.

Range

From south-western Angola southwards through Namibia and Cape Province (excluding the east) and eastwards to the southern half of the O.F.S.; generally absent from southern coastal areas of the Cape Province.

Zoogeographical classification: Cape Temperate.

Range cluster in O.F.S.: Southern (S).

Distribution in the Orange Free State (43 localities; Fig. 90)

Specimens examined from: Alpha; Babel; Bethany; Bloemfontein; Brakpan; Dundee; Exelsior, Edenburg; Francis Home; Hebron; Heenenweerskop; Honingberg; Joostenberg; Kades; Kleinplaas; Klipbankfontein; Klipdrift; Klipfontein; Lang Zeekoegat; Leeuwberg; Lemoenboord; Luiperfontein; Luiperskop; Naval Hill; Noodhulp; Poortje, Fauresmith; Rietfontein, Rouxville; Rohallion; Strathearn (TM 55990); Strijdfontein, Philippolis; Thaba Pachoa Berg; Tienfontein; Uitkijk; Verwoerd Dam; Waterhoek; Weltevreden, Smithfield; Wintershoek; Winterspoort; Wolvekop, Fauresmith; Zandfontein; Zoutpan, Fauresmith; Zuurfontein, Fauresmith.

Other records: Smithfield (Boulenger, 1910); Hoopstad (needs confirmation, not plotted on map) (FitzSimons, 1962); Fauresmith; Orange River (Loveridge, 1940).

Features (100 specimens examined)

Largest male (NMB R4755 - Lemoenboord) 653 + 245 = 898 mm.

Largest female (NMB R4433 - Verwoerd Dam) 628 + 242 = 870 mm.

Dorsum brown, usually with a thin, pale vertebral stripe and/or pale dorso-lateral stripes. Top of head with some white scales. A white band present on nape, usually confluent, which extends to venter, but absent in NMB R2229 and 2269 and failing to reach ventral plates in NMB R1970. Venter usually cream-white (but greyish in NMB R1965 and yellowish in NMB R2214, 2312 and 2491) with dark spots or stripes laterally; venter heavily spotted in NMB R2312 and 3190. Throat with several dark spots or stipples, but only a few are present in some specimens. NMB R1102 is a decapitated specimen.

Habitat and Ecology

These agile, diurnal, mildly poisonous, back-fanged snakes are largely confined to karroid habitat, where they have been collected mainly from inactive termitaria, but also under rocks in open veld in the O.F.S. (De Waal, 1978, p. 108). The following prey items were recovered from the stomachs of O.F.S. specimens: *Pachydactylus c. capensis, P. m. mariquensis, Cordylus polyzonus* (juvenile), lacertid remains and a grasshopper (De Waal, 1978). According to Broadley (1990, p. 135), agamid lizards are also eaten, whereas mice and other small mammals are occasionally taken. A gravid female collected during late October in the O.F.S. contained three eggs measuring 28 x 6 mm (De Waal, 1978).

Remarks

Loveridge (1940, p. 46) erroneously lists "Fauresmith" under "Cape Province". De Waal (1978, 109) did not note Loveridge's (1940) Fauresmith and Orange River localities.

Psammophis leightoni trinasalis Werner, 1902 Fork-marked Sand Snake

Psammophis sibilans trinasalis Werner, 1902, *Verh. Zool. Bot. Ges. Wien*, 52, p. 340. Type locality: Windhoek, Namibia. FitzSimons, 1962, p. 231, fig. 62, pls 24 & XLII.

Psammophis furcatus (Peters): Gough, 1908, p. 29; Hewitt & Power, 1913, p. 163.

Psammophis leightoni trinasalis Werner: Broadley, 1975, p. 12, fig. 5b; FitzSimons, 1970/74, p. 138, pl. 15(1); De Waal, 1978, p. 109; Broadley, 1983/90, p. 135, fig. 82, pl. 31; Branch, 1988a, p. 71, pl. 23.

Range

Eastern Namibia, Botswana (excluding north and east), northern Cape Province, O.F.S. (excluding east and north-east) and Transvaal (excluding the east); a record from Uitenhage in the southern Cape requires confirmation (Broadley, 1990, p. 135).

Zoogeographical classification: Western Tropical Transitional.

Range cluster in O.F.S.: Non-Northeastern (Non-NE).

Distribution in the Orange Free State (47 localities; Fig. 91)

Specimens examined from: Allanridge (TM 54432); Angra Pequina (TM 5518); Bergplaats, Bloemfontein; Beyersfontein; Bloemendal; Bloemfontein (NMB; MMK 646); Boschkop; Bothaville (TM 5511); Carlie; Cecilia; Deelfontein, Bethulie; Deelfontein, Bothaville; Die Hoogte; Di Poort; Erinmore; Francis Home; Gruiskop; Haagen's Stad; Honingberg; Houmoed; Kelly's View; Klipplaatdrift, Edenburg; Mimosa; Mooivlei; Ongegund; Petra; Pietersberg; Platberg, Boshof; Rietfontein, Brandfort; Rondavel; Rustfontein Dam; Sandveld Nature Reserve (SNR 2); Smaldeel; Smithskraal; Spijtfontein; Uitkyk; Usherwood; Van der Walt's Rust; Veepost; Viljoenskroon (NMZB-UM 12457); Welkom (TM 50331); Weltevrede; Wilhelmshohe; Willem Pretorius Game Reserve (TM 27270); 10 km north of Hendrik Verwoerd Dam wall (TM 37985).

Features (68 specimens examined)

Largest male (NMB R1613 - Bergplaats, Bloemfontein) 626 + 288 = 914 mm.

Largest female (NMB R2637 - Petra) 571 + 229 = 800 mm.

Dorsum with a thin, pale, black-bordered vertebral stripe (apr. ½ thickness of dorso-lateral stripe), a pair of brown paravertebral stripes, a pair of thin, pale, black-bordered dorsolateral stripes, and a pair of grey lateral bands. The pale median stripe does not extend onto top of head; a pair of pale stripes is present laterally on the head, and the pale lateral stripes reach the posterior part of the eyes; there is also a short, pale stripe on the snout, although it does not extend onto the rostral shield. One of the two elongate stripes on the head may be broken. The eye is encircled by a white ring. Chin and throat with dark spots and speckles which may extend onto the first few ventral plates as a pair of lateral "stripes". Stripes may be absent on belly and are usually absent on the ventral surface of the tail. Lateral stripes or series of spots on belly often enclose a yellowish median band.

Habitat and Ecology

This agile, diurnal, mildly poisonous, back-fanged snake occurs in open grassland in the O.F.S., and has been collected from inactive termitaria and under rocks (De Waal, 1978, p. 110). According to Hewitt & Power (1913, p. 163), this snake is sometimes found in thorn trees (*Acacia* spp.) near Kimberley. The following prey items were recovered from the stomachs of O.F.S. specimens: *Pachydactylus c. capensis, P. m. mariquensis, Mabuya capensis, M. varia, M. striata punctatissima, Panaspis wahlbergii,* lacertid remains, a juvenile *Pseudaspis cana*, rodent remains and a "hairy spider" (De Waal, 1978). Pienaar *et al.* (1983, p. 164) noted that agamids are also taken, while Jacobsen (1989, p. 902), presumably reporting on Transvaal populations, stated that *Mabuya varia, M. variegata* and rodents are eaten. A gravid female was collected in October in the O.F.S. and contained eight well developed eggs measuring 25 x 9 mm; a hatchling with umbilical chord attached was collected in January and measured 243 mm (presumably total length) (De Waal, 1978).

Remarks

De Waal's (1978) "Hendrik Verwoerd Dam" record should read "10 km north of Hendrik Verwoerd Dam wall" (TM 37985).

Psammophis crucifer (Daudin, 1803) Cross-marked Grass Snake

Coluber crucifer Daudin, 1803, *Hist. Nat. Rept.*, 7, p. 189. Type locality: "Indes orientales" = South Africa.

Psammophis crucifer Boie, 1827, in *Oken, Isis*, 20, cols 525 & 547; Boettger, 1883, p. 156; Symonds, 1887, p. 487; Gough, 1908, p. 29; Loveridge, 1940, p. 64; FitzSimons, 1962, p. 239, fig. 64, pl. XLIV and 1970/74, p. 142, pl. 15(5); De Waal, 1978, p. 111; Broadley, 1983/90, p. 146, figs 93 & 94, pl. 35; Branch, 1988a, p. 73, pls 23 & 34.

Range

Cape Province (excluding most of the central and northern parts), western Lesotho, Natal, eastern half of the O.F.S., southern and eastern Transvaal, and western Swaziland highveld, with isolated populations on the eastern escarpment of Zimbabwe.

Zoogeographical classification: Cape Temperate (probably Afromontane).

Range cluster in O.F.S.: Eastern (E).

Distribution in the Orange Free State (54 localities; Fig. 91)

Specimens examined from: Albion; Bachelor's Home; Berlin; Beth-Aven; Bethel; Boschkloof; Bramley's Hoek; Caledonspoort; Dipka; Donegal A; Elandsfontein; Eskol; Goedetrouw; Hebron; Houtkop; Kafferskop; Kestell (east of); Klipdrift; Klipoog; Klipplaat; La Belle France; Littlecote; Lorenzo; Louis Rust; Maseru; Mecklenburg; Merino, Bethlehem; Middenspruit; Mimosa; Monontsa Pass; Mooigelegen; Patrijsdraai; Perth; Rietspruit; Rondavel; Rusthof; Sterkfontein Dam; Thaba 'Nchu; Tweefontein; Tygerfontein; Vaalkop; Verdun, Reitz; Verdun, Ladybrand; Vergaderrand; Viljoenskroon (NMZB-UM 12458); Welgegund; Wittekopjes; Wolvenfontein; Zwartkoppies.

Other records: Kroonstad (Loveridge, 1940); Klavervlei (TM 56536); Lusthof (TM 36667); Op-die-Rivier (TM 37372); Tweeling (TM 47102); 1 mile ex Lindley - Bethlehem (TM 27564).

Features (80 specimens examined)

Largest male (NMB R3237 - Boschkloof) 409 + 137 = 546 mm.

Largest female (NMB R4312 - Mooigelegen) 561 + 148 = 709 mm.

A female (NMB R6224) from Eskol measured 402,5 + 129 = 531,5 mm and weighed 19,0 g.

Dorsum with a dark vertebral stripe, pale paravertebral stripes and grey lateral stripes with dark border lines. Chin and throat with pale-centred, dark outlined spots. Belly white, lateral edges of ventrals with dark spots or dark lateral broken or unbroken longitudinal stripes. Five specimens (6,3%; N = 80) are uniform light brown above (may have indistinct dark median band) and immaculate white below; no markings on top of head - *viz.* NMB R651 (Monontsa Pass), 710 (Perth), 2087 (Maseru), 2947 (Tygerfontein), 3534 (Mecklenberg). Seventy-one specimens (88,8%) lack any "cross" on the neck, whereas five (6,3%) have one cross - *viz.* NMB R51 (Rietspruit), 2095 (Mimosa), 2429 (Berlin), 2438 (Berlin), 2403 (Klipplaat), and four specimens (5,0%) have a double cross (= two crosses) - *viz.* NMB R3332 (Monontsa Pass), 4068 (Houtkop), 4315 (Mooigelegen), 6224 (Eskol). The pale paravertebral stripes extend to the back of the eyes, which are encircled in white; various short longitudinal markings are present on the top of the head.

Habitat and Ecology

This agile, diurnal, mildly poisonous, back-fanged snake has been collected from inactive termitaria and under rocks in the O.F.S. (De Waal, 1978, p. 112). Specimen TM 56536 (Klavervlei) was collected in a "stony area in grass veld" according to the Transvaal Museum catalogue; whereas NMB R6224 (Eskol) was found in a sandstone crevice. The diet includes geckos and other small lizards, although frogs may also be eaten (Broadley, 1990, p. 148). De Waal (1978) recorded the following prey items in O.F.S. snakes: *Mabuya striata punctatissima, M. varia, Nucras lalandii,* lacertid remains and the frog *Cacosternum boettgeri.* A specimen (NMB R5532) from Sterkfontein Dam (measuring 535 mm SVL) was collected among grass on a rocky slope; it fed on small white mice in captivity. Visser (1972, p. 50) noted that *Meroles* spp. are also eaten. Symonds (1887, p. 487) stated that the species preys on frogs, and noted that an "18½ inch long" snake was found dead in the mouth of a large bullfrog *Pyxicephalus*

adspersus. Additional enemies include other snakes and birds of prey (Broadley, 1990). Gravid females containing 3-13 eggs were collected from September to November in the O.F.S., the largest eggs measuring 31 x 9 mm (De Waal, 1978). According to Broadley (1990), females lay up to 13 eggs with mean dimensions of 21 x 18 mm, although some eggs are more elongated and measure up to 32 mm in length. A female from Port Elizabeth laid five eggs in late November; these had dimensions of 30,8 - 36,1 x 12,0 - 14,0 mm and individual masses of 3,3-4,4 g (Haagner, 1988, p. 37). Kunzi (1984, in Jacobsen, 1989, p. 926) recorded a clutch of eight eggs which were laid in December and hatched after 45 days at incubation temperatures of 29°-30°C and 65% day-time and 95% night-time humidity. Hatchlings measure 142,0-153,0 mm SVL and 44,0-50,0 mm tail length, with masses of 1,65-2,1 g (see Jacobsen, 1989, p. 926).

Remarks

The common name "Cross-marked Grass Snake" is hardly applicable to this species in the O.F.S., considering that only a little more than 11% of specimens had any "cross-marks" on the nape or in the neck region.

Genus: *Aparallactus* A. Smith, 1849

Aparallactus capensis A. Smith, 1849 — Cape Centipede Eater

Aparallactus capensis A. Smith, 1849, *Ill. Zool. S. Afr., Rept.*, App. , p. 16. Type locality: "Kaffirland to the eastward of Cape colony", i.e. Natal. Gough, 1908, p. 33; Hewitt & Power, 1913, p. 164; De Waal, 1978, p. 113; Broadley, 1983/90, p. 154, figs 99 & 100, pl. 29; Branch, 1988a, p. 76, pl. 26.

Aparallactus capensis capensis A. Smith: FitzSimons, 1962, p. 268, fig. 82, pl. XXXVIII and 1970/74, p. 154/153, pl. 15(2).

Range

From Tanzania southwards through the eastern half of southern Africa, including the western Caprivi Strip and eastern Botswana, and south to the eastern Cape Province. Absent from the Mozambique Plain, north-eastern O.F.S. and Lesotho; isolated records in central Namibia and southern Cape Province.

Zoogeographical classification: Tropical Wide Ranging.

Range cluster in O.F.S.: Non-Northeastern (Non-NE).

Distribution in the Orange Free State (70 localities; Fig. 92)

Specimens examined from: Annies's Rust; Babel; Bergkloof; Bergplaats, Bloemfontein; Bergplaats, Dewetsdorp; Bethel; Biddulphsberg; Bloemfontein; Boschrand; Boskop; Brabant; Brakfontein; Brockenhurst; Carlie; Cecilia; Ceylon; Damfontein; Deelfontein, Bothaville; Die Hoogte; Di Poort; Excelsior, Edenburg; Glen; Grootkrans; Gruiskop; Holme's Dale; Honingberg; Houmoed; Houtkop; Kareerand; Klipdrift; Klipfontein; Klipplaatdrift, Winburg; Knellpoort; Koppiesdam; Kraaifontein; Kroonstad (MMK 550/2, 2 specimens); Lanquedoc; Leliehoek; Littlecote; Lorenzo; Mara, Vredefort; Meyerskraal; Middenspruit; Mimosa; Morgenzon, Zastron; Mount Nelson; Patrijsdraai; Petra; Pietersberg; Quaggaspruit; Rambouillet; Rietfontein, Rouxville; Rohallion; Rondavel; Spijtfontein; Stoffelfontein; Straalfontein; Susannasfontein; Triangle; Tweefontein; Van der Walt's Rust; Venus; Weltevreden, Heilbron; Willem Pretorius Game Reserve; Wittekopjes; Zandfontein.

Other records: Fauresmith (Hewitt & Power, 1913); Parys; Smithfield; Zastron (FitzSimons, 1962).

Features (204 specimens examined)

Largest male (NMB R2825 - Mount Nelson) 259 + 57 = 316 mm.

Largest female (NMB R3699 - Rondavel) 282 + 60 = 342 mm.

Dorsum usually light brown, occasionally russet brown, usually with thin, dark longitudinal stripes which are sometimes not well defined; the median stripe is usually most prominent. In 11 specimens the dorsum is without stripes, or with a poorly or well defined median stripe only. Four specimens have dark greyish dorsa (i.e. NMB R1370, 2825, 3294 and 4463). There is a black cap (occasionally brown or grey) on the top of the head, followed by a short median stripe and a black band around the nape of the neck which does not extend onto the ventral plates. In a few specimens, the black bands on the lateral edges of the black cap join up with the band on the nape. The venter is white and unmarked.

Habitat and Ecology

Collected from inactive termitaria and occasionally under rocks virtually throughout the O.F.S. (De Waal, 1978, p. 114); one specimen (NMB R5871) was collected whilst swimming in the newly-filled Knellpoort Dam. In the Transvaal they have also been found under and in rotting logs and aloes, and under sheets of iron (Jacobsen, 1989, p. 942). Jacobsen (1989) reported finding up to five *A. capensis* together in the same termitarium. Also found among the roots of shrubs or grasses in open bush or savanna country (Broadley, 1990, p. 155). The diet is specialized, consisting of centipedes such as *Scolopendra morsitans* and *Cormocephalus* spp. (eaten in captivity) (Broadley, 1966, p. 411). De Waal (1978) noted that several O.F.S. specimens contained centipede remains; a 177 mm long snake had eaten a 71 mm long centipede. The bite of a centipede has little detrimental effect on the snake, which appears also to be immune to its poison (Broadley, 1990, p. 155). According to Auerbach (1987, p. 172), other arthropods are also eaten. Gravid females collected in October and November in the O.F.S. contained 3-5 eggs, the largest measuring 18 x 6 mm (De Waal, 1978). Females from the Transvaal laid clutches of 2-6 eggs in December (Jacobsen, 1989). Broadley (1966, p. 410) recorded clutches of 1-4 eggs, some of which measured 21-23 x 5 mm; these were laid in November or December in south-east Africa. Broadley (1990, p. 155) noted that southern African females lay 2-4 eggs with dimensions of 32 x 4-5 mm, and hatchlings measure 95-100 mm in length.

Genus: *Xenocalamus* Günther, 1868

Xenocalamus bicolor bicolor Günther, 1868 Bicoloured Quill-snouted Snake

Xenocalamus bicolor Gunther, 1868, *Ann. Mag. Nat. Hist.*, (4) 1, p. 415, pl. xix, fig. A. Type locality: "Zambeze" - in error, corrected to Damaraland by Broadley (1971).

Xenocalamus bicolor concavo-rostralis Hoffman, 1940, *Soöl. Navors. nas. Mus., Bloemfontein*, 1(11), p. 111, figs 1 & 2. Type locality: Kelly's View, near Bloemfontein. FitzSimons, 1946, p. 391, figs 18-20; Witte & Laurent, 1947, p. 47; FitzSimons, 1962, p. 258, fig. 77.

Xenocalamus bicolor concavorostralis Hoffman: FitzSimons, 1970, p. 151.

Xenocalamus bicolor bicolor Günther: Broadley, 1971, p. 675, fig. 18, pl. III (5) & IV; FitzSimons, 1974, p. 149, pl. 19(2); De Waal, 1978, p. 112; Broadley, 1983/90, p. 208, fig. 112, pl. 40 ("maculatus" phase); Lynch, 1986a, pp. 288 & 296 and 1986b, p. 15; Branch, 1988a, p. 81, pl. 18 ("maculatus" phase); Bates, 1988a, p. 51 and 1991e, p. 78, fig. 2.

Range (Fig. 93)

Northern half of Namibia, Botswana, north-western Transvaal and northern Cape Province, with apparently isolated populations in northern Zimbabwe, Cheringoma Plateau in Mozambique and in the Bloemfontein area.

Zoogeographical classification: Tropical Wide Ranging.

Range cluster in O.F.S.: Western (W).

Distribution in the Orange Free State (three localities; Fig. 94)

Specimens examined from: Bloemfontein (Zoological Gardens); Cecilia; Kelly's View.

Extralimital records (one locality; Fig. 93)

One specimen examined from: Pniel Estate, Barkly West.

Features (four specimens examined, including one from Barkly West)

The four specimens were examined and compared with descriptions of *X. b. concavorostralis* (Hoffman, 1940; FitzSimons, 1946, 1962) and *X. b. bicolor* (Broadley, 1971, 1983, 1990). Colour patterns, ventral counts (using the method of Dowling, 1951) and snout-vent length/midbody diameter ratios were compared with those of three specimens from the northern Cape Province examined by Broadley (1971) (see Table 7). The following measurements were taken on all specimens using vernier calipers (0,02 mm): head length (from tip of rostral to posterior border of parietals), greatest width of head, parietal length (greatest length on right side measured in a straight line), and third lower labial length (as a mean of left and right sides), while the following were measured using an optic micrometer

(0,1 mm): rostral length and posterior width (dorsally), length of parietal suture and length of scale postceding parietal suture (median nuchal scale). These measurements were used to calculate ratios relevant in comparing head shield proportions (cf. FitzSimons 1946, 1962) (Table 8).

Snout-vent length (SVL)/midbody diameter ratio was first used by FitzSimons (1946) to separate subspecies of *X. bicolor*. However, Broadley (1971) stated that geographical variation in this 'slenderness ratio' is obscured by individual variation owing to contents of the digestive tract, developing ova (if female), general condition of the specimen and probably also shrinkage following preservation. To determine whether or not a recent meal was the cause of the seemingly atypically robust form of *X. b. concavorostralis*, incisions were made through the belly and the gut examined. SVL/midbody diameter ratio has been determined on preserved specimens and the girth of snakes may be exaggerated if an excess of fixative was injected into the body cavity prior to preservation. The Barkly West specimen was somewhat emaciated before being injected with fixative, possibly resulting in a smaller girth than normal and therefore a slightly larger SVL/midbody diameter ratio.

To determine the sex of specimens, incisions were made through the belly and examined for the presence of testes or ovaries. The holotype of *X. b. concavorostralis* (NMB A.2077) is a male (with an everted hemipenis), as are the Cecilia (NMB R5318) and Bloemfontein Zoo (NMB R5904) specimens, whereas the Barkly West snake (NMB R5063) is a female.

Examination of the holotype of *X. b. concavorostralis* was generally consistent with FitzSimons' (1946; 1962) description. Hoffman's (1940) description and illustration of the rostral of *concavorostralis* as being very hooked in profile is erroneous, as pointed out by FitzSimons (1946). The three Bloemfontein snakes have very slightly hooked rostrals, while that of the Barkly West specimen is straight in profile. The holotype of *X. b. concavorostralis* differs from the other specimens in having a long head relative to SVL and a far more robust body (Tables 7 & 8). The head was slightly wider than the neck in all specimens. Examination of the gut of *concavorostralis* showed it to be undistended, with a little sand present in the hindgut only. The robust appearance of *concavorostralis* may be the result of injection of an excessive quantity of fixative.

All specimens had six upper and five lower labials, except for the Barkly West specimen, which had only four lower labials on the right side. The third and fourth upper labials enter the orbit, but only the fourth enters the orbit on the left side in the Barkly West specimen. Dorsal scales are in 17 rows. Median dorsal scales are as broad as long anteriorly (*cf.* FitzSimons, 1946; 1962). Variation in number of ventrals and subcaudals, size, total length/tail length ratio, SVL/midbody diameter ratio and SVL/head length ratio is shown in Table 7. The three Bloemfontein snakes are all males with similar low ventral and subcaudal counts, but the SVL/midbody diameter ratio ranged from 34-59. There was little variation in head shield proportions (Table 8), the greatest variation being in length of parietal suture relative to length of median nuchal scale (parietal suture/median nuchal scale length ratio: NMB A2077 = 0,61; NMB R5318 = 0,52; NMB R5904 = 0,90; NMB R5063 = 0,64).

Table 7: Data on *Xenocalamus bicolor bicolor* from the Orange Free State and northern Cape Province (specimens examined indicated in bold print; *l* = length).

Locality	Museum catalogue number	Sex	Ventrals (Dowling, 1951 method)	Subcaudals	SVL + tail *l* = total *l* (mm)	Total *l* / tail *l*	SVL/midbody diameter ratio	SVL / head *l*
Kelly's View, Bloemfontein	NMB A.2077	male	197	29	341 + 47 = 388	8,26	34*	31,6
Cecilia, Bloemfontein	NMB R5318	male	199	30	409 + 46 = 455	9,89	59	41,7
Bloemfontein Zoo	NMB R5904	male	191	27	456 + 48,5 = 504,5	10,4	53	41,8
Mareetsane	NMSR 1171	male	204				49	
Pniel Estate, Barkly West	NMB R5063	female	217	24/25	391 + 31 = 422	13,6	65	40,5
Zoet Vlei	AM 6770	female	228				50	
Aughrabies Falls	TM 36059	female	239				61	

* Determined as 36 by FitzSimons (1946)

Table 8: Variation in relative size of head and head scales in *Xenocalamus bicolor bicolor* from Bloemfontein [1] and Barkly West[2] (*l* = length; *w* = width).

	SVL/ head *l*	head *l*/ head *w*	head *w*/ neck *w*	frontal *l*/ frontal *w*	frontal *l*/ head *l*	frontal *l*/ rostral *l*	rostral *w*/ rostral *l*	parietal suture *l*/ median nuchal scale *l*	head *l*/ lower labial *l*	parietal *l*/ frontal *l*
NMB A.2077[1]	31,6	1,72	1,01	1,45	0,594	2,60	1,34	0,61	2,27	0,678
NMB R5318[1]	41,7	1,88	1,04	1,54	0,580	2,76	1,47	0,52	2,22	0,715
NMB R5904[1]	41,8	1,82	1,01	1,46	0,580	2,38	1,37	0,90	2,28	0,690
NMB R5063[2]	40,5	2,03	1,12	1,48	0,559	2,29	1,26	0,64	2,25	0,722

Broadley (1971, 1983, 1990) described four basic colour patterns in populations of *X. b. bicolor*. The type of *concavorostralis* and three Cape Province specimens are described as "reticulate", where the dorsum is brown or grey, each scale with a pale border and outer three or four scale rows and venter white. The type of *concavorostralis* is grey dorsally, has light-edged dorsal scales, three pale lateral scale rows (scales of first - most dorsal - row are dark above, pale below, all rows with occasional dark blotches) and has a white venter with very occasional small dark blotches. The Barkly West specimen is similar, but has a chocolate brown dorsum and four pale lateral scale rows (upper half of top row is dark). The latter two specimens therefore have the "reticulate" pattern. The other two Bloemfontein snakes have a grey-black dorsum with less easily discernible pale edges to the dorsal scales, three pale lateral scale rows (top scales dark dorsally, second row with more blotching than third) and venter with numerous dark blotches. These two specimens are close to the "bicolor" pattern described by Broadley (1971, 1983, 1990) (uniform black above, outer 1-3 scale rows and venter white, sometimes with dark blotches or infuscation). All specimens had pale grey head shields (cf. Broadley, 1971, p. 677).

Hoffman (1940) distinguished *X. b. concavorostralis* from typical *bicolor* on account of the rostral shape (hooked) and length of the parietal suture (distinctly shorter than scale behind). Examination of the type of *concavorostralis* indicated that FitzSimons' (1946, 1962) diagram of the head is more accurate, the rostral being only slightly hooked in profile. The length of the median nuchal scale relative to length of the parietal suture (parietal suture/median nuchal scale length ratio) showed much variation among the four specimens examined (0,52-0,90), indicating that this character is too variable for use as a diagnostic feature.

Habitat and Ecology

The Cecilia specimen was collected from an inactive termitarium and the Bloemfontein Zoo specimen was found drowned at the bottom of a drained pond (Bates, 1991d). According to Broadley (1990, p. 209), the subspecies typically inhabits Kalahari or alluvial sands. The stomachs of two specimens contained amphisbaenians, namely *Zygaspis quadrifrons* and *Monopeltis* sp. (Broadley, 1971). Enemies include the genet *Genetta genetta* and jackal *Canis mesomelas* (Broadley, 1971). Nothing is known of this subspecies' reproduction, but Branch & Patterson (1976) reported that *X. b. lineatus* lays three or four elongate eggs in January; these measure 26 x 6 mm and hatch after 55-57 days at 30-32°C incubation temperatures.

Remarks

FitzSimons (1946, 1962) considered the occurrence of the Bloemfontein specimen to be somewhat inexplicable as it was collected so far south of the general range of the genus (see also Broadley 1983/90, map 45), and expressed the hope that further specimens would be collected from the area to confirm or refute its validity as a distinct form. Broadley (1971) did not examine the holotype of *X. b. concavorostralis*, but considered it representative of a peripheral population clinally linked to typical

bicolor populations to the northwest. Despite De Waal's (1978) intensive survey of the reptiles of the O.F.S., no additional specimens of *Xenocalamus* were collected. However, in February 1983, a specimen of *X. b. bicolor* was collected on the farm Pniel Estate near Barkly West (2824 CB) (Bates, 1988g). This record bridges the gap between *X. b. bicolor* populations elsewhere in the northern Cape Province and the Bloemfontein population (2926 AA) (Fig. 93). In December 1985, a second *X. b. bicolor* was collected near Bloemfontein, from an inactive termitarium on the farm Cecilia, only 7 km from the type locality of *X. b. concavorostralis* (Kelly's View) (Lynch, 1986a,b; Bates, 1988a). In April 1989, a third specimen was found in a drained pond at the Bloemfontein Zoo, 10,5 km from Kelly's View and 3 km from Cecilia. This third specimen may have originated in soil taken from a quarry near Cecilia and used during building operations at the Bloemfontein Zoo, as it seems unlikely that it would have survived in such an actively utilized area as a zoological garden.

Broadley (1971, p. 678) noted that *X. b. bicolor* includes some very diverse populations, but that none seem to warrant subspecific status. Broadley (1971) categorized these populations into six geographical groups based on colour morphs, ventral counts and SVL/midbody diameter ratios, although much variation in these characters occurs throughout the range of *X. b. bicolor*.

Broadley's (1971) suggestion of a clinal increase in ventral counts from east to west is supported by the material examined here, but SVL/midbody diameter ratio showed much variation (34-65). The two colour patterns "reticulate" and "bicolor" identified in the four specimens examined indicates that this character also varies in the southernmost part of the subspecies' range. The type of *X. b. concavorostralis* differs from other *X. b. bicolor* in that it has a more robust form and distinctly longer head (relative to SVL) than the other three specimens examined (i.e. SVL/head length ratio = 31,6, compared to 41,7, 41,8 and 40,5). Numerous affinities between the holotype of *X. b. concavorostralis* and the other three specimens from the southernmost part of the species' range do, however, support Broadley's (1971) decision to place *X. b. concavorostralis* in the synonomy of *X. b. bicolor* (Bates, 1991e).

Genus: *Homoroselaps* Jan, 1858

Homoroselaps lacteus (Linnaeus, 1754) Spotted Harlequin Snake

Coluber lacteus Linnaeus, 1754, *Mus. Adolph. Frid.*, p. 28, pl. xxviii, fig. 1; 1758, *Syst. Nat.*, ed. 10, 1, p. 220 and 1766, ed. 12, 1, p. 381. Type locality: "In Indiis", i.e. South Africa.

Homorelaps lacteus (Linnaeus): Gough, 1908, p. 36.

Elaps lacteus (Linnaeus): FitzSimons, 1962, p. 283, fig. 86, pl. LVI and 1970/74, p. 178, pl. 24(2) & 26(3); De Waal, 1978, p. 118.

Homoroselaps lacteus (Linnaeus): Broadley, 1983/90, p. 215, figs 118 & 119, pl. 43; Branch, 1988a, p. 80, pl. 19.

Range

Western, southern and eastern Cape Province, Natal, eastern half of the O.F.S., southern and eastern Transvaal and western Swaziland highveld, with an apparently isolated population in the Kimberley district of the northern Cape.

Zoogeographical classification: Cape Temperate.

Range cluster in O.F.S.: Eastern (E).

Distribution in the Orange Free State (17 localities; Fig. 95)

Specimens examined from: Allanvale; Clocolan; Dipka; Kasteelkop; Kroonstad, 10 miles east of (TM 26839); Lange Hoek; Littlecote; Maghaleen (TM 28240); Mecklenburg; Reitz (LR 616); Rondeberg; Tafelberg; Tweefontein; Tygerfontein; Willem Pretorius Game Reserve (TM 30176).

Other records: Kroonstad; Smithfield (FitzSimons, 1962).

Features (19 specimens examined)

Largest male (NMB R2738 - Littlecote) 310 + 56 = 366 mm.

Largest female (NMB R2932 - Tygerfontein) 371 + 32 = 403 mm.

Dorsum black, scales with pale yellowish spot in centre; pale yellowish vertebral stripe from nape to tip of tail. Top of head black with pale spots. A dark streak runs down side of neck. Anterior border of ventrals black, as are anterior borders of scales on lateral sides of body and tail; also dark markings on scales of chin.

Habitat and Ecology

This nocturnal, largely subterranean, mildly poisonous snake has been collected in inactive termitaria and under rocks in the eastern half of the O.F.S. (De Waal, 1978, p. 119). It feeds mainly on small snakes such as *Leptotyphlops* spp. and *Typhlops* spp. and small lizards; a specimen in the Port Elizabeth Museum was preserved while swallowing a large *Duberria l. lutrix* (Broadley, 1990, p. 216). However, Visser (1972, p. 53) wrote that the diet consists of lepidopterous larvae and probably also small legless lizards (*Scelotes* spp.), while FitzSimons (1974, p. 179) noted that termite larvae and eggs are also eaten. According to Broadley (1990), females lay up to six eggs in December or January.

Remarks

FitzSimons (1962, p. 285) did not plot the Kroonstad and Smithfield records on his Map 62. FitzSimons' "Kroonstad" record may represent the same specimen given as "10 miles east of Kroonstad" in the Transvaal Museum catalogue, but as this is uncertain, both localities have been plotted in Fig. 95. Hewitt & Power (1913, p. 165) noted that a "Kamfersdam Mine, Kimberley" record probably represented an accidental introduction, but this is questionable in the light of the presently known distribution of the species (see Fig. 95).

Homoroselaps dorsalis (A. Smith, 1849) Striped Harlequin Snake

Elaps dorsalis A. Smith, 1849, *Ill. Zool. S. Afr., Rept.,* App., p. 21. Type locality: "Kaffirland and the country towards Port Natal".

Homorelaps dorsalis (A. Smith): Gough, 1908, p. 37; Boulenger, 1910, p. 520.

Elaps dorsalis (A. Smith): FitzSimons, 1962, p. 286, pls 27 & LVII and 1970/74, p. 180/179 & 210, pl. 26(5); De Waal, 1978, p. 80.

Homoroselaps dorsalis (A. Smith): Broadley, 1983/90, p. 217, fig. 120, pl. 44; Branch, 1988a, p. 80, pl. 24.

Range

Sparsely recorded from Transvaal, Swaziland highveld, northern half of Natal, central and south-eastern O.F.S., and north-eastern Cape Province; distributed mostly in highveld regions and Natal midlands.

Zoogeographical classification: Eastern Temperate Transitional.

Range cluster in O.F.S.: Central (C).

Distribution in the Orange Free State (six localities; Fig. 96)

Specimens examined from: Bloemfontein (NMB R491-97); Hebron (NMB R2481); Kroonstad (LR 1167-68).

Other records: Brandfort; Smithfield (Boulenger, 1910); Willem Pretorius Game Reserve (De Waal, 1978).

Features (nine specimens examined)

Largest male (NMB R495 - Bloemfontein) 252 + 28 = 280 mm.

Largest female (NMB R494 - Bloemfontein) 286 + 29 = 315 mm.

Dorsum dark brown in specimens NMB R2481 and LR 1167-68, but light brown in NMB R491-96 (which have been preserved since about 1940). There is a pale vertebral stripe from tip of snout to tip of tail in NMB R2481 and LR 1167-68 only. Venter white. NMB R496 is a decapitated specimen.

Habitat and Ecology

This rare, mildly poisonous species has been collected from inactive termitaria in the O.F.S. (De Waal, 1978, p. 119) and Transvaal (Jacobsen, 1989, p. 983). Virtually nothing else is known of its habits and ecology, although these may be similar to those of its close relative, *Homoroselaps lacteus.*

Remarks

Jacobsen (1989, p. 983) noted that the apparently disjunct distribution of this species may be the result of habitat fragmentation.

Genus: *Atractaspis* A. Smith, 1849

Atractaspis bibronii A. Smith, 1849 — Bibron's Stiletto Snake

Atractaspis bibronii A. Smith, 1849, *Ill. Zool. S. Afr., Rept.,* pl. 1 xxi. Type locality: "Eastern districts of the Cape Colony", but probably Natal (Broadley, 1983/90, p. 221). De Waal, 1978, p. 123; Broadley, 1983/90, p. 219, figs 121 & 122, pl. 45; Bates, 1988a, p. 51; Branch, 1988a, p. 75, pl. 38; Broadley, 1991, p. 501.

Range

Savannas of the Zambesiaca Region, from Afgoi in southern Somalia through the eastern half of southern Africa to southern Natal, O.F.S. and northern Cape Province, and west to Botswana, Namibia, Angola, south-eastern Zaire and Rwanda; most southerly record (outside Natal) is Colesberg (north-eastern Cape).

Zoogeographical classification: Tropical Wide Ranging.

Range cluster in O.F.S.: Non-Northeastern (Non-NE).

Distribution in the Orange Free State (three localities; Fig. 97)

Specimens examined from: Bloemfontein (Pellisier Park) (NMB R5338); Deelfontein, Bothaville (NMB R1908); Hertzogville (30 km south of) (NMB R6820).

Other records: De Brug Railway Siding (near to) (sight record of ± 25 cm long dead on road specimen, W. Rawlings, 05h30, 11 December 1992).

Extralimital records (one locality; Fig. 97)

Colesberg (Branch, 1990).

Features (three specimens examined)

Largest male (NMB R6820 - Hertzogville, 30 km south of) 493 + 39 = 532 mm.

Largest female (NMB R1908 - Deelfontein, Bothaville) 285 + 19 = 304 mm.

Dorsal colouration dark brown in alcohol (NMB R1908, 5338), purplish-brown to black in life (NMB R6820). Ventral plates cream with brown lateral ends (NMB R1908), or cream suffused with brown (NMB R5338) or immaculate white in life (NMB R6820). A few lateral scale rows also pale coloured. Ventrals and subcaudals - 233 + 22 (NMB R1908; female); 224 + 24 (NMB R5338; male); 226 + 27 (NMB R6820; male). Anal plate entire. The most basal and most terminal (few) subcaudals of NMB R1908 and 5338 are divided, whereas the most basal subcaudal of NMB R6820 is divided into four scales, the median pair the smallest.

Habitat and Ecology

This fossorial snake is poisonous (see Broadley, 1990, p. 22; Auerbach, 1987, p. 179). The species is widespread in savanna, where it is found under logs or stones which often have a burrow leading to a lower chamber (Broadley, 1966, p. 450). The Hertzogville specimen was collected by Mr W. Rawlings in November 1992 on a main road a few days after rain. A specimen collected at Colesberg, on the Cape Province side of the Orange River near the border with the southern O.F.S., was found crawling on lawn at night (Branch, 1990a, p. 39). The species preys on other snakes, e.g. *Leptotyphlops distanti, Typhlops bibronii, Xenocalamus* spp. (Jacobsen, 1989, p. 989), *Typhlops delalandei, Aparallactus capensis, Mehelya nyassae* (Broadley, 1966, p. 449), *Typhlops gracilis* (Mertens, 1937 in Broadley, 1966), amphisbaenians (Broadley, 1990, p. 221), lizards - e.g. *Acontias gracilicauda broadleyi* (= *A. percivali occidentalis*) and *Nucras taeniolata ornata* (= *N. ornata*) (Broadley, 1966), frogs (Branch, 1988a, p. 75) and small rodents - e.g. *Mus minutoides* and new-born mice (Broadley, 1966). Enemies include solifugid spiders and owls (e.g. *Tyto alba*) (Broadley, 1966). A 536-mm-long female contained six eggs measuring 36 x 12 mm in June (Wilson, 1965 in Broadley, 1966).

Remarks

Broadley (1991) recently reviewed the genus *Atractaspis* in southern Africa and recognized *A. duerdeni* Gough, 1907 as a valid species. The Herzogville and De Brug (sight record) specimens are only the third and fourth records of this species from the O.F.S., the other two having been examined by Broadley (1991) during his review.

Genus: *Prosymna* Gray, 1849

Prosymna sundevallii sundevallii (A. Smith, 1849) Southern Sundevall's Shovel-snout

Temnorhynchus sundevallii A. Smith, 1849, *Ill. Zool. S. Afr., Rept.*, App., p. 17. Type locality: "Kaffirland, eastward of Cape Colony", i.e. Natal.

Prosymna sundevalli (A. Smith): Gough, 1908, p. 24.

Prosymna sundevallii sundevallii (A. Smith): FitzSimons, 1962, p. 153, fig. 40, pl. XIX and 1974, p. 103, pls 7(5) & 10(2); De Waal, 1978, p. 94; Broadley, 1983/90, p. 224, figs 125 & 126, p. 46; Branch, 1988a, p. 66, pl. 16.

Prosymna sundevalli sundevalli (A. Smith): FitzSimons, 1970, p. 102, pls 7(5) & 10(2).

Range

From the western and southern Cape Province northwards through the O.F.S. (excluding north-west and north-east) and adjacent northern Cape, western Lesotho, southern and central Transvaal and southern Botswana, with isolated records elsewhere in the northern Cape and south-western Botswana.

Zoogeographical classification: Cape Temperate.

Range cluster in O.F.S.: Non-Northeastern (Non-NE).

Distribution in the Orange Free State (26 localities; Fig. 98)

Specimens examined from: Annies Rust; Babel; Bainsvlei; Baltespoort; Bloemendal; Bloemfontein; Brakpan; Doornplaat; Exelsior, Edenburg; Groenekloof; Honingberg; Houtkop; Karreepoort; Klipfontein; Kroonstad (LR 1229); Lindley (TM 65565); Milambi; Ongegund; Patrijsdraai; Pietersberg; Rayton; Uitkijk; Uitkomst; Weltevreden, Smithfield; Zandvoort.

Other records: Tweespruit (FitzSimons, 1962); Orange River Colony (Gough, 1908).

Features (30 specimens examined)

Largest male (NMB R3661 - Patrijsdraai) 238 + 34 = 272 mm.

Largest female (NMB R1956 - Klipfontein) 285 + 30 = 315 mm.

Dorsum light brown to grey with a paravertebral series of dark spots or blotches which extend onto the tail, and some of which may be fused across the midline. The dark spots may have a pale outline (e.g. NMB R2616, 4379, 4432). A poorly defined series of slightly lighter spots may be present on the sides of the body. Central head shields pale, rostrum slightly less pale; the other head shields are black, and a black band is present around the neck but does not continue onto the ventral plates. The black band is interrupted medially in NMB R35 only. Venter white.

Habitat and Ecology

This secretive burrowing snake has been collected from inactive termitaria and under rocks in the O.F.S. (De Waal, 1978, p. 94); one specimen (NMB R5528) from Bloemfontein was found dead in a swimming pool. The diet comprises reptile eggs (including those of geckos), small lizards such as hatchling *Lygodactylus* spp. (Broadley, 1979) and possibly insects and other small invertebrates (FitzSimons, 1970/74, p. 103). Females lay an average of 3-4 comparatively large, elongate eggs measuring about 28x9 mm (Broadley, 1990, p. 225). A Transvaal female contained two well developed ova in late December (Jacobsen, 1989, p. 998). According to Branch (1988a, p. 66), hatchlings measure 100-110 mm in length. This species is well known for its defensive display of violently coiling and uncoiling its body when molested.

Prosymna bivittata Werner, 1903 Two-striped Shovel-snout

Prosymna sundevallii var. *bivittata* Werner, 1903, *Abhandl. bayer Akad. Wiss.*, 22(2), p. 381. Type locality: "Deutsch Südwest-Afrika" = Namibia.

Prosymna bivittata Werner: De Waal, 1978, p. 95; Broadley, 1983/90, p. 226, figs 128 & 129, pl. 48; Branch, 1988a, p. 66, pl. 19.

Range

Northern Namibia, Botswana (absent in central areas), southern Zimbabwe, Transvaal and north-western O.F.S., with isolated records in Namaqualand.

Zoogeographical classification: Western Tropical Transitional.

Range cluster in O.F.S.: Western (W).

Distribution in the Orange Free State (three localities; Fig. 98)

Specimens examined from: Boskop (NMB R2065); Die Hoogte (NMB R3916); Wesselsdam (NMB R6194).

Features (three specimens examined)

Largest male (NMB R6194 - Wesselsdam) 120 + 12 = 132 mm; mass 0,8 g.

Largest female (NMB R3916 - Die Hoogte) 197 + 19 = 216 mm.

Dorsum brown with broad, pale median band from nape to tip of tail. Median band with small scattered dark spots, or large spots in a more or less linear series (NMB R6194). Venter cream. Frontal and parietals mostly cream coloured. Ventrals and subcaudals 173 + 20/21 in NMB R6194; 169-177 and 23-24 in other specimens (De Waal, 1978) - range therefore 169-177 and 20-24.

Habitat and Ecology

A burrowing species found in sandy areas and collected under rocks in the O.F.S. (De Waal, 1978, p. 95). Also collected from under logs in the Transvaal (Jacobsen, 1989, p. 1006). According to Pienaar *et al.* (1983, p. 185), the main diet is insects and other small invertebrates. A captive specimen collected near Beitbridge fed on the eggs of *Aparallactus capensis* and *Nucras intertexta* (Broadley, 1990, p. 227). Ingestion is similar to that of *Dasypeltis*, but the egg is slit by the long rear maxillary teeth and then squeezed by the throat muscles to force its contents into the stomach, after which (unlike *Dasypeltis* which regurgitates an egg package) the collapsed egg-shell is swallowed (Broadley, 1990). A fragmentary specimen was found in the stomach of a jackal (*Canis mesomelas*) from Kanyu in Botswana (Broadley, 1966, p. 337). Broadley (in Jacobsen, 1989, p. 1006) recorded a female containing four eggs measuring 27,0 x 7,0 mm. Pienaar *et al.* (1983) and Auerbach (1987, p. 177) stated that an average of 3-4 eggs measuring about 28 x 9 mm are laid. Defensive behaviour is similar to that recorded for *Prosymna s. sundevallii* (Pienaar *et al.*, 1983, p. 186).

Genus: *Philothamnus* A. Smith, 1840

Philothamnus natalensis occidentalis Broadley, 1966 — Western Natal Green Snake

Philothamnus natalensis occidentalis Broadley, 1966, *Ann. Natal Mus.*, 18(2), p. 419. Type locality: Camperdown, Natal. FitzSimons, 1974, p. 102 & 204; De Waal, 1978, p. 93; Broadley, 1983/90, p. 240, fig. 137; Branch, 1988a, p. 83, pl. 30; Bates, 1991b, p. 155.

Philothamnus natalensis (not A. Smith, 1848): FitzSimons, 1970, p. 99, pl. 10(1) (part).

Range

Southern and eastern Cape Province, Natal (excluding the north-east), north-eastern O.F.S., Swaziland and Transvaal (excluding the south-west); also solitary records in central Zimbabwe and at Kimberley in the northern Cape; the Kimberley record may represent a stray specimen which came down with the Vaal River (Broadley, 1983/90, p. 240), although the area is in Kalahari Thornveld, which would probably provide a suitable habitat for the species.

Zoogeographical classification: Eastern Tropical Transitional.

Range cluster in O.F.S.: Drakensberg (D).

Distribution in the Orange Free State (three localities; Fig. 99)

Specimens examined from: Golden Gate Highlands National Park (NMB R6253); Metz (TM 56535); Oever (NMB R1432).

Features (three specimens examined)

A female (NMB R1432 - Oever) measured 776 + 330 = 1106 mm.

Dorsum greenish-grey; venter pale green to bluish-grey. Two anterior temporals; 8-9 upper labials, two of which enter orbital (4th & 5th in NMB R6253 and TM 56535; 5th & 6th in NMB R1432). Ventrals and subcaudals (range = 163-167 and 118-119 respectively): 167 + 119 (NMB R1432); 165 + 118 (NMB R6253); 163 + 118 (TM 56535). Ventrals weakly keeled laterally; subcaudals smooth; anal divided.

Habitat and Ecology

Specimen NMB R1432 (Oever) was collected on the side of a pond and contained a frog (*Rana* sp.) in its stomach (De Waal, 1978, p. 94), while NMB R56535 (Metz) was found in a *Protea* tree on the eastern slope of a mountain. In the Transvaal these snakes are found in shrubs and trees near water at altitudes of 1000-2000 m a.s.l.; a female from Mariepskop laid nine eggs measuring 27,5 - 32,0 x 11,4 - 12,3 mm in October (Jacobsen, 1989, p. 1028). Branch & Boullé (1988, p. 47) recorded a *Philothamnus* specimen (either *P. hoplogaster* or *P. n. occidentalis*) measuring 461 mm SVL, and with a mass of 10,5 g, from the stomach of a Largemouth Bass *Micropterus salmoides* weighing 200 g, collected from the Blinderkloof River in the eastern Cape Province.

Remarks

Although occurring only in the north-eastern part of the O.F.S., this subspecies has also been recorded nearby in the Natal Drakensberg (Bourquin & Channing, 1980, p. 17) and northern Natal (Broadley, 1990, p. 237, map 55). Riverine bush and trees as well as *Protea* savanna of the Afromontane Region (White, 1978) occur in parts of the north-eastern O.F.S., providing suitable habitat for these snakes.

Genus: *Crotaphopeltis* Fitzinger, 1843

Crotaphopeltis hotamboeia (Laurenti, 1768) Red-lipped Snake

Coronella hotamboeia Laurenti, 1768, *Syn. Rept.*, p. 85. Type locality: "India orientali", i.e. Africa.

Leptodira rufescens (Laurenti): Symonds, 1887, p. 488.

Leptodira hotamboeia (Laurenti): Gough, 1908, p. 27; Bogert, 1940, p. 62, fig. 8B.

Crotaphopeltis hotamboeia hotamboeia (Laurenti): FitzSimons, 1962, p. 187, fig. 51, pls 12 & XXVIII; 1970, p. 118, pl. 8(5) and 1974, p. 119, pl. 8(5).

Crotaphopeltis hotamboeia (Laurenti): De Waal, 1978, p. 102; Broadley, 1983/90, p. 243, fig. 139, pls 52 & 53; Branch, 1988a, p. 85, pl. 33.

Range

Tropical Africa (excluding rain forests) southwards through eastern half of southern Africa to south-western Cape Province; absent from most of the dry western half of southern Africa (i.e. central and northern Cape, Namibia and southern and central Botswana), although an isolated record exists for north-central Namibia; also recorded from Bazaruto Island (Broadley, 1990, App., p. 382).

Zoogeographical classification: Afrotropical (= Ethiopian).

Range cluster in O.F.S.: Non-Northwestern (Non-NW).

Distribution in the Orange Free State (65 localities; Fig. 100)

Specimens examined from: Allanridge (TM 27238); Anna's Rust; Annies Rust; Bergkloof; Bergkraal; Berlin; Bethel; Biddulphsberg; Bloemfontein; Boesmansberg; Bothaville (TM 5227); Bramley's Hoek; Braunzijnkop; Driekop; Goedetrouw; Grootkrans; Heidedal; Holme's Dale; Hoogeveld, Kroonstad; Hoopstad (TM 31234); Italie (TM 39779); Houtkop; Kelly's View; Kleinplaas; Klipplaat; Kranskop; Kromhof; La Belle France; La Riviera; Leeuwkop; Lorenzo; Middenspruit; Milambi; Mimosa; Morgenzon, Harrismith; Mount Nelson; Olive Hill; Oorsprong; Patrijsdraai; Perth; Petra; Petra Quarry (west of); Pietersberg; Quaggaspruit; Richmond West (TM 39652); Ribblesdale; Rondavel; Roodekop (TM 39653); Spijtfontein; Stoffelfontein; Stoltzkop; Thaba Pachoa Berg; Tweefontein; Twee Zusters; Vaalbank Zuid; Vaalkop; Venus; Verdun, Fouriesburg; Willem Pretorius Game Reserve; Wolvekop, Kroonstad.

Other records: Kroonstad (Symonds, 1887); Bainsvlei; Deelfontein, Smithfield; Kelly's View; Rouxville; Winburg; Zastron (FitzSimons, 1962); Orange River Colony (Gough, 1908).

Features (99 specimens examined)

Largest male (NMB R3597 - Olive Hill) 504 + 70 = 574 mm.

Largest female (NMB R1361 - Willem Pretorius Game Reserve) 508 + 74 = 582 mm.

Dorsum light or dark grey, sometimes with white speckling. Upper lip, or at least most of the dorsal part of the upper lip, red, but may be faded to white in alcohol. Top of head grey, temporal region black. Underparts immaculate cream.

Habitat and Ecology

This back-fanged, mildly poisonous and primarily terrestrial nocturnal species has been collected in inactive termitaria and under rocks in the O.F.S. (De Waal, 1978, p. 102). It showed a preference for damp areas (such as gardens) and was collected at altitudes of 200-2000 m a.s.l. in the Transvaal (Jacobsen, 1989, p. 1040). Broadley (1966, p. 346) also observed several specimens hunting the frog *Hyperolius swynnertoni* in small shrubs along the Umzilizwe River in south-eastern Africa. The stomachs of four O.F.S. snakes contained the remains of the gecko *Pachydactylus c. capensis* and the ranid *Tomopterna cryptotis*, and a *Cacosternum boettgeri* was eaten by a captive O.F.S. specimen (De Waal, 1978, p. 102). Several species of frogs and toads (*Bufo* spp.) were the only prey items eaten by

south-east African snakes (see Broadley, 1966, p. 346). Broadley (1990, p. 245) noted that lizards, mice and other small rodents are also taken, usually when amphibians are not available, but Jacobsen (1989, p. 1040) noted that "this must be considered exceptional". Enemies of adults in south-eastern Africa include the snakes *Miodon chrysti, Naja naja crawshayi* and the Lizard Buzzard *Kaupifalco monogrammicus* (Broadley, 1966), while juveniles are preyed upon by the bullfrog *Pyxicephalus adspersus* at Salisbury (Broadley, 1966) and the Domestic Cat at Owen Sithole College of Agriculture in Natal (Hoffman, 1990, p. 160). No reproductive data are available for O.F.S. populations, but Broadley (1990, p. 245) stated that 6-12 elongately oval eggs measuring 27-35 x 8-12 mm are laid in late spring to early summer and hatch after three months, hatchlings measuring an average of 80 mm in total length. Jacobsen (1989) recorded a clutch of nine eggs from under a slab of concrete; eggs measured 20,6 - 22,8 x 10,9 - 14,6 mm (approximate average mass per egg for eight eggs = 2,17 g), while Dyer (1982) recorded a clutch of eight eggs measuring 25-30,5 x 11-13 mm which hatched out after 61-64 days at incubation temperatures of 23-29°C (and later at room temperature), with hatchlings measuring 170-183 mm in total length and having individual masses of 2,0-2,4 g; eggs were laid in December and the female measured 510 mm in total length. According to Bogert (1940, p. 63), nine eggs were removed from the oviducts of a female from Ganta in Liberia, and six eggs (three with full-term embryos) were dug from a termite hill in August.

Genus: *Telescopus* Wagler, 1830

Telescopus beetzii (Barbour, 1922) Namaqua Tiger Snake

Tarbophis beetzii Barbour, 1922, *Proc. biol. Soc. Washington*, 35, p. 230. Type locality: Kolmanskop, Great Namaqualand, Namibia.

Telescopus beetzii (Barbour): De Waal, 1978, p. 100; Broadley, 1983/90, p. 248, pl. 55; Branch, 1988a, p. 86, pl. 19.

Range

Southern Namibia southwards to Great Namaqualand, central Karoo and south-western O.F.S.

Zoogeographical classification: Western Temperate Transitional.

Range cluster in O.F.S.: Southwestern (SW).

Distribution in the Orange Free State (one locality; Fig. 100)

Specimens examined from: Weltevreden, Jacobsdal (NMB R3166, 3167).

Features (two specimens examined)

Largest male (NMB R3167 - Weltevreden, Jacobsdal) 340 + 61 = 401 mm.

Largest female (NMB R3166 - Weltevreden, Jacobsdal) 580 + 73 = 653 mm.

Dorsum pale brown with a longitudinal series of large, dark vertebral spots (NMB R3166: 32 to 34 spots from nape to above vent + 13 on tail = 45 - 47 spots; NMB R3167: 31 + 20 = 51 spots). A few small dark spots on flanks. Venter cream.

Habitat and Ecology

The two O.F.S. specimens were found in inactive termitaria (De Waal, 1978, p. 101), but Branch (1988a, p. 86) stated that this rare species, recorded from only 25 localities (Broadley, 1990, pp. 249-250), lives on rock outcrops, sheltering in cracks during the day and emerging at night to feed on lizards; although its presence is usually revealed only by its discovery dead on roads. Females lay 3-5 elongate eggs measuring 33-55 x 10-14 mm in December, with hatchlings of 170-190 mm emerging after 80-90 days (Branch, 1988a). A female from Victoria West, measuring 460 mm total length, laid three eggs in December; eggs measured 33-35 x 13-14 mm and hatched after 90 days in captivity; hatchlings measured 172-178 mm total length and weighed 5,0-5,4 g (Dyer, 1982, p. 16).

Remarks

Considering the fact that this species does not occur in the Namib Desert (see Branch, 1988a, p. 86), but does occur in Namaqualand (see type locality; and parts of the Karoo), the English name used here is "Namaqua Tiger Snake".

Genus: *Dispholidus* Duvernoy, 1832

Dispholidus typus typus (A. Smith, 1829) Boomslang

Bucephalus typus A. Smith, 1829, *Zool. Journ.*, 4, p. 441. Type locality: "Old Latakoo" = Lattakoo or Lithako, apr. 27°S, 24°E - i.e. between Kuruman and Taung, northern Cape Province.

Dispholidus typus typus (A. Smith): De Waal, 1978, p. 103; Broadley, 1983/90, p. 252, figs 143-145, pls 57 & 58; Branch, 1988a, p. 87, pl. 31.

Range

Throughout open bush and savanna country, from tropical Africa south of 15°N latitude to the southern tip of Africa, but absent from drier areas in the south, such as the Great Karoo, Little Namaqualand, Great Namaqualand and the Namib desert; also absent from south-eastern Botswana, southern Transvaal highveld and most of the O.F.S. (except for north-west), and most of the eastern Cape and

Lesotho; also absent from rain forest.

Zoogeographical classification: Tropical Wide Ranging.

Range cluster in O.F.S.: Northwestern (NW).

Distribution in the Orange Free State (four localities; Fig. 101)

Specimens examined from: Moirton (NMB R708).

Other records: Diepwater (TM 54131) (specimen not available for examination; probably a translocation, marked "?" in Fig. 101); Sandveld Nature Reserve (photographic record; also specimen SNR 4, probably collected in reserve); Solheim (unconfirmed sight record, Mrs C.G. van Niekerk).

Features (two specimens examined)

Largest male (NMB R708 - Moirton) 1173 + 370 = 1543 mm.

Dorsum and venter pale bluish-grey; dark markings between dorsal scales; eye large.

Habitat and Ecology

The two O.F.S. snakes were arboreal in *Acacia* sp. and *Zizyphus mucronata* trees in the Kalahari Thornveld of the north-west (De Waal, 1978, p. 104). These snakes may cross open ground, but if disturbed, will quickly make for trees or bushes (Broadley, 1990, p. 254); may enter holes in trees and even holes in *Macrotermes* termitaria (Jacobsen, 1989, p. 1058). Boomslang are diurnal, back-fanged, highly poisonous arboreal snakes that feed mainly on chameleons (e.g. *Chamaeleo d. dilepis*) and other arboreal lizards, but small birds (including nestlings and eggs), mice and frogs are also taken (Broadley, 1966, p. 354; 1990, p. 254). According to Auerbach (1987, p. 187), other snakes may also be eaten. Details on the venom of Boomslang are given by Broadley (1990, p. 254) and Branch (1988a, p. 87). Enemies include the ophiophagous snake *Mehelya c. capensis* and the sand snake *Psammophis s. sibilans* (see Broadley, 1966, p. 354), although neither of these occurs in the O.F.S. Mating occurs in spring in trees or bushes, and 8-23 (usually 10-14) eggs measuring 40-43 x 16-26 mm are laid about four months later (in late spring to midsummer) in holes or hollows in trees; incubation lasts 4-7 months, hatchlings measuring an average of 330 mm in total length (Broadley, 1990). Broadley (1966, p. 354) noted that one female contained only five eggs. Jacobsen (1989, p. 1058) recorded a Transvaal female with 13 eggs, measured *in situ*, with egg dimensions of 29,0 - 36,0 x 15,0 - 22,0 mm which were "due to be laid shortly". Boycott & Morgan (1990) reported in detail on the reproduction of captive Boomslang.

Remarks

Broadley's (1990) southern O.F.S. record (2926 BC) for this species, as plotted on his map, is dubious as that area lies outside the main distribution area of the species and seems unlikely to provide suitable tree habitat. It may refer to the "Diepwater" (TM 54131) specimen, which, if it was collected at that locality, could represent a translocation. This record is thus provisionally rejected and indicated on the map (Fig. 101) by a question mark only. There is, however, another isolated record for the species at locus 3026 CC in the north-eastern Cape Province near the southern O.F.S. border (Broadley, 1990, map 61).

Genus: *Dasypeltis* Wagler, 1830

Dasypeltis scabra (Linnaeus, 1758) Rhombic Egg Eater

Coluber scaber Linnaeus, 1758, *Syst. Nat.*, ed. 10, 1, p. 223 and 1766, ed. 12, 1, p. 384. Type locality: "in Indiis" = received via the Cape, i.e. "South Africa" (see Flower, 1933, p. 818).

Dasypeltis scabra scabra (Linnaeus): FitzSimons, 1962, p. 176, figs 47 & 48, pls II & XXV; 1970, p. 110, pl. 8(2) and 1974, p. 111, pl. 8(2).

Dasypeltis scabra (Linnaeus): Gough, 1908, p. 26; De Waal, 1978, p. 98; Broadley, 1983/90, p. 262, figs 150-152, pl. 61; Branch, 1988a, p. 84, pl. 15; Bates, 1991b, p. 155.

Range

Distributed virtually throughout southern Africa, extending northwards to southern Sudan, Ethiopia, Somalia and southern Arabia in the east and Gambia in the west; apparently absent from most of the central and northern Cape, south-western Botswana and most of Lesotho; also absent from true desert and closed-canopy forest.

Zoogeographical classification: Afrotropical (= Ethiopian).

Range cluster in O.F.S.: Throughout (T).

Distribution in the Orange Free State (150 localities; Fig. 102)

Specimens examined from: Alpha; Anna's Rust; Annies Rust; Atalanta; Babel; Bachelor's Home; Bainsvlei; Baltespoort; Ben Nevis; Bergkloof; Bergplaats, Bloemfontein; Bergplaats, Dewetsdorp; Berlin; Bethel; Beyersfontein; Biddulphsberg; Bloemfontein; Bloemfontein (Dan Pienaar); Boesmansberg; Bon Haven; Boschkloof; Boschkop; Boschrand; Brabant; Brandfort, 4 miles north of (NMZB-UM 841); Braunzijnkop; Brockenhurst; Caledonspoort; Carlie; Ceylon; Dealbata; Deelfontein, Bothaville; De Rust; Die Hoogte; Dipka; Di Poort; Doornland; Elandsfontein; Florisbad (NMB; NMZB-UM 818); Francis Home; Frazerfield; Golden Gate Highlands National Park; Goedetrouw; Grootkrans; Haagen's Stad; Hartebeestfontein, Boshof; Hebron; Honingberg; Hoogeveld, Theunissen; Houmoed; Houtkop; Joostenberg; Kafferskop; Kasteelkop; Kleinplaas; Klipdrift; Klipfontein; Klipoog; Klipplaat; Kopjeskraal; Koppiesdam; Kranskop; Lange Hoek; Lanquedoc; La Riviera; Leeuwkop; Leliehoek; Lessingskop; Littlecote; Lorenzo; Loskop; Lovedale; Luiperfontein; Maanhaar; Magdalen; Mandyville; Mara, Vredefort; Maseru; Mecklenburg; Merino, Bethlehem; Meyerskraal; Middenspruit; Milambi; Mimosa; Monontsa Pass; Mooigelegen; Morgenzon, Ficksburg; Morgenzon, Harrismith; Morgenzon, Senekal; Morgenzon, Zastron; Mount Nelson; Noodhulp; Onze Rust; Petra; Pietersberg; Platrand; Proces; Quaggaspruit; Ramalitse; Rambouillet; Rietfontein, Rouxville; Riverside; Rohallion; Rusthof; Slangheuvel; Smaldeel; Smithskraal; Spijtfontein; Stoffelfontein; Stoltzkop; Straalfontein; Tafelberg; Thaba Pachoa Berg; Triangle; Tweefontein; Twee Zusters; Uitkijk; Uitkomst; Vaalkop; Van Aswegen's Hoek; Van der Walt's Rust; Venus; Verdun, Reitz; Vergaderrand; Welbedacht; Weltevreden, Smithfield; Willem Pretorius Game Reserve; Winterspoort; Wittekopjes; Witzieshoek; Wolvekop, Kroonstad; Wonderkop; Woudzicht; Zandfontein; Zomervlakte; Zwartkoppies.

Other records: Bethulie; Jacobsdal; Kroonstad; Smithfield (FitzSimons, 1962); Orange River Colony (Gough, 1908); Driekloof Dam (TM 56534); Hoopstad, Vet River (TM 63592); Lindley (TM 45592); Odendaalsrus, near to (TM 27241); Ngotswane Gorge (TM 66273); Trentham (TM 48548-50); 16 miles ex Vrede-Warden (TM 27563).

Features (346 specimens examined)

Largest male (NMB R2075 - Van Aswegen's Hoek) 445 + 90 = 535 mm.

Largest female (NMB R6433 - Bainsvlei) 710 + 90 = 800 mm; mass = 93,8 g.

Dorsum grey-brown with black vertebral patches and dark blotches laterally. Thirty-three specimens (9,0%; N = 346) were basically uniform brown above, but usually with a slightly darker vertebral region. These specimens were usually grey laterally and cream-yellow ventrally; the lateral ends of the ventrals were also usually grey. Some uniform specimens had a dark median stripe on the underside of the tail; NMB R4254 has tiny dark speckles on the belly. The following specimens were uniform phase: NMB R1083, 1322, 1794, 1814-1816, 1820, 1856, 1857-61, 2627, 2632, 3476, 3477, 3544, 3545, 3602, 3636, 3637, 3796, 4082, 4233, 4234, 4254, 4257.

Habitat and Ecology

This slow-moving, non-poisonous, nocturnal, terrestrial and occasionally arboreal snake occurs virtually throughout the O.F.S., where it is usually found in inactive termitaria, but also under rocks (De Waal, 1978, p. 99); specimen TM 63592 was found under a log beside the Vet River during early morning. It has also been found in crevices between rocks, under building rubble, under the eaves of houses and under or in rotting logs in the Transvaal (Jacobsen, 1989, p. 1076).

The diet consists entirely of fresh birds' eggs (Broadley, 1990, p. 264). An egg-eater is capable of swallowing an egg with a diameter of up to three times the diameter of its head (Gans, 1952). The egg is ingested and broken by the projections of the vertebral column. The fluid is swallowed and a package of egg shells is regurgitated. However, De Waal (1978, p. 99) found shell fragments in the stomachs of several O.F.S. specimens. He also noted that two specimens contained bird embryos in their stomachs, three in one stomach and two in another. The embryos measured about 30 mm in length, suggesting that egg-eaters will consume eggs that have been incubated for a considerable period of time. This would be to the species' advantage, considering the short breeding seasons of some birds, and it would mean that at no matter what stage of incubation, any fresh (i.e. not rotten) egg encountered would be available for consumption. Lynch (1988) suggested that the eggs of ground-nesting birds provide the primary food source for egg-eaters in open grassland areas, and Ward (1989) recorded *D. scabra* as preying on the eggs of three plover species, genus *Vanellus*. With reference to the above and the size of the eggs of several ground-nesting bird species in southern Africa, Bates (1989d) argued that both adult and juvenile *D. scabra* probably utilize the eggs of ground-nesting birds (some of which have long breeding seasons) quite extensively, especially in areas of open grassland with few or no trees.

Six to 18 eggs averaging 36 x 18 mm are laid in December or January, but sometimes as late as April or May; these hatch after 3-4 months, producing hatchlings of about 230 mm in length (Broadley, 1990, p. 265). Eggs laid in April or May should hatch out in early spring. According to Branch (1988a, p. 84), 6-25 eggs measuring 36 x 18 mm are laid in summer and take 80-90 days to hatch, with young measuring 210-240 mm in length; two clutches may be laid per season by captive snakes. A juvenile (NMB R5492) collected at Golden Gate Highlands National Park on 10 April measured 198 + 32 = 230 mm.

Family: **ELAPIDAE** Boie, 1827

Genus: *Elapsoidea* Bocage, 1866

Elapsoidea sundevallii media Broadley, 1971 — Sundevall's Garter Snake

Elapechis sundevalli (not A. Smith, 1848): Gough, 1908, p. 34 (part, Orange River Colony).

Elapsoidea sundevallii decosteri (not Boulenger, 1888): FitzSimons, 1962, p. 279, pl. LV (part, Bloemfontein) and 1970, p. 175 & 210, pl. 27(3) (part).

Elapsoidea sundevallii media Broadley, 1971, *Occ. Pap. natn. Mus., Rhod.*, Ser. B, 4 (32), p. 615. Type locality: Galulis Farm, near Edenvale, Transvaal. FitzSimons, 1974, p. 175; De Waal, 1978, p. 116; Broadley, 1983/90, p. 272, fig. 159; Branch, 1988a, p. 91, pls 21 & 32.

Range

Highveld regions of the central and southern Transvaal and northern and central Orange Free State, extending into the northern Cape Province in the Kimberley area.

Zoogeographical classification: Eastern Temperate Transitional.

Range cluster in O.F.S.: Central (C).

Distribution in the Orange Free State (13 localities; Fig. 103)

Specimens examined from: Bloemfontein (Fichardt Park); Bloemfontein (Power Station); Bloemfontein (Railway Station); Cecilia; Holme's Dale; Kwaggafontein; Mimosa; Noodhulp; Northfield; Patrijsdraai; Petra; Rodenbeck; Springbokdam; Viljoenskroon (NMZB-UM 12456); Orange Free State; Orange River Colony (TM 6199).

Features (18 specimens examined)

Largest male (NMB R3660 - Patrijsdraai) 200 + 15 = 215 mm.

Largest female (NMB R1397 - Holme's Dale) 372 + 25 = 397 mm.

An unsexed specimen from Bloemfontein Power Station (NMB R5924) measured 291,5 + 20 = 311,5 mm.

Dorsum of adults black in colour; subadults with light and dark bands which extend onto tail. Venter pale laterally with greyish median band. In subadults the dark band on the nape extends onto the top of the head in an arrow-head shape; anterior and lateral parts of head pale coloured.

Habitat and Ecology

This poisonous species is found in inactive termitaria and under rocks in the northern and central parts of the O.F.S. (De Waal, 1978, p. 117). Collected in Highveld Grassland and Bushveld at altitudes of 1250-1800 m a.s.l. in the Transvaal (Jacobsen, 1989, p. 1089). Only one dietary record is available for this subspecies, namely that of a specimen from Cecilia (NMB R5285) which regurgitated the posterior half of what was almost certainly an *Aparallactus capensis* (NMB R6795) (Bates, *in press*.). Other subspecies of *E. sundevallii* prey on (at least partly) snakes, lizards and their eggs, rain frogs, rodents and moles (Broadley, 1971; Branch, 1988a, p. 91; Broadley, 1990). No dietary information is available for the subspecies *E. s. decosteri*.

Genus: *Hemachatus* Fleming, 1822

Hemachatus haemachatus (Lacépède, 1788) Rinkhals

Vipere haemachate Lacépède, 1788, *Hist. Nat. Quad. Ovip. Serp.*, 2, p. 115, pl. iii, fig. 2. Type locality: "Japon-et Perse", in error for South Africa (FitzSimons, 1962, p. 287).

Sepedon haemachates (Lacépède): Symonds, 1887, p. 488; Gough, 1908, p. 36.

Hemachatus haemachatus (Lacépède): Bogert, 1940, p. 87; FitzSimons, 1962, p. 287, fig. 87, pls 28-30 & LVIII; De Waal, 1978, p. 120; Broadley, 1983/90, p. 275, figs 162 & 163, pl. 64; Branch, 1988a, p. 94, pls 20 & 35.

Range

South-western, southern and eastern Cape Province, northwards through Natal (excluding the east), western Lesotho, central and eastern half of the O.F.S., southern and south-eastern Transvaal and western Swaziland highveld, with an isolated relict population on the Inyanga highlands in Zimbabwe, and an apparently isolated record in the Kimberley area of the northern Cape; records of specimens from the montane grasslands of the old escarpment in the Cape, and coastal records in the southern Cape, may represent relict populations.

Zoogeographical classification: Cape Temperate (possibility Afromontane-associated).

Range cluster: Eastern (E).

Distribution in the Orange Free State (37 localities; Fig. 104)

Specimens examined from: Groendraai; Karreepoort; Kasteelkop; Klipoog; Lange Hoek; Loskop; Louis Rust; Nova; Philippi; Randfontein; Reddersburg; Rietspruit; Schutte's Draai Estates (NMZB-UM 12502, 48 juveniles); Seekoeivleipoort; Serfontein Dam; Slangheuvel; Tafelberg; Tweespruit; Uitzicht; Wepener; Wolvenfontein.

Other records: Kroonstad (Symonds, 1887); Bethlehem; Bloemfontein; Harrismith; Kestell; Maweni Heights; Memel; Parys; Rietspruit; Serfontein; Viljoensdrift; Vrede; Winburg; Zastron (FitzSimons, 1962); Grootgeluk (TM 64329); Willem Pretorius Game Reserve (TM 27278); Golden Gate Higlands National Park (Groenewald, 1992, sight record; also R.M. Douglas & T. Peyper, 1984, sight record).

Features (75 specimens examined)

Largest male (NMB R2615 - Karreepoort) 1075 + 235 = 1310 mm.

Largest female (NMB R2614 - Karreepoort) 1152 + 213 = 1365 mm.

Dorsum brown, brown-and-black or black. Venter black with white and black bands on anterior region.

Habitat and Ecology

This largely diurnal, poisonous snake occurs from coastal plains up to an altitude of 2500 m a.s.l. (Broadley, 1990, p. 277). Symonds (1887, p. 489) noted that captive specimens (apparently from Kroonstad) would not eat mice, but ate frog's and hen's eggs. He also noted that they often lived in holes, although they did occasionally take to water and could swim well. A detailed account of their behaviour and the characteristics of their venom are given by Broadley (1990). In the O.F.S. they have been found in deserted mammal burrows in open grassland and occasionally under rocks (De Waal, 1978, p. 121). One specimen (NMB R5531) was observed by day crawling near, and then retreating into, the burrow of a Giant Girdled Lizard *Cordylus giganteus* in an open grassland area on the farm Randfontein near Harrismith. It was collected from the burrow (which did not house any lizards) the following day. The gut contents of this specimen were examined but did not contain any prey items (R.M. Douglas, pers. comm.). However, Groenewald (1992, p. 73) recorded "severe predation" on relocated *C. giganteus* by *H. haemachatus* as well as Yellow Mongooses, Suricates and Secretarybirds at Golden Gate Highlands National Park, and Rinkhals have also been observed feeding on *C. giganteus* in the southern Transvaal (see Jacobsen, 1989). Broadley (1990, p. 278) noted that a variety of prey is eaten, including rodents, toads, lizards and snakes. The stomach of one O.F.S. Rinkhals contained a *Psammophylax r. rhombeatus*, whereas that of another snake contained six crushed birds' eggs (De Waal, 1978). Jacobsen (1989, p. 1099) reported on a specimen regurgitating a frog, *Rana fuscigula*, and observed another chasing a rodent in the Transvaal. A snake from Zimbabwe had eaten a *Bufo regularis* (= *B. gutturalis*) (Broadley, 1966, p. 424). Jacobsen (1989) provided a detailed account of a pair of Pied Crows *Corvus albus* attacking a Rinkhals. Unlike true cobras of the genus *Naja, H. haemachatus* is ovoviviparous, giving birth to 15-60 young (usually 20-30) averaging 180 mm in total length during late

summer (i.e. January to March); the record number of young born was 63 to a female from Lothair, held captive at Durban Snake Park (Broadley, 1990, p. 278). Gravid females collected from September to December in the O.F.S. contained 26-47 embryos (De Waal, 1978). Jacobsen (1989, p. 1100), presumably reporting on Transvaal snakes, noted that up to 35 neonates, measuring 170,0-180,0 mm and weighing 3,4-5,5 g, are born from January to March.

Genus: *Aspidelaps* A. Smith, 1849

Aspidelaps lubricus lubricus (Laurenti, 1768) Southern Coral Snake

Natrix lubrica Laurenti, 1768, *Synop. Rept.*, p. 80 (based upon *Seba*, 1735, thes., II, pl. x1iii, fig. 3). Type locality: "Cape of Good Hope".

Aspidelaps lubricus (Laurenti): Gough, 1908, p. 36.

Aspidelaps lubricus lubricus (Laurenti): FitzSimons, 1962, p. 276, pl. LIII; FitzSimons, 1974, p. 171 & 210, pl. 26(1); De Waal, 1978, p. 116; Broadley, 1983/90, p. 278, pl. 65; Branch, 1988a, p. 89, pl. 20; Bates, 1991c, p. 17.

Range

From south-western Namibia southwards through Cape Province (excluding extreme northern, much of the southern and most of the eastern parts) and eastwards to south-eastern O.F.S.

Zoogeographical classification: Cape Temperate.

Range cluster in O.F.S.: Southeastern (SE).

Distribution in the Orange Free State (one locality; Fig. 103)

Smithfield (FitzSimons, 1962).

Extralimital records (one locality; Fig. 103)

One specimen examined from: Aliwal North, south bank of Orange River (NMB R3503).

Features (one specimen examined from Aliwal North)

Largest specimen (Aliwal North, south bank of Orange River - NMB R3503) 299 + 37 = 336 mm.

Dorsum light brown with 46 dark bands from nape to tip of tail which usually encircle body. Midbody scale rows 19; ventrals 140; subcaudals 23.

Habitat and Ecology

According to Broadley (1990, pp. 279-280) this poisonous burrowing snake occurs in sandy or stony areas, coming out at night to hunt other snakes, lizards and their eggs and small rodents. The Aliwal North specimen (NMB R3503) was collected among reeds on the southern bank of the Orange River (Bates, 1991c). The stomach of a female from Pomona Island, Namibia, contained a small unidentified rodent and nineteen soft-shelled eggs (presumably lizard eggs) measuring about 10 x 6 mm (Bogert, 1940, p. 94). Visser (1972, p. 51) stated that legless lizards (cf. *Acontias* spp.) are eaten. Branch (1988a, p. 89) noted that females lay 3-11 eggs measuring 50-54 x 15 mm in December, hatchlings appearing 59-71 days later and measuring 170-180 mm in length; captive females may lay clutches every two months during summer. Reporting on captive specimens, Jaensch (1988, p. 45) noted that mating behaviour was observed during the months September and October, while eggs were laid in November, December and January; clutches consisted of 3-5 eggs measuring "nearly 60 mm long" and "45 x 14 mm" (clutch of five eggs); one egg from each of two clutches hatched after 64 and 67 days at 25-28°C; hatchlings shed their skins after eight days and fed on one-day-old "pink" mice at the age of ten days. Jaensch (1988) also noted that the only previous record of captive reproduction for South Africa was "when a gravid wild-caught female laid 3 eggs and the young hatched after an incubation period of 83-85 days and measured 174-176 mm TL". Jaensch (1988) was referring to a 415 mm long Victoria West female which produced a clutch of three eggs (50-54 x 15 mm) in December; hatchlings had masses of 5,5-5,6 g (Dyer, 1982, p. 17).

Remarks

Broadley (1983, 1990) did not plot or record De Waal's (1978) Aliwal North record, which, apart from FitzSimons' (1962) Smithfield record, is the most north-easterly record of the subspecies (Bates, 1991c).

Genus: *Naja* Laurenti, 1768

Naja nivea (Linnaeus, 1758) Cape Cobra

Coluber niveus Linnaeus, 1758, *Syst. Nat.*, ed. 10, 1, p. 223 and 1766, ed. 12, 1, p. 384. Type locality: "In Africa", i.e. Cape of Good Hope (FitzSimons, 1962, p. 297).

Naia flava (not Merrem, 1820): Gough, 1908, p. 35.

Naja nivea (Linnaeus): FitzSimons, 1962, p. 297, fig. 90, pls LXI - LXIII and 1970/74, p. 157, pl. 16(3 & 4) & 22(1); De Waal, 1978, p. 121; Broadley, 1983/90, p. 289, figs 172 & 173, pls 70-72; Branch, 1988a, p. 93, pls 20 & 27.

Range

South Africa, west of approximately 28°E longitude, extending from the Cape Province northwards through western Lesotho, southern, central and western O.F.S., south-western Transvaal and the southern halves of Botswana and Namibia, extending a little north of the Tropic of Capricorn; no records exist for large parts of the north-western Cape Province (i.e. 27°S, 21°E; 29°S, 19°E; 29°S, 21°E) and only a few exist for the eastern Cape Province.

Zoogeographical classification: Cape Temperate.

Range cluster in O.F.S.: Western (W).

Distribution in the Orange Free State (28 localities; Fig. 105)

Specimens examined from: Albion; Beginseldam; Bloemfontein (slightly north of); Bloemfontein (Botanical Gardens); Doornlaagte; Grasslands; Groenekloof; Heilbron, Philippolis; Holme's Dale; Krugersdrift Dam; Lemoenboord; Magdalen; Marantha Kweberg; Spreeuwfontein (MMK 53/2); Sandveld Nature Reserve; Sweet Home; Vet River - Bloemhof Dam junction; 52 km from Bloemfontein on road to Florisbad.

Other records: Bethany; Bethulie; Bloemendal; Bloemfontein; Driebaden; Hoopstad; Jacobsdal; Philippolis; Trompsburg (FitzSimons, 1962); Kalkfontein Dam, near nature conservation offices (sight record, 29 October 1991; M.F. Bates & A.F. Flemming).

Features (25 specimens examined)

Largest male (NMB R591 - Albion) 1466 + 248 = 1714 mm.

Largest female (NMB R4564 - Beginseldam) 1275 + 225 = 1500 mm.

Dorsum light brown to yellowish, occasionally with dark spots or scattered black scales (e.g. NMB R4758). Venter cream, but plates may have brown terminal ends. The terminal end of the tail is almost always entirely black in adults, but not so in juveniles. Juveniles have several ventral plates in the neck region black, and in NMB R385, the dorsal part of the neck is also largely black. A few adults also have black ventrals anteriorly, e.g. NMB R3200.

Habitat and Ecology

This highly poisonous, front-fanged, crepuscular snake was collected from mammal burrows and under rocks in the arid western O.F.S. (De Waal, 1978, p. 121). In the south-western Transvaal the species inhabits the burrows of mongooses, Ground Squirrels, rodents and Spring Hares (Jacobsen, 1989, p. 1120). Stomach contents of O.F.S. specimens consisted of rodent remains, a toad (*Bufo* sp.) and a *Psammophylax tritaeniatus*. Broadley (1990, p. 290) noted that lizards, frogs, young birds and eggs are also eaten, and discussed the venom and bite of this species. Mongooses are important enemies of Cape Cobras (Broadley, 1990). Mating occurs during September or October, after which time females lay 8-20 eggs averaging 60-65 x 25-35 mm during December or January (Broadley, 1990, p. 291).

Family: **VIPERIDAE** Gray, 1825

Subfamily: **VIPERINAE** Gray, 1825

Genus: *Causus* Wagler, 1830

Causus rhombeatus (Lichtenstein, 1823) Rhombic Night Adder

Sepedon rhombeata Lichtenstein, 1823, *Verz. Doubl. Mus. Zool. Berlin*, p. 106. Type locality: not given.

Causus rhombeatus (Lichtenstein): FitzSimons, 1962, p. 324, fig. 98, pls 35, 36 & LXIX and 1970/74, p. 185, pl. 28(1) & 29(2); De Waal, 1978, p. 124; Broadley, 1983/90, p. 307, figs 185-187, pl. 77; Branch, 1988a, p. 97, pl. 15.

Range

Southern and eastern Cape Province, Natal, northern and north-eastern O.F.S., Transvaal, Swaziland, Mozambique (excluding most of the southern part), Zimbabwe (after a gap at the Limpopo Basin), northern Botswana, Caprivi Strip, westwards to Angola and eastwards to Tanzania, and then northwards through tropical Africa to eastern Nigeria, Sudan and Somalia; also apparently isolated populations in north-eastern Cape, Morija in Lesotho and in the Kimberley area of the northern Cape.

Zoogeographical classification: Tropical Wide Ranging.

Range cluster in O.F.S.: Eastern (E).

Distribution in the Orange Free State (three localities; Fig. 106).

One specimen examined from: Parys (TM 5691).

Other records: Harrismith; Serfontein (FitzSimons, 1962).

Extralimital records

Burghersdorp; Morija (Boulenger, 1910); Kimberley; Modder River (FitzSimons, 1962).

Features (one specimen examined)

The Parys specimen (TM) is large and typically-marked, but was not examined in detail.

Habitat and Ecology

This poisonous, nocturnal species is fond of damp localities and takes shelter in mammal burrows, piles of stones or rubbish heaps (Broadley, 1990, p. 309). Prey includes toads (*Bufo* spp.) and frogs (e.g. *Breviceps* spp.) (Broadley, 1966, p. 453, 1990, p. 309; Marais, 1985, p. 26; Jacobsen, 1989, p. 1139) and occasional small rodents (Broadley, 1990, p. 309). Captive specimens from Pretoria even ate the slippery *Xenopus l. laevis*, often consuming three or four frogs one after the other (pers. obs.). Broadley

(1966, p. 453) recorded the Lizard Buzzard *Kaupifalco monogrammicus* and domestic hen as enemies of the Night Adder. Mating occurs in early spring, 12-26 eggs measuring 25-28 x 14-18 mm being laid during summer; incubation lasts 3-4 months, and up to four clutches may be laid in a season (Broadley, 1990, p. 310). Hatchlings measure 13-16 cm in length (Marais, 1985, p. 26). Jacobsen (1989) recorded a Transvaal clutch of 15 eggs measuring 25,0 - 30,0 x 12,5 - 17,0 mm *in situ*. Dyer (1979, p. 6) reported that a 700 mm female laid 47 eggs over a period of six months and 44 eggs over two months; eggs measured 31-33 x 16-17 mm; young averaged 70 mm in (total ?) length. Hatchlings appear after about ten weeks and measure 130-160 mm; a 147,0 mm hatchling weighed 2,65 g (see Jacobsen, 1989, p. 1139). Sperm retention occurs in this species (Broadley, 1990, p. 310).

Remarks

The Harrismith, Parys (but also TM record) and Serfontein specimens were in the Durban Snake Park collection (see FitzSimons, 1962). The scattered distribution records for this species in the O.F.S., Lesotho and Kimberley areas are difficult to explain. Some of the specimens may have been translocated from moister areas.

Genus: *Bitis* Gray, 1842

Bitis atropos (Linnaeus, 1754) Berg Adder

Coluber atropos Linnaeus, 1754, *Mus. Adolph. Frid.*, 1, p. 22, pl. xiii, fig. 1; 1757; *Syst. Nat.*, ed. 10, 1, p. 216 and 1766, *Syst. Nat.*, ed. 12, 1, p. 375. Type locality: "Habitat in America", error, probably Cape of Good Hope.

Bitis atropos atropos (Linnaeus): De Waal, 1978, p. 126.

Bitis atropos (Linnaeus): Broadley, 1983/90, p. 322, figs 199 & 200, pl. 82; Branch, 1988a, p. 99, pl. 12; Bates, 1988a, p. 51 and 1991b, p. 155.

Range

Found in four disjunct populations in southern Africa, namely the Cape Fold Mountains of the south-western, southern and eastern Cape Province, from Table Mountain to Port Elizabeth; Natal Drakensberg, adjacent Lesotho [Haagner, 1991, p. 20] and north-eastern O.F.S.; Drakensberg escarpment of north-eastern and eastern Transvaal and adjacent Swaziland; and in the Chimanimani, Himalaya and Inyanga mountains of eastern Zimbabwe and adjacent Mozambique.

Zoogeographical classification: Cape Temperate (Afromontane).

Range cluster in O.F.S.: Drakensberg (D).

Distribution in the Orange Free State (five localities; Fig. 107)

Specimens examined from: Boschkloof (1981 m a.s.l.); Golden Gate Highlands National Park (NMB; LR 1357; elevations unknown); Sentinel (2591 m a.s.l.); Wodehousekop (2300 m a.s.l.).

Other records: Waterkloof (unconfirmed sight record, 1992, A. Rall).

Features (eight specimens examined)

Largest male (NMB R3353 - Sentinel) 229 + 27 = 256 mm.

Largest female (NMB R3354 - Sentinel) 205 + 15 = 220 mm.

Body squat, head distinct from body. Dorsum brown with paravertebral series of dark spots, also dark spots on flanks. Venter bluish-grey to grey. Lower labials marbled black and white. Anal entire. NMB R5493 (female) had 133 ventrals and 31 subcaudals; NMB R6343 (female) had 140 ventrals and 25 subcaudals. De Waal (1978) examined only one other female (ventrals 139, subcaudals 20). The range for ventrals and subcaudals for O.F.S. females in thus 133-140 and 20-31 respectively. O.F.S. males have 134-137 ventrals and 26-31 subcaudals (De Waal, 1978).

Habitat and Ecology

Although the main habitat of this poisonous adder occurs in mountainous areas (1981-2591 m a.s.l. in the O.F.S.), it is also found on rocky cliffs at sea level in the eastern Cape Province (Broadley, 1990, p. 324), at altitudes of 1200-2000 m in the Transvaal (Jacobsen, 1989, p. 1154) and at 1800-3000 m a.s.l. in the Natal Drakensberg (Bourquin & Channing, 1980, p. 19). The diet consists of small rodents, shrews, lizards and amphibians, and sometimes small snakes and nestlings of ground-nesting birds (Broadley, 1990, p. 324). Broadley (1966, p. 459) noted that the gut of a 340 mm Chimanimani snake contained a *Cordylus cordylus rhodesiana* (= *C. rhodesianus*), whereas a captive juvenile from Inyanga North fed readily on young *Bufo regularis* (= *B. gutturalis*). Marais (1985, p. 20) reported that rain frogs (*Breviceps* spp.) are also eaten. According to Broadley (1990, p. 324), females give birth to 8-15 young in March and April in South Africa, and in January in Zimbabwe. The gestation period may exceed 130 days (unless sperm retention and/or delayed fertilization occurs), with neonates measuring 141,0-149,0 mm in total length and weighing 3,7-3,8 g (see Jacobsen, 1989). Haagner & Hurter (1988) give neonate lengths of 94,5-124,9 mm and masses of 1,1-3,5 g for Barberton (Transvaal) females; whereas Broadley (1966, p. 459) reported that a 430 mm Chimanimani female contained seven embryos and one infertile egg, and noted that neonates measured 140-142 mm total length. According to Branch (1988a, p. 100), mating occurs in autumn, prior to hibernation, and 4-9 (maximum 15) young measuring 120-145 mm are born in late summer.

Bitis arietans arietans (Merrem, 1820) Puffadder

Vipera (Echidna) arietans Merrem, 1820, *Vers. Syst. Amphib.*, p. 152. Type locality: Cape of Good Hope, i.e. South Africa.

Bitis arietans (Merrem): Gough, 1908, p. 39.

Bitis arietans arietans (Merrem): FitzSimons, 1962, p. 334, figs 101 & 102, pl. LXXI and 1970/74, p. 188, pl. 28(2); De Waal, 1978, p. 125; Broadley, 1983/90, p. 324, figs 190, 201-203, pl. 83; Branch, 1988a, p. 98, pl. 12.

Range

Virtually throughout Africa, from southern Morocco east to Arabia and south to the Cape Province, excluding only forested areas, extreme deserts (e.g. Sahara) and mountain tops; apparently absent from large parts of the northern Cape Province and most of mountainous Lesotho (recorded only from Morija in the west). Replaced in Somalia by *B. a. somalica* (which has keeled subcaudals).

Zoogeographical classification: Afrotropical (= Ethiopian).

Range cluster in O.F.S.: Throughout (T).

Distribution in the Orange Free State (30 localities; Fig. 108)

Specimens examined from: Bloemendal; Bloemfontein; Boschkloof; Doornhoek; Glen; Kestell; Ladybrand; Lemoenboord; Lotters Rust; Merino, Bethlehem; Nova; Rayton; Reenens Hoop (TM 49805); Stoomhoek; Willem Pretorius Game Reserve; Wittepoort; Zomervlakte.

Other records: Afrikaskop; Ascent; Bethulie; Ficksburg; Harrismith; Hoopstad; Kestell; Marquard; Marseilles; Memel; Modderpoort; Rosendal; Winburg (FitzSimons, 1962); P.K. le Roux Dam (Thorne & Hamman, 1981; not known if voucher specimen exists); Golden Gate Highlands National Park (Marais, 1992, pl. 6; photographic record).

Features (37 specimens examined)

Largest male (NMB R4603 - Ladybrand) 988 + 135 = 1123 mm.

Largest female (NMB R4629 - Lotters Rust) 905 + 72 = 977 mm.

Dorsum light to dark brown with dark chevrons; anteriorly and sometimes also posteriorly, these have pale borders. Ventral plates cream with dark markings on their lateral ends.

Habitat and Ecology

This highly venomous, front-fanged, terrestrial and diurnal adder has been collected in open grassland and under rocks in the O.F.S. (De Waal, 1978, p. 126). Specimens are often killed during winter fires while lying under bundles of dry grass (Jacobsen, 1989, p. 1161). The diet consists mainly of small terrestrial mammals, although birds, lizards, toads and frogs will also be eaten (Broadley, 1990, p. 326).

The poisonous Red Toad *Schismaderma carens* is eaten (Hoffman, 1990, p. 180), and Wilson (1965, in Broadley, 1966) recorded a hatchling *Testudo pardalis babcocki* (= *Geochelone pardalis*) being eaten. Puffadders are ovoviviparous, usually giving birth from December to April to 20-40 young (the record is 156) measuring 15-20 cm in total length; mating occurs from October to December, with a gestation period of about five months (Broadley, 1990, p. 327). An O.F.S. female collected in February (summer) contained 15 very well developed embryos (De Waal, 1978). Growth, especially in captivity, is extremely rapid (see Jacobsen, 1989, p. 1162). Enemies include Ground Hornbills, birds of prey, mongooses (Pienaar *et al.*, 1983, p. 224), Warthogs and Man (Broadley, 1990, p. 327), as well as other snakes such as *Naja naja annulifera* (in Zimbabwe), African Wild Cats and Domestic Cats (Broadley, 1966, p. 458) and Sharptooth Catfish *Clarias gariepinus*. The latter record refers to a catfish collected in the P. K. le Roux Dam in the southern O.F.S. which contained a recently swallowed 605-mm-long Puffadder (Thorne & Hamman, 1981).

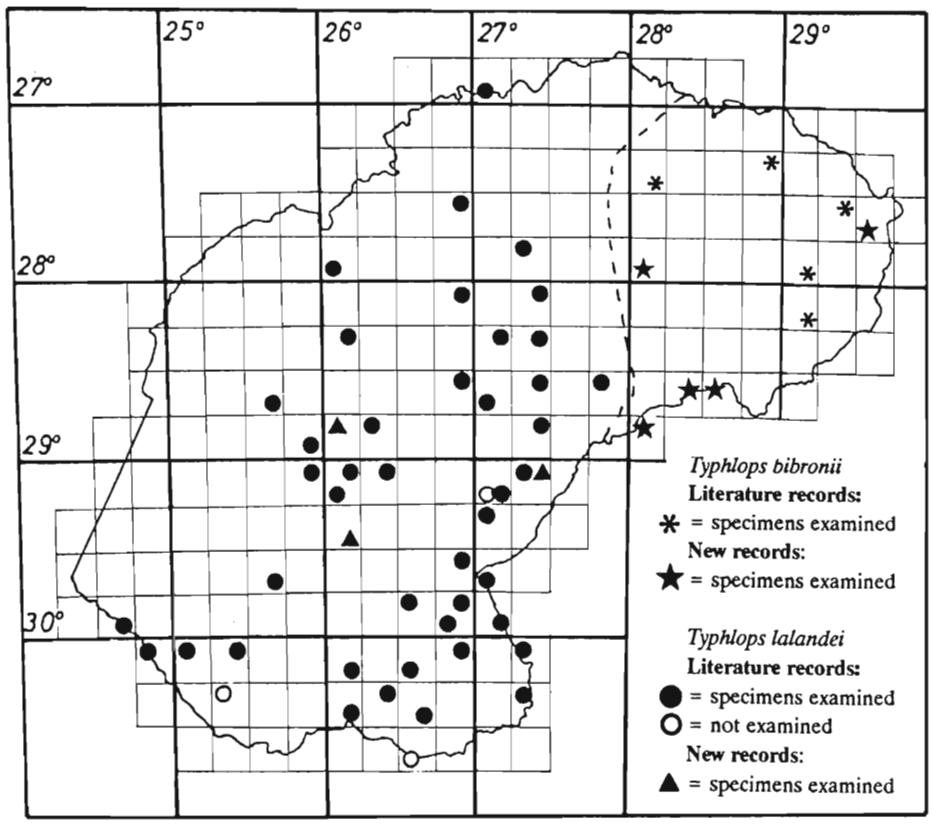


Figure 79: Distribution of *Typhlops bibronii* and *T. lalandei* in the Orange Free State.

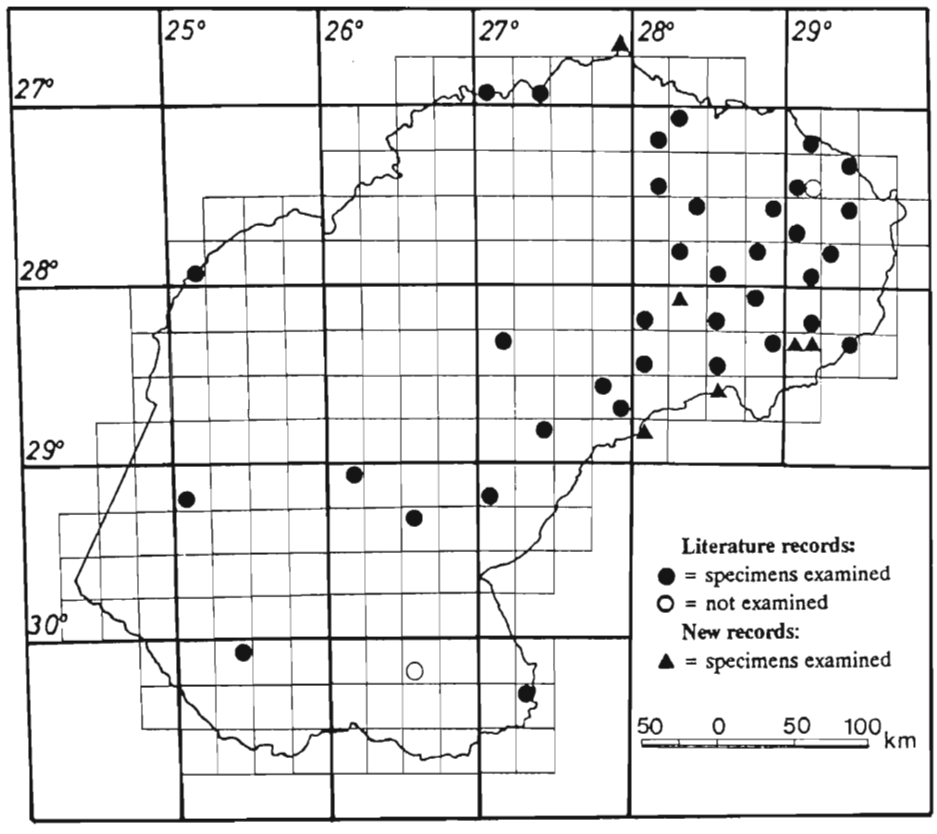


Figure 80: Distribution of *Leptotyphlops scutifrons scutifrons* in the Orange Free State.

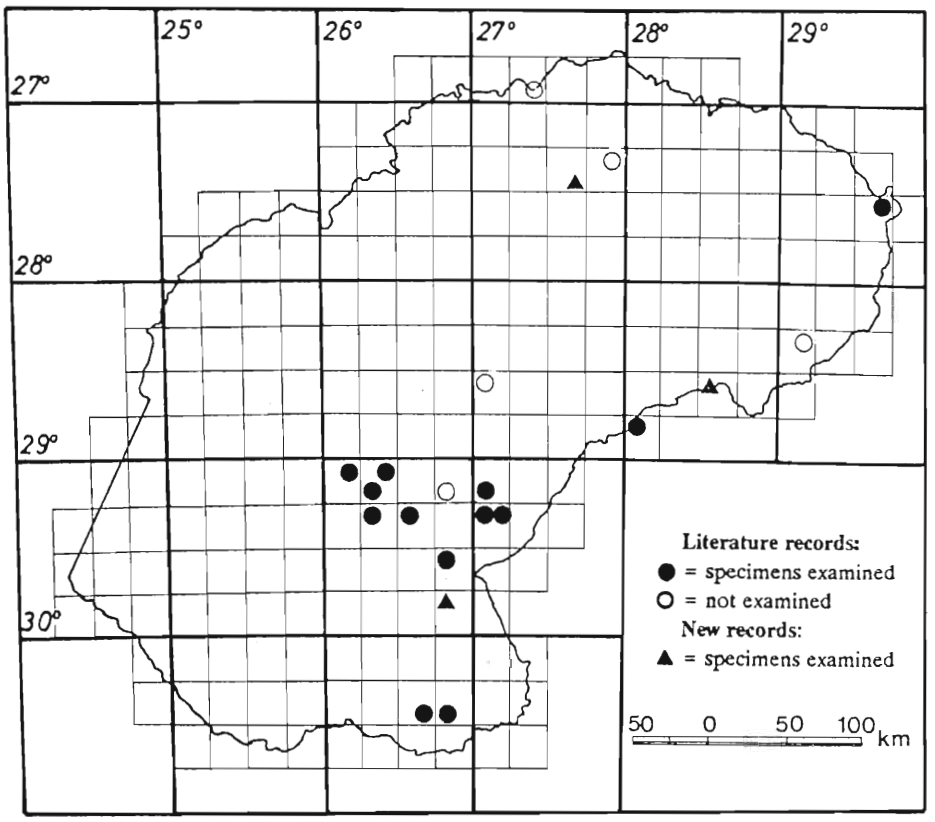


Figure 81: Distribution of *Lycodonomorphus rufulus* in the Orange Free State.

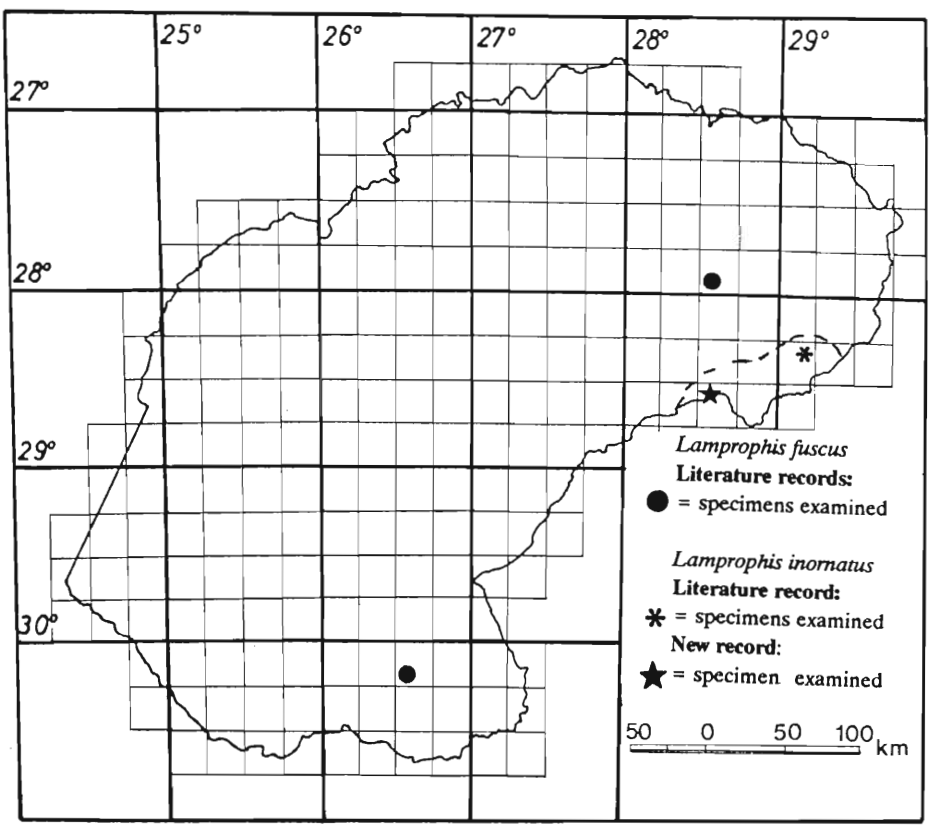


Figure 82: Distribution of *Lamprophis fuscus* and *L. inornatus* in the Orange Free State.

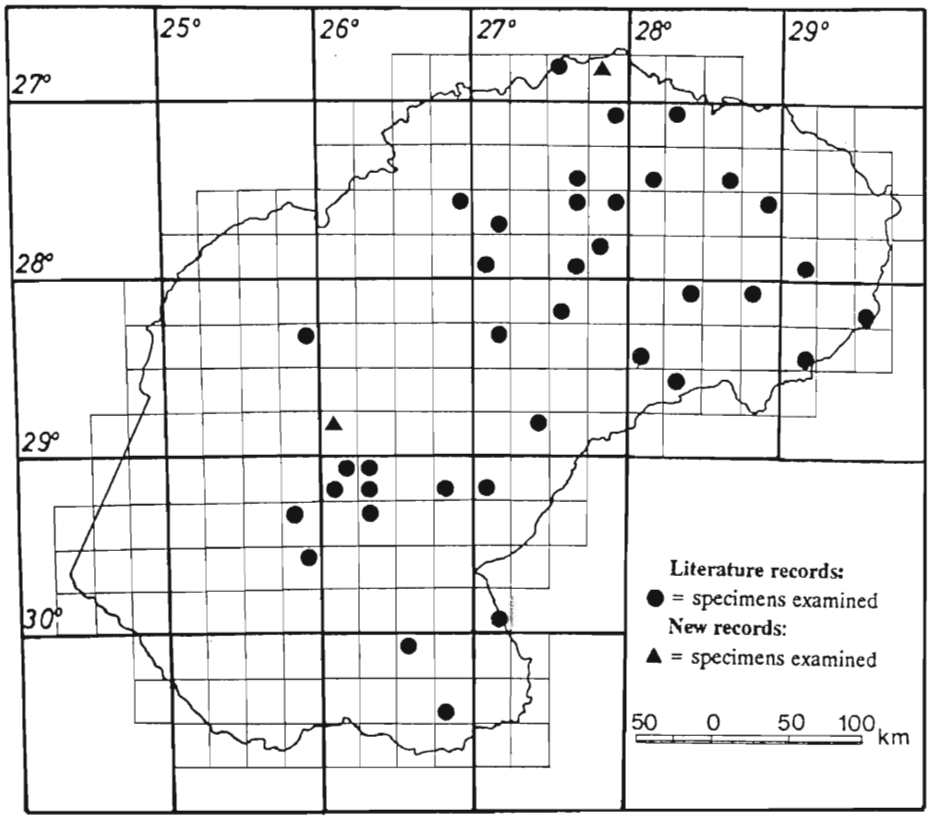


Figure 83: Distribution of *Lamprophis aurora* in the Orange Free State.

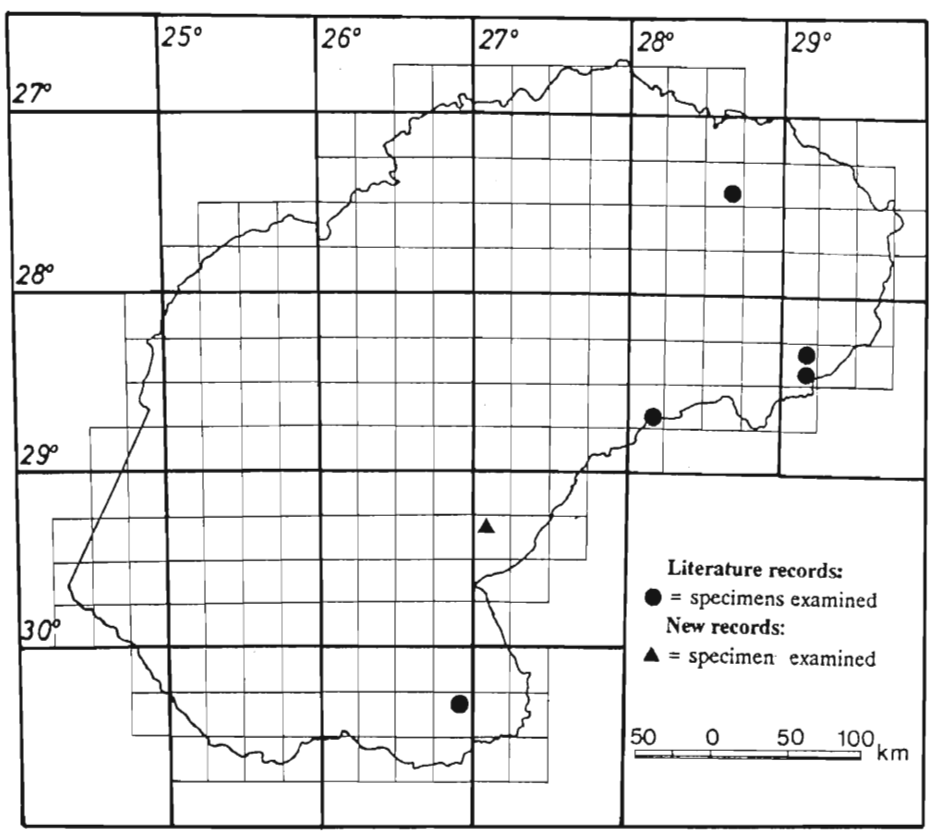


Figure 84: Distribution of *Lamprophis guttatus* in the Orange Free State.

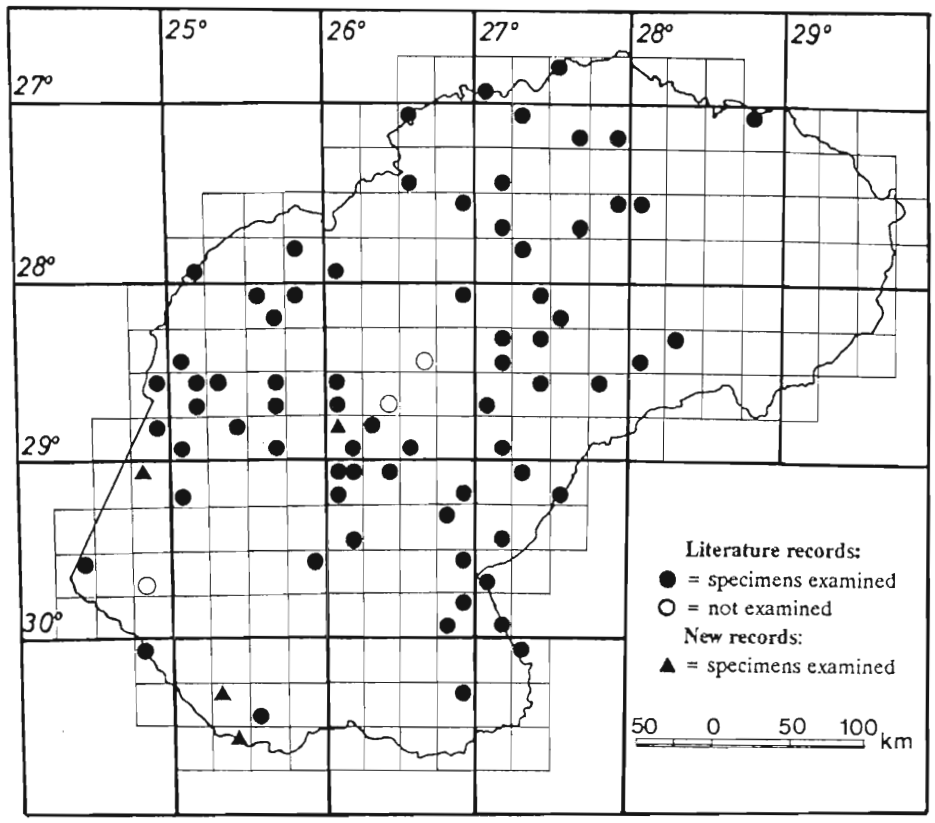


Figure 85: Distribution of *Lamprophis fuliginosus* in the Orange Free State.

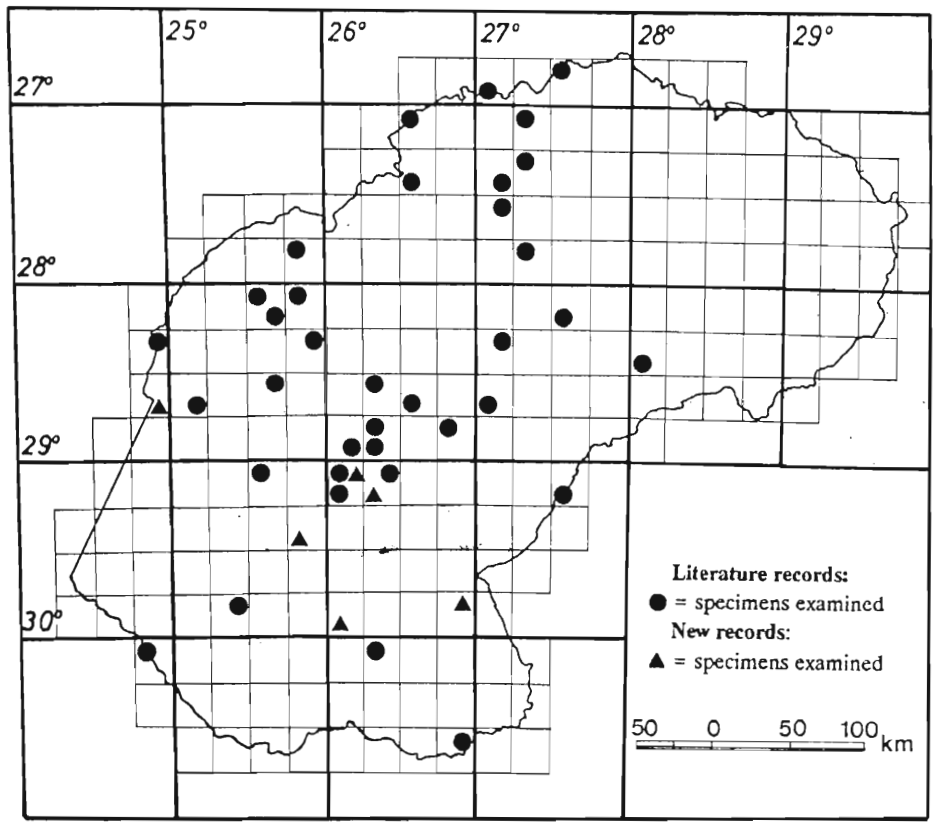


Figure 86: Distribution of *Lycophidion capense capense* in the Orange Free State.

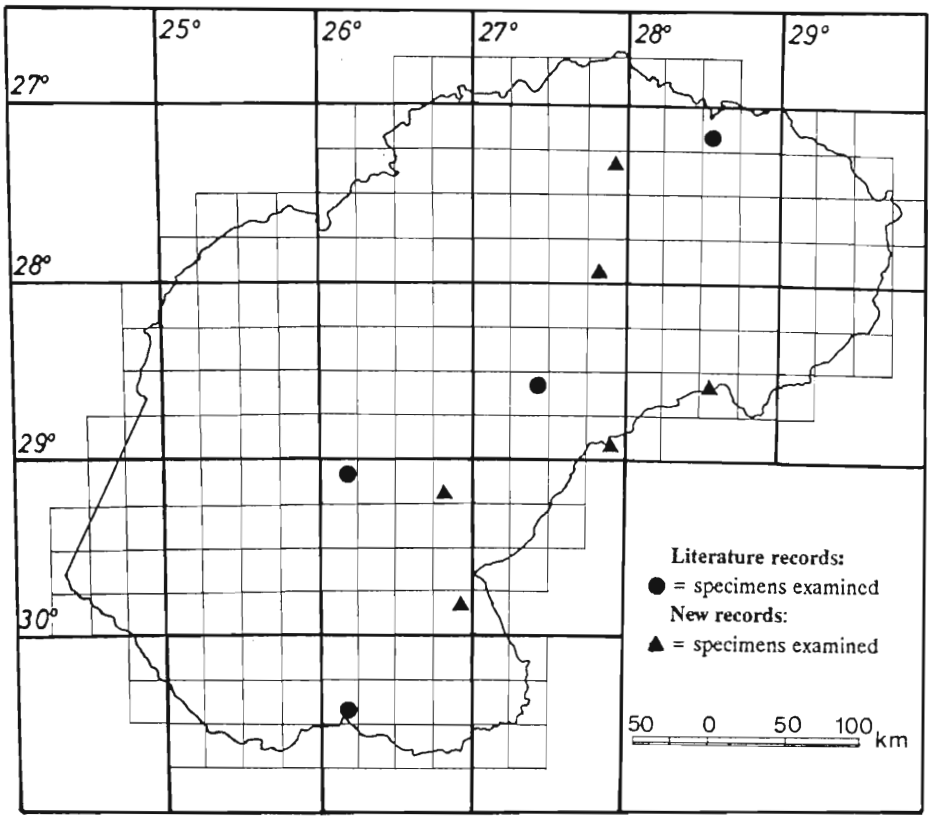


Figure 87: Distribution of *Duberria lutrix lutrix* in the Orange Free State.

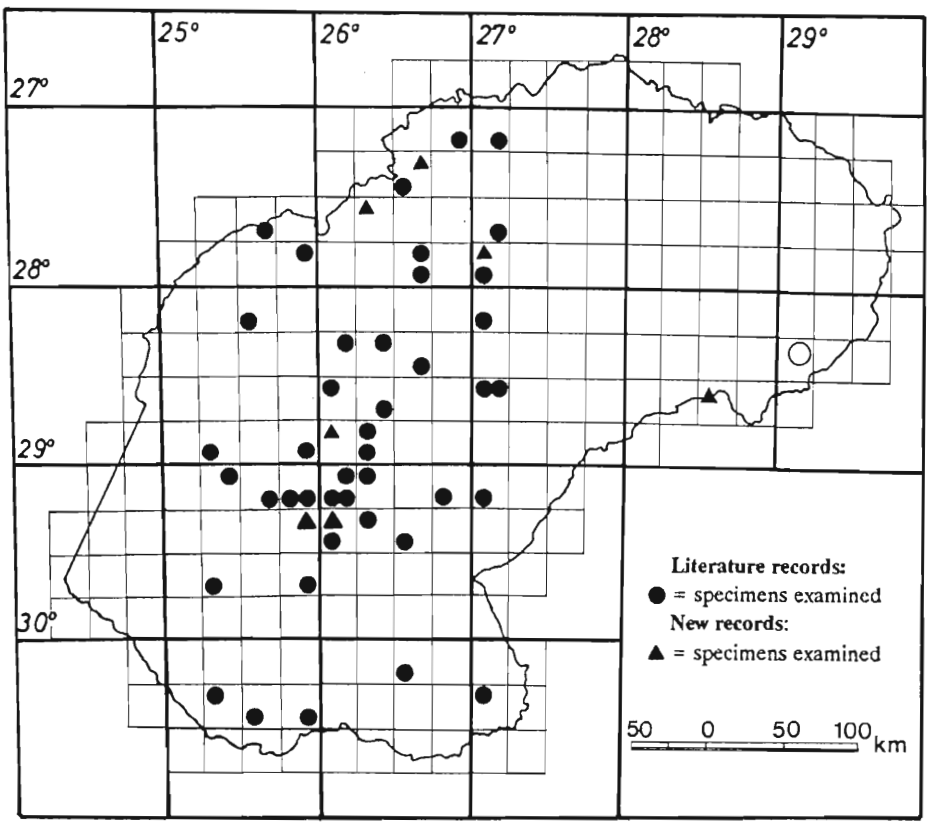


Figure 88: Distribution of *Pseudaspis cana* in the Orange Free State.

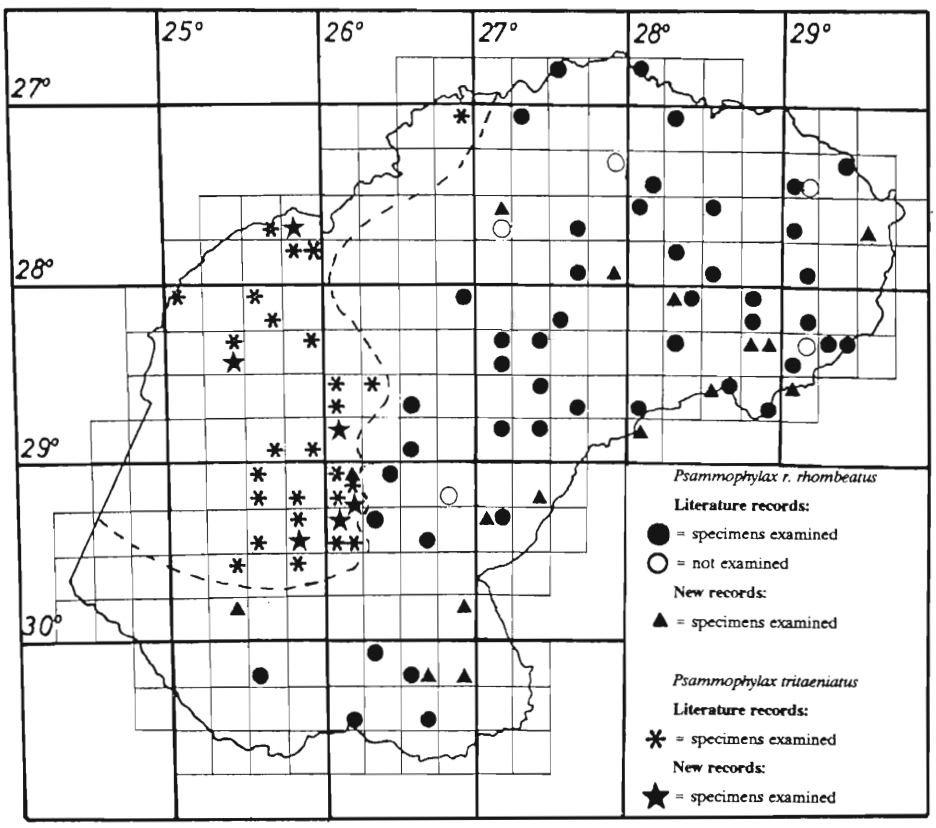


Figure 89: Distribution of *Psammophylax rhombeatus rhombeatus* and *P. tritaeniatus* in the Orange Free State.

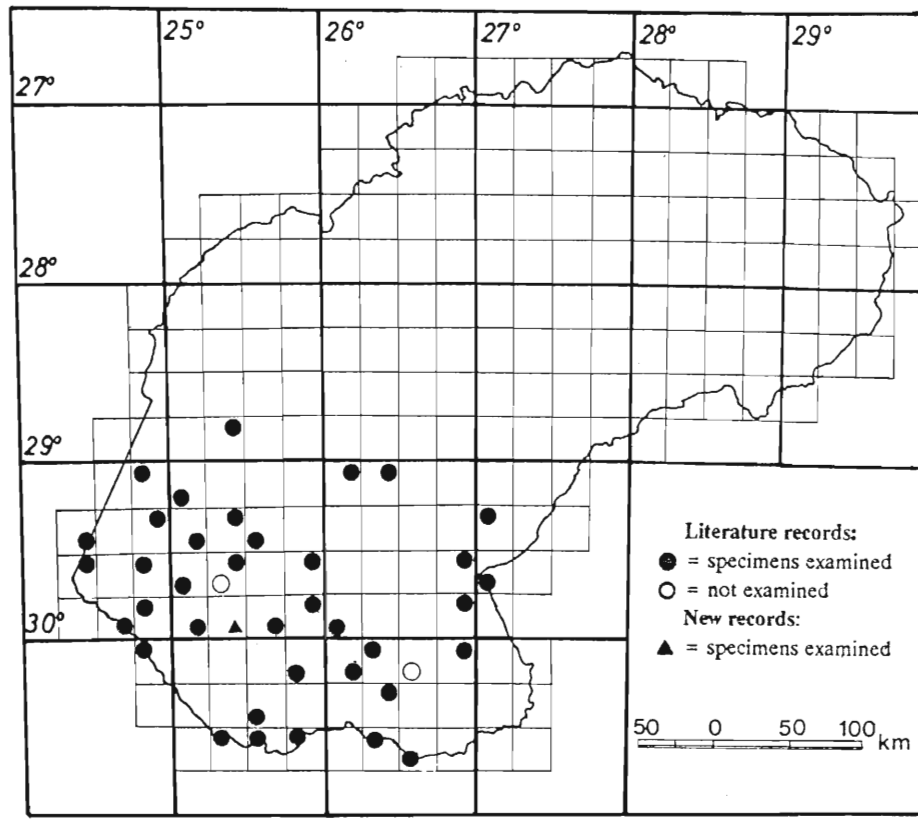


Figure 90: Distribution of *Psammophis notostictus* in the Orange Free State.

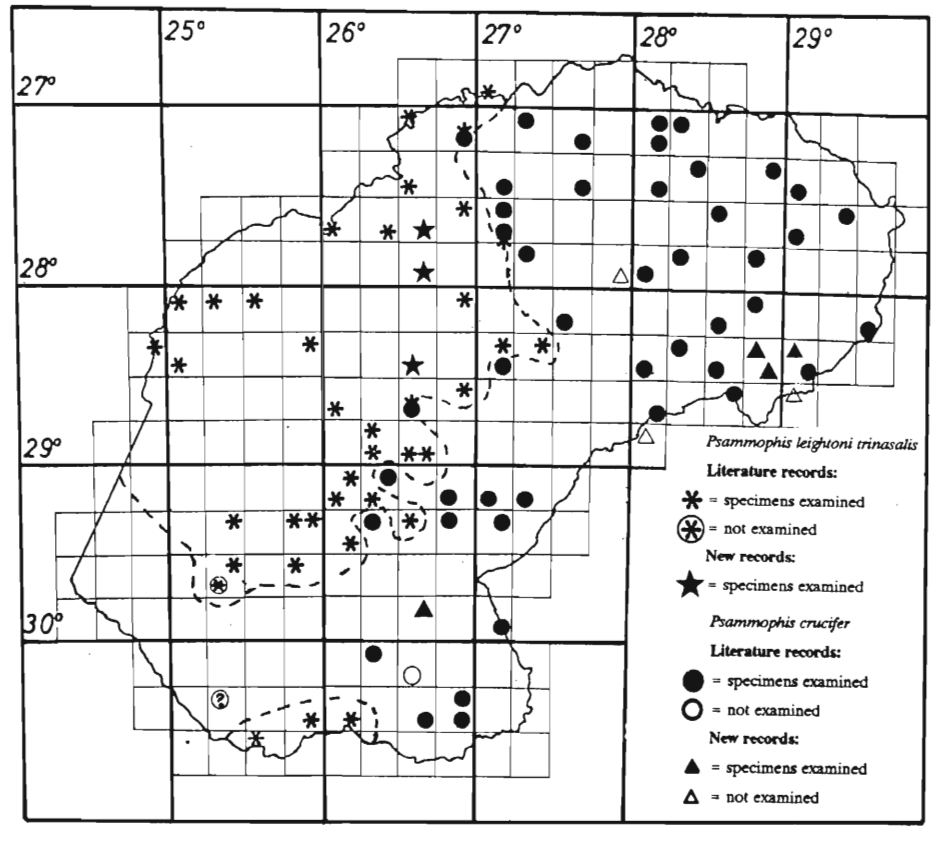


Figure 91: Distribution of *Psammophis leightoni trinasalis* and *P. crucifer* in the Orange Free State.

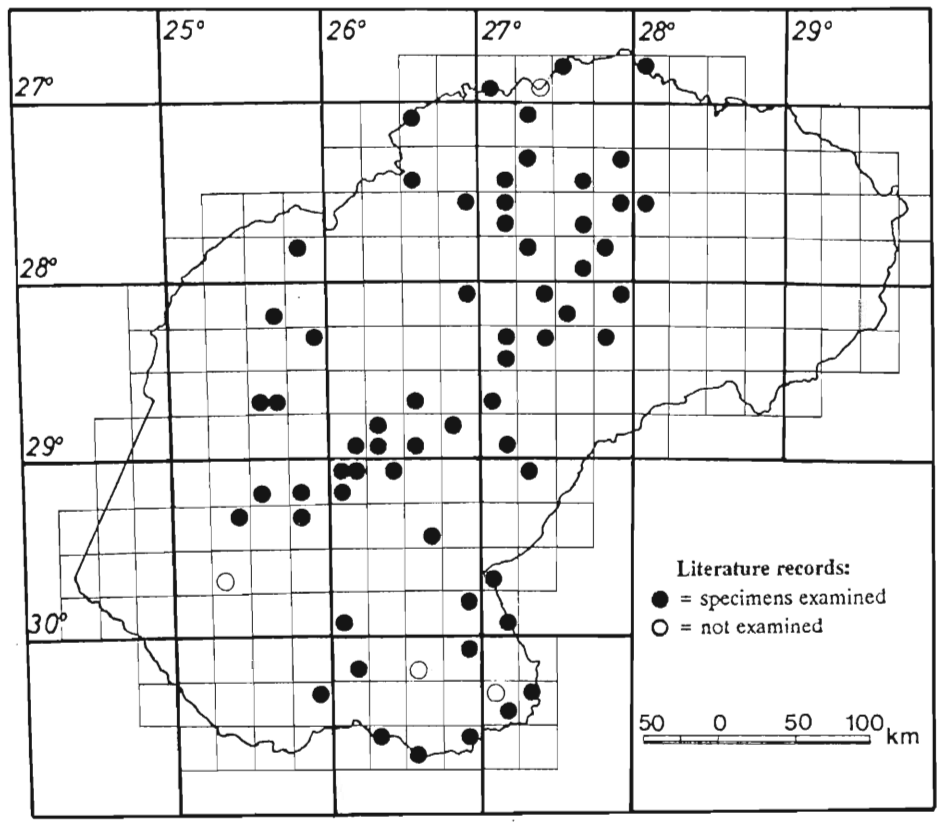


Figure 92: Distribution of *Aparallactus capensis* in the Orange Free State.

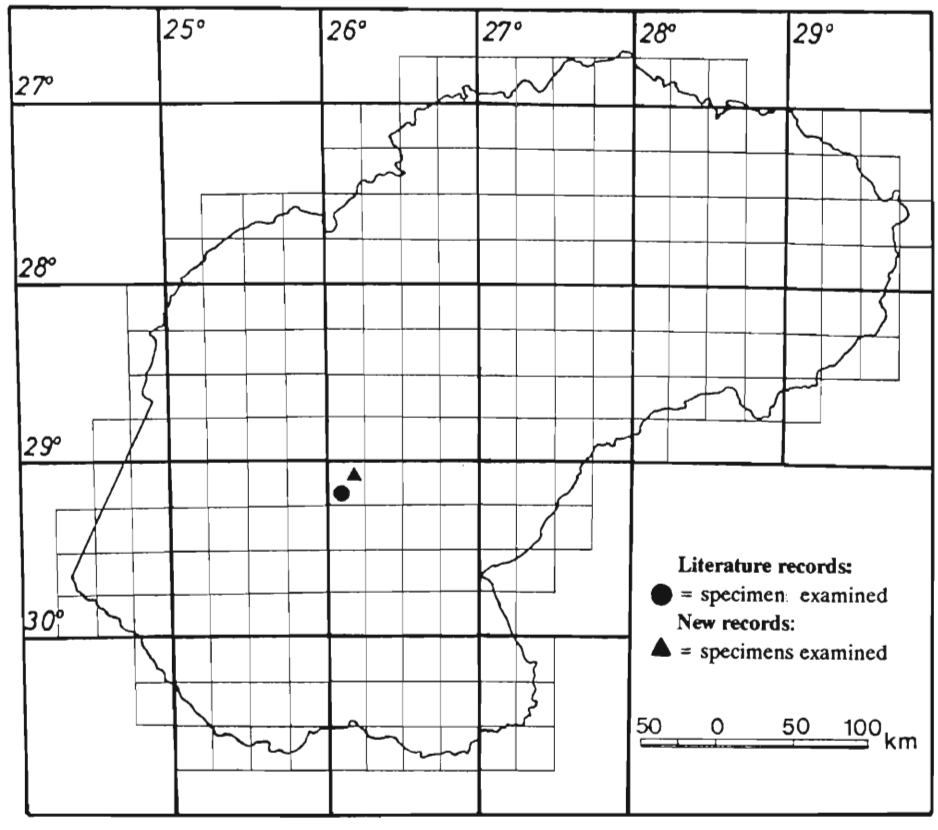


Figure 94: Distribution of *Xenocalamus bicolor bicolor* in the Orange Free State.

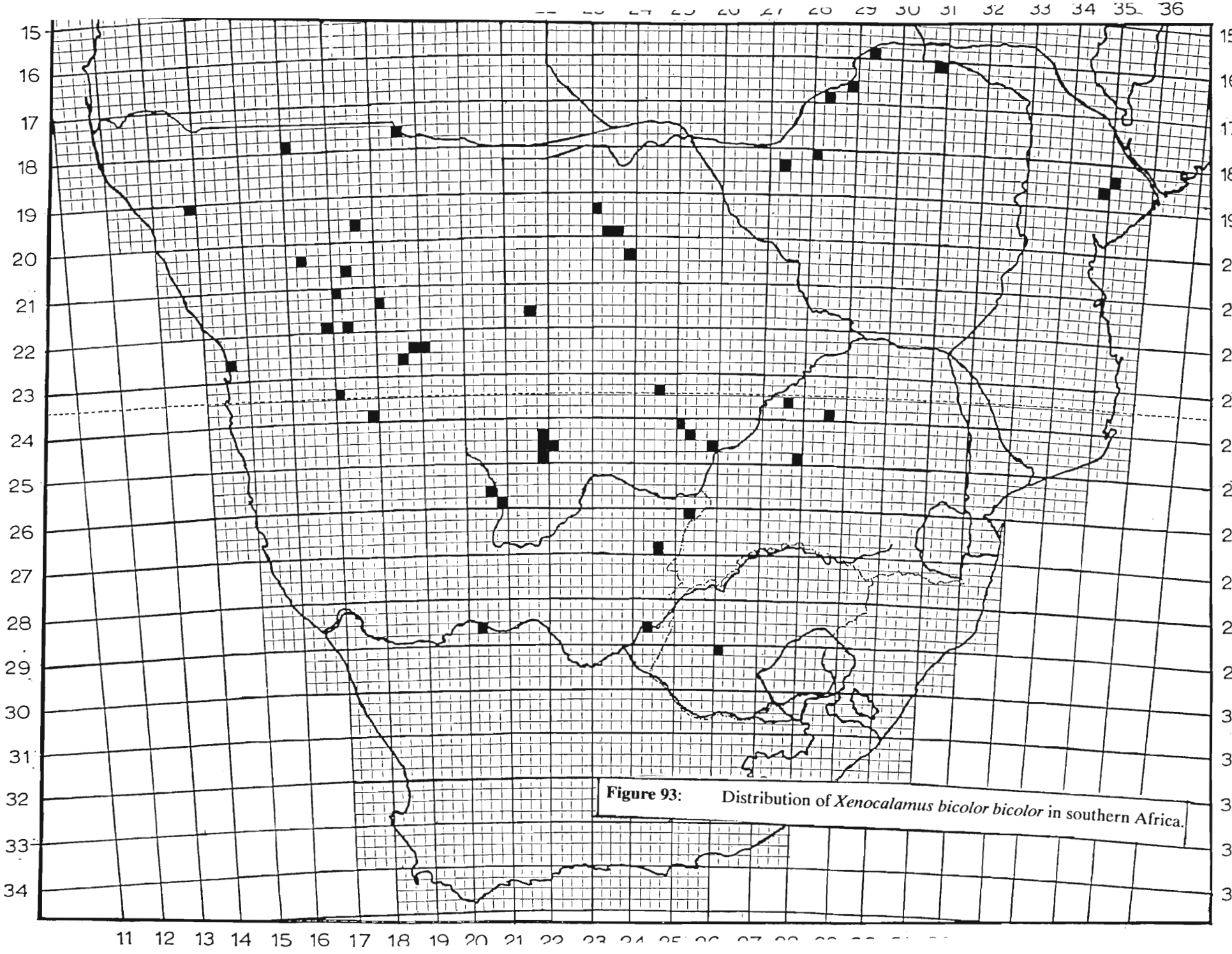


Figure 93: Distribution of *Xenocalamus bicolor bicolor* in southern Africa.

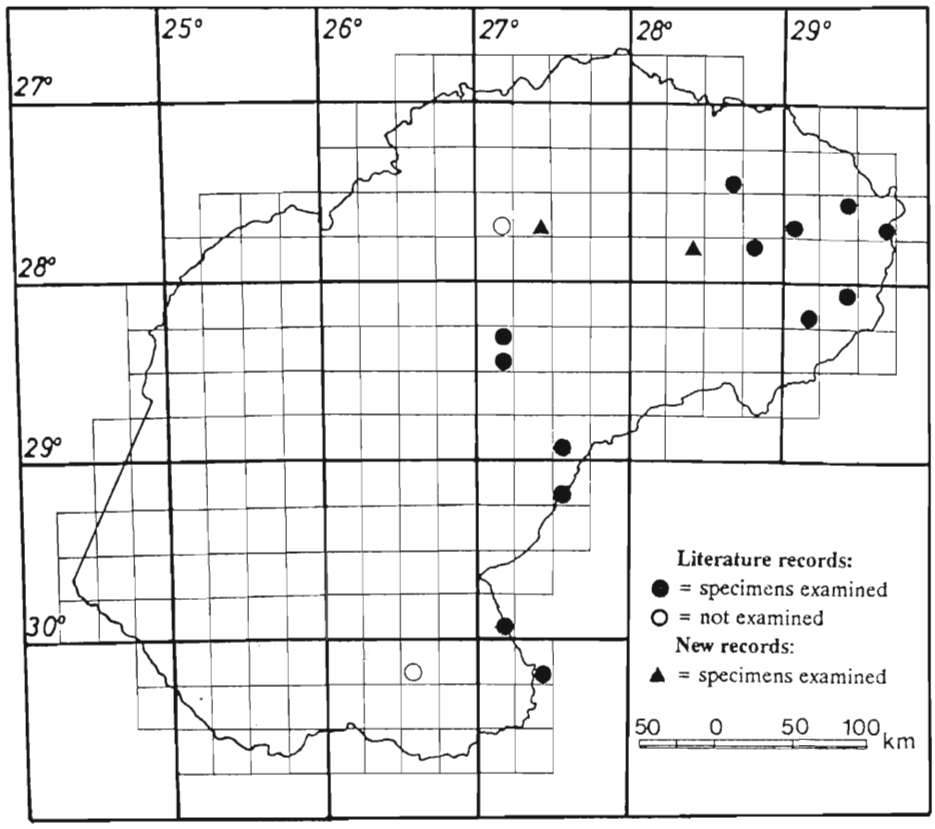


Figure 95: Distribution of *Homoroselaps lacteus* in the Orange Free State.

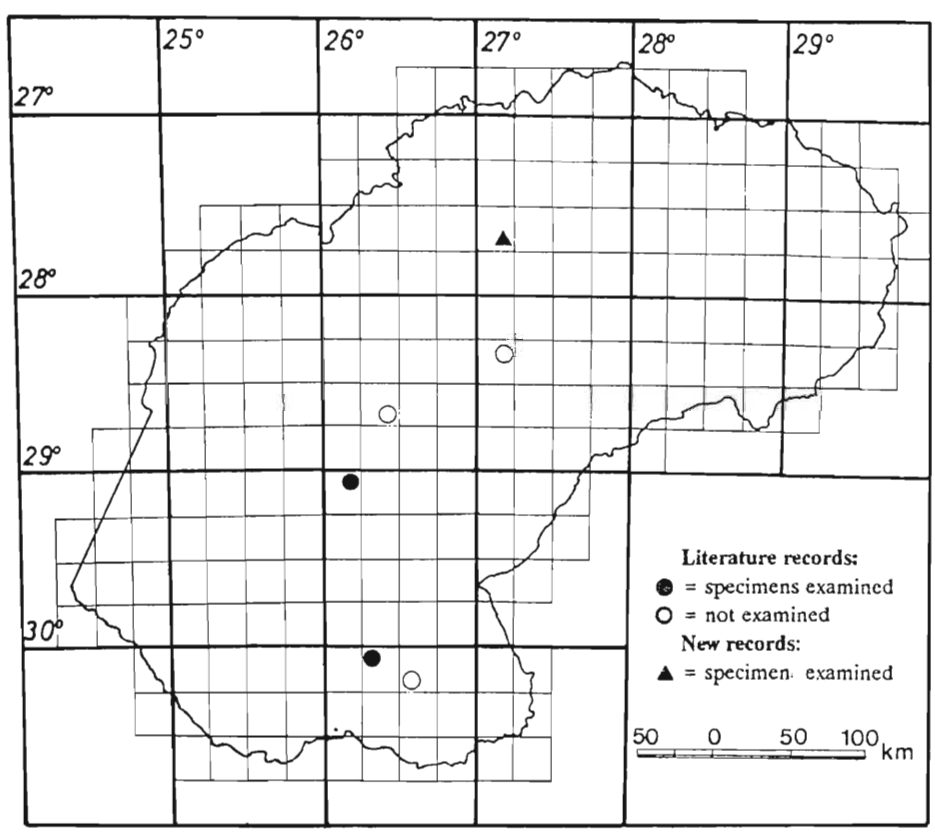


Figure 96: Distribution of *Homoroselaps dorsalis* in the Orange Free State.

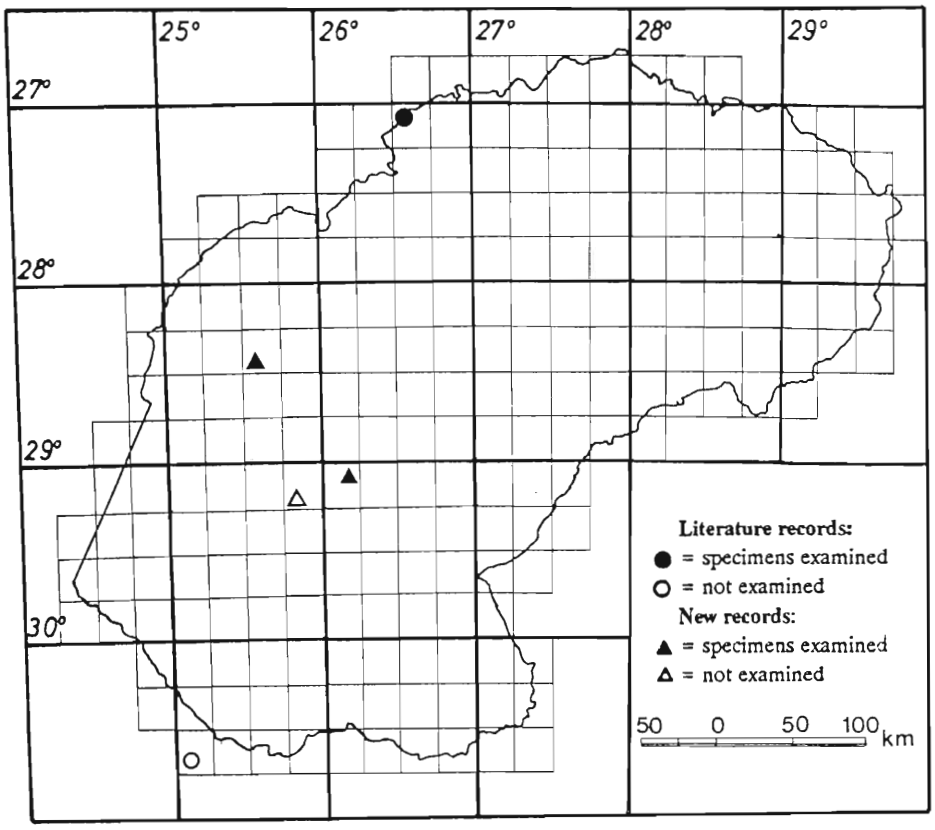


Figure 97: Distribution of *Atractaspis bibronii* in the Orange Free State.

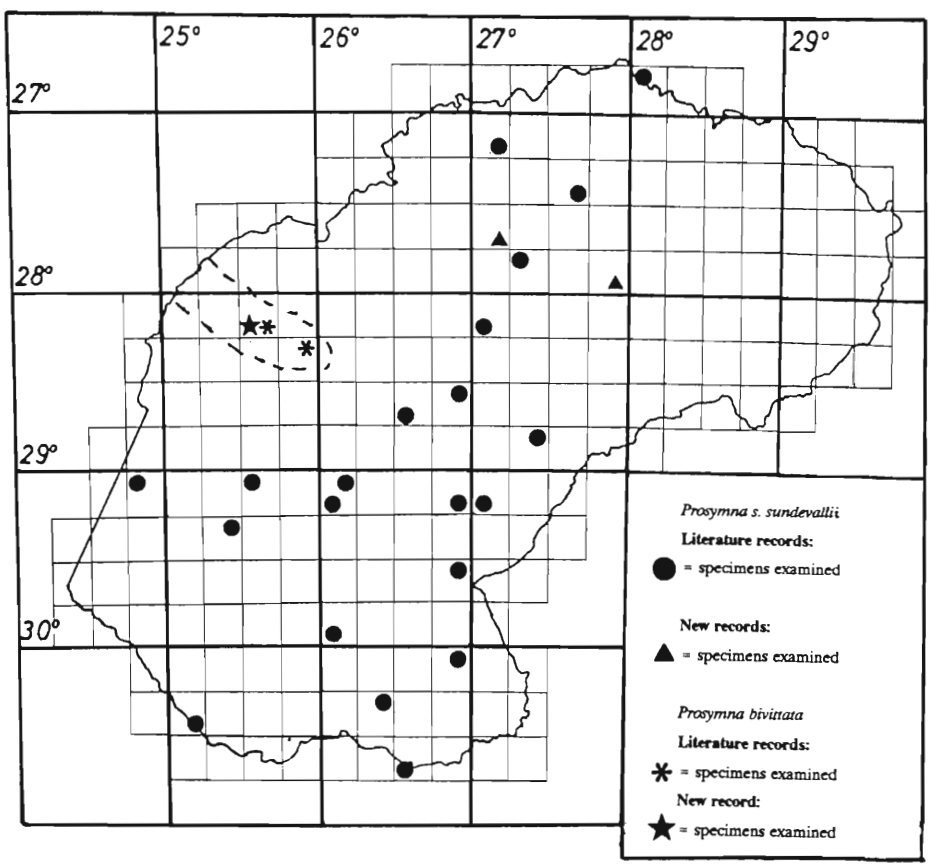


Figure 98: Distribution of *Prosymna sundevallii sundevallii* and *P. bivittata* in the Orange Free State.

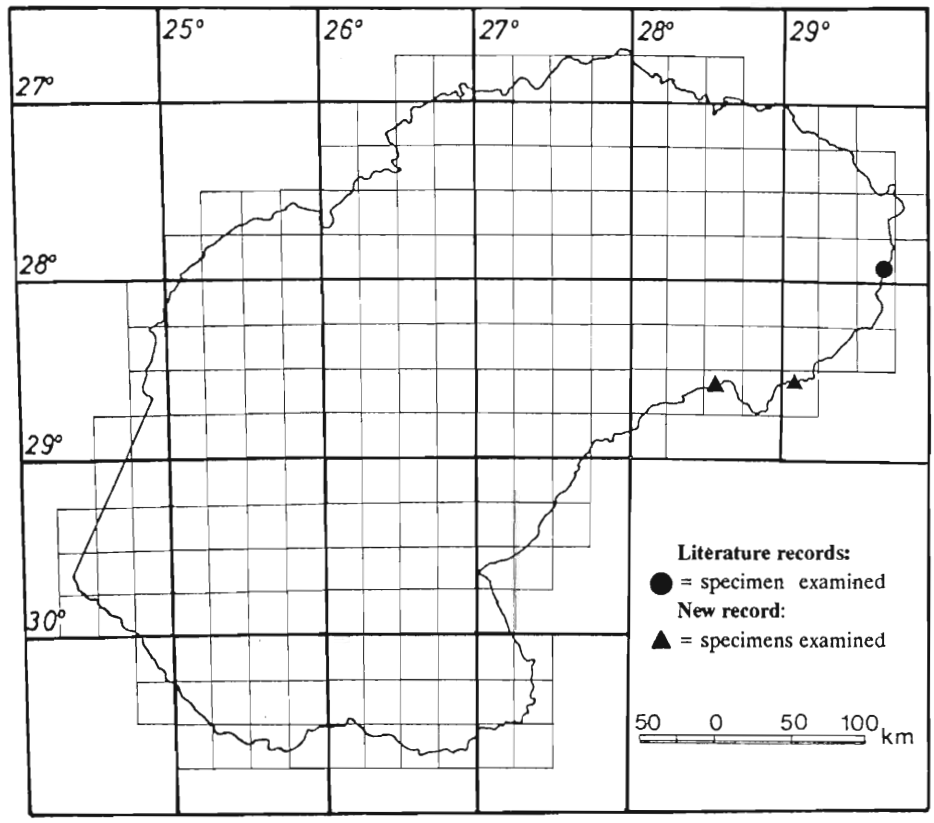


Figure 99: Distribution of *Philothamnus natalensis occidentalis* in the Orange Free State.

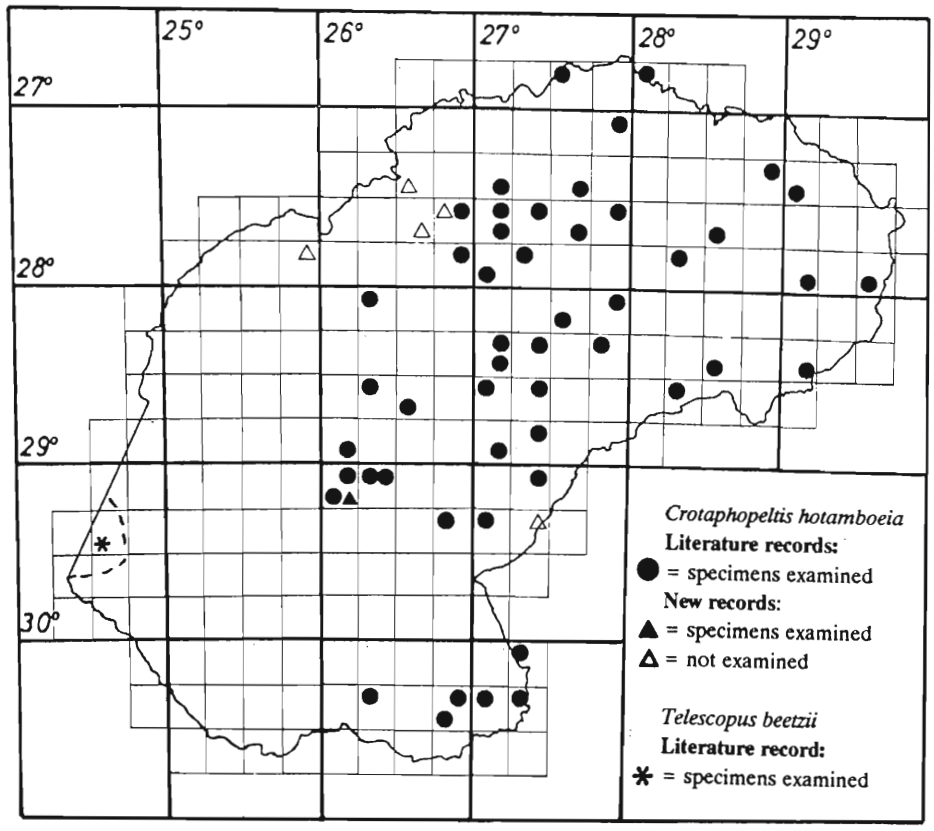


Figure 100: Distribution of *Crotaphopeltis hotamboeia* and *Telescopus beetzii* in the Orange Free State.

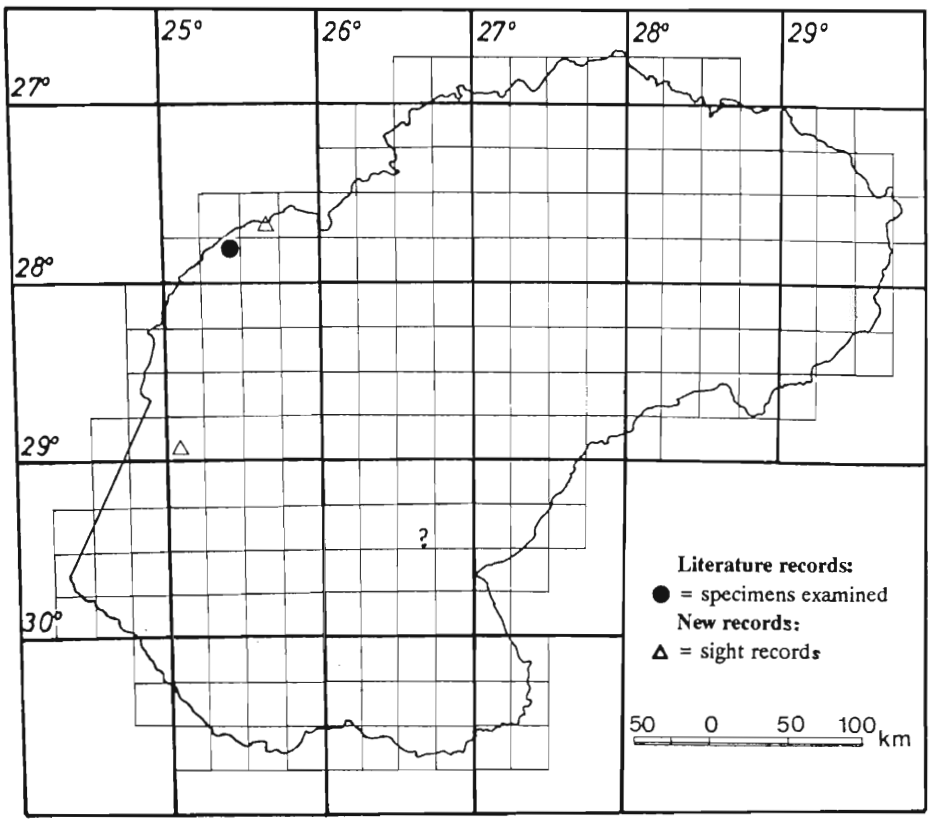


Figure 101: Distribution of *Dispholidus typus typus* in the Orange Free State.

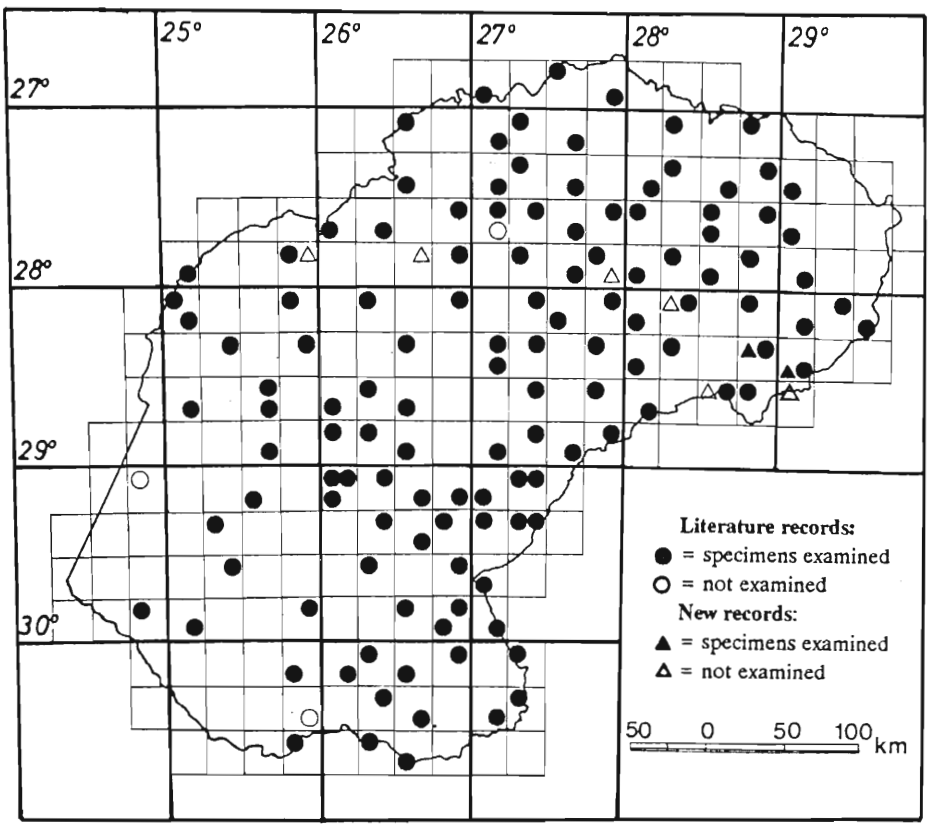


Figure 102: Distribution of *Dasypeltis scabra* in the Orange Free State.

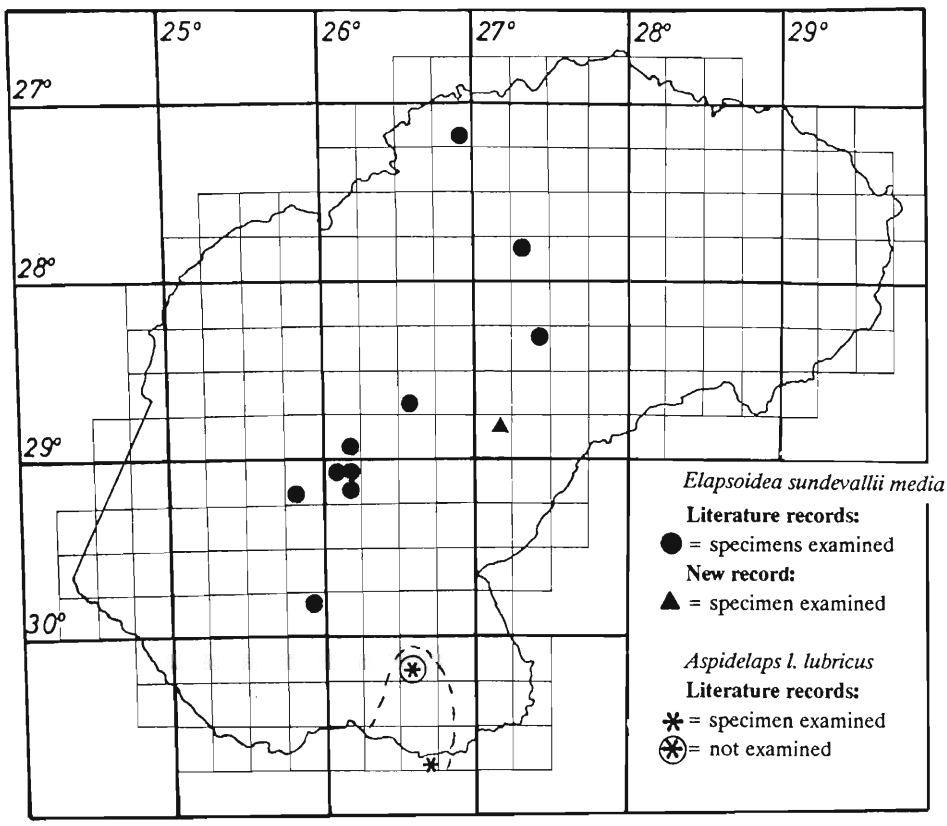


Figure 103: Distribution of *Elapsoidea sundevallii media* and *Aspidelaps lubricus lubricus* in the Orange Free State.

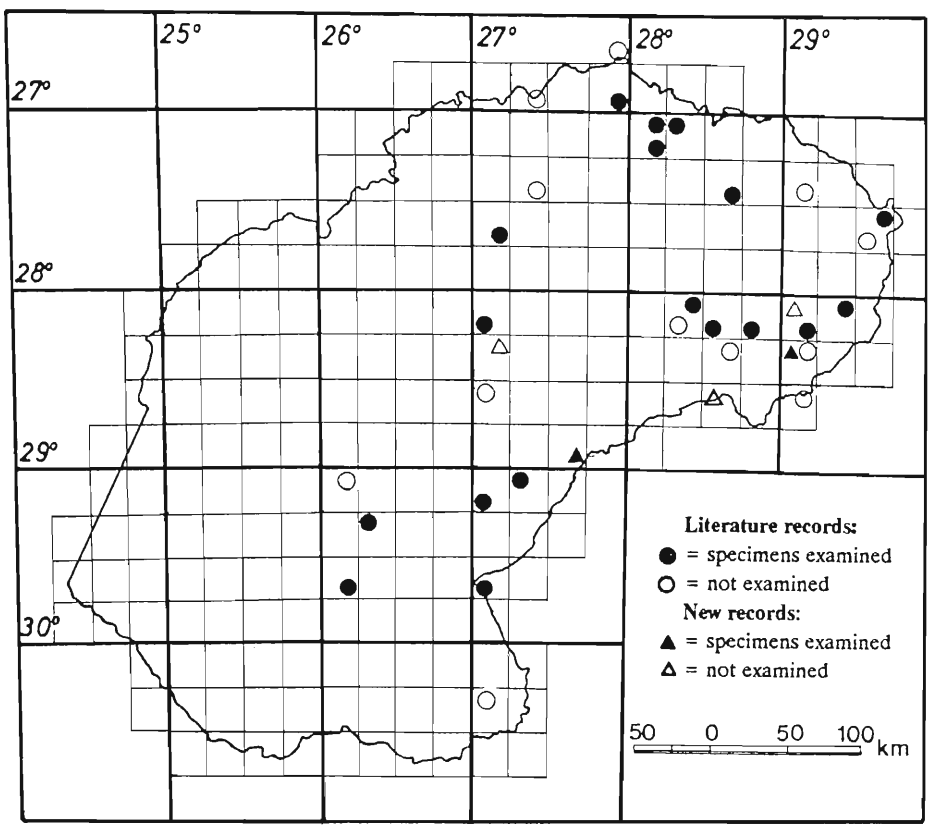


Figure 104: Distribution of *Hemachatus haemachatus* in the Orange Free State.

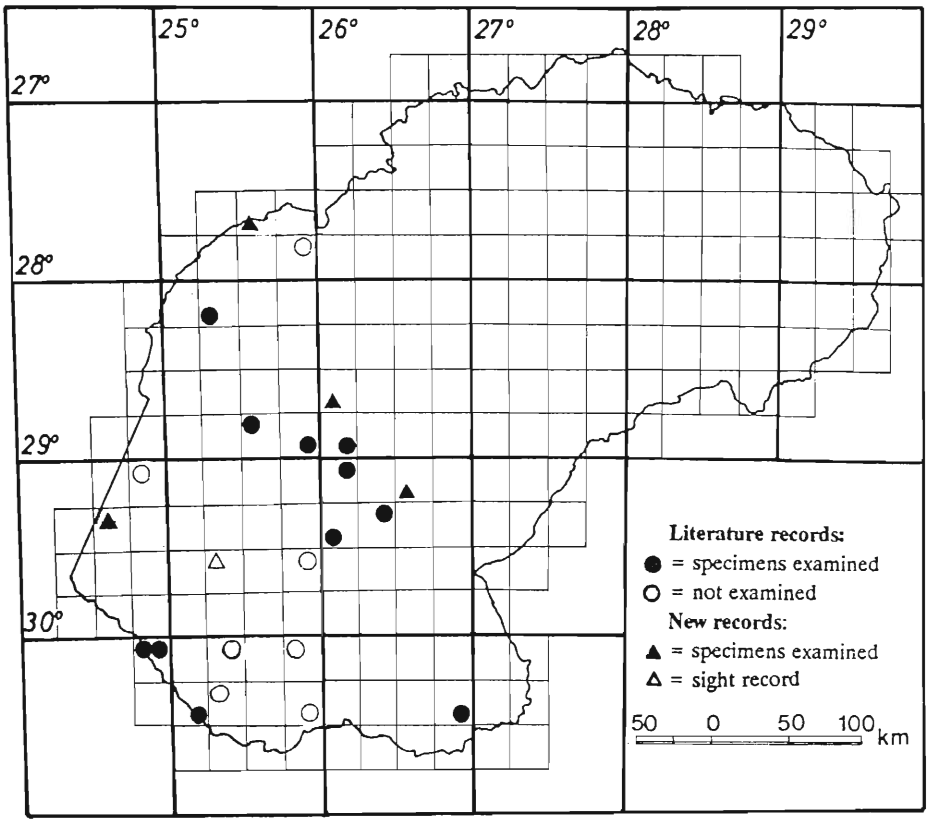


Figure 105: Distribution of *Naja nivea* in the Orange Free State.

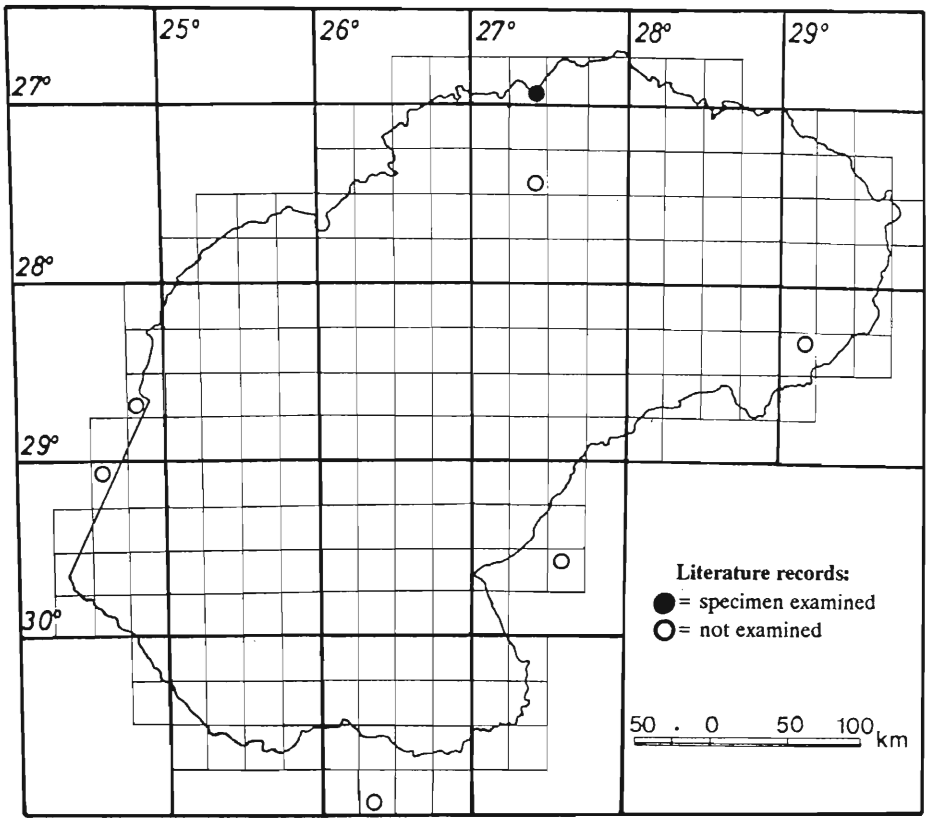


Figure 106: Distribution of *Causus rhombeatus* in the Orange Free State.

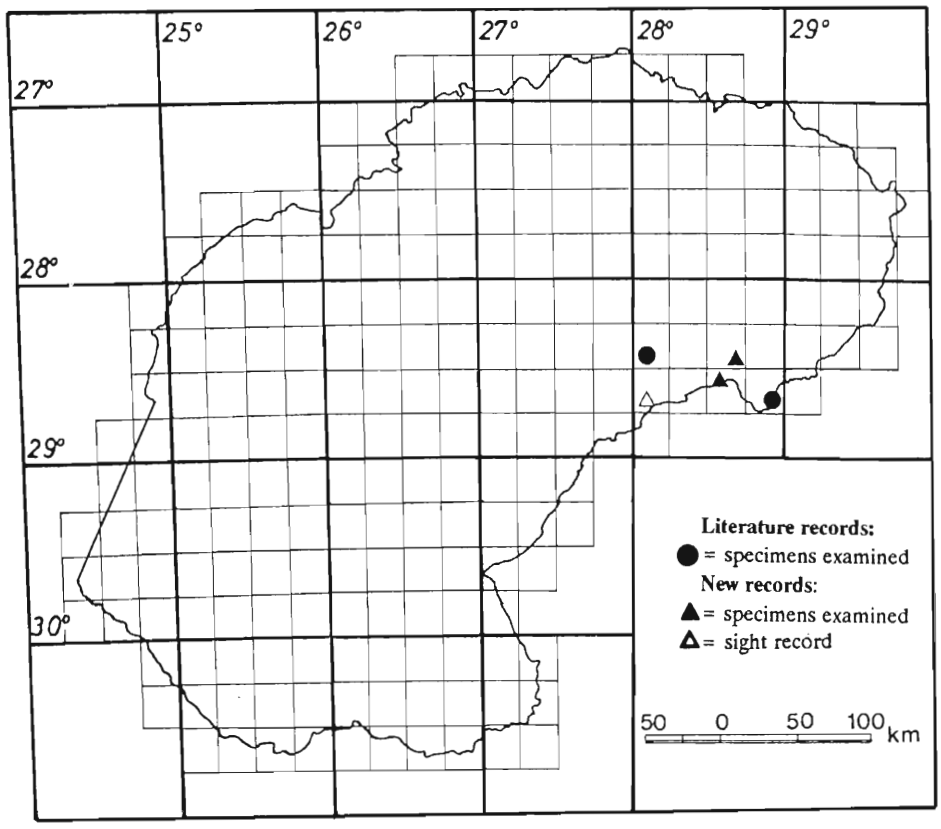


Figure 107: Distribution of *Bitis atropos* in the Orange Free State.

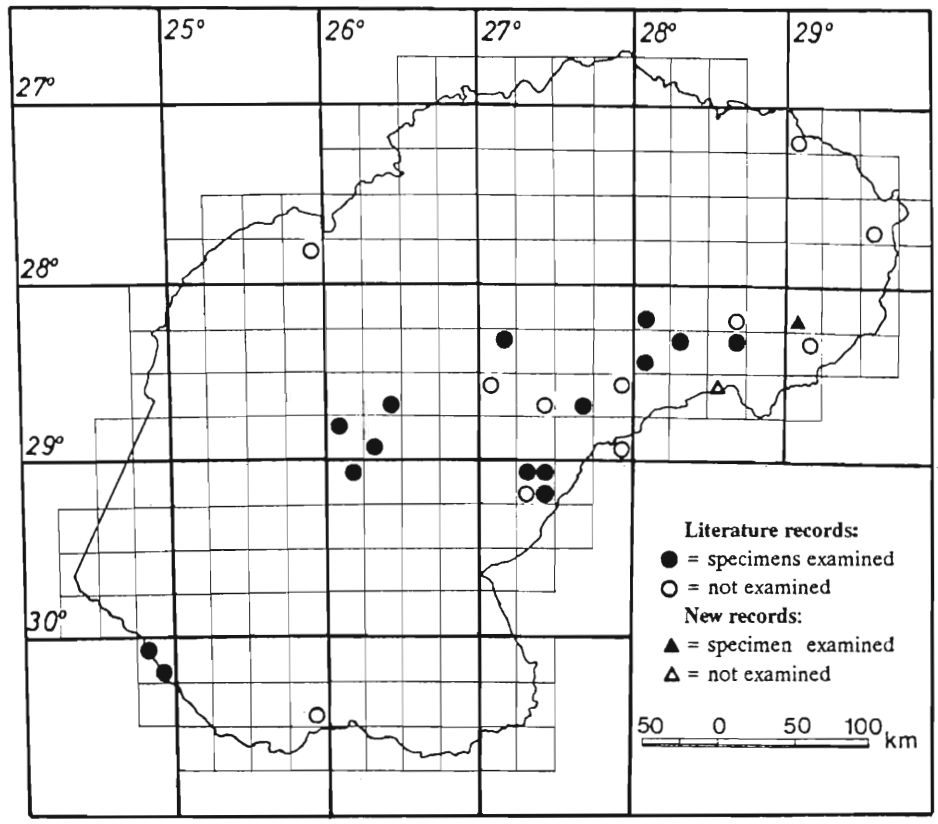


Figure 108: Distribution of *Bitis arietans arietans* in the Orange Free State.

Order: **CHELONIA**

Suborder: **CRYPTODIRA**

(Distribution maps for chelonians, represented by Figs 109-112, are presented on pages 306 to 307)

Family: **TESTUDINIDAE** Gray, 1825

Genus: *Geochelone* Fitzinger, 1835

Geochelone pardalis (Bell, 1828) Leopard Tortoise

Testudo pardalis Bell, 1828, *J. Zool. London*, 3, p. 420, *Suppl.*, Table 25. Type locality: Cape of Good Hope.

Testudo pardalis babcocki not Loveridge, 1935: De Waal, 1980b, p. 86.

Geochelone pardalis (Bell): Boycott & Bourquin, 1988, p. 86, fig. 17, pls 17 & 18.

Range

Throughout savanna areas of Africa, from the southern Cape Province northwards to Sudan.

Zoogeographical classification: Tropical Wide Ranging.

Range cluster in O.F.S.: Western (W).

Distribution in the Orange Free State (23 localities; Fig. 109)

Specimens examined from: Arcadia, Hoopstad; Basberg; Bergplaats, Bloemfontein; Bloemfontein; Bozrah; Cornwall; Doornhoek; Doornplaat; Gruisrand; Hertzogville; Holme's Dale; Houmoed; Krugersdrift Dam; Lemoenboord; Lentelus; Lovedale; Luiperfontein; Meyerskraal; Niekerk; Philippolis; Waterhoek; Wintershoek; Zuurfontein.

Other records: Naval Hill (sight record, M.F. Bates); Vrede, Hoopstad (TM 63770).

Features (28 specimens examined)

Largest specimen (NMB R4858 - Doornhoek) 136,8 mm plastron length.

Carapace domed; nuchal shield absent; plastron straw coloured with black patches.

Habitat and Ecology

Two *G. pardalis* juveniles were recovered from the stomach of a *Varanus a. albigularis* from the O.F.S. (De Waal, 1980b, p. 86). Females lay 5-16 eggs which take up to a year (Boycott & Bourquin, 1988) or longer (McMahon, 1990) to hatch. See Boycott & Bourquin (1988) for a more detailed account of life history.

Genus: *Psammobates* Fitzinger, 1835

Psammobates oculifer Kuhl, 1820 Serrated Tortoise

Testudo oculifera Kuhl, 1820, *Beitr. Zool. Amph.*, p. 77. Type locality: "Cap", presumably Cape Province. Loveridge & Williams, 1957; Greig & Burdett, 1976, fig. 6; De Waal, 1980b, p. 86.

Psammobates oculifer (Kuhl): Branch, 1988a, p. 28, pl. 7; Boycott & Bourquin, 1988, p. 94, fig. 19, pl. 23.

Range

Eastern Namibia, Botswana, northern and western Transvaal, northern Cape Province and western O.F.S.

Zoogeographical classification: Western Tropical Transitional.

Range cluster in O.F.S.: Western (W).

Distribution in the Orange Free State (14 localities; Fig. 110)

Specimens examined from: Alwyn; Cornwall; Danielskuil; Draaihoek; Dwaalhoek; Hagesdam; Karreelaagte; Krugersdrift Dam; Leliehoek; Merriesfontein; Moirton; Saltzmann's Pan; Sandveld Nature Reserve.

Other records: Bothaville (Loveridge & Williams, 1957).

Features (15 specimens examined)

Largest specimen (NMB R4868 - Dwaalhoek) 109,2 mm plastron length.

Nuchal present, marginal scutes serrated.

Habitat and Ecology

Females lay a single egg measuring 40 x 30 mm in summer (Boycott & Bourquin, 1988, p. 95). The last authors also provide additional life-history data.

Genus: *Homopus* Duméril & Bibron, 1835

Homopus femoralis Boulenger, 1888 Greater Padloper

Homopus femoralis Boulenger, 1881, *Proc. Zool. Soc. London*, p. 251, table 14. Type locality: Cradock, Cape Province. Loveridge & Williams, 1957; Greig & Burdett, 1976, fig. 13; De Waal, 1980b, p. 88; Branch, 1988a, p. 23, pl. 6; Boycott & Bourquin, 1988, p. 110, fig. 23, pls 35 & 36.

Range

Inland mountains of the eastern Cape Province, southern half of the O.F.S. and Kimberley region of the northern Cape.

Zoogeographical classification: Eastern Temperate Transitional.

Range cluster in the O.F.S.: Southern (S).

Distribution in the Orange Free State (31 localities; Fig. 111)

Specimens examined from: Alpha; Bergplaats, Dewetsdorp; Bethany; Bloemfontein; Damfontein; Exelsior; Hebron; Holme's Dale; Hoogeveld; Juist Zoo; Kalkdam; Karreeboomsvallei; Klipplaatdrift; Lang Zeekoegat; Leeuwberg; Lemoenboord; Luiperskop; Matjesfontein; Middelbron; Ospoort; Palmietfontein; Pietersberg; Susannasfontein; Thaba 'Nchu; Uitkijk; Vergaderrand; Weltevrede; Weltevreden; Winterspoort; Zandfontein; Zuurfontein.

Other records: Hopefield (TM 63769).

Features (39 specimens examined)

Largest specimen (NMB R4525 - Juist Zoo) 130,2 mm plastron length.

Carapace depressed, dark brown in colour; nuchal shield present.

Habitat and Ecology

In the O.F.S. these tortoises prefer rocky outcrops to open grassveld, but a few specimens were found in old, caved-out termite mounds (De Waal, 1980b, p. 88). Females lay 1-3 eggs (29-35 x 25-27 mm) in summer (Branch, 1988a, p. 23). Other life-history information is given by Boycott & Bourquin (1988).

Suborder: **PLEURODIRA**

Family: **PELOMEDUSIDAE** Cope, 1868

Genus: *Pelomedusa* Wagler, 1830

Pelomedusa subrufa subrufa (Lacépède, 1788) Marsh Terrapin

Testudo subrufa Lacépède, 1789, *Hist. nat. Quadrup. ovip. Serpens*, 2, Synopsis methodica.

Pelomedusa galeata orangensis not Hewitt, 1935, *Rec. Albany Mus.*, 4, pp. 283-357.

Pelomedusa subrufa subrufa (Lacépède): Loveridge, 1941, p. 470; Branch, 1988a, p. 39 (part).

Pelomedusa subrufa (Lacépède): De Waal, 1978, p. 88; Boycott & Bourquin, 1988, p. 60, fig. 14, pls 1 & 2.

Pelomedusa subrufa nigra (?): Branch, 1988a, p. 39 (part).

Range

Occurs virtually throughout Africa where quiet waters are found; also on Madagascar. Generally absent from mountainous areas, forests and desert regions.

Zoogeographical classification: Afrotropical.

Range cluster in O.F.S.: Non-Northeastern (Non-NE).

Distribution in the Orange Free State (19 localities; Fig. 112)

Specimens examined from: Bloemfontein; Brakput; Florisbad; Glen; Holme's Dale; Houmoed; Klipfontein; La Belle France; Meriba; Middenspruit; Onze Rust; Rondavel; Weltevreden; Wesselsdam; Winterspoort; Zandfontein.

Other records: Emmaus; Thaba 'Nchu (Hewitt, 1935).

Features (14 specimens examined)

Largest specimen (NMB R4877 - Rondavel) 183 mm plastron length.

Carapace depressed and grey in colour; plastron mostly black, straw coloured in centre (plastron of NMB R4634 has about equal extent of dark and light coloration).

Habitat and Ecology

Semi-aquatic, feeding on a variety of plant and animal matter (Boycott & Bourquin, 1988, p. 61). Females lay 10-40 (usually 10-30) eggs measuring 30-40 x 18-28 mm and weighing 10 g each; young hatch after 90-110 days (Branch, 1988a, p. 39). See Boycott & Bourquin (1988) for a detailed account of the life-history of *P. subrufa*.

Remarks

Loveridge (1941) recognized two subspecies, namely *P. s. subrufa* (Lacépède, 1788) and *P. s. olivacea* (Schweigger, 1814). Some authors (e.g. Boycott & Bourquin, 1988) now treat the species as monotypic, but Branch (1988a, pp. 39-40) noted that *P. s. nigra* occurs in Natal, adjacent O.F.S., Transkei and eastern Cape, and I have read a recent article on the occurrence of *P. s. olivacea* in Eritrea and vicinity (reference could not be traced). Branch (1988a, p. 40) noted that the plastron of *P. s. nigra* is black. Most O.F.S. specimens have mainly black plastrons. At this time, however, O.F.S. material is treated as *P. s. subrufa*, although it is obvious that the taxonomic status of *P. subrufa* in Africa requires reassessment.

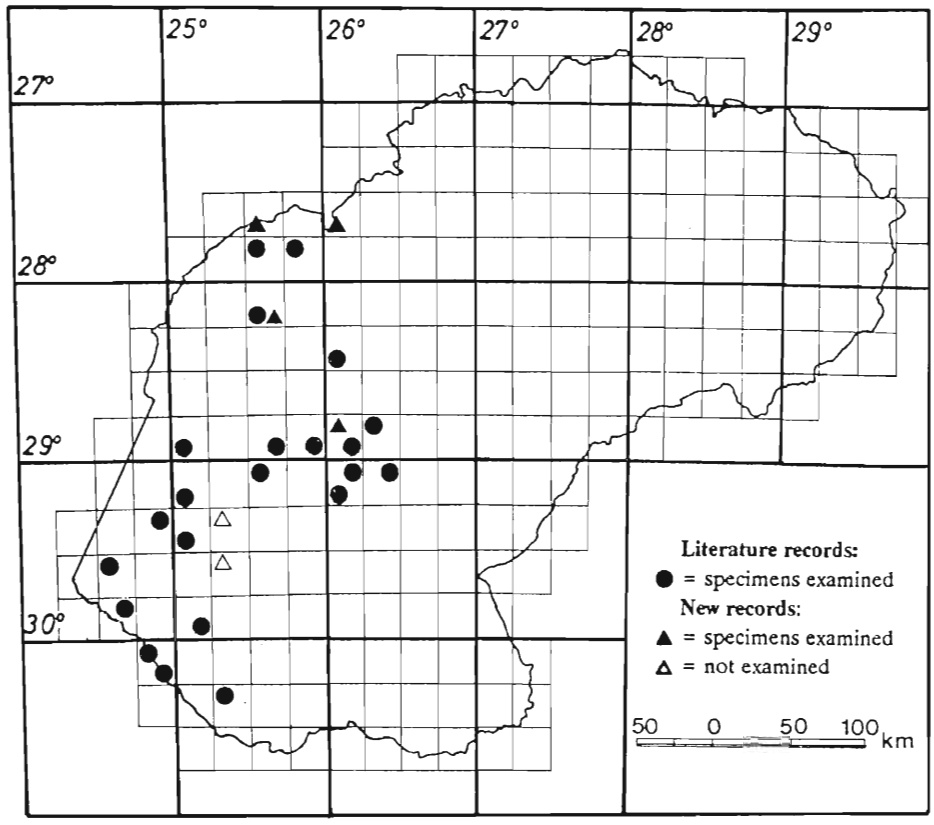


Figure 109: Distribution of *Geochelone pardalis* in the Orange Free State.

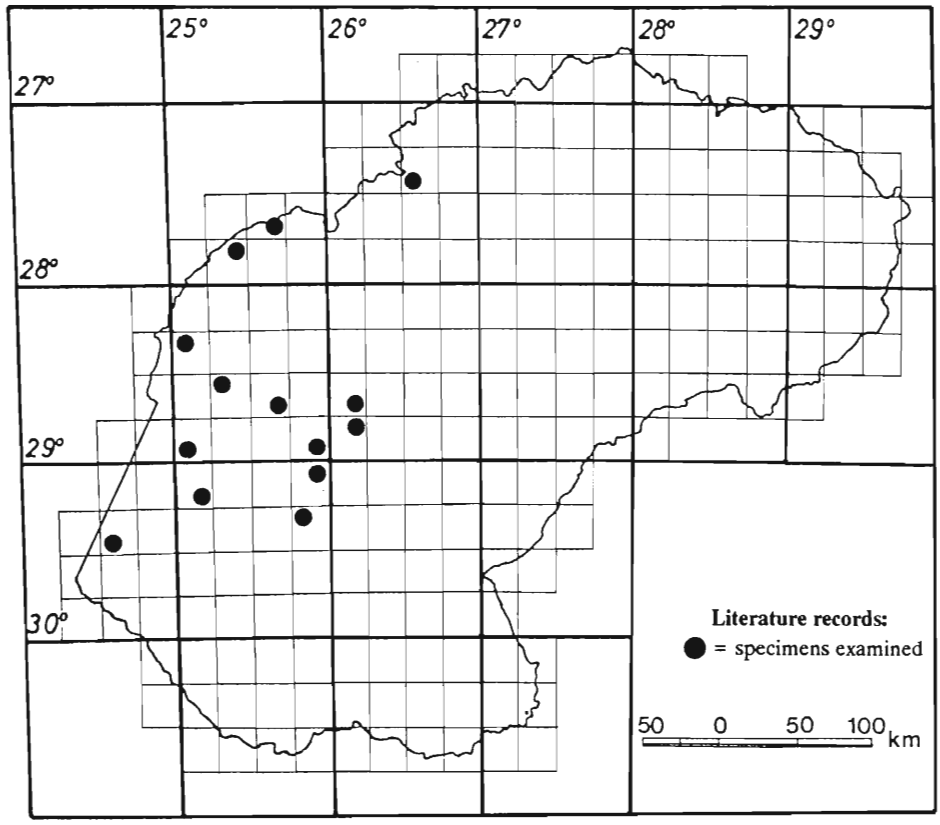


Figure 110: Distribution of *Psammobates oculifer* in the Orange Free State.

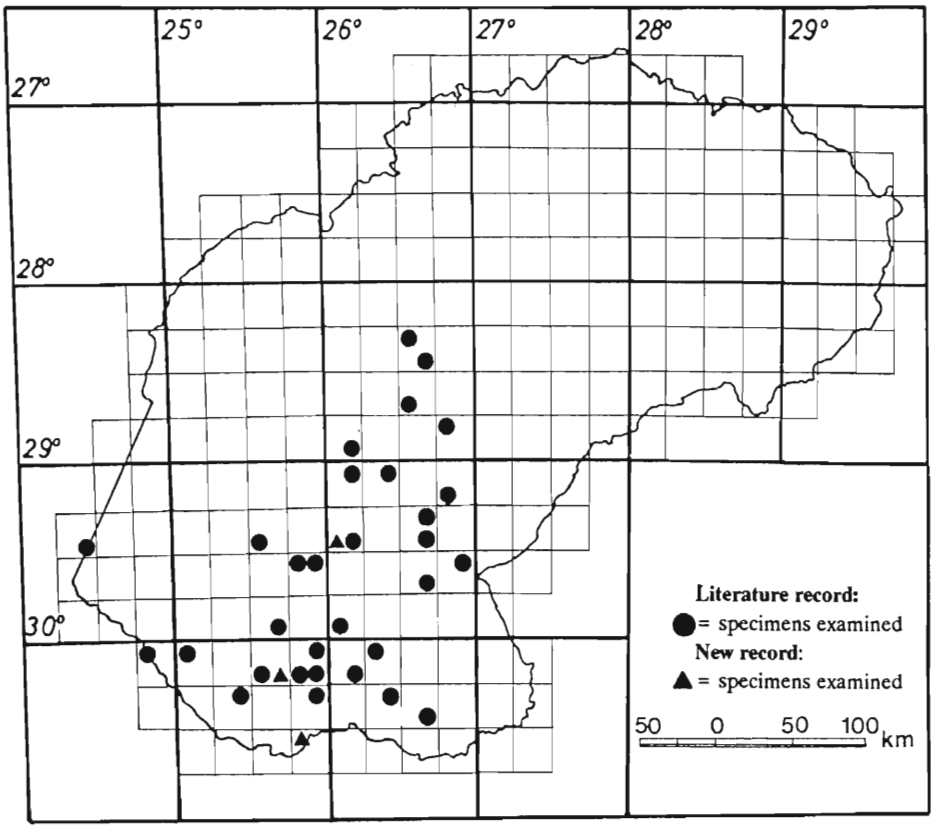


Figure 111: Distribution of *Homopus femoralis* in the Orange Free State.

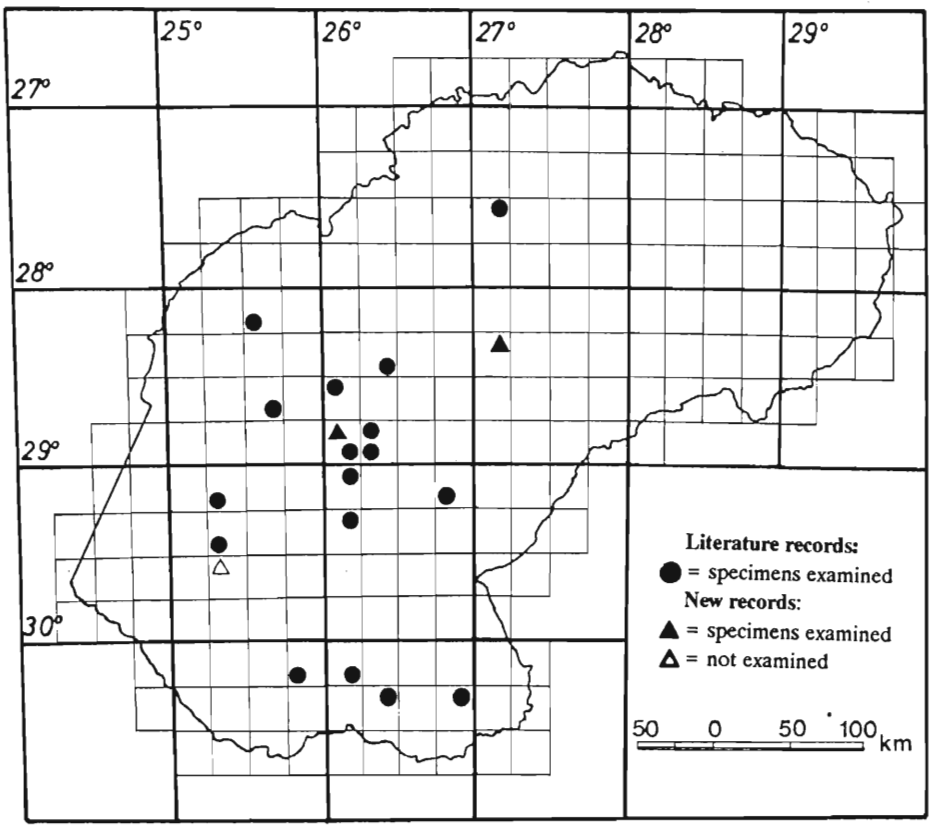


Figure 112: Distribution of *Pelomedusa subrufa subrufa* in the Orange Free State.

CHAPTER FIVE

ECOLOGY

As a background to the biogeographical study presented in chapter 6, some aspects of the ecology of O.F.S. amphibians and reptiles are discussed. In section 5.1 the distribution of O.F.S. amphibians and reptiles in biotic zones is discussed. This is followed by a discussion on O.F.S. herpetofauna associated with the Afromontane (or Afrotemperate) region of southern Africa (section 5.2), while section 5.3 provides information on the use of termitaria as a microhabitat for amphibians and reptiles. Finally, some general features of the ecology of amphibians and reptiles are discussed, namely habitat, diet and reproduction (section 5.4).

5.1 Distribution of herpetofauna in biotic zones

The distribution of herpetofaunal communities is largely determined by topography, climate and pre-historical factors, rather than vegetation (Jacobsen, 1989, p. 1444). Two of Rautenbach's (1978) southern African biotic zones occur in the Orange Free State, namely the Southern Savanna Grassland and South-West Arid biotic zones (Fig. 113). The grassland zone, composed mostly of Highveld Grassland, but including montane grassland in the eastern O.F.S., occupies about 70% of the total area of the O.F.S. (Lynch, 1985, p. 474). This zone includes, essentially, all grassveld vegetation units identified by Acocks (1988) as occurring in the O.F.S., namely Sweet, Mixed and Sour Grassveld. The South-West Arid zone covers about 30% of the province (Lynch, 1985) and is comprised primarily of Acocks' (1988) Karoo and Bushveld vegetation units (Fig. 113).

Although not indicated on Rautenbach's (1978) map, Afromontane Forest occurs in the eastern and north-eastern O.F.S. (Farkas, 1988; Du Preez, Bredenkamp & Venter, 1991; Du Preez & Bredenkamp 1991a; Du Preez & Bredenkamp, 1991b) and is here treated as a distinct biotic zone.

In order to analyze the ecological affinities of the O.F.S. herpetofauna, the approach of Broadley (1966) and Jacobsen (1989) has been followed. The three biotic zones mentioned above have been subdivided according to the utilization of available habitat, e.g. arboreal habitat (i.e. trees and large bushes) or terrestrial habitat (i.e. arenicolous forms and those usually occupying low-lying rocky ground). Many species are not entirely restricted to one habitat type (as will be indicated), but the groupings represent habitat preferences recorded and/or personally observed for O.F.S. populations, with preferences of extralimital populations also considered (e.g. *Arthroleptella hewitti* in forest in Natal).

A species assigned to one of the three biotic zones may have a limited or peripheral distribution in one or both of the other zones, but the approach here is to "group" taxa into the zone in which most of its recorded distribution lies. Eclectic forms are listed separately with a breakdown of their habitat preferences. Forms known to occur in Afromontane Forest, but with most of their range in other areas,

are not regarded as forest forms. Such forms are discussed further in the section on the Afromontane Region. Populations suspected or known to represent translocations (e.g. *Bradypodion ventrale* cf. *karroica*) are not considered here.

To determine in which biotic zone a particular taxon occurred, a transparency showing the Southern Savanna Grassland/South-West Arid zone border (see Fig. 113) was superimposed on the distribution maps of each form. When assigning a form to one or more zonal groupings, no attempt was made to indicate into which zone the majority of the form's distribution lies, although only two "borderline" cases occurred. The snake *Xenocalamus b. bicolor*, recorded from the "borderline" Bloemfontein quarter-degree unit (2926 AA), was assigned to the arid group, as the species is also known to occur in the arid zone west of Bloemfontein (Bates, 1991d; Figs 93 & 94), while the snake *Prosymna bivittata* is "peripheral" on both sides of the dividing line between arid and grassland. Tables 9 & 10 indicate whether or not a taxon occurs in the arid or grassland zones, even if represented by a single record, and peripheral occurrence (i.e. where it was difficult to decide into which zone the locality falls) is indicated using the slash / symbol.

No detailed analysis of the distribution of amphibians or reptiles in southern Africa in the six biotic zones of Rautenbach (1978) has been conducted. This section analyzes the occurrence of amphibians and reptiles in the two biotic zones covering the O.F.S., namely Southern Savanna Grassland and South-West Arid region, but incorporates Afromontane Forest as a distinct zone, following recent botanical work in the eastern O.F.S. (Du Preez, Bredenkamp & Venter, 1991; Du Preez & Bredenkamp, 1991a). However, a comparison between the O.F.S. distribution of taxa in grassland and arid areas with those elsewhere in Africa, as conducted for O.F.S. mammals by Lynch (1985), will not be attempted.

While 109 southern African mammal species occur in the Southern Savanna Grassland, 133 are found in the South-West Arid zone; and in the O.F.S. 78 occur in the arid zone with 83 in grassland (Lynch, 1985, p. 474). Lynch (1985, p. 474-475) also noted that although both zones are faunistically very similar, with a Faunal Resemblance Factor index value of 0,795 (with 64 species in common), the two zones are "influenced by intrinsic ecological features which in each zone inhibit the occurrence of some mammal species". Lynch (1985) used the following "vegetational communities" in analyzing mammalian distribution patterns in the O.F.S.: Karoo and Bushveld (constituting the South-West Arid zone, and the same as the vegetation units thus named by Acocks, 1988), Sweet-Mixed Grassveld and Mixed-Sour Grassveld (these being modifications of Acocks' "Sweet Grassveld" and "Mixed Grassveld" zones respectively) and Sour Grassveld (*vide* Acocks, 1988). However, in terms of the present study, a synopsis of species occurrence in Acocks' (1988) vegetation units only has been attempted (Tables 9 & 10). Mammalian distribution is more likely to be influenced by "veld types" and vegetation on the whole than reptilian distribution, as most mammals are herbivores and dependent on plants for food, and sometimes shelter, unlike amphibians and reptiles, especially in that vegetation is not a primary food source, although it may influence the distribution of prey (e.g. insects) and reflects climate and topography.

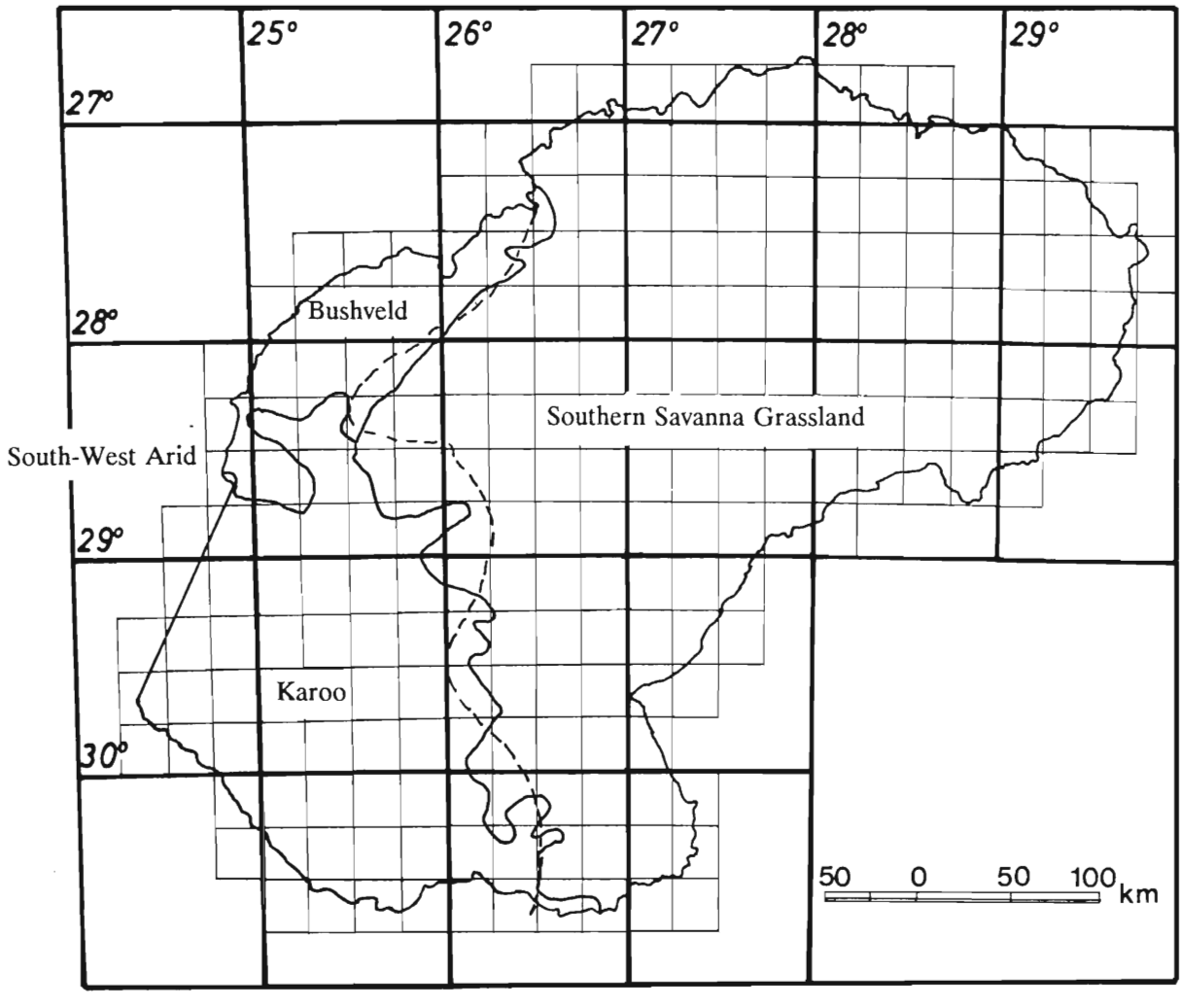


Figure 113: Location of the Southern Savanna Grassland and South-West Arid biotic zones (after Lynch, 1983) in relation to Bushveld and Karoo vegetational units (after Acocks, 1988) in the Orange Free State.

In the case of mammals, the close relationship between the Savanna zones (i.e. Woodland and Grassland) and the South-West Arid zone is accentuated in the O.F.S. as a result of the ecotonal effect created where these two zones meet and intergrade, and this was offered by Lynch (1985, p. 475) as an explanation as to why such a close faunal similarly existed between the mammals from the grassland and arid zones in the O.F.S. Tables 9 & 10 indicate the distribution of O.F.S. herpetofaunal forms in relation to Acocks' (1988) vegetation units. As the South-West Arid zone essentially contains Acocks' Karoo and Bushveld, and the Southern Savanna Grassland essentially includes Acocks' three Grassveld types, Tables 9 & 10 can be used to gain a more detailed impression as to the distribution of taxa within the two biotic zones. Factors such as climate and topography are here considered more enlightening in terms of the distribution of O.F.S. herpetofauna, and no more detailed a "veld type" analysis will be conducted. The distribution in terms of biotic zones does, however, correspond to some extent with climatic and topographical differences in the O.F.S., especially in as far as the wetter, mountainous eastern O.F.S. is concerned.

5.1.1 Southern Savanna Grassland

The two main grassland types, namely Highveld Grassland and montane grassland are distinguished mainly by the different grass species present, this being the result of higher rainfall in the mountainous eastern parts (Jacobsen, 1989, p. 1448). According to Jacobsen (1989), the "cold season" in southern Savanna Woodland (not present in the O.F.S.) is "at least a month" shorter than that in Southern Savanna Grassland. A very significant feature of any grassland area in the O.F.S., but especially in the Southern Savanna Grassland, is stands of (inactive) *Trinervitermes* termite mounds. These serve as alternate shelter, hibernation and possibly feeding sites in areas where rocks and other cover are either absent or sparsely distributed (Lynch, 1988). The burrows of mammals are also used as shelter by various grassland species, e.g. *Pseudaspis cana.*

a) Arboreal form: *Bradypodion* sp. nov. ("Zastron").

b) Terrestrial forms: *Lamprophis inornatus, L. fuscus, L. aurora, Prosymna bivittata* (probably partly fossorial), *Duberria l. lutrix, Crotaphopeltis hotamboeia, Psammophylax r. rhombeatus, Psammophis crucifer, Aspidelaps l. lubricus, Elapsoidea sundevallii media, Homoroselaps lacteus, H. dorsalis, Hemachatus haemachatus, Causus rhombeatus, Mabuya varia, Panaspis wahlbergii, Chamaesaura aenea, Gerrhosaurus f. flavigularis, Tetradactylus seps, T. a. africanus, T. breyeri, T. tetradactylus, Cordylus giganteus, Nucras lalandii, Pedioplanis burchelli, Tropidosaura essexi, Schismaderma carens, Breviceps adspersus pentheri, B. maculatus, Tomopterna natalensis, Strongylopus g. grayii, S. f. fasciatus, S. hymenopus, Cacosternum nanum, Kassina (Semnodactylus) wealii.*

c) Rupicolous forms: *Lamprophis guttatus, Bitis atropos, Afroedura karroica halli, A. nivaria, Hemidactylus mabouia, Pachydactylus vansoni, Mabuya homalocephala smithii* (also terrestrial), *Cordylus cordylus, C. v. vittifer, Cordylus* sp. ("Waterfall"), *Pseudocordylus m. melanotus, P. m. subviridis, P. spinosus.*

d) Fossorial forms: *Typhlops bibronii, Acontias g. gracilicauda.*

e) Semi-aquatic form: *Lycodonomorphus rufulus.*

5.1.2 South-West Arid biotic zone

This area is characterized mainly by its low elevation, low rainfall, higher temperatures and the Karoo and Bushveld vegetation units of Acocks (1988). Characteristic of the area, especially the Karoo, are dolerite hillocks within which are open grassland areas, often containing termitaria. The Bushveld part of the north-western O.F.S. is, apart from the Afromontane Forest in the east and north-east, the only part of the province where trees, in this case *Acacia* spp., are a dominant feature of the landscape. A typical "karoo-koppie" lizard community is composed of the following species: *Pachydactylus bibronii, Agama a. atra, Mabuya s. sulcata* and sometimes *Cordylus p. polyzonus.* The lower slopes of hills with dolerite (often black) rocks support *C. p. polyzonus* colonies, whereas *A. a. atra*, although it may occur microsympatrically with the former, is more common on the higher slopes.

a) Arboreal forms (restricted to Kalahari Thornveld [= savanna]): *Dispholidus t. typus, Lygodactylus c. capensis, Chamaeleo d. dilepis.*

b) Terrestrial forms: *Naja nivea, Telescopus beetzii* (also rupicolous), *Ptenopus g. garrulus* (largely arenicolous), *Agama a. aculeata* (largely arenicolous), *A. h. hispida, Mabuya occidentalis* (largely arenicolous), *Nucras intertexta, Pedioplanis namaquensis* (largely arenicolous), *Ichnotropis squamulosa, Homopus femoralis, Psammobates oculifer.*

c) Rupicolous forms: *Pachydactylus maculatus oculatus, P. bibronii, P. l. laevigatus, Mabuya v. variegata* (also terrestrial), *M. s. sulcata.*

d) Fossorial forms: *Xenocalamus b. bicolor, Atractaspis bibronii.*

5.1.3 Afromontane Forest

This biotic zone and the Afromontane Region as a whole will be discussed in more detail under section 5.2.

a) Arboreal forms: *Philothamnus natalensis occidentalis* (also terrestrial and known to occur in savanna), *Bradypodion dracomontanum, Bradypodion* sp. nov. ("Ngotswane Gorge").

b) Semi-aquatic forms: *Heleophryne natalensis*, *Arthroleptella hewitti*.

5.1.4 Eclectic forms (most of which do not occur in Afromontane Forest)

a) Terrestrial forms: *Lamprophis fuliginosus, Lycophidion c. capense, Prosymna s. sundevallii* (partly fossorial), *Pseudaspis cana* (partly fossorial), *Dasypeltis scabra* (occasionally arboreal), *Psammophylax tritaeniatus, Psammophis notostictus, P. leightoni trinasalis, Aparallactus capensis* (partly fossorial), *Bitis a. arietans, Pachydactylus m. mariquensis* (also arenicolous), *P. c. capensis* (sometimes rupicolous), *Agama aculeata distanti* (occasionally arboreal), *Mabuya capensis, M. variegata punctulata* (also rupicolous), *Mabuya striata punctatissima* (often rupicolous), *Nucras taeniolata holubi, Pedioplanis l. lineoocellata* (largely arenicolous), *Varanus a. albigularis* (also rupicolous), *Geochelone pardalis, Bufo gutturalis, B. g. gariepensis* (also rupicolous), *B. vertebralis* (also rupicolous), *B. garmani, B. rangeri, Breviceps a. adspersus, Pyxicephalus a. adspersus* (remains underground for most of the year), *Tomopterna cryptotis, Phrynobatrachus natalensis, Cacosternum boettgeri, Kassina senegalensis.*

b) Rupicolous forms: *Agama a. atra, Cordylus p. polyzonus.*

c) Fossorial forms: *Typhlops lalandei, Leptotyphlops s. scutifrons, Monopeltis c. capensis.*

d) Semi-aquatic forms: *Varanus n. niloticus, Pelomedusa s. subrufa, Rana fuscigula, R. angolensis.*

e) Aquatic form: *Xenopus l. laevis* (may cross land during or after rain).

Table 9: Biogeographical patterning of amphibians in the Orange Free State (/ = peripheral occurrence).

	Biotic Zones		Vegetation Units					Topographic Relief					Mean Rainfall (October to March)					
Species/ subspecies	South-West Arid	Southern Savanna Grassland	Bush-veld	Karoo	Sweet Grass-veld	Mixed Grass-veld	Sour Grass-veld	0-915m	916-1218m	1219-1522m	1523-1823m	1824-2134m	Up to 294mm	295-433mm	434-610mm	611mm ≤	Range Cluster	Zoogeographical Classification
Xenopus l. laevis	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	T	Cape Temperate
Heleophryne natalensis		•				•	•				•					•	D	Eastern Temperate Transitional
Bufo g. gariepensis	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	S & E	Central Temperate Transitional
Bufo gutturalis	•	•	•	•	•	•	•		•	•			•	•	•	•	Non-SW	Tropical
Bufo poweri	•	•	•	•	•			•	•				•	•	•		W	Tropical
Bufo rangeri	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	Non-SW	Eastern Transitional
Bufo vertebralis	•	•	•	•	•	•		•	•	•			•	•	•		S	Central Temperate Transitional
Schismaderma carens		•			•	•	•		•		•				•	•	N & NE	Tropical
Breviceps maculatus		•				•					•					•	D	Large Temperate Transitional
Breviceps a. adspersus	•	•	•	•		•	•	•	•	•			•	•	•	•	N & W	Eastern Tropical Transitional
Breviceps a. pentheri		•					•				•					•	D	Linkage Zone Transitional
Pyxicephalus a. adspersus	•	•	•	•	•	•	•	•	•	•			•	•	•	•	T	Tropical
Tomopterna cryptotis	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	T	Tropical
Tomopterna natalensis	•	•		•		•	•		•		•			•	•	•	N & NE	Eastern Transitional
Rana angolensis	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	Non-SW	Tropical
Rana fuscigula	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	T	Cape Temperate
Strongylopus g. grayii		•		•	•	•	•			•	•			/	•	•	E	Cape Temperate
Strongylopus f. fasciatus		•				•	•			•	•				•	•	E	Eastern Transitional
Strongylopus hymenopus		•					•				•					•	D	Large Temperate Transitional
Phrynobatrachus natalensis	•	•	•	•	•	•	•	•	•	•				•	•		Non-SW	Tropical
Cacosternum boettgeri	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	T	Cape Temperate
Cacosternum nanum		•					•			•						•	D	Large Temperate Transitional
Arthroleptella hewitti		•					•				•					•	D	Large Temperate Transitional
Kassina (Kassina) senegalensis	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	T	Tropical
Kassina (Semnodactylus) wealii		•				•	•		•	•	•			/	•	•	E	Cape Temperate

Table 10: Biogeographical patterning of reptiles in the Orange Free State (/ = peripheral occurrence).

Species/ subspecies	Biotic Zones		Vegetation Units					Topographic Relief					Range Cluster	Zoogeographical Classification
	South-West Arid	Southern Savanna Grassland	Bush-veld	Karoo	Sweet Grass-veld	Mixed Grass-veld	Sour Grass-veld	0-915m	916-1218m	1219-1522m	1523-1823m	1824-2134m		
Ptenopus g. garrulus	*			*					*				SW	Western Tropical Transitional
Afroedura karroica halli		*				*					*		E	Eastern Temperate Transitional
Afroedura nivaria		*				*	*				*	*	E	Eastern Temperate Transitional
Hemidactylus mabouia		*				*				*			E	Tropical Wide Ranging
Lygodactylus c. capensis	*		*					*	*				NW	Tropical Wide Ranging
Pachydactylus m. mariquensis	*	*		*	*	*		*	*	*			S	Western Temperate Transitional
Pachydactylus maculatus oculatus	*			*				*	*	*			SW	Eastern Temperate Transitional
Pachydactylus c. capensis	*	*	*	*	*	*	*	*	*	*	*	*	T	Western Tropical Transitional
Pachydactylus vansoni		*				*	*			*	*	*	NE	Eastern Temperate Transitional
Pachydactylus bibronii	*		*	*				*	*	*			SW	Tropical Wide Ranging
Pachydactylus l. laevigatus	*			*					*				SW	Western Tropical Transitional
Agama a. atra	*	*	*	*	*	*	*	*	*	*	*	*	Non-NE	Cape Temperate
Agama h. hispida	*		*					*	*				NW	Cape Temperate
Agama aculeata aculeata	*		/	*				*	*				SW	Western Temperate Transitional
Agama aculeata distanti	*	*	*	*	*	*	*	*	*	*	*	/	Non-SW	Eastern Temperate Transitional
Chamaeleo d. dilepis	*		*					*	*				NW	Tropical Wide Ranging
Bradypodion dracomontanum		*					*				*		D	Eastern Temperate Transitional
Bradypodion sp. nov. ("Ngotswane Gorge")		*					*				*		D	Eastern Temperate Transitional
Bradypodion sp. nov. ("Zastron")		*				*				*			SE	Eastern Temperate Transitional
Mabuya homalocephala smithii		*				*	*			*			E	Eastern Temperate Transitional
Mabuya capensis	*	*	*	*	*	*	*	*	*	*	*	*	T	Cape Temperate
Mabuya occidentalis	*			*				*	*				SW	Western Tropical Transitional
Mabuya varia	*	*	*	*	*	*	*		*	*	*		Non-SW	Tropical Wide Ranging

Table 10: Biogeographical patterning of reptiles in the Orange Free State (/ = peripheral occurrence).

Species/ subspecies	Biotic Zones		Vegetation Units					Topographic Relief					Range Cluster	Zoogeographical Classification
	South-West Arid	Southern Savanna Grassland	Bush-veld	Karoo	Sweet Grass-veld	Mixed Grass-veld	Sour Grass-veld	0-915m	916-1218m	1219-1522m	1523-1823m	1824-2134m		
Mabuya v. variegata	*	*		*		*		*	*	*			SW	Western Temperate Transitional
Mabuya v. punctulata	*	*		*	*	*		*	*	*			S	Tropical Wide Ranging
Mabuya s. sulcata	*		*	*				*	*	*			SW	Western Tropical Transitional
Mabuya striata punctatissima	*	*	*	*	*	*	*	*	*	*	*	*	Non-SW	Western Tropical Transitional
Panaspis wahlbergii	*	*	*	*	*	*			*				C	Tropical Wide Ranging
Acontias g. gracilicauda	*	*	*	*	*	*	*		*	*			Non-SW	Eastern Temperate Transitional
Gerrhosaurus f. flavigularis	*	*	/		*	*	*		*	*	*		E	Tropical Wide Ranging
Tetradactylus seps		*			*				*				SE	Cape Temperate
Tetradactylus tetradactylus		*		*					*				SE	Cape Temperate
Tetradactylus breyeri		*				*	*			*	*		NE	Eastern Temperate Transitional
Tetradactylus a. africanus		*					*				*		D	Eastern Temperate Transitional
Chamaesaura aenea		*				*				*	*		D	Eastern Temperate Transitional
Cordylus giganteus		*			*	*	*		*	*	*		NE	Eastern Temperate Transitional
Cordylus p. polyzonus	*	*	*	*	*	*		*	*	*			S	Cape Temperate
Cordylus cordylus		*			*	*			*	*			SE	Cape Temperate
Cordylus v. vittifer		*			*	*	*		*	*	*		NE	Eastern Temperate Transitional
Cordylus sp. ("Waterfall")		*					*					*	D	Eastern Temperate Transitional
Pseudocordylus m. melanotus		*				*	*			*	*		E	Eastern Temperate Transitional
Pseudocordylus m. subviridis		*				*	*				*	*	D	Eastern Temperate Transitional
Pseudocordylus spinosus		*					*					*	D	Eastern Temperate Transitional
Tropidosaura essexi		*					*				*		D	Eastern Temperate Transitional
Nucras lalandii		*				*	*		*	*	*	*	E	Eastern Temperate Transitional
Nucras intertexta	*	*	*	*	*	*		*	*				Non-NE	Western Tropical Transitional
Nucras taeniolata holubi	*	*	*	*	*	*		*	*	*			Non-NE	Eastern Tropical Transitional

Table 10: Biogeographical patterning of reptiles in the Orange Free State (/ = peripheral occurrence).

Species/ subspecies	Biotic Zones		Vegetation Units					Topographic Relief					Range Cluster	Zoogeographical Classification
	South-West Arid	Southern Savanna Grassland	Bush-veld	Karoo	Sweet Grass-veld	Mixed Grass-veld	Sour Grass-veld	0-915m	916-1218m	1219-1522m	1523-1823m	1824-2134m		
Pedioplanis namaquensis	*			*				*	*				SW	Western Temperate Transitional
Pedioplanis l. lineoocellata	*	*	*	*	*	*		*	*	*			S	Western Temperate Transitional
Pedioplanis burchelli		*			*	*	*		*	*	*	*	E	Cape Temperate
Ichnotropis squamulosa	*	*	*						*				NW	Western Tropical Transitional
Varanus a. albigularis	*	*	*	*	*	*		*	*	*			Non-NE	Tropical Wide Ranging
Varanus n. niloticus	*	*	*	*	*	*	*		*	*			T	Tropical Wide Ranging
Monopeltis c. capensis	*	*	*	*	*				*				W	Western Temperate Transitional
Typhlops bibronii		*				*	*			*	*		NE	Eastern Temperate Transitional
Typhlops lalandei	*	*		*	*	*		*	*	*			Non-NE	Cape Temperate
Leptotyphlops s. scutifrons	*	*	*	*	*	*	*	*	*	*	*	*	T	Tropical Wide Ranging
Lycodonomorphus rufulus	/	*			*	*	*		*	*	*		E	Cape Temperate
Lamprophis fuscus		*			*	*				*			E	Cape Temperate
Lamprophis aurora	*	*		*	*	*	*		*	*	*		Non-SW	Cape Temperate
Lamprophis inornatus		*			*	*					*		D	Cape Temperate
Lamprophis guttatus		*				*	*			*	*	*	E	Cape Temperate
Lamprophis fuliginosus	*	*	*	*	*	*	*	*	*	*	*		Non-NE	Afrotropical
Lycophidion c. capense	*	*	*	*	*	*	*		*	*	*		Non-NE	Tropical Wide Ranging
Duberria l. lutrix	*	*		*	*	*	*		*	*			E	Cape Temperate
Pseudaspis cana	*	*	*	*	*	*	*		*	*	*		Non-NE	Afrotropical
Psammophylax r. rhombeatus	*	*		*	*	*	*		*	*	*	*	E	Cape Temperate
Psammophylax tritaeniatus	*	*	*	*	*	/		*	*				W	Tropical Wide Ranging
Psammophis notostictus	*	*		*	*	*		*	*	*			S	Cape Temperate
Psammophis leightoni trinasalis	*	*	*	*	*	*		*	*				Non-NE	Western Tropical Transitional

Table 10: Biogeographical patterning of reptiles in the Orange Free State (/ = peripheral occurrence).

Species/ subspecies	Biotic Zones		Vegetation Units					Topographic Relief					Range Cluster	Zoogeographical Classification
	South-West Arid	Southern Savanna Grassland	Bush-veld	Karoo	Sweet Grass-veld	Mixed Grass-veld	Sour Grass-veld	0-915m	916-1218m	1219-1522m	1523-1823m	1824-2134m		
Psammophis crucifer	/	*			*	*	*		*	*	*	*	E	Cape Temperate
Aparallactus capensis	*	*	*	*	*	*	*		*	*			Non-NE	Tropical Wide Ranging
Xenocalamus b. bicolor	*			*	*				*				W	Tropical Wide Ranging
Homoroselaps lacteus		*			*	*	*		*	*	*		E	Cape Temperate
Homoroselaps dorsalis	*	*			*	*			*	*			C	Eastern Temperate Transitional
Atractaspis bibronii	*	*	*	*	*				*				W	Tropical Wide Ranging
Prosymna s. sundevallii	*	*		*	*	*		*	*	*			Non-NE	Cape Temperate
Prosymna bivittata	*	*	*		*				*				W	Western Tropical Transitional
Philothamnus natalensis occidentalis		*				*	*				*		D	Eastern Tropical Transitional
Crotaphopeltis hotamboeia	*	*	*	*	*	*	*		*	*	*	*	Non-SW	Afrotropical
Telescopus beetzii	*			*				*					SW	Western Temperate Transitional
Dispholidus t. typus	*		*					*	*				NW	Tropical Wide Ranging
Dasypeltis scabra	*	*	*	*	*	*	*	*	*	*	*	*	T	Afrotropical
Elapsoidea sundevallii media	*	*		*	*	*			*				C	Eastern Temperate Transitional
Hemachatus haemachatus	/	*		/	*	*	*		*	*	*		E	Cape Temperate
Aspidelaps l. lubricus		*		*	*				*	*			SE	Cape Temperate
Naja nivea	*	*	*	*	*	*			*	*	*		W	Cape Temperate
Causus rhombeatus	*	*		*		*	*	*	*	*	*		E	Tropcal Wide Ranging
Bitis atropos		*				*	*				*	*	D	Cape Temperate
Bitis a. arietans	*	*	*	*	*	*	*	*	*	*	*	*	T	Afrotropical
Geochelone pardalis	*	*	*	*	*			*	*				W	Tropcal Wide Ranging
Psammobates oculifer	*	*	*	*	*			*	*				W	Western Tropical Transitional
Homopus femoralis	*	*		*	*	*		*	*	*			S	Eastern Temperate Transitional
Pelomedusa s. subrufa	*	*	*	*	*	*			*	*			Non-NE	Afrotropical

5.1.5 Discussion

The numbers of amphibian and reptilian species and subspecies found in each of the three biotic zones, as well as widespread (eclectic) forms, are summarized in Table 11.

Table 11: Numbers of amphibian and reptilian taxa found in each of three biotic zones, and eclectic forms, in the Orange Free State.

Biotic zone and habitat preferences	**Total no. of taxa**	**Amphi-bians**	**Rep-tiles**	**Lizards**	**Amphis-baenians**	**Snakes**	**Chelo-nians**
Southern Savanna Grassland	**52**	**9**	**43**	**25**	**0**	**18**	**0**
a) arboreal forms	1	0	1	1	0	0	0
b) terrestrial forms	35	9	26	12		14	
c) rupicolous forms	13	0	13	11	0	2	0
d) fossorial forms	2	0	2	1	0	1	0
e) semi-aquatic forms	1	0	1	0	0	1	0
South-West Arid zone	**21**	**0**	**21**	**14**	**0**	**5**	**2**
a) arboreal forms	3	0	3	2	0	1	0
b) terrestrial forms	11	0	11	7	0	2	2
c) rupicolous forms	5	0	5	5	0	0	0
d) fossorial forms	2	0	1	0	0	2	0
Afromontane Forest	**5**	**2**	**3**	**2**	**0**	**1**	**0**
a) arboreal forms	3	0	3	2	0	1	0
b) semi-aquatic forms	2	2	0	0	0	0	0
Eclectic forms	**41**	**14**	**27**	**12**	**1**	**12**	**2**
a) terrestrial forms	31	11	20	9	0	10	1
b) rupicolous forms	2	0	2	2	0	0	0
c) fossorial forms	3	0	3	0	1	2	0
d) semi-aquatic forms	4	2	2	1	0	0	1
e) aquatic forms	1	1	0	0	0	0	0
	119	**25**	**94**	**53**	**1**	**36**	**4**

As many as 52 amphibians and reptiles (43,7%; N = 119) are restricted to the Southern Savanna Grassland, while 41 forms (34,5%) occur in both grassland and South-West Arid zones (Table 11). Only 21 forms (17,6%) are restricted to the South-West Arid zone, and five forms (4,2%) to Afromontane Forest. If the forest forms are treated as occurring within the Southern Savanna Grassland (see map in Lynch, 1985, p. 480), then a total of 57 forms (47,9%) occur only in the "grassland" zone.

The majority of the 25 amphibian forms, i.e. 14 (56,0%), occur in both biotic zones, with nine (7,6%) restricted to grassland and two (8,0%) to forest (Table 11). If the forest forms are added to the 14 recorded as occurring in grassland, then 16 forms (64,0%) are exclusive to the Southern Savanna Grassland biotic zone. Significantly, no amphibian form is restricted to the drier South-West Arid zone in the O.F.S.

Of the 94 reptiles, 43 (45,7%) are found only in the Southern Savanna Grassland. Twenty-seven taxa (28,7%) are found in both grassland and arid zones (some probably also in forest), 21 (22,3%) are restricted to the arid zone and three (3,2%) to forest (Table 11). If the three forest forms are included in the grassland zone, then 46 forms (48,9%) occur in that zone.

Of the 53 lizard taxa, 25 (47,2%) are found only in the grassland zone, 14 forms (26,4%) are restricted to the arid zone and 12 (22,6%) have eclectic distributions (Table 11). If the two forest forms are grouped with those from grassland, then 26 (49,1%) of the lizard taxa are exclusive to Southern Savanna Grassland. The only amphisbaenian found in the O.F.S., namely *Monopeltis c. capensis*, occurs in both the grassland and arid zones, but not in forest.

Eighteen (50,0%) of the 36 snake taxa are restricted to Southern Savanna Grassland, whereas 12 (33,3%) occur in both the grassland and arid zones (Table 11). Only five taxa (13,9%) are limited to the arid zone, and one (2,8%) is restricted to Afromontane Forest (Table 11). If the "forest" form *Philothamnus natalensis occidentalis* is added to the grassland group, then 19 (52,8%) snake taxa occur there.

Two (50%) of the four chelonian taxa in the O.F.S. are restricted to the South-West Arid zone, whereas two (50%) have eclectic distributions (Table 11). No tortoise or terrapin has been recorded from Afromontane Forest in the O.F.S.

Table 12 shows that the majority of amphibians (80,0%) and reptiles (60,6%) are essentially terrestrial in habits. The other four frog species (20,0%) are semi-aquatic or aquatic, while up to 21,5% of the reptiles are rupicolous. The vast majority of snakes (72,2%) are terrestrial, with 13,9% fossorial; while more than half of all lizards (52,8%) are terrestrial, although as many as 18 forms (34,6%) are rupicolous (Table 12).

Table 12: Habitat preferences of amphibians and reptiles in the Orange Free State.

Habitat	Amphibians		Reptiles		Lizards		Amphisbaenians		Snakes		Chelonians	
	no. of forms	% of total	no. of forms	% of total	no. of forms	% of total	no. of forms	% of total	no. of forms	% of total	no. of forms	% of total
Arboreal	0	0	7	7,4	5	9,6	0	0	2	5,6	0	0
Terrestrial	21	84,0	57	60,6	28	52,8	0	0	26	72,2	3	75,0
Rupicolous	0	0	20	21,5	18	34,6	0	0	2	5,6	0	0
Fossorial	0	0	7	7,5	1	1,9	1	100	5	13,9	0	0
Semi-aquatic	3	12,0	3	3,2	1	1,9	0	0	1	2,8	1	25,0
Aquatic	1	4,0	0	0	0	0	0	0	0	0	0	0
	25		94		53		1		36		4	

5.2 Herpetofauna of the Afromontane Region of the Orange Free State

The term "Afromontane" does not refer to all mountains in Africa, but to a distinct botanical region identifiable in the higher mountains and gorges of inter-tropical Africa (White, 1978), and includes forests reaching sea level in southern Africa. The distribution of the "islands" comprising the Afromontane archipelago was discussed by White (1978). Seven regional mountain systems are found in Africa (White, 1978), all within the Ethiopian biogeographical region of Pielou (1979). Two Afromontane mountain systems are found in southern Africa, namely the Chimanimani and Drakensberg systems. According to White (1978, p. 484), small patches of forest in eastern Zimbabwe, forming part of the Chimanimani system, are transitional between Afromontane and lowland forest. An example is the Chirinda forest, situated 1076-1250 m a.s.l., which is confined to doleritic soils. Although most plant species here are lowland-forest forms, Afromontane species are also present. The Drakensberg system is relatively depauperate in tree species, but has the highest percentage of local endemics, even though these represent only about a quarter of its Afromontane tree flora; however, the smaller plant flora of the Drakensberg system is more diverse than that of other systems (White, 1978, p. 508). In this system, the transition between the Afromontane Region and adjacent phytochoria is complex and it is not always clear whether a plant species is truly Afromontane or a transgressor (White, 1978, pp. 476-477). Most of the Montane Forest belt is composed of grassland, mainly *Themeda triandra*, but also *Hyparrhenia* and *Miscanthidium* - *Cymbopogon* grassland (White, 1978, p. 504). Small *Protea* trees (*P. multibracteata, P. roupelliae, P. caffra*) are found scattered in these grasslands, and could be regarded as forming a *Protea* savanna. The density of trees varies greatly and is inversely proportional to the frequency and severity of fire (White, 1978). Figure 14 in White (1978) shows a stand of *Protea roupelliae* scattered through montane *Themeda* grassland on the slopes of the Drakensberg in the Cathedral Peak area. Such situations also occur on the O.F.S./Natal border.

A great deal has been published on the flora of the Afromontane Region (White, 1978). However, apart from Van Zinderen Bakker's (1973) ecological investigations on the "ravine forests" of the eastern O.F.S., it was not until syntaxonomic and synecological studies on the moist forests (Du Preez, Bredenkamp & Venter, 1991) and drier western forests (Du Preez & Bredenkamp, 1991a) of the eastern O.F.S. were conducted that a distinct Afromontane Region in the O.F.S. was recognized. Du Preez *et al.* (1991, p. 199) treated the Afromontane Forest of the eastern O.F.S. as a distinct "vegetation class". In the O.F.S., these forests occur within a broad zone of mountainous area from Korannaberg Mountain at the western end to Harrismith in the east, bounded by longitudes 27° 00' and 29° 30' east and latitudes 28° 00' and 29° 00' south (Du Preez *et al.*, 1991). Most of the north-eastern O.F.S. can in fact be considered part of the Afromontane Region (P.J. du Preez, pers. comm.). According to the Köppen climate classification, this region experiences a mesothermic climate and receives about 550 mm or more of rain per year, mostly during summer and autumn; winters are cold and dry (Du Preez *et al.*, 1991). The warmest month has an average temperature of less than 22°C, and an average temperature of more than 10°C is maintained for at least four months of the year (Van der Wall, 1977). Annual precipitation and topographic relief decrease from east to west, whereas temperatures are higher in the western parts. Du Preez & Bredenkamp (1991b) later summarized all plant communities occurring within the Grassland biome of the southern and eastern O.F.S. and Lesotho highlands.

Although it is difficult to define the Afromontane Region in detail, and especially in terms of its fauna, eight O.F.S. amphibians and 18 reptiles (15 lizards, three snakes) are entirely or largely confined to this area as defined by Du Preez *et al.* (1991), but including Thaba Phatshwa Mountain. The "Natal Drakensberg" could be regarded as comprising the mountains of the eastern O.F.S., eastern Lesotho highlands, Natal Drakensberg proper and Drakensberg in the north-eastern Cape Province (= Southern Drakensberg). Twenty-six taxa are largely or entirely restricted (= "endemic", to Natal Drakensberg) to this region in the O.F.S., namely:

Heleophryne natalensis
Breviceps adspersus pentheri (Natal Drakensberg and Amatola mountains)
Breviceps maculatus (endemic)
Cacosternum nanum
Strongylopus hymenopus (endemic)
Strongylopus grayii grayii
Strongylopus faciatus fasciatus
Arthroleptella hewitti

Pachydactylus vansoni
Afroedura nivaria (endemic)
Afroedura karroica halli (Spitzkop and Thaba Phatshwa mountains)

Hemidactylus mabouia (Thaba Phatshwa Mountain)
Tetradactylus breyeri
Tetradactylus africanus africanus
Chamaesaura aenea
Cordylus vittifer vittifer var. B
Cordylus sp. ("Waterfall") (endemic)
Pseudocordylus melanotus subviridis
Pseudocordylus spinosus (endemic)
Bradypodion dracomontanum (endemic)
Bradypodion sp. nov. ("Ngotswane Gorge") (endemic)
Bradypodion sp. nov. ("Zastron") (endemic - Southern Drakensberg)
Tropidosaura essexi (endemic)

Lamprophis inornatus
Philothamnus natalensis occidentalis
Bitis atropos (isolated population in Natal Drakensberg)

Several widespread or easterly distributed amphibian and reptile species in the O.F.S. include parts of the Drakensberg and other parts of the Afromontane Region in their ranges, e.g. *Mabuya striata punctatissima,* which is common in most rocky habitats in the O.F.S. and has been discovered on the slopes of Ngotswane Gorge. Several species are limited to the eastern O.F.S., and may in fact be closely associated with the Afromontane Region. However, as it is difficult to define the region, it is often difficult to decide to what extent a taxon's affinity with it implies that it is, or is not, an Afromontane form.

As noted by Poynton (1964), forests are generally depauperate areas for amphibians. Some species occur up to, but not within, forests or gorges. For example, *Rana angolensis* was collected near a waterfall on the very edge of Ngotswane Gorge, but despite much searching, was not found within the gorge. In fact, after several hours of walking along the stream at Ngotswane Gorge, the only amphibian observed was a *Xenopus l. laevis.* However, it seems likely that at least two frog species do occur at Ngotswane Gorge, namely *Heleophryne natalensis* and *Arthroleptella hewitti*. The latter is bound to forest streams for breeding, although adults have been found away from forest, whereas *H. natalensis* has been collected at three typical Afromontane sites in the north-eastern O.F.S., namely Mount Pierre at GGHNP, Witzieshoek Mountain Resort and at a stream in riverine bush in mountainous terrain near Metsimatsho Dam. At Mount Pierre, adult *H. natalensis* were collected beside a waterfall in *Scolopia mundii* forest (*vide* Du Preez & Bredenkamp, 1991b). Another spectacular gorge is found on the farm Pinekloof in the Ladybrand district, and probably also provides suitable habitat for Afromontane forms.

Among the lizards, the flat geckos of the genus *Afroedura* are restricted to high-elevation sandstone mountains. *Afroedura nivaria* and *A. karroica halli* are both found mainly in crevices formed by flaking and exfoliating sandstone at elevations of about 1700 m a.s.l. and higher. They usually occupy the eastern or north-eastern (Thaba Phatshwa Mountain) aspect of the mountain. *A. nivaria* has been collected at the base of a sandstone cliff surrounded by typical *Scolopia mundii* forest (R.M. Douglas, pers. comm.). *A. k. halli* has been collected only on the upper reaches of Thaba Phatshwa Mountain and at Spitzkop Mountain. It has not been collected at Thaba 'Nchu Mountain, despite this mountain's overall similarity to Thaba Phatshwa. It is probable that, following past topographic changes, populations of *Afroedura* were split up. The taxonomic affinity of *A. nivaria, A. karroica, A. tembulica* and *A. amatolica* suggest that they are from the same founder stock, populations occurring which later separated into mountain islands with little accompanying morphological changes.

The dwarf chameleon *Bradypodion dracomontanum* is restricted to the forested gorges of the Natal Drakensberg. O.F.S. specimens have been collected at Sterkfontein Dam Nature Reserve, near Metsimatsho Dam and at Golden Gate Highlands National Park. One adult and eight neonate *Bradypodion dracomontanum* specimens were found on grass stalks near a gorge at Mount Pierre. Another dwarf chameleon, *Bradypodion* sp. nov. ("Ngotswane Gorge"), was discovered in Ngotswane Gorge. Three specimens were found in small cavities on a vertical, south-facing sandstone rock face which had some moss and fern plants growing on it; cavities were about 4 cm deep and situated 2 m above ground level (Douglas, 1992b). During a visit to Ngotswane Gorge, similar situations were observed. Although they seemed inaccessible to the chameleons, the possibility exists that they either climbed up the rock face or got there when the branch they were on was blown against the cliff face by wind. Being arboreal, dwarf chameleons are largely bound to the tree habitat of Afromontane Forest, although they also occur in the *Protea* savanna. The slow movement of these animals makes them interesting evolutionary subjects, but their taxonomy is currently very confused.

Among the snakes, only two O.F.S. forms could be considered "Afromontane", namely *Philothamnus natalensis occidentalis* (arboreal) and *Bitis atropos* (rupicolous). One O.F.S. *P. n. occidentalis* specimen, collected at Metz, was found in a *Protea* tree on the eastern slope of a mountain. *B. atropos* occurs in four disjunct Afromontane populations in southern Africa, the Natal Drakensberg representing one such population.

Centres of endemicity occur within the Afromontane Region in southern Africa. In the Chimanimani mountain system of the eastern Zimbabwean highlands, at least six amphibian forms appear to be endemic, namely *Rana johnstoni inyangae, Strongylopus grayii rhodesianus, Hyperolius s. swynnertoni, Bufo gariepensis inyangae, Bufo fenoulheti grindleyi* and *Probreviceps rhodesianus* (Poynton & Broadley, 1991). It is noteworthy than five of the above six amphibians are subspecies of more widespread forms.

Bufo amatolica and *Anhydrophryne rattrayi* (confined to forest) are endemic to the Amatola mountain range (Poynton, 1964; Branch, 1990). In the Natal Drakensberg, *Bufo gariepensis nubicolus, Breviceps maculatus, Rana vertebralis* (aquatic), *R. dracomontana, Strongylopus hymenopus, Cacosternum nanum parvum* and Lambiris' (1989a) *Strongylopus* sp. A all appear to be endemic forms. *Leptopelis xenodactylus* is restricted to the Southern Drakensberg (Poynton, 1964).

There are also reptile species endemic to the Afromontane Region in southern Africa. At least eight lizard taxa are endemic to the Natal Drakensberg, namely *Afroedura nivaria, Bradypodion dracomontanum, Bradypodion* sp. nov. ("Ngotswane Gorge"), *Pseudocordylus melanotus subviridis* (also widespread in Lesotho), *P. langi, P. spinosus, Tropidosaura essexi* and *T. cottrelli.* The newly-described snake, *Montaspis gilvomaculata* Bourquin is also restricted to the Natal Drakensberg (Bourquin, 1991). Other Afromontane reptiles include *Afroedura amatolica* (Amatola Mountains), the widespread but rarely encountered snake *Amplorhinus multimaculatus* (including an isolated population on Zimbabwean Highlands), various *Cordylus* species and subspecies in the south-western Cape Province (see Branch, 1988a) and numerous *Afroedura* and *Platysaurus* taxa in the Transvaal Drakensberg system (Jacobsen, 1989). Most Afromontane taxa are either rupicolous or arboreal, as might be expected of forms specialized for life in mountainous or forest habitats.

5.3 Termitaria as microhabitat for amphibians and reptiles

The occurrence of reptiles in disused or inactive termite mounds is of great significance, not only in the O.F.S., but also in other parts of the subcontinent, especially in open grassland areas (see also Jacobsen, 1989). Six O.F.S. amphibian and 27 reptile species and subspecies have been recorded from inactive termitaria. This includes *Homopus femoralis*, of which a few specimens were found in "caved-out" mounds (Table 13). Table 14 summarizes the number of representatives of each amphibian and reptilian family recorded from termitaria in the O.F.S. The snake family Colubridae is particularly well represented, with 19 forms, i.e. 57,6% of all amphibian and reptilian taxa known to utilize termitaria. Their lack of limbs allows easy passage to small snakes. As many as 61,1% (N = 36) of all snake species and subspecies recorded from the O.F.S. are known to inhabit termite mounds, at least while subadults, whereas six amphibians (24,0%; N = 25), one chelonian (25,0%; N = 4; only caved-out mounds) and only four lizards (7,5%; N = 53) are known to utilize termitaria (Tables 13 & 14).

The mounds of *Trinervitermes* termites occur virtually throughout the O.F.S., as attested by the widespread occurrence of the egg-eating snake *Dasypeltis scabra*, which according to De Waal (1978, p. 99) was collected mostly from these mounds and has a virtual blanket distribution in the O.F.S. (Bates, 1992, p. 42). These mounds are found in all five vegetation units and in virtually all of the 17 Veld Types (Acocks, 1988) occurring in the O.F.S. These mounds are conspicuous features of the O.F.S. and Transvaal Highveld landscape. They are certainly not restricted to Highveld Grassland, or only the three grassveld vegetation units in the O.F.S. (Acocks, 1988), although possibly most common in these

areas, but are also present in the Karoo and in grassland patches in Bushveld (pers. obs.). The mounds are constructed in both Southern Savanna Grassland and South-West Arid biotic zones, but are less common in the montane grassland of the Afromontane Region of the O.F.S., and are absent in forests.

Table 13: List of amphibians and reptiles recorded from inactive termitaria in the Orange Free State.

AMPHIBIA	
Anura	**Serpentes**
Bufonidae	**Typhlopidae**
Bufo gariepensis gariepensis	*Typhlops lalandei*
Bufo vertebralis	
Bufo rangeri	**Leptotyphlopidae**
	Leptotyphlops scutifrons scutifrons
Ranidae	
Tomopterna cryptotis	**Colubridae**
Cacosternum boettgeri	*Lamprophis fuscus*
	Lamprophis aurora
	Lamprophis fuliginosus
Hyperoliidae	*Lycophidion capense capense*
Kassina senegalensis	*Prosymna sundevallii sundevallii*
	Duberria lutrix lutrix
	Dasypeltis scabra
	Telescopus beetzii
REPTILIA	*Crotaphopeltis hotamboeia*
Squamata	*Psammophylax r. rhombeatus*
Sauria	*Psammophylax tritaeniatus*
Gekkonidae	*Psammophis notostictus*
Pachydactylus capensis capensis	*Psammophis leightoni trinasalis*
	Psammophis crucifer
	Xenocalamus bicolor bicolor
	Aparallactus capensis
	Homoroselaps lacteus
	Homoroselaps dorsalis
Scincidae	*Atractaspis bibronii*
Mabuya capensis	
Panaspis wahlbergii	**Elapidae**
Acontias gracilicauda gracilicauda	*Elapsoidea sundevallii media*
	Chelonia
	Cryptodira
	Testudinidae
	Homopus femoralis (caved-out mounds only)

Table 14: Summary of numbers of amphibian and reptilian taxa recorded from inactive termitaria in the Orange Free State.

Taxon	Number of forms recorded from termite mounds
AMPHIBIA	**6**
Anura	**6**
Family: **Bufonidae**	3
Family: **Ranidae**	2
Family: **Hyperoliidae**	1
REPTILIA	**27**
Squamata	**26**
Sauria	**4**
Family: **Gekkonidae**	1
Family: **Scincidae**	3
Serpentes	**22**
Family: **Typhlopidae**	1
Family: **Leptotyphlopidae**	1
Family: **Colubridae**	19
Family: **Elapidae**	1
CHELONIA	**1**
Cryptodira	**1**
Family: **Testudinidae**	1
	33

Many open grassland areas are largely devoid of trees, but rock piles and scattered rocks provide cover for reptiles and amphibians. In areas where rocks are absent or widely scattered, inactive or moribund termitaria provide an important source of refuge. These mounds provide a microhabitat with a stable microclimate, i.e. constant temperature and humidity (Lynch, 1988, p. 43), and provide egg-laying sites for some reptile species (e.g. *Pachydactylus c. capensis*; pers. obs.). They also afford protection during surface fires in grassland areas where such fires are often a natural phenomenon, especially on the Highveld (Lynch, 1988, p. 43; Jacobsen, 1989, p. 1510). There is also the likelihood that occupancy of termite mounds reduces predation pressure, although predation by snakes and even invertebrates may occur within the mound itself.

Once the termites have vacated their mounds (often after being attacked by black ants), the natural process of weathering by rain and attrition results in the internal passages of the mounds being exposed, providing access to both invertebrates and small vertebrates (Jacobsen, 1989, p. 1510). The "dead" mounds are characterized by holes in the normally hard, closed crust, and cracks occur at the base of the mound; after additional weathering, a "maze of cells and connecting passages" is evident over the entire outer surface of the mound (Lynch, 1986, p. 281).

Reptiles inhabiting termitaria are either small species or subadults of larger species, as the tunnels within the mounds, as well as the outer access holes of the mound, are restrictive. Lynch (1986, p. 281) noted that the tunnels in a mound vary greatly in size and shape, from round (10 mm diameter) to oblong passages, e.g. 7 x 20 mm. Some are smaller, but passages of 30 x 20 mm were also found, and the nests of the obligate termitarium-dwelling shrew *Suncus varilla* measure about 70-100 mm in diameter (Lynch, 1986, p. 282).

According to Van Wyk (1988, p. 459), 64% of 94 *Psammophylax r. rhombeatus* from the O.F.S. were collected from inactive termitaria, and these specimens were usually smaller than 440 mm SVL. Larger specimens would have a girth too excessive to allow passage through the labyrinth of tunnels within the mound. As lizards and snakes may occur in the same mound, is seems likely that the snake occupants might at times feed on such lizards while in the mound. This would need to be without the benefit of constriction (e.g. *Lamprophis fuliginosus*), as the tunnels and space in the mound would restrict this practice. Lizards like *Pachydactylus c. capensis* (a nocturnal species) may feed within the mound, although most feeding probably takes place outside and around the mound, as these mounds do not usually contain large invertebrate populations, even though several invertebrate taxa occur within them (Lynch, 1986, App. 1). Lynch (1988, p. 42) suggested that the high incidence of *Aparallactus capensis* in termite mounds was related to these mounds providing suitable habitat for centipedes (Chilopoda: Scolopendridae), the main prey of these snakes. Lizards and frogs found in termite mounds are usually of small species (e.g. *Pachydactylus c. capensis, Cacosternum boettgeri*), or subadults.

During an ecological study on the wholly termitarium-dwelling Lesser Dwarf Shrew *Suncus varilla* in the central O.F.S., Lynch (1986a) excavated hundreds of inactive *Trinervitermes* termite mounds and reported on the occurrence of reptiles in these mounds. Data from that study (Lynch, 1986a) and the results of additional field work (Lynch, 1988) provided quantitative data on reptilian utilization of these mounds. On the farm Cecilia, reptiles occurred in 19,5% of excavated inactive termitaria (N = 426; all disused mounds on this farm were excavated), in 36,8% (N = 19) on the farm Bultfontein and in 53,0% (N = 32) at Krugersdrift Dam (Lynch, 1988). When present, reptiles were usually represented by only one specimen per mound, although 23% of mounds contained more than one specimen. For example, *Dasypeltis scabra* and *Xenocalamus b. bicolor* were found together, as were *D. scabra, Aparallactus capensis* and *Elapsoidea sundevallii media*; three *D. scabra*, and nine *A. capensis*, were found in the same mounds. The most frequently collected reptile on the farm Cecilia was *D. scabra* (in 9,1% of mounds), at Bultfontein *Pachydactylus c. capensis* predominated (31,6%), while at Krugersdrift Dam *A. capensis* was most common and occurred in 15,6% of mounds (Lynch, 1988, p. 42). Lynch (1988) suggested that the specific habitat influenced which species were most common.

The frequency of disused termite mounds on the farm Cecilia was 6,7% out of a total of 2787 mounds (Lynch, 1986, p. 282). Nel & Malan (1974) in Lynch (1986) found that "dead" mounds at one site near Cecilia varied annually over four years from 6-24% (mean = 11,3%), and Coaton (1948) in Lynch (1986) noted that in heavily infested areas in the south-western O.F.S. the frequency of "dead" mounds was as high as 35% (N = 764) and 48% (N = 264).

Jacobsen (1989, p. 1511) commented on the habit of many farmers of destroying whole fields of termitaria, erroneously thinking that *Trinervitermes* termites have as devastating a negative effect on grass biomass as do *Hodotermes mossambicus*, and highlighted the destructive practice of "amateur herpetologists" who sometimes destroy numerous mounds (and viable microhabitats) in their search for "pet" snakes.

5.4 General features of the ecology of the herpetofauna of the Orange Free State

In order to provide a background for a biogeographical treatment of the amphibians and reptiles, some general features of the ecology of these animals will be discussed.

5.4.1 Amphibia

a) Habitat

Only one amphibian species in the O.F.S. can be regarded as fully aquatic (*Xenopus l. laevis*), four species are semi-aquatic, being found in water or on the damp banks of water bodies (*Heleophryne natalensis, Rana fuscigula, R. angolensis* and *Arthroleptella hewitti*) and the rest are basically terrestrial, returning to water only to breed (Table 12). Five forms are particulary well adapted to burrowing and may spend several months of the year underground, *viz. Breviceps a. adspersus, B. a. pentheri, Pyxicephalus a. adspersus, Tomopterna cryptotis* and *T. natalensis*. Two species move by "crawling" or "running" (*Kassina senegalensis, K. wealii*) and three are particularly well adapted to swimming in that they possess extensive webbing on the feet (*Xenopus l. laevis, Rana fuscigula* and *R. angolensis*).

Amphibians show a wide ecological tolerance, both in water and on land (Poynton, 1964, p. 207), and many species can even live and breed in water containing high salt concentrations (e.g. *Xenopus l. laevis*). According to Poynton (1964, p. 207), the most clear-cut difference in habitat choice is that of forest or non-forest, but the mere presence of tree cover or even dense grass tussocks may be enough for "forest" species to occur there; the botanical composition of the vegetation is of no apparent significance. Many frog species have "blanket" or almost blanket distributions, including several O.F.S. forms, and this is a reflection of the wide ecological tolerance of these animals. Many savanna and non-forest species can survive even in cultivated or urban areas, and the drainage of streams and marshes is often compensated for by the establishment of numerous man-made water bodies (e.g. dams) which are often used by amphibians as breeding sites (Poynton, 1964, p. 208). According to Poynton (1964), unlike predatory birds, mammals and many snake species, the "overall and profound ecological

upheaval that has followed European settlement" has not adversely affected the amphibian fauna. While this is probably true in many cases, recent evidence points to the fact that drainage of wetlands, especially in ecologically sensitive areas, has become a major problem, especially to more sensitive species, and amphibian populations are being adversely affected.

Forests are typically depauperate areas for amphibians (only 23 forms) in southern Africa (Poynton & Broadley, 1978, p. 938) and common or widespread species usually occur only as rarities within them (Poynton, 1964, p. 207). When discussing forest forms in the O.F.S., however, it should be noted that the Afromontane Forest in the east of the province represents only a small percentage of the total area. Two O.F.S. forms can be regarded as forest-dwelling, namely *Heleophryne natalensis* and *Arthroleptella hewitti*. However, as noted by Poynton (1964), the various forms of *Heleophryne* may be only incidentally sylvicolous, as their main habitat requirement is swiftly-flowing streams, for which their huge sucker-mouthed larvae are adapted. Such streams are, however, generally found in mountainous situations often associated with Afromontane Forest. Some "sylvicolous" forms are also sometimes found away from actual forest. For example, the four *Arthroleptella hewitti* specimens collected on Sentinel Mountain, north-eastern O.F.S., were collected on a grassy mountain slope at 2439 m a.s.l. (De Waal, 1980a, p. 112). However, the breeding habitat of both *A. hewitti* and *H. natalensis* is usually restricted to "wet mossy areas on the banks of fast-flowing streams or below waterfalls" (Lambiris, 1989a, p. 115) which are usually associated with forest, especially at lower altitudes.

b) Diet

Most anurans feed on whatever invertebrates of suitable size they may come into contact with (see Poynton, 1964). The only O.F.S. frog for which dietary information is available is *Cacosternum boettgeri* (Douglas, 1990a). The available data do indeed indicate euryphagy in this species. Some frogs are known to prey on small vertebrates (e.g. *Pyxicephalus a. adspersus*), including other frogs (Poynton & Broadley, 1978, p. 944). *Xenopus* spp. are known to take tadpoles, small fish and carrion (Poynton & Broadley, 1978).

c) Reproduction

All O.F.S. forms are oviparous, the eggs being laid in water or on damp surfaces; the number of eggs laid varies greatly (see species accounts).

5.4.2 Reptilia

a) Habitat

Reptiles in the O.F.S. are either arboreal (*Dispholidus t. typus, Lygodactylus c. capensis, Chamaeleo d. dilepis, Bradypodion dracomontanum, Bradypodion* sp. nov. ["Ngotswane Gorge"] and *Bradypodion* sp. nov. ["Zastron"]), terrestrial (under rocks or in inactive termitaria when not abroad), rupicolous, fossorial (in soil, under rocks or in termitaria) or semi-aquatic (*Lycodonomorphus rufulus, Varanus n.*

niloticus and *Pelomedusa s. subrufa*) (Table 12). It is notable that the arboreal forms listed above occur only in the Bushveld (Kalahari Thornveld) of the north-western O.F.S. or the Afromontane Region of the north-eastern O.F.S., as most of the province is essentially open grassland or Karoo, with few trees of suitable size. The semi-aquatic water snake *Lycodonomorphus rufulus* does not occur in the much drier South-West Arid region of the western O.F.S., which supports far less streams and drainage systems, and experiences lower rainfall than the Southern Savanna Grassland in the eastern half of the province. This may be related to the drier nature of the western O.F.S. and a possible shortage of readily available frog prey during at least the very dry months of the year.

Only seven (7,4%) of the 94 reptiles occurring in the O.F.S. are primarily arboreal (Table 12). These are restricted in range to three relatively small areas in the O.F.S., namely the Kalahari Thornveld of the north-west (*Dispholidus t. typus, Lygodactylus c. capensis, Chamaeleo d. dilepis*), the Afromontane Forest of the north-east (*Philothamnus natalensis occidentalis, Bradypodion dracomontanum, Bradypodion* sp. nov. ["Ngotswane Gorge"]) and Zastron, probably including Aasvoëlberg mountain, in the south-east (*Bradypodion* sp. nov. ["Zastron"]).

Fifty-seven reptile taxa (60,6%) are primarily terrestrial (Table 12). These include 28 (52,8%) of the 53 lizard taxa, 26 (72,2%) of the 36 snake taxa and three of the four chelonians. The most typical microhabitats from which "terrestrial" reptiles have been collected in the O.F.S. are under rocks and in inactive termitaria (De Waal, 1978). A total of 27 reptilian taxa (28,7% of all taxa recorded from the O.F.S.) have been recorded from termitaria, comprising 22 snake, four lizard and one chelonian species. The chelonian refers to a few *Homopus femoralis* specimens collected from caved-out termitaria (De Waal, 1980b, p. 88).

b) Diet

Lizards

The majority of southern African lizard species are primarily insectivorous (FitzSimons, 1943; Pianka & Huey, 1976; De Waal, 1978; Poynton & Broadley, 1978, p. 944; Jacobsen, 1982). Other small invertebrates are also eaten by most species (see De Waal, 1978), for example, millipedes and centipedes are eaten by the larger species of *Gerrhosaurus, Cordylus, Pseudocordylus* and *Varanus* (Poynton & Broadley, 1978, p. 944). *Varanus n. niloticus* includes molluscs, crabs and small vertebrates in its diet, whereas *V. a. albigularis* prefers achatinid snails and carrion, but also takes small vertebrates (Poynton & Broadley, 1978). According to these authors, *Cordylus giganteus* (although well known to be basically insectivorous) is partially vegetarian. Species of *Mabuya* and *Gerrhosaurus* are known occasionally to prey on small lizards (Poynton & Broadley, 1978), and De Waal (1978, p. 36) noted that the stomach of an O.F.S. *Mabuya capensis* contained the tail of another skink.

Although the assumption is often make that lizards are opportunistic feeders, Jacobsen (1982) showed that "a considerable degree of specialization is evident" after studying the ecology of the herpetofauna of Nylsvley Nature Reserve in the Transvaal. However, Pianka & Huey's (1976) study on the gekkonids of the southern Kalahari indicates that several gekkonid species, at least, feed on a variety of prey types.

Amphisbaenians

The only amphisbaenid found in the O.F.S., namely *Monopeltis c. capensis,* is insectivorous (De Waal, 1978).

Snakes

Pienaar *et al.* (1983) reported that the abundance and distribution of snakes in the Kruger National Park is dependent on the presence of specific prey species. Snakes, as a whole, tend to be more specialized in their feeding habits than frogs or lizards, and O.F.S. forms can be classified according to their major prey items as follows (note that these groupings should not be regarded as rigid):

Termites: *Typhlops bibronii, T. lalandei, Leptotyphlops s. scutifrons.*

Invertebrates: *Homoroselaps dorsalis.*

Centipedes: *Aparallactus capensis.*

Snails and slugs: *Duberria lutrix lutrix.*

Birds' eggs: *Dasypeltis scabra.*

Reptile eggs: *Prosymna sundevallii sundevallii* (also small lizards and invertebrates), *P. bivittata* (also invertebrates).

Amphibians: *Lycodonomorphus rufulus* (also fish), *Philothamnus natalensis occidentalis, Crotaphopeltis hotamboeia, Causus rhombeatus.*

Lizards: *Lycophidion capense capense, Lamprophis fuscus, L. guttatus, Telescopus beetzii, Psammophis crucifer* (also frogs).

Amphisbaenians: *Xenocalamus bicolor bicolor* (only *Monopeltis capensis capensis* occurs in the O.F.S.).

Snakes and Lizards: *Homoroselaps lacteus, Elapsoidea sundevallii media* (only snakes recorded, but probably also lizards and their eggs, frogs and small mammals).

Mammals and Lizards: *Lamprophis aurora, L. inornatus, L. fuliginosus, Pseudaspis cana, Psammophis notostictus, P. l. trinasalis, Aspidelaps lubricus lubricus* (also snakes), *Atractaspis bibronii.*

Vertebrates in general: *Dispholidus typus typus* (mainly lizards and birds), *Psammophylax rhombeatus rhombeatus* (mainly insectivores and rodents), *P. tritaeniatus* (largely lizards), *Hemachatus haemachatus* (largely toads), *Naja nivea, Bitis arietans arietans, B. atropos.*

c) Reproduction

Of the 95 reptile taxa recorded from the O.F.S., 26 (27,4%) are viviparous (or ovoviviparous), the rest being oviparous. Ovoviviparous forms include 20 lizards (37,7%; N = 53), the only O.F.S. amphisbaenid and five snake taxa (13,9%; N = 36). The following reptilian taxa are ovoviviparous:

Bradypodion dracomontanum
Bradypodion sp. nov. ("Ngotswane Gorge")
Bradypodion sp. nov. ("Zastron")
Bradypodion ventrale cf. *karroicum* (translocated)
Mabuya capensis
Mabuya occidentalis
Mabuya varia
Mabuya variegata variegata
Mabuya variegata punctulata
Mabuya sulcata sulcata
Mabuya striata punctatissima
Acontias gracilicauda gracilicauda
Cordylus giganteus
Cordylus polyzonus polyzonus
Cordylus cordylus
Cordylus vittifer vittifer
Cordylus sp. ("Waterfall")
Pseudocordylus melanotus melanotus
Pseudocordylus melanotus subviridis
Pseudocordylus spinosus

Monopeltis capensis capensis

Pseudaspis cana
Duberria lutrix lutrix
Hemachatus haemachatus
Bitis arietans arietans
Bitis atropos

Poynton & Broadley (1978, p. 943) noted that the two reptile species ranging furthest north in the Palaearctic Region are both ovoviviparous, which is an adaptation allowing the female to utilize all available solar radiation for the incubation of eggs. Several south-temperate species are also ovoviviparous, however, and an interesting example is that of *Psammophylax variabilis*, a montane

species which is ovoviviparous, but has a closely related congeneric species, *P. tritaeniatus*, which is oviparous (Poynton & Broadley, 1978). Only three ovoviviparous African snake genera exhibit essentially non-temperate distribution patterns, namely the adder genus *Bitis* (Poynton & Broadley, 1978), the mostly arboreal tropical viperids *Atheris* (Broadley, 1990, pp. 330-332) and the tropical and aquatic *Grayia* (W.R. Branch, pers. comm.).The lizard family Gekkonidae is the only group of oviparous reptiles common at high altitudes (Poynton & Broadley, 1978). With reference to gekkonids, the flat gecko *Afroedura nivaria* (which occurs in the eastern O.F.S.) has been recorded from above the snow line, i.e. 2750 m a.s.l. (Branch, 1988a, p. 191).

Members of the family Gekkonidae in the O.F.S. lay one to two (usually two) hard-shelled, oval-shaped eggs per clutch, with two or three clutches a year likely (Branch, 1988a, p. 199; Bates, 1991). Other lizards produce larger clutches of leathery-shelled eggs; one, possibly more clutches are laid each year. Snakes generally produce larger clutches. Breeding and egg-laying occur during spring and summer. The Spotted Skaapsteker *Psammophylax r. rhombeatus* is the only snake species occurring in the O.F.S. which is known to remain with its eggs (the female) after laying; the body temperature of the female may assist in incubation and her presence may ward off would-be egg-predators. According to Jacobsen (1989, p. 1468), most Highveld reptiles are oviparous, indicating a response to a more moderate climate.

Five southern African skinks (genus *Mabuya*) appear to exhibit reproductive bimodality. The Cape Skink *Mabuya capensis* is ovoviviparous virtually throughout southern Africa, but oviparity has been recorded at Ohrigstad and Pretoria in the Transvaal (Brown-Wessels, 1989) and at Port Elizabeth (Branch, 1988a, p. 129). No O.F.S. females, however, were oviparous (Flemming, in prep.). *M. occidentalis* in the O.F.S. (De Waal, 1978) and Namib Desert (Branch, 1988a) are ovoviviparous (seven embryos recorded), but females in the Kalahari Desert lay 5-7 eggs (Branch, 1988a). Reproductive bimodality has also been recorded for *M. varia*, which is oviparous in the bushveld and lowveld of the Transvaal (Jacobsen, 1982, 1989). An undescribed, wholly rupicolous sibling species of *M. varia* also shows similar bimodality (Jacobsen, 1989). Branch (1988a, p. 133) noted "informal reports" of *M. sulcata* females occasionally laying eggs.

CHAPTER SIX

BIOGEOGRAPHY

As an introduction to this chapter, and with reference to the relatively low amphibian and reptilian diversity in the O.F.S., Table 15 is presented to allow for a comparison with the higher-diversity "areas" of the Transvaal and Natal. Table 15a indicates that Natal has by far the richest amphibian fauna (76 forms), while the O.F.S. has by far the fewest species and subspecies, namely 25. Table 15b demonstrates that the number of lizard taxa in both the O.F.S. and Transvaal represent a similar proportion of each region's reptile fauna (56,4% vs 52,6%), as do the snakes in each region (38,3% vs 39,4% respectively). In Natal, however, lizards represent only 42,9% of all reptile taxa, while snakes comprise as much as 47,2% of all reptiles.

6.1 Biogeographical approach and method

In order to conduct a biogeographical study, accurate determination of the taxonomic status of individual animals or plants, as well as accurate plotting of locality records on maps, are prerequisites. The biogeographical analysis attempted here follows the classical, historical biogeography approach, where differences and similarities in the distribution patterns of the various taxa are looked for. The study is range-based, the recorded ranges of taxa being regarded as primary data for biogeographical classification. As noted by Poynton & Broadley (1991, p. 222), this differs from habitat-based or district-based approaches, which analyze distribution on the basis of species lists drawn up according to preconceived divisions which are often based on habitat types or a set of climatic factors. The drawbacks of habitat-based zoogeographical studies are discussed by Poynton & Broadley (1991, p. 222). In range-based studies, the quality of the data depends on the quantity of available locality records; the scarcer the records, especially at species margins, the more poorly definable will be the known species ranges (Poynton & Broadley, 1991, p. 222).

The procedure followed in identifying common distribution patterns follows that of Poynton (1964) and Poynton & Broadley (1991). Poynton (1964) attempted an agglomerative classification of the ranges of southern African amphibians by direct inspection of quarter-degree distribution maps, whereas this process was improved on by Poynton & Broadley (1991) who copied the ranges of taxa onto separate overhead transparencies to allow easier sorting and grouping. In the present study, distribution maps were spread out and species and subspecies with similar ranges grouped together. Transparencies of each taxon's range were then overlaid in order to determine the similarity in the pattern of ranges. Transparencies, made from maps, of taxa with similar ranges, were finally overlaid precisely and the "boundary" of the cluster group (combined range of all component taxa) drawn in to an accuracy of within one-eighth degree (occasionally up to about a quarter-degree when records were sparse) from the closest eighth-degree plot (Figs 114 & 115). The area within the "boundary" line was then shaded so

as to allow a visual impression of each range cluster. The shaded cluster areas are not intended to suggest a "fixed" area in which species occur, but their usage was considered an improvement on Poynton & Broadley's (1991) method of simply listing each cluster group and its component taxa without providing a clear idea as to the geographical location of each cluster area.

Table 15a: Diversity (number of species and subspecies) of amphibian fauna in the Orange Free State (this study), Transvaal (Jacobsen, 1989) and Natal (Lambiris, 1989a), expressed as a percentage of the Natal amphibian fauna.

Orange Free State	% of Natal Total	Transvaal	% of Natal Total	Natal	% of Natal Total
25	33	53	70	76	100

Table 15b: Diversity of reptilian fauna (number of species and subspecies) in the Orange Free State (this study), Transvaal (Jacobsen, 1989) and Natal (Bourquin, 1989).

	Orange Free State		Transvaal		Natal	
	No. of taxa	% of total	No. of taxa	% of total	No. of taxa	% of total
Lizards	53	56,4	112	52,6	69	42,9
Amphisbaenians	1	1,1	8	3,8	2	1,2
Snakes	36	38,3	84	39,4	76	47,2
Chelonians	4	4,3	8	3,8	13	8,1
Crocodilians	0	0	1	0,5	1	0,6
	94		213		161	

The shaded area includes within it the range of each form assigned to the particular cluster, but does not represent precisely the range of any one form assigned to that cluster. The distribution of taxa outside the O.F.S. was also taken into consideration when deciding into what cluster group any particular form most accurately belonged. This was especially necessary in the case of taxa represented by only a few records in the O.F.S., e.g. *Xenocalamus b. bicolor.*

The extent of range clusters identified (Figs 114 & 115) should not be regarded as rigid, but is considered "useful" in a discussion on range patterning. This type of classification should be regarded as an inductive generalization, as noted by Poynton & Broadley (1991, p. 224), who conducted a similar biogeographical analysis and noted that biogeographical classifications can be seen as theories or hypotheses, and the way a classification is arrived at, e.g. by direct inspection of mapped ranges, is unimportant (see Popper, 1972) as long as it is open to testing. The transect discussed further on in this chapter tests the broader classification determined by range clustering.

It should be pointed out at this stage that the concept of determining a "true" range for any form is regarded as a virtual impossibility. Despite its widespread occurrence in the O.F.S., even the frog *Cacosternum boettgeri* has not been recorded from every sampled quarter-degree unit, not to mention eighth-degree unit, in the province, nor is it certain that it does occur in literally every quarter-degree (excluding dams). When regarding *C. boettgeri* as a species with a "blanket" distribution in the O.F.S., the implication is that it has a widespread occurrence. It would also not be accurate to state with authority that a species like *Bufo vertebralis* is "definitely" absent from most of the northern half of the O.F.S., as any such statement would require an extremely intensive survey of the region. With reference to *B. vertebralis*, a recent record from Koppies Dam Nature Reserve, confirming Poynton's (1964) "Vredefort Road" record, brings into doubt what had appeared to be a strictly southerly distributed O.F.S. frog species. No faunal survey of any large region is ever likely to be "complete" or allow a statement to be made as to the "true" distribution of a taxon. Also, considering the time constraints of surveys, the discovery of species in areas far removed from other records may represent a recent range extension, considering the dynamic nature of many animal populations, and thus suggests that any attempt at "defining" the range of a species with any precision is a virtual impossibility.

Causal factors of distribution patterns were determined by relating environmental variables to the distribution of each amphibian form (Table 28), and also to each amphibian and reptilian cluster (this is based on the assumption that any one form in a cluster is prone to environmental influences determined for the cluster grouping as a whole - see Table 29).

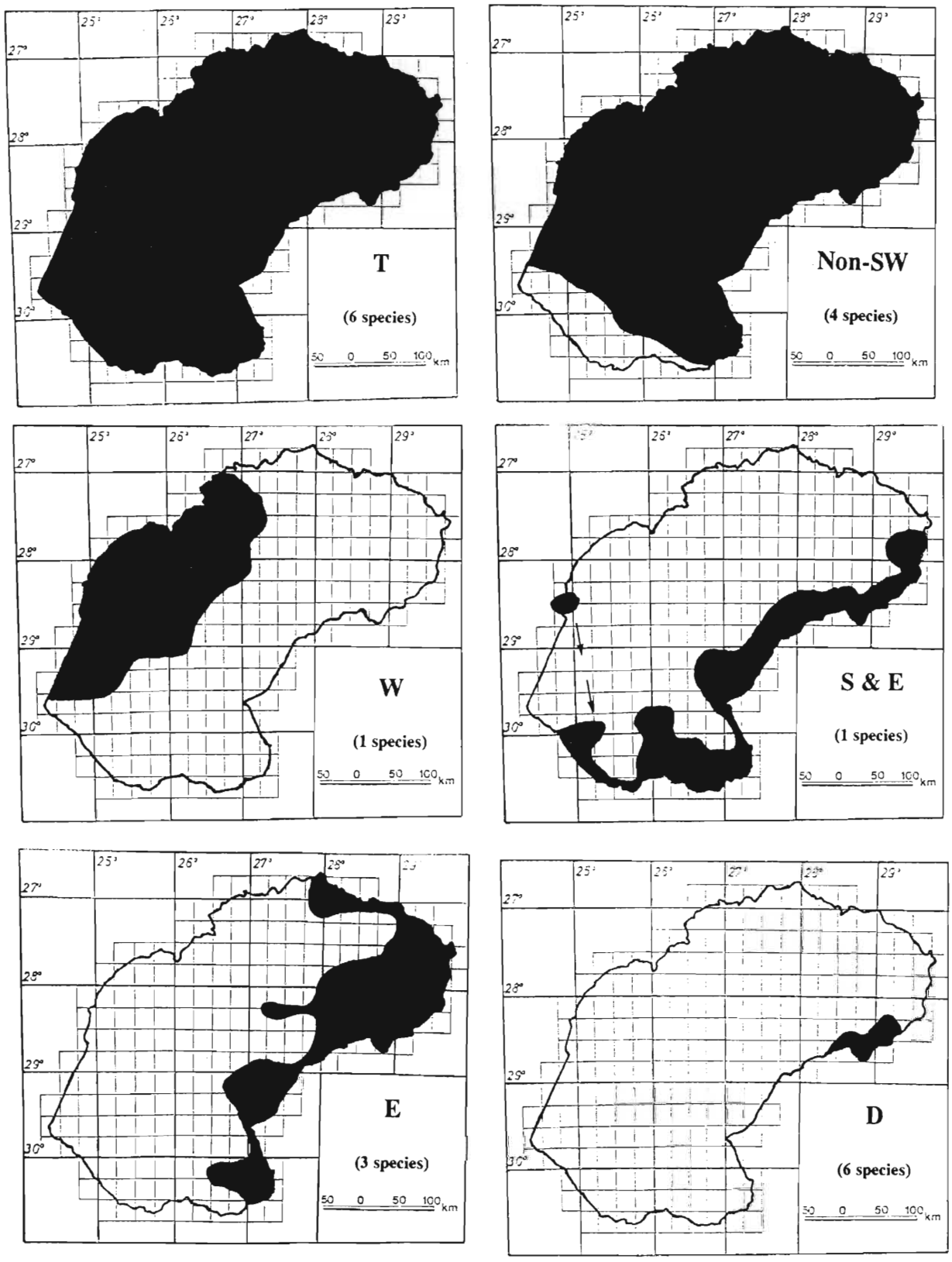


Figure 114: Range clusters for amphibians in the Orange Free State.
T = Throughout, Non-SW = Non-Southwestern, W = Western, S & E = Southern and Eastern, E = Eastern, D = Drakensberg.

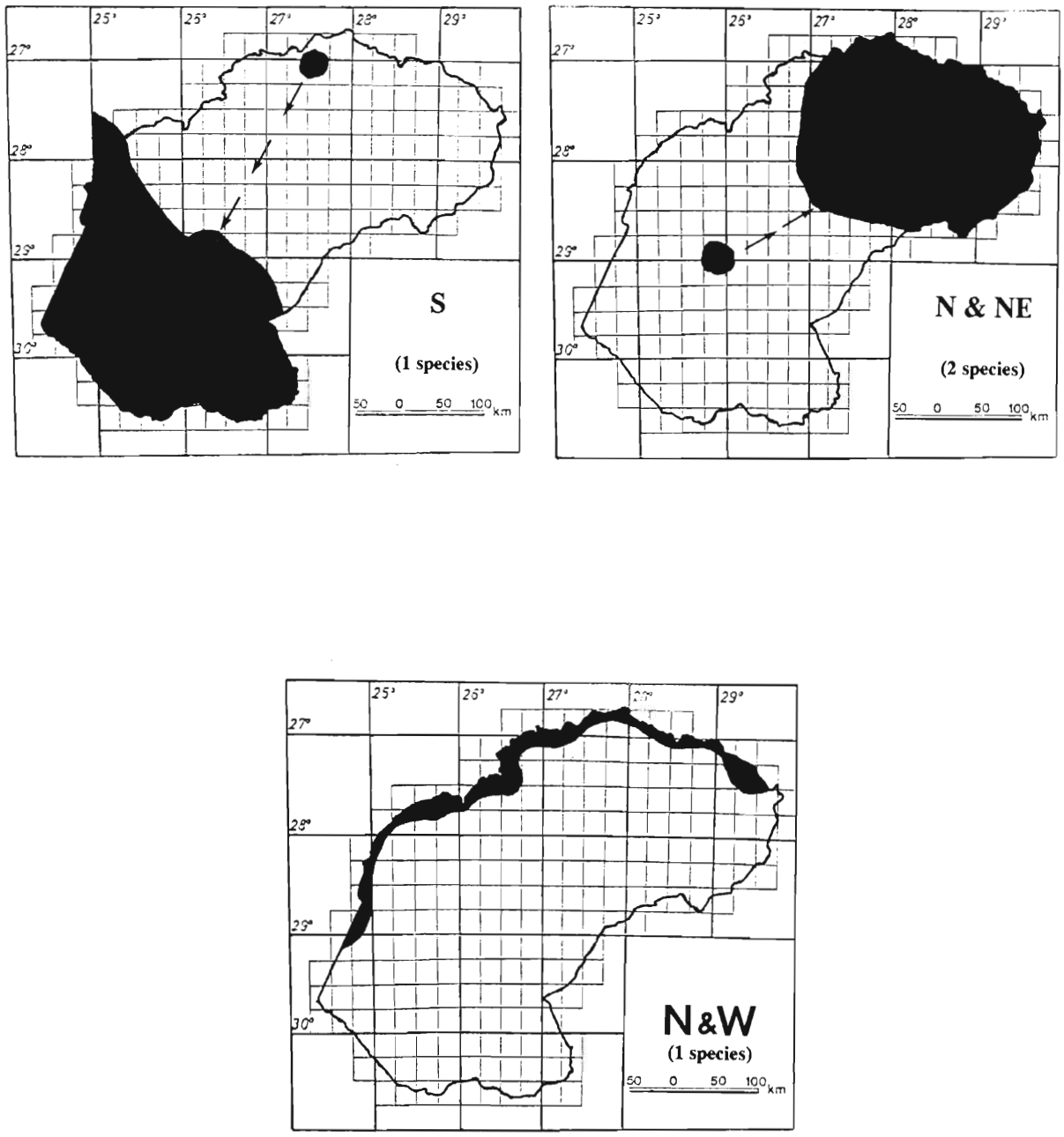


Figure 114: Range clusters for amphibians in the Orange Free State.
S = Southern, N & NE = Northern and Northeastern, N & W. = Northern and Western.

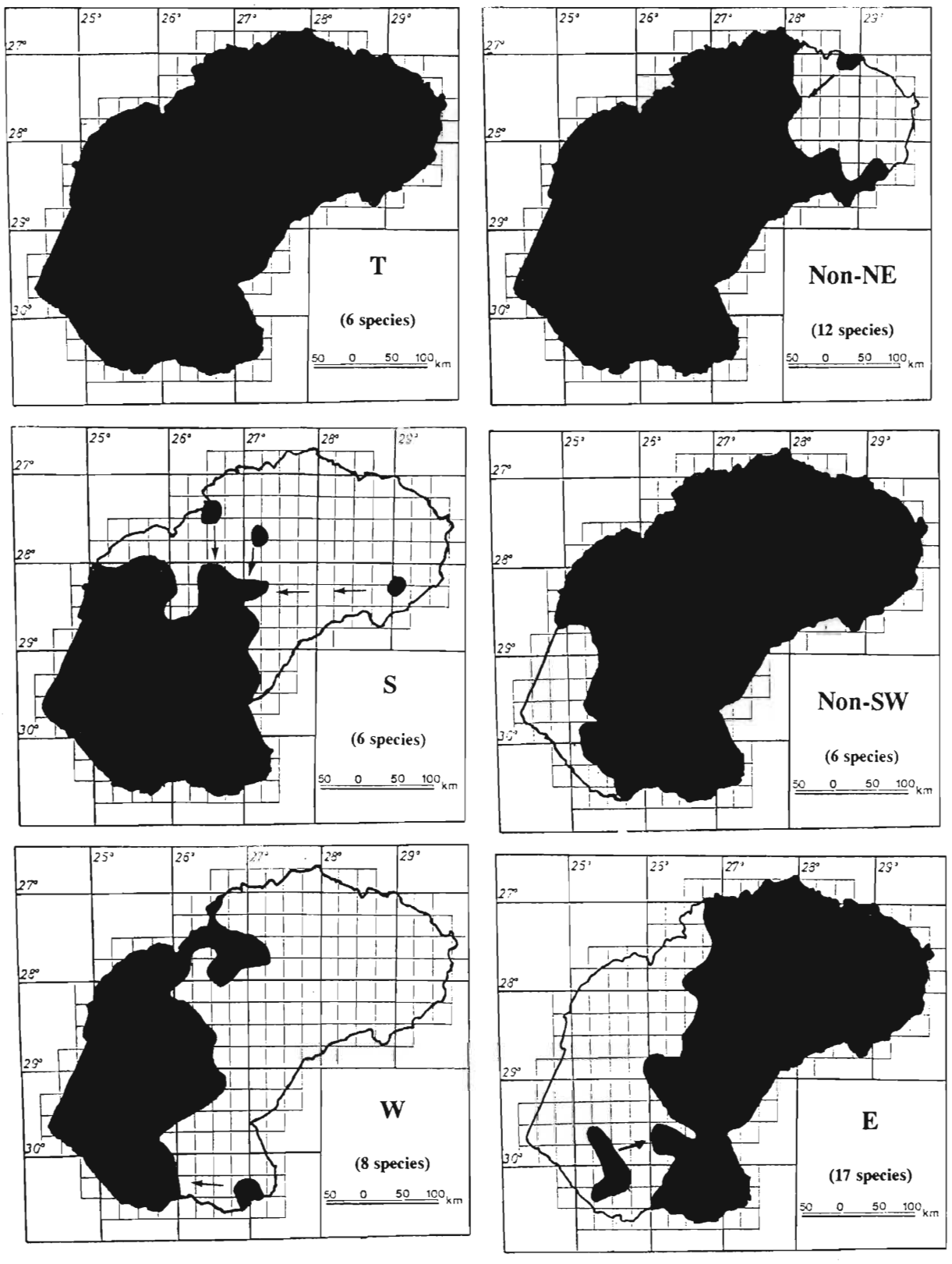


Figure 115: Range clusters for reptiles in the Orange Free State.
T = Throughout, Non-NE = Non-Northeastern, S = Southern, Non-SW = Non-Southwestern, W = Western, E = Eastern.

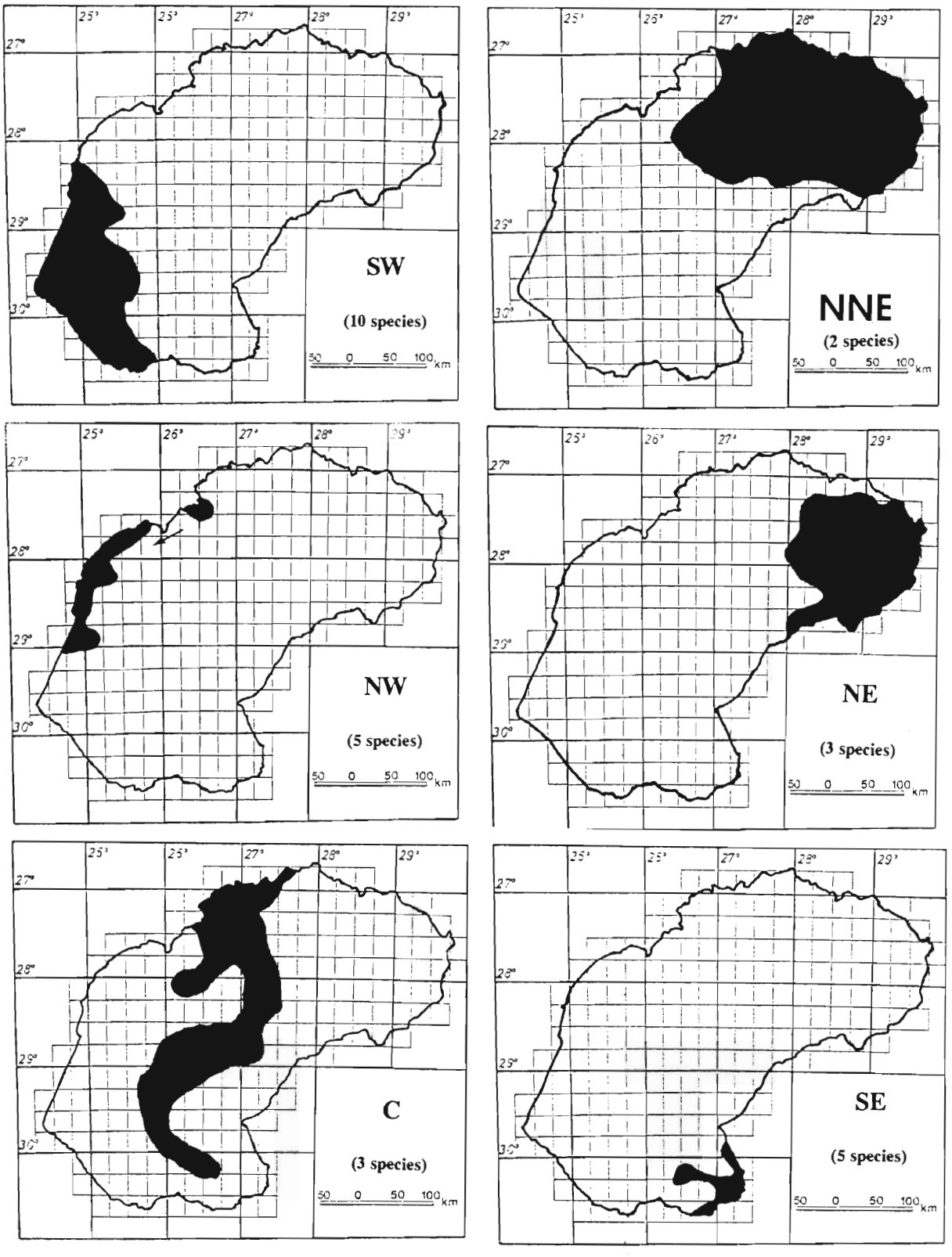


Figure 115: Range clusters for reptiles in the Orange Free State.
SW = Southwestern, N & NE = Northern and Northeastern, NW = Northwestern, NE = Northeastern, C = Central, SE = Southeastern.

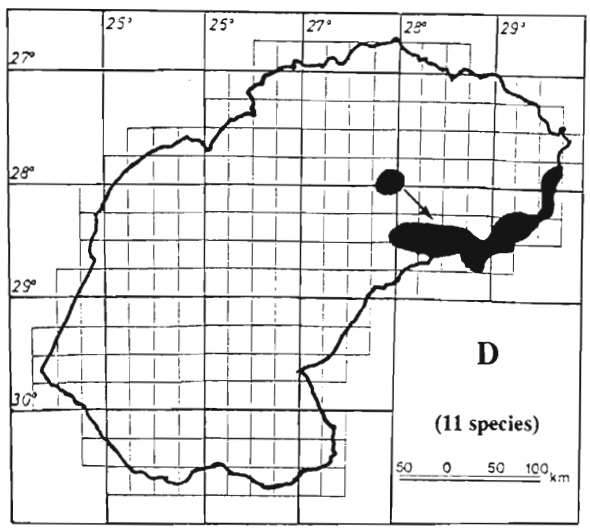


Figure 115: Range clusters for reptiles in the Orange Free State. D = Drakensberg.

6.2 **Amphibian range clustering in the Orange Free State** (Fig. 114)

According to the taxonomic analysis conducted, 25 anurans are known to occur within the borders of the Orange Free State. A record of *Pyxicephalus adspersus edulis* from Bloemfontein (Lambiris, 1991) is regarded as dubious, and this form is therefore not considered in the following analysis. Only one species is represented by two subspecies, namely *Breviceps a. adspersus* and *B. a. pentheri*. As a result of problems in the taxonomy of *Cacosternum nanum* (see species account), the three O.F.S. specimens are here referred to simply as *C. nanum*.

The ranges of all forms occurring in the O.F.S. extend beyond the borders of the province. Of the 25 forms, only *Breviceps maculatus* does not occur in the Cape Province (Poynton, 1964). With the exception of *Bufo g. gariepensis, Breviceps maculatus* and *Strongylopus hymenopus*, all O.F.S. forms occur in the Transvaal (Jacobsen, 1989), while, with the exception of *Bufo vertebralis* and *Bufo g. gariepensis*, all occur in Natal (Lambiris, 1989a). The Afromontane subspecies *Bufo gariepensis nubicolus*, however, occurs in the Drakensberg mountains of Natal, Lesotho and Transvaal.

Nine amphibian range clusters are identifiable in the O.F.S., and are named according to their common geographical area or centre (Fig. 114). Extralimital records plotted on distribution maps were also considered in the determination of range clusters. Four range clusters are represented by only one species each. Although this makes the present classification unusually fine, these clusters were considered the most realistic when considering the actual distribution of locality records. Forms with "blanket" distributions are assigned to a group "T". In all cluster groups, the relevant forms are listed in a sequence starting with the smallest and ending with the largest range in the O.F.S. Each group is given a code which allows ready assignment of a taxon to its group in the discussion that follows.

T - Occurring throughout the O.F.S. (Fig. 114 T)

Pyxicephalus a. adspersus, Xenopus l. laevis, Kassina senegalensis, Rana fuscigula, Tomopterna cryptotis, Cacosternum boettgeri.

This group includes forms with widespread occurrence in the O.F.S., even though such forms may not be represented by numerous locality records. For example, the distribution map of *P. a. adspersus* exhibits apparent "gaps" in the north-eastern and south-eastern regions of the province. It is very likely, however, that the species does occur in the Highveld Grassland of the north-east and probably also in the grassveld of the south-east. Also, outside the O.F.S., the species shows a wide distribution. The scarcity of records probably also reflects the fact that these frogs are active for only a few months each year, notably after heavy rains, and during drought periods they may remain underground for extended periods of time. The occasional "gaps" in the distribution of the ubiquitous *X. l. laevis* are generally considered here to be representative of poorly collected areas. There is the possibility that some of the forms listed in cluster group Non-SW (see below) may in fact occur throughout the O.F.S. (e.g. *Bufo rangeri*).

Non-SW - Occurring throughout the O.F.S. with the exception of the south-west (Fig. 114 Non-SW)
Phrynobatrachus natalensis, Bufo gutturalis, Rana angolensis, Bufo rangeri.

The four species listed above all reach their inland south-western limits at various distances north of, but near to (see maps), the south-western O.F.S. In the case of *B. gutturalis*, the pattern is less clear than for the other three forms, with a large "gap" in the central and southern O.F.S. The reason for this is unclear, but it should be noted that *B. vertebralis* largely replaces *B. gutturalis* in the southern O.F.S., with the exception of a single shared eighth-degree locality (3026-Ba3). *B. poweri*, to a large extent, replaces *B. rangeri* in the western O.F.S. Poynton & Broadley (1991, p. 228) noted a close similarity in the eastern edges of the ranges of *R. angolensis* and *P. natalensis* in south-eastern Africa, and the south-western edges of their ranges are also in similar locations in the O.F.S.

W - Western (Fig. 114 W)
Bufo poweri.

B. poweri is the only amphibian exhibiting a distinctly western distribution in the O.F.S. It replaces *B. g. gariepensis* in the west, with the exception of a shared record at locus 2824-Bd3. However, *B. garmani* (? *B. poweri*) has also been recorded from the southern Transvaal and north-western Natal.

S & E - Southern and Eastern (Fig. 114 S & E)
Bufo g. gariepensis.

This is the only frog species in the O.F.S. showing a distribution virtually throughout the mountainous, high-rainfall eastern region, as well as the lower, drier southern region (including Karoo). There are several Cape Province records just west of the O.F.S. border (see Poynton, 1964), some in Bushveld, and this species may also occur on the western periphery of the O.F.S. It is largely replaced on the western and northern peripheries of the O.F.S. by *Breviceps a. adspersus,* and appears to be absent from Highveld Grassland.

E - Eastern (Fig. 114 E)
Strongylopus f. fasciatus, Kassina (Semnodactylus) wealii, Strongylopus g. grayii.

The above three species, with the exception of a few isolated records for *S. g. grayii*, reach their western inland limits in the eastern O.F.S. All three species are basically restricted to the eastern half of southern Africa and the southern and south-western Cape Province. Their occurrence in the O.F.S. coincides with areas of high elevation and high rainfall. Although *K. wealii* lacks records in the south-eastern O.F.S., there is a record at locus 3127 AC in the north-eastern Cape (Poynton, 1964); but in the case of *S. f. fasciatus*, no records exist for both the south-eastern O.F.S. and adjacent north-eastern Cape.

D - Drakensberg (Fig. 114 D)

Arthroleptella hewitti, Strongylopus hymenopus, Cacosternum nanum, Breviceps adspersus pentheri, Breviceps maculatus, Heleophryne natalensis.

The above six species could be considered as belonging to an Afromontane Region. However, *Heleophryne natalensis* and *Arthroleptella hewitti* also occur in the Natal midlands, and *Cacosternum n. nanum*, as opposed to *C. n. parvum* (which is restricted to the Drakensberg), is not strictly Afromontane. The six species involved here essentially reach their inland western limits in the north-eastern O.F.S. This group is considered separate from the Eastern group on account of the association of its species with the Drakensberg mountains. Additional "Drakensberg" species may also be present in this area, e.g. *Strongylopus wageri* and *Rana vertebralis* (see Bourquin & Channing, 1980; Lambiris, 1989a).

S - Southern (Fig. 114 S)

Bufo vertebralis.

This species occurs in the north-eastern Cape Province and southern half of the O.F.S. (also isolated records in northern O.F.S.), with associated records at Kimberley, Kareeboomput farm (south-western Transvaal) and Maseru. The centre of distribution of the species is the Karoo in the vicinity of locus 3025 BB. Poynton's (1964) "Vredefort Road" record (northern O.F.S.) is confirmed by a specimen recently collected nearby at Koppies Dam Nature Reserve, although the exact location of "Vredefort Road" is open to question. The last two records suggest that *B. vertebralis* may be more widespread in the northern and central O.F.S., possibly indicating a "Non-Northeastern" range cluster (similar to that identified for reptiles, see Fig. 115 Non-NE), but based on available records, it is currently considered a Southern form with a northerly extension.

N & NE - Northern and Northeastern (Fig. 114 N & NE)

Tomopterna natalensis, Schismaderma carens.

This is the most poorly defined range cluster. In the case of *S. carens*, although the species has been recorded at several localities in the southern Transvaal and western Natal, it has been recorded at only four localities in the northern and one locality in the north-eastern O.F.S. It has here been assumed that the species occurs in the north-eastern part of the O.F.S. as a whole. Poynton & Broadley (1991, p. 227) noted that the "scattered distribution" of *S. carens* on the eastern lowlands of south-east Africa "might be associated with a lack of deepwater breeding sites in the region". The same reasoning may explain the sparse distribution of this species in the O.F.S. The distribution of *T. natalensis* in the O.F.S. is even more confusing. Its distribution in South Africa is similar to that of *S. carens*, and it is also

widespread in the southern Transvaal and western Natal. The Krugersdrift Dam record for *T. natalensis* is far removed from the other records, but its southern African and O.F.S. distributions nevertheless suggest affinity with the N & NE group.

N & W - Northern and Western (Fig. 114 N & W)
Breviceps a. adspersus.

B. a. adspersus in the O.F.S. is represented by a few records on the western and northern peripheries. The species has been recorded at several localities in the southern Transvaal and western Natal. Its limited occurrence in the O.F.S. may be indicative of a recent invasion into the O.F.S. from the northern banks of the Vaal River.

6.3 Distribution of diversity for amphibians

Paucity of locality records, as appears to be the case for several O.F.S. amphibians, results in poor definitions of species ranges and imprecision in estimating the number of forms occurring in a specific area; this in turn leads to imprecision in estimating species diversity (estimate of number of forms in an area) (Poynton & Broadley, 1991, p. 232).

Table 16 shows the number of forms assigned to each of the nine amphibian range clusters (i.e. species and subspecies diversity), as well as the total number of forms (including forms from other clusters) known to occur in any one cluster, even if represented by only one or two eighth-degree records. From Table 16 it is clear that most clusters are "invaded" by several forms grouped in different clusters. In fact, six of the nine groups include 20 or more forms. The most "distinct" clusters are the Western (16 forms) and Northern & Western (15 forms) range clusters. The high total number of forms which may be found in each group indicates that the classification is fine, but to allow for interpretation of general patterning trends, a coarser grouping might include W, N & W and S as a "western" group, and S & E, E, D and N & NE as an "eastern" group, with T and Non-SW range clusters forming an "eclectic" grouping (see Fig. 114 and Table 18). The relatively low total number of forms (i.e. 16; 64,0%; N = 25) having part of or all (*Bufo poweri*) of their range in the Western cluster suggests that the western and eastern halves of the O.F.S. provide limiting or restrictive environmental conditions for several taxa.

Table 16: Diversity of amphibian species and subspecies in cluster areas in the Orange Free State. T = Throughout; Non-SW = Non-Southwestern; W = Western; S & E = Southern and Eastern; E = Eastern; D = Drakensberg; S = Southern; N & NE = Northern and Northeastern; N & W = Northern and Western.

Range cluster area	No. forms assigned to each cluster	% of total no. of O.F.S. forms	Total no. of forms known to occur within borders of cluster area	% of total no. of O.F.S. forms
T	6	24,0	25	100,0
Non-SW	4	16,0	25	100,0
W	1	4,0	16	64,0
S & E	1	4,0	23	92,0
E	3	12,0	24	96,0
D	6	24,0	20	80,0
S	1	4,0	17	68,0
N & NE	2	8,0	25	100,0
N & W	1	4,0	15	60,0
	25	100%		

6.4 **Reptilian range clustering in the Orange Free State** (Fig. 115)

According to the taxonomic analysis conducted, 95 reptilian species and subspecies are known to occur within the borders of the Orange Free State. However, one of these, namely *Bradypodion ventrale* cf. *karroica*, is almost certainly represented by translocated specimens, and together with records of apparently translocated *Lygodactylus c. capensis* at Bloemfontein, Welkom and Kroonstad, and translocated *Hemidactylus mabouia* and *Pachydactylus bibronii* in Bloemfontein, is not considered in the following analysis. Two dwarf chameleons, namely *Bradypodion* sp. nov. ("Ngotswane Gorge") and *Bradypodion* sp. nov. ("Zastron") are apparently endemic to the O.F.S., while the major part of the range of *Cordylus giganteus* falls within the O.F.S. Jacobsen (1989) noted that Transvaal *C. giganteus* are generally much smaller than their conspecifics south of the Vaal River. This may be the result of the separation of gene pools, with resultant manifestation of smaller phenotypes in the Transvaal. With few exceptions (see checklist of species which may occur in O.F.S.), the Vaal and Orange Rivers do not appear to represent barriers to the distribution of reptiles, although it is not known what historical factors were involved.

Thirteen reptilian range clusters are identifiable in the O.F.S., and, as in the case of the amphibians, these groups are named according to their common geographical area or centre (Fig. 115). Three clusters are represented by two or three species, whereas another two clusters contain only five taxa each. This shows the classification to be rather fine, but again, with the possible exception of the NE

and N & NE groups, which could be combined, the proposed groupings are considered the most realistic. Forms with "blanket" distributions, or which, on account of the widespread distribution of plotted localities, are considered probably to occur very widely in the province, are given the code "T" (i.e. Throughout). The occasional extralimital records plotted on maps, together with observed tendencies in the overall distribution of taxa as determined from other maps in the literature, were also taken into consideration when assigning species to their respective cluster. In all cluster groups, forms are listed in a sequence from smallest to largest range in the O.F.S. However, the ordering of species in these sequences is not always clear-cut. Each range cluster is provided with a code so as to facilitate convenient assignment of each form to its cluster in the following discussion. The term "(end)" following a species name in the lists below indicates that the species is endemic to the O.F.S.

T - Occurring throughout the O.F.S. (Fig. 115 T)

Varanus n. niloticus, Bitis a. arietans, Leptotyphlops s. scutifrons, Mabuya capensis, Dasypeltis scabra, Pachydactylus c. capensis.

This group includes forms distributed throughout the O.F.S., or with distributions indicative of a widespread occurrence in the province. The lizards *M. capensis* and *P. c. capensis*, and the snake *D. scabra*, have "blanket" distributions. *P. c. capensis* occurs virtually throughout the O.F.S., despite the occurrence of the closely related *P. vansoni* in the north-east. Far fewer records exist for *V. n. niloticus* and *B. a. arietans*, but these species are nevertheless widely distributed in the province according to the available locality records. Both species are also widespread in southern Africa. *V. n. niloticus* is almost certainly more widespread than records suggest - adult specimens are difficult to capture because of their size and strength - and specimens are likely to inhabit the banks of any suitable rivers. In the case of *B. a. arietans*, the paucity of records is somewhat more difficult to explain, but agricultural practices and associated habitat destruction may have resulted in local extinctions. The taxonomic status of *Leptotyphlops* in the O.F.S. is unclear, but the genus, at least, appears to be widespread in the province, even though most records are in the north-east. Some of the taxa included in group Non-NE may in fact prove to be better placed in this group, especially when considering extralimital records in the Transvaal and Natal.

Non-NE - Non-Northeastern, i.e. distributed throughout the O.F.S. with the exception of the north-east (Fig. 115 Non-NE)

Nucras intertexta, Varanus a. albigularis, Pelomedusa s. subrufa, Psammophis leightoni trinasalis, Prosymna s. sundevallii, Typhlops lalandei, Nucras taeniolata holubi, Agama a. atra, Pseudaspis cana, Lycophidion c. capense, Aparallactus capensis, Lamprophis fuliginosus.

The majority of forms listed above occur widely in the O.F.S., but all are absent from most of the north-east. *Nucras intertexta* could be considered a Western species, but central O.F.S. records suggest that its affinity lies with the Non-NE group. *Pelomedusa s. subrufa* is common virtually throughout southern Africa, wherever suitable water bodies are available, and despite the scarcity of records in the O.F.S., this form is likely to occur at several localities in the Non-NE cluster area. De Waal's (1980b) chelonian "survey" appears to be an "offshoot" of his squamate survey, and further collecting in the north-eastern O.F.S. may well reveal the presence of this terrapin there. There are records for the species in the adjacent southern Transvaal and north-western Natal. The blind snake *Typhlops lalandei* is replaced by *T. bibronii* in the north-eastern O.F.S. *Agama a. atra* has been placed in this group, although it has a unique distribution pattern, being widespread throughout most of the O.F.S., but with a disjunct northern population. The reason for this is hard to explain, as suitable habitat appears to be available throughout the province (De Waal, 1978). The snakes *Pseudaspis cana, Lycophidion c. capense* and *Lamprophis fuliginosus* are all largely absent from the north-eastern O.F.S., and only *P. cana* has records suggesting that it may occur more widely in that region. *P. cana, L. c. capense* and *L. fuliginosus* are widespread throughout most of the Transvaal, but are largely absent from most of degree unit 26°S, 29°E and adjacent areas in the south-east (see Jacobsen, 1989, maps 139, 141 & 146). This situation is difficult to explain, but may be the result of grass fires or lack of suitable prey species. *Aparallactus capensis*, unlike the three snakes just mentioned, occurs throughout the Transvaal, including the south-east, but is absent from much of western Natal (see Jacobsen, 1989, map 160).

S - Southern (Fig. 115 S)

Pachydactylus m. mariquensis, Homopus femoralis, Psammophis notostictus, Mabuya variegata punctulata, Pedioplanis l. lineoocellata, Cordylus p. polyzonus.

The ranges of the six species listed above are centred in the southern O.F.S., but none are entirely restricted to the Karoo. *Psammophis notostictus*, however, could be regarded as a largely "Karoo" species and is largely restricted to the Karoo region of the O.F.S. *Cordylus p. polyzonus* appears to be restricted to dolerite rock outcrops, e.g. hillocks in the Karoo, although maps showing the distribution of dolerite in the O.F.S. (e.g. Fig. 15) do not provide sufficient detail to allow for precise correlations to be determined (see also De Waal, 1978, p. 137). *Pedioplanis l. lineoocellata* has two northerly records (shown as isolated "patches" in Fig. 115) and further collecting may prove it to be more closely associated with the Non-NE group. There is also an isolated record for *Mabuya variegata punctulata* in the north-eastern O.F.S. (shown as an isolated patch in Fig. 115 S). The use of drift fences and pit traps in the grasslands of the northern O.F.S. may show this sparingly collected species to be more widespread in the province. With the exception of *M. v. punctulata* and *P. l. lineoocellata*, the forms included in this group represent the most northerly populations of their kind.

Non-SW - Non-Southwestern, i.e. distributed throughout the O.F.S. with the exception of the south-west (Fig. 115 Non-SW)

Lamprophis aurora, Crotaphopeltis hotamboeia, Acontias g. gracilicauda, Mabuya varia, Agama aculeata distanti, Mabuya striata punctatissima.

Six taxa are included in this group. In all cases their absence from the south-western O.F.S. marks the inland south-western range limit of the form in southern Africa. *A. a. distanti* is replaced in the south-western O.F.S. and much of the Cape Province by the nominate subspecies, *A. a. aculeata. M. striata punctatissima* is replaced in the south-western O.F.S. by *M. s. sulcata*, an essentially western form in southern Africa. Non-SW forms are absent from most of the Karoo, suggesting that they are not adapted to drier conditions.

W - Western (Fig. 115 W)

Xenocalamus b. bicolor, Prosymna bivittata, Atractaspis bibronii, Psammophylax tritaeniatus, Psammobates oculifer, Geochelone pardalis, Monopeltis c. capensis, Naja nivea.

With the exception of *A. bibronii, G. pardalis* and *N. nivea*, the ranges of the other forms in this cluster essentially represent the southern and eastern range limits of their component species. The rarely seen burrowing snake *Atractaspis bibronii* is represented by only four localities in the O.F.S., but considering extralimital records, especially one such record at Colesberg (north-eastern Cape), and the absence of records in north-western Natal, this species is considered best placed as a Western form. *N. nivea* reaches its eastern limits in the western half of the O.F.S., with its most easterly record at 3026 - Bd4 (shown as an isolated patch on map), while *G. pardalis* occurs further southwards to the eastern Cape. *X. b. bicolor* in the O.F.S. is represented by only two eighth-degree localities, but, judging from extralimital records, it is most realistically placed in the Western grouping.

E - Eastern (Fig. 115 E)

Hemidactylus mabouia, Afroedura karroica halli, Lamprophis fuscus, Mabuya homalocephala smithii, Afroedura nivaria, Causus rhombeatus, Lamprophis guttatus, Nucras lalandii, Pedioplanis burchelli, Pseudocordylus m. melanotus, Duberria l. lutrix, Homoroselaps lacteus, Lycodonomorphus rufulus, Gerrhosaurus f. flavigularis, Hemachatus haemachatus, Psammophis crucifer, Psammophylax r. rhombeatus.

The extent of the Eastern range cluster is largely defined by the distribution of *Psammophylax r. rhombeatus*, which replaces the western form *P. tritaeniatus* (with sympatry at Bloemfontein only) in the eastern half of the O.F.S. Most forms in this grouping are, however, more closely associated with the mountainous region of the extreme eastern part of the province. Within the Eastern group, a subdivision between north and south could be made, considering the distribution of *Afroedura nivaria*

(north) and *A. karroica halli* (south), but the two forms are closely related and the taxonomy of the *A. nivaria - karroica - amalotica - tembulica* complex is in need of revision. Vicariance has probably resulted in two or more morphologically similar subspecies derived from the same founder stock. Two species, namely *Mabuya homalocephala smithii* and *Lamprophis fuscus*, both rare species, are represented by one northerly and one southerly record within this range cluster. However, this probably reflects failure to collect additional specimens in the mountainous eastern part of the O.F.S. as a whole, rather than a peculiar distribution pattern. *Nucras lalandii* lacks records in the "central" part of this grouping, but as was the case with *Lamprophis guttatus*, additional collecting subsequent to De Waal's (1978) survey revealed the presence of the species in that area. The gecko *Hemidactylus m. mabouia* has been collected only on Thaba Phatshwa Mountain in the central part of the Eastern cluster. Its "natural" occurrence in the O.F.S., however, requires confirmation (see species account). *Causus rhombeatus* has been recorded from the northern and north-eastern O.F.S. only, but is also known from Maseru and the north-eastern Cape. With the exception of records in the Kimberley area (translocations?), the species' general distribution pattern in southern Africa suggests that this form is, at least provisionally, best placed in the Eastern group. Both *Nucras lalandii* and *Pedioplanis burchelli* reach their western limits in the eastern O.F.S. Two records for *Homoroselaps lacteus* in the Kimberley area may represent specimens flooded down in the Vaal River, or possibly translocations. If the former is in fact the case, the species may also occur in the extreme northern O.F.S., south of the Vaal River, and further collecting may even indicate that this species is more closely associated with group Non-SW. The following members of this group display a possible Afromontane distribution pattern: *Afroedura* spp. (part of complex of forms found from the south-western Cape to the Transvaal Drakensberg), *Mabuya homalocephala smithii, Lamprophis fuscus, L. guttatus, Duberria l. lutrix* and *Psammophis crucifer.*

SW - Southwestern (Fig. 115 SW)

Telescopus beetzii, Pachydactylus l. laevigatus, Ptenopus g. garrulus, Mabuya occidentalis, Pachydactylus maculatus oculatus, Pedioplanis namaquensis, Mabuya v. variegata, Agama a. aculeata, Mabuya s. sulcata, Pachydactylus bibronii.

This cluster is centred in the False Upper Karoo of the south-western O.F.S. The forms included here occur almost exclusively within the Karoo. The south-western O.F.S. represents the northern limit of *Pachydactylus maculatus oculatus*, whereas it is the only part of the province occupied by *P. bibronii*. The latter is a Tropical species which is absent from the Highveld Grassland of the southern Transvaal and O.F.S., and its occurrence in the Karoo is explained by the suitable rocky habitat found there, i.e. dolerite hillocks. The other species listed above basically represent the eastern or south-eastern limit of arid or western populations which are typically distributed from north-western Namibia southwards to the Karoo of the middle Cape Province and south-western O.F.S.

N & NE - Northern and Northeastern (Fig. 115 N & NE)

Cordylus v. vittifer, Cordylus giganteus.

This cluster might be considered somewhat coarse, despite its small component, as *C. giganteus* occurs over a large area of grassland in the northern O.F.S. (where it shelters in burrows), whereas *C. v. vittifer* (including De Waal's [1978] varieties "A" and "B") is apparently restricted to rocky habitat in the extreme northern (variety A) and north-eastern (variety B) O.F.S. *C. giganteus* also occurs in the south-south-eastern Transvaal and extreme north-western Natal, whereas *C. v. vittifer* has a widespread occurrence in the Transvaal, Swaziland, Natal and extreme south-eastern Botswana.

NW - Northwestern (Fig. 115 NW)

Dispholidus t. typus, Chamaeleo d. dilepis, Agama h. hispida, Lygodactylus c. capensis, Ichnotropis squamulosa.

The five species included in this group are restricted to the Bushveld of the north-western O.F.S. In the case of the arboreal species *Dispholidus t. typus, Chamaeleo d. dilepis* and *Lygodactylus c. capensis*, their occurrence in the O.F.S. is confined to the bushveld as it provides suitable "tree-rich" habitat. All three forms are widely distributed in southern Africa. The north-western O.F.S. represents the south-western range limit of *L. c. capensis*. Although Branch (1988a) shows the range of *D. t. typus* as extending from the north-western through to the southern O.F.S., and then south to the north-eastern Cape Province, the south-central O.F.S. record for this species (see species account) is doubtful. The occurrence of *Agama h. hispida* in the O.F.S. is difficult to explain. McLachlan's (1981) south-eastern O.F.S. record is rejected (see species account), but the north-western records (see De Waal, 1978) are confirmed, and despite a large gap, appear to represent the north-eastern range limit of this largely Karoo species. The bushveld records for *Ichnotropis squamulosa* are the most southerly for this tropical species.

NE - Northeastern (Fig. 115 NE)

Tetradactylus breyeri, Pachydactylus vansoni, Typhlops bibronii.

Three forms are included in this group, which could conceivably be combined with cluster N & NE to form a "coarse" north-eastern group. *T. breyeri* is a rare species found in Natal (including a record at "Bushman's Cave", Witzieshoek, in the Drakensberg region on the Natal/O.F.S. border), but with isolated records in the O.F.S. and Transvaal. The scarcity of this species may be a result of man-made surface fires destroying its grassland habitat; however, the Witzieshoek record suggests that the species may also occur in rocky areas. The centre of distribution of *P. vansoni* is the eastern Transvaal, but the species extends southwards into northern Natal and rocky areas in the extreme north-eastern O.F.S. *Typhlops bibronii* replaces the fairly widespread *T. lalandei* in the north-eastern O.F.S.

C - Central (Fig. 115 C)

Panaspis wahlbergii, Homoroselaps dorsalis, Elapsoidea sundevallii media.

The three species listed above exhibit distribution patterns which could be regarded as transitional between, broadly speaking, western and eastern range clusters. These distribution patterns are difficult to explain considering the overall distribution of each species. Considering its overall distribution, *H. dorsalis* appears to be associated with the Eastern range cluster, as it also occurs in the southern Transvaal and northern Natal. *E. sundevallii media* may occur in the western O.F.S., considering two quarter-degree records in the Kimberley area (Broadley, 1990, p. 269). These records suggest that *E. s. media* is better placed in the Non-NE range cluster. This subspecies is replaced by the nominate subspecies in the south-eastern Transvaal, Swaziland highveld and western and southern Natal. The Snake-eyed Skink *P. wahlbergii* is a tropical species, its distribution range extending into the northern and central O.F.S. as a finger-like projection.

SE - Southeastern (Fig. 115 SE)

Tetradactylus tetradactylus, Bradypodion sp. nov. ("Zastron") (end), *Aspidelaps l. lubricus, Tetradactylus seps, Cordylus cordylus.*

Five forms are included in this group, one (*Bradypodion* sp. nov. ["Zastron"]) of which is endemic to it. *Tetradactylus tetradactylus* occurs at Boschberg farm in the Rouxville district, this being the northern limit of this Afromontane species. *T. seps* has been recorded from Smithfield and also Royal Natal National Park on the Natal/north-eastern O.F.S. border. It may therefore be better placed as an Eastern form. *Aspidelaps l. lubricus* is centred in the Cape Karoo and reaches its eastern and north-eastern limits in the Smithfield and Aliwal North areas. *Dipsina multimaculata* has a similar distribution to *A. l. lubricus*, and may also occur in the south-eastern O.F.S. The northern limit of *Cordylus cordylus* is the south-eastern O.F.S., where it is sympatric with *C. p. polyzonus* at Smithfield; it may also occur in south-western Lesotho.

D - Drakensberg (Fig. 115 D)

Pseudocordylus spinosus, Cordylus sp. ("Waterfall") (end), *Tetradactylus a. africanus, Bradypodion dracomontanum, Bradypodion* sp. nov. ("Ngotswane Gorge") (end), *Tropidosaura essexi, Lamprophis inornatus, Chamaesaura aenea, Philothamnus natalensis occidentalis, Pseudocordylus melanotus subviridis, Bitis atropos.*

Eleven forms are included in this group, of which six are endemic to the Natal Drakensberg, *viz. Pseudocordylus spinosus, P. melanotus subviridis, Cordylus* sp. ("Waterfall"), *Bradypodion dracomontanum, Bradypodion* sp. nov. ("Ngotswane Gorge") and *Tropidosaura essexi*. Also, *Bitis*

atropos is represented by four disjunct populations in southern Africa, one of which is centered in the Natal Drakensberg. The plated lizard *Tetradactylus a. africanus* is centred in eastern Natal, with a few more westerly records, including one at Witzieshoek in the O.F.S. part of the Natal Drakensberg; it is not regarded as an Afromontane species. The following three species are wider-ranging and basically found in the eastern half of southern Africa, although they enter the O.F.S. in the Drakensberg range cluster area: *Lamprophis inornatus, Chamaesaura aenea* (possibly Afromontane and associated with montane grassland; isolated record at Lindley shown as patch on map) and *Philothamnus natalensis occidentalis*. Three *Tetradactylus* species have been recorded from the Witzieshoek/Royal Natal National Park area, *viz. T. a. africanus, T. breyeri* and *T. seps*. The Drakensberg cluster is treated as separate from the NE cluster on account of the restriction of its component forms to the Drakensberg mountains and associated montane grasslands, which are associated with certain extreme environmental factors, e.g. high rainfall and high elevation.

6.5 Distribution of diversity for reptiles

De Waal's (1978) squamate survey, together with new records for the O.F.S., provide a large database allowing for what is considered to be a fairly accurate determination of species boundaries and species diversity in the O.F.S. Far fewer records are available for chelonians, however.

Table 17 shows the number of forms assigned to each of 13 range clusters, as well as the total number of forms known to enter a particular cluster (even if represented by only one record). From Table 17 it can be seen that three clusters, namely T, Non-NE and Non-SW each include all or most (91-94; N = 94) forms known to occur naturally in the O.F.S. The Eastern group has the greatest number of species and subspecies assigned to it, namely 17 forms (18,1% of all taxa), but almost 81% of all O.F.S. taxa have records in the Eastern cluster area. The Southwestern group includes 10 forms (10,6%), with only 45 forms known to occur within its area. The Northwestern cluster has only five forms (5,3%) restricted to it, with only 33 forms (35,1%) known to have records within its area. The classification is fine, but less so than that for the amphibians. There is a more obvious east-west subtraction margin evident among the reptilian fauna of the O.F.S.

6.6 Amphibian and reptilian diversity based on quarter-degree units

By determining the number of amphibian species and subspecies collected from each quarter-degree unit (sometimes inaccurately referred to as "square", see section 3.8) in the O.F.S. and peripheral areas on the northern Cape Province/O.F.S. border (i.e. 2824-Bd3, 2824-Db3, 2824-Dc3, 2924-Ba1, 2924-Cd3), it was determined that collections of amphibians have been made in 159 (70,0%) of the total of 227 units falling within the O.F.S. (even if only peripherally, judging from grids on the distribution maps used, e.g. Fig. 12). A total of 173 units (76% of total) had three or less taxa recorded (Fig. 116). Two units in the north-eastern O.F.S. have 12 or 13 taxa recorded (2828 DA and 2829 AC respectively), although more could be expected (see Bourquin & Channing, 1980), and these represent the areas with

the highest recorded amphibian diversity in the province. Quarter-degree units with eight or more taxa recorded are usually representative of areas at, or near which, collectors were based (e.g. Kimberley, Bloemfontein, Smithfield) or where intensive collecting, often over a number of years, has been conducted (e.g. Golden Gate and Ladybrand areas). Units with seven or more taxa are scattered throughout the O.F.S., suggesting that Figure 116 does not accurately represent amphibian diversity in the province, at least as far as diversity per quarter-degree unit is concerned.

Table 17: Diversity of reptile species and subspecies in cluster areas in the Orange Free State. T = Throughout; Non-NE = Non-Northeastern; S = Southern; Non-SW = Non-Southwestern; W = Western; E = Eastern; SW = Southwestern; N & NE = Northern & Northeastern; NW = Northwestern; NE = Northeastern; C = Central; SE = Southeastern; D = Drakensberg.

Range cluster area	No. forms assigned to each cluster	% of total no. of O.F.S. forms	Total no. of forms known to occur within borders of cluster area	% of total no. of O.F.S. forms
T	6	6,4	94	100,0
Non-NE	12	12,8	92	97,9
S	6	6,4	74	78,7
Non-SW	6	6,4	91	96,8
W	8	8,5	66	70,2
E	17	18,1	76	80,9
SW	10	10,6	45	47,9
N & NE	2	2,1	56	59,6
NW	5	5,3	33	35,1
NE	3	3,2	44	46,8
C	3	3,2	57	60,6
SE	5	5,3	40	42,6
D	11	11,7	39	41,5
	94	100%		

Peripheral records were not considered for reptiles in the quarter-degree analysis, as the number of available records and intensity of De Waal's (1978) squamate survey were considered adequate. Records of translocated reptiles were not considered in this analysis.

Collections of lizards have been made in 205 of the 227 quarter-degree units (i.e. 90,3%) falling within the O.F.S. The quarter-degree unit with the highest recorded lizard diversity is 3026 BA (Smithfield area), with 17 forms (Fig. 117). Fifteen forms have been recorded at locus 2827 AC, and 14 forms at locus 2926 AA (Bloemfontein area). Fourteen units (6,2%; N = 227), scattered throughout the O.F.S., have ten or more forms recorded. Only 22 units (9,7%) have no records; of these, 15 (6,6%) are

peripheral on the O.F.S. border, usually with one third or less of their area in the O.F.S., although locus 2726 CA falls largely within the borders of the province; and only seven uncollected units (3,1%) fall entirely within the O.F.S.

Only one amphisbaenid has been recorded from the O.F.S., namely *Monopeltis c. capensis*. It is known from three apparently isolated populations in the province - a northern, central, and southern population (Fig. 118).

Collections of snakes have been made in 200 (88,1%; N = 227) quarter-degree units in the O.F.S. The quarter-degree unit with the highest recorded snake diversity is 2926 AA (Bloemfontein area), with 23 forms (Fig. 119). A total of eight units (3,5%) scattered throughout the O.F.S. have 11 or more forms recorded, but the closest to 23 (at 2926 AA) is 14 forms at both 2727 CA and 2827 AC. Twenty-seven units (11,9%) have no species recorded, of which 16 (7,0%) are on the periphery of the province, while only 11 units (4,8%) falling entirely within the borders of the O.F.S. have no snake records.

The four chelonian species found in the O.F.S. occur together in only one quarter-degree unit, namely 2826 CC (Glen area), whereas three species occur in the adjacent unit 2926 AA (Fig. 120). Several units within the combined range of the four species, including areas where all four species are expected to occur, have no species recorded, suggesting that chelonian occurrence is poorly represented on distribution maps for the O.F.S.

Collections of reptiles, as a whole, have been made in 209 (92,1%; N = 227) quarter-degree units in the O.F.S. The quarter-degree unit with the greatest number of reptile forms recorded is 2926 AA (Bloemfontein area), with 41 forms (Fig. 121). However, only 12 units in all, i.e. 5,3% of the total of 227, have 20 or more forms recorded. Thirty forms have been recorded from units 2827 AC and 3026 BA (Smithfield area). A total of 18 units (7,9%) have no forms recorded, of which 14 (6,2%) are peripheral and four (1,8%) fall entirely within the borders of the O.F.S.

Collections of amphibians and reptiles (= herptiles) as a whole have been made in 211 (93,0%; N = 227) quarter-degree units in the O.F.S. The quarter-degree unit with the highest combined amphibian and reptile (or herptile) diversity is 2926 AA (Bloemfontein area), with 50 forms recorded (Fig. 122). Seven units (3,1%) have more than 30 forms recorded, i.e. 33-50. Sixteen units (7,0%) have no forms recorded, of which 12 (5,3%) are peripheral, all having one-third or less of their area within the O.F.S., and only four "uncollected" units (i.e. 1,8%) fall entirely within the borders of the O.F.S.

From the maps showing the number of amphibian and reptilian taxa recorded per quarter-degree unit, it is evident that the Bloemfontein and Smithfield areas (quarter-degree units) have "disproportionately" high species and subspecies diversities. This is probably the result of there having been collectors and/or museum workers based in Bloemfontein (e.g. A.C. Hoffman; S.W.P. de Waal; myself) and Smithfield (Dr. Kannemeyer, ± 1910). However, in the case of the Bloemfontein quarter-degree unit, the high diversity is probably also reflective of the fact that this area is included within the amphibian range clusters T, Non-SW, W and S, and reptile range clusters T, Non-NE, S, Non-SW, W, E and C. The Bloemfontein area is therefore likely to include the ranges of several species. However, several quarter-degree units adjacent to the Bloemfontein unit are in a similar "overlap" position, yet the number of forms recorded from them is generally much lower. This fact, together with the scattered distribution of "high diversity units" surrounded by "low diversity units" throughout the O.F.S., indicate that even in a relatively well surveyed region like the O.F.S., collecting, at least on the basis of quarter-degree units, may be far from adequate, and several units may be relatively poorly sampled. Figures 116-122 are useful when used in conjunction with Tables 18 to 21 to provide an indication as to why certain intervals in the transect appear to reflect a low percentage collecting success.

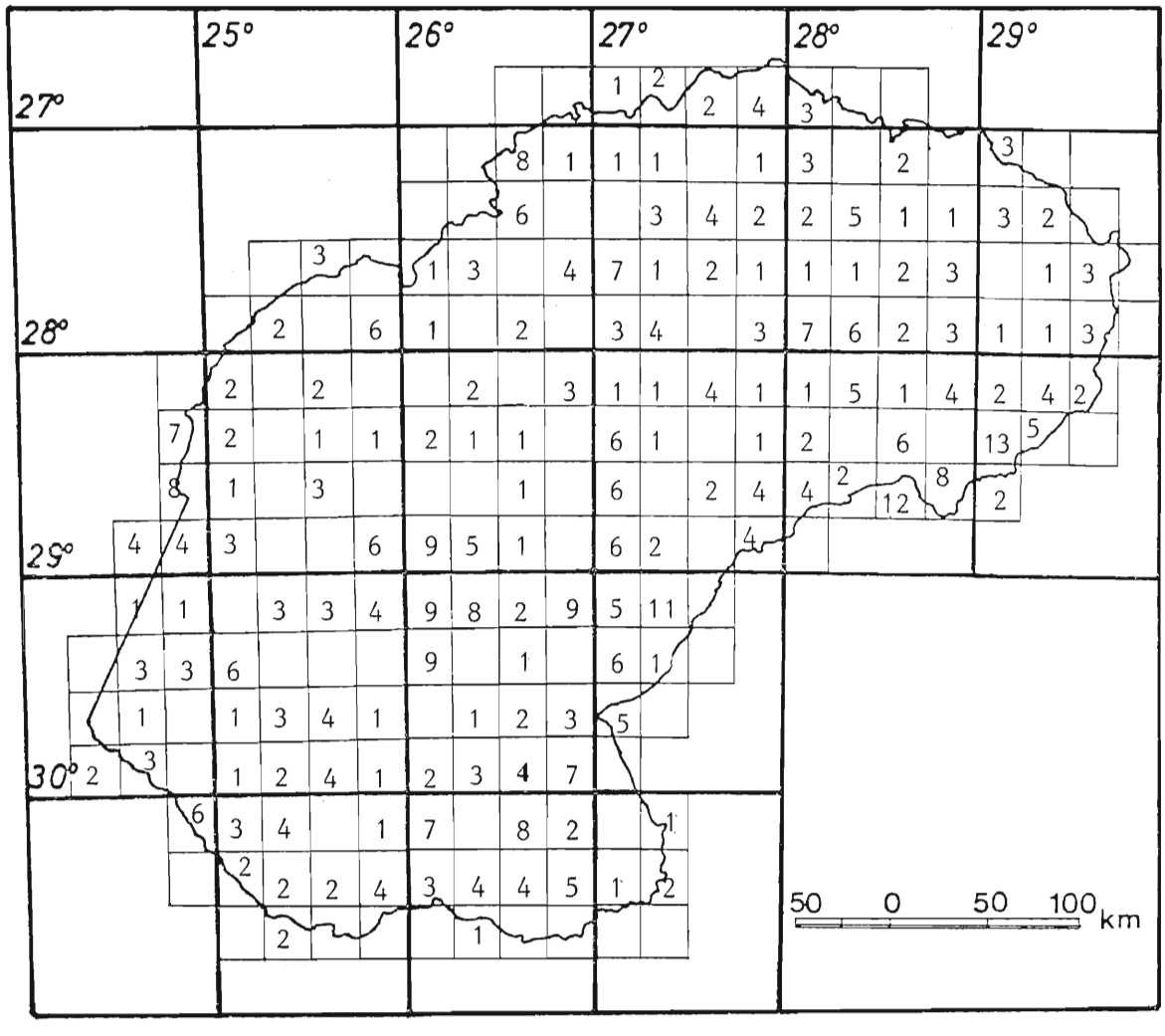


Figure 116: Numbers of amphibian species/subspecies recorded per quarter-degree unit in the Orange Free State.

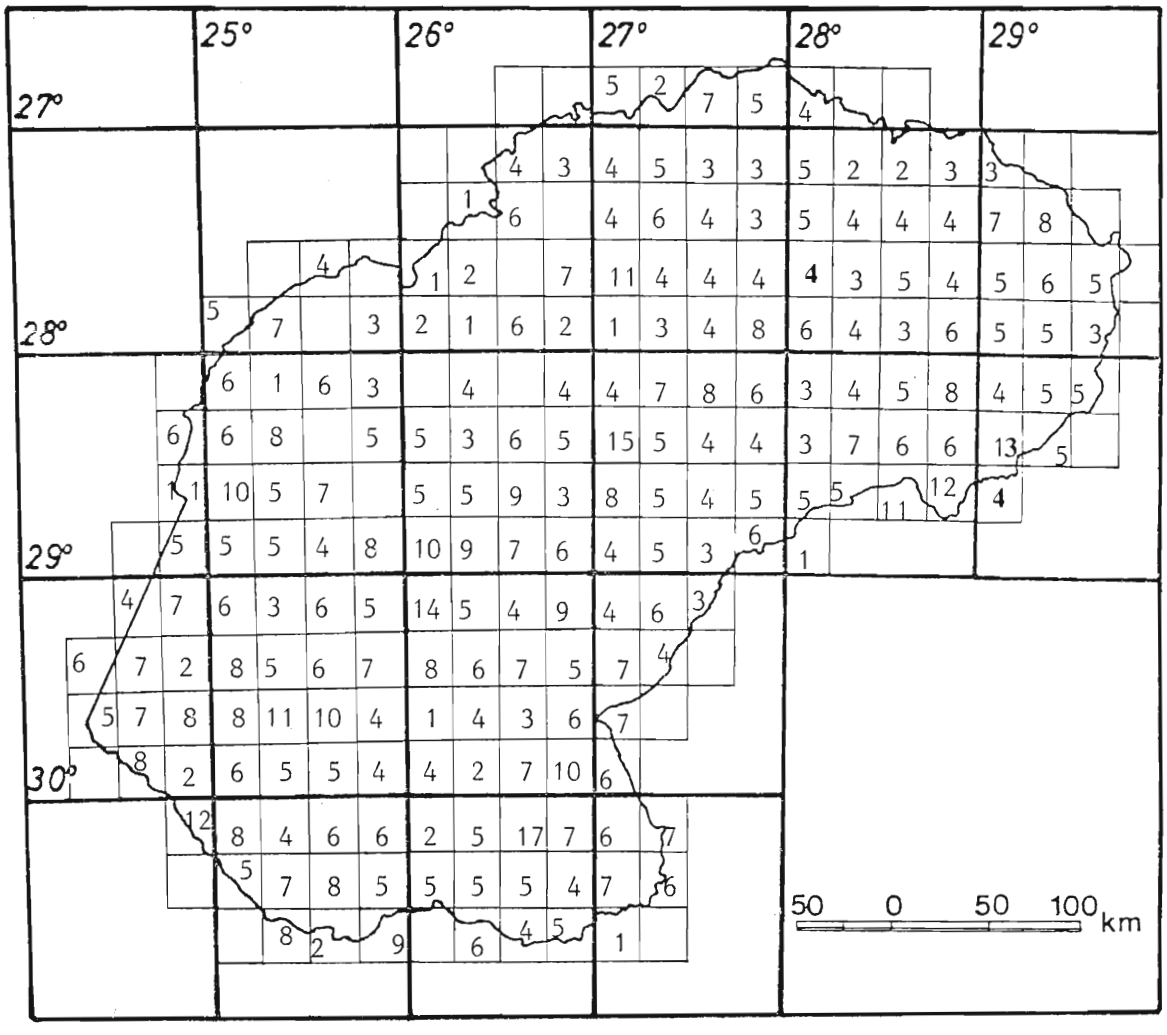


Figure 117: Numbers of lizard species/subspecies recorded per quarter-degree unit in the Orange Free State.

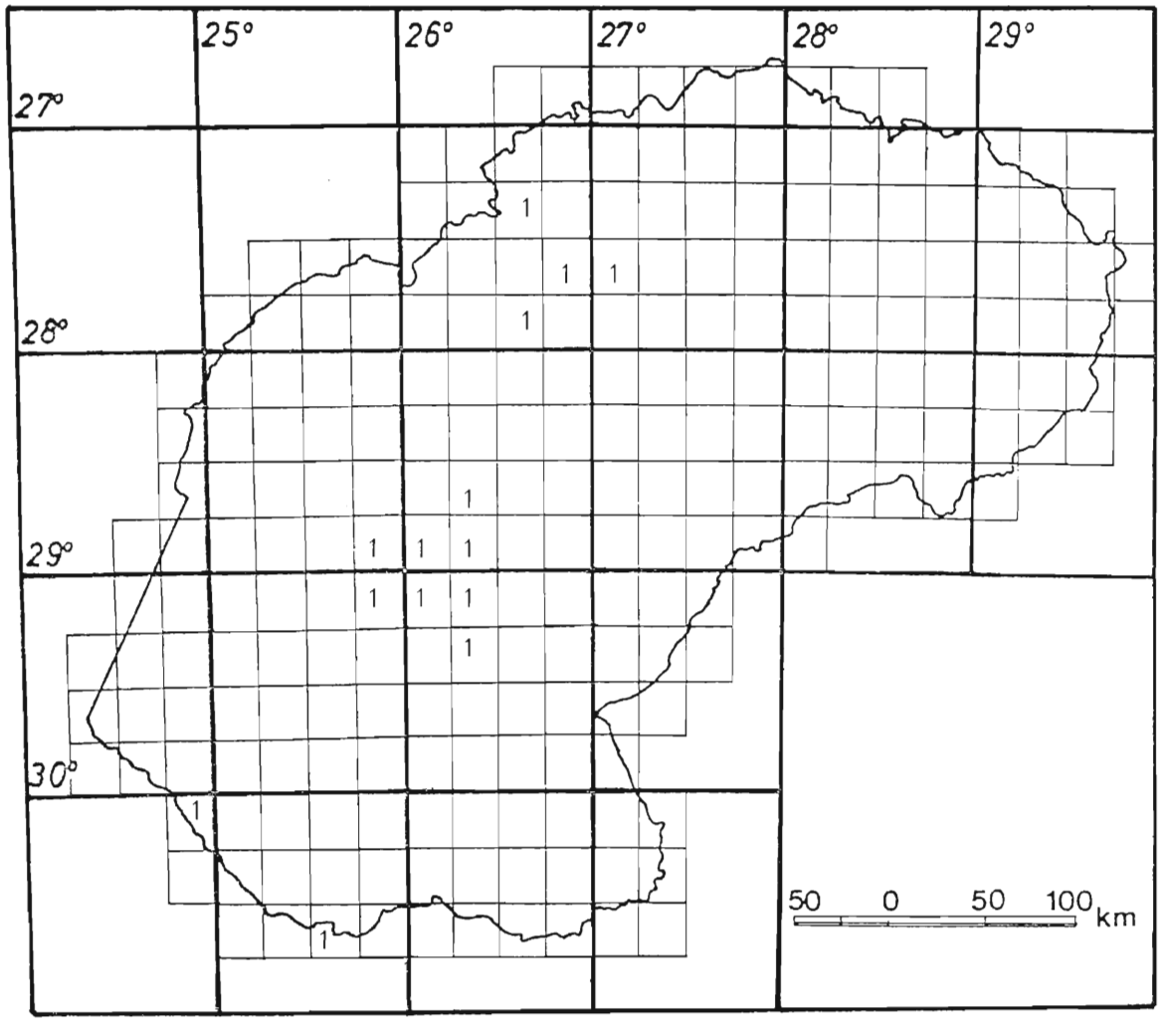


Figure 118: Numbers of amphisbaenian species/subspecies recorded per quarter-degree unit in the Orange Free State.

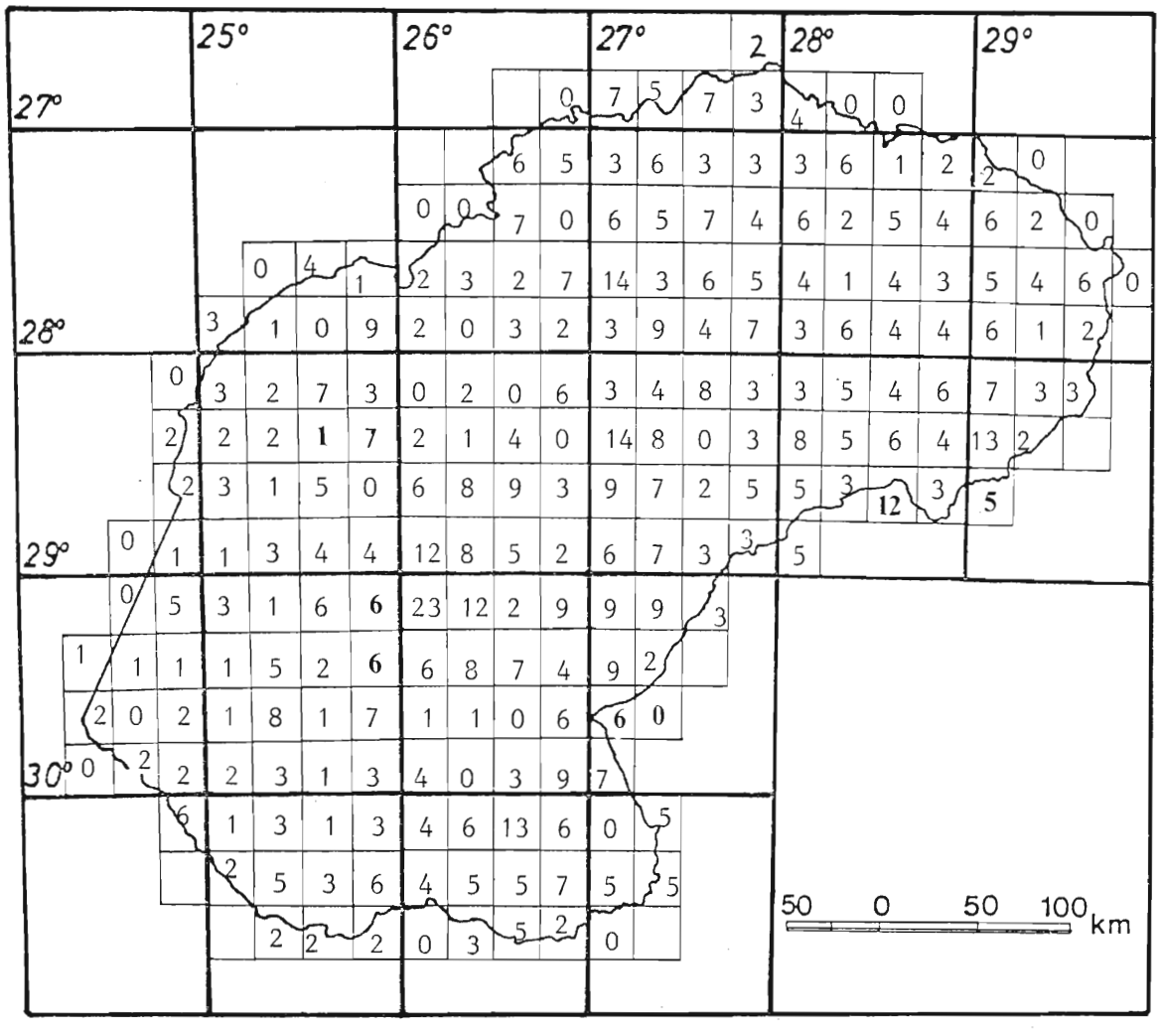


Figure 119: Numbers of snake species/subspecies recorded per quarter-degree unit in the Orange Free State.

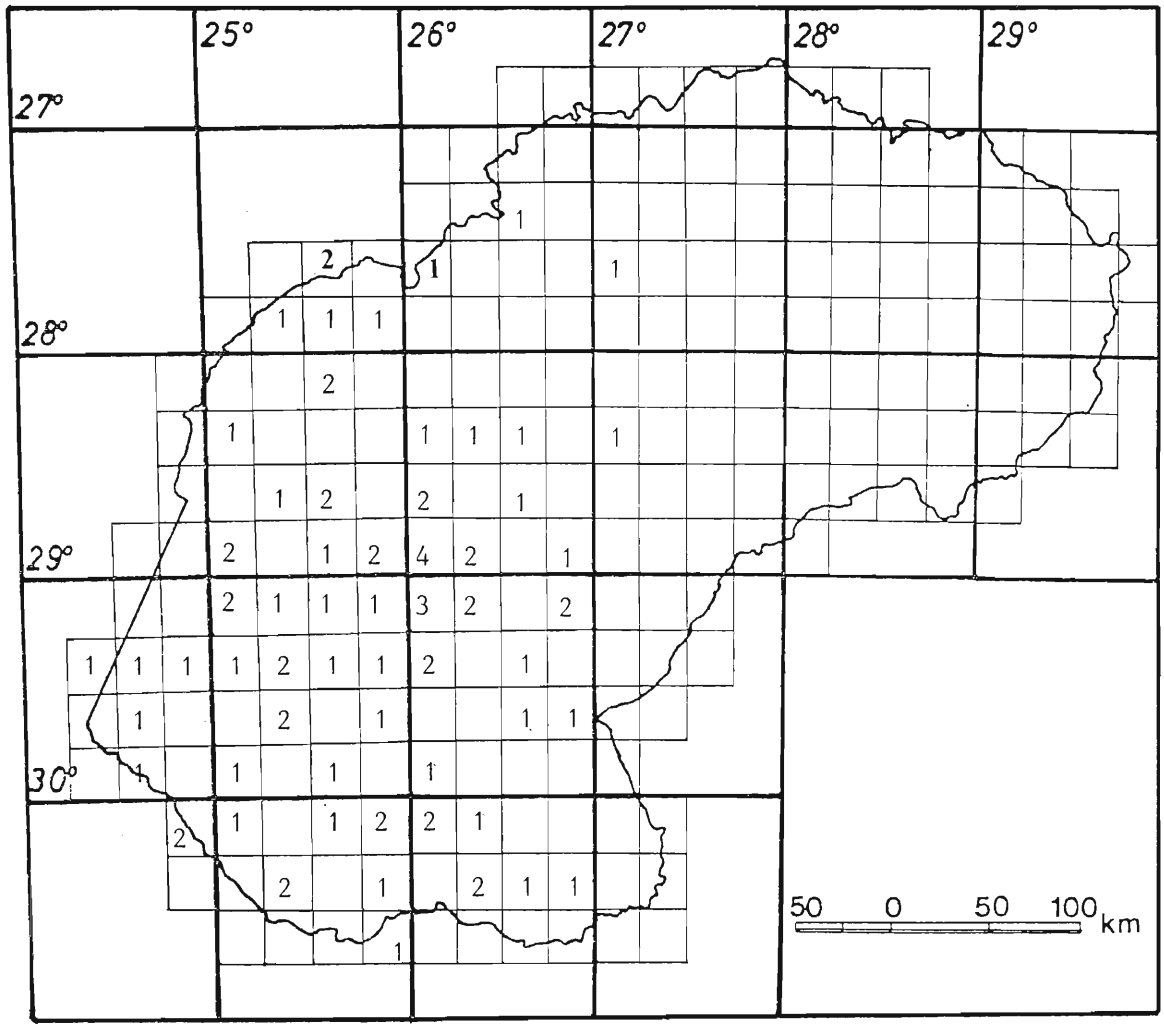


Figure 120: Numbers of chelonian species/subspecies recorded per quarter-degree unit in the Orange Free State.

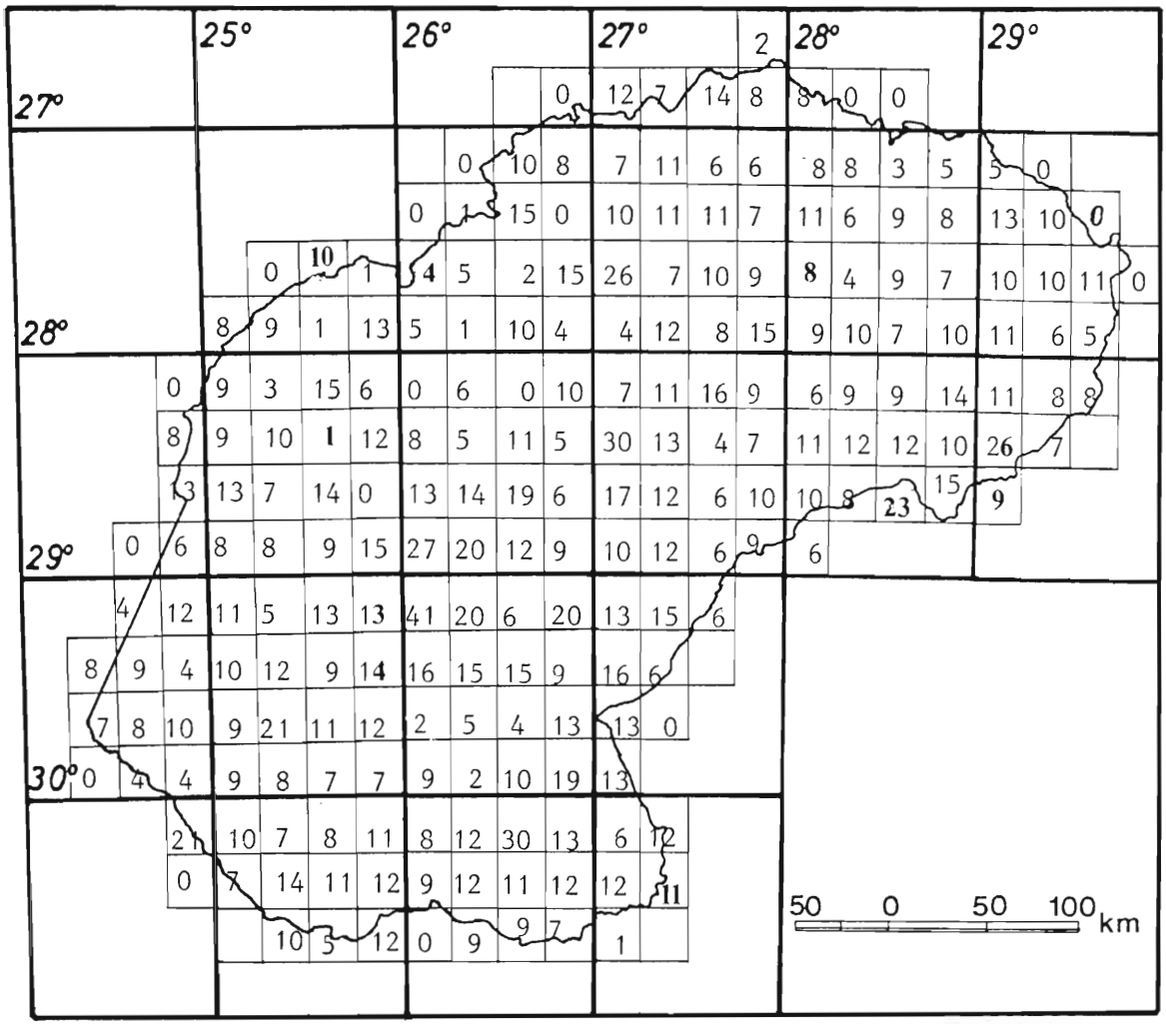


Figure 121: Numbers of reptile species/subspecies recorded per quarter-degree unit in the Orange Free State.

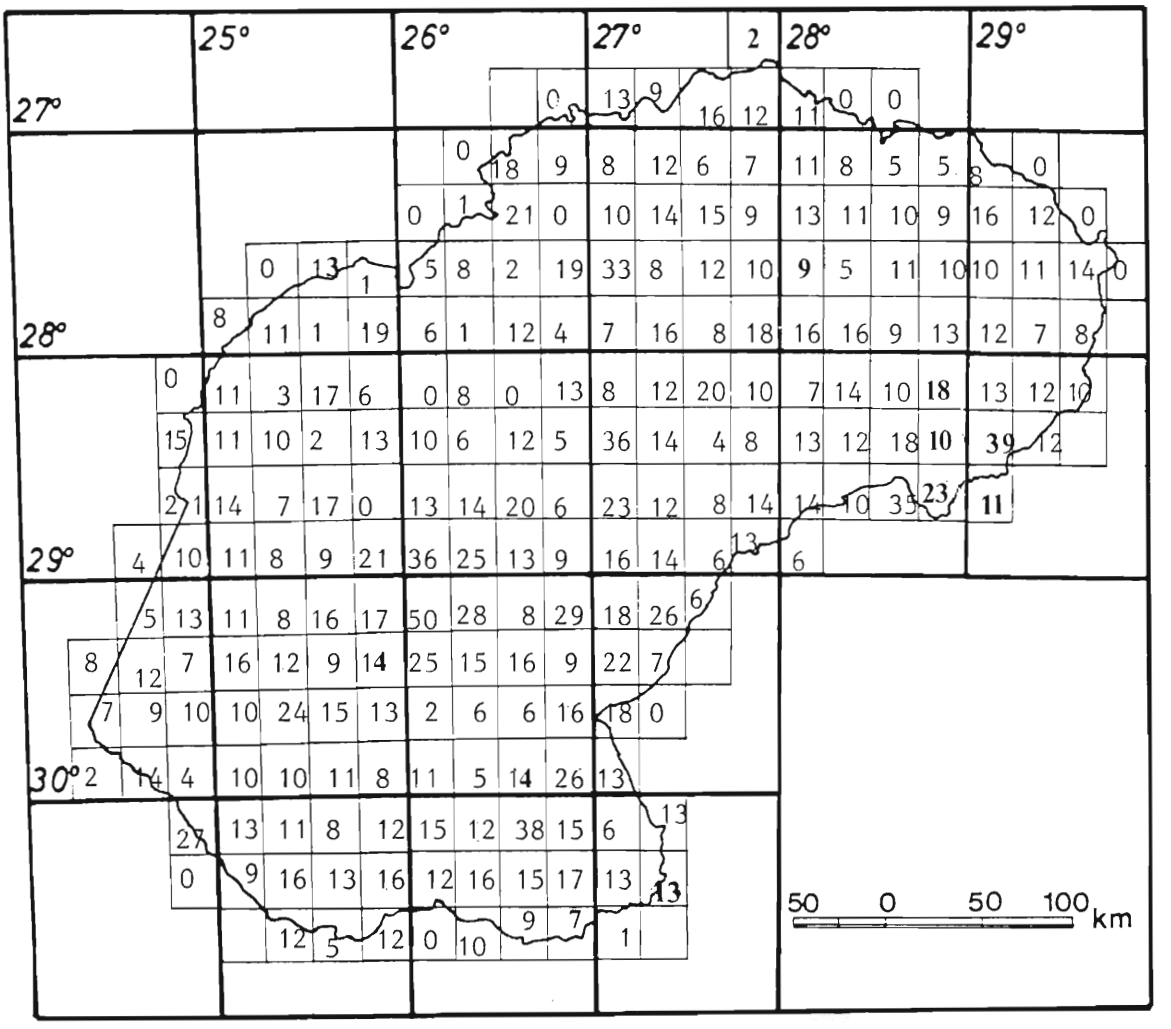


Figure 122: Numbers of amphibian and reptile species/subspecies recorded per quarter-degree unit in the Orange Free State.

6.7 Problems in analyzing distribution and diversity

Locality records are usually plotted using the quarter-degree grid format. As noted by Poynton & Broadley (1991, p. 224) and Poynton (1992, p. 2), this method results in a barely acceptable resolution of distributional patterning in areas of abrupt change. An example of such a quarter-degree unit is Pietermaritzburg, which is located within an area which includes Afromontane grassland, mist forest and dry bushveld (Poynton, 1992, p. 2), and some quarter-degree units in the north-eastern O.F.S. include montane grassland, sandstone mountains and forested gorges. Largely because of unsystematic collecting, quarter-degrees do not always provide enough records to span gaps in poorly collected areas. Consequently, large geographical areas cannot be effectively and realistically analyzed using mechanical procedures that assume a uniform spread of data (Poynton, 1992, p. 2). Even in the case of O.F.S. squamates, a "uniform spread" of data does not appear to have been achieved on the basis of quarter-degree units, judging from Figures 117 to 119. The large-scale approach of Crowe (1990), who used a more than two-degree square grid is considered unrealistic. Although such an approach overcomes the problem of too few quarter-degree records, analysis can be done only at a very coarse level, resulting merely in general distribution patterning (Poynton & Broadley, 1991; Poynton, 1992).

The aim of this section is to investigate whether or not quarter-degree partioning of a transect from the western to eastern ends of the O.F.S. (and adjacent areas) will allow a critical evaluation of existing data, and whether or not it provides a basis for analyzing amphibian and reptilian diversity and turnover. I have essentially followed the method used by Poynton & Broadley (1991) and Poynton (1992), but slight modifications have been adopted, as explained further on.

The validity of this study is dependent on an effective taxonomic analysis of the fauna. The smallest taxonomic unit recognized is the subspecies. The taxonomic status of some specimens from the transect area are problematic - e.g. *Cacosternum nanum* (subspecific status unclear) and *"C. boettgeri"* which may include more than one species (Poynton, 1992, p. 2). Poynton (1992, p. 2) stated that zoogeographical assessments are impaired by incorrect or uncertain identifications. For this reason, the detailed examination of as many specimens collected in the O.F.S. as was possible is regarded as very pertinent. Other problems include the possibility of species being introduced, and whether or not they occurred in an area recently restored to natural conditions. There are no cases of suspected amphibian translocations within the transect zone, but a record exists for the lizard *Lygodactylus c. capensis* from Kroonstad - an almost certain translocation (Yeadon, 1991a), and this record was therefore not considered during the current analysis.

One of the main problems involved in zoogeographical work is how to decide what constitutes a species boundary or range limit - is it the limit of the presumed normal range, or the limit to random movement, e.g. being washed down a river during floods? The latter is a strong possibility in the O.F.S., which periodically experiences heavy floods.

6.8 Setting up a transect

The transect zone is demarcated by 27°30'S and 28°30'S, from 24°45'E to 30°00'E (Fig. 123). This zone passes through a predominantly Kalahari Thornveld (Bushveld) area (2724 DB and DD, lower half of 27°S, 25°E), three degree squares of Highveld Grassland, followed by a predominantly high elevation, high rainfall, partly Afromontane area in the east. The quarter-degree grid format is accommodated by partitioning the east-west line into 21 quarter-degree intervals, each of which is about 24 km in length and comprises four quarter-degree units from top to bottom. The intervals have been given the notation 24d; 25a, b, c, d; 26a, b, c, d; 27a, b, c, d; 28a, b, c, d. Some landmarks are Warrenton, 24d; Hoopstad, 25d; Welkom, 26c; Kroonstad, 27a; Reitz, 28b; Harrismith, 29a; Newcastle, 29d (Fig. 123). The following quarter-degree units fall partly or wholly outside the O.F.S., but are contained within the transect zone - 2724 DB, DD; 2824 BB, BD; 2725 CA, CB, CC, CD; 2725 DA, DB; 2825 AA; 2726 CA; 2729 DA, DB, DC, DD; 2829 AC, AD, BA, BB, BC, BD.

Seven different symbols are used to indicate the occurrence or distribution of species and subspecies within each interval in the transect zone (Tables 18 & 19):

+ indicates a positive record.

0 indicates the absence of a record.

! indicates a positive record in a quarter-degree unit adjacent to (i.e. east or west, or north or south) of the most easterly (29d) or most westerly (24d) intervals within the transect zone; these symbols are regarded as representing "positive" records (i.e. +) for the purposes of calculations.

(!) as for symbol !, but not considered a positive or negative record; i.e. used in Tables 18 & 19 only for the purposes of indicating isolated records within the area bordering the transect zone.

/ indicates that the species or subspecies is not expected to occur in that interval (based on range clusters or "biological judgement"); not considered a positive or negative record, but used only to indicate range disjunctions for forms with positive records to the west and east.

← indicates that the range of the species or subspecies continues west of interval 24d (even if only slightly so) within the transect zone if extended westwards.

→ indicates that the range of the species or subspecies continues east of interval 29d (even if only slightly so) within the transect zone if extended eastwards.

The occurrence of each form (species or subspecies) in Tables 18 & 19 is shown by entering one of the above symbols in every relevant quarter-degree interval. Some intervals have only one locality (quarter-degree unit) plotted, whereas others have two, three, or the maximum of four, but the present study does not distinguish between intervals with respect to the number of records plotted within any one such interval.

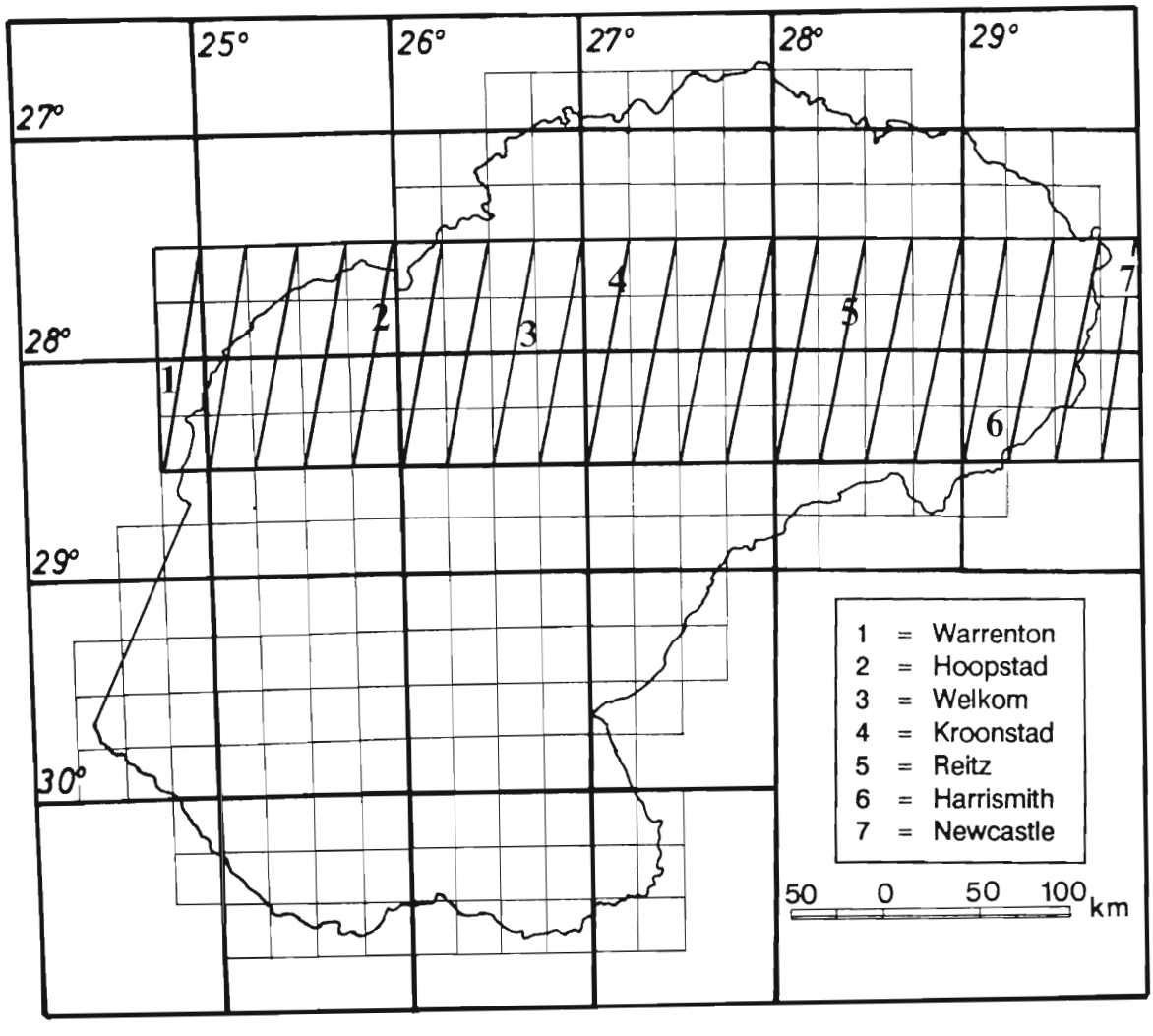


Figure 123: Transect zone through the northern part of the Orange Free State.

Table 18: Recorded ranges of amphibians within the transect zone, grouped into sets (see text).

	24	25				26				27				28				29				
	d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d	
SET 1 (n = 11)																						
Xenopus l. laevis	← !	0	0	+	0	+	+	0	0	0	0	0	0	+	0	+	+	0	0	0	+	→
Bufo gutturalis	← +	+	+	0	+	+	0	0	0	+	+	+	+	0	+	0	+	+	0	0	+	→
Bufo rangeri	+	0	0	0	0	+	0	0	+	+	+	0	+	+	+	+	+	+	+	+	0	→
Schismaderma carens	+	0	0	0	0	0	0	0	0	+	0	0	0	0	0	0	0	0	+	0	+	→
Pyxicephalus a. adspersus	+	+	+	+	+	0	0	+	0	0	0	0	0	0	0	0	0	+	+	0	!	→
Tomopterna cryptotis	+	+	+	+	+	0	0	0	+	+	0	+	+	+	+	+	0	+	+	0	+	→
Rana angolensis	← +	+	0	0	0	0	0	0	0	+	0	0	0	+	0	+	0	+	+	+	+	→
Rana fuscigula	← !	0	0	0	0	+	+	0	+	+	0	+	0	0	+	+	+	+	+	+	+	
Cacosternum boettgeri	!	0	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	0	0	→
Kassina senegalensis	+	+	0	0	+	0	+	0	0	+	+	+	0	+	+	+	0	0	+	0	+	→
Breviceps a. adspersus	+	0	0	+	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	+	→
SET 2 (n = 8)																						
Tomopterna krugerensis																					+	→
Ptychadena oxyrhynchus																					+	→
Hemisus guttatus																					+	→
Breviceps adspersus pentheri																		+	+	+	+	
Strongylopus f. fasciatus																		+	0	0	!	→
Kassina (Semnodactylus) wealii														+	+	+	+	+	+	0	!	
Strongylopus g. grayii											+	0	0	!	0	!	!	+	+	0	0	→
Tomopterna natalensis										+	0	0	0	0	0	0	0	0	+	+	+	→
SET 3 (n = 4)																						
Bufo vertebralis	!	+										(!)										
Phrynobatrachus natalensis	+	+	0	0	0	+				(!)		(!)			(!)		(!)				(!)	→
Bufo poweri	← +	+	+	+	+	0	0	0	+	+												
Bufo g. gariepensis	← +	/	/	/	/	/	/	/	/	/	/	(!)	(!)	+	0	+	0	+	+	+		
SET 4 (n = 1)																						
Cacosternum nanum																		+	+			

Table 19: Recorded ranges of reptiles within the transect zone, grouped into sets (see text).

	24	25				26				27				28				29			
	d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d
SET 1 (n = 17)																					
Mabuya capensis	← +	+	+	0	+	+	0	+	+	+	+	+	+	+	0	+	+	+	+	0	!
Mabuya varia	+	+	+	+	+	+	0	+	+	+	+	+	+	0	+	0	+	+	0	0	0 →
Mabuya striata punctatissima	!	!	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	0 →
Gerrhosaurus f. flavigularis	← +	+	0	0	0	0	0	0	+	+	+	0	+	+	0	+	0	+	+	+	+ →
Varanus n. niloticus	+	0	0	0	+	0	0	0	0	+	0	0	0	0	0	0	+	0	0	0	+ →
Leptotyphlops s. scutifrons	← +	+	0	0	0	0	0	0	0	+	0	0	0	+	+	+	+	+	+	0	+ →
Lamprophis aurora	!	0	0	0	+	0	0	0	+	+	0	+	+	+	+	0	+	+	0	+	+ →
Pseudaspis cana	← +	+	+	+	+	+	+	+	0	+	0	0	0	0	0	0	0	+	0	0	+ →
Crotaphopeltis hotamboeia	!	+	0	0	+	0	+	+	+	+	+	+	+	0	+	+	0	+	0	+	+ →
Dasypeltis scabra	← !	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+ →
Hemachatus haemachatus	!	0	0	+	0	0	0	0	0	+	0	0	0	0	+	+	+	+	+	+	+ →
Bitis a. arietans	← +	+	0	0	+	0	0	0	0	+	0	0	0	+	+	+	0	+	0	+	+ →
Lamprophis fuliginosus	← +	+	+	+	+	+	0	+	+	+	+	+	+	+	+	/	/	/	/	/	+ →
Lycophidion c. capense	+	+	+	+	+	0	0	0	0	+	+	+	0	/	/	/	/	/	/	/	+ →
Aparallactus capensis	+	+	+	+	+	+	0	0	+	+	+	+	+	+	/	/	/	/	/	/	+ →
Pelomedusa s. subrufa	← +	0	+	+	0	+	+	0	0	+	/	/	/	/	/	/	/	/	/	/	+ →
Chamaeleo d. dilepis	← +	+	+	+	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	+ →
SET 2 (n = 21)																					
Philothamnus hoplogaster																					+ →
Elapsoidea s. sundevallii																					+
Philothamnus natalensis occidentalis	(!)																			+	+ →
Agama aculeata armata																				+	0 →
Dasypeltis inornata																			+	+	+ →
Lycodonomorphus rufulus	(!)																	+	+	+	+ →
Lamprophis inornatus																		+	+	0	+
Causus rhombeatus	(!)																	+	0	+	+ →
Lamprophis guttatus																		+	0	0	0 →
Pachydactylus vansoni																	+	+	+	+	0 →
Cordylus v. vittifer																	+	+	+	!	! →
Nucras lalandii																+	+	+	+	+	0 →
Lamprophis fuscus																+	0	0	0	0	+
Typhlops bibronii														+	0	0	0	+	+	+	+ →
Pseudocordylus m. melanotus													+	+	+	0	+	+	+	+	! →
Duberria l. lutrix													+	0	0	0	0	0	+	0	0 →
Psammophis crucifer	(!)									+	+	+	+	+	+	+	+	+	+	+	+ →
Homoroselaps lacteus	(!)									+	+	0	0	0	+	0	+	+	+	+	+ →
Pedioplanis burchelli									+	0	0	0	0	+	+	+	+	+	+	+	+ →
Psammophylax r. rhombeatus									+	+	+	+	+	+	+	+	+	+	+	+	+
Cordylus giganteus								+	+	+	+	+	+	+	+	+	+	+	+	+	+
SET 3 (n = 27)																					
Pachydactylus bibronii	← +																				
Agama a. aculeata	← +																				
Acontias percivali occidentalis	+																				
Pedioplanis namaquensis	← +																				
Psammophis sibilans brevirostris	+																				
Mabuya s. sulcata	← 0	+																			(!) →
Ichnotropis squamulosa	← 0	+						(!)													
Philothamnus s. semivariegatus	← +	+																			
Atractaspis bibronii	+	0	0	+																	
Lygodactylus c. capensis	+	+	+	+																(!)	(!) →
Dispholidus t. typus	← !	+	+	+																	
Psammobates oculifer	← +	+	+	+				(!)													
Cordylus p. polyzonus	← +	+	+	+	+																
Naja nivea	← +	+	+	+	+																
Geochelone pardalis	← +	0	+	+	+	+															
Psammophylax tritaeniatus	← +	+	+	+	+	+															
Nucras intertexta	+	+	0	+	0	0	0	+	0	+											
Pedioplanis l. lineoocellata	← +	+	+	0	0	0	0	0	0	+											
Varanus a. albigularis	← +	+	+	+	0	0	+	0	0	+											
Monopeltis c. capensis	+	0	0	+	0	0	0	+	+	+											
Typhlops lalandei	← +	+	+	0	0	+	0	0	+	+	+										
Psammophis leightoni trinasalis	← +	+	+	+	+	+	+	+	+	+	+										
Nucras taeniolata holubi	← +	0	0	0	0	+	0	+	+	+	+	+									
Acontias g. gracilicauda	← +	0	0	+	+	+	+	0	0	+	+	+	+	0	0	+					
Agama a. atra	← +	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+				
Mabuya variegata punctulata	← 0	+	0	0	0	0	0	0	0	+	0	0	0	0	0	0	0	+			
Pachydactylus c. capensis	← +	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	

Table 19: (continued)

	24 d	25 a	b	c	d	26 a	b	c	d	27 a	b	c	d	28 a	b	c	d	29 a	b	c	d
SET 4 (n = 15)																			+		
Cordylus sp. ("Waterfall")																+	0	+			
Afroedura nivaria			+	0	0	0	0	+	0	+	+	0	+	0	0	+	+	+	(!)		
Agama aculeata distanti															(!)		(!)	+			
Tetradactylus breyeri															+	+	(!)				
Pseudocordylus melanotus subviridis														+	0	+					
Bitis atropos															+	(!)					
Tropidosaura essexi													+			(!)	(!)		(!)		(!)
Chamaesaura aenea										+	+	0	+								
Prosymna s. sundevallii											+										
Elapsoidea sundevallii media	← (!)																				(!) →
Panaspis wahlbergii		+	+	0	0	0	+	0	+	+	+										
Homoroselaps dorsalis										+											
Homopus femoralis								+													
Prosymna bivittata			+	+		+															
Agama h. hispida			+					(!)													

Distribution records (for O.F.S. and extralimital areas) for amphibians were obtained from this study, Poynton (1964, for southern Africa), Jacobsen (1989, for Transvaal) and Lambiris (1989a, for Natal); while reptile records are from this study, Broadley & Greer (1969, *Acontias g. gracilicauda*), Broadley (1972, *Nucras taeniolata*), Broadley (1975, *Mabuya variegata punctulata*), FitzSimons (1943, southern African lizards), Greig & Burdett (1976, southern African tortoises), Broadley (1977a, *Mabuya striata punctatissima*), Bourquin & Channing (1980, for Natal Drakensberg), McLachlan (1981, *Agama aculeata* sspp.), Visser (1984a-h, lizards in southern Africa), Lambiris (1989b, *Agama aculeata armata* and *Chamaesaura aenea* in Royal Natal National Park), Jacobsen (1989, for Transvaal), Bourquin (1990a-c, for Natal) and Broadley (1990, southern African snakes).

Fortunately, both the Transvaal (Jacobsen, 1989) and Natal (Lambiris, 1989a - amphibians only; Bourquin, 1990a-c - reptiles only) have recently been surveyed and several records are available from these areas falling within and peripheral to the transect zone. There are currently no amphibian species and only three reptile species (*Psammophis sibilans brevirostris; Philothamnus s. semivariegatus; Acontias percivali occidentalis* - needs confirmation) from the Transvaal included in that part of the transect cutting through the south-western Transvaal that are not recorded from the O.F.S., suggesting that for the purposes of this study, the Vaal River is not a significant barrier influencing the ranges of species found on either side of the river. There were three amphibian taxa recorded from the eastern (Natal) part of the transect which have not been recorded from the O.F.S., namely *Tomopterna krugerensis, Ptychadena oxyrhynchus* and *Hemisus guttatus*; also *Breviceps adspersus pentheri* has been recorded from the north-eastern O.F.S., but is unrecorded from the O.F.S. part of the transect. In addition, one lizard (*Agama aculeata armata*) and three snake species (*Philothamnus hoplogaster, Elapsoidea s. sundevallii, Dasypeltis inornata*) from the Natal part of the transect were not recorded from the O.F.S. There was only one reptile taxon (*P. s. semivariegatus*) from the Cape Province part of the transect which does not occur in the O.F.S.; also, *Agama a. aculeata* and *Pedioplanis namaquensis*,

both of which occur in the south-western O.F.S., have only been recorded from the Cape Province part of the transect.

No amphibian or reptilian species or subspecies was represented by positive records in every quarter-degree interval along the transect zone, although some had records in most intervals, e.g. *Dasypeltis scabra* lacks records only in interval 24d, whereas *Pachydactylus c. capensis* lacks records only in 29d. As noted by Poynton (1992, p. 3), the absence of a record could be a result of the absence of the taxon from the interval, or it may reflect failure to collect material despite the interval being included within the overall range of the taxon. Fossorial and rarely emerging species are usually represented by few and scattered records (e.g. *Atractaspis bibronii*, *Xenocalamus b. bicolor, Breviceps* spp.). If an interval that lacks an actual record lies between intervals with positive records, the assumption is made that such an interval is included within the range of the taxon within the transect zone. However, in the case of the frogs *Breviceps a. adspersus* and *Bufo g. gariepensis* (not recorded from the most easterly interval), and the arboreal lizard *Chamaeleo d. dilepis*, distribution records indicated a distinct disjunction in distribution between the western and eastern ends of the transect. *B. a. adspersus* may not be as sparingly distributed in the northern O.F.S. as currently appears to be the case, but the species does appear to be in the process of moving southwards. *B. g. gariepensis* appears to occur in bushveld (western end) (cf. Poynton, 1964) and mountainous areas (eastern end of transect), but is absent from the central grassland areas, including the Highveld. The same applies to *C. d. dilepis*, although it is known from savanna in western Natal and not from mountainous areas in that region. An actual distribution gap for the grassland region of the transect is thus presumed for *B. a. adspersus, B. g. gariepensis* and *C. d. dilepis*. An additional four reptile species also have disjunct distributions, namely *Lamprophis fuliginosus, Lycophidion c. capense, Aparallactus capensis* and *Pelomedusa s. subrufa*. For the species listed above, intervals lacking records are marked /, indicating that the species "is known" not to occur there, while in other cases, if an interval lacking a record lies between intervals with positive records, the interval lacking a record is included in the "known" range of that taxon, and marked 0 in Tables 18 & 19. The symbol ! is used only for intervals at the western and/or eastern ends of the transect so as to allow for the placing of particular wide-ranging forms into set 1, 2 or 3, as is applicable to the overall southern African distribution of the form within an extension of the transect zone.

Tables 18 & 19 show, respectively, the various amphibians (24 forms) and reptiles (80 forms) recorded along the transect zone. Taxa are grouped into four sets based on estimations of the known range of each taxon. Set 1 contains those taxa presumed to occur along the entire length of the transect zone; set 2 includes forms recorded from the high-elevation eastern area, 29d, but lacking records at the western end of the transect zone; set 3 includes forms found at the western end but lacking records at the eastern end of the transect zone; and set 4 includes forms unrecorded at both ends of the transect zone.

The percentage composition of these sets for O.F.S. amphibians and reptiles is shown in Tables 24 & 25 respectively. In Table 18, the frog *Breviceps a. adspersus* is placed as the last species in Set 1. This has been done so as to indicate that, although it has positive records at both ends of the transect zone, a range disjunction is apparent, and the distribution of the species within the transect zone is not typical of other forms grouped into Set 1. *B. a. adspersus* therefore represents a subdivision (or subset) of Set 1. The distribution of *Bufo g. gariepensis* as indicated by its occurrence as shown in Set 3, suggests a similar situation, and it can be regarded as representing a subdivision of Set 3. By the same reasoning, the five reptile species listed at the end of Set 1 in Table 19 (i.e. *Lamprophis fuliginosus, Lycophidion c. capense, Aparallactus capensis, Pelomedusa s. subrufa* and *Chamaeleo d. dilepis*) can be regarded as a subdivision of that set. In the case of *Pachydactylus c. capensis* it could be argued that the lack of a record in the most easterly interval only should not mean that the taxon is not distributed throughout the transect zone. However, the species is apparently replaced by the closely related *P. vansoni* in that region, and although Bourquin (*in press.*) records "*P. capensis*" from western Natal, it is unclear as to whether or not the specimens are "*P. c. capensis*" or "*P. c. vansoni*". It has therefore been accepted that interval 28c represents the eastern range limit of *P. c. capensis* in the O.F.S./Natal area, justifying the placing of *P. c. capensis* as a "wide-ranging" western form. Sets 1 to 4 do not correspond with zoogeographical classifications covering the whole of southern Africa, or the whole of the O.F.S., as the transect zone is restricted to a smaller and more homogeneous area.

The only way to test whether or not the known ranges of a taxon correspond with actual (or "true") ranges is to obtain more records (Poynton, 1992, p. 3). The degree of confidence that can be held regarding such correspondence can, however, be assessed by estimating the intensity, or success of collecting, in each quarter-degree interval by calculating the ratio of + and ! symbols to 0 entries in each interval (Poynton, 1992, p. 3) as presented in Tables 20 & 21. These tables show the calculated ratios expressed as the percentage of + (and !) symbols in each interval (e.g., in interval 27a of Table 20 there are 10 "+" and 2 "0" entries, therefore 10 out of a total of 12 = 83% intensity of collecting).

Tables 20 & 21 both indicate fairly intensive collecting at either end (and very intense collecting in the middle, 27a) of the transect zone, allowing some confidence about the assignation of the various taxa to the sets 1 to 4. However, variability in the ratios indicates that the data are not suitable for mechanical methods of analysis, which require uniformity in sampling.

Table 20: Estimated percentage intensity (or success) of amphibian collecting in quarter-degree intervals within the transect zone.

24	25				26				27				28				29			
d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d
11/15	8/14	5/13	6/13	6/12	6/12	4/11	2/11	5/11	10/12	4/12	5/12	4/12	8/14	7/14	9/14	6/14	13/17	14/17	6/16	13/19
73%	57%	38%	46%	50%	50%	36%	18%	45%	83%	33%	42%	33%	57%	50%	64%	43%	76%	82%	38%	68%

Table 21: Estimated percentage intensity (or success) of reptile collecting in quarter-degree intervals within the transect zone.

24	25				26				27				28				29			
d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d
35/44	30/40	26/39	26/39	21/34	17/32	11/29	16/31	19/32	35/36	23/31	16/27	20/29	19/29	19/29	21/30	20/29	29/32	22/31	22/32	28/38
80%	75%	67%	67%	62%	53%	38%	52%	59%	97%	74%	59%	69%	66%	66%	70%	69%	91%	71%	69%	74%

6.9 Range boundaries and patterning

The adequacy of locality data can be investigated by determining whether or not a coherent picture emerges of the distribution of known range boundaries and patterning of ranges (Poynton, 1992, p. 3). Poynton (1992, p. 3) suggested that the "known range boundaries" of a taxon may be taken to occur at those intervals containing its most westerly and easterly records (excluding *Breviceps a. adspersus, Bufo g. gariepensis* and *Chamaeleo d. dilepis*, *Lamprophis fuliginosus, Lycophidion c. capense, Aparallactus capensis* and *Pelomedusa s. subrufa* in the present study as explained earlier), and if a taxon occurs in one interval only, both boundaries can be assumed to occur in the ± 24-km-wide interval. This is shown in Tables 22 & 23, in which the boundaries have been partitioned according to sets 1 to 4 of Tables 18 & 19.

Poynton (1992, p. 3) noted that amphibian "forms occurring in Bloemfontein continue their range westwards, so no westerly boundaries occur at the western end of the transect zone". However, he included *Bufo gutturalis* in his set 2 (lowland forms), failing to note that this species also extends west to 2923 BB; and *Breviceps a. adspersus* also occurs in Kimberley (Poynton, 1964), albeit showing a disjunct distribution, being absent from all but the Cape Province and Transvaal border with the O.F.S. in the transect zone area.

In the present study, a western boundary (see Poynton, 1964) has been recognized for nine amphibian species (Tables 18 & 22) and 16 reptile species (Tables 19 & 23), whereas seven amphibian and seven reptilian eastern range limits are recognized (Tables 18 & 19 and 22 & 23 respectively). Some other taxa reach their western limits (at least in central South Africa) in the vicinity of, and near to, the western end of the transect zone (see Poynton, 1964; Branch, 1988a), but comments are here limited to occurrence within the transect zone extended westwards and eastwards to the coastline in southern Africa. Any statement regarding the western or eastern "range limits" of a species should be treated with caution, however, as species may be absent within large areas, but "reappear" westwards or eastwards where environmental conditions are again suitable (see also Poynton, 1962). In the case of both amphibians and reptiles, the lack of collecting in the northern Cape Province (i.e. Cape north of the Orange River) might in part explain the large number of "range limits" in the 24d interval at the western end of the transect.

The relatively large numbers of amphibian range boundaries in intervals 24d (nine) and 29d (seven) indicate dynamic biogeographical situations in those areas, subtraction occurring eastwards and westwards (Tables 18 & 22). Intervals 29a to 29d include 12 such range boundaries, clearly indicating that the Drakensberg mountains are a barrier to frog distribution. The large number of range boundaries at the western end (24d) might be indicative of bushveld or grassland (and the associated climatic variables) as a limiting factor to distribution, especially when related to the higher temperatures and lower rainfall at the western end of the transect zone.

Table 22: Number of presumed amphibian range boundaries occurring in each quarter-degree interval within the transect zone.

SET	24	25				26				27				28				29			
	d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d
1	7	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
2	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	2	0	0	5
3	2	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
Total	9	1	0	1	0	1	0	0	0	2	1	0	0	2	0	0	0	3	1	1	7

Table 23: Number of presumed reptile range boundaries occurring in each quarter-degree interval within the transect zone.

SET	24	25				26				27				28				29			
	d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d
1	7	0	0	1	0	0	0	0	0	1	0	0	0	2	1	0	0	0	0	0	1
2	0	0	0	0	0	0	0	1	2	2	0	0	2	1	0	2	2	4	1	2	6
3	9	3	0	4	2	2	0	0	0	4	2	1	0	0	0	1	1	1	0	1	0
4	0	1	2	1	0	1	0	1	0	2	2	0	2	1	2	3	0	3	1	0	0
Total	16	4	2	6	2	3	0	2	2	9	4	1	4	4	3	6	3	8	2	3	7

Table 24: Percentage composition of sets 1-4 of the present amphibian transect in comparison with that of Bloemfontein - Durban and Chinhoyi - Beira transects (Poynton, 1992).

SET	Present transect		Bloemfontein - Durban transect		Chinhoyi - Beira transect	
	No. of forms (N = 24)	% of 24	No. of forms (N = 53)	% of 53	No. of forms (N = 67)	% of 67
1	11	45,8	5	9,4	16	23,9
2	8	33,3	21	39,6	23	34,3
3	4	16,7	6	11,3	20	29,9
4	1	4,2	21	39,6	8	11,9

Table 25: Percentage composition of sets 1-4 of the reptile transect.

Set	No. of forms (N = 80)	% of 80
1	17	21,3
2	21	26,3
3	27	33,8
4	15	18,8

For reptiles in the transect zone, large numbers of range boundaries occur in intervals 24d (16), 27a (nine) and 29a (eight) and 29d (seven). These areas appear to represent dynamic biogeographical situations, subtraction occurring eastwards and westwards (Tables 19 & 23). Intervals 28a to 29d have a total of 36 range boundaries (i.e. 39,6% of all boundaries [= 91] in transect zone), again suggesting the importance of the mountainous eastern O.F.S. as a limiting area (or "cut-off" point) for distribution. The large number of boundaries in interval 24d (sixteen) may be at least partially explained in the same way as for amphibians, i.e. the northern Cape has been poorly collected. Interval 27a has nine reptile range boundaries, representing part of the relatively narrow east-west subtraction margin (see also Fig. 115 for overlap region of Western and Eastern range clusters).

The composition of sets 1-4 for amphibians and reptiles is shown in Tables 24 & 25. For amphibians, Set 1 is by far the largest, while for reptiles Set 3 (western forms) is the largest.

Table 26: Amphibian diversity (number of forms recorded in each quarter-degree interval) based on presumed ranges, in the transect.

SET	24	25				26				27				28				29			
	d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d
1	11	11	11	11	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	11
2	0	0	0	0	0	0	0	0	0	1	2	2	2	3	3	3	3	5	5	5	8
3	4	3	2	2	2	2	1	1	1	1	0	0	0	1	1	1	1	1	1	1	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
Total	15	14	13	13	12	12	11	11	11	12	12	12	12	14	14	14	14	17	17	16	19
% 29d	79	74	68	68	63	63	58	58	58	63	63	63	63	74	74	74	74	74	74	84	100

Table 27: Reptile diversity (number of forms recorded in each quarter-degree interval) based on presumed ranges, in the transect.

SET	24	25				26				27				28				29			
	d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d
1	17	17	17	17	16	16	16	16	16	16	15	15	15	15	13	12	12	12	12	12	17
2	0	0	0	0	0	0	0	1	3	5	5	5	7	8	8	10	12	16	17	19	21
3	27	22	19	19	15	13	11	11	11	11	7	5	4	4	4	4	3	2	1	1	0
4	0	1	3	3	3	3	2	3	2	4	4	2	3	2	4	4	2	3	1	0	0
Total	44	40	39	39	34	32	29	31	32	36	31	27	29	29	29	30	29	33	31	32	38
% of 24d	100	91	89	89	77	73	66	70	73	82	70	61	66	66	66	68	66	75	70	73	86
% of 29d	116	105	103	103	89	84	76	82	84	95	82	71	76	76	76	79	76	87	82	84	100

6.10 Diversity and turnover

In the case of amphibians, Table 26 indicates that the diversity at the western end of the transect zone is 79% that of the eastern end. This is much higher than the 42% determined by Poynton (1992) for the Bloemfontein area as compared to the Durban area. The reason for this is partly explainable by the fact that diversity in the 29d interval is much lower than that in Poynton's (1992) Durban area (i.e. 19 vs 26 forms), and 24d has 15 forms recorded, compared to 11 in the Bloemfontein area. It is fortunate that both the present transect and that of Poynton (1992) have western ends in well collected areas (i.e. Kimberley and Bloemfontein respectively). Poynton (1992, p. 6) also noted that there is slightly less of a turnover between Bloemfontein and the Drakensberg than between the Drakensberg and the coast (38% vs 42% similarity). Considering the fact that only eight forms are found in Set 2, compared to Set 3 (which has four forms), a much less dramatic difference in diversity at either end of the transect zone can be expected. Most intervals (25a to 28d) have only 11-14 forms, suggesting that the grassveld region of the O.F.S. supports a "species-poor" amphibian population. Although there are no abrupt changes along the transect zone, a fairly distinct turnover of species and subspecies is demonstrated (Table 18), although only *Bufo poweri* of the four taxa grouped into Set 3 appears certain not to occur in the eastern half of the O.F.S., as judged by records extralimital to the transect zone (marked with the symbol !). The present study, as was the case with Poynton's (1992) study, corroborates Crowe's (1990, his Fig. 26) findings regarding a drop in species diversity from east to west in southern Africa.

In the case of reptiles, Table 27 indicates that the diversity at the eastern end of the transect zone is 86% that of the western end. This is the reverse situation found in amphibians, where diversity is highest at the eastern end of the transect zone. Most reptile intervals have fewer than 34 recorded forms, the lowest being 27 (27c). The large number of species and subspecies (36) at interval 27a can be related to the high number of species boundaries in that interval (i.e. nine), as this area is part of the overlap margin between Eastern and Western range clusters. There are no abrupt changes along the transect zone, but a distinct turnover of taxa is apparent from west to east (Table 19).

6.11 Causal factors of distribution patterns

To determine possible causal factors for the plotted occurrence of amphibian and reptilian taxa, correlations between distribution records or patterns and maps of the O.F.S. showing rainfall (Fig. 11), temperature (Figs 8 & 9) and topographic relief (Fig. 6) were sought. Table 28 lists amphibian forms and their association with nine environmental variables. However, only rainfall, temperature and relief are discussed in more detail, as correlations of distribution with other variables indicated extensive variation. Table 29 shows the same nine environmental variables grouped according to the nine range clusters (Fig. 114) determined for amphibians. As the number of reptilian taxa is large, and as comparisons could not be made due to the fact that similar studies on southern African reptiles have not been conducted, correlations were looked for between the 13 reptile range clusters and the 19 environmental variables shown in Table 29. As for amphibians, only correlations with rainfall, temperature and topographic relief were examined in detail (see Table 29).

Table 28: Environmental variables related to amphibian distribution in the Orange Free State.

Species/ Subspecies	Topographic Relief 1 = < 915 m 2 = 916-1218 m 3 = 1219-1522 m 4 = 1523-1823 m 5 = 1824-2134 m	Frost Zones 1 = moderately severe 2 = severe	Humidity zones 1 = semi-arid 2 = semi-humid 3 = humid	Mean June isotherms °C (e.g. between 6 & 7 °C)	Effective Temperature °C (e.g. 14 - 14,5 °C)	Mean January isotherms °C (e.g. 22 - 23 °C)	Geological Formations 1. Dwyka 2. Ecca 3. Beaufort 4. Stormberg 5. Basalt VD = Vredefort Dome	Mean annual precipitation (e.g. between 400 - 500 mm)	% Summer rainfall (e.g. between 74 - 76%)
X. l. laevis	1 - 5	1,2	1,2	6 - 10	14 - 15	18 - 25	1 - 5 not VD	300 - 800	68 - 82
H. natalensis	4	1	3	6 - 7	13 - 14	18 - 19	4/5 not VD	800	80 - 82
B. gutturalis	1 - 5	1,2	1,2	7 - 10	14 - 16	18 - 25	1 - 4 not VD	300 - 800	74 - 84
B. g. gariepensis	1 - 5	1,2	1 - 3	6 - 10	13 - 16	18 - 25	1 - 3, 5 not VD	300 - 1000 +	68 - 84
B. vertebralis	2, 3 (1 marg.)	1,2	1 (2 marg.)	7 - 10	14 - 16	21 - 25	1 - 3 (4 marg.) VD 1,2 (3 marg.) not VD	300 - 700	68 - 82
B. poweri	1,2	1	1	8 - 10	14,5 - 16	23 - 25	1 - 5 VD	300 - 600	72 - 84
B. rangeri	1 - 5	1,2	1 - 3	6 - 10	13 - 16	18 - 25	1 - 3 VD	300 - 900	72 - 84
S. carens	2, 3	1,2	1,2	6 - 9	13 - 16	18 - 23	1 - 3 (VD marg.)	600 - 800	78 - 84
Br. a. adspersus	1 - 3	1	1,2	8 - 10	14,5 - 16	21 - 25	5 not VD	400 - 800	76 - 84
Br. maculatus	4	2	2	6 - 7	13 - 14	18 - 19	3 not VD	800	80
Br. a. pentheri	4	2	2	7 - 8	13 - 14	18 - 19	1 - 3 VD	700 - 800	82
P. a. adspersus	1 - 3	1,2	1,2	7 - 10	14 - 16	18 - 25	1 - 4 not VD	300 - 700	72 - 84
T. cryptotis	1 - 4	1,2	1 - 3	6 - 10	13 - 16	17 - 25	2, 3, 5 not VD	300 - 800	68 - 84
T. natalensis	2, 3	1,2	1 - 3	6 - 8	13 - 15	18 - 24	1 - 5 not VD	500 - 800	78 - 82
R. fuscigula	1 - 5	1,2	1 - 3	6 - 10	13 - 16	18 - 25	1 - 5 VD	300 - 1000	68 - 84
R. angolensis	1 - 5	1,2	1 - 3	6 - 10	13 - 16	18 - 25	3 - 5 not VD	300 - 1000 +	72 - 84
S. g. grayii	3 - 5	1,2	1 - 3	6 - 8	14 - 14,5	18 - 22	3 - 5 not VD	500 - 900	74 - 84
S. f. fasciatus	3 - 4	1,2	1 - 3	6 - 7	13 - 14,5	18 - 20	5 not VD	600 - 800	78 - 82
S. hymenopus	4/5	1	3	6	14	18	5 not VD	900	82
A. hewitti	4/5	1	3	6	14	18	1 - 4 not VD	900	82
Ph. natalensis	1 - 3	1	1,2	6 - 10	13 - 16	18 - 25	1 - 4 not VD	400 - 800	76 - 84
C. boettgeri	1 - 4	1,2	1,2	7 - 10	13 - 16	18 - 25	3/4 not VD	300 - 800	68 - 84
C. nanum	3	1	2	7	14	18	1 - 4 not VD	800	82
K. senegalensis	1 - 4	1,2	1,2	6 - 10	13 - 16	19 - 25	2 - 4 not VD	300 - 800	68 - 84
K. wealii	2 - 5	1,2	1,2	6 - 9	13 - 15	18 - 22	3 not VD	600 - 800	78 - 84
P. a. edulis	2	1	1	8	14,5 - 15	23		500	76

Table 29: Environmental variables related to amphibian and reptilian range clusters in the Orange Free State.

CLUSTER GROUP	Topographic Relief 1 = < 915 m 2 = 916-1218 m 3 = 1219-1522 m 4 = 1523-1823 m 5 = 1824-2134 m	Frost Zones 1 = moderately severe 2 = severe	Humidity zones 1 = semi-arid 2 = semi-humid 3 = humid	Mean June isotherms °C (e.g. between 8 - 10 °C)	Effective Temperature °C (e.g. 14 - 14,5 °C)	Mean January isotherms °C (e.g. 22 - 23 °C)	Geological Formations 1. Dwyka 2. Ecca 3. Beaufort 4. Stormberg 5. Basalt VD = Vredefort Dome	Mean annual precipitation (e.g. between 400 - 500 mm)	% Summer rainfall (e.g. between 74 - 76%)
AMPHIBIANS									
D	1522 - 2134	1,2	2,3	6 - 7,5	14	18 - 19	3 - 5 not VD	700 - 1000	80 - 84
S	915 - 1522	1,2	1	7 - 10	14 - 16	19 - 25	1 - 4 VD	300 - 600	66 - 82
N & W	915 - 1522	1,2	1,2	8 - 10	14,5 - 15	21 - 25	1 -3 VD	300 - 800	74 - 84
N & NE	1218 - 2134	1,2	1 - 3	6 - 9	13 & 15/16	18 - 23	2 - 4 VD	500 - 1200	80 - 84
E	1218 - 2134	1,2	1 - 3	6 - 8	13 - 15	18 - 22	2 - 4 not VD	500 - 1200	74 - 84
Non- SW	915 - 2134	1,2	1 - 3	6 - 10	13 - 16	18 - 25	1 - 5 VD	300 - 1200	70 - 84
W	915 - 1218	1	1	8 - 10	15 - 16	23 - 25	1 - 2 (3 marg.) not VD	300 - 600	72 - 84
S & E	915 - 1218	1,2	1 - 3	10	13 - 15	21 - 25	1 - 5	300 - 1200	66 - 84
REPTILES									
D	1522 - 2134	1,2	2,3	6 - 9	13 - 15	18 - 21	3 - 5 not VD	700 - 1200	80 - 84
NE	1522 - 2134	1,2	2,3	6 - 9	13 - 15	18 - 22	2 - 5 not VD	600 - 1200	78/80 - 84
E	1218 - 2134	1,2	1 - 3	6 - 9	13 - 16	18 - 24	2 - 5 VD	400 - 1200	68 - 84
N & NE	1218 - 2134	1,2	1 - 3	6 - 10	13 - 16	18 - 24	2 - 5 VD	500 - 1200	80 - 84
W	915 - 1522	1,2	1	7 - 10	14 - 16	23 - 25	1 - 3 not VD	300 - 600	66 - 84
SW	915 - 1522 (mostly 915-1218)	1	1	7½ - 10	13 - 16	22 - 25	1 - 3 not VD	300 - 400	66 - 80
NW	915 - 1218	1	1	9 - 10	15 - 16	24 - 25	1 - 2 not VD	400 - 500	74 - 84
C	1218 - 1522	1,2	1,2	7 - 10	14,5 - 16	20 - 24	2,3 (4 marg.) VD	400 - 700	72 - 84
Non - NE	915 - 2134	1,2	1 - 3	6 - 10	13 - 16	18 - 25	1 - 5 VD	300 - 1000	66 - 84
Non - SW	915 - 2134	1,2	1 - 3	6 - 10	13 - 16	18 - 25	1 - 5 VD	400 - 1200	66 - 84
S	915 - 1823	1,2	1,2	7 - 10	14,5 - 16	20 - 25	1 - 4 (mostly 1-3)	300 - 700	66 - 84
SE	1523 - 1823	1	1	8	14	22 - 23	3 - 4	400 - 500	66 - 84

6.11.1 Amphibians

a) Precipitation

All forms in range cluster T (found throughout O.F.S.) and Non-SW (with the exception of *Phrynobatrachus natalensis* which is not found in areas with less than 400 mm mean annual precipitation) occur in regions with between 300-800 mm mean annual precipitation. Some species in this group also occur in the narrow higher-rainfall area of the O.F.S. (i.e. 1000 mm +). The only member of the Southern group, namely *Bufo vertebralis*, occurs in areas of 300-700 mm mean annual precipitation, and the only member of the S & E group, *Bufo g. gariepensis*, occurs in regions of 300-1000 mm mean annual precipitation, being replaced to the east in Natal by the monticolous subspecies *B. g. nubicolus*. The Western form, *Bufo poweri*, occurs in areas receiving 300-600 mm mean annual precipitation. *Breviceps a. adspersus* of the N & W group occurs in areas with 400-800 mm precipitation. *Tomopterna natalensis* (N & NE) occurs in areas with 500-800 mm, whereas the other member of its group, *Schismaderma carens*, is found in areas receiving 600-800 mm precipitation. The forms included in the Eastern (E) cluster occur primarily in the 600-800 mm zone, although *Strongylopus g. grayii* has records in the 500-900 mm area. The six Drakensberg (D) forms occur in areas with a mean annual precipitation of 800 mm or more, although *Breviceps adspersus pentheri* is found only in an area receiving between 700-800 mm precipitation.

With reference to Table 28, at least four fairly distinct groupings can be made according to the main occurrence of O.F.S. forms in relation to mean annual precipitation. The first includes forms is clusters T (300-800 mm) and N & W (400-800 mm; this is an uncertain grouping because of a lack of distribution records. The second grouping is an assemblage of essentially eastern forms occurring primarily within the 600-800 mm area (E, NNE, D), the third is a western and southern group found in the 300-600 mm area (W, S), and the fourth a group largely restricted to the 300-800 mm area, i.e. avoiding the driest (south-western) part of the province (Non-SW, S & E). The above groupings are also suggested by Table 29.

b) Temperature

Forms assigned to range cluster T, Non-SW, S & E and S occur in areas experiencing mean June ambient temperatures of 6-10°C (or 7-10°C). The Western form *Bufo poweri* and N & W form *Breviceps a. adspersus* occur in the warmer 8-10°C area. The easterly forms are found in areas with June temperatures mainly between 6-8°C (E, D and N & NE), although *Schismaderma carens* occurs in an area with temperatures of 6-9°C. From the above it is evident that three main groupings are indicated, namely a generalized group (T, Non-SW, S & E, S) (6-10°C), a western group (W, N & W) (8-10°C) and an eastern group (E, D, N & NE) (6-8°C).

In terms of mean January temperatures, clusters T, Non-SW, S & E, S and N & NE occur within areas with temperatures of 18-25°C (17-25°C for *Tomopterna cryptotis*; 19-25°C for *Kassina senegalensis*; 18-23°C for *Schismaderma carens*; 18-24°C for *Tomopterna natalensis* and 21-25°C for both *Bufo vertebralis* and *Breviceps a. adspersus*). A second group (23-25°C) is composed only of *Bufo poweri* (W), while the third includes clusters E and D and experiences temperatures of mainly 18-20°C (18-22°C for *Strongylopus g. grayii*); the area in which the Drakensberg cluster (D) occurs (six forms) has an even more restricted temperature range, namely 18-19°C. As for mean June temperatures, O.F.S. amphibians can be assigned to three main groupings, namely a generalized group (T, Non-SW, S & E, S, N & NE, N & W) (18-25°C), a western group (W) (23-25°C) and an eastern group (E, D) (18-20°C). The only differences here are that *Breviceps a. adspersus* is placed in the generalized group rather than the western group as was the case with June temperatures (it occurs effectively in the intermediate area between the generalized and western groupings for January temperatures), and *S. carens* and *T. natalensis* of the N & E group are placed in the generalized group rather than the eastern group.

c) Topographic relief

Amphibian forms were assigned to one or more of the following five elevation "zones": (1) <915 m, (2) 916-1218 m, (3) 1219-1522 m, (4) 1523-1823 m, (5) 1824-2134 + m. The following groupings were determined: zones 1-5 (including *Tomopterna cryptotis* and *Kassina senegalensis*), 1-4 - *Kassina wealii*, and zones 2-5 - which includes virtually all forms assigned to clusters T (excluding *Pyxicephalus a. adspersus),* Non-SW (excluding *Phrynobatrachus natalensis*) and S & E forms, zone 1-3 (most forms occur in at least two zones, see Table 28) which includes all forms in clusters W, S, N & NE and N & W, with the addition of *Pyxicephalus a. adspersus* (T), and zone 3-5 (most forms occur in at least two zones see Table 28) which includes all forms assigned to cluster E (with the exception of *Kassina wealii* which occurs in zones 2-5) and D (five forms are found in zones 4, or 4 and 5, whereas *Cacosternum nanum*, being an easterly form and known by its precise locality to fit here, has been placed in this zonal grouping rather than the second). While the "zonal groupings" used above are somewhat coarse (the exact elevation at which specimens were collected was usually not known), they are useful in that they indicate three general groupings, namely one in which species and subspecies are found at a variety of low and high elevations in the O.F.S. (zone 1), a grouping of low-elevation, grassland forms (zone 2) and a high-elevation, largely montane group (zone 3).

6.11.2 Reptiles

a) Precipitation

Four groupings were established using data in Table 29. The first is a region with a mean annual precipitation of 300-1200 mm per annum - clusters T, E (400-1200 mm), Non-NE (300-1000 mm), and Non-SW (400-1200 mm); the second group experiences 300-700 mm precipitation per annum and includes clusters S, SE (400-500 mm), W (300-600 mm), SW (300-400 mm) and NW (400-500 mm); the third has 500-1200 mm per annum and includes NE (600-1200 mm), D (700-1200 mm) and N & NE (500-1200 mm); and the fourth contains only the three species comprising the Central group, with precipitation of 400-700 mm per annum.

b) Temperature

Three groupings based on similar mean June and January temperatures (Table 29) were identified: a western group experiencing mean June temperatures of 7-10°C (W, 7-10°C; SW, 7,5-10°C; NW, 9-10°C; C, 7-10°C; S, 7-10°C) and mean January temperatures of 20-25°C (W, 23-25°C; SW, 22-25°C; NW, 24-25°C; C, 20-24°C; S, 20-25°C); an eastern group experiencing June temperatures of 6-10°C (D, 6-9°C; NE, 6-8,5°C; E, 6-9°C; N & NE, 6-9,5°C; Non-NE, 6-10°C; Non-SW, 6-10°C), and January temperatures of 18-25°C (D, 18-21°C; NE, 18-22°C; E, 18-24°C; N & NE, 18-24°C; Non-NE, 18-25°C; Non-SW, 18-25°C) and group T which experiences the full range of conditions.

c) Topographic relief

Seven groupings based on the elevation, or range of elevation, at which its component species and subspecies are found, are demonstrable (see Table 29). The range of elevations used here are the same as those (numbers 1-5) for amphibians: Zone 1 includes clusters T, Non-NE and Non-SW; zone 2 includes clusters W, S and SW; zone 3 includes only cluster C; zone 4 includes only cluster NW; zone 5 includes only cluster SE; zone 6 includes clusters E and N & NE; and zone 7 includes clusters D and NE (see Table 29).

In summary, the range clusters identified for amphibians and reptiles correspond largely with the west-east differentiation of rainfall, temperature and topography, as indicated above. The western half of the O.F.S. is drier, warmer and of a low elevation, whereas the eastern half of the province is wetter, cooler and more mountainous (higher elevation).

6.12 **Distribution patterns of southern African Amphibia**

The amphibian population of southern Africa is polarized into two main faunal groups, one centered in the north-east and the other in the south-west, with a complex intermediate complex (Poynton, 1964, p. 222). Poynton's (1964) faunal units were determined from distribution patterns represented on maps, as opposed to preselected geographical divisions (i.e. habitat-based).

A Tropical Fauna

The north-eastern assemblage is considered a tropical fauna. According to Poynton (1964, p. 223), a "tropical form" is one with a substantial part of its range included in an area with a tropical climate as defined by Köppen, i.e. in which the coldest month of the year has a mean temperature above 18°C.

Poynton (1964, p. 223) found that 41 forms (32,5% of all amphibian forms known from southern Africa up to 1964) belonged to the Tropical Fauna. Seven (28%) of the 25 O.F.S. forms (*Pyxicephalus adspersus edulis* is excluded here on account of its questionable occurrence in the O.F.S.) fall into this category, namely: *Bufo gutturalis, Schismaderma carens, Pyxicephalus a. adspersus, Tomopterna cryptotis, Rana angolensis, Phrynobatrachus natalensis, Kassina senegalensis*.

Most tropical forms have wide ranges, including those listed above, and occur at least as far north as Tanzania, with the majority occupying savanna south and east of the Congo basin; and eight forms extend north of the Congo basin along the savanna of West Africa, including four O.F.S. forms, *viz. Bufo gutturalis, Pyxicephalus a. adspersus, Phrynobatrachus natalensis* and *Kassina senegalensis* (Poynton, 1964, p. 223). Five taxa occur only on the western side of the lowlands, and can be classified as "quasi-tropical", including *Schismaderma carens, Rana angolensis* and *Phrynobatrachus natalensis*.

B Cape Fauna (= Cape Temperate)

Non-tropical forms generally have fairly restricted ranges, although *Xenopus l. laevis, Rana fuscigula, Strongylopus g. grayii* and *Cacosternum boettgeri* occur over most of southern Africa. The south-western Cape center contains 20 endemic forms, with an additional two species, namely *Bufo pardalis* and *Kassina (Semnodactylus) wealii*, which include the south-western Cape in their ranges without conforming to any other common pattern (Poynton, 1964, p. 225). An additional four taxa which are widespread but southerly centered (i.e. *Xenopus l. laevis, Rana fuscigula, Strongylopus g. grayii* and *Cacosternum boettgeri*) are also included in the Cape Fauna, which accordingly consists of 26 forms or 20,5% of all southern African amphibian species (Poynton, 1964). Five (20%) O.F.S. taxa belong to the Cape Fauna: *Xenopus l. laevis, Rana fuscigula, Strongylopus g. grayii, Cacosternum boettgeri* and *Kassina (Semnodactylus) wealii*. Herpetofaunal forms treated as Cape Fauna have records at least within the Fynbos Biome of the south-western Cape Province (W.R. Branch, pers. comm.).

C Transitional Complex

The area containing the overlapping subtraction margins of the Tropical and Cape amphibian faunas is called a transition zone, and forms endemic to this zone are called "transitional forms" (Poynton, 1964, p. 226). Taxa endemic to the transition zone are grouped into various zoogeographical units shown on Poynton's map 2. A total of 60 forms are endemic to this zone, constituting 47% of the amphibian taxa of southern Africa. It is thus the "largest" faunal zone involved here. Apart from the central tropical transitional fauna, most of the remaining transitional units are essentially eastern in distribution. Six eastern transitional forms occur over a wide area, namely *Heleophryne natalensis* (now known to occur in the north-eastern O.F.S. and northern half of Lesotho), *Bufo rangeri, Tomopterna natalensis, Strongylopus f. fasciatus, Cacosternum n. nanum* and *Hemisus guttatum* (Poynton, 1964, p. 227). Poynton (1964) noted that *Bufo rangeri* occurs in the south-western Cape and could be treated as a "Cape" form, and pointed out that *Bufo f. fenoulheti* (non-O.F.S.) and *Breviceps a. adspersus*, although widespread, are largely confined to subtropical areas and are therefore included in an eastern tropical transition unit, although they could also be treated as "quasi-tropical" forms.

A Temperate Transitional fauna (eight forms) occurs on the Natal uplands, Lesotho and the eastern Transvaal Plateau (Poynton, 1964, p. 228). In this group are included *Breviceps maculatus, Strongylopus hymenopus, Arthroleptella hewitti* and *Cacosternum nanum parvum*. According to Poynton (1964), the temperate transitional fauna is divided from the tropical transitional fauna of the lowlands along the 13°C July isotherm, which reaches an altitude of about 4000 ft (= 1219 m) in central Natal. The range of *Breviceps adspersus pentheri* and *Afrixalus brachycnemis knysnae* (non-O.F.S.) have a range linking the large temperate transitional fauna and the smaller temperate transitional fauna (Poynton, 1964, p. 228). The two toads *Bufo g. gariepensis* and *B. vertebralis* occur on the southern part of the central plateau, and form a small central temperate transitional fauna (Poynton, 1964, p. 228). Poynton (1964) noted that the transitional fauna "does not form an overall faunal unit", but is a complex mosaic overlying the opposing subtraction margins of the Tropical and Cape faunas (p. 228), and that although the transitional zone has a greater number of forms than the tropical region, this does not imply that the transitional complex had a greater evolutionary potential from a phylogenetic point of view (p. 229). Twelve out of 25 (48%) O.F.S. forms belong to Poynton's (1964) transitional complex, namely:

Eastern Transitional forms (four forms): *Heleophryne natalensis, Bufo rangeri, Tomopterna natalensis, Strongylopus f. fasciatus*.

Large Temperate Transitional forms (four forms): *Breviceps maculatus, Strongylopus hymenopus, Arthroleptella hewitti, Cacosternum nanum parvum* (treated as *C. nanum* in the present study).

Central Temperate Transitional forms (two forms): *Bufo g. gariepensis, Bufo vertebralis*.

Eastern Tropical Transitional forms ("quasi-tropical") (one form): *Breviceps a. adspersus*.

Linkage "zone" between large and small transitional forms complexes (one form): *Breviceps adspersus pentheri*.

The addition amphibian records obtained for the O.F.S. (De Waal, 1980a; this study) complement the distribution patterns for southern African amphibians as determined by Poynton (1962, 1964).

6.13 **Distribution patterns of southern African Reptilia**

The reptiles of southern Africa are, like the amphibians (Poynton, 1964), separable into Tropical (centred in the north-east) and Temperate (centred in the south-west) groups (Bruton & Haacke, 1980). These last authors, with reference to FitzSimons (1943, 1962, 1975), Pienaar (1978) and Poynton & Broadley (1978), proposed six zoogeographical zones for the reptiles of southern Africa (Bruton & Haacke, 1980, Fig. 1). They also assigned each reptile species and subspecies found in Maputaland to one of these zones, but without explaining how their "zoogeographical classification" was determined, or what criteria were used in deciding into what group a particular taxon belonged. However, it was evident that the "centre of distribution" of a species or subspecies was the main criterion.

Using distributional data from the present study (O.F.S.) and Branch (1988a, southern Africa), I have attempted to assign the reptile fauna of the O.F.S. to the zones proposed by Bruton & Haacke (1980), but with some modifications, i.e. all forms with records in the south-western Cape Province are treated as "Cape Temperate", in opposition to assigning a form with a centre of distribution north of the south-western Cape, but with records in the south-western Cape, to the "Temperate Transitional" group; also, Temperate Transitional has been divided into Western and Eastern Temperate Transitional (cf. Poynton, 1964), depending on which side of southern Africa (i.e. west or east) the centre of distribution of the form is located; and forms with very wide-ranging distributions (i.e. to north of southern Africa) are assigned to an "Afrotropical" group rather than attempting to determine whether or not they are Tropical or Temperate. O.F.S. reptiles are assignable to five of the six zoogeographical zones of Bruton & Haacke (1980); only the Tropical East Coast Littoral is not represented.

A Tropical Fauna

Four zoogeographical zones are "tropical", namely Tropical Wide Ranging, Western Tropical Transitional, Eastern Tropical Transitional and Tropical East Coast Littoral (Bruton & Haacke, 1980). Thirty-eight O.F.S. forms (40,4% of total) can be regarded as Tropical. This includes the six very wide-ranging forms listed under "Afrotropical", 19 Tropical Wide Ranging forms, 11 Western Tropical Transitional forms and two Eastern Tropical Transitional forms. The latter two groupings are, however, included under the "Transitional Complex". The Tropical Fauna therefore consists of 25 taxa or 26,6% of all O.F.S. forms.

The following 25 taxa are treated as Tropical Fauna:

Afrotropical (six forms): *Lamprophis fuliginosus, Dasypeltis scabra, Crotaphopeltis hotamboeia, Pseudaspis cana, Bitis arietans arietans, Pelomedusa subrufa subrufa.*

Tropical Wide Ranging (19 forms): *Hemidactylus mabouia, Lygodactylus c. capensis, Pachydactylus bibronii, Chamaeleo d. dilepis, Mabuya varia, Mabuya variegata punctulata, Panaspis wahlbergii, Gerrhosaurus f. flavigularis, Varanus a. albigularis, Varanus n. niloticus, Leptotyphlops s. scutifrons, Lycophidion c. capense, Dispholidus t. typus, Psammophylax tritaeniatus, Xenocalamus b. bicolor, Aparallactus capensis, Atractaspis bibronii, Causus rhombeatus, Geochelone pardalis.*

B Cape Fauna (= Cape Temperate)

The Temperate or non-tropical reptilian fauna of the O.F.S. consists of 56 forms (59,6% of total). Of these, 24 forms (25,5% of total) could be regarded as forming part of a Cape Fauna (*vide* Poynton, 1964), as they are represented by at least some records in the south-western Cape. Several forms listed here as Cape Temperate would be regarded as Temperate Transitional by Bruton & Haacke (1980), as their centres of distribution lie to the north of the south-western Cape center. Both the Cape Temperate and Temperate Transitional zones include taxa which may be assignable to an Afromontane or Afrotemperate fauna (see section 5.2). Representatives of the Temperate Transitional zone are listed under "Transitional Complex".

Cape Temperate (24 forms): *Agama a. atra, Agama h. hispida, Mabuya capensis, Tetradactylus seps, Tetradactylus tetradactylus, Cordylus p. polyzonus, Cordylus cordylus, Pedioplanis burchelli, Typhlops lalandei, Lycodonomorphus rufulus, Lamprophis fuscus, Lamprophis aurora, Lamprophis inornatus, Lamprophis guttatus, Prosymna s. sundevallii, Duberria l. lutrix, Psammophylax r. rhombeatus, Psammophis notostictus, Psammophis crucifer, Aspidelaps l. lubricus, Homoroselaps lacteus, Hemachatus haemachatus, Naja nivea, Bitis atropos.*

C Transitional Complex

As in the case of amphibians, the area containing the overlapping subtraction margins of the Tropical and Cape reptilian faunas gives rise to a complex of endemic transitional forms. The transitional zones for reptiles have not been as well defined as those for amphibians (Poynton, 1964), but the following three "zoogeographical zones" proposed by Bruton & Haacke (1980) are recognized: Western Tropical Transitional (centre of distribution in Namibia) (WTT), Eastern Tropical Transitional (ETT) and Temperate Transitional (divided into Western and Eastern Temperate Transitional in the present study). The Transitional Complex is the largest zoogeographical grouping for O.F.S. reptiles, with 45 forms (47,9% of total) recorded. The Western Tropical Transitional group contains 11 forms (11,7% of total), the Eastern Tropical Transitional contains two forms (2,1%), the Western Temperate Transitional group contains seven forms (7,4%) and the Eastern Temperate Transitional group (the largest transitional group) contains 26 forms (27,7%).

Western Tropical Transitional (11 forms): *Ptenopus g. garrulus, Pachydactylus c. capensis, Pachydactylus l. laevigatus, Mabuya occidentalis, Mabuya s. sulcata, Mabuya striata punctatissima, Nucras intertexta, Ichnotropis squamulosa, Prosymna bivittata, Psammophis leightoni trinasalis, Psammobates oculifer.*

Eastern Tropical Transitional (two forms): *Nucras taeniolata holubi, Philothamnus natalensis occidentalis.*

Western Temperate Transitional (seven forms): *Pachydactylus m. mariquensis, Agama a. aculeata, Mabuya v. variegata, Pedioplanis namaquensis, Pedioplanis l. lineoocellata, Monopeltis c. capensis, Telescopus beetzii.*

Eastern Temperate Transitional (25 forms): *Afroedura karroica halli, Afroedura nivaria, Pachydactylus maculatus oculatus, Pachydactylus vansoni, Bradypodion dracomontanum, Bradypodion* sp. nov. ("Ngotswane Gorge"), *Bradypodion* sp. nov. ("Zastron"), *Agama aculeata distanti, Mabuya homalocephala smithii, Acontias g. gracilicauda, Tetradactylus breyeri, Tetradactylus a. africanus, Cordylus giganteus, Cordylus v. vittifer, Cordylus* sp. ("Waterfall"), *Pseudocordylus melanotus melanotus, Pseudocordylus melanotus subviridis, Pseudocordylus spinosus, Nucras lalandii, Pedioplanis l. lineoocellata, Tropidosaura essexi, Chamaesaura aenea, Typhlops bibronii, Elapsoidea sundevallii media, Homoroselaps dorsalis, Homopus femoralis.*

Table 30 shows the numerical composition of O.F.S. amphibian and reptilian faunal groupings. It is evident that for both taxa, the transitional complex is the largest (i.e. 48%), whereas Tropical and Cape groupings are about equal, although the tropical group is slightly larger for amphibians (32% vs 20%). Among the transitional groupings, the temperate transitional component is larger than the tropical transitional component, especially for reptiles (i.e. 71,1% of all transitional forms), and when grouped with the Cape Fauna, temperate or non-tropical reptilian forms comprise 59,6% of all reptiles occurring in the O.F.S. This is to be expected for a region falling entirely within the temperate region of Africa.

Table 30: Numerical composition of amphibian and reptilian faunal groupings in the Orange Free State.

Amphibia		
Group	No. of forms	% of fauna
Tropical	8	32,0
Cape	5	20,0
Transitional	12	48,0
Total	25	100%
Eastern Transitional	4	16,0
Large Temperate Transitional	4	16,0
Central Temperate Transitional	2	8,0
Eastern Tropical Transitional	1	4,0
Linkage Zone Transitional	1	4,0
Total	12	48,0%

Reptilia		
Group	No. of forms	% of fauna
Tropical	25	26,6
Cape	24	25,5
Transitional	45	47,9
Total	94	100%
Western Tropical Transitional	11	11,7
Eastern Tropical Transitional	2	2,1
Western Temperate Transitional	7	7,4
Eastern Temperate Transition	25	26,6
Total	45	47,9%

6.14 Discussion

The biogeographical (or zoogeographical) approach followed is a zoocartographic one. Being range-based, it involves direct examination of distribution maps, with an attempt being made to derive some form of faunal classification. A study of all available locality records for southern Africa was followed by the assigning of the various taxa to zoogeographical zones (see Poynton, 1964; Bruton & Haacke, 1980).

It was apparent that both amphibians and reptiles were assignable to three basic geographical groups. The Tropical Fauna included 32% of the O.F.S. amphibians and 27% of reptiles, whereas the Cape Fauna included 20% of the amphibians and 26% of the reptiles. The largest grouping for both taxa was the Transitional grouping, which included 48% of amphibians and 48% of reptiles. Although no comparison with the reptiles of the rest of southern Africa could be made, as no such study has been published, the numerical composition of the three faunal divisions for southern African amphibians has been determined by Poynton (1964, p. 229). According to Poynton (1964), the Tropical Fauna compises 32,5% of all forms (O.F.S. = 32,0%), Cape fauna 20,5% (O.F.S. = 20,0%) and Transitional fauna 47,0% (O.F.S. = 48,0). As indicated, the O.F.S. amphibian fauna is thus representative, by relative number of forms, of the southern African amphibians as a whole in terms of numerical composition of the three faunal groups.

The grouping of O.F.S. amphibian taxa into range clusters, based on similar distribution patterns in the province, indicated that, although nine finer clusters were identifiable, three broad groupings were apparent, namely an eastern group (S & E, E, D and N & NE), a western group (W, S, N & W) and a generalized group (i.e. records widely distributed in the O.F.S.) containing range clusters T and Non-SW (Fig. 114). The nine finer clusters correspond well with the distribution ranges of taxa in southern Africa as a whole (see Poynton, 1964), with the exception of the N & NE group having a record for *Tomopterna natalensis* in the central O.F.S.

The reptilian fauna of the O.F.S. was sorted into 13 range clusters, and can be more coarsely grouped into five clusters, namely an eastern group (E, N & NE, D, NE), a western group (W, NW and SW), a southern group (S, SE), a central group (C) and a generalized group (T, Non-NE, Non-SW) (Fig. 115). The thirteen finer groupings also correspond well with the overall distribution of their component forms in terms of recorded range "limits" in southern Africa.

The amphibian and reptilian transects (Tables 18 & 19) corroborate the range clusters identified, at least as far as illustrating the occurrence of widespread forms (Set 1), basically eastern forms (Set 2) and basically western forms (Set 3).

Various approaches to biogeographical studies have been attempted in the past, and none are "perfect". The approach of Poynton & Broadley (1991), as followed in the present study, is regarded as useful in that it allows, by the grouping of forms with similar ranges into "range clusters", a clear idea as to the general patterns evident according to known locality data, without resorting to mathematical and often artificial manipulation of data; and the use of transects provides useful data on subtraction margins.

Some problems with the approach of Poynton & Broadley (1991) and Poynton (1992), however, need to be pointed out. Perhaps the most troublesome aspect of recording the ranges of species within a transect zone in the form of a Table is the sometimes large number of intervals for a taxon that have no positive records. For example, Poynton & Broadley (1991, Table 2) placed *Tomopterna cryptotis* into their Set 1 ("occurring" at both ends of transect zone) despite there being eight intervals (excluding the most eastern one) on the eastern side that lacked positive records. Does this mean that the species is expected to occur in those intervals, despite there being such a large series of "empty" intervals? Biological judgement and inspection of maps showing the species' overall distribution would indeed suggest that the species does belong in Set 1. The point here is that the scarcity of records alone should not be regarded as "proof" of the species' absence in the transect zone (which represents only part of the species' range), although in some cases a lack of records may well be related to the likely absence of the species in such areas (see Tables 18 & 19 of this manuscript). Series of "empty" intervals may represent intensely farmed land, inhospitable habitat or an area in which the species has become extinct.

Poynton & Broadley (1991; Table 2) also included *Hyperolius mitchelli* in their Set 2 (eastern forms), despite it lacking records in the first five intervals at the eastern end of the transect zone, having only one positive record, this being in the sixth interval inland from the coast. Again, the overall distribution of the species indicates that it is an eastern form (as indicated by its range cluster). If it had not been placed in Set 2, it would have ended up in Set 4 (restricted range within transect zone). However, members of Set 4 are essentially either endemic, isolated inland populations (see Poynton & Broadley, 1991) or represent extensions of the range of a species into the central parts of the transect zone. In the case of some species, their placing in Set 4 is thus justified, considering that the overall distribution of the species may clearly indicate a narrow, e.g. southerly, extension inland, as shown by *Panaspis wahlbergii* in the O.F.S.

Poynton's (1992) approach to grouping species into sets is incompatible with the approach of Poynton & Broadley (1991). Poynton (1992) included 21 forms (40% of all taxa) in set 4 of his Bloemfontein-to-Durban transect. Several of these, and certainly such species as *Strongylopus g. grayii* and *Hyperolius semidiscus*, would have been included in set 2 by Poynton & Broadley (1991). Also, at least one member of Poynton's (1992) set 3 (*Bufo rangeri*) would have been best placed in Set 1 (it lacks a record only in the most easterly interval). Poynton's (1992) Table 4, which compares the percentage

compositions of sets 1-4 of his Bloemfontein-to-Durban transect with that of Poynton & Broadley's (1991) Chinhoyi-Beira transect, is thus untenable, as the composition of sets for the two areas were determined using different methods. Poynton's (1992) approach also explains the high disparity in "estimated percentage intensity of collecting" between his paper and that of Poynton & Broadley (1991). In Poynton's (1992) Table 1, all but one terminal interval is represented by positive records. If he had included some (typically) eastern forms (grouped into his set 4) in Set 2, and some (typically) western forms (grouped into his set 4) in set 3, he would have calculated far less than 100% collecting success at both ends of the transect (cf. Poynton & Broadley, 1991; this study) and lower percentages at most other intervals at the western and eastern ends of the transect zone. The approach and method of Poynton & Broadley (1991) was therefore considered more realistic and preferred to that of Poynton (1992). The former method was therefore used in the present study.

The zoocartographic approach to anuran ecology was discussed by Van Dijk (1971b). After noting that Poynton (1964, p. 213) mentioned thermal conditions as the variable most closely correlated with, and acting directly on, amphibian distribution in southern Africa, Van Dijk (1971b, p. 85) attempted to determine whether, if Poynton's (1964) zoocartographic conclusions were faulty, this was the result of "hazards inherent in the zoocartographic approach, largely because distribution maps are essential to the approach". Van Dijk (1971b, p. 86) was of the opinion that even minimal errors resulting from the manipulation of large quantities of data could render conclusions questionable. He noted that some frog species are difficult to identify from preserved material, suggesting that in such cases "only identifications from fresh specimens would be acceptable for locality records for zoocartography". While it would be ideal to follow this approach, it would result in far fewer "usable" records, especially when considering the fact that taxonomists and museum workers are not always afforded the opportunity to determine the status of specimens soon after collection, or shortly before or after death. It is true, however, that especially with regard to colour (cf. *Hyperolius* spp.), fresh material is often essential for accurate determination of specific and especially subspecific status of specimens. However, well or even fairly well preserved museum material is usually quite acceptable when basing identifications on established morphological and morphometric criteria.

Van Dijk (1971b, p. 89) noted that amphibian ranges were determined from locality records of adult specimens, but that the occurrence of larvae would provide the best means of establishing the range of species. However, one could argue that, if anuran larvae are present in an area, despite being uncollected, it could be excepted that adults also occur in the area, and, unless specific restrictions occur, such adults should be collected during the survey of an area. It is true, however, that tadpoles are often easier to find and collect (e.g. *Kassina* spp.), and in terms of breeding habit being the most important aspect determining the occurrence of a species in an area, tadpoles do provide the best means of accurately establishing at least the breeding the range of species (Van Dijk, 1971b, p. 89).

In his discussion of limiting factors to amphibian distribution, and environmental correlations with these, Van Dijk (1971b) questioned the accuracy of Poynton's (1964, map 3) southern African isotherms. Van Dijk (1971b) provided evidence showing that Poynton's (1964) 18°C mean July isotherm should be situated further north, and that the 13°C isotherm was also inaccurately placed in some areas (e.g. Zimbabwe). Van Dijk (1971b) finally concluded that "the 18°C mean July isotherm in southern Africa cannot be plotted with sufficient accuracy to be useful as a zoocartographic correlate, and this applies also to the 13°C mean July isotherm in Rhodesia (as well as in the west of the subcontinent)". Van Dijk (1971) failed to provide a more accurate map, however, although he did show mean July isotherms at various weather stations which did not corroborate Poynton's (1964) map. Van Dijk's (1971b) suggestion that difficulty in accurately illustrating the position of isotherms renders this variable of little use for zoogeographical analyses is considered somewhat extreme, as weather patterns change over time and a particular species' association with a certain temperature regime is unlikely to ever be very strictly demarcated. Poynton's (1964) zoogeographical analysis, based largely on temperature, is therefore still considered useful even if in some cases only "trends" are demonstrated. It should be noted here that the lack of weather stations in most quarter-degree units in southern Africa make a direct comparison between amphibian (and reptilian) distribution on the whole and meteorological variables impossible.

Van Dijk (1971b, p. 94) found that the area in southern Africa receiving 801 mm or more of rainfall a year "seemed to correspond reasonably well to the region from which the anurans in question were absent". Van Dijk matched large versions of Poynton's (1964) distribution maps to the 1 : 500 000 rainfall map in "W.B. 28", and found that some species and subspecies were more or less confined to the area receiving 801 mm or more of rainfall in the eastern half of southern Africa, with a few areas of such high rainfall in the southern and south-western Cape Province. However, Van Dijk (1971b) noted that rainfall may not directly determine frog distribution, and local relief could also considerably increase rainfall, or decrease it in the case of rain shadows.

Van Dijk's (1971b) Figure 3 demonstrates that for the most part, *Pyxicephalus adspersus* occurs in the area receiving 800 mm of rainfall and less. *P. adspersus* was subsequently separated into three subspecies (Parry, 1982) and this was followed by the publication of numerous new locality records for the species (Lambiris, 1989; Jacobsen, 1989; Branch, 1990a). The "highveld" subspecies *P. a. adspersus* is, however (as suggested by Van Dijk, 1971b), found mostly outside the high rainfall area. In the O.F.S., only two localities for *P. a. adspersus* fall within the area receiving 801 mm or more of rainfall, namely Frazer Spruit (2829 AC) and Van Reenen (peripheral on Natal/O.F.S. border; 2829 AD). However, the eighth-degree unit into which Frazer Spruit falls is 2829-Ac1, placing that locality only about 50% within the high-rainfall area. According to Van Dijk (1971b, p. 96), *Tomopterna cryptotis* occurs in only three quarter-degree units within the area receiving 800 mm or more of rainfall (South Africa), but Lambiris (1989a) recently provided three more records for that area. Van Dijk (1971b)

also noted that the ranges of *T. cryptotis* and *T. natalensis* were roughly complementary. However, more recent records indicate that *T. natalensis* has a widespread occurrence in the Transvaal (Jacobsen, 1989) and also occurs in the area receiving 800 mm of rainfall and less in the north-eastern and central O.F.S. (this study). This suggests that *T. natalensis* is less closely associated with the high rainfall area as indicated by Van Dijk (1971b).

Recent records of *Cacosternum nanum* confirm its affinity with the area receiving 801 mm or more of rainfall (De Waal, 1978; Jacobsen, 1989a; Lambiris, 1989a), but Lambiris' (1989) Natal records indicate that *C. boettgeri* occurs more widely within this zone. Although largely confined to the area receiving 801 mm or more of rainfall, *Kassina (Semnodactylus) wealii* is now known to occur within fairly large areas outide the high rainfall area in the eastern O.F.S. (this study) and southern Transvaal (Jacobsen, 1989).

In the case of *Strongylopus fasciatus*, Van Dijk's (1971b, p. 100) grouping of this form as being largely restricted to high-rainfall areas is negated by Jacobsen's (1989, map 241) discovery of this form virtually throughout the Transvaal, with several localities well outside the area receiving 801 mm or more of rainfall. Also, *S. g. grayii*, although closely associated with the high rainfall area (801 mm +), is now known to occur well outside that area in both the eastern half of the O.F.S. (this study) and the northern Transvaal (Jacobsen, 1989). A third species of *Strongylopus*, namely *S. hymenopus*, appears to be entirely confined to the area receiving 801 mm or more of rainfall in the Natal Drakensberg (also single records in O.F.S. and Drakensberg of the Cape Province). Van Dijk (1971b, p. 103) and De Waal (1978, p. 109) pointed out that a record for *S. hymenopus* plotted at 2926 BB (Thaba 'Nchu) by Poynton (1964) was misplaced, the record being referrable to Thaba Putsua in western Lesotho (Hewitt, 1927; Poynton, 1964, p. 119). Van Dijk (1971, pp. 103-104) pointed out that the discrepancy in the above-mentioned record was suggested by the fact that 2926 BB fell outside the area receiving 801 mm or more of rainfall, giving credibility to the hypothesis that distribution correlates with rainfall have value in predicting possible errors in the plotting of locality records.

It is Van Dijk's (1971b, pp. 104-105) contention that the rate of change of altitude is the most important variable related to anuran ecology, and that this variable should be related to aspect (absolute and relative), distance from the sea, and latitude (determining prevailing winds, day length and zeniths). In this regard, Van Dijk (1971b, p. 105) noted that *Heleophryne* spp., *Strongylopus hymenopus, S. wageri* and *Rana vertebralis* (all associated with the "Drakensberg" range cluster in the O.F.S.) are associated with the area receiving 801 + mm rainfall, "not only because of the high rainfall, but also because the high rainfall is associated, south of 22°S, with high slope (except at the coast)".

Van Dijk (1971b, p. 107) also stressed the importance of checking correlations indicated by zoocartographic techniques by direct correlation of the variables with locality records.

In the summary to his paper, Van Dijk (1971b, p. 107) writes that "identifications, synonymies and locality records should be expressed as far as possible by a presentation of data which the reader can assess for validity himself, rather than forcing him to rely on the judgements of some other investigator, however reliable that investigator may be". Despite the above statement, in a section entitled "Notes on the maps" of a later paper, Van Dijk (1977, p. 173) refers to "new records" plotted on his maps without providing any supporting data "which the reader can assess for validity himself" (see Van Dijk, 1971b, p. 107), although he adds that he would "appreciate queries about any of the localities considered suspect". This is not a satisfactory state of affairs, as queries made by one person do not necessarily become resolved to the betterment of the scientific community as a whole. Perhaps the most important objection to simply plotting new records on a map is that the reader cannot check whether or not the records have been plotted in the correct position without knowing the name of each locality or at least the grid reference. Van Dijk's (1977) attempt at representing the distribution of all southern Africa taxa comprising a single genus on the same map is considered highly confusing on account of the large number of often poorly defined and relatively small symbols used on a single map.

Van Dijk (1977) discussed amphibian habitats and dispersal mechanisms, noting that locality records do not always provide information on available habitat. A locality record may not reflect the presence of a breeding population of amphibians or reptiles, and Van Dijk (1977, p. 169) noted that a locality (for amphibians) might serve primarily as a dispersal route, especially if the area provides suitable breeding conditions in certain seasons. Van Dijk (1977, p. 189) pointed out that there is a distinction between breeding habitats and dispersal sites. For example, *Xenopus l. laevis* may cross land after rains, and the locality site of such specimens would not represent areas of regular occurrence. The distinction between "breeding habitats" and "dispersal sites" is not usually indicated in museum catalogues, and distribution records would thus seldom reflect the difference.

According to Van Dijk (1977, p. 171), specific habitats are related to disjunct distribution patterns. This would apply to *Heleophryne natalensis* and *Arthroleptella hewitti* (both Afromontane-associated) and to a large extent also *Breviceps* spp. and *Strongylopus* spp. in the O.F.S. (Figs 21, 36, 28, 34, 35 & 36 respectively). *Heleophryne* is associated with torrents, whereas *Arthroleptella* occurs on steeply-sloping terrain in forested areas, where their eggs develop on moss kept damp by seepage; *Strongylopus* occurs in high rainfall regions, and *S. hymenopus* is additionally restricted to areas of fast-flowing water (Van Dijk, 1977, p. 171).

Rivers may represent barriers to anuran movement. Van Dijk (1977, p. 171) noted that the Zambezi River "appears to be a more or less effective barrier southwards to the *Breviceps poweri* genes". The same reasoning seems to apply to *Breviceps a. adspersus*, considering the small number of records from south of the Vaal River in the O.F.S. It is likely, however, that specimens of various species are washed

downstream and across rivers, or transported on branches and reach the opposite banks of rivers, but their continued survival there is not assured considering the possibility of unsuitable local conditions. Such naturally translocated specimens may cause confusion when attempting to define species ranges (see *Lycodonomorphus laevissimus fitzsimonsi* in the Transvaal; Jacobsen, 1989).

Another well known barrier to amphibian and reptilian movement or dispersal is the dry Limpopo Valley. The present conditions in the Limpopo Valley appear to have been a relatively recent development, as several subspecies of wide-ranging Afromontane species, found mostly to the south, are now "isolated" in the eastern highlands of Zimbabwe (see maps in Poynton, 1964 and Broadley, 1990).

Van Dijk (1971b, 1977, p. 172) noted that isolated populations of *Strongylopus g. grayii* in the dry western half of southern Africa may be associated with stands of poplar trees, suggesting that their eggs, which are laid out of water and often in poplar plantations, could have been conveyed with poplar slips.

Van Dijk (1977, p. 172) also suggested that dam-breeding frogs (e.g. *Xenopus l. laevis, Schismaderma carens, Kassina senegalensis*) have probably extended their ranges substantially. With regard to the use of man-made water bodies, both *X. l. laevis* and *Rana fuscigula* were often found in cattle drinking troughs and circular cement farm dams in the O.F.S. Poynton (1964) also noted that many anuran species have coped well with human urban development and often occupy man-made water bodies where they breed. Quarries for road gravel often provide breeding sites for frogs, and roads are thus likely to be important dispersal routes (Van Dijk, 1977). Tadpoles of *Bufo poweri, B. gutturalis* and *B. rangeri* were collected in roadside rainpools (some formed through positioning of roadside rubble) in the O.F.S.

GAZETTEER

Names printed in italics refer to localities outside the Orange Free State.

Locality	District	Locus Code
Aberdeen (245)	Harrismith	2829 - Ac3
Afrikaskop	Harrismith	2828 - Ba4
Albion (100)	Rouxville	3026 - Bd4
Allanridge (425)	Odendaalsrus	2726 - Da4
Allanvale (249)	Vrede	2729 - Da4
Alma (1511)	Harrismith	2828 - Bc1/4
Alpha (125)	Smithfield	3026 - Ba3
Alwyn (774)	Boshof	2825 - Ac1
Angra Pequina (8)	Bothaville	2726 - Bc3
Anna's Rust (1389)	Kroonstad	2727 - Cb2
Annies Rust (763)	Heilbron	2628 - Cc1
Ararat (1822)	Harrismith	2829 - Ac3
Arcadia (187)	Lindley	2728 - Cc3
Arcadia (623) (Sandveld Nature Reserve)	Hoopstad	2725 - Da3
Ark (1010)	Harrismith	2829 - Ac3
Ascent (79)	Vrede	2729 - Aa3
Atalanta (225)	Ladybrand	2927 - Ad1
Avalon (554)	Fauresmith	2925 - Da2
Babel (144)	Rouxville	3026 - Bb2
Bachelor's Home (800)	Harrismith	2829 - Ba3
Bainsvlei	Bloemfontein	2926 - Aa2
Baltespoort (998)	Vredefort	2727 - Aa4
Basberg (416)	Bultfontein	2826 - Ac3
Baunton (2164)	Bloemfontein	2926 - Ab1
Beestkraal (358)	Hoopstad	2725 - Db3
Beginselsdam (195)	Boshof	2825 - Ab3
Ben Nevis (186)	Thaba 'Nchu	2927 - Ac1
Benfontein on Benaauwdheidsfontein (1442)	Boshof	2824 - Dd1
Bergkloof (203)	Zastron	3027 - Ad1
Bergkraal (2213)	Bloemfontein	2926 - Ab2
Bergplaats (41)	Bloemfontein	2926 - Aa3

Bergplaats (234)	Dewetsdorp	2926 - Bc4
Berlin (497)	Vrede	2729 - Ac3
Berlin (536)	Bethlehem	2828 - Ad4
Beth Aven (905)	Ladybrand	2927 - Ac2
Bethany (16)	Edenburg	2925 - Db2
Bethel (6)	Senekal	2827 - Ba3
Bethlehem	Bethlehem	2828 - Ab3
Bethlehem (16 km north of)	Bethlehem	2828 - Ab1
Bethulie	Bethulie	3025 - Bd4
Beyersfontein (301)	Hoopstad	2825 - Bb1
Biddulphsberg (9)	Senekal	2827 - Bd1
Blaauwbank (364)	Fauresmith	2925 - Ac3
Blaauwbanksdrift (195)	Fauresmith	
Blaauwfontein (94)	Trompsburg	3026 - Aa2
Blesbokpan (2467)	Bloemfontein	2925 - Bb2
Bloemendal	Bloemfontein	2926 - Aa2
Bloemfontein	Bloemfontein	2926 - Aa2
Bloemfontein (slightly north of)	Bloemfontein	2926 - Aa2
Bloemfontein (11 km south of)	Bloemfontein	2926 - Aa4
Bloemfontein (19 miles west of)	Bloemfontein	2925 - Bb2
Bloemfontein (Bayswater)	Bloemfontein	2926 - Aa2
Bloemfontein (Botanical Gardens)	Bloemfontein	2926 - Aa2
Bloemfontein (near Botanical Gardens)	Bloemfontein	2926 - Aa2
Bloemfontein (Dan Pienaar)	Bloemfontein	2926 - Aa2
Bloemfontein (Fichardt Park)	Bloemfontein	2926 - Aa2
Bloemfontein (General de Wet)	Bloemfontein	2926 - Aa2
Bloemfontein (Industrial Area)	Bloemfontein	2926 - Aa2
Bloemfontein (Langenhoven Park)	Bloemfontein	2926 - Aa2
Bloemfontein (Oliewenhuis Art Museum)	Bloemfontein	2926 - Aa2
Bloemfontein (Pellisier Park)	Bloemfontein	2926 - Aa2
Bloemfontein (Power Station)	Bloemfontein	2926 - Aa2
Bloemfontein (Raadsaal)	Bloemfontein	2926 - Aa2
Bloemfontein (Railway Station)	Bloemfontein	2926 - Aa2
Bloemfontein (Universitas)	Bloemfontein	2926 - Aa2
Bloemfontein (University of the O.F.S.)	Bloemfontein	2926 - Aa2
Bloemfontein (Zoological Gardens)	Bloemfontein	2926 - Aa2
Blydschap (504)	Bloemfontein	2926 - Ab3
Boesmansberg (308)	Brandfort	2826 - Cb1

Bon Haven (1692)	Harrismith	2829 - Ac4
Boschberg (59)	Rouxville	3026 - Db3
Bosch Kloof (48)	Harrismith	2828 - Db2
Boschkloof (589)	Bethlehem	2828 - Ac3
Boschkop (58)	Wesselsbron	2726 - Cb4
Boschrand (361)	Bothaville	2726 - Bc3
Boshof	Boshof	2825 - Ca2
Boshof Townlands	Boshof	2825 - Ca2
Boskop (165)	Boshof	2825 - Ba4
Boskop (704)	Bloemfontein	2925 - Bd2
Bosmansrust (932)	Boshof	2825 - Ca2
Bothaspas	Vrede	2729 - Da4
Bothaville	Bothaville	2726 - Bc3
Bozrah (449)	Fauresmith	2924 - Da1
Brabant (205)	Bloemfontein	2926 - Aa1
Brakfontein (636)	Boshof	2825 - Da3
Brakfontein (708)	Harrismith	
Brakpan (18)	Jacobsdal	2924 - Bb1
Bramley's Hoek (52)	Bethlehem	2828 - Bc3
Brandfort	Brandfort	2826 - Cb4
Brandfort (10 miles north-west of)	Brandfort	2826 - Cb1
Brandwag Gardens (GGHNP)	Bethlehem	2828 - Da1
Brandwag Kop (GGHNP)	Bethlehem	2828 - Da1
Braunzijnkop (1126)	Kroonstad	2726 - Dd2
Brightside (338)	Ladybrand	2927 - Ab4
Brockenhurst (273)	Lindley	2727 - Dc4
Bultfontein	Bultfontein	2826 - Ac2
Bultfontein (113)	Thaba 'Nchu	2926 - Bb3
Burghersdorp	*Burgersdorp*	*3026 - Cd3*
Caledonspoort (190)	Fouriesburg	2828 - Ca4
Campen (308)	Harrismith	2829 - Ad1
Carlie (555)	Ventersburg	2826 - Bb2
Cecilia (2352)	Bloemfontein	2926 - Aa2
Ceylon (290)	Wepener	2926 - Dd2
Chubani (9)	Thaba 'Nchu	2926 - Bb2
Clarens	Bethlehem	2828 - Cb2
Clarens (11 miles east of)	Bethlehem	2828 - Da1

Clifford (214)	Harrismith	2829 - Ac2
Clocolan	Clocolan	2827 - Dc3
Colesberg	*Colesberg*	*3025 - Ca3*
Constanza	Fauresmith	2825 - Cc4
Cornwall (1332)	Boshof	2825 - Cc3
Dam van Trane	Bloemfontein	2926 - Aa2
Damfontein (169)	Bethulie	3025 - Bd2
Dasklip (1371)	Frankfort	2728 - Ba3
De Brug (197)	Bloemfontein	2925 - Bb3
De Brug (1191)	Hoopstad	2725 - Dd1
De Hague (786)	Reitz	2728 - Da4
De Kiel (393) near De Kiel Oost (101)	Jacobsdal	2924 - Bd1
De Rust (254)	Reddersburg	2926 - Cb1
Dealbata (363)	Reitz	2728 - Dc3
Dealesgift (2804)	Bloemfontein	2926 - Ab1
De Brug Railway Siding (near to)	Bloemfontein	2925 - Bb3
Debsie (54)	Kroonstad	2727 - Ad3
Deelfontein (2)	Smithfield	3026 - Ad1
Deelfontein (251)	Bethulie	3026 - Ac4
Deelfontein (482)	Bothaville	2726 - Ba1
Deelfontein (482)	Bothaville	2726 - Ba3
Di Poort (280)	Brandfort	2826 - Dc3
Die Hoogte (225)	Bultfontein	2825 - Bd2
Diepkloof (1720)	Bethlehem	2828 - Bc4
Diepwater (227)	Dewetsdorp	2926 - Bc4
Dipka (200)	Vrede	2729 - Ca3
Donegal A (488)	Dewetsdorp	2926 - Dc2
Doornberg NW (384)	Winburg	2827 - Ad1
Doornbult (1310)	Hoopstad	2726 - Cc3
Doornfontein (337)	Boshof	2825 - Aa4
Doornhoek (139)	Jacobsdal	2924 - Bc2
Doornhoek (158)	Philippolis	3024 - Bb4
Doornlaagte (865)	Boshof	2825 - Dc1
Doornland (649)	Kroonstad	2727 - Cb2
Doornplaat (435)	Bloemfontein	2925 - Ba1
Dooms (131)	*Kimberley*	*2924 - Ba2*
Dorps-Gronden (432)	Boshof	2825 - Ca2

Driebaden (493)	Fauresmith	3025 - Ab2
Driekloof (2836)	Bloemfontein	2925 - Bb4
Driekloof Dam	Harrismith	2829 - Ca1
Driekop (677)	Brandfort	2826 - Da3
Dundee (416)	Fauresmith	2924 - Dc4
Edenburg	Edenburg	2925 - Db4
Edenburg (4 miles south of)	Edenburg	2925 - Dd2
Edenville	Kroonstad	2727 - Da2
El Bethal	Edenville	2727 - Dc4
Elandsfontein (990)	Lindley	2728 - Cc3
Elim (926)	Vrede	2729 - Ad2
Elliesdal (1062)	Boshof	2825 - Bc1
Emmaus (514)	Fauresmith	2925 - Ab3
Erinmore (1224)	Boshof	2825 - Ab1
Eskol (692)	Harrismith	2828 - Bd4
Estoire	Bloemfontein	2926 - Ab1
Evenston A (115)	Ventersburg	2827 - Ab3
Excelsior (20 km south-east of)	Ladybrand	2927 - Ab1
Excelsior (62)	Ladybrand	2927 - Ab4
Exelsior (467)	Edenburg	2926 - Cc3
Falle Grange (632)	Reitz	2728 - Cb2
Fauresmith	Fauresmith	2925 - Cb3
Ferreira School	Bloemfontein	2926 - Aa4
Ficksburg	Ficksburg	2827 - Dd4
Florisbad (686)	Brandfort	2826 - Cc1
Fonteintje (77)	Reddersburg	2926 - Cb1
Fouriesburg	Fouriesburg	2828 - Ca2
Francina (680)	Rouxville	3027 - Ca1
Francis Home (108)	Fauresmith	2925 - Cb2
Franshoek (106)	Ficksburg	2828 - Ca3
Frazer Spruit (94)	Harrismith	2829 - Ac1
Frazerfield (187)	Harrismith	2829 - Ac3
Geluk (14)	Kroonstad	2727 - Cc1
Geluk (498)	Philippolis	3025 - Aa4
Geluk (718)	Boshof	2826 - Ca1

General Will (628)	Harrismith	2828 - Da2
Giddy's Home (362)	Vrede	2729 - Dc2
Glen	Bloemfontein	2826 - Cd3
Glen Gariff (778)	Harrismith	2829 - Ac1
Glen Lennie (183)	Harrismith	2828 - Bd2
Glenisla (1096)	Harrismith	2829 - Ac4
Goede Hoop (725)	Boshof	2825 - Cc2
Goedehoop (76)	Senekal	2827 - Bc4
Goedetrouw (465)	Reitz	2728 - Cd1
Goedgenoeg (2249)	Winburg	2827 - Ac3
Golden Gate Highlands National Park	Bethlehem	2828 - Da1
Golden Gate Highlands National Park (± 2 miles east of)	Bethlehem	2828 - Da1
Grasslands (2247)	Brandfort	2826 - Cd?
Greenlands (1245)	Harrismith	2829 - Ac1
Greylingsfontein (843)	Fauresmith	2925 - Ab2
Greyvenstein Pan	Bloemfontein	2926 - Aa2
Groendraai (140)	Harrismith	2828 - Bb3
Groenekloof (16)	Philippolis	3025 - Ac4
Groenland (267)	Bethlehem	2828 - Da1
Grootberg on Lemoenshoek (1600)	Boshof	2925 - Da4
Grootfontein Noord (497)	Harrismith	2829 - Ac2
Grootgeluk (58)	Harrismith	2829 - Aa1
Grootkloof (251)	Ficksburg	2827 - Db4
Grootkrans (71)	Heilbron	2727 - Db2
Gruiskop (2072)	Bloemfontein	2925 - Bd1
Gruisrand (59)	Fauresmith	2924 - Dc2
Haagen's Stad (665)	Brandfort	2826 - Ca3
Hagesdam	Bloemfontein	2925 - Bd1
Hamanskraal West (760)	Brandfort	2826 - Da3
Harrismith	Harrismith	2829 - Ac2
Harrismith (Botanical Gardens)	Harrismith	2829 - Ac2
Hartebeespan (330)	Christiana	2725 - Cc1
Hartebeestfontein (72)	Frankfort	2728 - Ad2
Hartebeestfontein (236)	Bloemfontein	2925 - Ba4
Hartebeestfontein (298)	Boshof	2825 - Ad2
Hartenbosch (43)	Bultfontein	2826 - Ac1

Hebron (674)	Smithfield	3026 - Ab1
Hebron (1549)	Bloemfontein	2925 - Bb2
Heenenweerskop (49)	Fauresmith	2925 - Ca3
Heidedal	Bloemfontein	2926 - Aa4
Heilbron	Heilbron	2727 - Bd2
Heilbron (148)	Philippolis	3024 - Bb2
Heilbron Townlands	Heilbron	2727 - Bd2
Helderfontein (184)	Bloemfontein	2926 - Bc1
Hendrik Verwoerd Dam	Bethulie	3025 - Cb4
Hendrik Verwoerd Dam (25 miles north of)	Philippolis	3025 - Ad2
Hennenman	Ventersburg	2727 - Cc3
Hertzogville	Boshof	2825 - Ba3
Hertzogville (30 km south of)	Boshof	2825 - Bc3
Het Loo (178)	Fouriesburg	2828 - Ca4
Hexrivier (405)	Reddersburg	2926 - Cc2
Hitzakker, Petrus Steyn		
Holfontein (88)	Kroonstad	2727 - Cc1
Holme's Dale (95)	Bloemfontein	2826 - Cc4
Honingberg (411)	Fauresmith	2925 - Ad2
Hoogeveld (313)	Theunissen	2826 - Bc1
Hoogeveld (2439)	Kroonstad	2727 - Cc3
Hoopstad	Hoopstad	2725 - Dd2
Hoopstad (at Vet River)	Hoopstad	2725 - Dd2
Hopefield (1381)	Bloemfontein	2826 - Cc4
Houmoed (516)	Brandfort	2826 - Cd1
Houtkop (326)	Koppies	2727 - Bc4
Houtkoppies	Fauresmith	?
Immigrant (200)	Bloemfontein	2925 - Ba1
Imperani (57)	Ficksburg	2827 - Dd1
Inglewood (549)	Boshof	2824 - Db1
Italie (87)	Ladybrand	2927 - Ad2
Jacobsdal	Jacobsdal	2924 - Bb1
Jagersfontein	Fauresmith	2925 - Cd2
Jagersrus (near Petrus Steyn)	Heilbron	?
Jonkerskraal (475)	Bothaville	2726 - Ba1
Joostenberg (462)	Fauresmith	2924 - Dd1

Juist Zoo (281)	Dewetsdorp	2926 - Da4
Juta (658)	Smithfield	3026 - Ba4
Kades (1051)	Boshof	2825 - Cd2
Kafferskop (89)	Koppies	2727 - Ba4
Kaffirrivierdam (= Tierpoort Dam)	Bloemfontein	2926 - Ac4
Kalbasdrift (1017)	Fauresmith	2925 - Ac1
Kalbasdrift (1017)	Fauresmith	2925 - Cb1
Kalieskraal (78) (GGHNP)	Bethlehem	2828 - Da2
Kalkdam (52)	Trompsburg	3025 - Bb2
Kalkfontein (677) near Alphaheim	Fauresmith	2925 - Cb1
Kalkfontein (677) near Sendelingsfontein	Fauresmith	2925 - Ca2
Kalkfontein Dam Nature Reserve	Fauresmith	2925 - Cb1
Kalkfontein Dam (near Nature Conservation Offices)	Fauresmith	2925 - Cb1
Kalkfontein Dam near Bergfontein (763)	Fauresmith	2925 - Ac4
Kalkfontein Dam near Kalbasdrift (1017)	Fauresmith	2925 - Cb1
Kalkoenkrans (280)	Harrismith	2828 - Bb2
Kalkplaat (444)	Fauresmith	2924 - Cb4
Kameelpan (815)	Boshof	2824 - Dd2
Karee (543)	Brandfort	2826 - Cd1
Kareerand (60)	Bloemfontein	2925 - Bb3
Karreeboomsvallei (258)	Theunissen	2826 - Bc4
Karreelaagte (158)	Jacobsdal	2924 - Bc3
Karreepoort (624)	Ventersburg	2827 - Aa3
Kasteelkop (156)	Frankfort	2728 - Bc4
Kelly's View	Bloemfontein	2926 - Aa3
Kestell	Bethlehem	2828 - Bc2
Kestell (east of)	Bethlehem	2828 - Bd1
Kimberley	*Kimberley*	*2824 - Db3*
Kimberley (Brickfields)	*Kimberley*	*2824 - Db3*
Kimberley (De Beers Mine)	*Kimberley*	*2824 - Db3*
Kimberley (Queens Park)	*Kimberley*	*2824 - Db3*
Klavervlei (=Klavervley) (451)	Harrismith	2829 - Ca1
Kleinplaas (490)	Bethulie	3025 - Db1
Klipbankfontein (116)	Philippolis	3025 - Bc3
Klipdrift (10)	Bloemfontein	2926 - Ab2
Klipfontein (8)	Jacobsdal	2924 - Ba2

Klipfontein (35)	Rouxville	3026 - Da3
Klipoog (148)	Frankfort	2728 - Ab1
Klippan (376)	Bloemfontein	2925 - Ba1
Klippiespan (205)	Boshof	2824 - Dd2
Klipplaat (380)	Vrede	2728 - Bd2
Klipplaatdrift (260)	Edenburg	2925 - Db1
Klipplaatdrift (28)	Winburg	2827 - Ca3
Knellpoort (48)	Wepener	2926 - Dd2
Kolbe (1538)	Bloemfontein	2926 - Aa4
Koortshoek (302)	Trompsburg	3025 - Ba3
Kopjeskraal (11)	Clocolan	2827 - Dc4
Koppiesdam (473)	Bloemfontein	2925 - Ba3
Koppies Dam Nature Reserve	Koppies	2727 - Bc2
Kraaifontein (109)	Rouxville	3026 - Db2
Kraankuil (east of)	*Hopetown*	*2924 - Cd3*
Kranskop (392)	Zastron	3027 - Ab1
Kristalpan on Wonderhoek (1698)	Bethlehem	2828 - Bc4
Kromhof (530)	Harrismith	2729 - Dc3
Kromrant (123)	Boshof	2825 - Ca3
Kroonstad	Kroonstad	2727 - Ca4
Kroonstad (10 miles east of)	Kroonstad	2727 - Cb4
Krugersdrift Dam	Bloemfontein	2825 - Dd4
Kwaggafontein (2300)	Bloemfontein	2926 - Aa1
La Belle France (458)	Rouxville	3026 - Bd2
La Riviera (111)	Bultfontein	2826 - Ab1
Ladybrand	Ladybrand	2927 - Ab4
Lake Warden (38) (Sandveld Nature Reserve)	Hoopstad	2725 - Da4
Lakeview (505)	Bloemfontein	2926 - Ab3
Lang Zeekoegat (66)	Trompsburg	2925 - Dc4
Lange Hoek (352)	Harrismith	2829 - Ab2
Langeberg (farm)	*Kimberley*	*2824 - Dc3*
Langhoek (56)	Jacobsdal	2924 - Bc2
Lanquedoc (1179)	Heilbron	2728 - Ca1
Last Poort (361)	Reddersburg	2926 - Cd1
Laveno (318)	Dewetsdorp	2926 - Db1
Leeuwberg (465)	Fauresmith	2925 - Bc3
Leeuwfontein (10)	Boshof	2825 - Ca2

Leeuwfontein (256)	Theunissen	2826 - Bd1
Leeuwkop (230)	Marquard	2827 - Cb2
Leeuwkuil (384)	Boshof	2824 - Db2
Leeuwrant (681)	Bloemfontein	2925 - Bd2
Leliehoek (748)	Boshof	2825 - Da4
Leliehoek Resort	Ladybrand	2927 - Ab4
Lemoenboord (320)	Philippolis	3024 - Bb1
Lemoenhoek (415)	Ladybrand	2927 - Ac4
Lentelus (1119)	Fauresmith	2925 - Ac3
Lessingskop (92)	Dewetsdorp	2926 - Dc1
Linde's Vley (908)	Bloemfontein	2926 - Bc1
Lindley	Lindley	2727 - Dd4
Lismore (420)	Zastron	3027 - Ad3
Littlecote (46)	Wepener	2927 - Cc4
Lockshoek (192)	Fauresmith	2925 - Da3
Lomagundi (736)	Bothaville	2726 - Ad4
Lorenzo (1352)	Kroonstad	2727 - Ac4
Loskop (819)	Bethlehem	2828 - Ab2
Loskop (916)	Fauresmith	2925 - Ab3
Lotters Rust (464)	Brandfort	2826 - Cb4
Louis Rust (1073)	Heilbron	2728 - Aa2
Louisa's Mount (1064)	Harrismith	2829 - Aa3
Lovedale (1844)	Bloemfontein	2825 - Dc4
Luckhoff	Fauresmith	2924 - Db3
Lugwijini (GGHNP)	Bethlehem	2828 - Da1
Luiperfontein (334)	Fauresmith	2925 - Cc4
Luiperskop (130)	Jacobsdal	2924 - Ad4
Lusthof (1456)	Kroonstad	2727 - Bc4
Maanhaar (854)	Harrismith	2828 - Bd2
Machbela (595)	Harrismith	2729 - Cd1
Magdalen (1471)	Bloemfontein	2926 - Ad2
Magersfontein Field Museum (near to, on O.F.S. side)	Boshof	2824 - Dd2
Maghaleen (287)	Zastron	3027 - Ab4
Manchester (466)	Ladybrand	2927 - Ac2
Mandyville (787)	Frankfort	2728 - Bb1

Mara (395)	Parys	2627 - Dc1
Mara (855)	Vredefort	2727 - Ad1
Marantha Kweberg, Libhlong (Sannaspos)	Bloemfontein	2926 - Ba3
Marquard	Marquard	2827 - Cb4
Marseilles (37)	Ladybrand	2927 - Ab3
Mazelspoort (= Maselspoort)	Bloemfontein	2926 - Ab2
Maseru	*Lesotho*	*2927 - Ad2*
Maseru (64)	Thaba 'Nchu	2927 - Aa3
Matjesfontein (82)	Bethulie	3025 - Bb4
Maweni Heights (644)	Harrismith	2829 - Ca2
Mazelspoort (= Maselspoort)	Bloemfontein	2926 - Ab2
Meadows (225)	Dewetsdorp	2926 - Bc4
Mecklenburg (64)	Harrismith	2728 - Dd1
Memel	Vrede	2729 - Da3
Mensvreterberg north of Hillside (617)	Thaba 'Nchu	2927 - Aa1
Meriba (farm)	Bloemfontein	2925 - Bd2
Merino (1375)	Bloemfontein	2925 - Bd4
Merino (1487)	Bethlehem	2828 - Ad1
Merriesfontein (70)	Boshof	2825 - Cb1
Metz (950)	Harrismith	2829 - Ca1
Meyerskraal (20)	Hoopstad	2725 - Dd1
Middelbron (501)	Philippolis	3025 - Aa1
Middeldeel (2701)	Bloemfontein	2925 - Bd3
Middelpunt (105)	Brandfort	2826 - Cd3
Middenspruit (151)	Kroonstad	2727 - Ca2
Mierdam (638)	Boshof	2825 - Da3
Mierfontein (171)	Smithfield	2926 - Dc4
Milambi (235)	Marquard	2827 - Cd2
Mimosa (1188)	Brandfort	2826 - Da3
Mimosa (1319)	Bloemfontein	2826 - Cc2
Modder River	*Kimberley*	*2924 - Ba1*
Modderpoort (34)	Ladybrand	2927 - Ab2
Moirton (679)	Hoopstad	2725 - Cd2
Monontsa Pass (Witzieshoek)	Harrismith	2828 - Da2
Mooigelegen (863)	Harrismith	2828 - Bb1
Mooihoek (180)	Harrismith	2829 - Aa4
Mooihoek (556)	Lindley	2727 - Dd3
Mooivlei (2823)	Bloemfontein	2925 - Bd2

Moreson (407)	Marquard	2827 - Cc2
Morgenzon (73)	Ficksburg	2827 - Dd2
Morgenzon (123)	Senekal	2827 - Db1
Morgenzon (143)	Zastron	3027 - Ac4
Morgenzon (370)	Harrismith	2729 - Cc4
Morija	*Lesotho*	*2927 - Da1*
Mount Nelson (330)	Winburg	2827 - Cc4
Mount Pierre (GGHNP)	Bethlehem	2828 - Da2
Mount Pleasant (1302)	Winburg	2827 - Cc4
Musgrove (near to)	Bloemfontein	2926 - Aa4
Naudesville	Welkom	2726 - Dc4
Naval Hill	Bloemfontein	2926 - Aa2
Newlands A (760)	Ladybrand	2927 - Aa4
Ngotswane Gorge (= Kgotswane Gorge)	Harrismith	2828 - Db1
Niekerk (276)	Hoopstad	2725 - Dc1
Noodhulp (81)	Edenburg	2925 - Dd2
Northfield (1374)	Bloemfontein	2925 - Bb3
Nova (667)	Ladybrand	2927 - Ab1
Odendaalsrus	Odendaalsrus	2726 - Dc2
Odendaalsrus (near to)	Odendaalsrus	2726 - Dc2
Oever (645)	Harrismith	2729 - Dc4
Olive Hill	Bloemfontein	2926 - Ab1
Ongegund (1119)	Winburg	2826 - Db2
Onverwacht (419)	Koppies	2727 - Ba3
Onze Rust (1204)	Boshof	2825 - Aa4
Oorsprong (135)	Heilbron	2727 - Bb2
Op-die-Rivier (621)	Ficksburg	2828 - Cc1
Ospoort (44)	Philippolis	3025 - Ad2
Oudefontein (29)	Jacobsdal	2924 - Bb4
Palm (852)	Kroonstad	2727 - Ad3
Palmietfontein (99)	Parys	2627 - Dc1
Paradys (137)	Viljoenskroon	2726 - Bb2
Parva Sed Mea (865)	Harrismith	2828 - Bb4
Parys	Parys	2627 - Cd4
Patrijsdraai (906)	Kroonstad	2727 - Cd1

Perth (1084)	Harrismith	2829 - Ac4
Petra (451)	Senekal	2827 - Ad2
Petra Quarry (west of)	Bloemfontein	2926 - Aa2
Petrus Steyn	Lindley	2728 - Ca3
Petrusburg	Fauresmith	2925 - Ab2
Philadelphia (316)	Wesselsbron	2726 - Cd4
Philippi (952)	Bethlehem	2828 - Ba3
Philippolis	Philippolis	3025 - Ad1
Pietersberg (751)	Brandfort	2826 - Da3
Pinekloof (291)	Ladybrand	2927 - Ab4
Plaatjeskraal (143)	Trompsburg	2925 - Dc3
Platberg (539)	Boshof	2824 - Bd2
Platberg Mountain	Harrismith	2829 - Ac2
Platkop (1069)	Boshof	2825 - Cd3
Platrand (136)	Kroonstad	2727 - Cb2
Poortje (92)	Edenburg	2925 - Da4
Poortje (990)	Fauresmith	2925 - Ac4
Prior (249)	Bethulie	3025 - Bc3
Proces (1293)	Boshof	2825 - Ca4
Quaggaspruit (115)	Lindley	2727 - Da4
Ramalitse (22)	Thaba 'Nchu	2926 - Ba4
Rambouillet (396)	Lindley	2727 - Dd1
Randfontein (1184)	Harrismith	2829 - Ac1
Rayton	Bloemfontein	2926 - Aa2
Reddersburg	Reddersburg	2926 - Ca4
Reenens Hoop (182)	Harrismith	2829 - Aa3
Reitz	Reitz	2728 - Cd2
Rhenosterspruit	Bloemfontein	2926 - Ab1
Ribblesdale (1506)	Bloemfontein	2926 - Ab1
Richmond West (135)	Bothaville	2726 - Db3
Rietfontein (9)	Rouxville	3026 - Cb1
Rietfontein (144)	Brandfort	2826 - Dc4
Rietfontein (288)	Vrede	2729 - Ad2
Rietfontein (328)	Bultfontein	2826 - Ca1
Rietkuil (62)	Bothaville	2726 - Db1
Rietput (117)	Fauresmith	2924 - Db2

Rietspruit (2251)	Bloemfontein	2926 - Ad1
Riverside (927)	Ladybrand	2927 - Ad2
Riverton	*Kimberley*	*2824 - Bd3*
Rodenbeck	Bloemfontein	2926 - Aa4
Rohallion (280)	Wepener	2927 - Ca3
Roma (311)	Reitz	2728 - Cd4
Rondavel (383)	Brandfort	2826 - Ad4
Rondavel (627)	Kroonstad	2727 - Ca4
Rondeberg (112)	Ladybrand	2927 - Ba3
Rondebuld (193)	Bethlehem	2828 - Aa4
Roodedraai (92)	Hoopstad	2725 - Cd1
Roodekop (75)	Kroonstad	2726 - Db
Roodekop (290)	Ventersburg	2827 - Aa3
Rooidraai (190)	Fauresmith	2925 - Ac1
Rooilaagte (344)	Jacobsdal	2924 - Bb3
Rorich's Hulp (505)	Fauresmith	2924 - Da4
Rosendal	Ficksburg	2827 - Db2
Rouxville	Rouxville	3026 - Bd3
Royal Natal National Park	*Natal*	*2828 - Db4*
Ruigtepoort (61)	Fauresmith	2925 - Cd1
Rusfontein Dam	Bloemfontein	2926 - Bc1
Rusthof (17)	Heilbron	2728 - Ac4
Rusthoff (204)	Brandfort	2826 - Cc1
Rydal Mount (469)	Harrismith	2828 - Db1
Sandfontein (farm)	*Hopetown*	*2924 - Cd3*
Sandveld Nature Reserve	Hoopstad	2725 - Da4
Sandveld Nature Reserve (Nature Conservation Offices)	Hoopstad	2725 - Da3
Sannaspos	Bloemfontein	2926 - Ba3
Sannaspos (2850)	Bloemfontein	2926 - Ba3
Sasol Mine	Heilbron	2627 - Dd1
Schaapkraal (79)	Wepener	2926 - Dd2
Scheerpan Oost (1239)	Boshof	2825 - Ba4
Serfontein Dam	Kroonstad	2727 - Ca4
Schoongezicht (237)	Theunissen	2826 - Ad2
Schoongezicht (farm)	Bloemfontein	2925 - Bd2
Schutte's Draai Estates (748)	Ficksburg	2827 - Dc4

Sedan (893)	Harrismith	2829 - Ac3
Seekoeivlei Nature Reserve	Vrede	2729 - Da3
Seekoeivleipoort (1316)	Vrede	2729 - Da2
Sentinel (Witzieshoek)	Harrismith	2828 - Db4
Sentinel Mountain (top of)	Harrismith	2828 - Db4
Serfontein (438)	Koppies	2727 - Ad4
Serfontein Dam	Kroonstad	2727 - Ca4
Shannon	Bloemfontein	2926 - Ab3
Slangheuvel (192)	Heilbron	2627 - Dd4
Smaldeel (1245)	Hoopstad	2726 - Ca3
Smitherton (753)	Harrismith	2828 - Bb3
Smithfield	Smithfield	3026 - Ba3
Smithskraal (1519)	Boshof	2825 - Aa1
Soetdoring Nature Reserve	Brandfort	2826 - Cc1
Solheim (1075)	Boshof	2825 - Cc3
Solheim (1075) on Aletheim (924)	Boshof	2825 - Cc1
Somerset (393)	Dewetsdorp	2926 - Bc3
Sophiasdal (280)	Hoopstad	2725 - Dd3
Spes Bona (2355)	Bloemfontein	2926 - Aa1
Spijtfontein (639)	Kroonstad	2726 - Db2
Spitzkop (56)	Zastron	3027 - Aa4
Spreeuwfontein (181)	Jacobsdal	2924 - Bc1
Springbokdam (2042)	Winburg	2827 - Cc2
Sterkfontein Dam	Harrismith	2829 - Ca1
Sterkfontein Dam (eastern side)	Harrismith	2829 - Ca1
Sterkfontein Dam Nature Reserve	Harrismith	2829 - Ca1
Sterkfontein Dam Nature Reserve (near Gateman's Quarters)	Harrismith	2829 - Ac1
Stoffelfontein (407)	Lindley	2827 - Bb2
Stoltzkop (134)	Reitz	2728 - Da3
Stoom Hoek (826)	Bloemfontein	2826 - Cc1
Stowlands (719)	Boshof	2725 - Cc4
Straalfontein (117)	Ladybrand	2927 - Ab1
Strathearn (2154)	Bloemfontein	2926 - Aa2
Strijdfontein (72)	Philippolis	3025 - Cb1
Strijdfontein (189)	Heilbron	2727 - Bb4
Sunny Hills (1784)	Winburg	2827 - Ca3
Susannasfontein (370)	Winburg	2826 - Dd1

Swartwaterdam	Harrismith	2828 - Db2
Sweet Home (2570)	Bloemfontein	2926 - Ac3
Sweetwaters (674)	Vrede	2729 - Da2
Swinburn	Harrismith	2829 - Ad1
Table Farm (242)	Boshof	2824 - Db4
Tafelberg (815)	Harrismith	2829 - Aa4
Tempe	Bloemfontein	2926 - Aa2
Tempe (near to)	Bloemfontein	2926 - Aa2
Tertia (739)	Ladybrand	2927 - Ab4
Thaba 'Nchu	Thaba 'Nchu	2926 - Bb3
Thaba 'Nchu (Goronyane High School)	Thaba 'Nchu	2926 - Bb3
Thaba 'Nchu (Selosesha School)	Thaba 'Nchu	2926 - Bb3
Thaba Pachoa Berg (668)	Thaba 'Nchu	2927 - Ac1
Thesen'slaagte (1020)	Kroonstad	2726 - Db2
Theunissen	Theunissen	2826 - Bc4
Three Fountains (269)	Harrismith	2829 - Ac1
Tienfontein (137)	Wepener	2926 - Dd2
Tierfontein (close to)	Wesselsbron	2826 - Ab1
Torbek (67)	Reddersburg	2926 - Cb1
Trentham (470)	Bethlehem	2828 - Ab1
Triangle (254)	Ventersburg	2827 - Ab2
Trompsburg	Trompsburg	3025 - Bb1
Tussen-die-Riviere Game Farm	Bethulie	3026 - Ac4
Tussen-die-Riviere Game Farm (western side)	Bethulie	3026 - Ca1
Twee Zusters (251)	Ladybrand	2927 - Ab2
Tweefontein (154)	Reddersburg	2926 - Ca2
Tweefontein (390)	Winburg	2827 - Ac4
Tweeling (1031)	Frankfort	2728 - Da1
Tweespruit	Thaba 'Nchu	2927 - Aa3
Tygerfontein (240)	Vrede	2729 - Cb2
Uitkijk (536)	Wepener	2926 - Db2
Uitkomst (558)	Thaba 'Nchu	2926 - Bb4
Uitkyk (486)	Boshof	2825 - Ac3
Uitkyk (614)	Boshof	2824 - Db4
Uitvlugt (227)	Vrede	2729 - Ad4

Uitzicht (630)	Harrismith	2828 - Bb3
Usherwood (2412)	Bloemfontein	2926 - Ab3
Utopia (1690)	Winburg	2827 - Ca2
Vaalbank (135)	Welkom	2726 - Dc3
Vaalbank (156)	Bethlehem	2828 - Ad1
Vaalbank (2351)	Bloemfontein	2925 - Bb1
Vaalbank Zuid (1853)	Bloemfontein	2926 - Ab1
Vaalkop (66)	Thaba 'Nchu	2926 - Bd1
Van Aswegen's Hoek (493)	Boshof	2725 - Cc4
Van der Walt's Rust (1021)	Vredefort	2627 - Cc3
Van Reenen	*Natal*	*2829 - Ad2*
Veepost (738)	Brandfort	2826 - Cd3
Ventersburg	Ventersburg	2827 - Aa2
Venus (165)	Parys	2627 - Dc1
Verdun (230)	Fouriesburg	2828 - Cb1
Verdun (617)	Reitz	2728 - Da1
Verdun (752)	Ladybrand	2927 - Ab3
Vergaderrand (49)	Rouxville	3026 - Bc4
Verkeerdevlei	Brandfort	2826 - Dd1
Verwoerd Dam	Bethulie	3025 - Da1
Vet River - Bloemhof Dam junction	Hoopstad	2725 - Da4
Vet Rivier's Mond (78)	Hoopstad	2725 - Da4
Viljoen's Drift	Heilbron	2627 - Db4
Viljoensdrift (713)	Heilbron	2627 - Db4
Viljoenskroon	Viljoenskroon	2726 - Bb4
Villiers (25 km south-east of)	Frankfort	2728 - Bb3
Virginia	Ventersburg	2826 - Bb1
Vissershoek West (129)	Philippolis	3025 - Ab2
Vrede	Vrede	2729 - Ac4
Vrede (746)	Hoopstad	2726 - Ca3
Vredefort	Vredefort	2727 - Ab1
Vredefort (2 miles north-east of)	Vredefort	2727 - Ab1
Vredefort (8 miles south of)	Vredefort	2727 - Ab1
Vredefort (18 km east-south-east of)	Koppies	2727 - Ab2
Wagenmaker's Drift (24)	Jacobsdal	2925 - Ac1
Waterbron (2576)	Bloemfontein	2926 - Aa1

Waterfall (1157)	Harrismith	2829 - Ad2
Waterhoek (156)	Jacobsdal	2925 - Aa3
Waterkloof (602)	Ficksburg	2828 - Ca3
Waterval (247)	Vrede	2729 - Da3
Waterval (1541)	Winburg	2827 - Cd3
Weenkop (434)	Rouxville	3026 - Bb3
Welbedacht (285)	Wepener	2926 - Dd3
Welbedacht Dam (at Nature Conservation Office)	Wepener	2926 - Dd1
Welbekend (187)	Fauresmith	2925 - Da3
Welgedacht (108)	Brandfort	2826 - Ca1
Welgegund (1781)	Bethlehem	2828 - Ba3
Welgelegen (489)	Fauresmith	2925 - Cb3
Welkom	Welkom	2726 - Dc4
Wellwood (farm)	*Graaff-Reinett*	*3124 - Dc1*
Weltevrede (395)	Reddersburg	2926 - Ac4
Weltevreden (126)	Jacobsdal	2924 - Bc3
Weltevreden (257)	Heilbron	2727 - Bd2
Weltevreden (94)	Smithfield	3026 - Ad2
Welverdiend (1118)	Fauresmith	2925 - Ac3
Wepener	Wepener	2927 - Ca3
Wesselsdam (379)	Boshof	2825 - Ba3
Westminster	Ladybrand	2927 - Aa4
Whitehills (139)	Ladybrand	2927 - Ab2
Wilhelmshohe (693)	Boshof	2825 - Ba1
Willem Pretorius Game Reserve	Winburg	2827 - Ac2
Williamstrip (1701)	Bloemfontein	2925 - Bd2
Winburg	Winburg	2827 - Ca1
Wintershoek (41)	Jacobsdal	2924 - Bd2
Winterspoort (86)	Trompsburg	3025 - Bb3
Winterspoort (869)	Fauresmith	2925 - Da1
Wittekopjes (169)	Vredefort	2727 - Ab1
Wittepoort (789)	Ficksburg	2827 - Da4
Witzieshoek	Harrismith	2828 - Db1
Witzieshoek Mountain Resort	Harrismith	2828 - Db4
Wodehousekop (GGHNP)	Bethlehem	2828 - Bc4
Wolfkop (2353)	Bloemfontein	2926 - Aa3
Wolvekop (314)	Kroonstad	2727 - Cd1
Wolvekop (446)	Fauresmith	2924 - Db1

Wolvenfontein (256)	Heilbron	2728 - Aa4
Wonderkop (471)	Boshof	2825 - Da2
Woonhuis near Marah (420)	Bloemfontein	2926 - Ba3
Woudzicht (492)	Vrede	2728 - Db2
Zandfontein (4)	Smithfield	3026 - Aa4
Zandfontein (887)	Fauresmith	2925 - Ab3
Zandvoort (218)	Bloemfontein	2926 - Aa3
Zastron	Zastron	3027 - Ac1
Zion (301)	Bethlehem	2728 - Cd3
Zoetbron (151)	Vrede	2729 - Aa4
Zoeten Inval (268)	Odendaalsrus	2726 - Dc2
Zoetvlei (630)	Boshof	2725 - Cd1
Zomervlakte (295)	Bethlehem	2828 - Aa3
Zoutpan (33)	Jacobsdal	2924 - Ba4
Zoutpan (722)	Fauresmith	2924 - Cb2
Zuurfontein (92)	Fauresmith	2925 - Cd4
Zuurfontein (2022)	Bloemfontein	2926 - Ab2
Zwartfontein (93)	Philippolis	3024 - Bb2
Zwartkoppies (520)	Frankfort	2728 - Ad2
Stream north of Metsimatsho Dam and east of Phuta Ditjhaba	Harrismith	2828 - Db2
19 miles west of Bloemfontein	Bloemfontein	2925 - Bb4
10 km west of Hendrik Verwoerd Dam wall	Bethulie	2925 - Ca2
15 km east of Hendrik Verwoerd Dam wall	Bethulie	2925 - Da4
10 km north of Hendrik Verwoerd Dam wall	Bethulie	3025 - Cb2
19 km from Theunissen on Bultfontein Road	?	2826 - Bc3
16 miles ex Vrede - Warden	?	2729 - Ca3
1 mile ex Lindley - Bethlehem	?	2727 - Dd4
10 km from Bloemfontein on Florisbad Road	Bloemfontein	2926 - Aa2
52 km from Bloemfontein on road to Florisbad	Brandfort	2826 - Ca3
6 km from Springfontein - Trompsburg	?	3025 - Ba4
67 km from Trompsburg - Bloemfontein	?	2926 - Ac3

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ADDENDUM

This list includes specimens collected during the early part of 1993 as well as occasional specimens not examined prior to the finalization of the thesis. Those marked with an asterisk represent new locality records for the taxon. Under locality, the farm name and number (when applicable) and administrative district are given. These new localities were not plotted on the distribution maps, included under "Features" or considered during the ecological or biogeographical analyses (chapters 5 & 6 respectively), but they do not in any significant way affect the results of the analyses.

AMPHIBIA

Taxon	Locality	Locus Code	NMB A
Xenopus l. laevis	*Alma (1511) Harrismith	2828-Bc1	5587
	*De Villiers Drift (338) Fouriesburg	2828-Cb3	5708
Bufo g. gariepensis	*Elim (906) Ladybrand	2927-Ab4	5699
Bufo gutturalis	*Elim (906) Ladybrand	2927-Ab4	5700-04
Bufo rangeri	*Alma (1511) Harrismith	2828-Bc1	5588
Pyxicephalus a. adspersus	Bloemfontein (University of the O.F.S.)	2926-Aa2	5669-77
Tomopterna cryptotis	Bloemfontein	2926-Aa2	5653-56
	Sandveld Nature Reserve, Hoopstad	2725-Da4	5705-06
	*Vergelegen (342) Bethulie	3026-Ca2	5711, 5712 (two tadpoles)
Rana angolensis	*Naval Hill, Bloemfontein	2926-Aa2	5692
Rana fuscigula	*Elim (906) Ladybrand	2927-Ab4	5697-98
Kassina senegalensis	Moreson (407) Marquard	2827-Cc2	5647
	Bloemfontein (University of the O.F.S.)	2926-Aa2	5648

REPTILIA

Taxon	Locality	Locus Code	NMB A
Lygodactylus c. capensis	*Bainsvlei (Bokmakiere Nursery) - probably introduced with aloes from the eastern Cape Province) Bloemfontein		6857
Pachydactylus c. capensis	*De Villiers Drift (338) Fouriesburg	2828-Cb3	6863-64
Agama a. atra	*De Villiers Drift (338) Fouriesburg	2828-Cb3	6865
Bradypodion ventrale cf. *karroicum*	*Bloemfontein (Hennie Potgieter Crecent)	2926-Aa2	6862
Mabuya capensis	*Naval Hill (top of), Bloemfontein	2926-Aa2	6827
Mabuya varia	*Mierfontein (171) Smithfield	2926-Dc4	6804
	Naval Hill, Bloemfontein	2926-Aa2	6826
Mabuya striata punctatissima	*Boshof Townlands (432) Boshof	2825-Ca2	6848
	*De Villiers Drift (338) Fouriesburg	2828-Cb3	6866
Acontias g. gracilicauda	*Mierfontein (171) Smithfield	2926-Dc4	6805

Cordylus p. polyzonus	*Wesselsrust (18) Smithfield	2926-Dc4	6806-08
Leptotyphlops s. scutifrons	*Collies Dale (818) Vrede	2729-Da2	6869-70
Lycodonomorphus laevissimus	Shangrilla near Sasolburg	2627-Dd1	PEM R8057

The following data apply to the above specimen (housed at the Port Elizabeth Museum): male; 597 + 216 = 813 mm total length; mass 83,8 g; ventrals 174, subcaudals 84, midbody scale rows 21 (G.V. Haagner, Port Elizabeth Museum, pers. comm.). Although this locality is given as "Shangrila, District Sasolburg, O.F.S." by G.V. Haagner (pers. comm.), the only likely locality found on the 1 : 50 000 topocadastral map with a spelling similar to it is "Shagri la" on the northern (i.e. Transvaal) side of the Vaal River near Sasolburg. However, G.V. Haagner (pers. comm.) noted that a specimen was collected in a quarter-degree unit "adjacent" to 2627 DD (O.F.S. side), and another specimen was collected at 2627 DD. These records again suggest that *L. laevissimus* is likely to occur in the northern O.F.S.

Psammophylax r. rhombeatus	*Botshabelo, Thaba 'Nchu	2926-Bb3	6855
Psammophis leightoni trinasalis	*Bloemfontein (Langenhoven Park)	2926-Aa2	6859
Dasypeltis scabra	*Bloemfontein (Oliewenhuis Art Museum)	2926-Aa2	6867
Hemachatus haemachatus	*Bloemfontein (Old Industrial Area)	2926-Aa2	6868
Geochelone pardalis	*Dealesville, 13 km south-west of (sight record, M.F. Bates, 24 March 1993)	2825-Dd1	-

Sight records: M. Rall, 1993 (Tussen-die-Riviere Game Farm)

Varanus n. niloticus	3026-Ad3 3026-Ca2
Naja nivea	3026-Ca2 3026-Ac4 3026-Ad3
Bitis a. arietans	3026-Ac4 3026-Ad3
Geochelone pardalis	?
Homopus femoralis	?
Pelomedusa s. subrufa	?