Integrative taxonomy of the endemic Karoo agile grasshoppers, the Euryphyminae

by

Precious Tshililo

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Supervisor: Dr. Corinna Sarah Bazelet

Co-supervisors: Dr. Pia Addison and Dr. Minette Karsten

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Declaration

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Summary

The Euryphyminae are a small, African subfamily of grasshoppers which are not very well known. They are endemic to sub-Saharan Africa and consist of 23 genera, 16 of which have records of occurrence in South Africa. They are extremely agile and difficult to either catch or spot. Morphologically they are adapted to arid regions.

The aim of this study was to use an integrative taxonomy approach to fill gaps in knowledge relating to Euryphyminae taxonomy and diversity in the Karoo biome. I collected all Euryphyminae information from literature and digitized 626 museum specimens which had been positively identified. I also conducted two month-long sampling trips and collected 624 specimens of Euryphyminae in thirty sites across the southern Karoo biome. Utilizing all data at my disposal, I conducted the first taxonomic review of South African Euryphyminae, investigated morphological and molecular variation within one speciose genus, *Euryphymus*, and analysed the ecology and diversity of Euryphyminae across space and time in the Karoo.

In Chapter 2, I investigate the relationships among Euryphyminae genera by comparing morphological characters and molecular markers from three genes. I find that while most Eurphyminae genera are monophyletic and well-resolved, the evolutionary history does not comply with easily visible morphological traits. I provide an updated key to males of the Euryphyminae genera.

In Chapter 3, I first classify various individual of genus *Euryphymus* on the basis of their morphology. I then use DNA barcoding to determine the relationship between individuals with various polymorphism. Results show that individuals group into five valid species using the 3% species divergence cutoff which is most commonly used for insect phylogenetics. Of these five species, some may be new to science and may require species description. This study shows that variation among and within Eurypyhminae genera is very high and that morphology alone may not be sufficient to differentiate among species.

Finally, in Chapter 4, I investigate species richness, abundance and species composition of the Euryphyminae across space and time. I find that there are at least two distinct peaks of Euryphyminae abundance containing different species. Futhermore, most Euryphyminae species seem to be localized to a particular place and time, as most Karoo sites were dominated by one Euryphyminae species at a particular

time, but this species composition turned over with the different seasons. This ecology seems to be closely tied to the arid ecosystem which Euryphyminae is specially adapted to utilize.

As the first ever in-depth study on Euryphyminae, this study reveals that Euryphyminae are diverse and abundant in the Karoo biome. There may be many more as yet undiscovered species, and many of the known genera require taxonomic revision. Taxonomic revision will benefit from utilization of genetic traits. Furthermore, the evolutionary history of the Euryphyminae is not straight-forward and requires investigation to better understand how and when the Euryphyminae became specially adapted to utilize the arid and sparsely inhabited Karoo biome.

Results from this study will be analysed in conjunction with results from ten other plant and animal taxa sampled in the same sites through SANBI's Karoo BioGaps project. As a whole, these data will be used to aid in government decision making for the management and conservation planning of the Karoo, especially as it relates to shale gas exploration or fracking.

Opsomming

Die Euryphyminae is ‘n klein, redelik onbekende subfamilie springkane van Afrika. Hulle is endemies aan sub-Saharaanse Afrika en bestaan uit 23 genera waarvan 16 al gevind is in Suid-Afrika. Hulle is besonders rats en moeilik om raak te sien of te vang en is morfologies aangepas tot droë streke.

Die doel van hierdie studie was om met gebruik van ‘n geïntegreerde taksonomiese benadering die gapings te vul in die kennis van Euryphyminae taksonomie en diversiteit in die Karoo bioom. Ek het alle inligting oor Euryphyminae van die literatuur verkry en 626 museum eksemplare wat positief identifiseer is, gedigitaliseer. Ek het ook twee insamelings gedoen van twee maande elk waarin ek 624 Euryphyminae eksemplare versamel het vanaf dertig verskillende areas in die suidelike Karoo bioom. Deur al die inligting tot my beskikking te gebruik, het ek die eerste taksonomiese hersiening gedoen van Suid-Afrikaanse Euryphyminae, morfologiese en molekulêre variasie in die genus *Euryphymus* ondersoek, asook die ekologie en diversiteit van Euryphyminae oor verskillende tydperke en plekke in die Karoo geanaliseer.

In hoofstuk 2 ondersoek ek die verhoudings tussen Euryphyminae genera deur morfologiese kenmerke en molekulêre merkers van drie gene. Ek vind dat terwyl die meeste Eurypheminae genera monofileties en goed uiteengesit is, stem die evolusionêre geskiedenis nie ooreen met maklik sigbare morfologiese kenmerke nie.

In hoofstuk 3 klassifiseer ek eers tien morfospesies in die genus *Euryphymus* op grond van hul morfologie. Ek gebruik dan DNS strepieskodering om vas te stel of die tien morfospesies geldige spesies is. Resultate toon dat die tien morfospesies verdeel word in vyf geldige spesies met gebruik van die 3% spesie divergensie afsnypunt wat mees algemeen gebruik word vir insek filogenetiese studies. Van hierdie vyf spesies mag sommiges nuut wees vir die wetenskap en moontlik verdere beskrywing benodig. Die studie toon dat variasie tussen en binne die Euryphyminae genera baie hoog is en dat slegs morfologie moontlik nie voldoende is om tussen spesies te kan onderskei nie.

In hoofstuk 4 ondersoek ek spesierykheid, verspreiding en spesie samestelling van die Euryphyminae oor verskillende tydperke en areas. Ek vind dat daar minstens twee duidelike pieke van Euryphyminae getalle is, wat bestaan uit verskillende spesies. Verder wild it voorkom of die meeste Euryphyminae spesies gelokaliseer is tot ‘n sekere

tyd en plek, omdat die meeste Karoo areas gedomineer was deur een Euryphyminae spesies op 'n sekere tyd. Hierdie spesie samestelling het egter verander tussen seisoene. Die wil voorkom of hierdie ekologie verbind is aan die droë ekosisteem, waarvoor Euryphyminae spesiaal aangepas is.

As die eerste in-diepte studie van Euryphyminae, toon hierdie studie dat Euryphyminae spesieryk en volop is in die Karoo bioom. Daar mag wel baie spesies wees wat nognie beskryf is nie en baie van die bekende genera benodig taksonomiese hersiening. Taksonomiese hersiening sal baat by die gebruik van genetiese kenmerke. Verder is daar gevind dat die evolusionêre geskiedenis van die Euryphyminae nie eenvoudig is nie en meer navorsing benodig word om beter te verstaan hoe en wanneer die Euryphyminae spesiaal aangepas geword het om die droë en yl bewoonde Karoo bioom te benut.

Resultate van hierdie studie sal geanaliseer word saam met resultate van tien ander plant en dier taksa wat versamel is in dieselfde areas as deel van SANBI se Karoo BioGaps projek. Hierdie data sal uiteindelik gebruik word om die regering te help met besluitneming oor die bestuur en bewaring van die Karoo, veral ten opsigte van skaliegas eksplorasie en hidrouliese breking.

This thesis is dedicated to

Mulangaphuma M. Margareth

Biographical sketch

Precious Tshililo earned her Bachelor of Science degree in Botany and Zoology from University of Venda, South Africa, in 2015. For her Honours project, she studied the diversity of ground-dwelling beetles (Coleoptera) across different landscapes. In 2016, she enrolled for a Master's degree of Entomology at Stellenbosch University. She was part of the BioGaps project and she worked on grasshoppers, studying *"integrative* t*axonomy of the Karoo agile grasshoppers, the Euryphyminae"*. Her interest on Entomology was sparked by one of her lectures when she was still doing her BSc, C. S. Schoeman who became her Honours Supervisor and also encouraged her to continue with her Masters degree. Her aspirations is to become one of the influential taxonomist in South Africa and beyond.

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Preface

This thesis is presented as a compilation of 5 chapters. Each chapter is introduced separately and is written according to the style of the journal *Journal of Orthoptera Research* to which Chapter 2, 3 and 4 will be submitted for publication.

Chapter 1 **General Introduction and project aims**

Chapter 2 **Research results**

Morphological and phylogenetic relationships among Euryphyminae genera including review of South African Euryphyminae.

Chapter 3 **Research results**

Investigating the relationship between different individuals of *Euryphymus* genus collected in the southern Karoo, South Africa.

Chapter 4 **Research results**

Biodiversity of the Karoo agile grasshoppers (Acrididae:Euryphyminae)

Chapter 5 **General discussion and conclusions**

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CHAPTER 1

General introduction and project aims

The Euryphyminae are a small, African subfamily of grasshoppers which are not very well known, even among orthopterists. The group is most easily recognized by the unusual and elaborate species-specific shape of the male cercus, which is most similar, but still distinct, from that of the Calliptaminae (Dirsh 1956). Euryphyminae is a Southern African endemic subfamily which consists of 23 genera and only 17 genera have records of occurrence in South Africa (Cigliano et al. 2017).

The subfamily is restricted to sub-Saharan Africa. The Euryphyminae have rarely been studied and due to high levels of intraspecific variation and low levels of interspecific variation, currently available taxonomic keys are insufficient for distinguishing between species and sometimes even genera (Bazelet and Naskrecki 2014).

In this thesis, I aim to address the gap of poor taxonomy of the Karoo Euryphyminae by reviewing the South African genera of the subfamily, quantifying the levels of inter- and intraspecific variation in one genus, *Euryphymus*, and assessing the biodiversity of Euryphyminae in a threatened ecosystem, South Africa's Karoo biome. This study will shed light on community and population level diversity within an important faunal component of the Karoo, and will improve our decision-making capabilities for the management of the Karoo and for conservation planning.

The karoo biome

The arid regions of southern Africa are situated in the western part of the African continent, approximately to the west of 27 ºE and north of 34 ºS (Fig. 1) (Desmet and Cowling 1999). This area is bounded on the west by the cold Atlantic coastline, in the south by the winter rainfall fynbos and evergreen forest as well as by arid and mesic savannas in the north and east. The flora and fauna of the Karoo also includes biodiversity from the surrounding biomes (Dean and Milton 2003).

The Karoo is divided into two biomes (Nama Karoo and Succulent Karoo) (Cowling 1986). These two biomes differ in terms of their climate, soil and landforms (Mucina et al. 2006). Nama Karoo covers 19.5% and Succulent Karoo covers 6.5% of the world surface area and they are the most species rich arid areas in the world.

Succulent Karoo

The Succulent Karoo Biome is located in the Western, Northern and Eastern Cape Provinces and covers approximately 116 000 km^2 (Young et al. 2016; Mucina et al. 2006). This region get its name because of its many succulent plants and is known to contain a large amount of plant biodiversity (Mucina et al. 2006; Cowling et al. 1998). Succulent Karoo contains the greatest diversity of succulent plants of all global ecosystems, succulent species recorded in the Succulent Karoo from 10 000 of the world estimated succulents (Rutherford et al. 2006).

The Succulent Karoo is divided into two regions composed of different landscapes: the Namaqualand-Namib domain and the Southern Karoo domain (Mucina et al. 2006). These are further divided into six bioregions according to geographical and environmental gradients, of which the Southern Karoo domain contains four regions (from the North to the South: Richtersveld, Namaqualand Hardeveld, Namaqualand Sandveld and Knersvlakte), and the Namaqualand-Namib domain contains the last two regions (The Rainshadow Valley Karoo and Trans-Escarpment Succulent Karoo) (Fig. 2) (Rutherford et al. 2006; Mucina et al. 2006; Young et al. 2016).

The Richtersveld bioregion is mostly in the northern mountainous area and covers the largest amount of vegetation, the Namaqualand Hardeveld covers the hilly areas and the Namaqualand Sandveld is to the west of Namaqualand Hardeveld and it is the lowest lying of the six bioregions (Young et al. 2016). The Knersvlakte bioregion is the smallest of the bioregions and lies in the lower altitudes while the Trans-Escarpment Succulent Karoo lies in the highest altitude of all the bioregions (in the Namaqualand-Namib domain region) and is also the most sparsely vegetated (Rutherford et al. 2006). The Rainshadow Valley Karoo covers the largest area of all of the bioregions, in its basin it includes the Little Karoo, Tankwa Karoo and Robertson, which are each notable for unique environmental variables leading to a unique assemblage of species (Rutherford et al. 2006).

Nama Karoo

The Nama Karoo is situated in the north central part of South Africa and covers 346 100 km^2 of South Africa's interior (Ndhlovu et al. 2016). This biome borders the Succulent Karoo, Grassland, Savanna, Fynbos and Albany Thicket Biomes (Mucina et al. 2006).

The Nama Karoo is made up of three bioregions: Bushmanland, Upper Karoo and Lower Karoo (Rutherford et al. 2006). The Bushmanland in the North is dominated by arid grassy shrubland; the Upper Karoo is a central region containing succulent dwarf shrubland and grassy shrubland. The Upper Karoo is the largest bioregion in terms of area and the highest in altitude. The Lower Karoo is the southern part of the Nama Karoo Biome and is the smallest of the bioregions in the lowest altitude (Rutherford et al. 2006).

Climate

The Succulent Karoo and Nama Karoo Biomes vary in terms of their geology and climate which determines their vegetation structure and composition (Dean and Milton 1999).

The Succulent Karoo is a semi-desert biome which receives low annual rainfall. Highest percentage of rainfall is during the winter months of May-September and mean annual precipitation of 100-200 mm (Cowling et al. 1998; Mucina et al. 2006) with mean annual temperature of 16 - 20 ºC (Burke 2015). Its winter rainfall is influenced by the disturbance in the western stream and cold fronts of the winter season (Desmet and Cowling 1999). The rain falls for long durations, and the region has high humidity at night and early in the mornings but there is drought in summer. Fog, heavy dew and frost are rare (Burke 2015).

Nama Karoo is very hot and it receives its rainfall during late summer (100-300 mm). During late summer, overall rainfall is low and variable (Desmet and Cowling 1999; Beukes et al. 2002; Cowling et al. 1998). Rainfall in the Nama Karoo is influenced by the tropical disturbance during summer. It also receives small amounts of rain in winter due to winter cold fronts and a mean annual precipitation of 70-500 mm (Mucina et al. 2006). The Nama Karoo's rain does not last for long periods, it is unpredictable and its summers are hot and very dry (Lombard et al. 1999).

With climate determining the structure and composition of Karoo vegetation, climate is the main driver of Karoo biodiversity in general (Mucina et al. 2006). The climate varies in different bioregions of the Karoo. The Succulent Karoo, which receives more annual rainfall, has greater plant diversity than the Nama Karoo, which receives low annual rainfall (Mucina et al. 2006; Beukes et al. 2002). Generally, there is a positive correlation between plant diversity and amount of rainfall (Lombard et al. 1999).

Flora and fauna of the Karoo

Overall, the Nama Karoo and Succulent Karoo are characterised by succulent dwarf shrublands, woody dwarf shrublands and grasslands (Dean and Milton 2003; Burke et al. 2003). The Succulent Karoo is one of the few arid biomes classified as a biodiversity rich biome (Cowling et al. 1998; Young et al. 2016). It has 6356 species of vascular plants in 1002 genera and 168 families, with 26% (1630 species) of its plants endemic to the biome and 17% are listed as Red data species (Mucina et al. 2006). The Succulent Karoo is also a centre of endemism for quite a few faunal species (Young et al. 2016). With a number of endemic species including arachnids, hopliinid beetles, aculeate hymenoptera, reptiles and tortoises (Mucina et al. 2006).

The Nama Karoo's flora is not as species rich as the Succulent Karoo's flora (Mucina et al. 2006). It contains an estimated 2147 plant species but overall this area is dominated by open dwarf shrubs intermixed with grasses and succulents (Mucina et al. 2006). The Nama Karoo shares its biodiversity with other transitional biomes (Savanna and Grassland biomes) hence it is not rich in endemics like the Succulent Karoo (Procheş and Cowling 2007). Its fauna includes birds and larger mammals which migrate in time due to the availability of resources (Mucina et al. 2006).

Although flora, especially in the Succulent Karoo, is well researched, not much is known about the distribution of its animals, which includes many undescribed species especially invertebrates (Mucina et al. 2006).

How much of the Karoo is protected?

Only 5.8% (6 500km^2) of the Succulent Karoo is formally protected under statutory and non-statutory reserves (Mucina et al. 2006). From the six Succulent Karoo bioregions, only three contain national parks (the Richtersveld, Namaqualand Hardeveld, and Rainshadow Valley Karoo) and four contain provincial reserves (Namaqualand Sandveld, Knersvlakte, Trans-Escarpment Succulent Karoo, and Rainshadow Valley Karoo) (Mucina et al. 2006).

Most of the Nama Karoo is privately owned and only 0.7% of the land is formally protected under statutory reserves (Upper Karoo) and national parks (Bushmanland, Upper Karoo and Lower Karoo) (Mucina et al. 2006).

Sampling bias in the Karoo

Biodiversity in the Karoo biome is poorly surveyed mainly due to lack of easy access and more often than not people tend to sample close to the road side. This is because it is not easy to move around due to logistical constraints, such as physical barriers created by fences (Botts et al. 2011). These physical constraints reduce sampling effort, thereby reducing the probability of collecting more species, either endemic or common (Botts et al. 2011; Bazelet et al. 2016; Burke 2007). This is likely why available biodiversity data in the Karoo biome has many gaps and barely represent the amount that is available (Fig. 3).

Although few studies have specifically investigated this, Reddy and Davalos (2003) found that birds of the Karoo have been extensively sampled towards priority areas. Botts et al. (2011) found that frogs are mostly sampled in reserves and in areas closer to the reserves, areas far from the reserves were found to contain fewer records of frog occurrence.

Karoo BioGaps project

The Karoo BioGaps project is funded by the National Research Foundation (NRF) and Department of Science and Technology (DST) through the FBIP (Foundational Biodiversity Innovation Programme) grant programme. Karoo BioGaps is led by the South African National Biodiversity Institute (SANBI) and it involves a consortium of scientists from various institutions who are surveying 11 target taxa of plants, vertebrates and invertebrates across the Karoo, especially in areas targeted for shale gas exploration.

The stated aim of the project is for the purpose of "mobilising foundational biodiversity data to support government decision making plans" (https://www.sanbi.org/biogaps). In order to mobilize data, Karoo BioGaps has four main activities: (1) to digitize existing museum and herbarium collections of Karoo biodiversity; (2) to actively sample and collect new records for target taxa in the Karoo; (3) to conduct DNA barcoding of Karoo biodiversity; and (4) to perform Red-Listing of key biodiversity components of the Karoo.

For field collection of new specimens, sampling sites were selected by the Karoo BioGaps project team led by Res Altwegg, Simon Todd, and Dominic Henry, so that all 11 participating taxa would be sampled in the same places in order to enable statistical comparisons among taxa. The shale gas exploration area was divided into pentads. Thirty pentads were selected at random using an algorithm designed specifically for this purpose, to be evenly distributed across the shale gas exploration area and to take into account all biomes in the region. Then, each selected pentad was investigated in detail on Google Earth in order to designate a 1 km x 1 km square within the pentad that met the following criteria: accessibility in the form of roads, a variety of microhabitats (Fig. 5) including slopes, riparian areas and a diversity of vegetation types. In some cases, pentads and 1 km^2 squares proved to be unsuitable when visited in person, and these were modified as needed.

For digitization, there are thousands of collected museum specimens over time, which are stored in historical museums and herbaria. The information in these specimen records is informative for determining species distribution as well as historical processes of species shifts. Digitization of these specimens is vital in order to make the information stored in these museums available to scientist (https://www.sanbi.org/biogaps).

The ultimate expected outcome of the project as stated by the BioGaps website is, "by the end of the project approximately 200 000 new primary occurrence records will inform species occupancy and habitat richness models which, along with approximately 300 Red List assessments of species of conservation concern, will be served to decision makers via the SANBI's Land Use Decision Support (LUDS) tool" (https://www.sanbi.org/biogaps).

Orthoptera

Orthoptera higher taxonomy

The Orthoptera is one of the most diverse orders among the polyneopteran insects with more than 25700 extant species. This order includes katydids, crickets, grasshoppers and locusts (Song et al. 2015). The order is divided into two suborders: Ensifera (e.g. crickets, katydids, weta) and Caelifera (grasshoppers and locusts) (Song et al. 2015). The Caelifera are predominantly diurnal and herbivorous whereas the Ensifera are predominantly nocturnal and may range from herbivorous to predatory (Floren et al. 2001). However, in general terms, both the Caelifera and Ensifera are known for acoustic communication, which is achieved by different mechanisms in the two suborders, and for having enlarged and muscular hind femora that are specialized for jumping.

Acridoidea is one of the largest superfamilies in the Orthoptera with Acrididae being the largest family in Acridoidea (Huang et al. 2013) and containing more than 11,000 described species (Dong et al. 2015). They are most diverse and abundant in grassland ecosystems (hence the name "grasshoppers") but, because this is a large and diverse family, several groups have become specialized over time and have adapted to unusual environments or conditions.

Orthoptera of South Africa

In South Africa, there are approximately 970 described species of Orthoptera (Cigliano et al. 2017). Of these, the most common families are the Acrididae (= grasshoppers, 350 spp, 36% of South African species), Tettigoniidae (= katydids, 160 species, 17% of species), and Gryllidae (= crickets, 110 spp, 11% of species) (Cigliano et al. 2017). Proportionally, this distribution of species among families' mirrors that of the global Orthoptera, in which Acrididae and Tettigoniidae are the two families with the greatest number of describes species, followed by the Gryllidae (Song et al. 2015).

Grasshoppers are the predominant insect herbivores in African savannas. Most grasshopper species are highly mobile and able to choose from a wide variety of potential microhabitats (Prendini et al. 1996). They are important herbivores in many open ecosystems and show high levels of endemism (Matenaar et al. 2015). Therefore they provide an opportunity for studying the influence of vegetation disturbance on the structure and abundance of insect guilds (Prendini et al. 1996).

Orthoptera of the Karoo

Grasshoppers in the Karoo are mostly found inhabiting the dwarf Karoo shrubs and rocky or bare ground. The Karoo environment makes them difficult to spot and the sparse dwarf vegetation allows them good visibility to spot their predators (Bazelet and Naskrecki 2014).

The brown locust, *Locustana pardalina* (Orthoptera: Acrididae: Oedipodinae), is the most notable component of the Karoo Orthoptera fauna. They are more abundant in summer and exist in two forms, the solitary and gregarious form. The solitary form is harmless and of no economic importance, the gregarious forms are the migratory locust (brown locust) which forms large swarms and are destructive to crops and other vegetation (Henschel 2015).

The brown locust represents an invertebrate component of the Karoo which is relatively well understood as its biology has been well studied. Unlike the brown locust, the agile grasshoppers (Acrididae: Euryphyminae) are an important component of the Karoo which has been rarely studied and its life history, biology and diversity are poorly understood.

The only studies conducted on Orthoptera of the Karoo were from the PhD thesis of Solomon Gebeyehu (Gebeyehu and Samways 2003, 2006). These studies showed that habitat heterogeneity increases the diversity of short-horned grasshoppers, sparse vegetation and less grass coverage and rockiness provide a wide range of microhabitats and influences grasshopper diversity and abundance. These studies further found that grasshoppers are more sensitive to grazing sites, that are continuously grazed, contain less diversity and rotationally grazed sites contain more diversity and abundance.

Euryphyminae

The Euryphyminae is an endemic grasshopper subfamily in sub-Saharan Africa .They are extremely agile and difficult to either catch or spot (Bazelet and Naskrecki 2014). Morphologically they are adapted to arid regions: they are relatively robust, small to medium sized (body length: 15–28 mm) compared to other grasshoppers. Both sexes either have wings which surpass the end of the abdomen in length, or short wings which just cover the tympanum (Bazelet and Naskrecki 2014). In most species, internal hind femora of both sexes are coloured black when mature and many species also have colourful hind wings and tibiae. When at rest, they camouflage with their environment because their bodies are either spotted or darkly coloured (Bazelet and Naskrecki 2014). It has been suggested that Euryphyminae use their colourful body characters for intraspecific communication, most likely as a sexual display, as all colourful body parts are hidden while at rest but can be displayed strategically during flight or movement.

The Euryphyminae subfamily was erected by Dirsh (1956) based on its distinct ephiphallus and unusual male cercus. Euryphyminae are superficially similar in appearance to Calliptaminae, which also have ornate ephiphallus and male cerci, strategically colourful morphological characters and occur throughout the Old World. In South Africa, 54 species of Euryphyminae have been recorded vs. only six species of Calliptaminae, indicating that the Calliptaminae center of endemism and diversity is farther to the north than that of Euryphyminae (Cigliano et al. 2017). Catantopinae and Eyprepocnemidinae, too, have similar ornate male reproductive structures, colourful characters, and occur throughout the Old World, but Catantopinae extend into Polynesia and Australia as well. A recent analysis of all Orthoptera for which complete mitochondrial genomes have been sequenced found that Catantopinae, Calliptaminae and Eyprepocnemidinae, together with Cyrtacanthacridinae (which includes large-bodied grasshopper and locust species, including the desert locust, *Schistocerca gregaria*), form a distinct clade (Song et al. 2015). On the basis of morphology and distribution, Euryphyminae would most likely also belong to this clade, but its mitochondrial genome has not been sequenced so it was not included in this study.

Dirsh (1956) did most of the taxonomic work on this subfamily, including extensive revision of the genera which were erected by Uvarov (1922). Naskrecki (1992; 1995) reviewed the Namibian Euryphyminae and revised the *Rhachitopis* genus. Bazelet and Naskrecki (2014) revised the genus *Pachyphymus*, and Rowell (2016) added two new species to the genus *Phymeurus* from Tanzania. Only three specimens of Euryphyminae have previously had DNA sequenced, and these sequences did not include any mitochondrial genes because the purpose of the study was to elucidate higher taxon relationships within the Orthoptera so two ribosomal RNA genes and two nuclear markers were targeted (Song et al. 2015).

Major threats to Euryphyminae in the Karoo

Although little information is known about the Karoo's grasshoppers, their diversity is considered to be threatened (Stewart 1998). Urbanization, the use of pesticides, over-grazing and drought in particular, threaten to extirpate many species (Hilton-Taylor and Le Roux 1989). The Karoo is threatened by periodic drought, it is a water scarce area, and this affect the aquatic ecosystem and its species (Holness et al. 2016). Meanwhile overgrazing by livestock leads to habitat loss, which directly affects biodiversity. The use of pesticides to control swarming of the brown locusts also affect other invertebrates while also leading to eutrophication of water bodies (Holness et al. 2016).

Grasshoppers share the same habitat with the brown locust, which has been moderately studied (Todd et al. 2002) and is regarded as a pest (Henschel 2015). Outbreaks of the brown locust occur during the Nama Karoo's rainy season (summer) when green vegetation is available for the locusts to feed on (Mucina et al. 2006). This locust is known to form large gregarious migratory swarms which are destructive to crops and other vegetation (Henschel 2015).

The brown locust competes with other herbivores like grazing sheep, cows and other livestock for food, so its outbreaks are usually controlled using synthetic pyrethroid deltamethrin (Decis®) insecticide which also affects non-target invertebrates (Stewart 1998). Stewart (1998) further indicates that the pesticide used has no detrimental effects on mammals and birds.

The diversity of grasshoppers along with other Karoo organisms are also threatened by urbanisation and mining (Hoffman and Rohde 2007; Atkinson 2016; Cornelissen 2016). Urbanisation and mining involve the removal of vegetation which greatly influences the diversity of grasshoppers (Gebeyehu and Samways 2003; 2006). Grasshopper diversity is said to be influenced by the structural diversity of vegetation (Bazelet and Samways 2011), therefore if removed this poses a biodiversity threat not only to grasshoppers but to the Karoo's biodiversity as a whole.

With shale gas exploration (pre-emptive steps to evaluate the feasibility of fracking for fuel production) soon to take place, the likelihood of the Karoo biome losing its poorly documented biodiversity before it can be discovered, is high (Scholes et al. 2016). Due to this threat of future biodiversity loss of both known and unknown taxa from a possible exploration of shale gas, SANBI developed its 'Karoo BioGaps' project. This project aims to collect biodiversity data through survey of different taxa occurring in the Karoo to know which organisms occur where before exploration events start.

Integrative taxonomy

Species concepts in taxonomy

Before describing species, taxonomists must determine the definition of what constitutes an individual species and what differentiates a species from its sister species by selecting a species concept. Several species concepts have been proposed by different biologists in different fields and the most popular concepts are the biological, ecological and phylogenetic species concepts. The biological species concept states that two species which are reproductively isolated (cannot inter-mate) are distinct species, the ecological species concept separates species on the basis of the ecological niches they occupy and the phylogenetic species concept uses monophyly as its species separation criterion (de Queiroz 2005).

Different fields of biology have adopted different species concepts which are regarded as incompatible because they lead to different conclusions of species delimitation (Harrison 1990). For example, taxonomists use morphological differences while systematists use monophyletic species concepts amongst others.

Despite all these conflicting species concepts, they do have some congruencies between them although they differ in wording. The existing species concepts agree that species are separately evolving meta-population lineages, however they vary in terms of properties they evolved during diversification (de Queiroz 2007). Subsequently, de Queiroz (2007) proposed a unified species concept which states that a lineage is considered a species if it evolved separately from other lineages.

However careful consideration should be given to the existence of any contingent characteristic. The absence of the same characteristic is not sufficient evidence to conclude that lineages have not separated, because the lineage might be in the early stages of diversification (de Queiroz 2007). Here, we adhere to the unified species concept when delimiting species.

Alpha taxonomy versus integrative taxonomy

Alpha taxonomy, sometimes referred to as “classical taxonomy” or ”traditional taxonomy” (Schlick-Steiner et al. 2010; Hajibabaei et al. 2007), is a method of species delimitation, the science of describing and naming species and providing biodiversity maps that are used universally (Mayo et al. 2008). Delimitation in alpha taxonomy is mainly based on the presence of conserved morphological diagnostic characters which distinguishes a species from all others (Wiens and Servedio 2000). However this method is slow, and can cause misidentifications in some cases due to phenotypic plasticity which can lead to either cryptic diversity or to large degrees of variation within species (DeSalle et al. 2005). Diagnostic keys are often insufficient, as often they are only effective for certain life stages and gender, such as in cases where identification is based on male genitalia (Valentini et al. 2008).

Due to limitations in alpha taxonomy, biologists introduced integrative taxonomy which is the process of incorporating all available information from morphological data, molecular data, ecological data and behavioural data to delimit species (Goldstein and DeSalle 2011; Schlick-Steiner et al. 2010). Most integrative taxonomy studies combine only molecular and morphological datasets. There have been some controversies that integrative taxonomy will replace alpha taxonomy (Hebert and Gregory 2005). However, integrative taxonomy promises a more rigorous delimitation than alpha taxonomy alone (Schlick-Steiner et al. 2010), can aid in revealing cryptic species if present (Hajibabaei et al. 2007) and is also a cost effective way of species identification (Hebert and Gregory 2005).

Molecular methods in integrative taxonomy

The inclusion of molecular tools has gained in popularity due to it producing relatively fast identification and classification results. It can also be useful for revealing cryptic species and speciation events if present (Goldstein and DeSalle 2011). A variety of molecular methods exist. DNA barcoding is the simplest and most popular method as it is being used for the Barcoding of life project (BOLD). And therefore involves the use of the *cytochrome c oxidase subunit I* (COI) gene to identify Molecular Operational Taxonomic Units (MOTU) (Smith et al. 2005).

The theory behind DNA barcoding is that the COI gene encodes for a protein which is necessary for the survival of all animals and therefore all animals share this gene, but that COI mutates at such a rapid pace, that each individual animal species in existence is hypothesized to have a slightly different sequence. In theory, the more distantly related the species, the more mutations have accumulated over time, and the more divergent the DNA barcode sequences will be. Therefore, once all animal species have had their DNA barcode sequenced and deposited in an online database, then the ~638 bp DNA barcode will be used like a fingerprint for the rapid identification of any animal on Earth (Hebert et al. 2003). In rare cases, however, unrelated species might contain the same mitochondrial gene due to introgression or incomplete sorting and errors can result due to amplifying nuclear copies of the mitochondria (Valentini et al. 2008).

In particular, careful consideration must be taken when barcoding Orthoptera because they contain pseudogenes (*numts*) which are non-functional copies of mtDNA which have been inserted into the nuclear genome, and which are easily amplified alongside the functional COI gene during DNA barcoding procedures. The *numts* when amplified, are divergent from orthologs of mtDNA sequences, and during analysis the number of unique species may be overestimated (Song et al. 2015). *Numts* can be identified and filtered by using in frame stop codons, indels and also examining nucleotide composition (Song et al. 2008).

DNA barcoding alone may be sufficient for delimiting species. However, in order to determine evolutionary relationships among the species (as is necessary for delimiting higher level taxa such as genera, tribes, subfamilies and families), it is not suitable for resolving phylogenetic relationships at deeper levels. This is why mitochondrial and nuclear genes are usually the requirement in order to build phylogenetic trees and analyse coalescent events (evolutionary history of genes) to delimit species (de Queiroz 2007; Fujita et al. 2012; Hajibabaei et al. 2007).

Ecology as a tool in integrative taxonomy

Closely related species, especially sympatric species, are expected to inhabit separate but adjacent ecological niches. For example, scientists have often debated the likelihood and prevalence of sympatric speciation of phytophagous insects which have shifted host plants (Berlocher and Feder 2002; Drès and Mallet 2002). In these cases, observing the host plant on which an insect occurs or feeds can be used as an additional data source for delimitation of species, alongside morphology and genetics.

Most grasshoppers (Orthoptera: Acrididae) are resource generalists which consume a variety of food plants, so it is unlikely that they will have speciated as a result of shifting host plants. However, two distantly related genera of Orthoptera in the Cape Floristic Region of South Africa, *Betiscoides* (Orthoptera: Caelifera: Lentulidae) grasshoppers (Matenaar et al. 2014) and *Megalotheca* (Orthoptera: Ensifera: Tettigoniidae) katydids, have clearly and visibly converged morphologically to mimic restio plants (Restionaceae). Both of these genera have limited mobility and apparently complete their entire life cycle on and within restios. Recent taxonomic work shows that *Betiscoides* is far more speciose than originally thought (D. Matenaar, personal communication of work soon to be published), and that some *Betiscoides* species may be limited to a particular restio species. Although no work has been done on *Megalotheca* yet, a similar specialization has been shown for restio leafhoppers (Hemiptera: Cicadellidae) (Augustyn 2013 and therefore this phenomenon may be quite widespread in the Orthoptera or in hemimetabolous insects occupying similar niches to the Orthoptera.

The survival and reproduction of grasshoppers (Orthoptera: Acrididae) is influenced by biotic and abiotic factors (Schell and Lockwood 1997). In arid regions, species occurrences and distributions may be limited by physiological constraints which allow certain species to occupy particular niches, while closely related species cannot occupy the same niches. Some evidence that this may be the case for the Euryphyminae can be seen in the genus *Pachyphymus* (Bazelet and Naskrecki 2014). The four existing species were delimited on the basis of morphology alone, but pockets of distinct morphological characters, such as the slightly divergent wing pattern in *Pachyphymus cristulifer* individuals from Touws Rivier, could indicate ongoing speciation, perhaps in response to specialized ecological conditions. There is no apparent geographical boundary to dispersal in this region but molecular and ecological evidence could help to determine whether the Touws Rivier population is indeed a distinct species or subspecies or simply a morphological variant due to developmental processes which occur in this region alone. In order to understand the ecology of the Euryphyminae, it is important to also consider their habitat (Bazelet and Naskrecki 2014).

Integrative taxonomy of Euryphyminae

When working with a taxon such as Euryphyminae which has high morphological variation within species and low variation between species, integrative taxonomy is crucial (Bazelet and Naskrecki 2014). Since Euryphyminae species are possibly found in distinct pockets of space and time due to the restrictive conditions of their arid environments, ecological characters may also be useful for species delimitation. Molecular tools have never been employed for the taxonomy or systematics of Euryphyminae and may be very helpful for this group because molecular tools can help to associate females to conspecific males in groups where female taxonomy is poorly understood (Song et al. 2015).

Aims and objectives

The aim of this study was to use an integrative taxonomy approach to fill gaps in knowledge relating to Euryphyminae taxonomy and diversity in the Karoo biome.

Objectives:

1. To review the South African Euryphyminae genera by gathering and analysing all information from publications, museum specimens and field collected specimens.
2. To utilize multiple molecular markers in order to determine relationships among Euryphyminae genera.
3. Investigating the relationship between different individuals of Euryphymus genus collected in the southern Karoo, South Africa.
4. To investigate the ecological characteristics of Euryphyminae in the southern Karoo.

The chapters that follow are presented as separate publishable papers and, for this reason, some repetition in the different chapters is unavoidable.

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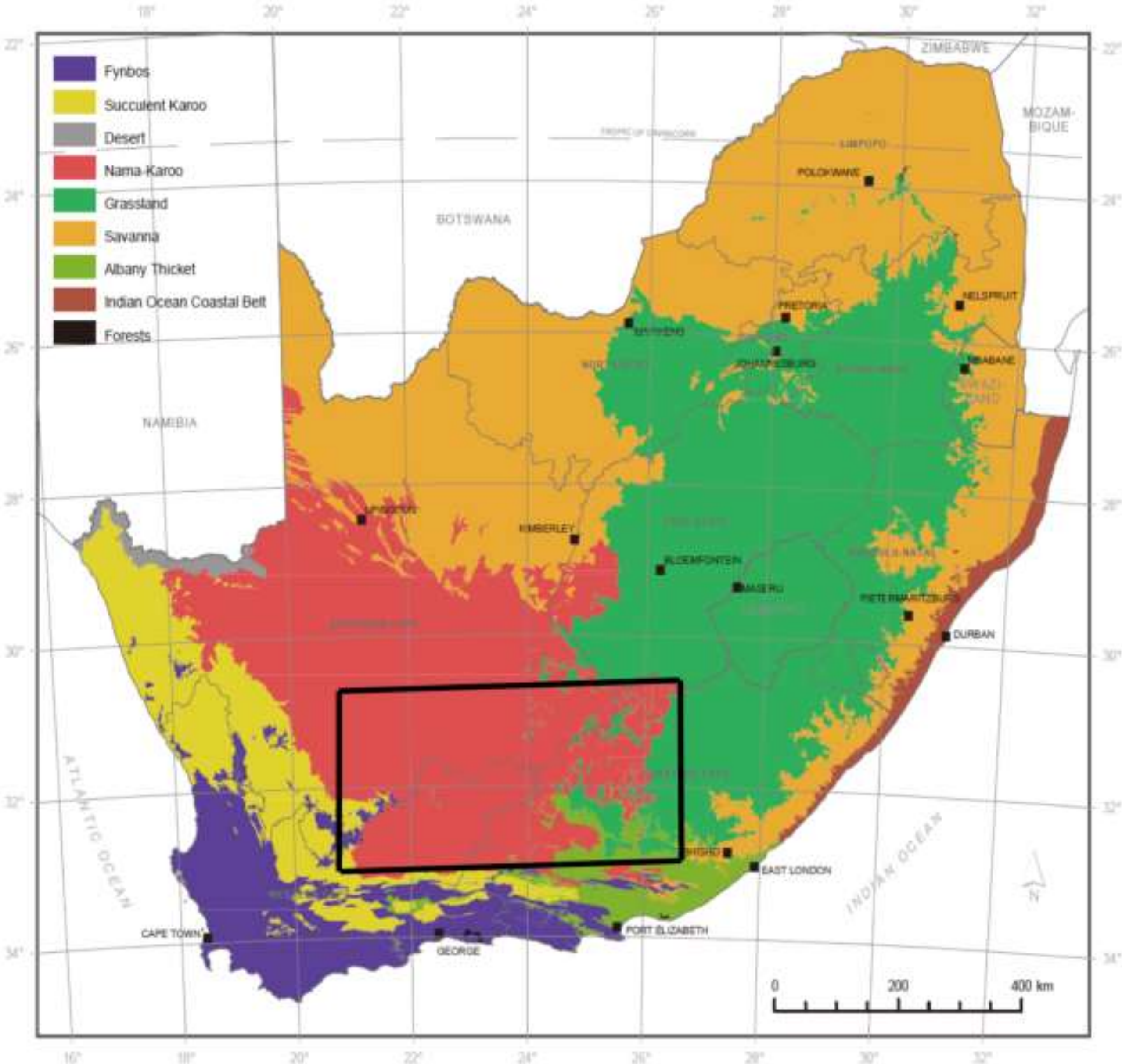

Figure 1. Biomes of South Africa, with Succulent Karoo indicated by yellow and Nama-Karoo indicated by red (Source: Rutherford et al. 2006) and approximate shale gas exploration site indicated by a black outline.

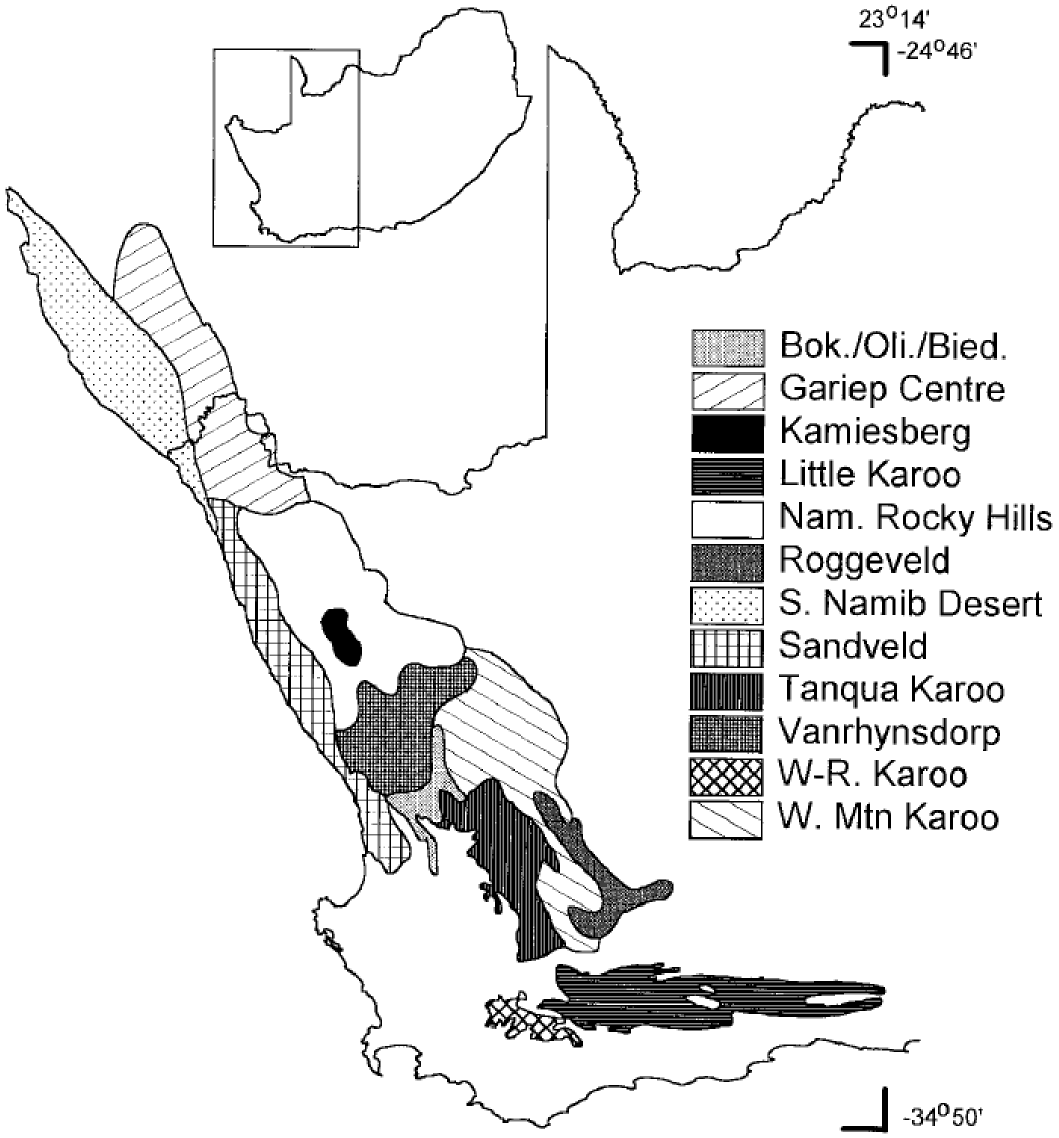

Figure 2. Six bioregions of the Succulent Karoo (Source: Lombard et al. 1999)

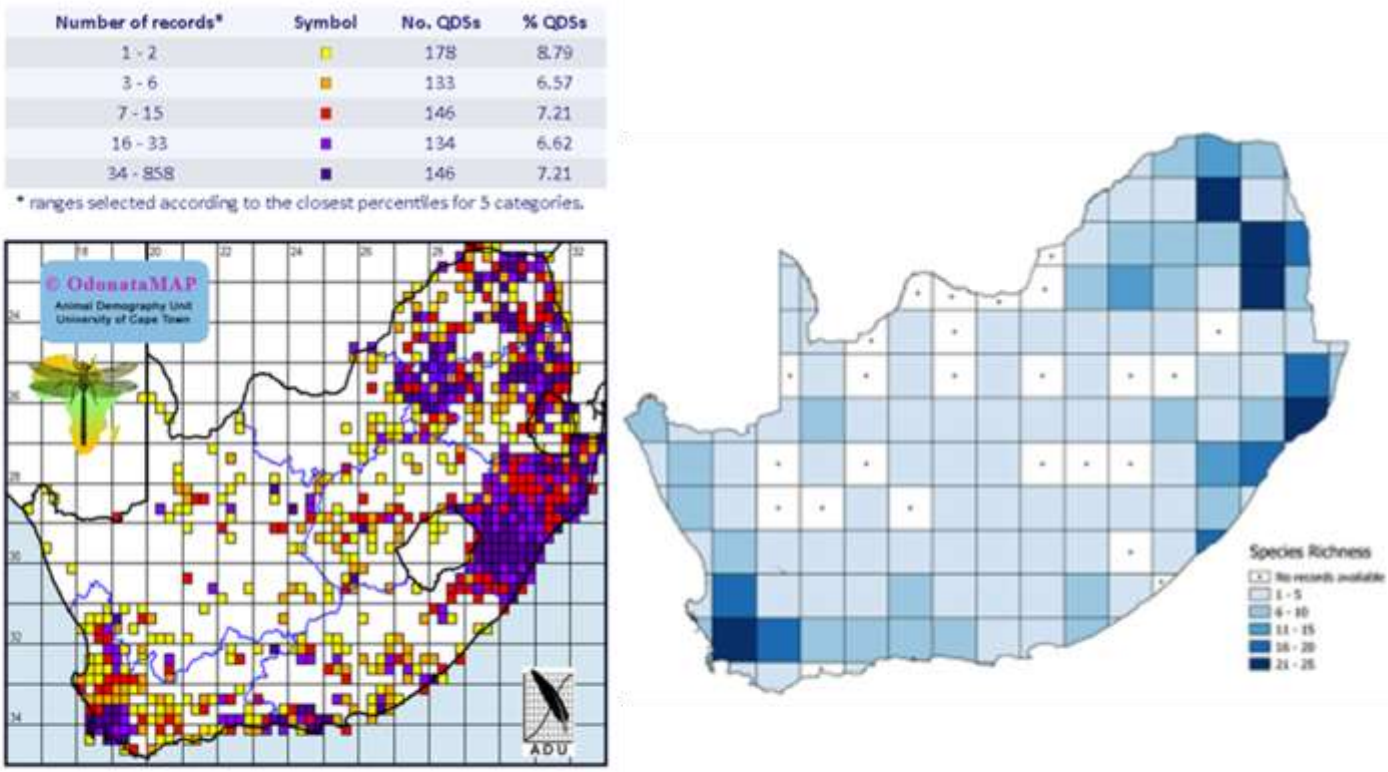

Figure 3. Represents the distribution of dragonflies (A) and katydids (B) in South Africa and illustrates data gaps which are localized around the central Nama-Karoo region (Source: Bazelet et al. 2016; http://sabap2.adu.org.za/coverage.php#menu-top).

Figure 4. Represents the distribution of Euryphyminae in Africa (Source: Cigliano et al. 2017).

Figure 5. Showing four different habitat types that we sampled in- southern Karoo South Africa.

CHAPTER 2

Morphological and phylogenetic relationships among Euryphyminae genera including review of South African Euryphyminae

Abstract

Euryphyminae includes endemic agile grasshoppers from southern African which consists of 23 genera and 48 species, 16 genera (61%) of which have been recorded in South Africa previously. No comprehensive studies have focused on Euryphyminae diversity in South Africa, with distribution and taxonomic records scattered throughout the historic literature, most of which were published prior to 1960. Furthermore, Euryphyminae have traditionally been scarcely sampled due to their inaccessible habitats in the sparsely populated arid interior of South Africa. Here, we compile all available information from historic literature accounts, 626 positively identified museum specimens from 16 genera, and 624 freshly field-collected specimens from eight genera to review the Euryphyminae genera of South Africa and to conduct a preliminary evaluation of the evolutionary relationships among them. On the basis of two easily identifiable and genus-specific morphological characters – shape of the pronotum and shape of male cercus – I hypothesise that the diversity of Euyphyminae in South Africa resulted from one primary speciation event resulting in two main clades. I then test this hypothesis using DNA sequencing of three molecular markers – H3A (nuclear), 12S (ribosomal RNA) and COI (mitochondrial). I also provide an updated key to the males of the southern African genera of Euryphyminae. Finally, two genera are recorded for the first time to occur in South Africa, *Rhodesiana* and *Acrophymus*. All genera form monophyletic clades with high levels of support with the exception of *Brachyphymus* and *Amblyphymus* which require further investigation. Greater taxon sampling is required to determine the relationships among genera. Molecular evidence does not support the hypothesis of two speciation events. This should be combined with reconstruction of ancestral morphological traits to determine the number and nature of speciation events which occurred within the South African Euryphyminae.

Introduction

Euryphyminae is a southern African endemic subfamily which consists of 23 genera and 48 species, 16 genera (61%) of which have been recorded previously to occur in South Africa (Cigliano et al. 2017). Very few previous work have focused on this group. This subfamily was erected by Dirsh (1956) based on its genera having a similar appearance to Calliptaminae but with a distinct type of ephiphallus and an unusual male cercus. Nine studies have been done on this group and one short report have been published in a newsletter (Metaleptea) (Cigliano et al. 2017). Following the erection of this subfamily, a review of the whole subfamily which included an addition of nine species and two genera by Dirsh (1956) was done. Dirsh (1961) also revised the subfamily again as part of the "revision of the families and subfamilies of Acridoidea". Many authors have revised this subfamily since Dirsh, including Johnsen (1990) who erected a genus, *Catantopoides*, and described the species, *C minutissimus*, in 1990. Moreover, Naskrecki (1992, 1995) also contributed to the taxonomy of this group by revising a genus, *Rhachitopis* (Naskrecki 1992), and reviewing the Euryphyminae of Namibia and Angola (Naskrecki 1995). Bazelet and Naskrecki (2014) revised the genus, *Pachyphymus*, and described two new species. Rowell (2014) described two new species in the genus *Phymeurus* from East Africa. All of the mentioned studies utilized alpha taxonomy based on morphological characters only.

Euryphyminae are widespread throughout South Africa but most species are rarely encountered or collected due in part to their prevalence within South Africa's vast and largely inaccessible Karoo biome. In these regions, they are often the most common grasshopper, or insect in general, encountered, suggesting that they may comprise an important component of the Karoo biomass. Whereas few insects or other animals are well-adapted for survival in the arid Karoo (Bazelet and Naskrecki 2014 and Mucina et al. 2006), it seems as though Euryphyminae may have evolved to fill this unique niche, although no ecological studies have been conducted to date on this endemic subfamily.

Identifying South African Euryphyminae to species-level is difficult at present, especially for female specimens, because of the lack of one unified resource, which has examined the genera in a comparative framework. Furthermore, there is some confusion in the literature about which morphological characters are most useful for genus diagnosis. Here, I address this gap in knowledge by reviewing all published information about South African Euryphyminae, and comparing this line of evidence with historical museum specimens as well as field collected specimens which were used for both morphological and molecular analysis.

Based on morphology, I hypothesize one primary speciation event from which arose two lineages of Euryphyminae. These lineages can be classified primarily by the shape of their pronotum – tectiform or flat. Since shape of the pronotum is not expected to be sexually-selected, I assume that it is a conserved character which is representative of the ancestral state from which the genera evolved. Within the two primary lineages, I hypothesize that there were multiple independent speciation events which led to diversification in the shape of the cercus, which I expect to be a sexually selected character and to possess a function in mating. Sexually selected characters tend to be under stronger selective pressure and to evolve faster than non-sexually selected characters (Knowles et al. 2016) which is why I expect this diversification to explain the shallow (more recent) nodes in the Euryphyminae phylogeny. I test this hypothesis using molecular evidence.

In addition to testing this principal hypothesis, I also present the following information in a series of appendices: 1) Review of the described Euryphyminae genera and species of South Africa; 2) Digitized records of the largest museum collection of Euryphyminae globally; 3) An updated key to the southern African genera of Euryphyminae. Finally, I draw conclusions regarding the taxonomic status of South Africa’s Euryphyminae and the evolutionary processes which may have led to their adaptation to South Africa’s arid Karoo ecosystem.

Materials and methods

Sites and specimens

All possible Euryphyminae specimens were collected in the field as well as from museums. Approximately 2500 specimens were loaned from the Agricultural Research Council Plant Protection Research Institute (ARC-PPRI), which is the largest collection of Euryphyminae in the world. Of these, only approximately 300 specimens (12%) could be reliably identified to a known Euryphyminae species. Approximately 35 specimens from the Academy of Natural Sciences in Philadelphia (ANSP), 100 specimens from the Ditsong Museum in Pretoria (formerly Transvaal Museum, TMP), 70 specimens from the

Iziko South Africa Museum in Cape Town (SAM), and 120 specimens from the Stellenbosch University Entomological Collection (SUEC) were also reliably identified by P. Naskrecki, C.S. Bazelet or myself, and were included in this analysis (Supplement 2). All museum specimens were accessioned in the MANTIS v.2.0 database (Naskrecki 1996). These specimens were georeferenced by P. Tshililo, or SANBI digitizers – Mutsinda Ramavhunga, Jill Earle, Portia and Given and distribution maps were created in QGIS 2.14 for each genus.

Based on the assumption that grasshoppers will have at least two peaks of abundance, as has been found elsewhere in Florida (Squitier and Capinera 2002), field work was conducted in two sessions: “early season” was considered to be in austral spring, 27th September to 15th October 2016 and “late season” was in austral autumn, 1st to 30th March 2017. A total of thirty sites were sampled over both seasons, with 6 sites sampled twice, once in each season (Supplement 1).

To sample grasshoppers, three 50 m × 50 m quadrats were selected within each site of 1 km × 1 km. Quadrats were positioned in different microhabitats, landscape features and aspect to include as much diversity of grasshoppers as possible. Each quadrat was sampled for 30 minutes twice at different times of the day by two collectors to ensure adequate representation of the diversity at a site. Sampling was done by means of box quadrats sampling which involves “flushing” grasshoppers and capturing grasshoppers using sweepnets from swards. This method was used, as opposed to random surveying, in order to enable estimation of grasshopper density and abundance and to standardize among sites for a biodiversity survey (Gardiner et al. 2005) (see thesis Chapter 4). After collection, specimens were curated, this included pinning, labelling and identification to species level. All field-collected specimens will be accessioned at Iziko South Africa Museum (SAM) (Supplement 3).

Morphology

Specimens were sorted by species and genus. Five male specimens per species per genus were selected for morphological characterization. A list of 25 diagnostic characters was gathered from the literature which were used previously to describe Euryphyminae genera or species. From this preliminary list, two characters (shape of the pronotum, angle of posterior margin and degree of flatness when viewed laterally and general cercus shape) were selected for generic classification because preliminary investigations showed that these characters were conserved within genera and were easily observable.

Photographs were taken using the Leica DFC400 auto-montage camera and processed in Canva (www.canva.com). Specimens were positioned carefully to make sure that specimens were always in the same position so that photos were taken at the same angle.

DNA sequencing

A total of 32 specimens from eight genera belonging to Euryphyminae were sequenced. Three individuals belonging to *Acorypha pallidicornis pallidicornis* (Stål, 1876) (Acrididae: Calliptaminae) and two specimens of *Sphingonotus* sp. (Acrididae: Oedipodinae) were included as outgroups. The specimen's middle leg were kept in 99% ethanol during curation process. Specimens were then washed to remove alcohol and DNA extracted from muscle tissue of a middle leg using the NucleoSpin DNA Insect extraction kit (Macherey - Nagel) by the African Centre for DNA Barcoding (ACDB).

Three genetic markers were sequenced: cytochrome c oxidase 1 (COI) mitochondrial gene, 12S ribosomal RNA (12S), and Histone 3A nuclear gene (H3A). In general, all primers and PCR reactions and conditions used were adopted from (Huang et al. 2013). Standard capillary sequencing was conducted and all PCRs were conducted on an AB GemAmp PCR system 9700. Cycle sequencing was conducted using the ABI PRISM BigDye Terminator v3.1 cycle sequencing kits and sequences were run on the ABI 3500XL Genetic Analyzer. Cleaned sequences were uploaded to BOLD Systems (http://www.boldsystems.org/, see Supplement 3 for accession numbers). DNA extraction, PCR amplification and COI sequencing were performed by the African Centre for DNA Barcoding (ACDB) at University of Johannesburg. DNA sequencing for 12S and H3A genes was performed by Inqaba from the DNA extraction product supplied by ACDB.

DNA barcoding is not normally conducted for Orthoptera because they are known to have high prevalence of *numts* or non-functional insertions of mitochondrial pseudogenes into the nuclear genome. These *numts* can co-amplify together with the COI gene and lead to the overestimation of the number of species (Song et al. 2008). In order to detect the presence of *numts* in Euryphyminae COI sequences, I aligned my COI sequences to EU589055 (*Schistocerca americana* (Acrididae: Cyrtacanthacridinae)) downloaded from GenBank, which was the reference sequence known to be clean of *numts* in Song et al.

(2008). Euryphyminae sequences aligned to this sequence perfectly, and were therefore considered to be free of *numts.*

Statistical analysis

A classification scheme representing intergeneric variation of the Euryphyminae was created based on a qualitative method using morphological characters (own observation). All genera with a flat dorsum where grouped together, others with tectiform dorsum were grouped together and again others with a humped-shaped dorsum were also grouped together. Groups were further broken down by grouping genera with short cerci (Cerci which does not extend towards the supra anal plate), long cerci (Cerci extend supra anal plate and the apex can be seen when viewing supra anal plate dorsally), straight cerci and excurved cerci, respectively.

Morphological classification hypothesis

A morphological topology was constructed qualitatively to illustrate a hypothesis of monophyletic clades (Figure 22). Euryphyminae were hypothesized to form two primary clades in terms of morphology, Clade I share tectiform dorsum with an acute posterior margin. This clade consists of Group 1A: short and excurved cercus (*Pachyphymus, Euryphymus,* and *Acrophymus*), Group 1B: straight cercus – can be either long or short *(Amblyphymus, Aneuryphymus, Phymeurus, Rhodesiana* and *Brachyphymus*). Clade II is characterized by a flat dorsum and consists of Group 2A: short and excurved cercus (*Calliptamicus* and *Calliptamulus*) and Group 2B: straight cercus – can be either long or short (*Plegmapterus, Plegmapteropsis, Plegmapteroides* and *Calliptamuloides*).

Phylogenetic analysis and reconstruction

Sequence editing and preliminary analysis were done in Geneious using PAUP version 4.0a (build 154) (Swofford 2002), sequences from the 12S gene was run through gBlocks. Phylogenetic analyses were done in both parsimony and Bayesian frameworks (Song et al. 2008, Huang et al. 2013). Within the Bayesian inference, we analyzed the data sets by using the program MrBayes version 3.2 (Ronquist and Huelsenbeck 2003), after selecting best-fit models of nucleotide evolution under the BIC criteria by using jModelTest 0.1.1 (Posada 2003). The analysis consisted of running four simultaneous chains for 20 million generations. Two independent identical Bayesian runs were performed to ensure convergence on similar results and the nodal support was assessed by using the posterior probability generated from a consensus tree of the sampled trees past burn-in determined by using Tracer 1.4 (http:// beast.bio.ed.ac.uk) (Song et al. 2008, Huang et al. 2013).

Results

We list all species (Appendix 1) and digitize 626 new records of museum (Supplement 2) and 624 field-collected (Supplement 3) specimens in order to enhance our current knowledge on the distribution, occurrence and taxonomic status of all described South African Euryphyminae species. These records are mapped in order to provide a visual illustration of the current known distributions and geographic ranges of the South African Euryphyminae (Appendix 3).

The 14 previously known genera of Euryphyminae in South Africa are widespread across the country (Table 1). The subfamily has a total of 48 described species although 60% of these genera require revision (Table 1, Appendix 1). Distribution maps (Appendix 2) show that 60% of species are known from less than five specimens and that there are major gaps in our knowledge for these species.

During the course of this study, distribution records for two genera were found to occur in South Africa, which had not previously been recorded to occur in the country, *Rhodesiana* and *Acrophymus*. This brings the number of genera of Euryphyminae in South Africa from 14 to 16.

Genera of Euryphyminae can now be identified using this key to the males:

An updated key to the southern African genera of Euryphyminae Modified from Dirsh (1956) – Figures in Appendix 2.

1. Pronotum in prozona crest-like with deep incision at first transverse sulcus (Fig. 13a)……………………………………………………………………...….***Pachyphymus***

Pronotum without "camel-like" humped crests……………………………………..……….**2**

2. Male cerci not curved…………………………...…………………………………...…**3**

Male cerci excurved………………………………..…………………………….……………**5**

3. Lower margin of male cercus strongly dented, cerci straight, ending in an acute point (Fig. 17c) ……….……………………………………………………..…***Aneuryphymus***

Male cercus longer, ending in rounded or flattened surface, but not pointed. …………..…**4**

4. Male cercus stump-like, bottom edge straight, apex square, flattened, forms right angle with bottom margin (Fig. 17g). ..………………….……………………..……***Rhodesiana***

Male cercus stump-like, not quite straight along bottom margin, apex rounded, does not form right angle with bottom margin (Fig. 17f)……………..……………………..…***Phymeurus***

5. Male cercus relatively short, with very wide triangular base covered in coarse sensilla or setae, ending in simple pointed or blunt apex. ………………….…………………………**6**

Male cercus relatively longer, often upcurved with or without complex 3-dimensional shape………………………………………………………...……………….……………**7**

6. Male cerci short and slightly excurved, as long as its width, posterior margin of pronotum acute angular (Fig. 17b). ....***Euryphymus***

Integument with a sandy brownish colour, posterior margin of pronotum with corrugated edges (Fig. 14f)…………………...***Plegmapteroides***

7. Male cercus apex folded into almost right angle relative to base. Apex pointed or blunt. Sclerotized lobe extends outwards at right angle juncture. ……………….……………...**8**

Male cercus upcurved at various angles with apex from pointed to blunt to rectangular or triangular. ……………………………………………………………………………………**9**

8. Male cercus slender towards apex, ending in blunt point; basal lobe at right angle cercus (Fig. 2c)…………….…………………………………………...……***Platacanthoides***

Small. Cerci slightly excurved not extending towards apex, with obliquely truncate apex; angle between apex and base of cercus rounded rather than angular; lobe at right angle rectangular rather than rounded (Fig. 18d) ………………..……………***Calliptamuloides***

9. Male cerci long, very slender with obliquely truncate apex (Fig. 17d); hind tibia curved. ………………………………………………………………………………...…***Rhachitopis***

Hind tibia not curved, cercus long and curved but not very slender. ………...…..………**10**

10. Body smooth, dorsum of pronotum flat when viewed laterally posterior margin of pronotum obtuse ………………………………………………………………….…………**11**

Upcurved cercus, body varies in rugosity but not very smooth; dorsum of pronotum may be tectiform, rounded or irrelgular but does not appear flat when viewed laterally. ………………………………………………………………………………………….………**12**

11. Small. Fastigium of vertex concave, lower margin of male cerci slightly dented, male cerci hook shaped (Fig. 18d)………………………………..……….…..….....***Calliptamulus***

Male cerci with a narrowed base and obliquely truncate apex (Fig. 18a)…..***Calliptamicus***

12. Integument marked with patterns of brown, reddish-brown and grey; abdomen may be yellow; integument appears smooth and rather shiny. ……………………….…........…..**13**

Greyish brown integument moderately rugose and matte coloured, not smooth and shiny. ………………………………………………………………………………..…. . ………………**14**

13. Male cerci hook-shaped (Fig. 17e) and prosternal process "pointy" ……………………………………………………………………………….***Brachyphymus***

Male cerci narrowed at base, apex strongly widened and rounded (Figure 17.h)..…...........***Amblyphymus***

14. Body robust; hind wings often brightly coloured. Cercus upcurved sharply, apex with complex 3-dimensional shape (Fig. 18c)……………………………….………….***Plegmapterus***

Body slender, cercus forms 45º angle with base; apex knob-like rounded. ……………………………………………………………………….……..….***Plegmapteropsis***

Phylogeny reconstruction

The COI alignment consisted of 419 bp, with 10 variable sites of uninformative parsimony sites and 123 parsimony informative sites. The best fit model chosen by JModel test was TIM2+I+G. The 12S gene alignment consisted of 316 bp, with 4 variable sites of uninformative parsimony sites and 56 parsimony informative sites. The best fit model chosen by JModel test was TPM3uf+I and finally the H3A gene alignment consisted of 243 bp, with one variable site of uninformative parsimony sites and 33 parsimony informative sites. The best fit model chosen by JModel test was F81+I.

The combined sequence data of 978bp had 751 conserved sites, 15 variable sites of uninformative parsimony sites and 212 parsimony informative sites. In parsimony, no deep nodes were resolved, and a polytomy of nine clades was produced (Fig. 2A and Fig. 2B). Each of these nine clades had 98-100% support and corresponded to one of the genera included in the study. The only genus which was paraphyletic was *Brachyphymus*. There was one singleton of *Amblyphymus rubidus*, which did not cluster well with any other genera (Fig. 2A-B).

Results shown here are from a consensus tree, separate trees are also shown in Appendix 4. In the Bayesian phylogeny, resolution of clades was achieved more successfully (Fig. 2A, Appendix 4). Here, too, *Brachyphymus* was not resolved as a monophyletic clade. However, *Amblyphymus* and *Plegmapterus* emerge as sister taxa with high support (pp = 0.97). Together, they form a sister taxa to *Euryphymus.* This did not match my morphological hypothesis because I expected *Plegmapterus* to fall in group II (flat dorsum) whereas *Amblyphymus* and *Euryphymus* both have tectiform pronota and I expected them to fall in Group I.

Calliptamuloides and *Platacanthoides* emerged as sister taxa with insufficient support (pp = 0.65) and together they were sister to the clade containing *Euryphymus, Plegmapterus* and *Amblyphymus* with high support (pp = 0.75). The relationship of *Platacanthoides* and *Calliptamuloides* were expected based on the shape of pronotum. Surprisingly, *Pachyphymus* and *Calliptamicus* emerged as sister taxa although their pronotal morphology is very different, with *Pachyphymus* being the only Euryphyminae genus with a double-hump shaped pronotal crest.

Discussion and conclusion

Euryphyminae genera were found to be mostly monophyletic. However, in this study and historically, relationships among genera were assumed to be relatively easy to discern on the basis of morphology. Euryphyminae genera fall into quite obvious groupings based on their shape of pronotum and shape of cercus. Historically, scientists who have named the genera also observed these groupings and named the genera accordingly – e.g. *Calliptamicus*, *Calliptamulus* and *Calliptamuloides* are similar morphologically while *Plegmapterus, Plegmapteroides and Plegmapteropsis* are also similar morphologically. The most surprising finding of this study is that some of the quite obvious relationships are not supported by DNA data – e.g. *Euryphymus*, *Plegmapterus and Amblyphymus* are a surprising clade, as are *Pachyphymus and Calliptamicus.*

My hypothesis based on morphological characters with one speciation event and diversification was not supported by DNA data however, a monophyletic relationship between Euryphyminae and Calliptaminae, the out group, was retained. From the phylogenetic trees (Fig. 2A and Fig. 2B), the relationship between most genera was not clearly depicted. I can therefore deduce that my stated hypothesis was not supported, possibly because the morphological characters we included are not evolving at the same rate as the DNA characters included.

All the genera came out as monophyletic and Euryphyminae as a subfamily is completely supported relative to outgroups. However, we still know very little about the relationships between tribes or why the Eurypyhminae evolved as it did. Some genera, which are questionable, were diagnosed using colour and pronotum rugosity, which varies between species and within species. The supra-anal plate, its shape, position and number of basal turbercles, has been used extensively (by Dirsh 1956) for species and genera identification, however these characters are not conserved throughout one genus and can only be used successfully in conjunction with other characters.

Dirsh (1956) did a lot of the initial work for this subfamily– but a lot of it is problematic because some species did not suit certain genera descriptions, others did not even suit the subfamily's description but were left in the subfamily without redescribing a genus. In this review I added and mapped new distribution records from the southern Karoo. The maps indicate that a lot of gaps still exist in our knowledge of Euryphyminae. This indicates that a lot more sampling is still required. No redescriptions have been done here, but from my analysis, a number of genera are in need of revision. I estimate that there are approximately 20 species in museum collections (if the generic level classifications are correct) that remain to be described. This study serves as a baseline for future work although more sampling still needs to be conducted around the country to fill the current data gaps. I strongly recommend that the Euryphyminae's taxonomy be revised, to investigate other possible diagnostic features for identification.

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Table 1. A summary of the South African Euryphyminae genera. Species chosen to represent the genus were subjectively selected as those with typical morphology which is representative of the rest of the species in the genus and for which there were specimens available for examination. Detailed species list with remarks can be found in Appendix 1. List of localities from museum specimens and from field-collected specimens can be found in Supplement 2 and 3, respectively. Images and distribution maps can be found in Appendix 2. Taxonomic status: * Stable taxonomic status, ** Revision is not urgent, ***** in need ofrevision, †Genus recorded for the first time to occur in South Africa.

Genus	# of species described	# of species in SA	Representative of the genus	Cercus shape (Appendix 2 Figure)	Pronotum shape (Appendix 2 Figure)	# of museum specimens added (Supplement 2)	# of field-collected specimens added (Supplement 3)	In need of revision?
Acrophymus†	8	1	*Acrophymus* nr. *rossi*	None	None	1		**
Amblyphymus	7	5	*transvaalicus* Dirsh, 1956	17h	13h	51	1	**
Aneuryphymus	3	3	*erythropus* (Thunberg, 1815)	17c	13c	39		**
Brachyphymus	4	3	*vylderi* (Stål, 1876)	17e	13e	19		*****
Calliptamicus	2	2	*semiroseus* (Serville, 1838)	None	14a	99	78	*****
Calliptamuloides	1	1	*minimus* Dirsh, 1956	18e	14e	26	4	**
Calliptamulus	3	3	*natalensis* (Sjöstedt, 1913)	18b	14b	52	7	*****
Euryphymus	6	3	*tuberculatus* Martínez y Fernández-Castillo, 1898	17b	13b	21	168	**
Pachyphymus	4	4	*cristulifer* (Serville, 1838)	17a	13a	43	17	*
Phymeurus	20	1	*illepidus* (Walker, 1870)	17f	13f	5		*
Platacanthoides	3	3	*bituberculatus* Uvarov, 1922	19c	19a	0	47	*****
Plegmapteroides	1	1	*minutus* Dirsh, 1959	18f	14f	48		**
Plegmapteropsis	1	1	*gracilis* Dirsh, 1956	18d	14d	19	2	**
Plegmapterus	5	5	*splendes* Dirsh, 1956	18c	14c	150	85	*****
Rhachitopis	10	9	*crassus* (Walker, 1870)	17d	13d	51	215	**
Rhodesiana†	2	1	*maculata* Dirsh, 1959	17g	13g	1		**

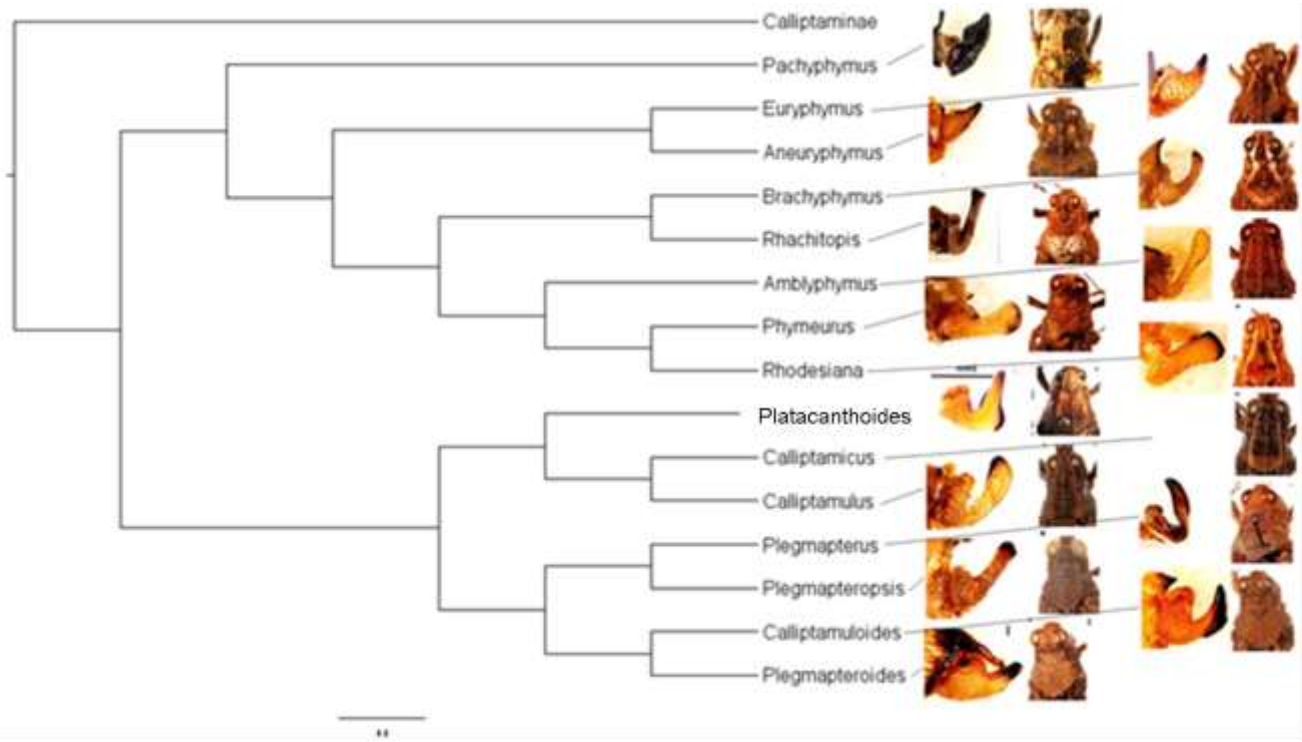


Figure 1. Dendogram showing relationships among 15 genera of Euryphyminae and the outgroup Calliptaminae based on estimated morphology. Branch lengths have no meaning because this was not a quantitative analysis.

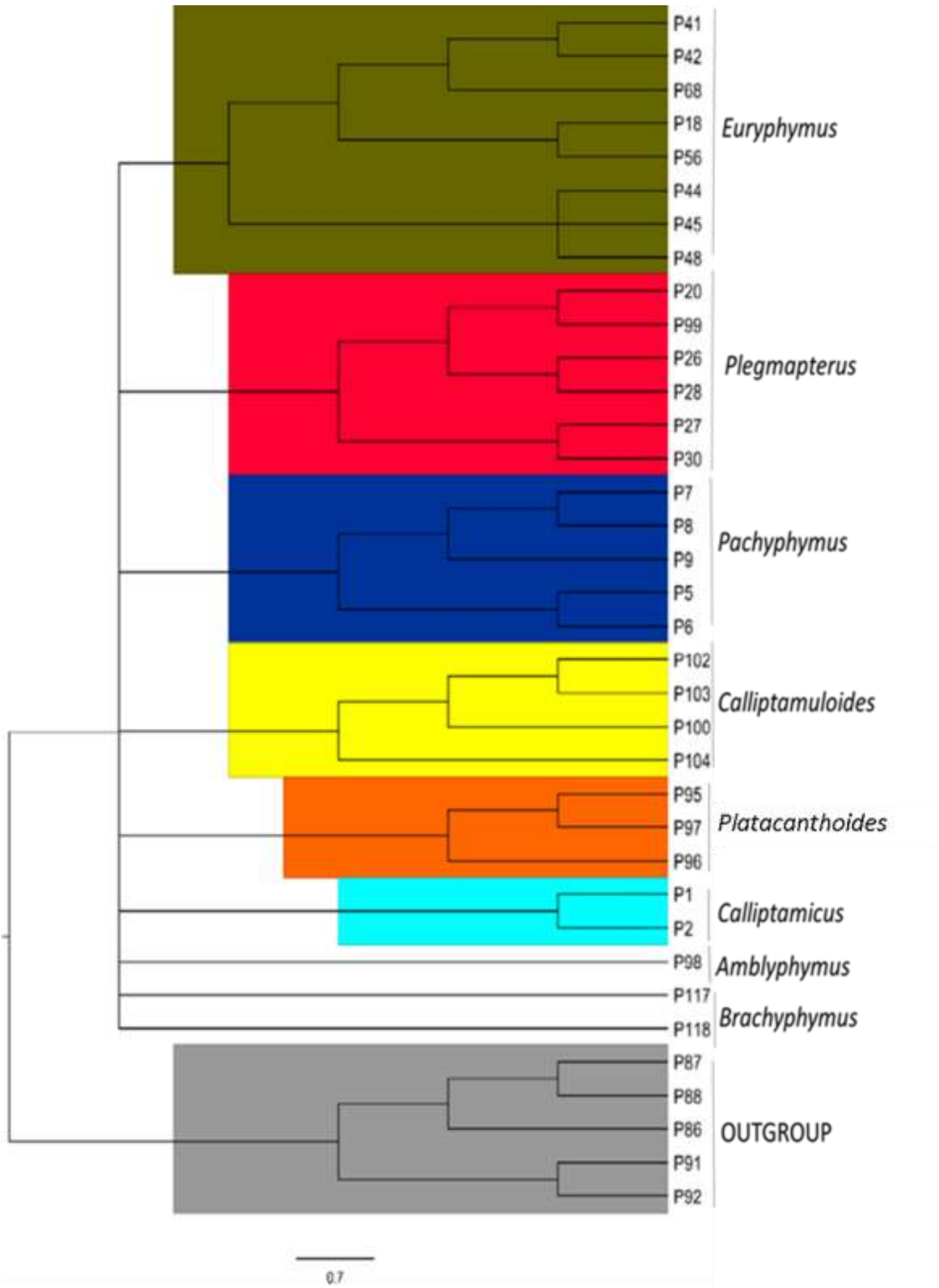


Figure 2A. Parsimony (consensus) tree resulting from analysis of the combined sequences (COI, 12S, and H3A) of 36 grasshoppers. Numbers on nodes show the bootstrap values for a 1000 replicates.

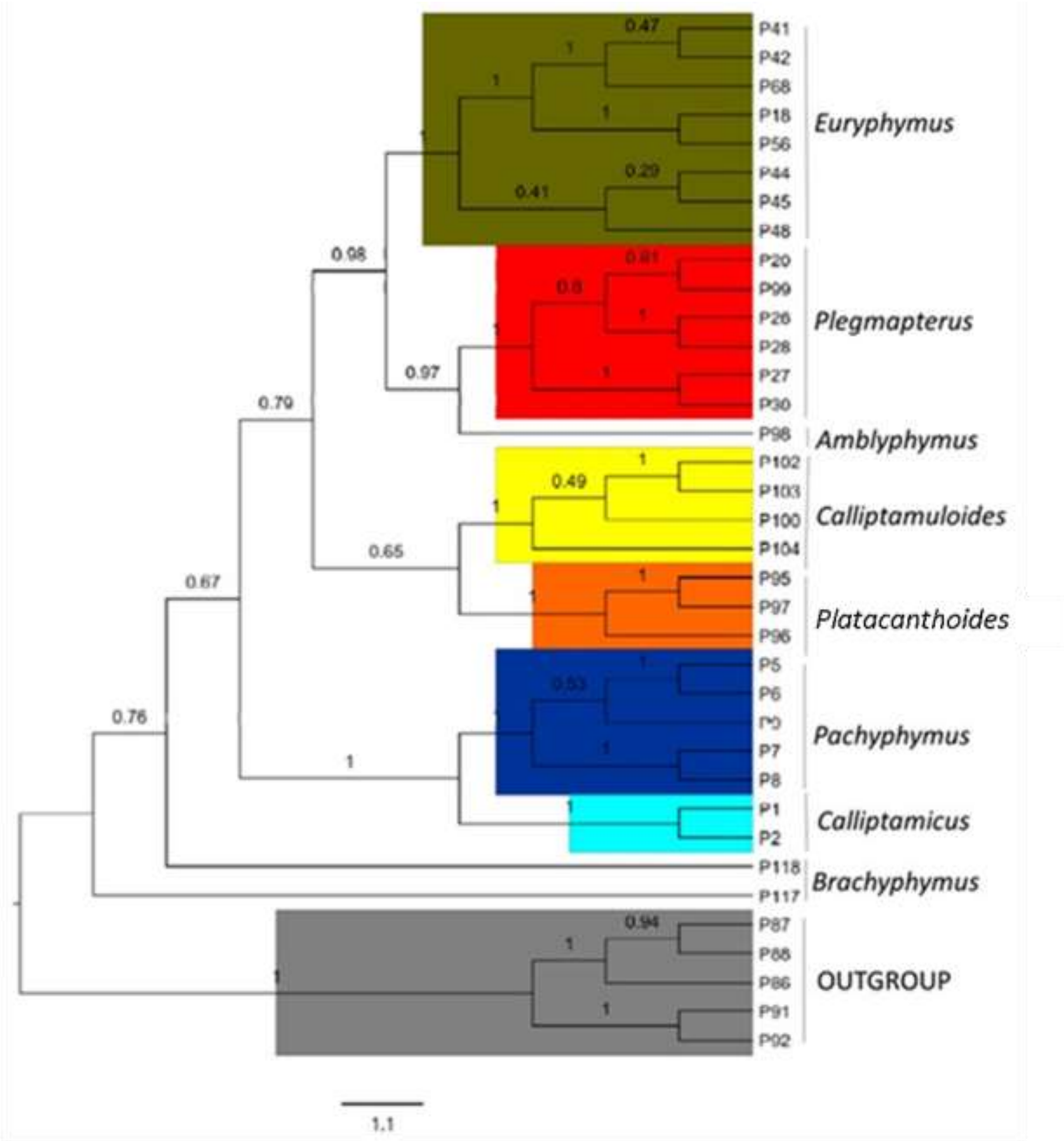


Figure 2B. Bayesian (consensus) tree resulting from analysis of the combined sequences (COI, 12S, and H3A) of 36 grasshoppers. Numbers on nodes showed the posterior probabilities for 1000 replicates.

Appendix 1

List of species

Digitized locality records of museum and field-collected specimens are found in Supplements 1 and 2. All images can be found in Appendix 2.

1. Genus: *Acrophymus* Uvarov, 1922

(Appendix 2 Fig. 8)

Acrophymus nr. *rossi*

Distribution.—Eight species of this genus were previously recorded from Angola (Naskrecki 1995) and from Zimbabwe (Dirsh 1963; Dirsh 1965). No species were known to occur in South Africa. Naskrecki (1995) described a female from Angola, similar to *rossi*, which may constitute a ninth species. In the ARC-PPRI collection, one female specimen was found which may belong to *A*. *rossi* or may be a tenth species. In order to determine whether this species is *A. rossi* or a new species, the first to be detected in South Africa, we require a male and a female specimen collected from the same locality. The current known distribution of *A. rossi* is Zimbabwe. Given that the only known specimen of *Acrophymus* from South Africa was found near the Zimbabwe border, this could be an extension in the known range of *A. rossi*. It seems unlikely that there would be more undescribed species from South Africa.

Remarks.—Genus *Acrophymus* was erected by Uvarov (1922) on the basis of its shape of pronotum, shape of prosternal tubercle, shape of male genitalia, lateral elytra and undeveloped wings. This genus is said to be related to genus *Amblyphymus* (Uvarov 1922).

Dirsh (1963) revised the genus and identified new diagnostic features. The structure of the phallic complex is very unique to this genus, with strongly sclerotized ectophallic membrane, sometimes forming a strong dorsal shield with the tendency of forming a capsule covering the endophallus and the cingulum (Dirsh 1963). Another key diagnostic feature is the moderately large, compressed, widened and weakly sclerotized distal part of the apical valves of penis, with narrow and strongly sclerotized valves of cingulum.

Uvarov's diagnostic features to this genus are misleading and when carefully examining the structure of the phallic complex, there is a great diversity and the genus might be split into two genera Dirsh (1963).

This genus might be in need of a revision, since Dirsh (1963) in his revision found a great diversity in the structure of the phallic complex but did not revise the genus. We also could not revise the genus since we only have a single female specimen found in South Africa which may or may not be *A. rossi*.

2. Genus: *Amblyphymus* Uvarov, 1922

(Appendix 2 Figs 1, 13h, 15h, 17h)

Amblyphymus matopo Dirsh, 1956

Type locality.—Zimbabwe: Matopo Hills.

Distribution.— This species was previously recorded from Botswana (Johnsen 1982a, 1990), Zimbabwe (Dirsh 1965) and South Africa (Johnsen 1990).

Amblyphymus roseus Uvarov, 1922

Type locality.—South Africa: Transvaal: Masil Nek

Distribution.—Previously recorded from South Africa (Uvarov 1922).

Amblyphymus rubidus Brown, 1959

Type locality.—South Africa: N.W. Transvaal, Zoutpan (= Limpopo, Soutpansberg).

Distribution.—This species was also previously recorded from Zimbabwe (Son 1959).

Amblyphymus rubripes Dirsh, 1956

Type locality.—South Africa: Transvaal (=Limpopo), Kruger National Park, Skukuza

Distribution.—This species was previously recorded from Zimbabwe (Brown 1967).

Amblyphymus transvaalicus Dirsh, 1956*:* Appendix 2 Figs 13h, 15h, 17h

Type locality.—South Africa: Transvaal (=Gauteng), Johannesburg, Modder Fontein.

Distribution.—This species was previously recorded from Namibia (Grootfontein Distr.) by Johnsen (1990b), known also from South Africa (Dirsh 1956a) and Botswana (Houston 1978, Johnsen 1990a, Naskrecki 1995).

Remarks.—This genus was erected by Uvarov (1922) based on the structure of both male and female genitalia and shape of hind legs. This genus is related to *Rhachitopis* (Naskrecki 1995).

The genus does not have stable taxonomy. Uvarov (1922) placed species based on their integument rugosity and male cercus. Furthermore it is closely related to *Rhachitopis* by its genital structure and shape of hind legs however differs by its less rugose head and pronotum. Dirsh (1956) placed species based on another diagnostic feature different from Uvarov (1922), on the basis of male cercus, pronotum and prosternal tubercle but admitted that the species are rather different and may be transferred to other genera in future (Dirsh 1956).

This genus has seven described species, five have records of occurrence in South Africa. There are an additional ten specimens in the ARC collection which could not confidently be assigned to one of the described species, and may constitute one or more new species. In addition, although Dirsh (1956) described this genus as unstable, in comparison with other Euryphyminae genera it does not seem to be of high priority for revision although there may be a small number of undescribed species.

3. Genus*: Aneuryphymus* Uvarov, 1922

(Appendix 2 Figs 2, 13c, 15c, 17c)

Aneuryphymus erythropus Thunberg , 1815: Appendix 2 Figs 13c, 15c, 17c

Type locality.—Africa

Distribution.—Previously also recorded from Botswana (Faure 1928) and Lesotho (Brown 1995).

Aneuryphymus montanus Brown, 1960

Type locality.—South Africa: Cape Province, Langkloof Valley

Distribution.—This species has only been recorded in South Africa.

Aneuryphymus rhodesianus Uvarov, 1922

Type locality.—Zimbabwe: Gazaland, R. Mahakata.

Distribution.—This species has only been recorded from South Africa and Zimbabwe (Uvarov 1922).

Remarks.—This genus was erected by Uvarov (1922) based on its overall short and broad body shape, distinctly more rugose pronotum which is short with the hind angle obtuse and rounded. Elytra scarcely reaching the hind knees. The last abdominal segment with an obtuse angular emargination and a small black tooth like in the middle of the hind margin. Supra anal plate with only one submedian pair of tubercles and another pair at the basal angles. Cerci about twice as long as they are broad, with two obtuse teeth on the lower margin, with the apex obtuse. Elytra with smaller scattered brownish spots, and the inner side of the hind femora red, only partly blackened along the upper carina. This genus is stable, its revision is also not urgent.

4. Genus: *Brachyphymus* Uvarov, 1922

(Appendix 2 Figs 3, 13e, 15e, 17e)

Brachyphymus nr. *vylderi*

Brachyphymus vylderi vylderi (Stål, 1876): Appendix 2 Figs 13e, 15e, Fig 17e

Type locality.—Namibia: Damaraland.

Distribution.—Previously recorded from Namibia (Stål 1876, Karny 1910, Sjostedt 1932, Dirsh 1956a, 1965), Botswana (Dirsh 19561, Johnsen 1990a), and South Africa (Kirby1902, Uvarov 1922, Dirsh 1956a, 1965, Naskrecki, 1995).

Remarks.—Uvarov (1922) erected this genus which is closely related to *Euryphymus* on the basis of its prosternal tubercle shape and shape of cercus. Dirsh (1956) assigned a new species *B. basuto* (Dirsh 1956) to this genus but admitted that it differs significantly from species *vylderi* Stål 1976, but kept it in this genus until the revision of the whole subfamily. However, the species in question is not distributed in South Africa, so we did not review it.

I reviewed *B.* nr. *vylderi* and *B. vylderi vylderi* (Stål 1876) from the ARC collection. The two subspecies share a distribution however I suggest that *B.* nr. *vylderi* is most likely a unique species. The two specimens differ in shape of male cerci and prosternal process. *B*. *vylderi vylderi* (Stål 1876) seems to be a complex species, from our field collected specimens we found a specimen similar to it. We compared both materials to the type material from Swedish Museum of Natural History, Stockholm (NRM). The new material might be a new species but needs further study. Therefore, for that reason the taxonomic status of this genus is not satisfactory and may be in need of revision.

5. Genus: *Calliptamicus* Uvarov, 1922

(Appendix 2 Figs 4, 14a, 16a)

Calliptamicus antennatus (Kirby, 1902)

Type locality.—South Africa: Gauteng, Pretoria

Distribution.—This species has only been recorded from South Africa.

Calliptamicus semiroseus (Serville, 1838)*:* Appendix 2 Figs 14a, 16a

Type locality.—South Africa: Cape of Good Hope

Distribution.—Previously recorded from Namibia (Karny 1910), from Angola recorded by Martinez (1902), from Lesotho (Dirsh 1956a), and South Africa (Serville 1838, Stal 1861, 1873, Walker 1870, Kirby 1902, Karny 1910, Uvarov 1922, Key 1930, Dirsh 1956a, Johnsen 1990b, Naskrecki 1995).

Remarks.—This genus *Calliptamicus* was erected by Uvarov (1922) on the basis of its peculiar slender hind femora and the shape of its male genitalia.. So far its taxonomic status is stable or satisfactory although the two nominate species are very similar in appearance and their species boundaries require investigation.

6. Genus: *Calliptamuloides* Dirsh, 1956

(Appendix 2 Figs 5, 14e, 16e, 18e)

Calliptamuloides minimus Dirsh, 1956*:* Appendix 2 Figs 14e, 16e, 18e

Type locality.—South Africa: Cape Province: 15 m. S. Middleton

Distribution.—This species was previously recorded from Namibia (Brown 1972).

Remarks.—This genus was erected by Dirsh (1956) on the basis of flat pronotum, narrow fastigium of vertex and trilobate subgenital plate of female. This genus resembles *Calliptamulus* by its shape of the male cercus. Its taxonomic status is not satisfactory. The ARC collection contains a few specimens which may be unique species.

7. Genus*: Calliptamulus* Uvarov, 1922

(Appendix 2 Figs 6, 14b, 16b, 18b)

Calliptamulus hyalinus Uvarov, 1922

Type locality.—South Africa: Orange Free State (= Free State): Petrus.

Distribution.—Previously recorded from Botswana (Brown 1972) and Lesotho (Brown 1959).

Calliptamulus natalensis (Sjöstedt, 1913): Appendix 2 Figs 14b, 16b, 18b

Type locality.—South Africa: Natal (= KwaZulu-Natal): Appelsbosch.

Distribution.—This species has only been recorded from South Africa.

Calliptamulus sulfurescens Uvarov, 1922

Type locality.—South Africa: Free State, Bloemfontein

Distribution.—This species was previously recorded from Botswana (Brown 1959) and Namibia (Botha 1955).

Remarks.—This genus was erected by Uvarov (1922) on the basis of its shape of prosternal tubercle and of its male genitalia, this genus is related to *Calliptamicus*. Its taxonomic status is not satisfactory because it has a possible four undescribed species in the ARC collection.

8. Genus: *Euryphymus* Stål, 1873

(Appendix 2 13b, 15b, 17b)

Euryphymus haematopus (Linnaeus,1758)

Type locality.—Africa: 'In Indiis'

Distribution.—Previously recorded from Botswana (Connelly 1924), Lesotho (Mally 1924) and South Africa (Brain 1917, Brauns 1926)

Euryphymus kalahariensis Barker, 1984

Type locality.—Botswana

Distribution.—This species was previously recorded from Botswana (Johnsen 1990) and South Africa (close to Botswana border) (Barker 1985a).

Euryphymus tuberculatus Martinez y Fernández-Castillo,1898: Appendix 2 Figs 13b, 15b, 17b

Type locality.—South Africa: Cape of Good Hope.

Distribution.—Previously recorded from South Africa (Martinez 1898, 1902, Uvarov 1922, Dirsh 1956a), Zimbabwe (Uvarov 1922, Pinhey 1965), Botswana (Houston 1978, Johnsen 1990a), Namibia (Barker 1985) and Zambia (Willemse 1994, Naskrecki 1995).

Remarks.—Genus *Euryphymus* was erected by Stål (1873). Of the described species of this genus, they all suit the description of this genus except for *E. xanthocnemis* Branc. 1897 (Dirsh1956). Dirsh (1956) argues that this species does not suit the descriptions of this genus and he has no doubt that it does not belong to this genus or even to the Euryphyminae subfamily but he kept it there anyway. I was not able to review the specimen in question because I could not get hold of the material. I also found a lot of diversity in the shape of the male cercus of this genus when I reviewed our field collected specimens, and a revision is necessary (see thesis Chapter 3 for additional discussion).

9. Genus: *Pachyphymus* Uvarov, 1922

(Appendix 2 Figs 7, 13a, 15a, 17a)

Pachyphymus carinatus Dirsh, 1956

Type locality.—South Africa: Cape Province, Steinweld.

Distribution.—This species was previously recorded from Namibia by Johnsen (1990b), known also from South Africa (Dirsh 1956b, 1965, Naskrecki 1995).

Pachyphymus cristulifer (Serville, 1838): Appendix 2 Figs 13a, 15a, 17a

Type locality.—South Africa: Cape Province, Olifants R.

Distribution.—This species has only been recorded from South Africa.

Pachyphymus namaquensis Bazelet and Naskrecki, 2014

Type locality.—South Africa: Northern Cape, Namaqualand, 8 km S of Nababeep.

Distribution.—This species was recorded from South Africa (Bazelet and Naskrecki 2014).

Pachyphymus samwaysi Bazelet and Naskrecki, 2014

Type locality.—South Africa: Western Cape, 10 miles N Brandvlei.

Distribution.—This species was recorded from South Africa (Bazelet and Naskrecki 2014).

Remarks.—This genus *Pachyphymus* was erected by Uvarov (1922) on the basis of species *Calliptamus crustulifer* which had only one sex (female) known. *Pachyphymus* is unique among the Euryphyminae and easily recognizable because it is the only genus with hump-shaped pronotum in both sexes. Dirsh (1956) examined both sexes of the species and confirmed that the species suits the description of the genus by examining the external characters and the structure of the phallic complex, specifically the epiphallus which is a diagnostic character for this genus.

This genus was recently revised by Bazelet and Naskrecki (2014). The taxonomic status of this genus is good and no new species are expected.

10. Genus: *Phymeurus* Giglio-Tos, 1907

(Appendix 2 Figs 8, 13f, 15f, 17f)

Phymeurus illepidus (Walker, 1870): Appendix 2 Figs 13f, 15f, 17f

Type locality.—South Africa: Natal (= KwaZulu-Natal).

Distribution.—This species was previously recorded from Namibia (Haacke 1966, Naskrecki 1995), Uganda (Rowell 2015), and Tanzania (Jago 1964).

Remarks.—This genus was erected by Giglio Tos in 1907. It was later revised by Dirsh (1965) and Mason (1966). This genus was also recently revised by Rowell (2015). As this genus has recently been revised, its taxonomic state is good. Its distribution is mostly to the North of South Africa, and no new species are expected to occur in South Africa.

11. Genus: *Platacanthoides* Kirby, 1910

(Appendix 2 Figs 19a-19h)

Platacanthoides bituberculatus Uvarov ,1922

Type locality.—South Africa

Distribution.—. This species was previously recorded from South Africa (Smith A) and Basutoland in 1951.

Platacanthoides reductus Dirsh, 1956

Type locality.—South Africa, Free State, Witzeshoek

Distribution.— This species has only been recorded from South Africa (Schott H, 1929) and Basutoland (1951)

Platacanthoides morusus (Walker, 1870)

Type locality.—South Africa

Distribution.—This species has only been recorded from South Africa.

Remarks.—This genus was erected by Kirby (1910). Uvarov (1922) re-described the genus based partly on *Platacanthoides bituberculatus* (Uvarov 1922). The genus has three described species of which one has a two subspecies: *P*. *reductus* Dirsh 1956 and *P*. *morosus* Walker 1870 and two subspecies of *bituberculatus*: *bituberculatus* Uvarov 1922 and *attenuatus* Uvarov 1922 all of which have records of distribution in South Africa. *P*. *morusus* was originally described based on one female specimen by Walker (1870*),* this is very unreliable since female specimens are difficult to assign to conspecific male, and I however had no specimens of this genus to evaluate.

Furthermore I caught a lot of *Platacanthoides bituberculatus in* the field but had no other specimns to compare with.

12. Genus: *Plegmapteroides* Dirsh, 1959

(Appendix 2 Figs 10, 14f, 16f, 18f)

Plegmapteroides minutus Dirsh, 1959: Appendix 2 Figs 14f, 16f, 18f

Type locality.—South Africa: Northern Cape, Soebatsfontein.

Distribution.—This species was previously recorded from Namibia (Brown 1962) and South Africa (Dirsh 1959).

Remarks.—This genus was erected by Dirsh (1959) based on its flat dorsum which is similar to that of *Plegmapterus* Martinez 1898, *Plegmapteropsis* Dirsh 1956, and *Calliptamuloides* Dirsh 1956. The shape of its head is more similar to that of *Plegmapteropsis,* however it differs from *Plegmapteropsis* by its posterior margin of the last abdominal tergite, supra-anal plate, hind femur and male cercus. Its taxonomic state is satisfactory or stable.

13. Genus: *Plegmapteropsis* Dirsh, 1956

(Appendix 2 Figs 11, 14d, 16d, 18d)

Plegmapteropsis gracilis Dirsh, 1956: Appendix 2 Figs 14d, 16d, 18d

Type locality.—Namibia: Aus

Distribution.—This species was previously known only from Namibia (Dirsh 1956a; Naskrecki 1995).

Remarks.—This genus was erected by Dirsh (1956) on the basis of its robust body, broad wing and elytra, broad and robust hind femur, dorsal lobe of hind knee obtuse, posterior margin of the last abdominal tergite with small projections or with rough edge, supra anal plate transverse and moderately convex eyes, this genus is closely related to *Plegmapterus.*

14. Genus: *Plegmapterus* Martínez y Fernández-Castillo, 1898

(Appendix 2 Figs 12, 14c, 16c, 18c)

Plegmapterus fernandezi (Uvarov, 1922)*:* Appendix 2 Figs 14c, 16c, 18c

Type locality.—South Africa: Deelfontein.

Distribution.—Species has only been recorded from South Africa.

Plegmapterus irisus Serville, 1838

Type locality.—South Africa: Cape Province, Prince Albert Rd.

Distribution.—Species has only been recorded from South Africa.

Plegmapterus saturatus Walker, 1870

Type locality.—South Africa: KwaZulu-Natal, Zululand

Distribution.—Previously recorded from Namibia (Brown 1962) and South Africa (Brown1968).

Plegmapterus sinuosus (Martinez, 1898)

Type locality.—South Africa: Namaqualand

Distribution.—Previously known from the type specimens collected in "Namaquois", the locality was assigned to S.W. Africa (= Namibia) by Johnsen (1956) (Naskrecki 1995).

Plegmapterus splendens Dirsh, 1956

Type locality.—South Africa: Cape Province, Upington, Orange R.

Distribution.—This species was previously recorded from Namibia (Johnsen 1990b, Nakrecki1995) and South Africa by Dirsh (1956a)

Remarks.—This genus was erected by Uvarov (1922), on the basis of its head integument, pronotum and the degree of development of the lateral carinae. Dirsh (1956) reviewed the genus and found that Uvarov's (1922) generic characters are misleading because those generic characters vary between and within species.

I found a great deal of diversity in the shape and rugosity of its pronotum when I reviewed museum and field collected specimens. This also supports the statement by

Dirsh (1956) that those characters (dorsum rugosity and shape) are misleading as they vary within species. However the taxonomic status of this genus is not satisfactory and the genus has approximately four undescribed species, therefore revision is necessary.

15. Genus: *Rhachitopis* Uvarov, 1922

(Appendix 2 Figs 9, 13d, 15d, 17d)

*Rhachitopis crassus (*Walker,1879): Appendix 2 Figs 13d, 15d, 17d

Type locality.—South Africa:

Distribution.—This species was previously recorded from Namibia by Naskrecki (1995).

Rhachitopis curvipes curvipes (Stål, 1876)

Type locality.—Namibia: Damaraland.

Distribution.—Previously recorded from Namibia (Green 1993).

Rhachitopis nigripes Uvarov, 1922

Type locality.—South Africa: Cape of Good Hope.

Distribution.—Species has only been recorded from South Africa.

Rhachitopis sanguinipes Brown, 1960

Type locality.—South Africa: Cape Province, Langkloof Valley.

Distribution.—Species has only been recorded from South Africa.

Remarks.—This genus was erected by Uvarov (1922) based on its hooked male cercus, thickened hind femora, curved hind tibiae and prosternal tubercle not truncate but either triangular or with apex strongly rounded.

Dirsh (1956) reviewed the genus and found that the first descriptions of species *melanopus* and *aphripes* were poor and the types were lost so their taxonomic status or positions were not known.

Naskrecki (1992) later revised the genus and updated the key diagnostic features based on the phallic complex, cercus, supra anal plate, subgenital plate (females), coloration, morphometrical data and structure of male paraproct. The taxonomic state of this genus is satisfactory.

16. Genus: *Rhodesiana* Dirsh, 1959

(Appendix 2 Figs 8, 13g, 15g, 17g)

Rhodesiana maculata Dirsh, 1959: Appendix 2 Figs 13g, 15g, 17g

Type locality.—Zimbabwe: Beit Bridge

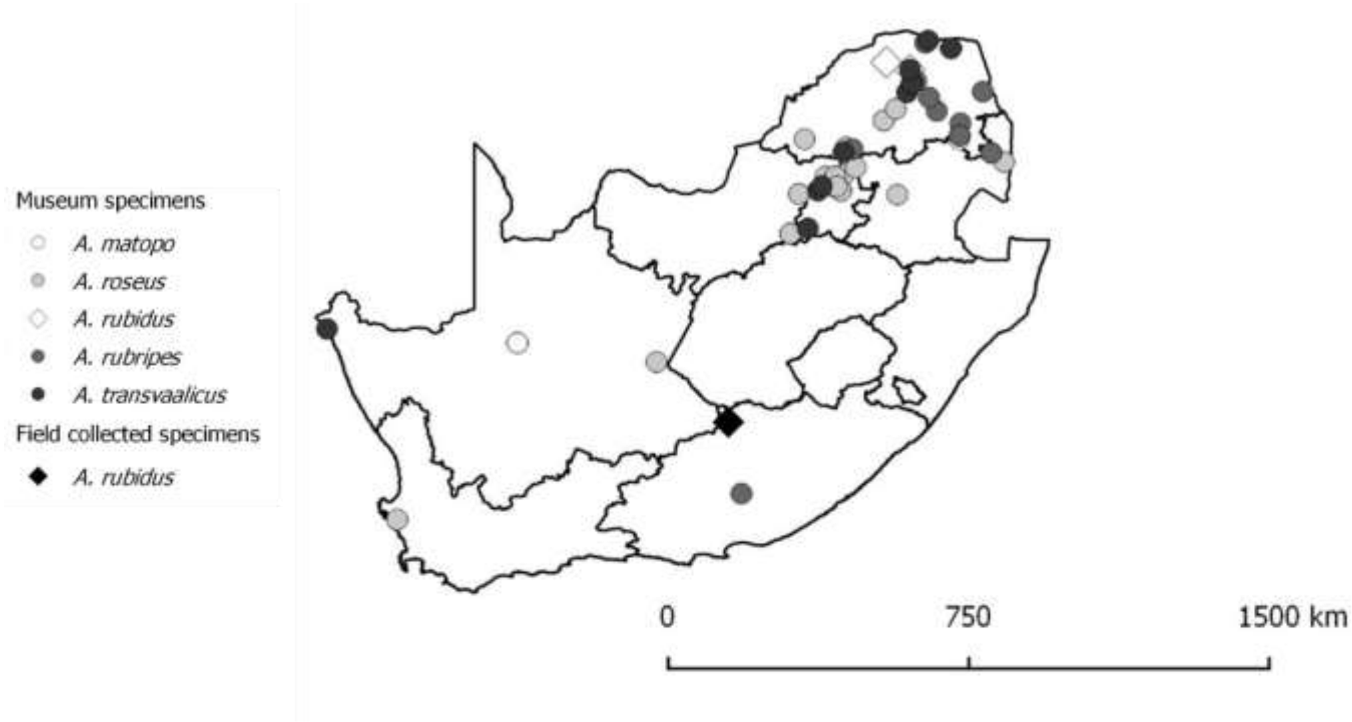
Material.—South Africa: Limpopo, Langjan, S22.842198, E29.243016, 27 Feb. 1988, coll. K. Kappmeier, - adult.

Distribution. — This is the first record of this genus from South Africa.

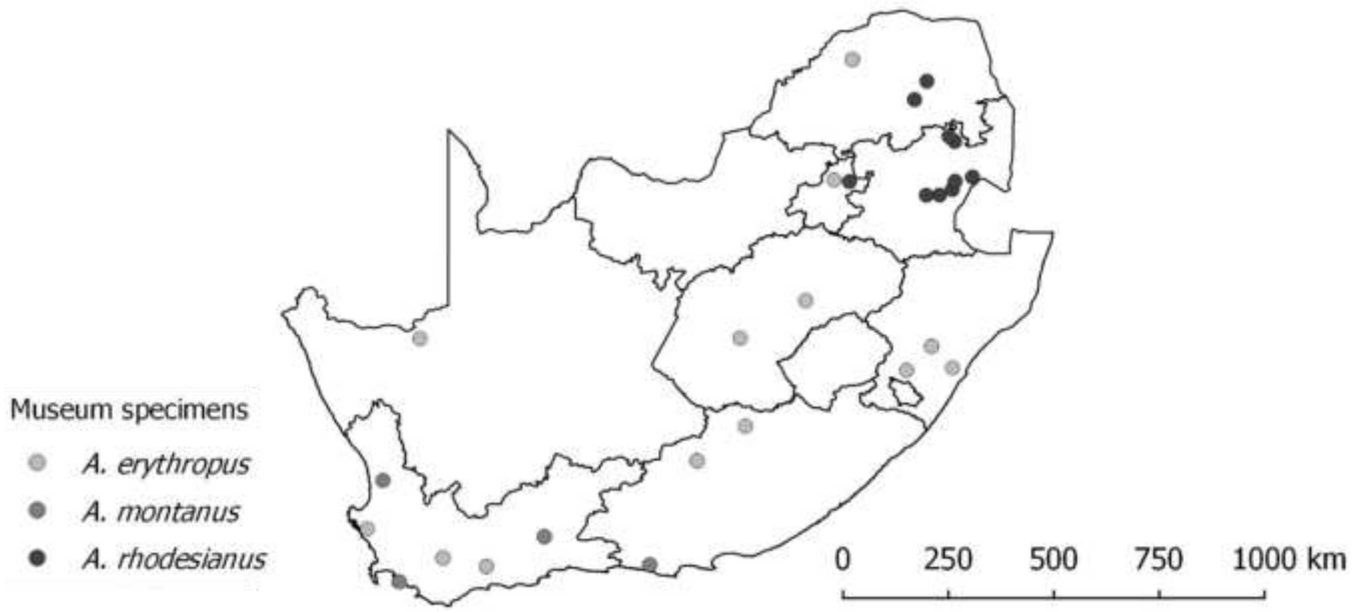
Remarks. — This genus was erected by Dirsh (1959), based on its transverse depression on pronotum. It is similar to *Anabibia* Dirsh 1956 but strongly differs in the shape of male cercus, posterior margin of pronotum (in *Anabibia* is rounded), shape of supra-anal plate (in *Anabibia* is tuberculate) and also by the shape of epiphallus. The shape of its male cercus is similar to that of *Euryphymus* Stål 1873 which is also short. Revision is not necessary for this genus.

Appendix 2

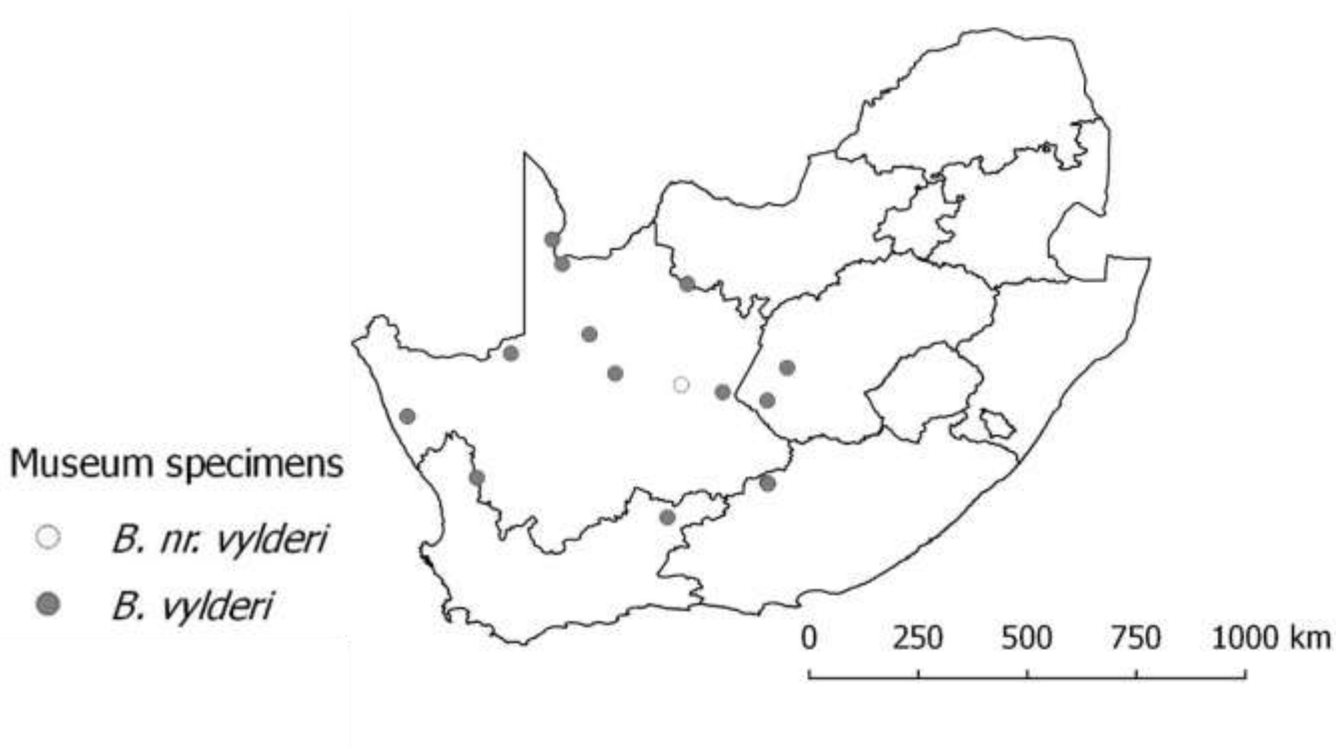
Distribution maps and generic photos



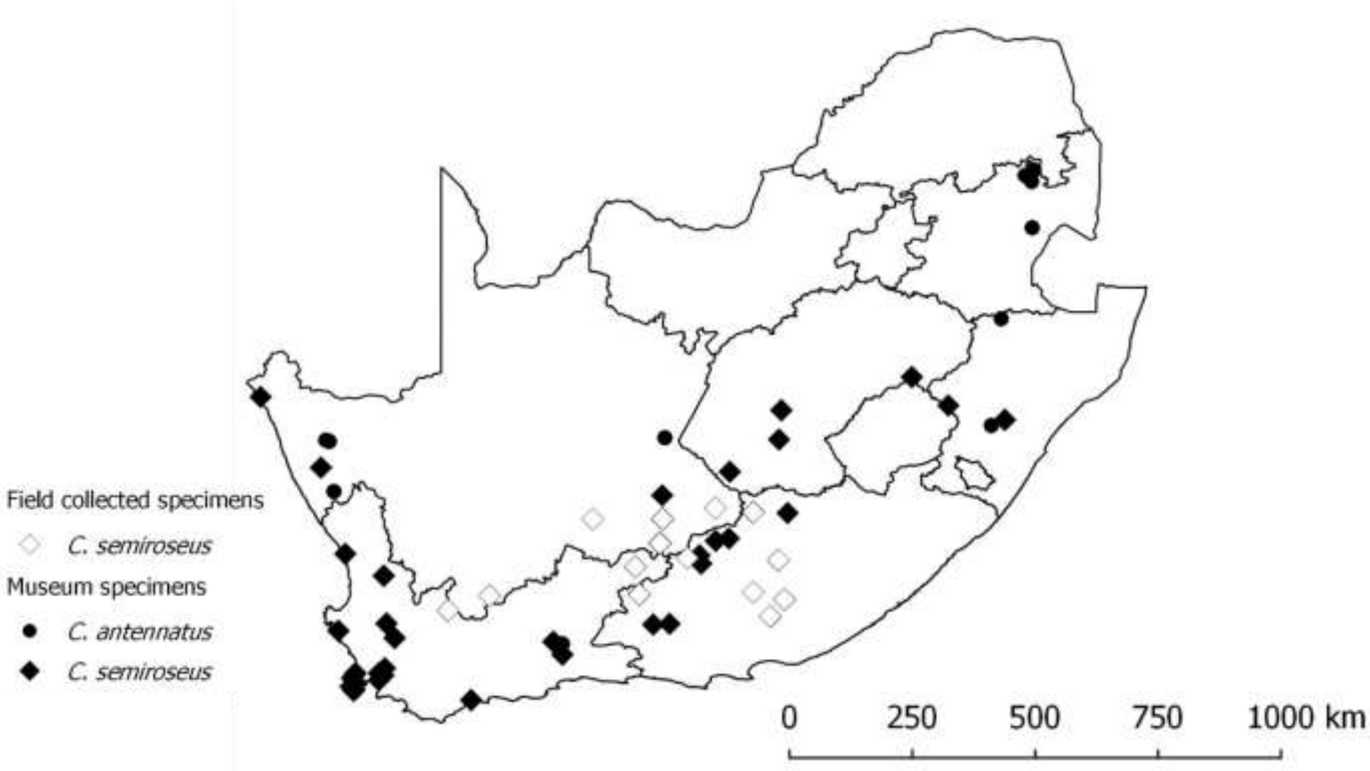
A2 Figure 1. Map showing collecting localities of *Amblyphymus* species.



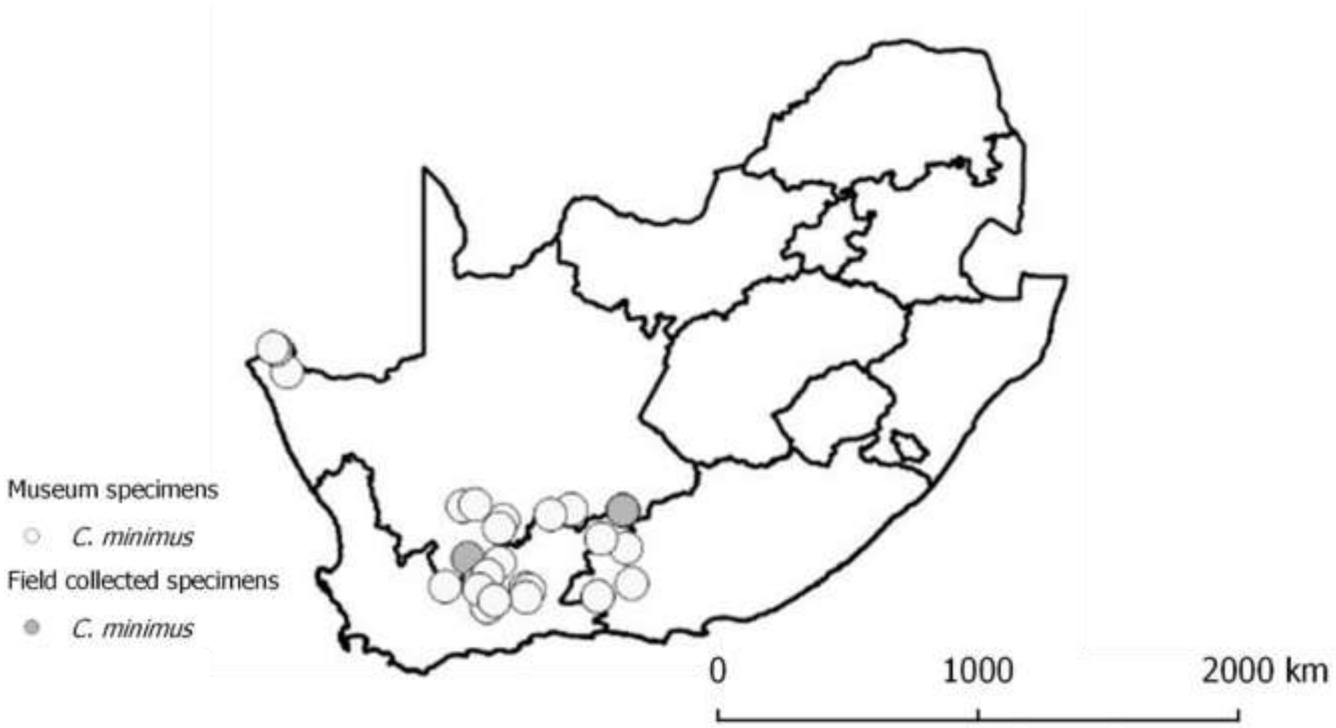
A2 Figure 2. Map showing collecting localities of *Aneuryphymus* species.



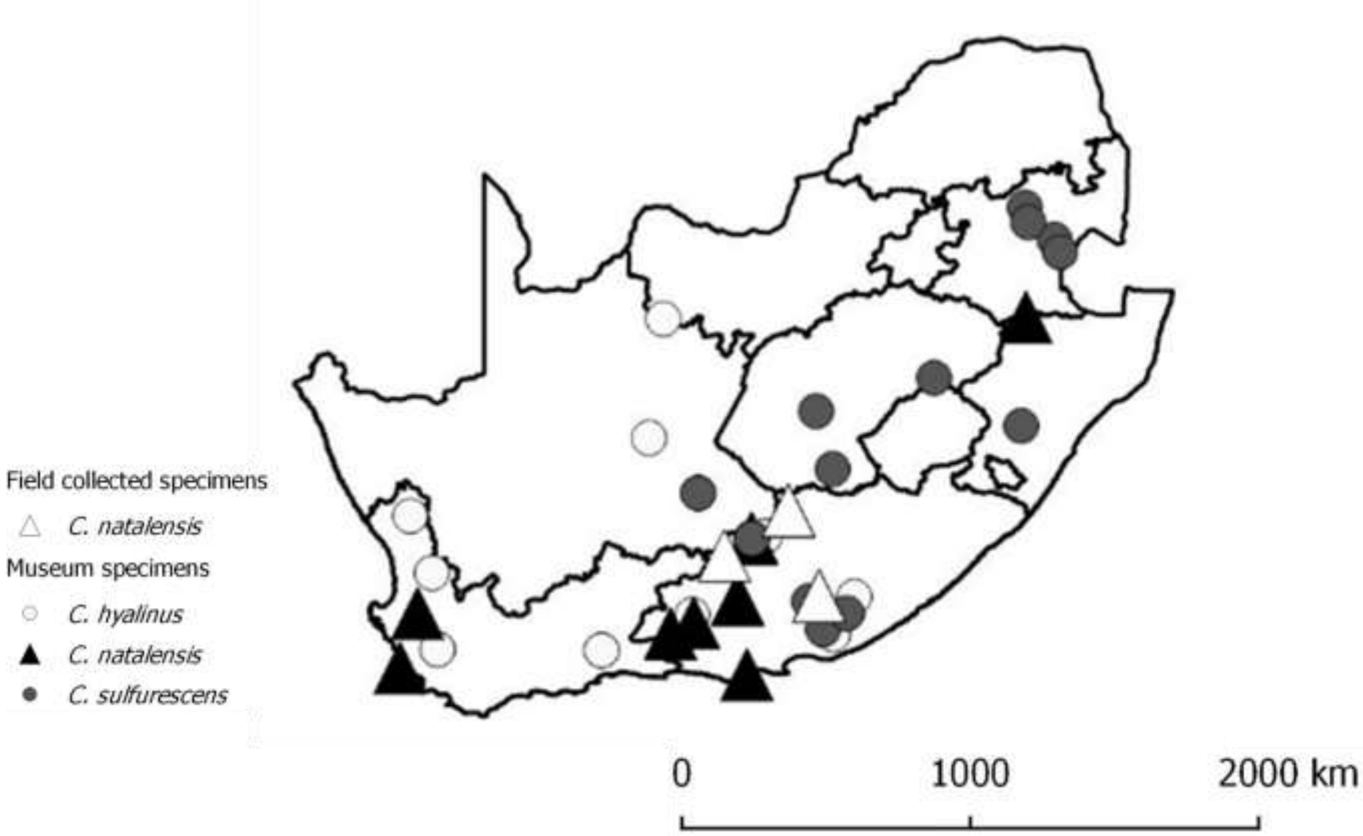
A2 Figure 3. Map showing collecting localities of *Brachyphymus* species.



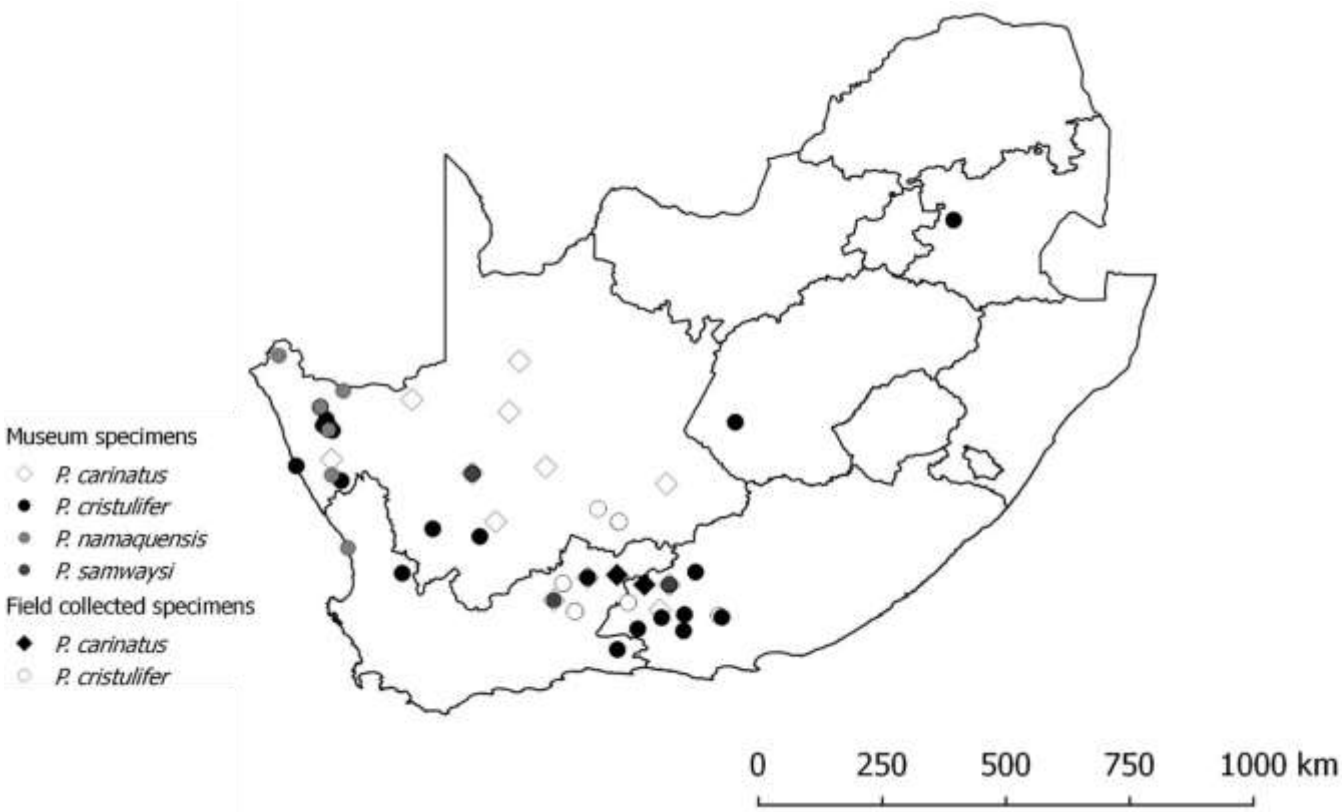
A2 Figure 4. Map showing collecting localities of *Calliptamicus* species.



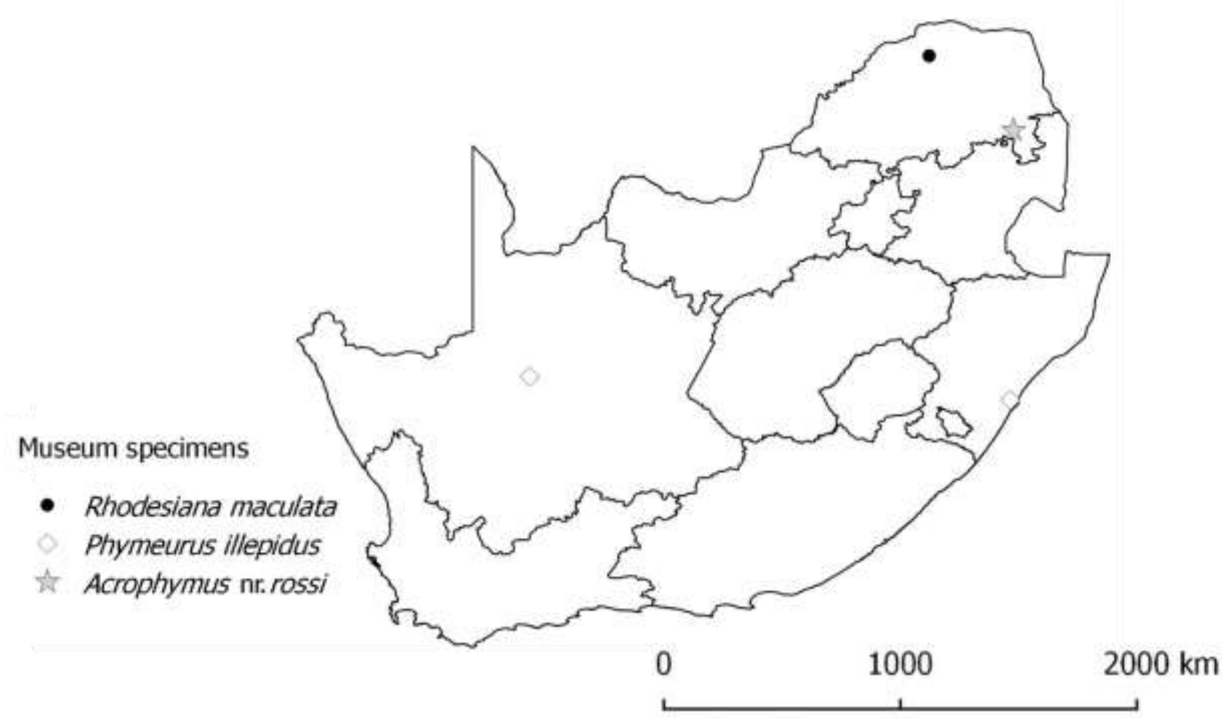
A2 Figure 5. Map showing collecting localities of *Calliptamuloides* species.



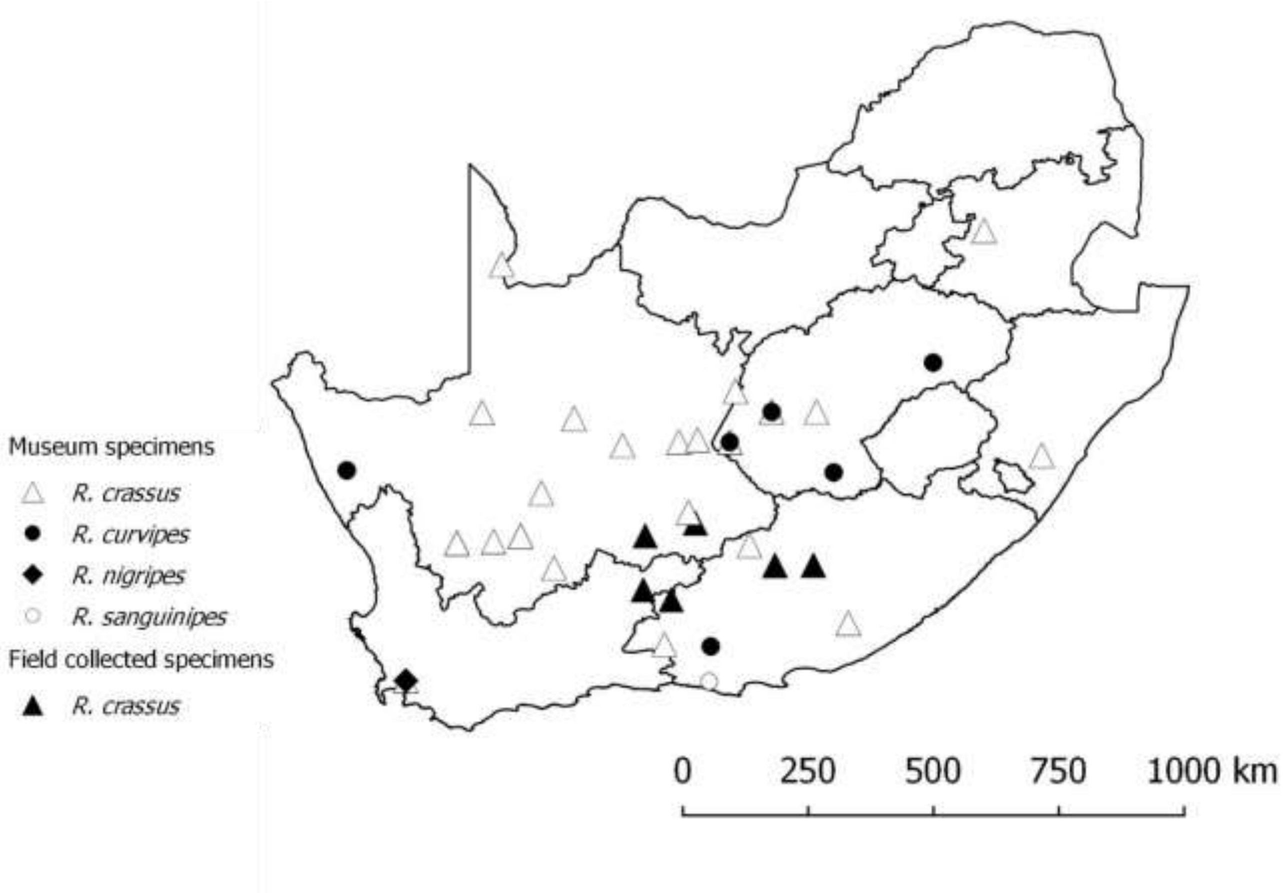
A2 Figure 6. Map showing collecting localities of *Calliptamulus* species.



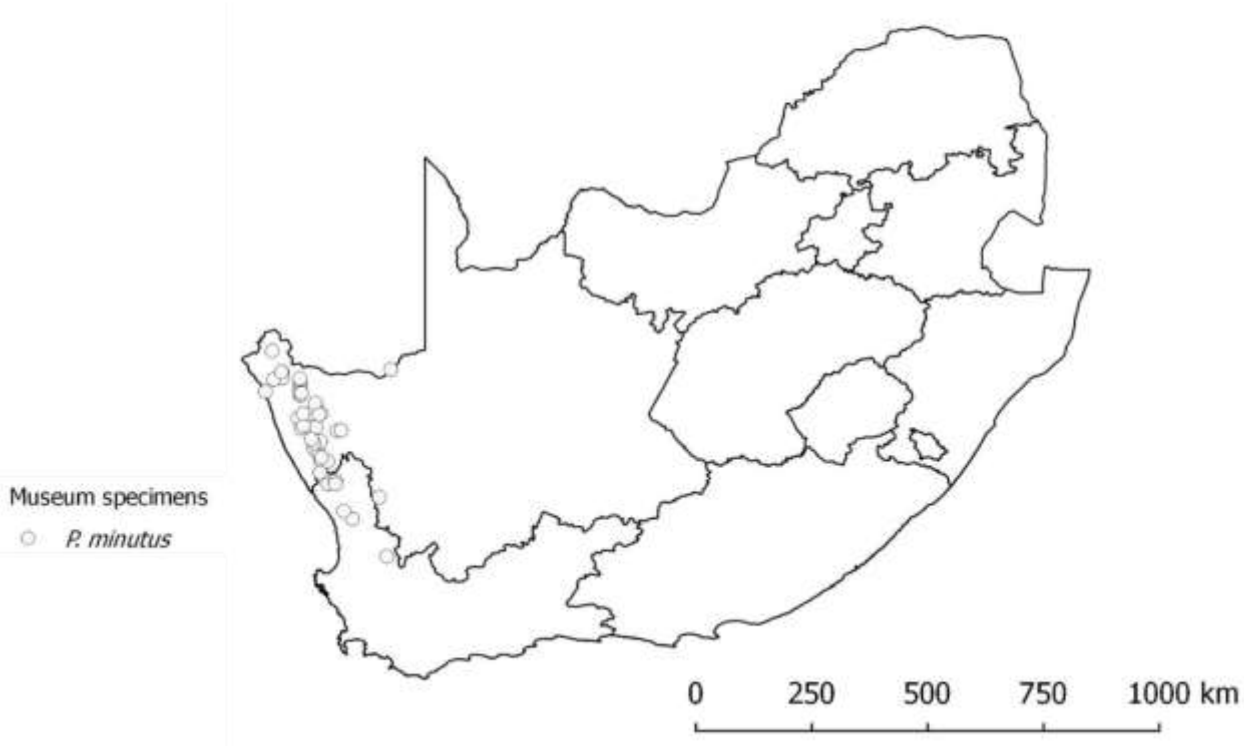
A2 Figure 7. Map showing collecting localities of *Pachyphymus* species.



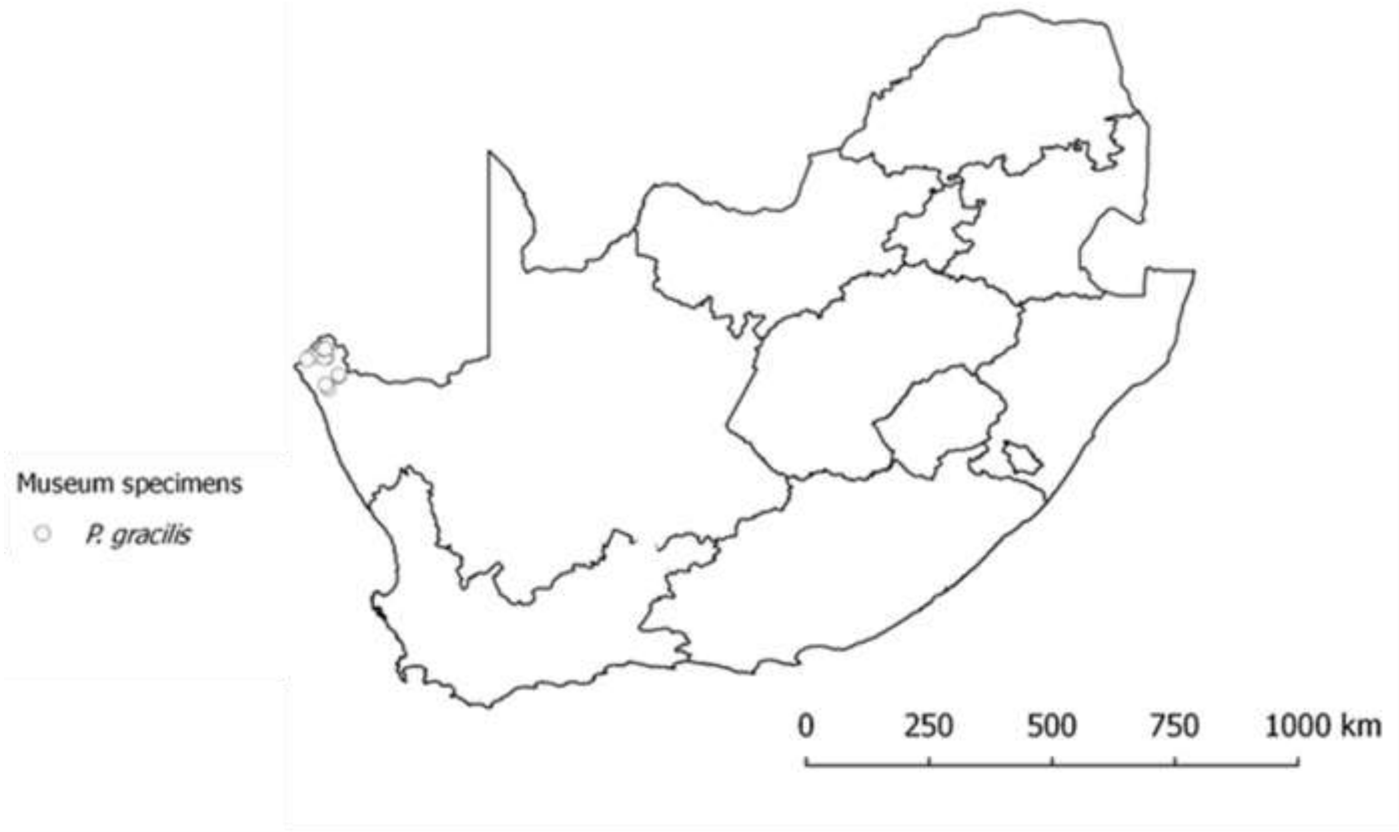
A2 Figure 8. Map showing collecting localities of *four genera* (*Phymeurus, Acrophymus and Rhodesiana*) species.



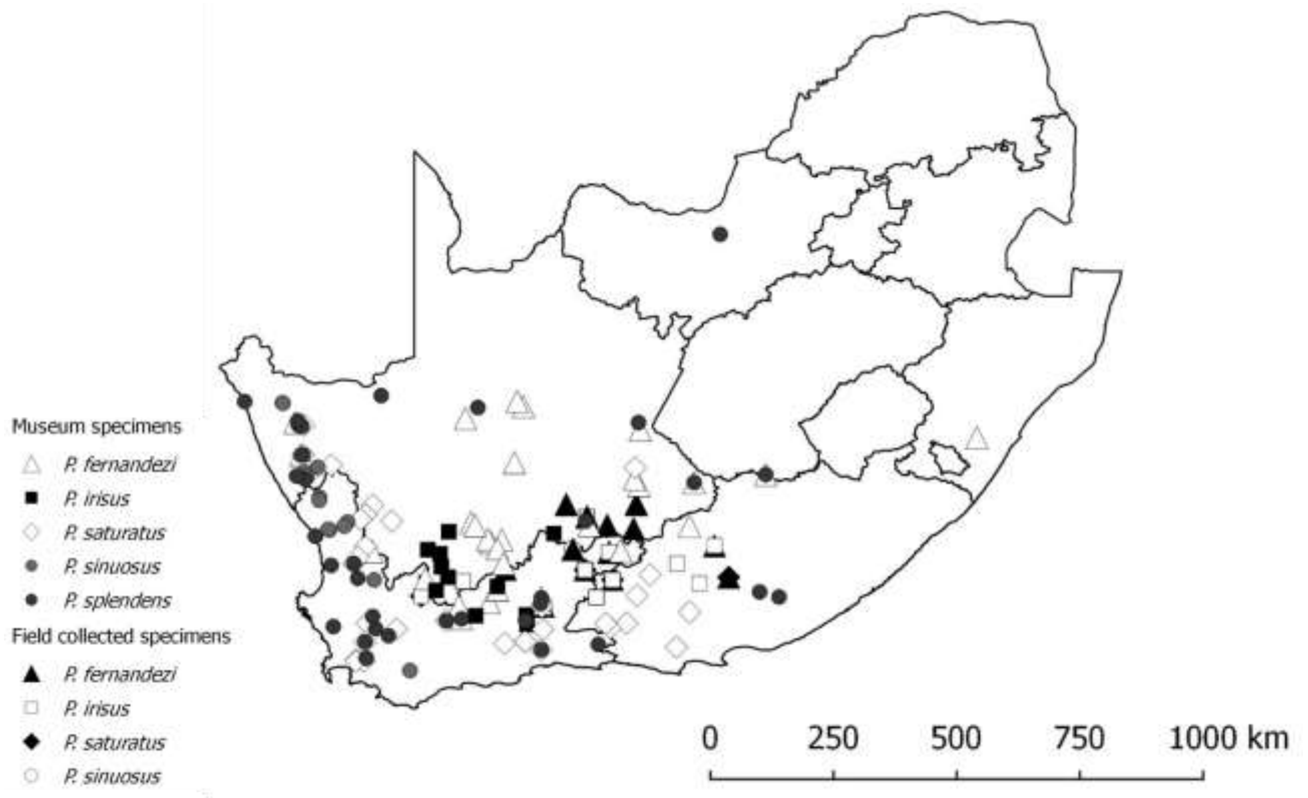
A2 Figure 9. Map showing collecting localities of *Rhachitopis* species.



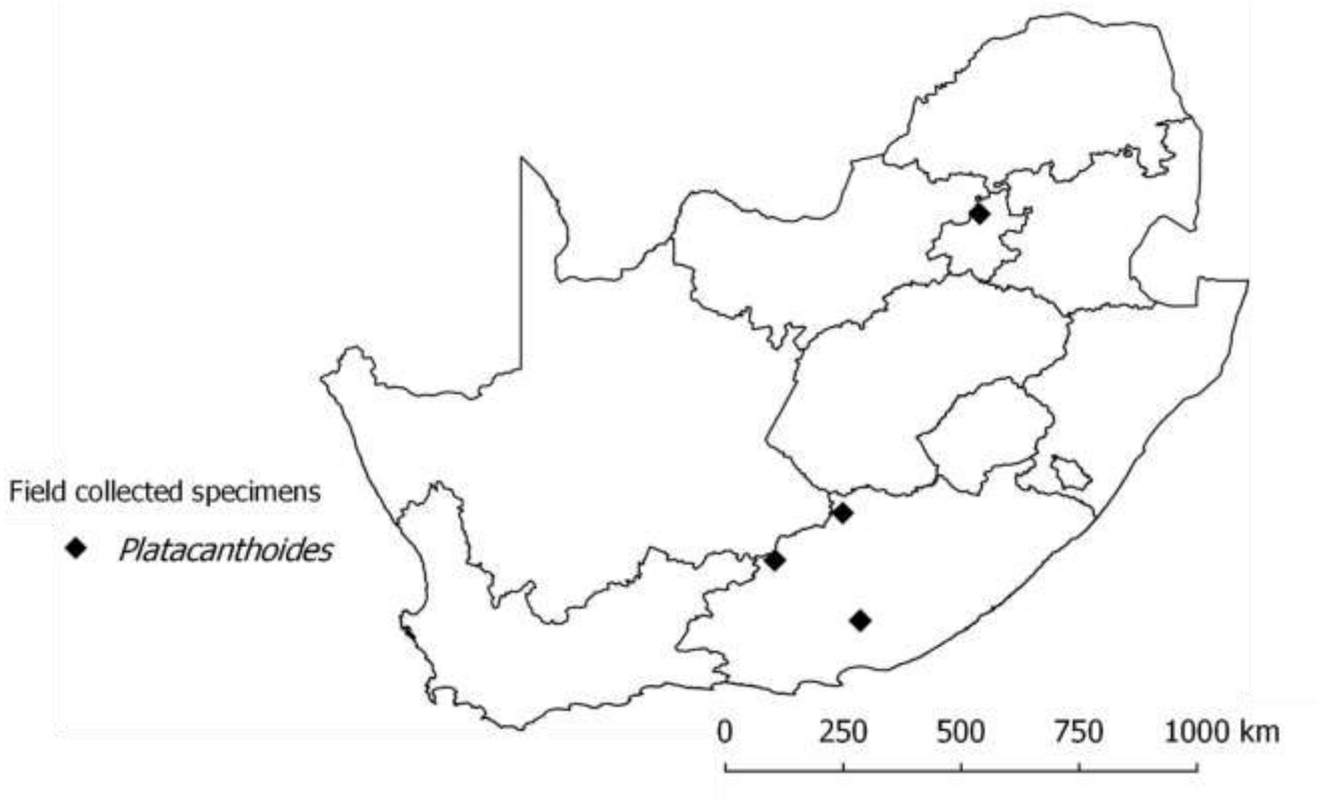
A2 Figure 10. Map showing collecting localities of *Plegmapteroides* species.



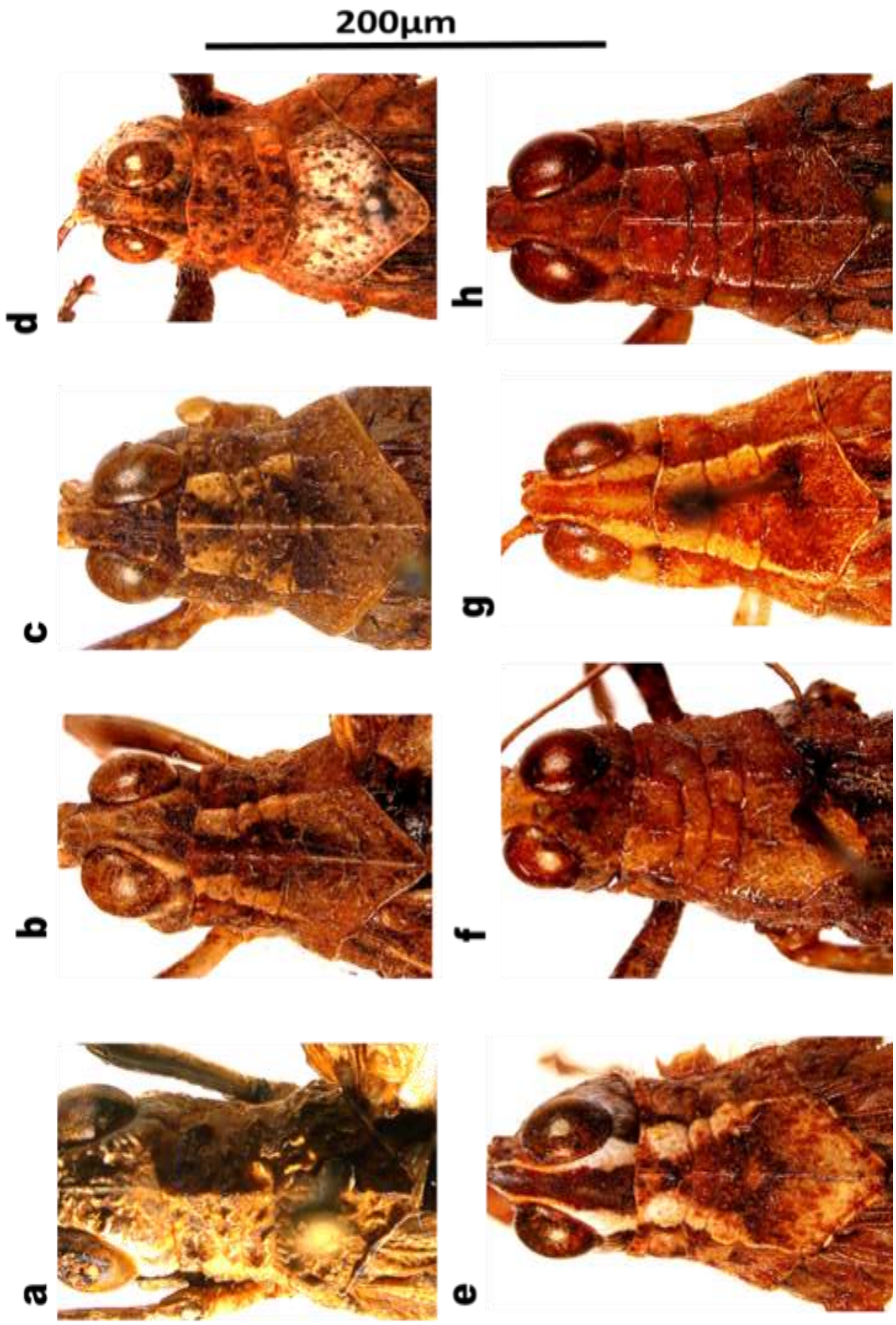
A2 Figure 11. Map showing collecting localities of *Plegmapteropsis* species.



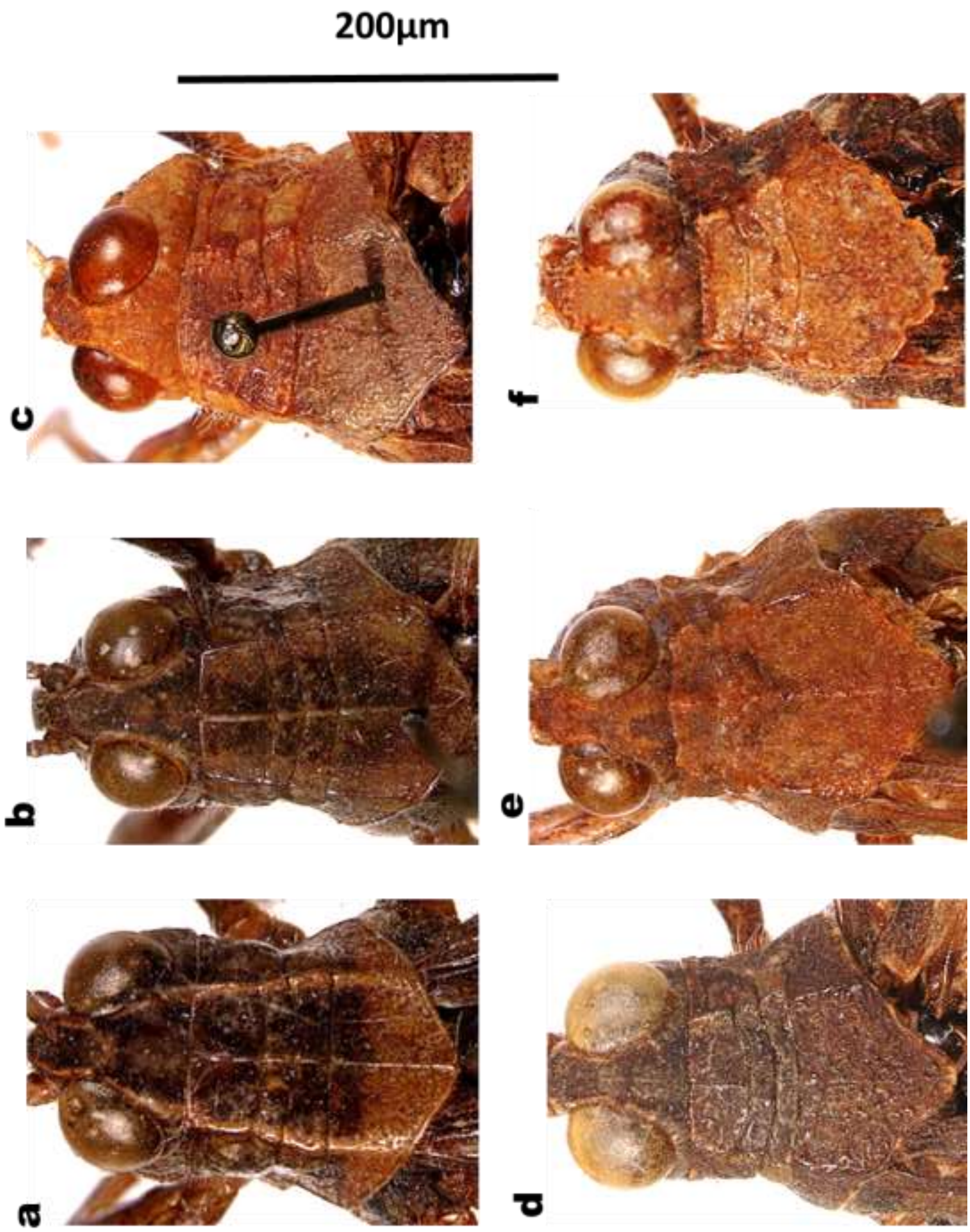
A2 Figure 12. Map showing collecting localities of *Plegmapterus* species.



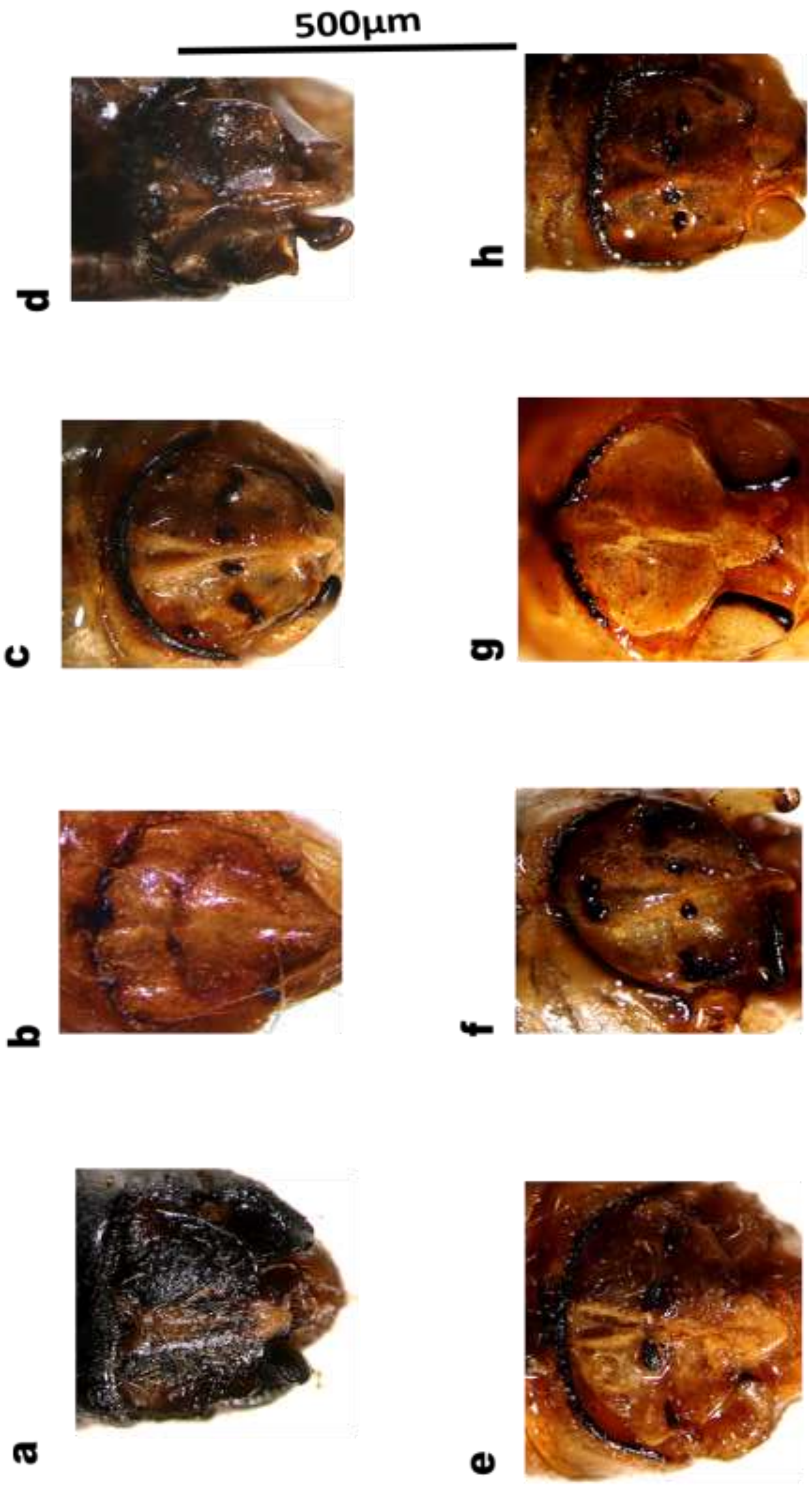
A2 Figure 13. Map showing collecting localities of *Platacanthoides* species.



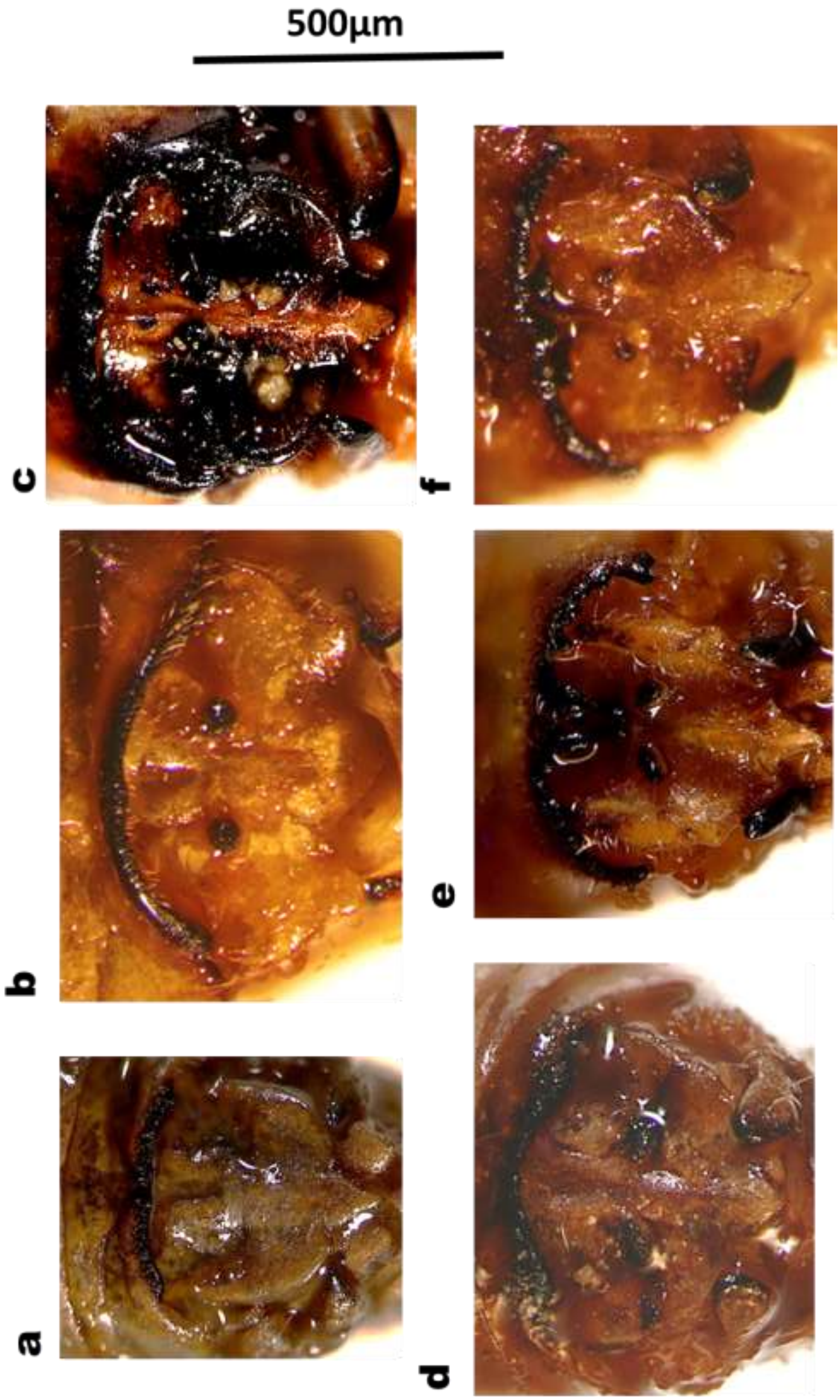
A2 Figure 14. Figure showing tectiform dorsum of (a) *Pachyphymus*, (b) *Euryphymus*, (c) *Aneuryphymus*, (d) *Rhachitopis*, (e) *Brachyphymus*, (f) *Phymeurus*, (g) *Rhodesiana* and (h) *Amblyphymus*.



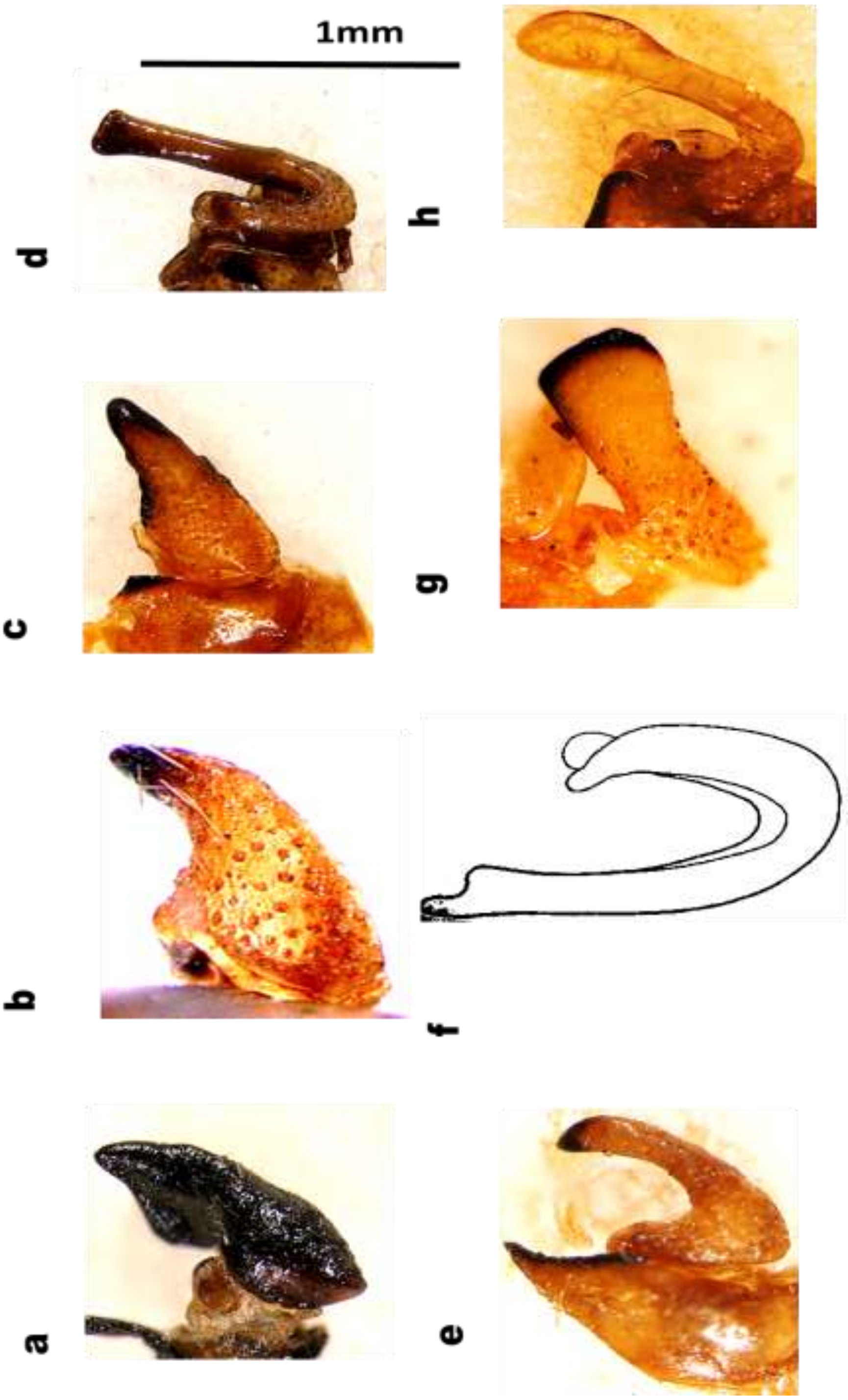
A2 Figure 15. Figure showing flat dorsum of (a) *Calliptamicus*, (b) *Calliptamulus*, (c) *Plegmapterus*, (d) *Plegmapteropsis*, (e) *Calliptamuloides* and (f) *Plegmapteroides*.



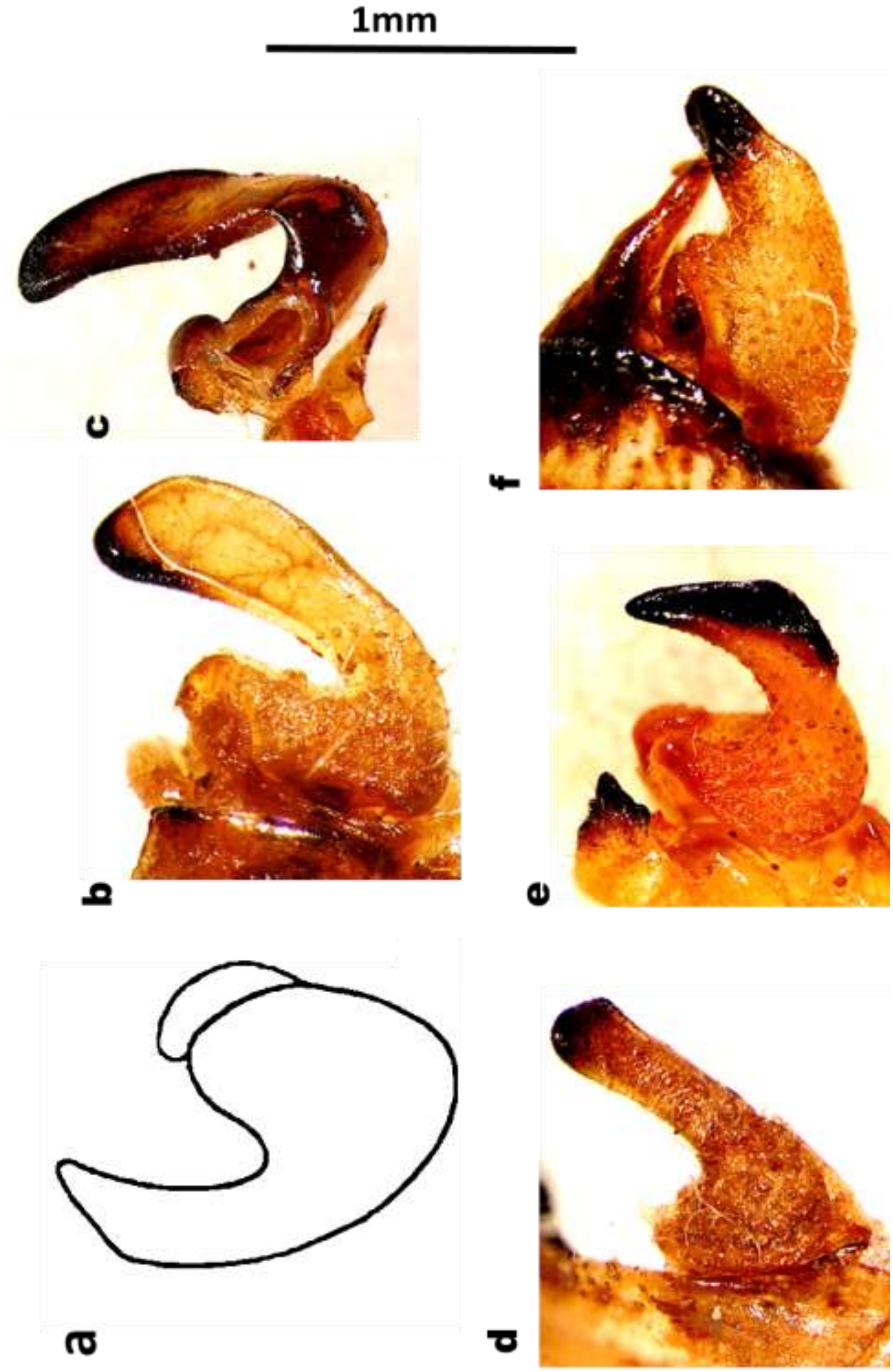
A2 Figure 16. Figure showing supra anal plates of (a) *Pachyphymus*, (b) *Euryphymus*, (c) Aneuryphymus, (d) *Rhachitopis*, (e) *Brachyphymus*, (f) *Phymeurus*, (g) *Rhodesiana* and (h) *Amblyphymus*.



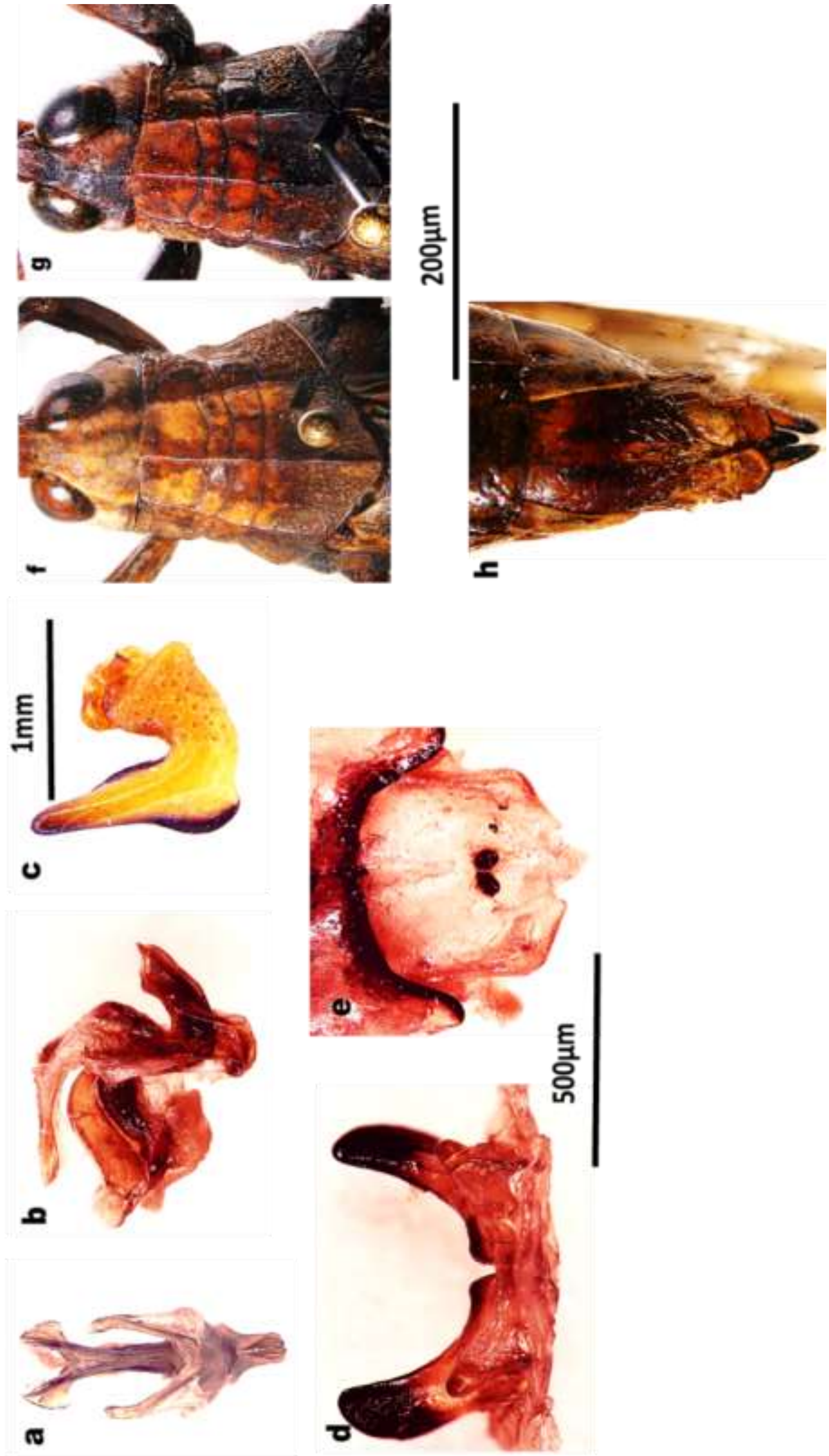
A2 Figure 17. Figure showing supra anal plates of (a) *Calliptamicus*, (b) *Calliptamulus*, (c) *Plegmapterus*, (d) *Plegmapteropsis*, (e) *Calliptamuloides* and (f) *Plegmapteroides*.



A2 Figure 18. Figure showing various shapes of cerci of (a) *Pachyphymus*, (b) *Euryphymus*, (c) *Aneuryphymus*, (d) *Rhachitopis*, (e) *Brachyphymus*, (f) *Phymeurus (*source: Dirsh 1956*)*, (g) *Rhodesiana* and (h) *Amblyphymus*.



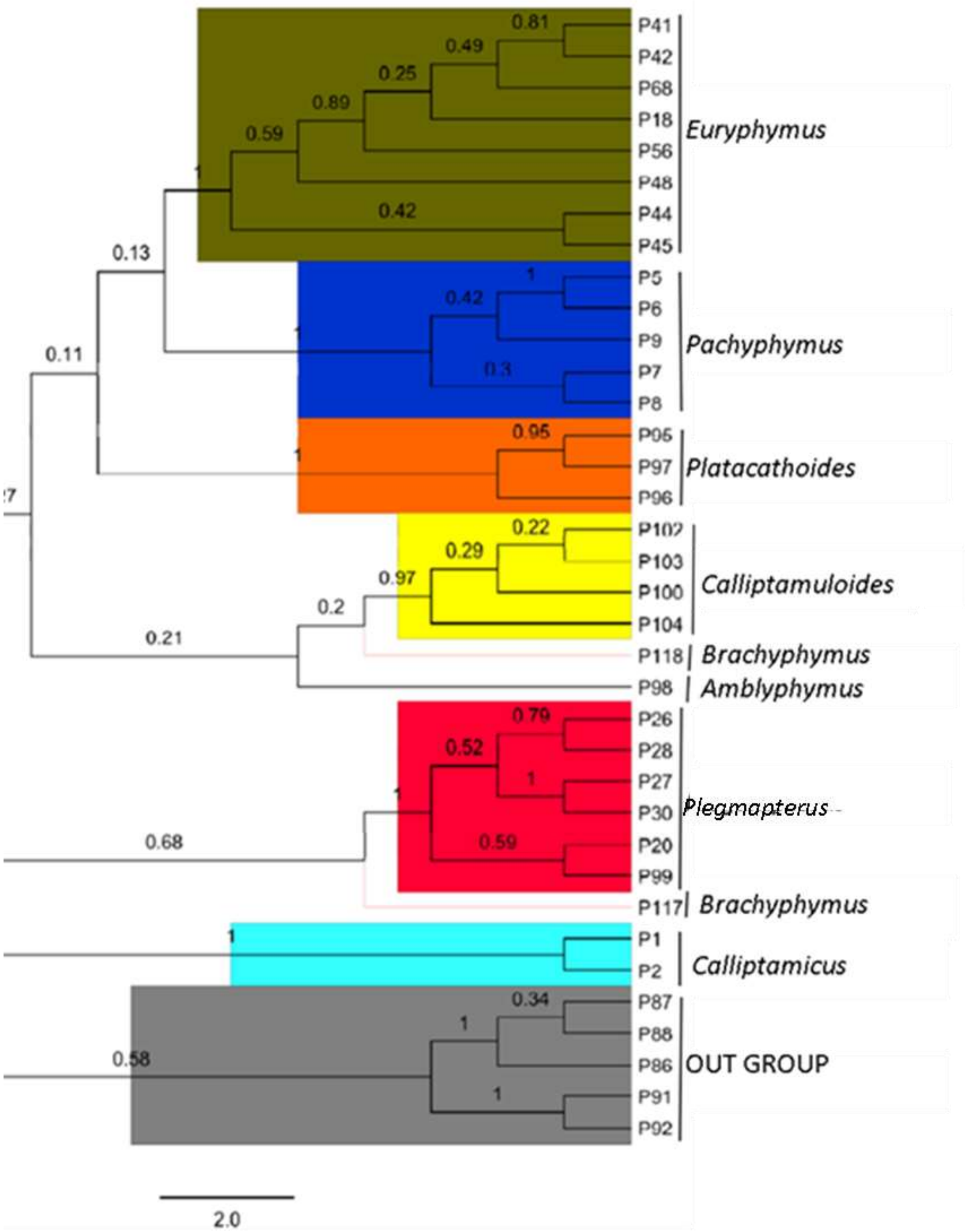
A2 Figure 19. Figure showing various shapes of cerci of (a) Calliptamulus (source: Dirsh 1956) (b) *Calliptamicus*, (c) *Plegmapterus*, (d) *Plegmapteropsis*, (e) *Calliptamuloides* and (f) *Plegmapteroides*.



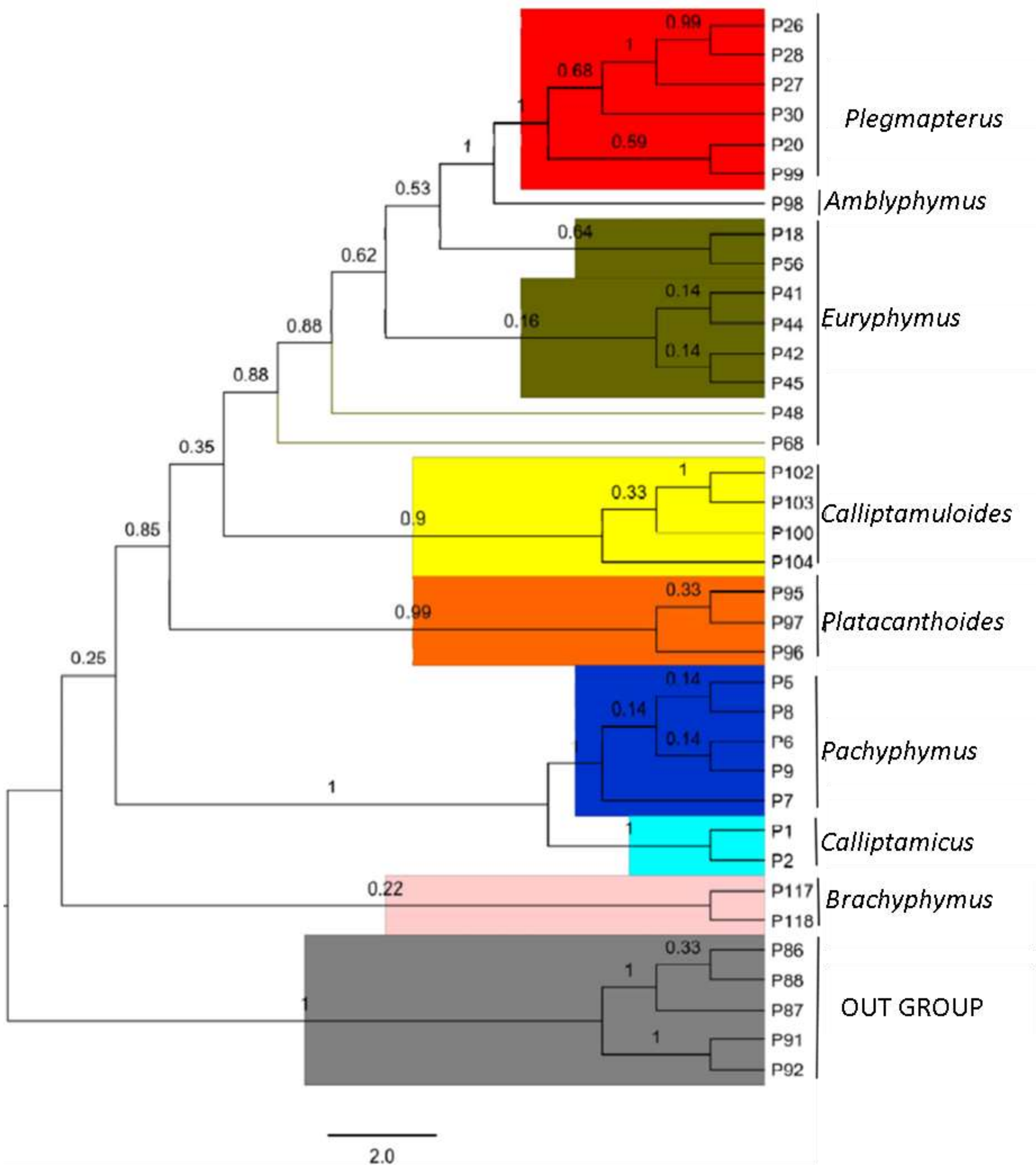
A2 Figure 20. *Platacathoides bituberculatas*: (a) phallic complex, ectophallic membrane removed, dorsal (a) and lateral view (b), (c) ♂ cercus, (d) phallic complex, (e) ♂ supral-anal plate, (f) ♀ dorsum, (g) ♂ dorsum, (h) ♀subgenital plate.

Appendix 3

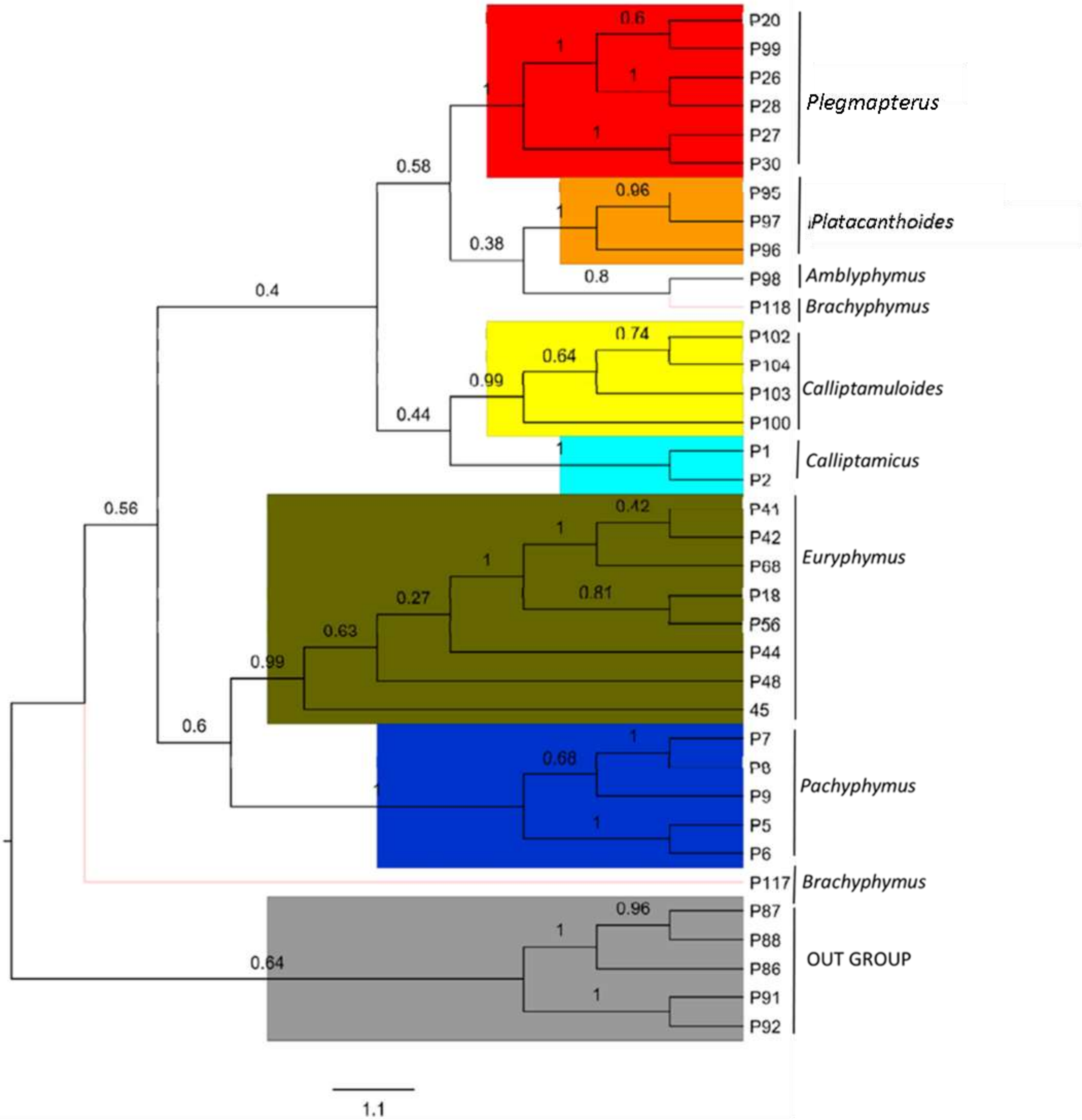
Phylogenies of separate gene trees



Appendix 4 Figure 1A. Bayesian tree resulting from analysis of 12S sequence of 36 grasshoppers. Numbers on nodes showed the bootstrap values for 1000 replicates.



Appendix 4 Figure 1B. Bayesian tree resulting from analysis of H3A sequence of 36 grasshoppers. Numbers on nodes showed the bootstrap values for 1000 replicates.



Appendix 4 Figure 1C. Bayesian tree resulting from analysis of CO1 sequence of 36 grasshoppers. Numbers on nodes showed the bootstrap values for 1000 replicates.

CHAPTER 3

Investigating the relationship between different individuals of *Euryphymus* genus collected in the southern Karoo, South Africa.

Abstract

Speciation in arid ecosystems is common because organisms are able to utilise many ecological niches in these habitats. Before this study, *Euryphymu*s had three described species distributed across South Africa and another three known to occur only in Madagascar, Botswana and Angola, respectively. On two field trips in October 2016 and March 2017, I collected a variety of individuals belonging to *Euryphymus* genus in the southern Karoo. Here, I investigate if these sampled populations are indeed one species with a variety of forms or if they are different species with similar morphology. For this, I compiled two datasets of male morphological characters (13 characters) and DNA barcodes (427 bp) for both males and females. DNA barcoding successfully assigned female specimens to their conspecific males identified using morphological characteristics. In two separate cladistic analyses of morphological characters and DNA barcodes for 13 male specimens, the trees were resolved but with low support. A consensus phylogeny using morphological and DNA barcode characters together resolved the same topology with slightly better support. A phylogenetic analysis using DNA barcodes from an ingroup of 27 male and female *Euryphymus* specimens produced a topology with well-supported nodes. Assuming a 3% species divergence threshold as is often used in insect phylogenetics, different individuals of *Euryphymus* were reduced to five valid species. From the five species, two have already been described and two are potential new species. These results show that levels of morphological variation in Euryphyminae can complicate species diagnosis and that DNA barcoding is efficient for differentiating among congeneric species.

Introduction

Speciation is a process that leads to the diversification of species (Barraclough and Nee 2001). This process is mainly caused by adaptation of species to a diversity of niches (adaptive radiation) and biogeographic isolation which causes the production of new species (Gavrilets and Losos 2009). In the case of adaptive radiation the result is genetically distinct species which are sexually isolated.

Speciation in arid ecosystems is expected to be common as organisms are able to utilise many ecological niches (Chapple and Keogh 2004). Storr (1968) studied an endemic Australian genus of scincid lizards that has wide distributions in Australia that includes the arid region and temperate regions; he found that the lizards form two subgroups. The rock-dwelling subgroup (has species from arid and temperate region) named *Egernia whitii* (*E. whitii, E. montana, E. guthega, E. m. margaretae, E. m. personata and E. modesta*) and the obligate burrowing subgroup named *Egernia inornata* (*E. inornata, E. striata, E. kintorei and E. multiscutata*), utilise a range of different niches. The two subgroups formed a well-supported monophyletic clade within species. Species from each subgroup share morphological, ecological and behavioural traits. He further found that the genetic distance between *Egernia whitii* and *Egernia inornata* were very high (5.5–6.5%) indicating that they were indeed genetically distinct.

Euryphyminae is an endemic subfamily to the southern Karoo (Bazelet and Naskrecki 2014). They seem to be arid region specialists and are morphologically adapted to arid regions. No ecological studies and very few taxonomic studies have previously focused on this group (but see Dirsh 1956, Naskrecki 1994, 1995, Bazelet and Naskrecki 2014). Existing taxonomic keys are insufficient for differentiating among species morphologically and it is especially difficult to associate females to their conspecific males. This is because females of different species look similar to each other and existing taxonomic keys are based on males.

Molecular tools have never been employed for the taxonomy or systematics of Euryphyminae and may be very helpful for this group, especially for the association of females with their conspecific males (Song et al. 2015). The inclusion of molecular tools has the added benefit of producing relatively fast identification and classification results. It can also be useful for revealing cryptic species and speciation events if present (Goldstein and DeSalle 2011).

Before this study, *Euryphymu*s had three described species distributed across South Africa, *E. tuberculatus, E. haematopus*, and *E. xanthocnemis*, and one species each from Angola (*E. eremobioides*), Botswana (*E. kalahariensis*) and Madagascar (*E. exemptus*), respectively. On a recent field trip, I sampled many specimens with diverse morphologies across the southern Karoo. By focusing on this genus, I test the hypothesis that Euryphyminae have high morphological variation within species and low variation between species using an integrative taxonomic approach by assessing the congruence of morphological with molecular datasets. I also investigate if whether I collected one species with a high degree of polymorphism or if there are different species of *Euryphymus* in the Karoo using morphological and molecular techniques.

Methods

Taxon sampling

Sampling was conducted as reffered in Chapter 2, of which five sites sampled yielded *Euryphymus* and additional specimens were included which had been recently collected by C.S. Bazelet at Kgalagadi National Park, Northern Cape Province, and West Coast National Park, Western Cape Province in 2008.

Morphological character sampling

For morphological character sampling, I consulted Dirsh (1956, 1965) and all other taxonomic keys or species descriptions published for Euryphyminae to construct a list of internal and external diagnostic characters that had been used for Euryphyminae taxonomy in the past (Table 2). I then compared morphological characters of my series of 13 available male specimens with the published list of characters to determine which ones were easily identifiable.

For male genitalic dissection, the membrane between the epiproct and subgenital plate was cut open carefully. The tip of a forceps was inserted and gently pulled through under the ventral section of the phallic complex for extrusion. The dissected phallic complex structure was digested in <10% KOH solution for 3-4 hours. Sclerotized structures were rinsed and placed in genitalia vials in 70% ethanol after being photographed and stored with the pinned specimen.

Detailed photographs were taken of selected specimens using a Leica DFC400 auto-montage microscopic camera. These images were processed in Canva (www.canva.com) for light balance, colour and saturation.

DNA barcoding

Twenty-nine specimens of *Euryphymus* (Acrididae: Euryphyminae) and an outgroup with five specimens of *Pachyphymus* (Acrididae: Euryphyminae) were included. DNA was extracted from muscle tissue of a middle leg using the NucleoSpin DNA Insect Extraction Kit (Macherey - Nagel). The 5’ region of the cytochrome c oxidase 1 (COI;

DNA barcode) gene was then amplified (Huang et al. 2013). Primers used were designed for Orthoptera: COBU (5’-TYTCAACAAAYCAYAARGATATTGG-3’) and COBL (5’-TAAACTTCWGGRTGWCCAAARAATCA-3’).

The COI gene is known to be standard barcode for members of the animal kingdom (Huang et al. 2013, Hajibabaei et al. 2007). Careful consideration must be taken when barcoding Orthoptera because they contain pseudogenes (*numts*) which are non-functional copies of mtDNA which have been inserted into the nuclear genome, and which are easily amplified alongside the functional COI gene during DNA barcoding. The *numts* when amplified are divergent from orthologies of mtDNA sequences, and during analysis the number of unique species may be overestimated (Song et al. 2016). *Numts* can be identified and filtered by using in frame stop codons, indels and also examining nucleotide composition (Song et al. 2008). In order to detect the presence of *numts* in Euryphyminae COI sequences, I aligned my COI sequences to EU589055, downloaded from GenBank, which is a reference sequence known to be clean of *numts* in Song et al. (2008). Euryphyminae sequences aligned to this sequence perfectly, and were therefore considered to be free of *numts.*

Methods used were adopted from Huang et al. (2013). Standard capillary sequencing was conducted and all PCRs were conducted on an AB GemAmp PCR system 9700. Cycle sequencing was conducted using the ABI PRISM BigDye Terminator v3.1 cycle sequencing kits and sequences were run on the ABI 3500XL Genetic Analyzer. Cleaned sequences were uploaded to BOLD Systems (http://www.boldsystems.org/.see Supplement 3 for accession numbers). DNA extraction, PCR amplification and DNA sequencing were performed by the African Centre for DNA Barcoding (ACDB) at University of Johannesburg.

Statistical analysis

Morphological cladistics analysis

I consulted Bazelet and Naskrecki (2014) and Dirsh (1961) for diagnostic characters used in species descriptions and diagnostic keys of Euryphyminae. We excluded female specimens from our morphological analysis as male and female morphology cannot be used simultaneously for tree construction and we preferred to use males which have useful diagnostic genitalic characters which have traditionally been used extensively in Euryphyminae taxonomy. A data matrix consisting of 13 in-group taxa, five outgroup taxa and ten morphological characters with 36 character states were created (Table 1).

Missing data were scored as "?" and matrix data were used for Bayesian analysis in MrBayes Version 3.2 (Ronquist and Huelsenbeck 2003). The analysis consisted of running four simultaneous chains for 20 million generations and FigTree v1.4 (Rambaut 2007) was used to view the tree.

Phylogenetic analysis and reconstruction

Sequence editing and preliminary analysis were done in Geneious using PAUP version 4.0a (build 154) (Swofford 2002). Phylogenetic analyses were done in Bayesian frameworks (Song et al. 2008, Huang et al. 2013). Within the parsimony framework, the aligned sequences were analysed by using the heuristic search algorithms with gaps replaced by "n" in PAUP 4.0. First I analysed male specimens only to match that of the morphological cladistics and then repeated the analyses with both males and females to assign females to their conspecific males. To assess support, we calculated standard bootstrap values based on 1,000 replicates in PAUP 4.0. Within the Bayesian inference, we analysed the two separated data sets by using the program MrBayes version 3.2, after selecting best-fit models of nucleotide evolution under the BIC criteria by using jModelTest 0.1.1. The analysis consisted of running four simultaneous chains for 20 million generations (TIM2+G). Two independent identical Bayesian runs were performed to ensure convergence on similar results and the nodal support was assessed by using the posterior probability generated from a consensus tree of the sampled trees past burn-in determined by using Tracer 1.4 (http:// beast.bio.ed.ac.uk) (Song et al. 2008, Huang et al. 2013).

Sequence divergences were calculated using the Kimura two parameter (K2P) distance model in MEGA4. Pairwise species divergence was calculated for all pairs of species which were assigned based on a threshold of 3% divergence used to assign species, as is often the case for insect groups (Hebert et al. 2002).

Results

Cladistic analysis

I first analysed males only using morphological data, a cladistic tree produced by Bayesian inference resolved the relationship between ingroup and outgroup taxa but was not strongly supported by posterior probabilities. Posterior probabilities ranged from 0.18-0.93. Neither shallow nor deep nodes were strongly supported (Fig. 2).

Phylogeny reconstruction

A Bayesian tree resolved the monophyletic clades of outgroup and ingroup taxa and better resolved the relationship between clades (Fig. 3). The tree was well resolved and the relationships were clear but posterior probabilities were relatively high, they ranged from 0.26 - 1, with deep nodes supported by low values as compared to shallow nodes (Fig. 3). All individuals of the Euryphymus genus formed a monophyletic clade consisting of five sub-clades.

Overall DNA and cladistic trees yieded similar results interms of individuals grouping but varied in placement and the two individuals of E. tuberculatus were separated in the cladistic tree (Fig.2). Both datasets had four singletons, which could change the trees completely if more samples are added.

For the COI alignment of male and female specimens (32 specimens), Bayesian inference resolved the monophyletic clades of outgroup and ingroup taxa with high posterior probabilities (Fig. 4). DNA analysis was able to assign female specimens to their conspecific males yielding five distinct groups. Posterior probabilities ranged from 0.20 – 1, with shallow nodes supported by relatively high values and deep nodes supported by low posterior probabilities.

Sequence divergence among and within species

When we calculated genetic distances between five genetically distinct groups, based on the a threshold for species assignment (3%) (Herbert et al. 2003) (Table 3), the results showed that interspecific variation within five groups were less than 1% (Table 4) and intraspecific variation between groups were more than 3% with the highest variation being 5%.

Discussion and conclusion

I tested the hypothesis that *Euryphymus* have high morphological variation within species and low variation between species using an integrative taxonomic approach by looking at the congruence of morphological with molecular datasets. Based on morphology, the *Euryphymus* individual’s specimen grouping yieded a very poorly supported topology. Furthermore, statistically the Euryphymus specimens are almost the same morphologically, meaning that morphological variation in Euryphymus is very low that I initially hypothesised (Fig.2).

COI-based identification systems can aid with the initial delineation of species using divergence thresholds (Herbert et al. 2003). From the ten initial OTU's, calculations of genetic distances revealed only five distinct species using a divergence threshold of 3% between species. DNA barcodes grouped species together; however, it questioned the taxonomy used.Suggesting that the morphological characters used were not sufficient to highlight the evolutionary relationship or to diagnose species.

I also investigated if whether I collected one species with a high degree of polymorphism or if there are different species of *Euryphymus* in the Karoo using morphological and molecular techniques. Because different indiviaduals with different polymorphisms were grouped into five species, this implies that the Euryphymus genus has species with high polymorphism or various forms.

Of the five species revealed here, three species have been described. Two have distribution records across South Africa. In addition, three species *Euryphymus* sp. 1, *Euryphymus* sp.2 and *Euryphymus* sp.3 are possible new species.

DNA barcoding alone may be sufficient for delimiting species, however, in order to determine evolutionary relationships among species (as is necessary for delimiting higher-level taxa such as genera, tribes, subfamilies and families), it is not suitable for resolving phylogenetic relationships at deeper levels. This is why mitochondrial and nuclear genes are usually the requirement in order to build phylogenetic trees and analyse coalescent events (evolutionary history of genes) to delimit species (de Queiroz 2007; Fujita et al. 2012; Hajibabaei et al. 2007).

To my knowledge, this was the first study which attempted classify *Euryphymus* species using integrative taxonomy. Due to small sample size, the classification is not definitive but does serve as a baseline for future work. I therefore recommend that both mitochondrial and nuclear molecular markers be used to classify *Euryphymus* species. Furthermore, a taxonomic study of this group coupled with descriptions of new species should be done urgently in addition to investigating the speciation events which led to species polymorphisms and lastly to identify which species.

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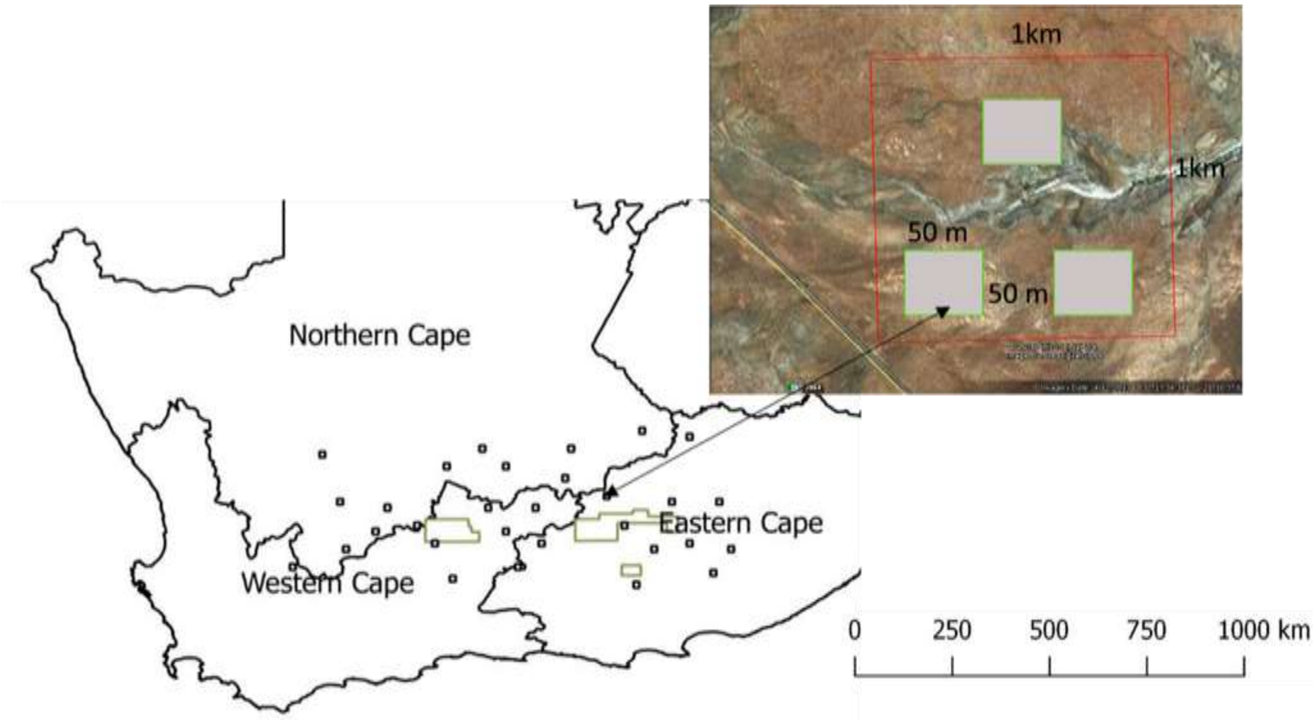

Figure 1. Map showing the relative location of the 30 study sites across the southern Karoo. Inlay indicates relative positioning of quadrats within sampling site in a semi-randomized positioning to cover all major habitat features present at a site (e.g. a slope, a flat plain, a river bed). The areas highlighted by green are national parks and are included as geographic reference points.

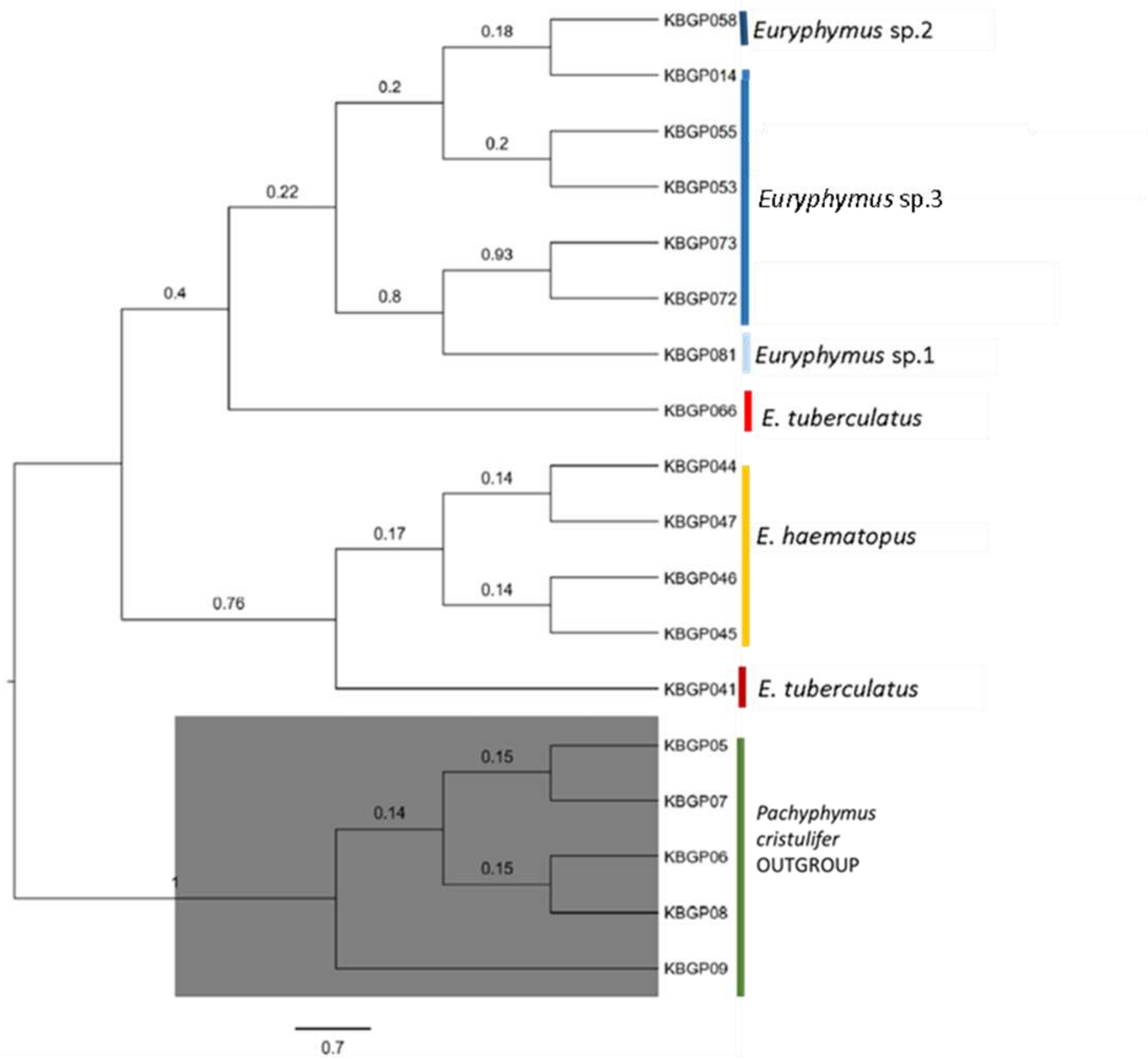

Figure 2. Cladistic analysis based on morphological characters in Bayesian framework of 13 male *Euryphymus* specimens and five *Pachyphymus* specimens as outgroups. Numbers on branches indicate posterior probabilities.

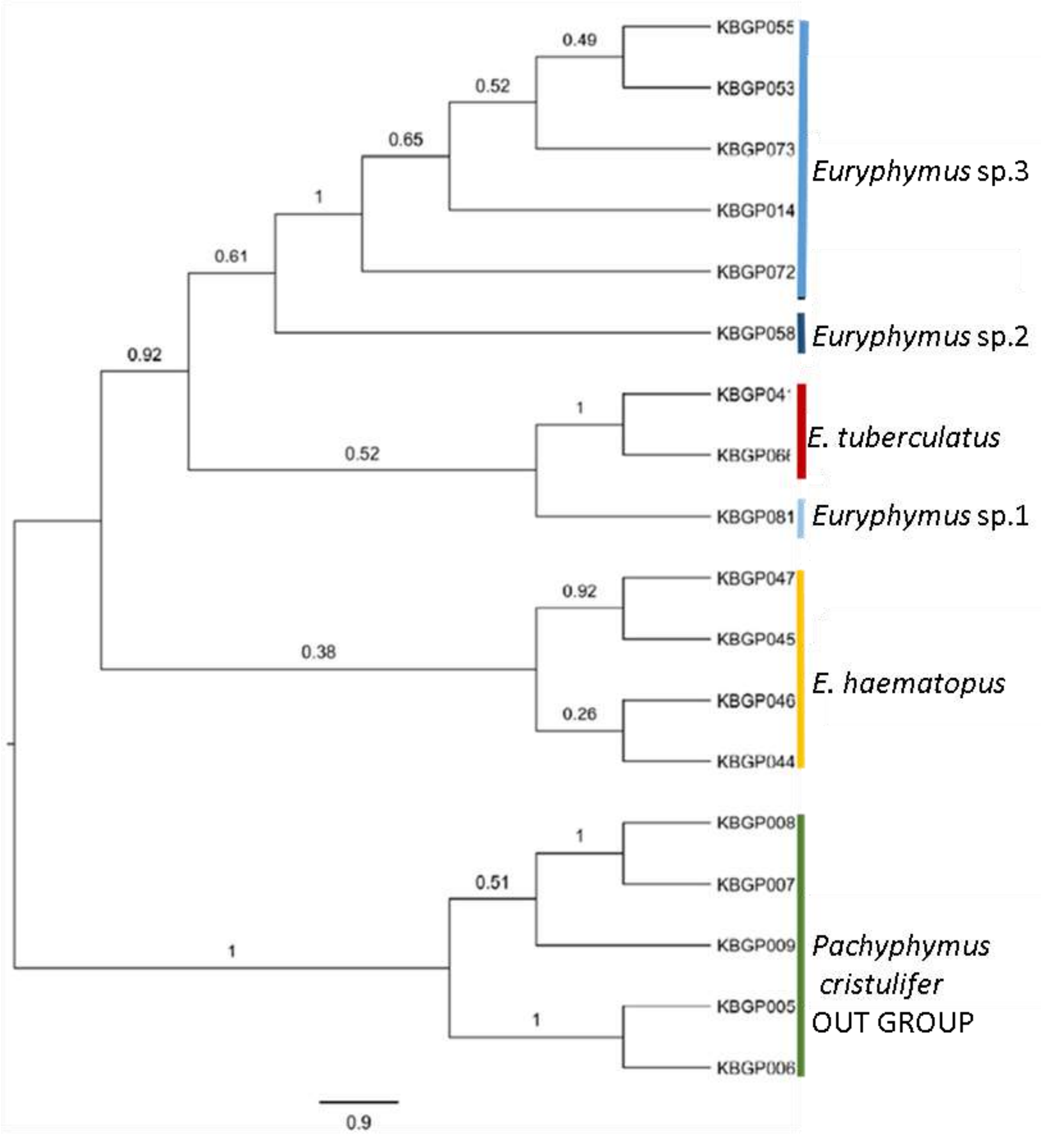

Figure 3. Bayesian Phylogenetic analysis based on mtDNA COI in of 13 male *Euryphymus* specimens and five *Pachyphymus* specimens as outgroup. Numbers on branches indicate posterior probabilities.

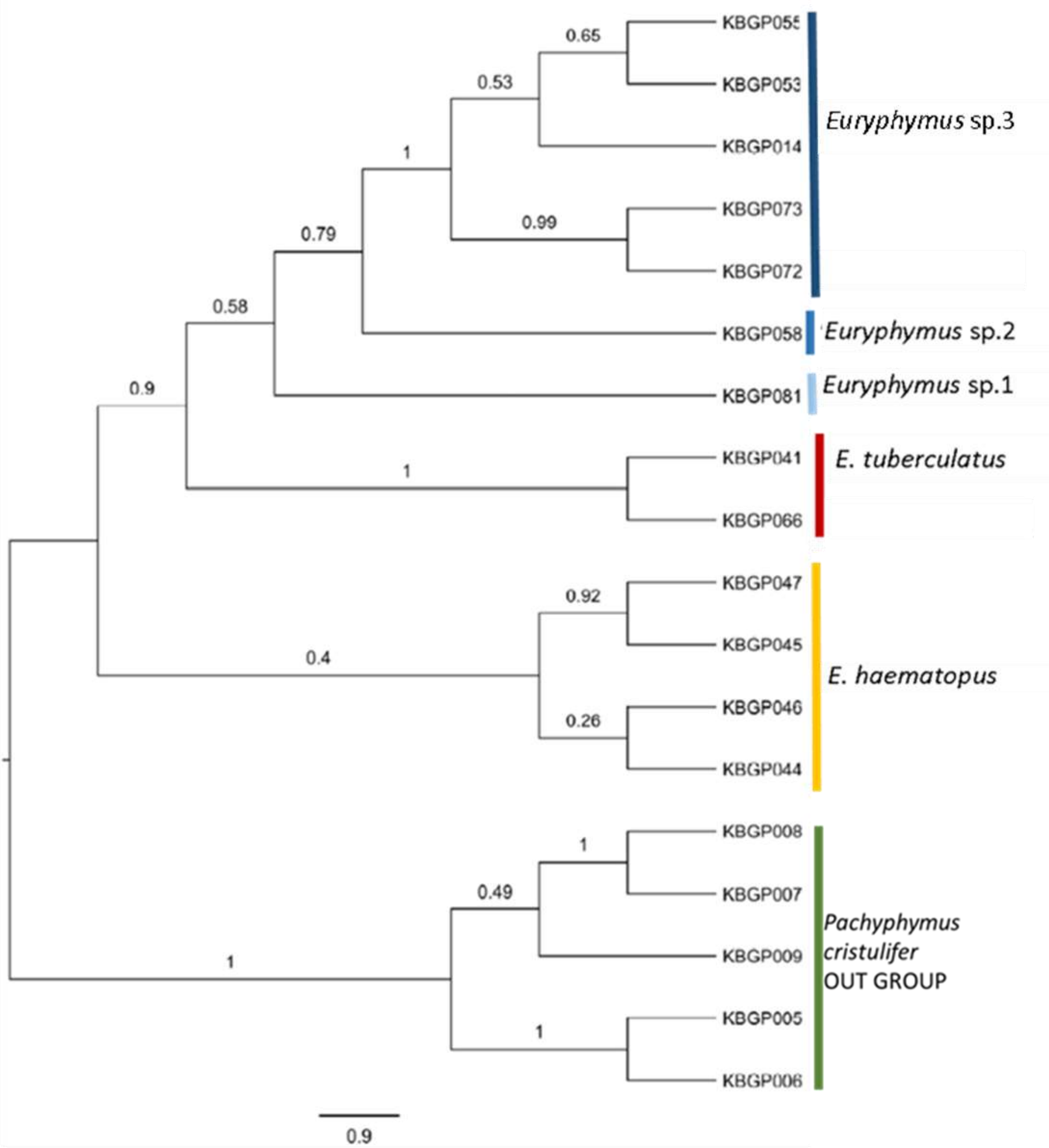

Figure 4. Phylogenetic analysis (consensus tree) based on both mtDNA COI and morphology of 13 male specimens and five *Pachyphymus* specimens as outgroup in Bayesian frameworks. Numbers on branches indicate posterior probability.

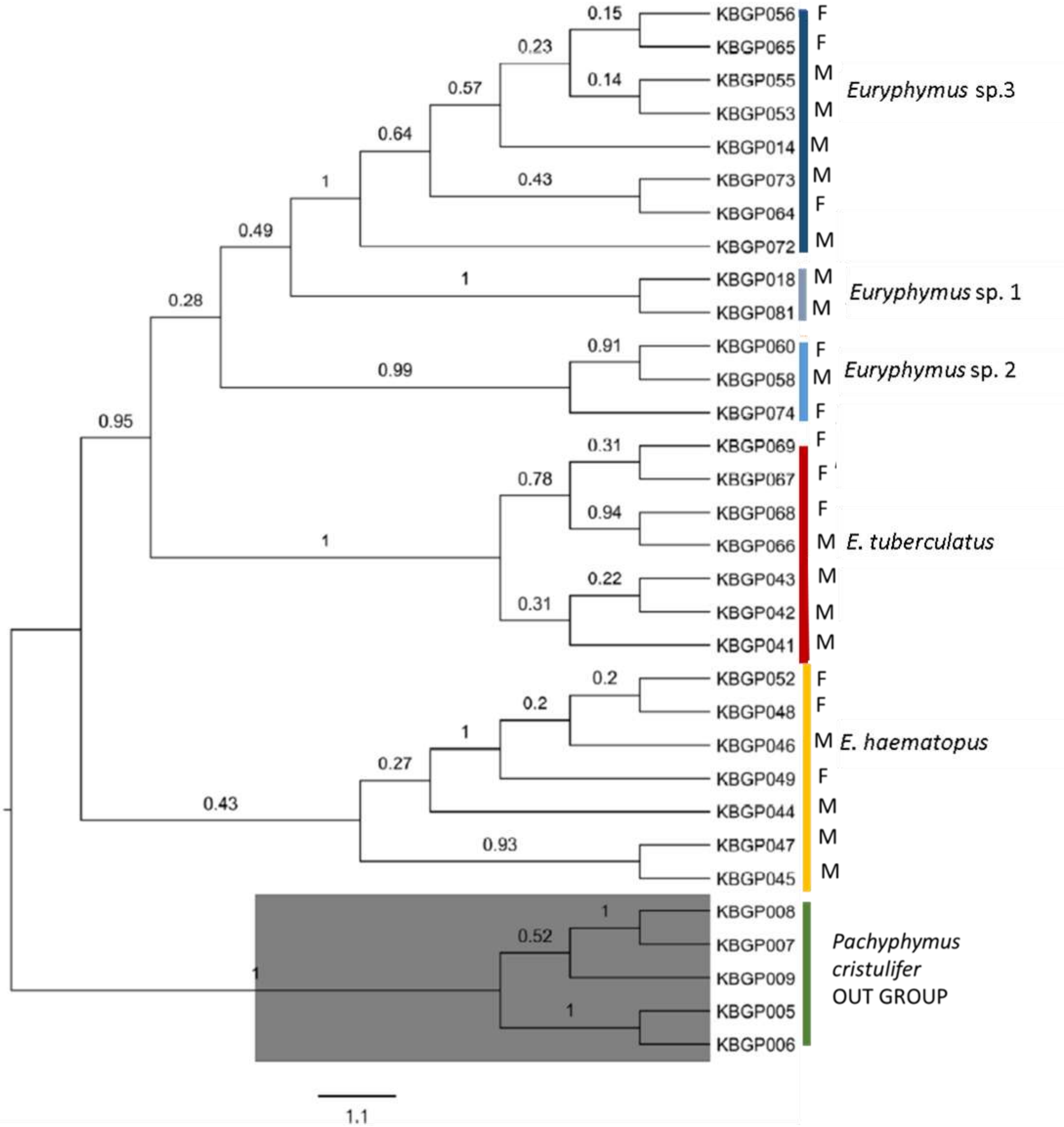

Figure 5. Phylogenetic analysis based on mtDNA COI of 27 male and female *Euryphymus* morphospecies in Bayesian frameworks. Numbers on branches indicate posterior probability. M = male, F = female.

Table 1. *Euryphymus* specimens used in this study including their BOLD accession numbers. Only males were included in morphological analyses, which took into account male characters only.

Taxon	Bold accession Number	Subfamily	Genus	Species	Sex	Locality
Ingroup	KBGP14	Euryphyminae	*Euryphymus*	sp.3	Male	Rooi draai (P8)
	KBGP18	Euryphyminae	*Euryphymus*	sp.1	Female	Plains of Camdeboo (P5)
	KBGP41	Euryphyminae	*Euryphymus*	*tuberculatus*	Male	Kgalagadi (Kg)
	KBGP42	Euryphyminae	*Euryphymus*	*tuberculatus*	Female	Kgalagadi (Kg)
	KBGP43	Euryphyminae	*Euryphymus*	*tuberculatus*	Female	Kgalagadi (Kg)
	KBGP44	Euryphyminae	*Euryphymus*	*haematopus*	Male	West coast (WC)
	KBGP45	Euryphyminae	*Euryphymus*	*haematopus*	Male	West coast (WC)
	KBGP46	Euryphyminae	*Euryphymus*	*haematopus*	Male	West coast (WC)
	KBGP47	Euryphyminae	*Euryphymus*	*haematopus*	Female	West coast (WC)
	KBGP48	Euryphyminae	*Euryphymus*	*haematopus*	Male	West coast (WC)
	KBGP49	Euryphyminae	*Euryphymus*	*haematopus*	Female	West coast (WC)
	KBGP52	Euryphyminae	*Euryphymus*	*haematopus*	Female	West coast (WC)
	KBGP53	Euryphyminae	*Euryphymus*	sp.3	Male	Kalk dam (P6)
	KBGP55	Euryphyminae	*Euryphymus*	sp.3	Male	Kalk dam (P6)
	KBGP56	Euryphyminae	*Euryphymus*	sp.3	Female	Popelierbos (P14)
	KBGP58	Euryphyminae	*Euryphymus*	sp.2	Male	Saltpansdrifttrust (P2)
	KBGP60	Euryphyminae	*Euryphymus*	sp 2	Female	Saltpansdrifttrust (P2)
	KBGP64	Euryphyminae	*Euryphymus*	sp.3	Female	Popelierbos (P14)
	KBGP65	Euryphyminae	*Euryphymus*	sp.3	Female	Popelierbos (P14)
	KBGP66	Euryphyminae	*Euryphymus*	*tuberculatus*	Male	Saltpansdrifttrust (P2)
	KBGP67	Euryphyminae	*Euryphymus*	*tuberculatus*	Female	Plains of Camdeboo (P5)
	KBGP68	Euryphyminae	*Euryphymus*	*tuberculatus*	Female	Rooi draai (P8)
	KBGP69	Euryphyminae	*Euryphymus*	*tuberculatus*	Female	Popelierbos (P14)
	KBGP72	Euryphyminae	*Euryphymus*	sp.3	Male	Popelierbos (P14)
	KBGP73	Euryphyminae	*Euryphymus*	sp.3	Male	Popelierbos (P14)
	KBGP74	Euryphyminae	*Euryphymus*	sp.2	Male	Rooi draai (P8)
	KBGP81	Euryphyminae	*Euryphymus*	sp.1	Female	Plains of Camdeboo (P5)
Outgroup	KBGP05	Euryphyminae	*Pachyphymus*	*cristulifer*		
	KBGP06	Euryphyminae	*Pachyphymus*	*cristulifer*		
	KBGP07	Euryphyminae	*Pachyphymus*	*cristulifer*		
	KBGP08	Euryphyminae	*Pachyphymus*	*cristulifer*		
	KBGP09	Euryphyminae	*Pachyphymus*	*cristulifer*		

Table 2. A list of character and states of different *Euryphymus* species investigated in this study.

#	**CHARACTER**
1	Overall body colour (integument)
	(0) strongly rugose n sparsely hairy
	(1) smooth
	(2) tuberculate n sparsely hairy
	(3) sparsely hairy
2	Body thickness - general impression
	(0) Small
	(1) medium
	(2) robust
4	Frontal ridge
	(0) shallow to deep sulcus
	(1) sulcate
	(2) flat
5	Pronotum integument
	(1) strongly rugose
	(2) smooth
	(3) tuberculate
	(4) sparsely hairy
6	shape of lateral carinae
	(0) straight
	(1) excurved
7	Posterior margin of pronotum
	(0) obtuse angular
	(1) Acute angular
	(2) slightly excurved
8	Hind tibia colour
	(0) yellow
	(1) red
	(2) with a blue spot on the base
9	Black mark at basal end of tibia
	(0) present

	(1) absent
10	Supra anal plate
	(0) without any basal tubercle
	(1) with one black basal tubercle
	(2) with two black basal tubercles
11	finger-like projection on the supra anal plate
	(1) Short
	(2) long
	(3) medium
12	shape of male cercus
	(0) strongly widened
	(1) not wide
	(2) stump-like
13	curve on apex of male cercus
	(0) not excurved
	(1) slightly excurved
	(2) upcurved

Table 3. Genetic distances for intraspecific variation of ten morphospecies of *Euryphymus* resulting from the K2P model in MEGA 4.

Species	Genetic distance
Euryphymus sp.2	0.003137278
Euryphymus sp.3	0.005222909
Euryphymus haematopus	0.009707683
Euryphymus tuberculatus	0.003135696
Euryphymus sp.1	0.009438362
outgroup	0.035116688

Table 4. Pairwise genetic distances for interspecific variation of ten morphospecies of *Euryphymus* resulting from the K2P model in MEGA 4.

Species	Genetic distance					
	[1	2	3	4	5	6]
[1] [*Euryphymus* sp.2]						
[2] [*Euryphymus* sp.3]	0.03					
[3] [*Euryphymus haematopus*]	0.03	0.05				
[4] [*Euryphymus tuberculatus*]	0.03	0.04	0.04			
[5] [*Euryphymus* sp.1]	0.03	0.04	0.04	0.03		
[6] [outgroup]	0.10	0.11	0.10	0.11	0.11	

CHAPTER 4

Biodiversity of the Karoo agile grasshoppers (Acrididae: Euryphyminae)

Abstract

South Africa's Karoo biome is an arid semi-desert which has been under sampled in comparison with South Africa's other habitats. Museum records show that the Euryphyminae, a small, under-studied African subfamily of grasshoppers, may be speciose and diverse in the Karoo. Previous studies on Euryphyminae mainly focused on taxonomy and no ecological study has ever been conducted. Therefore, the aim of this study was to investigate the diversity of Euryphyminae in the southern Karoo over space and time. Euryphyminae were sampled across 18 sites and over two seasons in the southern Karoo. Environmental variables were measured randomly using vegetation surveys and variables were correlated with Euryphyminae species richness, abundance and seasonal population dynamics. Differences in species richness and abundance among sampling seasons and sites were assessed. Multivariate ordination techniques were used to investigate correlations between species composition and environmental variables. Euryphyminae were abundant and speciose in the sampled Karoo region and ten of the 23 known genera were collected. Species composition varied over space and time and most species seemed to be localized to a relatively small area and specific season. Proportions of bare ground and dead vegetation were both negatively correlated with the ordination space, while short grass and tall grass were both positively correlated. Although much more work is needed to better understand the dynamics of the Euryphyminae in the arid and sparsely vegetated Karoo environment, this study indicates that they are uniquely suited for this habitat and that they may be an important component of the total biodiversity.

Introduction

The arid regions of southern Africa are situated in the western part of the continent, approximately to the west of 27 ºE and north of 34 ºS (Desmet and Cowling 1999). This area is bounded on the west by the cold Atlantic coastline, in the south by the winter rainfall fynbos biome and evergreen forest as well as by arid and mesic savannas in the north and east. The flora and fauna of the Karoo also includes biodiversity elements from the surrounding biomes (Dean and Milton 1999).

The Karoo is divided into two biomes (Nama Karoo and Succulent Karoo) on the basis of their aridity (Cowling 1986) and vary in terms of their climate, soil and landform (Dean and Milton 1999). These biomes occupy the smallest surface area on Earth (Nama Karoo is 19.5% and Succulent Karoo 6.5%) but are the most species rich arid areas in the world. They contain most of the world's succulent plants, with 1589 (16%) succulent species recorded in the Succulent Karoo from of the world's 10 000 total estimated succulents (Rutherford et al. 2006).

The Succulent Karoo and Nama Karoo biomes vary in terms of their geology and climate which determines the structure and composition of their vegetation (Dean and Milton 1999). The Succulent Karoo, which receives more annual rainfall, has greater plant diversity than the Nama Karoo (Mucina et al. 2006; Beukes et al. 2002). Generally, there is a positive correlation between plant diversity and the amount of rainfall in an area (Lombard et al. 1999).

Biodiversity in the Karoo biome is poorly surveyed mainly due to lack of easy access. The density of roads across the Karoo is low and all roadways are lined with fences delimiting the private property of the farms, creating a physical barrier to accessing the majority of Karoo vegetation. These physical constraints increase sampling effort necessary in order to conduct biodiversity surveys, thereby reducing the probability of collecting more species, either endemic or common (Botts et al. 2011).

Grasshoppers in the Karoo are mostly found inhabiting dwarf Karoo shrubs and rocky or bare ground (Bazelet and Naskrecki 2014). The Karoo environment makes them difficult to spot because they camouflage with it and the sparse dwarf vegetation allows them good visibility to spot their predators (Bazelet and Naskrecki 2014). The only Orthoptera that is relatively well studied in the Karoo is the brown locust, *Locustana pardalina*

(Orthoptera: Acrididae: Oedipodinae), due to its propensity to swarm and pose an economic threat to regional farmers (Henschel 2015).

The Euryphyminae are a small, African subfamily of grasshoppers which are not very well known, even among orthopterists. Based on historic museum collections, Euryphyminae seem to be arid region specialists (Bazelet and Naskrecki 2014) and are expected to have high levels of endemism in the arid Karoo as compared to other insect taxa, although this has never been explored. The group is most easily recognized by the species-specific, unusual and elaborate shape of the male cercus, which is most similar, but still distinct, from that of the Calliptaminae (Dirsh, 1956). Currently there are 23 genera recognised within the Euryphyminae (Bazelet and Naskrecki 2014), and 69% of these (14 genera) were known to occur in South Africa prior to the present study (Cigliano et al. 2017).

Here, I investigate Euryphyminae biodiversity in the southern Karoo in order to: (1) assess differences in Euryphyminae (agile grasshoppers) abundance, richness and composition over space and time; and (2) to investigate the correlation between vegetation cover and species abundance. Given rainfall patterns in the Karoo, I expect that Euryphyminae will be more speciose and abundant after or during a rainy season.

Methods

Study area

Fieldwork was carried out in the southern Karoo in the area targeted for shale gas exploration as part of the South African National Biodiversity Institute (SANBI) Karoo BioGaps project. The targeted area includes a small portion of the Succulent Karoo but the majority is within the Nama Karoo and the three biomes which border the Karoo (Fynbos, Grassland and Albany thicket biome) (Fig.1).

Euryphyminae sampling protocol

Field work was carried out in two consecutive years, in two different seasons, October 2016 (austral spring) and March 2017 (austral autumn).

Thirty 1 km × 1 km sites within the targeted area were selected by the organizers of the Karoo BioGaps project for sampling (Fig. 1). Of these thirty, six sites were selected for repeat sampling in both seasons. The remaining twenty-two sites were sampled once – either in one season or the other, but not in both seasons. Within each site, three small quadrats of 50 m × 50 m were selected to represent the range of meso- and microhabitats available at the site (e.g. a slope, a river bed, a koppie, etc.) (Fig. 1). Each quadrat was surveyed twice, once in the morning and once in the afternoon, for half an hour each time by two people, culminating in 216 hours of sampling in total (30 sites [24 sites sampled once + 6 replicated sites (6 sites x 2 seasons)] x 3 quadrats per site x 2 sampling events x 2 collectors x 30 minutes per sample). Sampling occurred on non-windy days with low cloud cover between 7:00 - 17:00.

The box quadrat method was used, as opposed to random surveying, in order to enable estimation of grasshopper density and abundance and to standardize among sites for a biodiversity survey (Gardiner et al. 2005). A large 50 m x 50 m quadrat was large enough to encompass strong fliers as opposed to a small quadrat wherein some grasshoppers would fly out (Bazelet and Samways 2011).

Sampling was done by using two methods. The first was a “flushing” method where two collectors walked through the quadrat slowly while holding a sweep net. When a grasshopper was disturbed by the walking observer, it jumped or flew to escape, and drew attention to itself and was chased and caught. The second was sweep netting. Twelve minutes of the total hour were spent in standardized sweep netting of regular forward and backward strokes over vegetation. The sweep net was emptied after 20 strokes. Inclusion of this method allowed for the detection of the very small proportion of grasshoppers (estimated ~10%) which do not flush readily when disturbed (Bazelet and Samways, 2011). The proportion of sweep netting was equivalent to the estimated proportion of non-flushing grasshoppers (30 minutes x 2 events x 2 people = 120 people minutes of active searching per 50 m x 50 m plot; 10% = 12 people minutes).

During fieldwork, collected specimens were placed individually in plastic Zip-loc bags which were labelled with site and date information. At night, plastic bags were placed directly into a freezer and remained there for a minimum of 2-3 days to kill specimens. Then, specimens were sorted from the plastic bags into labelled paper envelopes for drying and subsequent pinning.

After each fieldwork session, all specimens were pinned and an individual specimen code was assigned to each specimen. These were entered into an Excel spreadsheet in Darwin Core format together with locality information. At the end of both field trips all specimens were examined using a microscope and identified to species level using existing keys, especially the key found in Dirsh (1956).

Environmental variables

For sampling environmental variables, we adapted methods used by Bazelet and Samways (2011). Only structural diversity of vegetation was surveyed because grasshopper species respond to vegetation cover or structure rather than plant species (Bazelet and Samways 2011). Vegetation type was measured along ten, 5 m transects positioned randomly within each 50 m x 50 m quadrat. Ground cover was grouped into the following categories: tall grasses (>30 cm), short grasses (<30 cm), shrubs, trees, large rocks, gravel and bare ground. From these data, we calculated the proportion of each vegetation category at a site. I also measured vegetation height at 30 random points throughout each quadrat. Randomization for vegetation surveys was accomplished by one observer walking in a random direction while the other had their back turned. Without looking the second observer would call out to stop and that point would have its vegetation height measured.

Statistical analysis

I first tested whether sampling was sufficient by constructing species accumulation curves in EstimateS (Colwell 2009) and plotting species by number of individuals. If this curve approaches an asymptote, sufficient sampling was conducted and even with additional sampling we would not expect to encounter significantly more species (Colwell 2009). To show species dominance/evenness I plotted rank abundance curves in Excel (Microsoft Office Excel 2017) (Magurran 2004). I then characterised grasshopper community differences among the various sites, by calculating species richness, grasshopper abundance and the Shannon-Wiener Diversity index (H') by hand in Excel 2007 (Fishel 2014). The Shannon-Weiner Diversity index is widely used when comparing diversity of different habitats and it assumes that individuals are randomly sampled from an independent large population and all the species are represented in the sample (Bibi and Ali 2013; Clarke and Warwick 2001).

To detect differences among sampling seasons, I focused on only those six sites which were sampled in both seasons. Since abundance and species richness data were not normally distributed (Shapiro Wilk's test $W = 0.01$, $P > 0.05$), I used a Mann-Whitney U test to assess differences in species richness and abundance among sampling seasons in Statistica v 13.2 (StatSoft 2009). Kruskal–Wallis tests in Statistica (StatSoft 2009) were used to analyse differences among sites.

To investigate the similarity between species composition and environmental variables I used two ordination techniques. Non-metric multidimensional scaling analysis (NMDS) is an unconstrained ordination technique which plots samples on an ordination space based on a species x samples dissimilarity matrix. Environmental variables can then be correlated with the ordination space and projected onto it, but are not used in the calculation of similarity among assemblages. Moreover, I used a constrained correspondence analysis (CCA), which is a technique in which environmental variables are taken into account together with the species assemblage at a given site to determine the similarity/difference among sites.

To calculate these ordinations, site pairs must have a total number of specimens >0 because this value is in the denominator of the Bray-Curtis calculation, and must have positive Bray-Curtis dissimilarity >0. Thirty-two of the 105 quadrats had no Euryphyminae specimens at all and four site pairs had identical species assemblages (Bray-Curtis dissimilarity = 0), so one of the sites in the pair was removed from the dataset at random. Therefore, only 69 of the 105 sampled quadrats could be used in these analyses.

NMDS was run using a Bray-Curtis dissimilarity matrix using function *metaMDS* in the package *vegan* in R version 2.3.0 (R Core Team 2014). Environmental variable vectors were fitted on the ordination space using the function *envfit* in the package *vegan*. CCA was plotted using function *CCA* in *vegan*. I created two dimensional plots of NMDS and CCA outputs by plotting the first and second significant axes relative to each other (Oksanen 2015).

Results

Population estimates

Overall, 1626 individual grasshoppers were collected at 30 sites, of which 476 individuals at 18 sites were from the Euryphyminae subfamily. Twenty-six Euryphyminae species from 11 genera were collected (Fig. 2, Table 1 see thesis Chapter 2).

The overall sample completeness for the 18 sites was very low, the curve did not reach an asymptote (Fig. 3) meaning sampling was not exhaustive. Estimated species richness was 31 and the observed species richness was 26. The rank abundance curve shows that the most abundant species was *Rhachitopis nigripes* followed by *Calliptamicus semiroseus* and the least abundant species was *Calliptamicus antennatus, Euryphymus* sp. 11 and sp.12 (Fig. 4).

Among sites comparison

Species richness per site varied from one to seven with a median value of three (3). Euryphyminae abundance ranged from 4 to 30 with a median of five (5). Species richness (Kruskal Wallis test: $H = 57.7$, $P < 0.001$) and abundance (Kruskal Wallis test: $H = 59.7$, $P < 0.001$) differed significantly among sites. Pairwise comparisons indicated that site P22 had significantly more species than site P6 (Kruskal Wallis test: $H = 57.7$, $P = 0.024$) and site P17 had significantly more species than site P7 (Kruskal Wallis test: $H = 57.7$, $P = 0.024$).

Among seasons comparison

From the 476 Euryphyminae specimens, 297 individuals (62% of individuals) from 16 species and eight genera were collected in the six sites that were sampled in both seasons. Overall sample completeness for season 1 was very low, the curve did not reach an asymptote (Fig. 5A). Estimated species richness was 15 while the observed species richness was 12. For season 2 estimated species richness was 14 while the observed was 10 and, the curve did not reach an asymptote (Fig. 5B). Species richness differed significantly among seasons, with season 1 having significantly higher species richness than season 2 (Mann-Whitney U- test: $U = 83.5$, $z = 2.47$, $P = 0.01$). Although the total number of specimens collected in season 1 ($n = 125$) was almost double that collected in season 2 ($n = 172$), median abundance did not differ significantly among seasons as season 2 had a far greater range of values collected per site than season 1 (Mann-Whitney U- test: $U = 129$, $z = 1.03$, $P = 0.30$) (Fig. 6).

Four species were collected in season 1 only, five species were collected in season 2 only, and four species were collected in both seasons, but at very low abundance in season 2 (Fig. 7). Grasshopper assemblages reflected seasonal variation in species influenced by climate which directly influence food availability, the more the rainfall the more food is available (Fig.8).

Correlation of environmental variables with Euryphyminae community

The NMDS plot showed weak ties between species and sites, with stress = 0.09. Vectors of environmental variables fitted onto the ordination space showed that the proportion of bareground (r^2 = 0.31, P < 0.001), short grass (r^2 = 0.26, P < 0.001), tall grass (r^2 = 0.18 P < 0.01), and dead vegetation (r^2 = 0.09, P = 0.03) were significantly correlated with species assemblages (Table 1, Fig. 9). Proportions of bare ground and dead vegetation were both negatively correlated with the ordination space, while short grass and tall grass were both positively correlated.

The total CCA model inertia of 10.12 and 2.08 (or 20.52% of the total inertia) was accounted for by the constrained axes. The first three constrained axes accounted for 33.5, 21.9 and 14.5% of the variability in the data, respectively.

Discussion

Results of this study show that Euryphyminae communities in the Karoo biome are diverse, speciose, and localized. In only two months of sampling in 18 sites within a relatively limited region of the Karoo biome, I collected ten genera of Euryphyminae. Given that only 23 genera of Euryphyminae were previously described in the world, this result indicates that Euryphyminae are relatively speciose and abundant, and most likely also partially endemic, in the Karoo biome. In order to confirm this conclusion, comparative data for other flora and fauna of the Karoo would be necessary, data which are lacking at present.

This high diversity of Euryphyminae in the Karoo could most likely be attributed to specialized characteristics which make the Euryphyminae uniquely adapted to this arid and sparsely vegetated habitat. Grasshopper assemblages strongly respond to structural diversity as it provides different microhabitats (Gebeyehu and Samways 2006; Matenaar et al. 2015). In South Africa's grassland biome, the proportion of shrubs and grasses was significantly correlated with species richness because of the higher abundance of their food plants (Bazelet and Samways 2011). However, in the case of Euryphyminae of the Karoo, the strongest correlation was between a high proportion of bareground and greater species abundance. Euryphyminae most likely utilize the bareground for thermal regulation (basking during daylight hours) and as a vantage point to see oncoming predators. Indeed their colouration is strongly suited to camouflage with bare soil. Many Euryphyminae species also possess colourful structures in discrete areas which are flashed during mating displays such as in the interior of the hind femur and hind wing. The dark substrate of bareground may serve as an effective background for emphasis of the colourful features. Together, these clues indicate that Euryphyminae may be uniquely adapted to the arid habitat and sparse vegetation of the arid Karoo biome.

The sites with the highest species richness clustered in the centre of the sampling region, because they were sampled twice (Fig. 9), the more the sampling effort the more the probability of encountering more species. The sites with the lowest species richness were sampled once. The proportion of dead vegetation and tall grass strongly correlated with species richness too (Fig. 9A-B). *Euryphymus* sp. 1 closely correlated with a high proportion of dead vegetation. The proportion of tall grass strongly correlated with *Rhachitopis nigripes*, which was more abundant in the second season (Austral autumn) in the grassland.

Sampling six sites repeatedly in two seasons provided a positive indication that there are at least two distinct seasons of abundance for Euryphyminae in the Karoo biome, similarly to other regions of South Africa (Bazelet and Samways 2011). Although grasshopper abundance did not differ significantly among the two seasons, the species composition of any given site was different in season 1 than it was in season 2. Austral autumn had significantly greater species richness than austral spring, with a median species richness of 2.7 species per site in autumn versus 1.2 species in the spring. Although Euryphyminae are highly mobile with strong flight and jumping capabilities, it seems that the distribution of individual species remains confined to specific areas and that most species have a relatively localized distribution. The lack of rainfall in austral autumn could have contributed to the season having less species as compared to austral spring, this factor has been shown to limit population increase in acridids in semiarid regions, due to limited food resources (Hunter et al. 2001).

Euryphyminae seemed to have increased population size during the rainy season when they had more food availability. This is also the case with locusts which tend to have population outbreaks with increased food availability (Hunter et al. 2001). Most species in the Karoo are expected to correlate or to be influenced by rainfall, which was what we expected with the Euryphyminae- the more rainfall the larger the population size.

Conclusion and recommendations

This study clearly highlights how poorly surveyed the Karoo Orthoptera are and how diverse the Euryphyminae are in the southern Karoo. In the two months that I sampled, I was able to collect half of the Euryphyminae genera described (ten out of 23 genera). These findings help to emphasize the importance of SANBI's Karoo BioGaps study. There is alot left to discover about Karoo biodiversity, especially in relation with other organisms. I strongly recommend a long-term study or survey of the Euryphyminae in the Karoo, and additional environmental variables to uncover the effect of various environmental variables, time and space on the diversity of the Euryphyminae and their population dynamics. In addition future research could focus on investigating how disturbance (i.e. grazing) and drought in the Karoo affect the diversity of the Euryphyminae. This study provides important baseline data for future research on the Euryphyminae.

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Table 1. Results from non-metric multidimensional scaling (NMDS) environmental variable vector fitting onto species and site ordination plot using 1000 permutations. NMDS1 and NMDS2 give direction cosines of the vectors, r2 gives the squared correlation coefficient, and p indicates significance level.

	NMDS1	NMDS2	r2	Pr(>r)
Bare ground (BG)	-0.23577	-0.97181	0.3085	0.000999 ***
Rock (R)	0.99998	-0.00654	0.0390	0.262737
Shrubs (SH)	-0.87098	-0.49131	0.0341	0.315684
Gravel (G)	-0.72358	0.69024	0.0215	0.490509
Dead vegetation (DV)	-0.43270	-0.90154	0.0872	0.028971 *
Short grass (SG)	0.54625	0.83762	0.2633	0.000999 ***
Tall grass (TG)	0.39735	0.91767	0.1824	0.002997 **
Trees (TR)	0.80370	0.59503	0.0465	0.154845

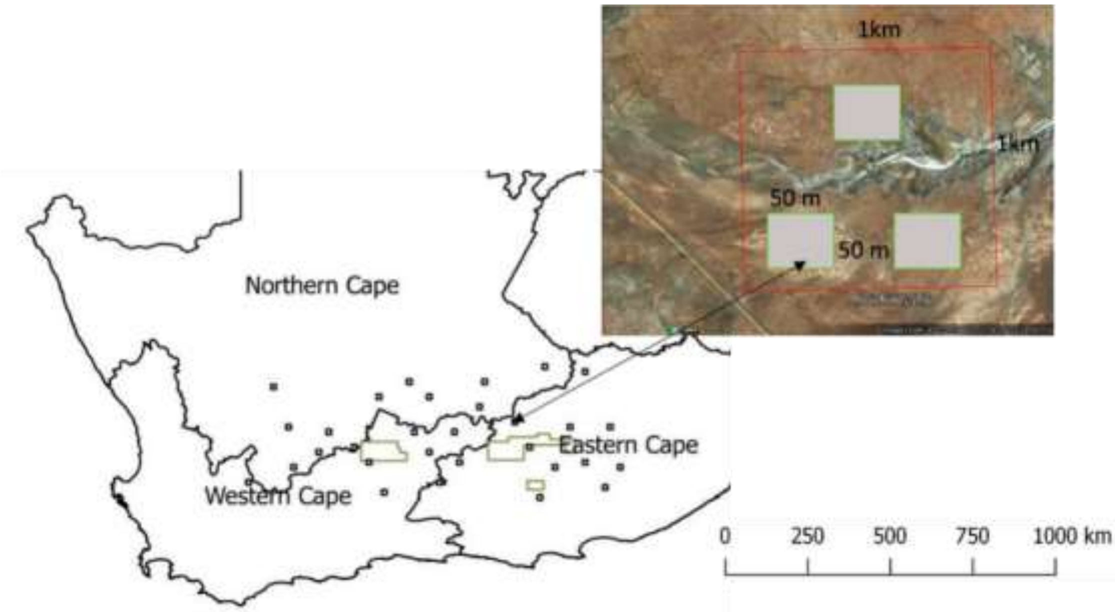


Figure 1. Map showing the study area situated in the southern Karoo in the area targeted for shale gas exploration, with each dot indicating a sampling site. The areas outlined in green are National parks which are excluded from the study sites as they are not considered for fracking activities. The inset indicates the quadrat sampling method employed in this study.

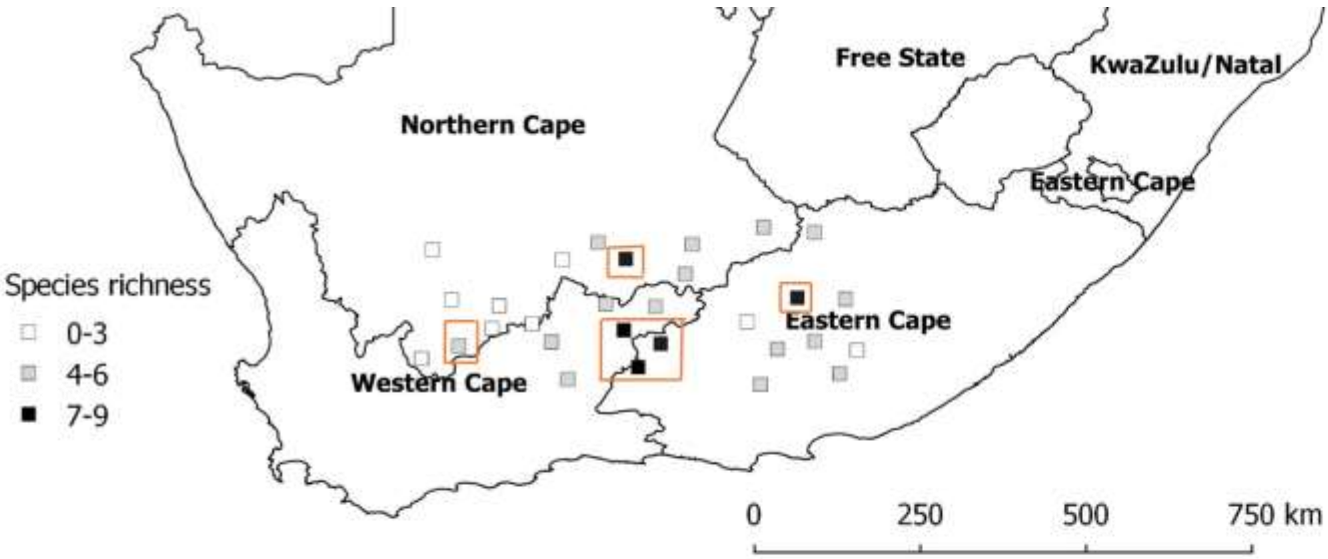


Figure 2. Overall species richness of the Euryphyminae at 30 sites sampled across the southern Karoo shale gas exploration area. Sites with a red outline represent the six sites which were sampled in both seasons.

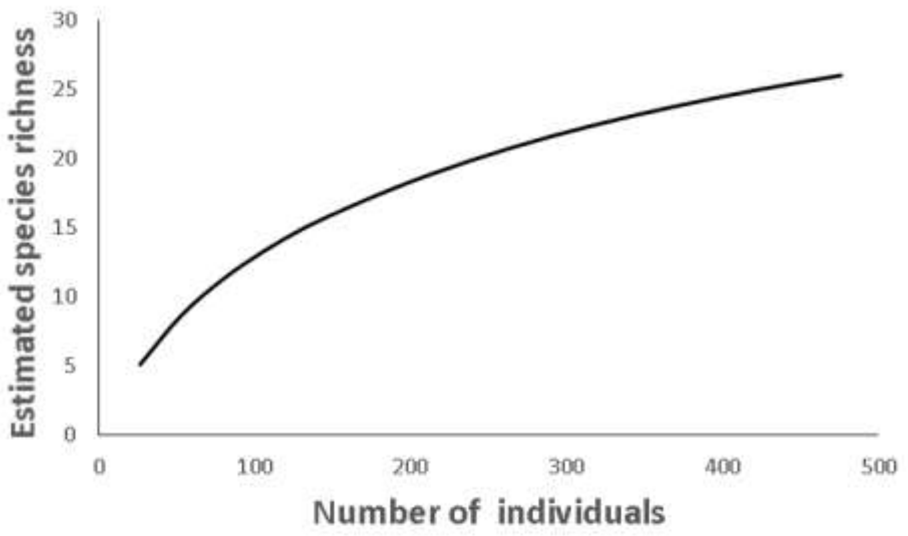


Figure 3. Overall species accumulation curve estimated in EstimateS for Euryphyminae sampled at 30 sites across the southern Karoo shale gas exploration area.

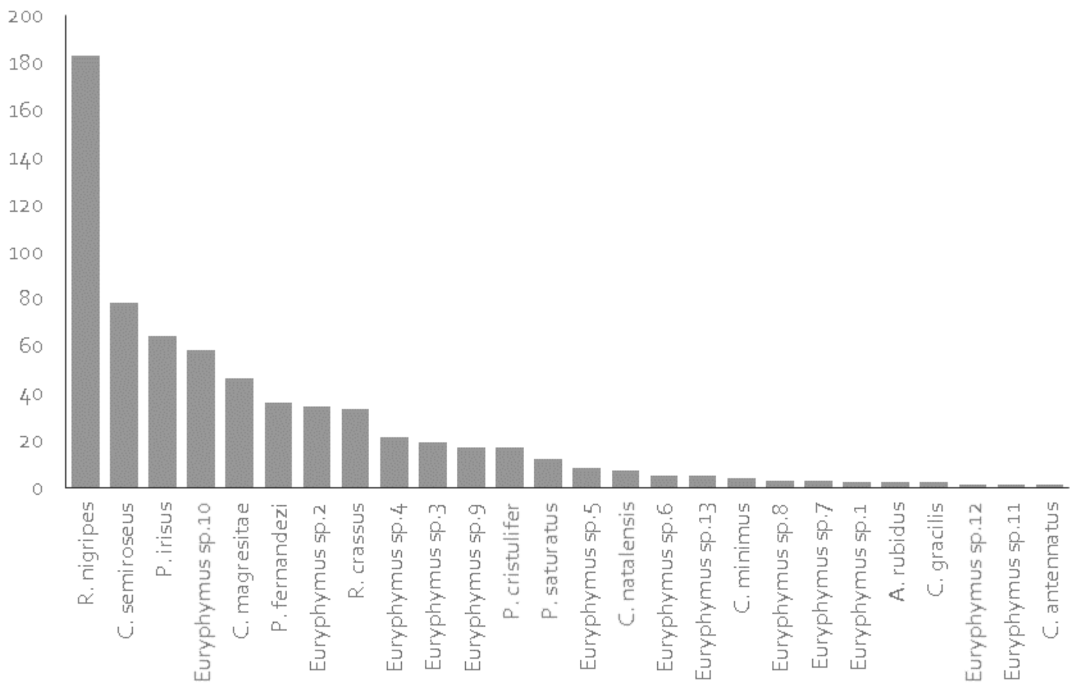
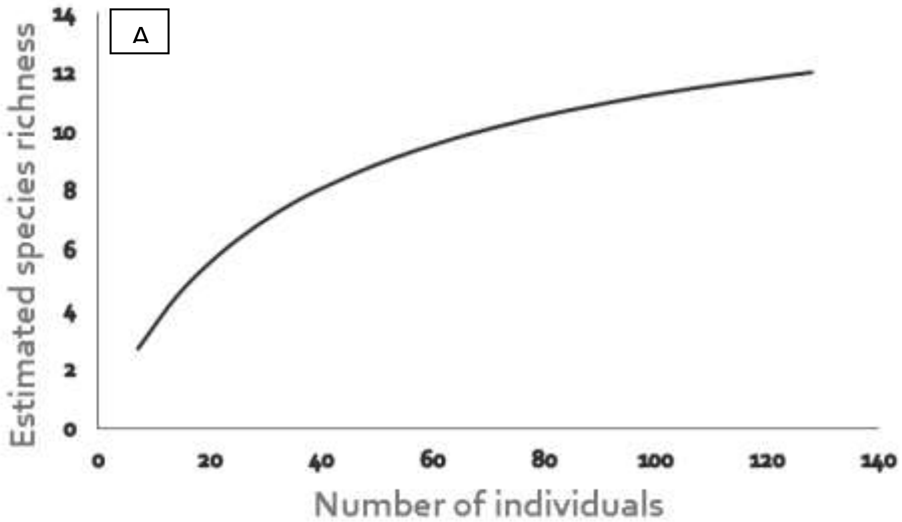


Figure 4. The rank abundance curve for Euryphyminae species collected at all sites (n = 18 sites).



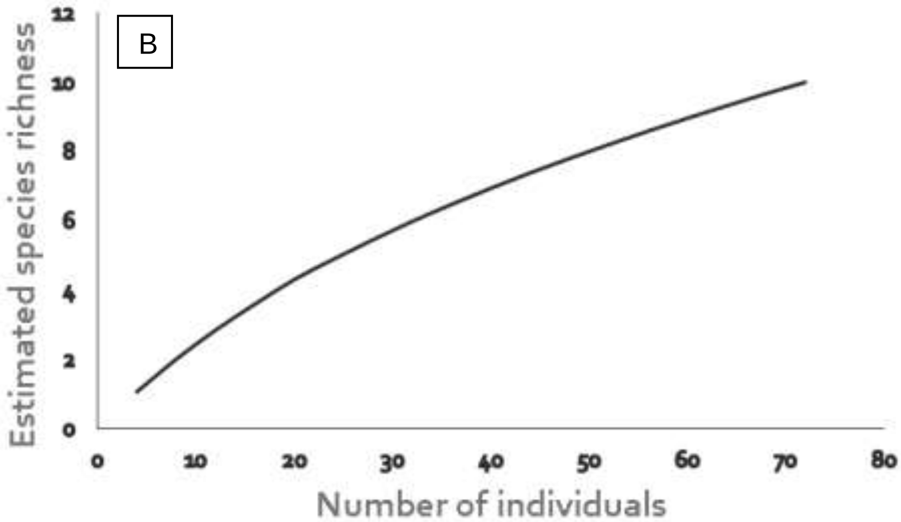


Figure 5. Species accumulation curves for season 1 (A) and season 2 (B) for Euryphyminae sampled across the southern Karoo shale gas exploration area separately.

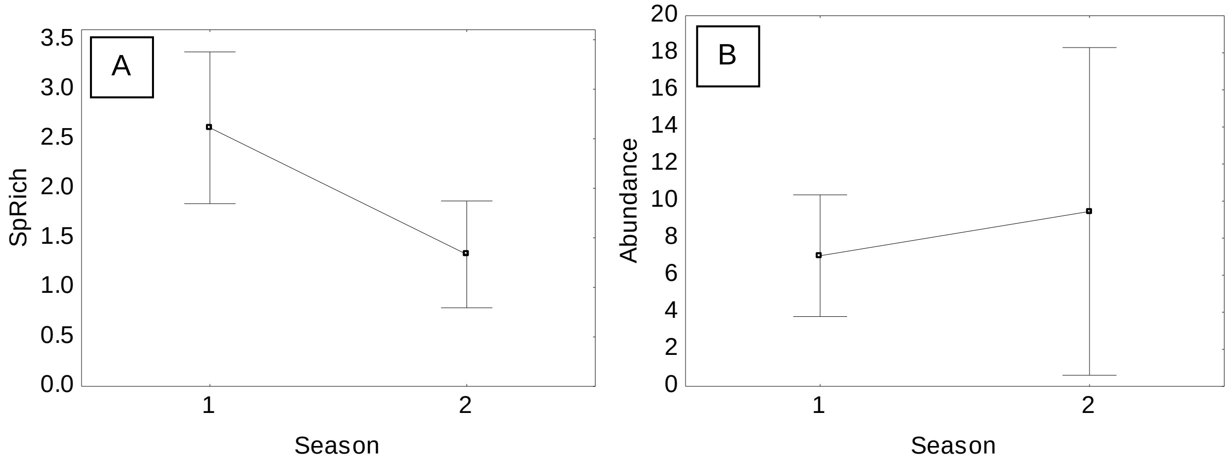


Figure 6. Seasonal variation in species richness (A) and abundance (B) of six sites sampled in two consecutive seasons (Austral spring and austral autumn) for Euryphyminae sampled across the southern Karoo shale gas exploration area.

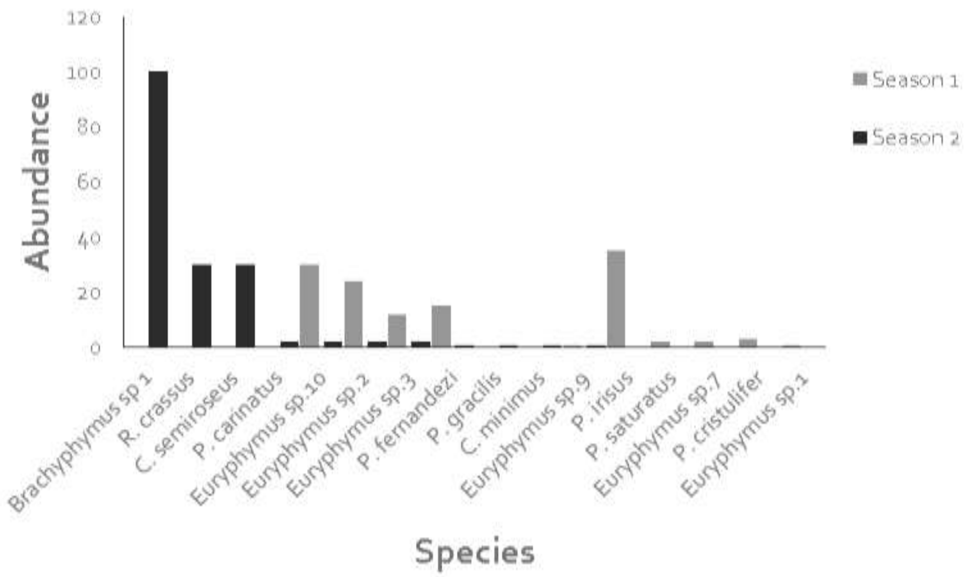


Figure 7. Species composition at six sites sampled twice in two seasons for Euryphyminae sampled across the southern Karoo shale gas exploration area.

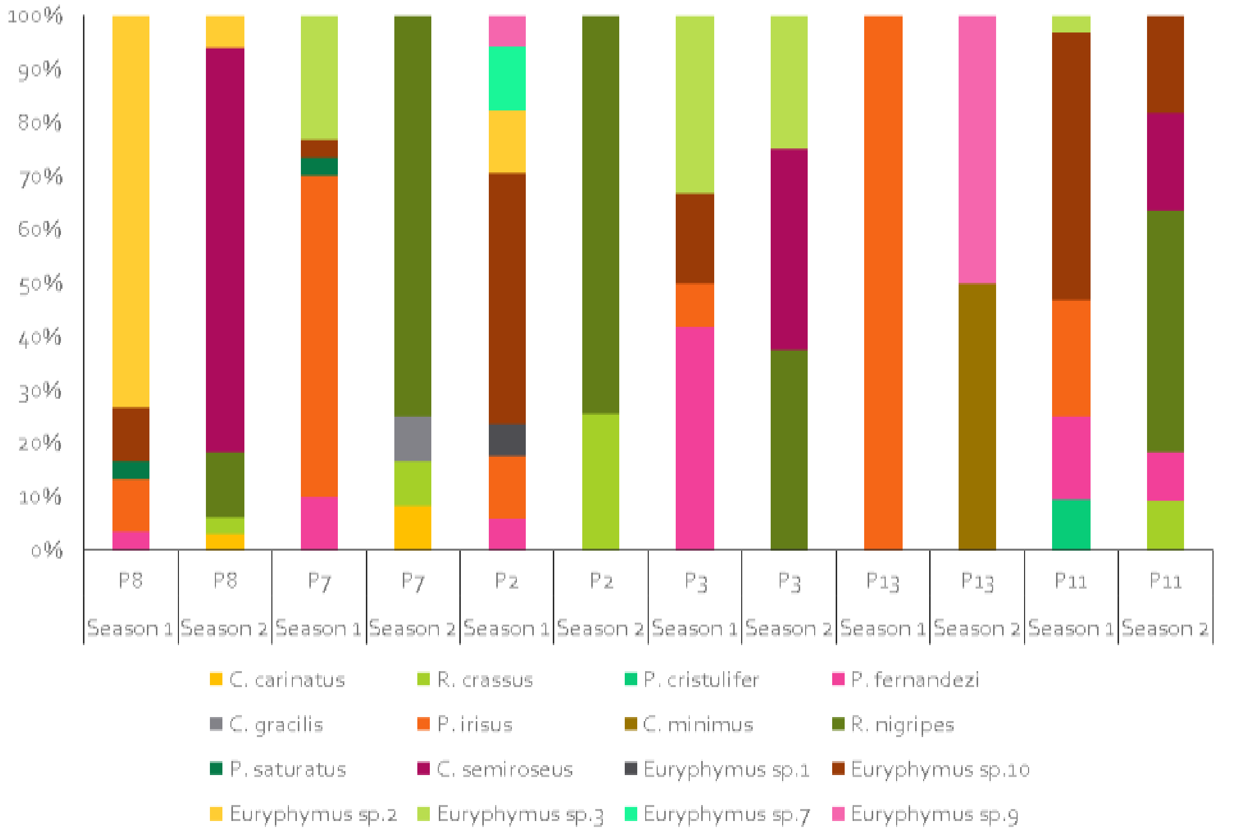


Figure 8. Differences in species assemblage structure over space (site) and time (season) for Euryphyminae sampled across the southern Karoo shale gas exploration

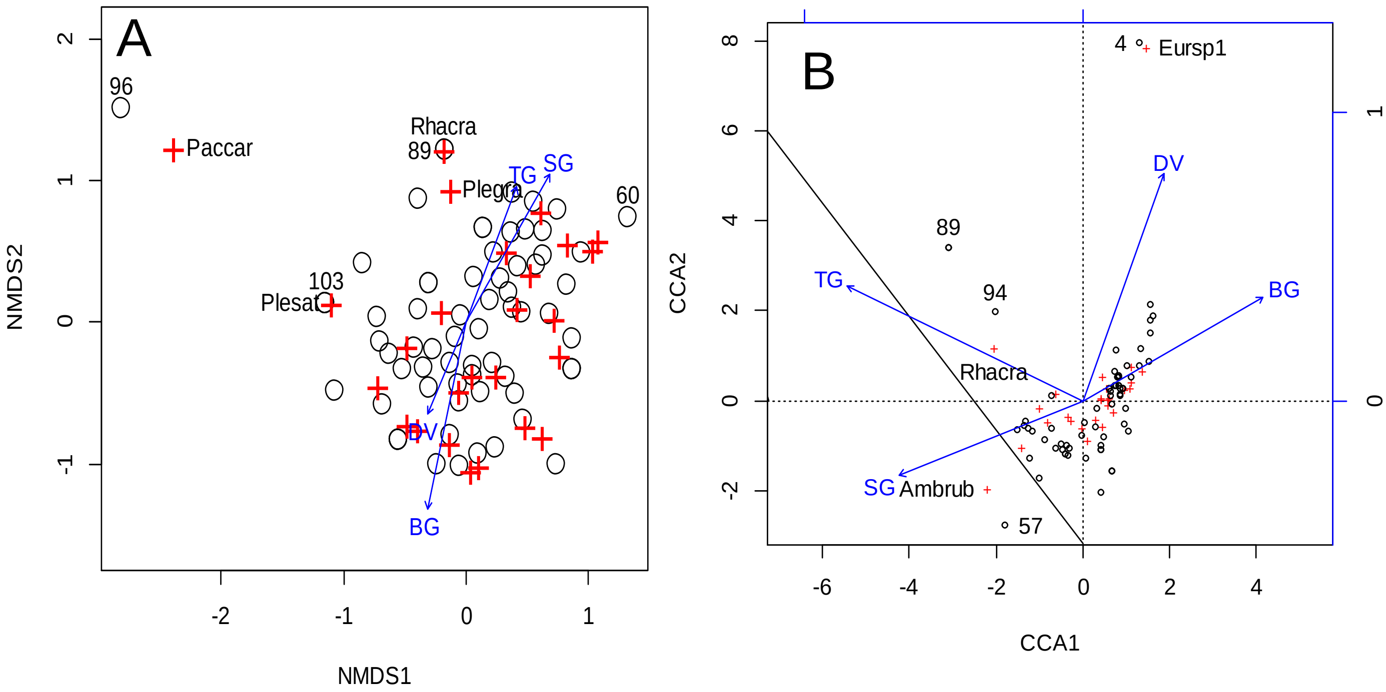


Figure 9. Ordination plot of non-metric multidimensional scaling (NMDS) analysis using Bray-Curtis dissimilarity matrix and 1000 permutations (A) and constrained correspondence analysis (CCA) (B) illustrating ordination of sites (black circles and numbers), species (red crosses and six-letter abbreviations) and environmental variables (blue arrows and two-letter abbreviations). Arrows point to the direction of the most rapid change in the environmental variable, length of the arrow is proportional to the correlation between ordination and environmental variable. Significant environmental variables include proportion of bare ground (BG), short grass (SG), dead vegetation (DV) and tall grass (TG). In NMDS, environmental variable vectors are correlated with the ordination space and fitted onto ordination. Only variables with over 95% fit to ordination are included. In CCA, environmental variables are utilized in calculation of ordination space.

CHAPTER 5

General discussion and future research recommendations

Euryphyminae grasshoppers are southern African endemic insects which are morphologically adapted to arid regions (Bazelet and Naskrecki 2014). The Karoo region provides the Euryphyminae with different ecological niches and enables them to adapt to their respective niches allowing them to diversify. Their taxonomy is complicated in such a way that even taxonomic keys to genera are not sufficient, they only work for male specimens. Morphologically, most taxonomists are not able to assign females to their conspecific males unless a mating pair was caught or males and females of the same species were caught in the same ecological niche. Using integrative taxonomy catalyses the species identification and delimitation process. This process involves the use of multiple data sets including DNA data, ecological data and morphological data. DNA barcoding is able to reveal information that morphology alone cannot reveal, for instance cryptic species or polymorphic species (Goldstein and DeSalle 2011; Schlick-Steiner et al. 2010).

Euryphyminae have high levels of intraspecific and low levels of interspecies variation so integrative taxonomy is very beneficial (Bazelet and Naskrecki 2014). Since Euryphyminae species are possibly found in distinct pockets of space and time due to the restrictive conditions of their arid environments, ecological characters are useful for species delimitation. Information presented here will act as a baseline for future studies on this group, as part of the Karoo BioGaps project, this will aid in government decision making plans for the management and conservation planning of the Karoo.

Chapter 2 – Review of South African Euryphyminae

Before this study, Euryphyminae had 23 genera worldwide, and only 14 genera had records of occurrence in South Africa. Few studies done on this group as a whole focused on reviewing the subfamily. Some reviewed and revised genera within the subfamily, but none ever discussed the imperfect taxonomy of this group in South Africa (the only similar study by Naskrecki (1992) did this for the Namibian species of Euryphyminae). Furthermore, this was the first study to use integrative taxonomy to investigate the relationship between the genera.

The results of Chapter 2 showed that the Euryphyminae was erected by Dirsh (1956) based on the shape of the male cercus and internal genitalia. Most genera were erected based on the male genitalia however some were diagnosed using color or morphological characters which are not conserved throughout a genus. Dirsh (1956) in his initial review in which he erected the subfamily, did question the taxonomy of certain genera, however he left the species or genera in question the way it was and wrote that he was leaving the work to the taxonomist who would review the subfamily.

Analysis of morphological data based on a hypothesis which suggested one speciation event found that topologies support monophyletic genera. All Euryphyminae genera form a monophyletic group with Calliptaminae as a clear outgroup. Inclusion of molecular data which consisted of three genes (12S, H3A and COI) produced a different topology compared to morphological topology. Furthermore my hypothesis was not support, speciation was not in morphological characters that we thought but rather in characters that we did not investigate.

The male cercus shape along with the shape of the dorsum used here as diagnostic features and also used by taxonomists who previously worked on this group, are good diagnostic features for diagnosing genera, but the evolution in their shape is not easy to understand and did not match my expectations. The relationship between genera elucidated by DNA barcodes in Chapter 2 did not support my hypothesis. However it did support that our genera are distinct from each other, indicated by their monophyly and high support for nodes.

Chapter 3 – Variation within *Euryphymus*

Euryphymus specimens collected in the southern Karoo, when identified morphologically were classified into ten morphospecies. I wondered if these morphospecies were actually one species with a large variety of forms that can all interbreed (large intraspecific variation) or if these were many different species? This was tested using integrative taxonomy which quantified the levels of intra- and inter-specific variation in *Euryphymus*. Analysis of male specimens using DNA and morphologically yielded similar results with variation only in species placement and support values. Meaning that there was a correlation between my morphological and molecular dataset. Furthermore inclusion of both male and female specimens in molecular analysis revealed ten distinct morphospecies which however when we calculated genetic distances, the analysis showed that most of the clades had not accumulated enough mutation to be genetically different, meaning that lineages between clades had not sorted to become individual species. This suggests that from the ten morphospecies we actually have only five genetically diverged species which are sexually isolated.

Chapter 4 – Biodiversity of Euryphyminae in the Karoo

No ecological study has been conducted on the Euryphyminae in the past. This study is the first to do such, according to my knowledge. Biodiversity in the Karoo biome is poorly surveyed mainly due to lack of easy access. This reduces sampling effort and also reduces the chances of collecting more species. Grasshoppers in the Karoo are mostly found inhabiting dwarf Karoo shrubs and rocky or bare ground (Bazelet and Naskrecki 2014). Here, I investigated Euryphyminae biodiversity in the southern Karoo in order to assess differences in species abundance, richness and composition over space and time. I found that overall grasshopper diversity was much higher than anticipated. The diversity varied over different seasons, austral autumn season which had more rain was more species rich than austral spring which was very dry, and therefore there was a variation in species over time. There were no significant differences in the diversity and abundance of grasshoppers with regard to where they were collected, so no variation in space. It seems that many Euryphyminae species are localized to quite a small pocket of space and time, so sampling a month earlier or later may result in the discovery of more species. Essentially, there could be many more species of Euryphyminae in the Karoo which have not yet been discovered.

Future research recommendations

This subfamily is in need of an urgent revision. This does not mean the genera are not valid. I did not assess all 24 genera using both molecular and morphology but the ones which I did assess revealed that Euryphyminae genera are valid and can be distinguished morphologically. A study needs to be conducted to investigate diagnostic characters which are evolving at the same time scales as molecular genes (12S, H3A and CO1) in order to better understand the speciation process in Euryphyminae. Morphological characters which seem to be closely related, did not emerge as such in phylogenetic analyses, illustrating that some characters are evolving much slower or much faster than anticipated. I also recommend a study to investigate speciation events of grasshoppers with regard to colour patterns on their wings and internal hind femur, and whether the colour on their internal hind femur plays a role in mating.

In two months of field work, I was able to collect half of the Euryphyminae genera (10 out of 24 genera) including a new genus. There is much still left to discover about Karoo biodiversity, especially in relation with other organisms. I strongly recommend a long term study or survey of the Euryphyminae in the Karoo, and additional environmental variables to uncover the effect of various environmental variables, time and space on the diversity of the Euryphyminae and their population dynamics. In addition future research could focus on investigating how disturbance (i.e. grazing) and drought in the Karoo affect the diversity of the Euryphyminae. This study provides important baseline data for future research on the Euryphyminae.

References

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SUPPLEMENTARY INFORMATION

SUPPLEMENT 1

Sites sampled during field work for karoo BioGaps project.

SITE	GPS latitude	longitude	Sampled in 2016	2017	Site name used in each chapter Chap. 2	Chap. 3	Chap. 4
Marseilles	-31.339813	23.14459	+	+			
Rooidraai, Oorlogspoort	-32.485854	23.619196	+	+	P7	P7	P7
Saltpans Drift Trust	-31.864023	25.47051	+	+			
Hopewell	-32.30179	23.119131	+	+			
Kalkdam	-32.804367	23.313656	+				
Ezelfontein	-30.980463	25.702159		+			
Taaiboschfontein	-31.949021	22.87572		+			
Vliegekraal - or Landsig	-31.980388	23.549761	+	+			
Alstonfield	-32.888561	26.039813		+	P2	P2	P2
Klein Waterval	-32.966599	22.361048	+				
Rietfontein, Vetvlakte, Vaalkop	-30.912134	25.01142		+			
Rietkuil	-32.460331	22.138136	+				
Rockdale, Kanonkrans, Driehoekfontein	-31.542128	23.953076		+			
Biesiebult	-31.116219	22.770169		+			
Doornberg	-32.214311	21.875146		+			
Good Luck	-33.040313	24.968393	+				
Mesfontein and Elandsfontein	-31.140548	24.04648		+	P8	P8	P8
Modderfontein	-31.880003	26.121071		+			
Plains of Camdeboo Nature Reserve	-32.55735	25.198924	+		P3	P3	P3
Portugalsrivier	-32.515462	20.885882	+	+	P11	P11	P11
Waterval	-32.452211	25.70729		+			
Rietvlei	-32.214311	21.875146		+			
Black Hill	-32.572059	26.275423		+			

Rooiheuwel	-32.688947	20.37905		+	
Titusfontein	-31.892337	20.784556		+	
Driefontein	-32.279929	21.330668		+	
Droogvoetsfontein	-31.972426	21.432434		+	
Excelsior	-32.186701	24.789221	+		
Hoedjiesfontein / Grasbult	-31.215738	20.526135		+	
Lushof	-31.353099	22.289284	+		
ADDITIONAL SITES					
Tankwa Karoo NP, Elandsberg cottages	-32.523100	19.675580			TK
Kgalagadi NP, Nossob rest camp	-25.970600	20.396200			KG
West coast N.P road to Tsaarsbank	-33.170870	18.149208			WC
Cederberg wilderness jeep track near Clanwilliam Rd	-32.09762	19.02194			CD
West coast N.P road to Tsaarsbank	-33.170870	18.149208			WC

SUPPLEMENT 2

Museum specimens

Specimen	Species	Country	Province	Locality	Date	Collector	Latitude	Longitude
3243096	*Acrophymus nr. rossi*	South Africa	Limpopo	Hoedspruit	17.ii.1958	M. Prinsloo	-24.35244	30.9514
3243132	*Amblyphymus matopo*	South Africa	Northern Cape	35 km NW Kenhardt			-29.189731	20.96704
3243133	*Amblyphymus matopo*	South Africa	Mpumalanga	Groblersdam	15.v.1987	T. Grobbelaar	-25.167361	29.398692
3243134	*Amblyphymus matopo*	South Africa	Mpumalanga	Mariepskop	17.iv.1979	J.A. Irish	-24.583333	30.866667
3240319	*Amblyphymus roseus*	South Africa	Free State	Potchefstroom	19.ii.1911		-25.389842	28.282874
3240325	*Amblyphymus roseus*	South Africa	Free State	Potchefstroom	14.ii.1911		-25.424918	27.874365
3240327	*Amblyphymus roseus*	South Africa	Northern Cape	Hopetown	12.ii.1931		-24.769056	28.336196
3242912	*Amblyphymus roseus*	South Africa	Gauteng	Soutpan, Pretoria	9.iii.1993	R. Toms and S. Green	-24.894421	31.598388
3243125	*Amblyphymus roseus*	South Africa	Limpopo	Pietersburg	Feb-75		-29.61956	24.08693
3243126	*Amblyphymus roseus*	South Africa	Gauteng	Pretoria	May-71		-25.687283	28.133377
3243127	*Amblyphymus roseus*	South Africa	Gauteng	Winternest	15.ii.1988	A.v. Buuren	-24.155952	29.182303
3243128	*Amblyphymus roseus*	South Africa	Western Cape	Rietfontein	1.v.1987	T. Beyers	-24.155952	29.182303
3243129	*Amblyphymus roseus*	South Africa	Northwest	Rust de Winter	30.iii.1987	L.V. de Jager	-25.838284	29.484625
3243130	*Amblyphymus roseus*	South Africa	Limpopo	Thabazimbi	28.iii.1987	L.E.G.R. Vos	-23.896638	29.450998
3243503	*Amblyphymus roseus*	South Africa	Limpopo	6 mi SW Nylstroom	11.ii.1963	H.D. Brown, W. Furst	-26.716054	27.089014
3243504	*Amblyphymus roseus*	South Africa	Limpopo	Zoutpan, Silvermanspost	20.v.1958	H.D. Brown	-26.716054	27.089014
3243505	*Amblyphymus roseus*	South Africa	Gauteng	Pienaar's River Dam, Pretoria Dist.	30.i.1960	H.D. Brown, Furst, Haacke	-25.746533	28.223951
3243506	*Amblyphymus roseus*	South Africa	Gauteng	25 mi N Pretoria	31.i.1961	H.D. Brown, Furst, Haacke	-25.746533	28.223951
3243507	*Amblyphymus roseus*	South Africa	Gauteng	30 mi NW Pretoria	5.iii.1961	H.D. Brown	-25.819198	27.281698
3243508	*Amblyphymus roseus*	South Africa	Limpopo	Salietjie NKW 10 mi from Skukuza	15.iii.1960		-25.819198	27.281698
3243509	*Amblyphymus roseus*	South Africa	Limpopo	7 mi N Skukuza	27.iv.1963	H.D. Brown	-33.185097	18.268967
TMOR 7153	*Amblyphymus roseus*	South Africa	Gauteng	Pretoria	16.ii.1957	L. Vari	-25.624167	28.094167
TMOR 7154	*Amblyphymus roseus*	South Africa	Gauteng	Rosslyn	17.ii.1957	L. Vari	-25.624167	28.094167

TMOR 7156	*Amblyphymus roseus*	South Africa	Northwest	Retiefskloof nr. Rustenburg	3-5.ii.1994	R. Toms and S. Green and Kriegbaum and Nel	-25.094718	31.880829
TMOR 7159	*Amblyphymus roseus*	South Africa	Gauteng	Magaliesberg, Pretoria	13.ii.1994	Kriegbaum and Toms and Green	-25.425294	28.092396
TMOR 7160	*Amblyphymus roseus*	South Africa	Limpopo	Makapansgat, 20 km N of Potgietersrus Valley	17-18.ii.1994	Kriegbaum and Toms and Green	-24.584314	27.404513
TMOR 7178	*Amblyphymus roseus*	South Africa	Gauteng	Soutpan, Pretoria	9.iii.1993	R. Toms and S. Green	-23.00837	29.768993
3243131	*Amblyphymus rubidus*	South Africa	Limpopo	Langjan	27.ii.1988	K. Kappmeier	-22.842198	29.243016
3243510	*Amblyphymus rubidus*	South Africa	Limpopo	Zoutpan, Zoutpansberg	6.iv.1958	H.D. Brown	-23.00837	29.768993
3242875	*Amblyphymus rubripes*	South Africa	Gauteng	Wits Rural Unit 2431 CA	Apr.1994	L. Prendini	-22.526894	30.691476
3243511	*Amblyphymus rubripes*	South Africa	Limpopo	15 mi S Louis Trichardt	26.iii.1962	H.D. Brown	-31.757913	21.592479
3243512	*Amblyphymus rubripes*	South Africa	Limpopo	2 mi NE Bandolierkop	13.ii.1963	H.D. Brown, W. Furst	-24.804755	28.483767
3243513	*Amblyphymus rubripes*	South Africa	Limpopo	7 mi N Skukuza	27.iv.1963	H.D. Brown	-23.270572	29.910661
3243514	*Amblyphymus rubripes*	South Africa	Limpopo	5 mi NE Duiwelskloof	13.ii.1963	H.D. Brown, W. Furst	-23.292984	29.81761
3243515	*Amblyphymus rubripes*	South Africa	Limpopo	6 mi SE Mica	29.iv.1963	M.J.D. White	-23.50662	31.405057
3243516	*Amblyphymus rubripes*	South Africa	Limpopo	30 mi N Letabe, KNP	16.i.1965	A.L. Capener	-29.665395	17.984934
3243517	*Amblyphymus rubripes*	South Africa	Eastern Cape	8 mi NW Bedford	15.iv.1967	H.D. Brown	-22.404777	30.11223
3243518	*Amblyphymus rubripes*	South Africa	Mpumalanga	11 mi N Ofcolaco	14.iv.1967	H.D. Brown	-24.220228	30.90295
3243519	*Amblyphymus rubripes*	South Africa	Gauteng	13 mi ENE Warmbaths	23.i.1967	N.J. van Rensburg	-24.894421	31.598388
3243520	*Amblyphymus rubripes*	South Africa	Limpopo	1 mi E Tshipise	16.ii.1963	H.D. Brown	-32.597383	25.98926
3243521	*Amblyphymus rubripes*	South Africa	Limpopo	6 mi SE Messina	2.v.1963	H.D. Brown	-24.500409	30.882497
3243522	*Amblyphymus rubripes*	South Africa	Eastern Cape	Blyde River nr. Bedford	12.iv.1967	H. Snyman		
3243097	*Amblyphymus transvaalicus*	South Africa	Gauteng	Warmbaths	Apr-80	P. du Plessis	-22.526894	30.691476
3243470	*Amblyphymus transvaalicus*	South Africa	Northern Cape	22m N Kimberley	15.i.1963	M.J.D. White	-28.872666	16.69531
3243471	*Amblyphymus transvaalicus*	South Africa	Limpopo	Zoutpan, Zoutpansberg	6.iv.1958	H.D. Brown	-25.746056	27.706182
3243472	*Amblyphymus transvaalicus*	South Africa	Limpopo	Bandolierkop, Ensolerg Formation	3.iv.1958	H.D. Brown	-23.525696	29.70447
3243473	*Amblyphymus transvaalicus*	South Africa	Limpopo	35 mi S Louis Trichardt	1.iv.1962	H.D. Brown	-22.352119	30.177632
3243475	*Amblyphymus transvaalicus*	South Africa	Northwest	30 mi W Pretoria, Mogaliesberg Mtn. Brits	1.vi.1958	H.D. Brown	-32.35286	22.584107
3243478	*Amblyphymus transvaalicus*	South Africa	Limpopo	1 mi S Tshipise	3.v.1963	H.D. Brown	-25.642648	27.793452
3243479	*Amblyphymus transvaalicus*	South Africa	Limpopo	8 mi E Messina	3.v.1963	H.D. Brown	-26.600401	27.478357

3243480	*Amblyphymus transvaalicus*	South Africa	Gauteng	Pretoria Dist. Renosterspruit	11.ii.1975	M. Powell	-24.873989	28.2799
3243482	*Amblyphymus transvaalicus*	South Africa	Northwest	Brits, Hartebeespoort Dam	19.ii.1975	M. Powell		
3240240	*Aneuryphymus erythropus*	South Africa	Northern Cape	Pofadder	2.ii.1944	T. van Niekerk	-29.117693	26.21782
3240241	*Aneuryphymus erythropus*	South Africa	Free State	Senekal	28.i.1942		-29.117693	26.21782
3240242	*Aneuryphymus erythropus*	South Africa	Eastern Cape	Burghersdorp	Jan.1930	P. van Heerden	-29.117693	26.21782
3240243	*Aneuryphymus erythropus*	South Africa		Jansesmith	24.ii.1945		-29.750384	30.74878
3240244	*Aneuryphymus erythropus*	South Africa	Free State	Bloemfontein	25.iii.1918		-29.805748	29.767983
3240245	*Aneuryphymus erythropus*	South Africa	Western Cape	Robertson	26.ix.1927		-30.997075	26.330848
3240259	*Aneuryphymus erythropus*	South Africa	Eastern Cape	Conway	28.xi.1947		-31.733794	25.303231
3240260	*Aneuryphymus erythropus*	South Africa	Free State	Bloemfontein	16.v.1919	Ch. K. Brain	-31.733794	25.303231
3241413	*Aneuryphymus erythropus*	South Africa	KwaZulu-Natal	Gilboa Forestry Estate - Mondi Shanudka	2.xi.2007	C.S. Bazelet and H. Nene	-29.294462	30.302648
3241414	*Aneuryphymus erythropus*	South Africa	KwaZulu-Natal	G5 - Gilboa Forestry Estate - Mondi Shanduka	3.xi.2007	C.S. Bazelet and H. Nene	-29.294462	30.302648
3241415	*Aneuryphymus erythropus*	South Africa	KwaZulu-Natal	G6 - Gilboa Forestry Estate - Mondi Shanduka	5.xi.2007	C.S. Bazelet and H. Nene	-29.294462	30.302648
3241416	*Aneuryphymus erythropus*	South Africa	KwaZulu-Natal	G4 - Gilboa Forestry Estate - Mondi Shanduka - large wetland, home to cranes	3.xi.2007	C.S. Bazelet and H. Nene	-29.294462	30.302648
3243098	*Aneuryphymus erythropus*	South Africa	Western Cape	Rietfontein	1.xi.1986	T. Beyers	-33.984677	20.810598
3243260	*Aneuryphymus erythropus*	South Africa	Northwest	Pieta Rustief?	4.ii.1929	J.C. Faure		
I1479	*Aneuryphymus erythropus*	South Africa	Free State	Bloemfontein	6.v.1919	Ch. K. Brain	-23.178112	28.610266
I1481	*Aneuryphymus erythropus*	South Africa	Western Cape	Robertson	26.ix.1927		-29.128299	19.394915
TMOR 7120	*Aneuryphymus erythropus*	South Africa	KwaZulu-Natal	Botha's Hill	3.x.1957	C.G.C. Dickson	-25.746533	28.223951
TMOR 7121	*Aneuryphymus erythropus*	South Africa	Gauteng	Pretoria	6.i.1952		-33.185097	18.268967
TMOR 7122	*Aneuryphymus erythropus*	South Africa	Western Cape	Grootvadersbos	1-6.xi.1940	G. van Son.	-33.803989	19.885889
TMOR 7123	*Aneuryphymus erythropus*	South Africa	Limpopo	Makapan, Potgietersrust	12.xi.1954	Ch. K. Brain	-33.803989	19.885889
TMOR 7124	*Aneuryphymus erythropus*	South Africa	KwaZulu-Natal	Bulwer	7.xi.1957	C.G.C. Dickson	-28.319708	27.620816
3240257	*Aneuryphymus montanus*	South Africa	Western Cape	Graafwater	12.xii.1992	C. Laubscher	-32.153409	18.604203
3240271	*Aneuryphymus montanus*	South Africa	Western Cape	Langkloof V. 3m N Isuberana	18.ii.1958	H.D. Brown	-33.950479	24.293841
3243262	*Aneuryphymus montanus*	South Africa	Western Cape	Langkloof V., 10km W Kareedouw	18.ii.1958	H.D. Brown	-33.950479	24.293841
3243266	*Aneuryphymus montanus*	South Africa	Western Cape	Langkloof V., 11m W of Kareedouw	18.ii.1958	H.D. Brown	-33.950479	24.293841
3243270	*Aneuryphymus montanus*	South Africa	Western Cape	Swartberg Pass	11.xii.1961	H.D. Brown, W. Furst, F. Pick	-33.950479	24.293841

3243271	*Aneuryphymus montanus*	South Africa	Western Cape	Palmietvlei, S. Clarkson, nr. Kleinmond	19.ii.1958	H.D. Brown	-33.950479	24.293841
3243272	*Aneuryphymus montanus*	South Africa	Western Cape	Langkloof V., 11m W of Kareedouw	18.ii.1958	H.D. Brown	-34.313855	18.957102
3243276	*Aneuryphymus montanus*	South Africa	Western Cape	Swartberg Pass	11.xii.1961	H.D. Brown, W. Furst, F. Pick	-33.352244	22.046496
3243460	*Aneuryphymus rhodesianus*	South Africa	Gauteng	20 mi E Pretoria	23.x.1960	H.D. Brown	-25.949209	30.743572
3243461	*Aneuryphymus rhodesianus*	South Africa	Mpumalanga	4m W of Graskop	12.xi.1964	H.D. Brown	-26.068384	30.472972
3243462	*Aneuryphymus rhodesianus*	South Africa	Mpumalanga	10 mi SW Badplaate	10.xi.1964	H.D. Brown	-25.775226	30.80324
3243463	*Aneuryphymus rhodesianus*	South Africa	Mpumalanga	10 mi E Badplaate	10.x.1964	H.D. Brown	-25.782417	28.552281
3243464	*Aneuryphymus rhodesianus*	South Africa	Mpumalanga	15m W Barberton	10.xi.1964	H.D. Brown	-26.070822	30.189105
3243465	*Aneuryphymus rhodesianus*	South Africa	Mpumalanga	Sheba, 10 mi NE Barberton	10.xi.1964	H.D. Brown	-24.92914	30.793458
3243466	*Aneuryphymus rhodesianus*	South Africa	Limpopo	6 mi S Haenertsburg	12.i.1965	H.D. Brown	-29.665395	17.984934
3243467	*Aneuryphymus rhodesianus*	South Africa	Mpumalanga	7m NW Pilgrim's Rest	12.xi.1964	H.D. Brown	-24.034965	29.939096
3243468	*Aneuryphymus rhodesianus*	South Africa	Limpopo	5 mi NE Duiwelskloof	13.ii.1963	H.D. Brown, W. Furst	-24.817803	30.673559
3243469	*Aneuryphymus rhodesianus*	South Africa	Mpumalanga	4 mi E Carolina	9.xi.1964	H.D. Brown	-25.683582	31.173974
3243139	*Brachyphymus nr. vylderi*	South Africa	Northern Cape	7m NW Kuruman	9.ii.1959	H.D. Brown	-29.467684	23.232245
3243153	*Brachyphymus nr. vylderi*	South Africa	Eastern Cape	43m SW Douglas	4.iv.1961	W. Furst, F. Pick	-27.389063	23.356758
3243154	*Brachyphymus nr. vylderi*	South Africa	Eastern Cape	Middelburg	Mar-57	A.L. Reyneke	-31.506917	25.017263
3240329	*Brachyphymus vylderi vylderi*	South Africa	Northern Cape	Van Rhyn's Pass	7.vii.1998	G. du Plessis	-27.389063	23.356758
3240331	*Brachyphymus vylderi vylderi*	South Africa	Northern Cape	Soebatsfontein	13-14.xi.1933	G. van Son.	-32.2	22.95
3240332	*Brachyphymus vylderi vylderi*	South Africa	Western Cape	Breipaal	18.v.1934		-31.49316	25.00694
3240339	*Brachyphymus vylderi vylderi*	South Africa	Northern Cape	Van Rhyn's Pass	4-5.xi.1933	G. van Son.	-28.42917	21.34453
3243485	*Brachyphymus vylderi vylderi*	South Africa	Northern Cape	Middelburg	16-18.v.1955	D.H. Botha	-26.978388	20.780407
3243486	*Brachyphymus vylderi vylderi*	South Africa	Northern Cape	Gordonia District (old name)	9.iv.1937	C. du Plessis	-29.794021	25.006457
3243487	*Brachyphymus vylderi vylderi*	South Africa	Eastern Cape	Middelburg	Apr-57	A.L. Reyneke	-28.823294	19.723199
3243488	*Brachyphymus vylderi vylderi*	South Africa	Eastern Cape	Fern Rocks, Middelburg	7.iii.1957	H.D. Brown	-31.506917	25.017263
3243489	*Brachyphymus vylderi vylderi*	South Africa	Free State	Petrusviille	13.v.1957	C.P. Lounsberg, J.C. Faure	-31.506917	25.017263
3243490	*Brachyphymus vylderi vylderi*	South Africa	Free State	Leeufontein, Luckhoff	Mar-29	S.J.S. Marais	-29.115975	25.414347
3243491	*Brachyphymus vylderi vylderi*	South Africa	Northern Cape	Hope Town	14.v.1917		-29.234811	21.873143
3243493	*Brachyphymus vylderi vylderi*	South Africa	Northern Cape	Kuruman River, 10 mi E Askham	30.iv.1971	H.D. Brown	-30.118482	17.592344
3243501	*Brachyphymus vylderi vylderi*	South Africa	Northern Cape	Lower Swart Modder, 30 mi NNE	7.iii.1969	H.D. Brown	-30.118482	17.592344

				Pofadder				
3243502	*Brachyphymus vylderi vylderi*	South Africa	Northern Cape	7m NW Kuruman	9.ii.1959	H.D. Brown	-26.473052	20.577997
TMOR 7198	*Brachyphymus vylderi vylderi*	South Africa	Northern Cape	Twee Rivieren, S. Kalahari, Auob River	11-20.ii.1958	G. van Son.	-26.473052	20.577997
TMOR 7209	*Brachyphymus vylderi vylderi*	South Africa	Northern Cape	Putzonderwater	18.iii.1958	G. van Son.	-31.383187	19.021515
3242627	*Calliptamicus antennatus*	South Africa	Northern Cape	Goegap NR, on 4x4 route	3.x.2008	P. Naskrecki and C. Bazelet	-25.775226	30.80324
3243217	*Calliptamicus antennatus*	South Africa	KwaZulu-Natal	Yellow Woods, Balgowan	18-28.i.1960	G. van Son.	-24.92914	30.793458
3243218	*Calliptamicus antennatus*	South Africa	Mpumalanga	New Chum Falls, Vaalhoek	17.i.1969	A.L. Capener	-24.817803	30.673559
3243219	*Calliptamicus antennatus*	South Africa	Mpumalanga	7m NW Pilgrim's Rest	12.xi.1964	H.D. Brown	-29.686148	17.949329
3243220	*Calliptamicus antennatus*	South Africa	KwaZulu-Natal	Utrecht MD, Dwarsbalk	30.i.1998	A.J. Armstrong	-29.686148	17.949329
3243221	*Calliptamicus antennatus*	South Africa	Western Cape	Kango Caves, Oudtshoorn	20.iii.1973	H.D. Brown	-29.61956	24.08693
3243222	*Calliptamicus antennatus*	South Africa	Mpumalanga	4m W of Graskop	12.xi.1964	H.D. Brown	-33.392436	22.214674
3243223	*Calliptamicus antennatus*	South Africa	Mpumalanga	15m W Barberton	10.xi.1964	H.D. Brown	-24.719292	30.837695
3243224	*Calliptamicus antennatus*	South Africa	Northern Cape	3m SE Garies	15.ix.1967	H.D. Brown	-29.664336	17.886495
3243225	*Calliptamicus antennatus*	South Africa	Northern Cape	Hopetown	1-8.iv.1961	H.D. Brown, W. Furst, F. Pick	-27.440406	30.236519
3243226	*Calliptamicus antennatus*	South Africa	Northern Cape	Springbok	3.x.1972	H.D. Brown, E. Koster, A. Prinsloo	-29.395609	30.054751
3240219	*Calliptamicus semiroseus*	South Africa	Western Cape	Oudtshoorn	20.i.1963	H.J. Greef	-31.462328	25.257342
3240220	*Calliptamicus semiroseus*	South Africa	Western Cape	Tulbagh	Dec.1947	J.G. Theron	-30.241788	25.274789
3240221	*Calliptamicus semiroseus*	South Africa	Western Cape	De Hoop Nature Reserve	Apr.1985	M. Wright	-28.872666	16.69531
3240222	*Calliptamicus semiroseus*	South Africa		Keurboom River	Jan.1922	Ch. K. Brain	-31.771558	24.720479
3240223	*Calliptamicus semiroseus*	South Africa	Free State	Bloemfontein O.F.S.	10.ii.1918		-31.922586	24.751994
3240224	*Calliptamicus semiroseus*	South Africa	Western Cape	Stellenbosch	22.iv.1922	Ch. K. Brain	-30.674916	24.038328
3240225	*Calliptamicus semiroseus*	South Africa	Western Cape	Stellenbosch	28.ii.1922	Ch. K. Brain	-33.039816	23.874068
3240226	*Calliptamicus semiroseus*	South Africa	Western Cape	Stellenbosch	2.iv.1922	Ch. K. Brain	-33.026428	24.173786
3240229	*Calliptamicus semiroseus*	South Africa	Western Cape	Stellenbosch	7.iii.1956	W.T. Malherbe	-33.839974	18.967645
3240230	*Calliptamicus semiroseus*	South Africa	Western Cape	Bien Donne	29.iii.1989	D. Laubscher	-29.117693	26.21782
3240231	*Calliptamicus semiroseus*	South Africa	Western Cape	Jonkershoek	Mar.1989	L. Cornelissen	-29.117693	26.21782
3240234	*Calliptamicus semiroseus*	South Africa	Western Cape	Stellenbosch	24.iii.1927		-30.997075	26.330848
3240235	*Calliptamicus semiroseus*	South Africa	Western Cape	Jonkershoek	Apr.1989	M. Pusch	-34.22913	18.41082
3240236	*Calliptamicus semiroseus*	South Africa	Western Cape	Stellenbosch	Mar.1963	Richfield	-33.92751	18.428821

3240237	*Calliptamicus semiroseus*	South Africa	Western Cape	Stellenbosch	11.iv.1981	H. Ulok	-33.92751	18.428821
3240252	*Calliptamicus semiroseus*	South Africa	Free State	Golden Gate Nat. Park, Echo Ravine trail	4.iii.2008	P. Naskrecki and C. Bazelet	-29.652982	26.17484
3240275	*Calliptamicus semiroseus*	South Africa	Western Cape	Cape Town side of Reddensburg	Nov-60	A. Jago	-32.146331	18.947532
3240282	*Calliptamicus semiroseus*	South Africa	Western Cape	False Bay	1.iii.1939	E.R. Helwig	-32.146331	18.947532
3241186	*Calliptamicus semiroseus*	South Africa	Western Cape	Cape Peninsula	1.iii.1939	E.R. Helwig	-29.294462	30.302648
3241188	*Calliptamicus semiroseus*	South Africa	Western Cape	Witsand	1.iii.1939	E.R. Helwig	-29.294462	30.302648
3241191	*Calliptamicus semiroseus*	South Africa	Western Cape	Hout Bay	5.iii.1939	E.R. Helwig	-29.294462	30.302648
3241192	*Calliptamicus semiroseus*	South Africa	Western Cape	Kalk Bay	21.iv.1939	E.R. Helwig	-34.422217	20.545528
3241418	*Calliptamicus semiroseus*	South Africa	KwaZulu-Natal	Control - Gilboa Forestry Estate - Mondi Shanduka	5.ii.2008	C.S. Bazelet and B.N. Gcumisa	-34.422217	20.545528
3241419	*Calliptamicus semiroseus*	South Africa	KwaZulu-Natal	Control - Gilboa Forestry Estate - Mondi Shanduka	16.ii.2008	C.S. Bazelet and B.N. Gcumisa	-33.019454	18.994884
3241420	*Calliptamicus semiroseus*	South Africa	KwaZulu-Natal	G9 - Gilboa Forestry Estate - Mondi Shanduka	5.ii.2008	C.S. Bazelet and B.N. Gcumisa	-33.019454	18.994884
3241422	*Calliptamicus semiroseus*	South Africa	KwaZulu-Natal	G9 - Gilboa Forestry Estate - Mondi Shanduka	15.ii.2008	C.S. Bazelet and B.N. Gcumisa	-29.294462	30.302648
3241423	*Calliptamicus semiroseus*	South Africa	KwaZulu-Natal	G2 - Gilboa Forestry Estate - Mondi Shanduka	5.ii.2008	C.S. Bazelet and B.N. Gcumisa	-29.294462	30.302648
3241424	*Calliptamicus semiroseus*	South Africa	KwaZulu-Natal	G5 - Gilboa Forestry Estate - Mondi Shanduka	5.ii.2008	C.S. Bazelet and B.N. Gcumisa	-29.294462	30.302648
3241425	*Calliptamicus semiroseus*	South Africa	KwaZulu-Natal	G5 - Gilboa Forestry Estate - Mondi Shanduka	11.ii.2008	C.S. Bazelet and B.N. Gcumisa	-29.294462	30.302648
3241426	*Calliptamicus semiroseus*	South Africa	KwaZulu-Natal	G5 - Gilboa Forestry Estate - Mondi Shanduka	13.ii.2008	C.S. Bazelet and B.N. Gcumisa	-29.294462	30.302648
3241427	*Calliptamicus semiroseus*	South Africa	KwaZulu-Natal	G13 - Gilboa Forestry Estate - Mondi Shanduka	5.ii.2008	C.S. Bazelet and B.N. Gcumisa	-29.294462	30.302648
3241428	*Calliptamicus semiroseus*	South Africa	KwaZulu-Natal	G14 - Gilboa Forestry Estate - Mondi Shanduka	15.ii.2008	C.S. Bazelet and B.N. Gcumisa	-29.294462	30.302648
3241429	*Calliptamicus semiroseus*	South Africa	KwaZulu-Natal	G7 - Gilboa Forestry Estate - Mondi Shanduka	3.xi.2007	C.S. Bazelet and H. Nene	-29.294462	30.302648
3241430	*Calliptamicus semiroseus*	South Africa	KwaZulu-Natal	G6 - Gilboa Forestry Estate - Mondi Shanduka	5.xi.2007	C.S. Bazelet and H. Nene	-29.294462	30.302648
3241431	*Calliptamicus semiroseus*	South Africa	KwaZulu-Natal	Control - Gilboa Forestry Estate - Mondi Shanduka	9.xi.2007	C.S. Bazelet and H. Nene	-29.294462	30.302648
3241432	*Calliptamicus semiroseus*	South Africa	KwaZulu-Natal	Gilboa Forestry Estate - Mondi Shanudka	2.xi.2007	C.S. Bazelet and H. Nene	-29.294462	30.302648
3241433	*Calliptamicus semiroseus*	South Africa	Western Cape	Cederberg Wilderness area - jeep track near Clanwilliam Rd.	13.xii.2007	C.S. Bazelet	-29.294462	30.302648
3241434	*Calliptamicus semiroseus*	South Africa	Free State	Golden Gate Nat. Park, Echo Ravine trail	4.iii.2008	P. Naskrecki and C. Bazelet	-28.5098	28.604366

3241435	*Calliptamicus semiroseus*	South Africa	Free State	Golden Gate Nat. Park, Mushroom Rock Trail	4.iii.2008	P. Naskrecki and C. Bazelet	-28.5098	28.604366
3241436	*Calliptamicus semiroseus*	South Africa	Western Cape	Table Mountain National Park	26.ii.2006	C.S. Bazelet and E. Bredenhand	-28.5098	28.604366
3241437	*Calliptamicus semiroseus*	South Africa	Western Cape	Cederberg Wilderness area - jeep track near Clanwilliam Rd.	23.i.2008	C.S. Bazelet and B.N. Bamberger	-28.5098	28.604366
3241438	*Calliptamicus semiroseus*	South Africa	Western Cape	West Coast National Park - Atlantic view point	11.xii.2007	C.S. Bazelet and B.N. Bamberger	-34.021947	18.366269
3241439	*Calliptamicus semiroseus*	South Africa	Western Cape	Olifantsbos - Cape Point - Table Mountain NP	7.xii.2007	C.S. Bazelet and B.N. Bamberger	-33.969357	18.936351
3241440	*Calliptamicus semiroseus*	South Africa	Western Cape	Cederberg Wilderness area - jeep track near Clanwilliam Rd.	13.xii.2007	C.S. Bazelet	-33.969357	18.936351
3241441	*Calliptamicus semiroseus*	South Africa	Western Cape	West Coast National Park - Atlantic view point	11.xii.2007	C.S. Bazelet and B.N. Bamberger	-33.969357	18.936351
3241442	*Calliptamicus semiroseus*	South Africa	Western Cape	West Coast National Park - near South entrance	11.xii.2007	C.S. Bazelet	-33.969357	18.936351
3242568	*Calliptamicus semiroseus*	South Africa	Western Cape	Dreammaker Fruit - Teeland Farm, nr. Porterville	29.xi.2008	C.S. Bazelet and J. Simaika and E. Bredenhand	-33.969357	18.936351
3243245	*Calliptamicus semiroseus*	South Africa	Western Cape	Somerset West	31.xii.1958	C.G.C. Dickson	-33.969357	18.936351
3243246	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Middelburg	Nov.1940	C. Smit	-33.969357	18.936351
3243247	*Calliptamicus semiroseus*	South Africa	Eastern Cape	14m E Middelburg	8-14.xii.1960	H.D. Brown, Furst, Haacke	-33.969357	18.936351
3243248	*Calliptamicus semiroseus*	South Africa	Eastern Cape	24m SW Middelburg	23.i.1963	H.D. Brown, Furst	-33.969357	18.936351
3243250	*Calliptamicus semiroseus*	South Africa	Northern Cape	2m SE De Aar	5.xii.1960	H.D. Brown, Furst, Haacke	-33.969357	18.936351
3243251	*Calliptamicus semiroseus*	South Africa	Western Cape	Swartberg Pass	11.xii.1961	H.D. Brown, W. Furst, F. Pick	-33.969357	18.936351
3243252	*Calliptamicus semiroseus*	South Africa	KwaZulu-Natal	Little Berg, Cathedral Peak	24.xi.1963	H.D. Brown	-33.969357	18.936351
3243253	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Burghersdorp	24.ii.1958	H.D. Brown	-33.969357	18.936351
3243254	*Calliptamicus semiroseus*	South Africa	Eastern Cape	27m NE Graaf-Reinet	23.i.1963	H.D. Brown, Furst	-33.969357	18.936351
3243255	*Calliptamicus semiroseus*	South Africa	Eastern Cape	9m W Klipplaat	22.i.1963	M.J.D. White	-33.969357	18.936351
3243256	*Calliptamicus semiroseus*	South Africa	Free State	1m N Philippolis	20.xii.1960	H.D. Brown, Furst	-33.969357	18.936351
3243257	*Calliptamicus semiroseus*	South Africa	Northern Cape	22m N Kimberley	15.i.1963	M.J.D. White	-33.969357	18.936351
3243258	*Calliptamicus semiroseus*	South Africa	Eastern Cape	4m NW Miller Stn.	13.xii.1961	H.D. Brown, W. Furst, F. Pick	-34.126117	18.44918
I1498	*Calliptamicus semiroseus*	South Africa	Free State	Bloemfontein	10.ii.1918			
I1503	*Calliptamicus semiroseus*	South Africa	Western Cape	Oudtshoorn	20.i.1963	H.J. Greeff		
I1508	*Calliptamicus semiroseus*	South Africa	Western Cape	Jonkershoek	Mar.1989	L. Cornellison	-31.506917	25.017263

I1509	*Calliptamicus semiroseus*	South Africa	Western Cape	Bien Donne	29.iii.1989	D. Laubscher	-30.166015	17.798652
I1510	*Calliptamicus semiroseus*	South Africa	Western Cape	Tulbagh	Dec.1947	J.G. Theron	-34.2524282	18.3968027
I1511	*Calliptamicus semiroseus*	South Africa	Western Cape	Jonkershoek	13.ii.1980	J.H. Giliomee	-33.589094	22.213406
I1512	*Calliptamicus semiroseus*	South Africa	Western Cape	Jonkershoek	28.iv.1980	C.H.G. Schlettwein	-33.589094	22.213406
I1513	*Calliptamicus semiroseus*	South Africa	Western Cape	Jonkershoek	7.xii.1989	A.W. Giliomee	-34.060036	18.856647
I1514	*Calliptamicus semiroseus*	South Africa	Western Cape	Jonkershoek	14.iv.1981	C.H.G. Schlettwein	-33.934621	18.859209
I1515	*Calliptamicus semiroseus*	South Africa	Western Cape	Jonkershoek	7.i.1980	G.A. Giliomee	-33.934621	18.859209
I1516	*Calliptamicus semiroseus*	South Africa	Western Cape	Jonkershoek	14.i.1980	G.A. Giliomee	-33.934621	18.859209
I1517	*Calliptamicus semiroseus*	South Africa	Western Cape	Jonkershoek	8.v.1981	C.H.G. Schlettwein	-33.934621	18.859209
I1518	*Calliptamicus semiroseus*	South Africa	Western Cape	Jonkershoek	10.ix.1982	Len van Zyl	-33.934621	18.859209
I1520	*Calliptamicus semiroseus*	South Africa	Western Cape	Jonkershoek	1.iv.1980	G.A. Giliomee	-33.934621	18.859209
I1521	*Calliptamicus semiroseus*	South Africa	Western Cape	Jonkershoek	7.i.1980	G.A. Giliomee	-33.934621	18.859209
I1522	*Calliptamicus semiroseus*	South Africa	Western Cape	Jonkershoek	11.xii.1979	G. Giliomee	-33.934621	18.859209
I1523	*Calliptamicus semiroseus*	South Africa	Western Cape	Jonkershoek	14.iv.1981	C.H.G. Schlettwein	-33.934621	18.859209
I1525	*Calliptamicus semiroseus*	South Africa	Western Cape	Jonkershoek	13.iii.1981	C.H.G. Schlettwein	-31.744742	18.243366
I1526	*Calliptamicus semiroseus*	South Africa	Western Cape	Jonkershoek	7.xii.1979	G. Giliomee	-33.352244	22.046496
I1527	*Calliptamicus semiroseus*	South Africa	Western Cape	De Hoop NR	Apr.1985	M. Wright	-33.96187	18.411605
I1529	*Calliptamicus semiroseus*	South Africa	Western Cape	Jonkershoek, Stellenbosch	Apr.1989	M. Pusch	-33.284812	19.144425
I1530	*Calliptamicus semiroseus*	South Africa	Western Cape	Stellenbosch, SW Cape	11.iv.1981	H. Vlok	-33.284812	19.144425
I1531	*Calliptamicus semiroseus*	South Africa	Western Cape	Stellenbosch, SW Cape	24.iii.1927		-33.155747	18.116524
TMOR 8011	*Calliptamicus semiroseus*	South Africa	Western Cape	Strandfontein	6.iii.1959	C.G.C. Dickson	-33.155747	18.116524
TMOR 8012	*Calliptamicus semiroseus*	South Africa	Western Cape	Cape Town	26.xii.1958	C.G.C. Dickson	-33.155747	18.116524
TMOR 8013	*Calliptamicus semiroseus*	South Africa	Western Cape	Cape Town	9.i.1958	C.G.C. Dickson	-34.175848	18.343161
3241183	*Calliptamuloides minimus*	South Africa	Northern Cape	Seven Weeks Poort	21.iii.1939	E.R. Helwig	-33.124566	22.04191
3241184	*Calliptamuloides minimus*	South Africa	Western Cape	Ladismith	22.iii.1939	E.R. Helwig	-31.474147	20.784047
3243436	*Calliptamuloides minimus*	South Africa	Eastern Cape	11 mi NNW Fraserburg	26.ii.1969	H.D. Brown	-31.53865	22.958855
3243437	*Calliptamuloides minimus*	South Africa	Eastern Cape	12 mi N Aberdeen	19.i.1963	H.D. Brown, W. Furst	-31.443029	21.034951
3243438	*Calliptamuloides minimus*	South Africa	Western Cape	Amandelboom, 30 km SW Merweville	24.ii.1974	H.D. Brown	-31.640899	22.544566
3243439	*Calliptamuloides minimus*	South Africa	Western Cape	10 mi NE Seekoegat	12.xii.1961	H.D. Brown, W. Furst, F. Pick	-32.127177	23.565299
3243440	*Calliptamuloides minimus*	South Africa	Eastern Cape	9 mi W Klipplaat	22.i.1963	H.D. Brown, W.	-33.081798	20.427553

						Furst		
3243441	*Calliptamuloides minimus*	South Africa	Western Cape	32 mi SW Merweville	7.xii.1961	H.D. Brown, W. Furst, F. Pick	-28.781148	17.255577
3243442	*Calliptamuloides minimus*	South Africa	Northern Cape	16 mi SE Loxton	23.ii.1969	H.D. Brown	-33.000997	21.121014
3243443	*Calliptamuloides minimus*	South Africa	Northern Cape	13 mi SW Victoria West	22.ii.1969	H.D. Brown	-32.606222	21.51507
3243444	*Calliptamuloides minimus*	South Africa	Northern Cape	Creswelle Prospect, Richtersveld	22.ix.1967	H.D. Brown	-31.506163	18.723128
3243445	*Calliptamuloides minimus*	South Africa	Western Cape	19 km N Koup Sta, 40 km W Laingsburg	23.ii.1974	H.D. Brown	-33.303011	22.053851
3243446	*Calliptamuloides minimus*	South Africa	Western Cape	16 mi SW Murraysburg	18.i.1963	M.J.D. White	-33.024137	24.174497
3243447	*Calliptamuloides minimus*	South Africa	Western Cape	Ruiterskop Sta. 30 km NNE Laingsburg	23.ii.1974	H.D. Brown	-32.862539	21.28354
3243448	*Calliptamuloides minimus*	South Africa	Western Cape	10 km N Prince Albert	28.ii.1974	H.D. Brown	-30.652473	24.010663
3243449	*Calliptamuloides minimus*	South Africa	Western Cape	8 km S Prince Albert	28.ii.1974	H.D. Brown	-31.91316	21.51406
3243450	*Calliptamuloides minimus*	South Africa	Western Cape	7 mi NE Prince Albert	12.xii.1961	H.D. Brown, W. Furst, F. Pick	-28.327798	17.036627
3243451	*Calliptamuloides minimus*	South Africa	Western Cape	4 mi N Merweville	6-7.xii.1961	H.D. Brown, W. Furst, F. Pick	-28.327798	17.036627
3243452	*Calliptamuloides minimus*	South Africa	Northern Cape	Hellskloof Pass, Richtersveld	12.x.1972	H.D. Brown, E. Koster, A. Prinsloo	-33.494168	21.271827
3243453	*Calliptamuloides minimus*	South Africa	Northern Cape	3 mi N Stinkfontein, Richtersveld	13.ix.1961	H.D. Brown, W. Furst	-33.494168	21.271827
3243454	*Calliptamuloides minimus*	South Africa	Northern Cape	16 km SE Williston	26.ii.1974	H.D. Brown	-28.292402	16.969617
3243456	*Calliptamuloides minimus*	South Africa	Northern Cape	Hellskloof Pass, Paradysberg	14.ix.1968	H.D. Brown	-33.142491	21.115528
3243458	*Calliptamuloides minimus*	South Africa	Northern Cape	Numees Mine, Richtersveld	21.ix.1967	H.D. Brown	-33.366667	21.416667
TMOR 7983	*Calliptamuloides minimus*	South Africa	Eastern Cape	Willowmore	Sept.1916	Dr. Brauns	-33.366667	21.416667
TMOR 7984	*Calliptamuloides minimus*	South Africa	Eastern Cape	Willowmore	-..	Dr. Brauns	-33.284216	23.492517
TMOR 7985	*Calliptamuloides minimus*	South Africa	Eastern Cape	Fraserburg	20.xii.1957	C.G.C. Dickson	-33.284216	23.492517
3240238	*Calliptamulus hyalinus*	South Africa	Western Cape	Paardeberg	6.iv.1921	Ch. K. Brain	-32.939284	23.897031
3242731	*Calliptamulus hyalinus*	South Africa	Western Cape	Vredefort ORD, Bain's Kloof	-..		-31.462328	25.257342
3242733	*Calliptamulus hyalinus*	South Africa	Eastern Cape	Grahamstown	Feb.1935	R.F. Laurence	-29.62061	23.088989
3242734	*Calliptamulus hyalinus*	South Africa	Western Cape	Hogsback Amatoia Mtns.	Oct.1933	R.F. Laurence	-27.389063	23.356758
3242749	*Calliptamulus hyalinus*	South Africa	Mpumalanga	Great Fish River Game Reserve, Kommandosvlei East T2	22.i.2000	M. Pareja	-30.652473	24.010663
3242750	*Calliptamulus hyalinus*	South Africa	Mpumalanga	Great Fish River Game Reserve - Graskop T2	31.i.2001	M. Pareja	-30.652473	24.010663
3243141	*Calliptamulus hyalinus*	South Africa	Eastern Cape	Middelburg	Apr-57	A.L. Reyneke	-30.652473	24.010663
3243142	*Calliptamulus hyalinus*	South Africa	Northern Cape	De Aar	19.ii.1959	A.L. Reyneke	-33.30213	26.53313

3243143	*Calliptamulus hyalinus*	South Africa	Northern Cape	De Aar	13.ii.1959	H.D. Brown	-32.902986	26.787928
3243144	*Calliptamulus hyalinus*	South Africa	Western Cape	Pakhuis Pass, Clanwilliam Dist.	1.x.1967	H.D. Brown	-32.902986	26.787928
3243145	*Calliptamulus hyalinus*	South Africa	Northern Cape	7m NW Kuruman	9.ii.1959	H.D. Brown	-24.35244	30.9514
3243146	*Calliptamulus hyalinus*	South Africa	Northern Cape	De Aar	13.xii.1959	H.D. Brown	-31.080691	18.620289
3243147	*Calliptamulus hyalinus*	South Africa	Eastern Cape	14m E Middelburg	8-14.xii.1960	H.D. Brown, Furst, Haacke	-31.506917	25.017263
3243148	*Calliptamulus hyalinus*	South Africa	Eastern Cape	10m N Miller Stn.	13.xii.1961	H.D. Brown, W. Furst, F. Pick	-31.506917	25.017263
3243149	*Calliptamulus hyalinus*	South Africa	Western Cape	Knersvlakte, 20km N from Van Rhynsdorp	6.x.1974	H.D. Brown	-33.600684	22.202469
3243150	*Calliptamulus hyalinus*	South Africa	Northern Cape	60m W Hopetown	8.iv.1961	H.D. Brown	-33.600684	22.202469
3243151	*Calliptamulus hyalinus*	South Africa	Eastern Cape	Middelburg	7.ii.1958	A.L. Reyneke	-32.148422	19.027098
I1532	*Calliptamulus hyalinus*	South Africa	Western Cape	Paardeberg	May 6, 1921	Ch. K. Brain	-33.581944	19.130627
3243106	*Calliptamulus natalensis*	South Africa	Mpumalanga	Wakkerstroom	9.i.1987	R.L. Veenemans	-32.64344	24.747647
3243156	*Calliptamulus natalensis*	South Africa	Eastern Cape	Doornberghoek, Middelburg	20.iv.1939			
3243157	*Calliptamulus natalensis*	South Africa	Eastern Cape	Miller Stn., Aberdeen	24.iii.1957	H.D. Brown	-33.92751	18.428821
3243159	*Calliptamulus natalensis*	South Africa	Eastern Cape	Willowmore	5.xii.1926	Dr. Brauns	-31.495129	25.006072
3243160	*Calliptamulus natalensis*	South Africa	Eastern Cape	Middelburg	Jan-58	A.L. Reyneke	-34.0498342	24.9225085
3243162	*Calliptamulus natalensis*	South Africa	Eastern Cape	Middelburg	7.ii.1958	A.L. Reyneke	-31.506917	25.017263
3243164	*Calliptamulus natalensis*	South Africa	Western Cape	39m S Cape Town	2.ii.1963	W. Furst	-31.506917	25.017263
3243165	*Calliptamulus natalensis*	South Africa	Eastern Cape	Jeffrey's Bay	24.i.1961	A. Lea	-33.081105	23.924993
3243166	*Calliptamulus natalensis*	South Africa	Eastern Cape	28m SSE Graaf-Reinet	23.i.1963	H.D. Brown, Furst	-32.90323	18.757043
3243167	*Calliptamulus natalensis*	South Africa	Western Cape	Cape Town	6.ii.1958	C.G.C. Dickson	-27.354925	30.143841
TMOR 1786	*Calliptamulus natalensis*	South Africa	Western Cape	Piketberg	11.ii.1957	C.G.C. Dickson	-33.284216	23.492517
TMOR 1787	*Calliptamulus natalensis*	South Africa	Eastern Cape	Willowmore	10.iv.1968	Dr. Brauns	-33.284216	23.492517
TMOR 7189	*Calliptamulus natalensis*	South Africa	Eastern Cape	Willowmore	-..	Dr. Brauns	-33.284216	23.492517
3242754	*Calliptamulus sulfurescens*	South Africa	Mpumalanga	Dullstroom, Verloren Valei NR	Mar.1996	A.J. Armstrong	-28.496301	28.422677
3242755	*Calliptamulus sulfurescens*	South Africa	Mpumalanga	Great Fish River Game Reserve, Ostrich Vlei T3	13.ii.2001	M. Pareja	-33.208245	26.34672
3243194	*Calliptamulus sulfurescens*	South Africa	Free State	Smithfield District	9.v.1917		-25.900668	30.674351
3243197	*Calliptamulus sulfurescens*	South Africa	Free State	Bloemfontein	24.ii.1918	Ch. K. Brain	-32.67878	26.08756
3243198	*Calliptamulus sulfurescens*	South Africa	Northern Cape	De Aar	13.ii.1959	H.D. Brown	-29.117693	26.21782

3243199	*Calliptamulus sulfurescens*	South Africa	Eastern Cape	Middelburg	Jan-58	A.L. Reyneke	-30.652473	24.010663
3243200	*Calliptamulus sulfurescens*	South Africa	Eastern Cape	Middelburg	20.i.1958	A.L. Reyneke	-31.495129	25.006072
3243201	*Calliptamulus sulfurescens*	South Africa	Eastern Cape	Middelburg	7.ii.1958	A.L. Reyneke	-25.304063	30.124265
3243202	*Calliptamulus sulfurescens*	South Africa	Eastern Cape	20km NW Grahamstown	3.i.1976	H.D. Brown	-25.304063	30.124265
3243203	*Calliptamulus sulfurescens*	South Africa	Eastern Cape	Bedford	26.iv.1957	A.L. Reyneke	-32.902986	26.787928
3243204	*Calliptamulus sulfurescens*	South Africa	Eastern Cape	Middelburg	27.i.1958	A.L. Reyneke	-26.140496	30.78274
3243205	*Calliptamulus sulfurescens*	South Africa	Eastern Cape	Middelburg	Mar-57	A.L. Reyneke	-25.577558	30.18473
3243206	*Calliptamulus sulfurescens*	South Africa	Eastern Cape	Middelburg	7.i.1958	A.L. Reyneke	-31.506917	25.017263
3243207	*Calliptamulus sulfurescens*	South Africa	Eastern Cape	Middelburg	Apr-57	A.L. Reyneke	-31.506917	25.017263
3243208	*Calliptamulus sulfurescens*	South Africa	Eastern Cape	Doornberghoek, Middelburg	20.iv.1939		-31.506917	25.017263
3243209	*Calliptamulus sulfurescens*	South Africa	Mpumalanga	60m NE Ermelo	Jan.1962	F. Pick	-31.506917	25.017263
3243210	*Calliptamulus sulfurescens*	South Africa	Free State	1m N Clarens	23.ii.1962	H.D. Brown, Furst	-31.506917	25.017263
3243211	*Calliptamulus sulfurescens*	South Africa	Mpumalanga	Dullstroom, Verloren Valei NR	Mar.1996	A.J. Armstrong	-31.506917	25.017263
3243214	*Calliptamulus sulfurescens*	South Africa	Mpumalanga	Lydenburg	14.i.1963	A.L. Capener	-31.506917	25.017263
TMOR 7183	*Calliptamulus sulfurescens*	South Africa	KwaZulu-Natal	Yellow Woods, Balgowan	18-28.i.1960	G. van Son.	-30.201691	26.525934
TMOR 7184	*Calliptamulus sulfurescens*	South Africa	Mpumalanga	Lochiel	Feb.1959	G. van Son.	-29.395609	30.054751
3240254	*Euryphymus haematopus*	South Africa	Western Cape	Stellenbosch	19.ix.1936		-32.146331	18.947532
3240255	*Euryphymus haematopus*	South Africa	Western Cape	Stellenbosch	Oct.1942		-32.146331	18.947532
3240276	*Euryphymus haematopus*	South Africa	Northern Cape	Namaqualand	-..		-29.658901	24.663591
3241409	*Euryphymus haematopus*	South Africa	Western Cape	Cederberg Wilderness area - jeep track near Clanwilliam Rd.	13.xii.2007	C.S. Bazelet	-30.166015	17.798652
3242444	*Euryphymus haematopus*	South Africa	Western Cape	Cederberg Wilderness area - jeep track near Clanwilliam Rd.	23.i.2008	C.S. Bazelet and B.N. Bamberger	-33.934621	18.859209
3243119	*Euryphymus haematopus*	South Africa	Northern Cape	Herbert	May 15, 1917	Ch. K. Brain	-33.934621	18.859209
TMOR 7126	*Euryphymus haematopus*	South Africa	Western Cape	Stellenbosch	11.xi.1926	Dr. Brauns	-33.934621	18.859209
3243545	*Euryphymus kalahariensis*	South Africa	Northern Cape	Kgalagadi NP, nr. Nossob Rest Camp	3.xii.2010	C.S. Bazelet , L. Strauss, J.P. Simaika	-25.421327	20.596637
3243546	*Euryphymus kalahariensis*	South Africa	Northern Cape	Kgalagadi NP, nr. Nossob Rest Camp	2.xii.2010	C.S. Bazelet , L. Strauss, J.P. Simaika	-25.421327	20.596637
3240256	*Euryphymus tuberculatus*	South Africa	Western Cape	Ceres	12.iv.2004	F. Ungerer	-33.369061	19.310775
3241417	*Euryphymus tuberculatus*	South Africa	Western Cape	West Coast National Park - near South entrance	11.xii.2007	C.S. Bazelet	-33.369061	19.310775

3242579	*Euryphymus tuberculatus*	South Africa	Northern Cape	Goegap NR, Klippas, stop 32	3.x.2008	P. Naskrecki and C. Bazelet	-29.686148	17.949329
3242589	*Euryphymus tuberculatus*	South Africa	Northern Cape	Goegap NR, nr. Ribbokkop	3.x.2008	P. Naskrecki and C. Bazelet	-29.686148	17.949329
3242593	*Euryphymus tuberculatus*	South Africa	Northern Cape	Goegap NR, on 4x4 route	3.x.2008	P. Naskrecki and C. Bazelet	-29.686148	17.949329
3243100	*Euryphymus tuberculatus*	South Africa	Mpumalanga	Groblersdal	28.ii.1977	J.S. van Eeden	-25.167361	29.398692
3243101	*Euryphymus tuberculatus*	South Africa	Free State	Whites O.V.S.	8.i.1972	H.C. de Lange	-25.746533	28.223951
3243102	*Euryphymus tuberculatus*	South Africa	Gauteng	Pretoria	1975	U. Burger	-25.746533	28.223951
I1536	*Euryphymus tuberculatus*	South Africa	Western Cape	Ceres, W Cape	Apr.12, 2004	F. Ungerer	-26.473052	20.577997
TMOR 7128	*Euryphymus tuberculatus*	South Africa	Gauteng	Pretoria	Mar.1969		-33.155747	18.116524
TMOR 7129	*Euryphymus tuberculatus*	South Africa	Eastern Cape	Willowmore	5.xi.1916	Dr. Brauns	-28.007892	26.995098
TMOR 7130	*Euryphymus tuberculatus*	South Africa	Northern Cape	Twee Rivieren, S. Kalahari, Auob River	11-20.ii.1958	G. van Son.	-33.284216	23.492517
3243083	*Pachyphymus carinatus*	South Africa	Northern Cape	Kenhardt	Nov.1948		-32.939284	23.897031
3243084	*Pachyphymus carinatus*	South Africa	Northern Cape	Gordonia District (old name)	Nov.1948		-32.483734	24.065777
3243085	*Pachyphymus carinatus*	South Africa	Northern Cape	De Aar	5.xii.1960		-23.320191	29.8042
3243086	*Pachyphymus carinatus*	South Africa	Eastern Cape	Aberdeen	16.xii.1960		-30.652473	24.010663
3243087	*Pachyphymus carinatus*	South Africa	Northern Cape	Vanwyksvlei	Feb-Mar 1956		-28.42917	21.34453
3243088	*Pachyphymus carinatus*	South Africa	Northern Cape	Gous se Kolk, N. Brandvlei	2.iii.1969		-30.46226	20.48993
3243089	*Pachyphymus carinatus*	South Africa	Eastern Cape	10m N Miller Stn.	13.xii.1961	H.D. Brown, W. Furst, F. Pick	-30.209366	17.933853
3243090	*Pachyphymus carinatus*	South Africa	Western Cape	Beaufort West	5.xii.1961		-29.345736	21.157857
3243091	*Pachyphymus carinatus*	South Africa	Northern Cape	Kamieskroon	2.x.1972		-32.763878	21.968561
3243093	*Pachyphymus carinatus*	South Africa	Northern Cape	Leeu-Gamka	28.ii.1974		-29.128299	19.394915
3243094	*Pachyphymus carinatus*	South Africa	Northern Cape	Williston	26.ii.1974		-30.349709	21.824611
3243095	*Pachyphymus carinatus*	South Africa	Northern Cape	Pofadder	23.ii.1989		-31.34028	20.91548
3240199	*Pachyphymus cristulifer*	South Africa	Eastern Cape	Willowmore	15.iv.1916	Dr. Brauns	-30.597692	18.110627
3242624	*Pachyphymus cristulifer*	South Africa	Northern Cape	Goegap NR, on 4x4 route	3.x.2008	P. Naskrecki and C. Bazelet	-29.489102	17.840102
3242625	*Pachyphymus cristulifer*	South Africa	Northern Cape	Goegap NR, on 4x4 route	3.x.2008	P. Naskrecki and C. Bazelet	-31.60873	20.627066
3243065	*Pachyphymus cristulifer*	South Africa	Western Cape	Uniondale	14.ii.1958		-32.483734	24.065777
3243066	*Pachyphymus cristulifer*	South Africa	Northern Cape	Brandvlei	1.iii.1969		-23.320191	29.8042

3243067	*Pachyphymus cristulifer*	South Africa	Eastern Cape	Klipplaat	22.ii.1958		-30.465165	20.488016
3243068	*Pachyphymus cristulifer*	South Africa	Eastern Cape	Miller Station	12.ii.-12.xii.1958		-31.46852	19.77315
3243069	*Pachyphymus cristulifer*	South Africa	Northern Cape	Nababeep	7.x.1972		-25.868804	29.223776
3243070	*Pachyphymus cristulifer*	South Africa	Eastern Cape	Waterford	21.x.1961		-29.686148	17.949329
3243071	*Pachyphymus cristulifer*	South Africa	Western Cape	3 mi SW Seekoegat	12.xii.1961	H.D. Brown, W. Furst, F. Pick	-29.686148	17.949329
3243072	*Pachyphymus cristulifer*	South Africa	Eastern Cape	Graaf-Reinet	12.xii.1961		-29.686148	17.949329
3243073	*Pachyphymus cristulifer*	South Africa	Northern Cape	Steinkopf	17.xi.1962		-32.253221	24.540653
3243074	*Pachyphymus cristulifer*	South Africa	Western Cape	Beaufort West	5.xii.1961		-32.595173	26.932255
3243075	*Pachyphymus cristulifer*	South Africa	Eastern Cape	Aberdeen	13.xii.1961		-29.535341	25.262938
3243076	*Pachyphymus cristulifer*	South Africa	Northern Cape	Springbok	3.x.1972	H.D. Brown, E. Koster, A. Prinsloo	-33.024791	24.339991
3243077	*Pachyphymus cristulifer*	South Africa	Northern Cape	Hondeklipbaai	29.ix.1967		-33.081105	23.924993
3243078	*Pachyphymus cristulifer*	South Africa	Northern Cape	Okiep	17.xi.1962		-29.592499	17.785553
3243079	*Pachyphymus cristulifer*	South Africa	Eastern Cape	Steytlerville	21.ii.1958		-29.591103	17.875198
3243080	*Pachyphymus cristulifer*	South Africa	Free State	Kalkfontein Dam NR	30.xi.1962		-29.664336	17.886495
3243081	*Pachyphymus cristulifer*	South Africa	Northern Cape	Calvinia	26.ix.1972		-29.262954	17.733405
3243082	*Pachyphymus cristulifer*	South Africa	Western Cape	Wuppertal	27.ix.1972		-33.320767	24.323589
TMOR 3253	*Pachyphymus cristulifer*	South Africa	Northern Cape	Goegap NR, Springbok	18-20.viii.1993	R. Toms and S. Green	-33.658951	23.12317
TMOR 3254	*Pachyphymus cristulifer*	South Africa	Northern Cape	20 km N Springbok	21.viii.1993	R. Toms and S. Green	-33.074982	25.018168
TMOR 3255	*Pachyphymus cristulifer*	South Africa	Northern Cape	12 km E Garies, Doringkraal Road	25.viii.1993	R. Toms and S. Green	-33.284216	23.492517
TMOR 7114	*Pachyphymus cristulifer*	South Africa	Eastern Cape	Willowmore	20.ii.1916	Dr. Brauns	-33.284216	23.492517
TMOR 7115	*Pachyphymus cristulifer*	South Africa	Eastern Cape	Willowmore	5.xi.1916	Dr. Brauns	-33.284216	23.492517
TMOR 7116	*Pachyphymus cristulifer*	South Africa	Eastern Cape	Willowmore	1914	Dr. Brauns	-33.284216	23.492517
TMOR 7117	*Pachyphymus cristulifer*	South Africa	Eastern Cape	Willowmore	15.xi.1916	Dr. Brauns	-33.284216	23.492517
TMOR 7118	*Pachyphymus cristulifer*	South Africa	Eastern Cape	Willowmore	20.ii.1916	Dr. Brauns	-33.284216	23.492517
TMOR 9568	*Pachyphymus cristulifer*	South Africa	Eastern Cape	Willowmore	1.xii.1916	Dr. Brauns	-33.284216	23.492517
TMOR 9570	*Pachyphymus cristulifer*	South Africa	Mpumalanga	De La Rey	Jan.1917	Dr. Brauns	-32.2750328	19.218328 3
3240239	*Phymeurus illepidus*	South Africa	Northern Cape	Kenhardt	22.viii.1946	F.S.W. Schumann	-29.345736	21.157857
3240315	*Phymeurus illepidus*	South Africa	KwaZulu-Natal	Pinetown	8.ii.1909	Leigh	-29.345736	21.157857

3240317	*Phymeurus illepidus*	South Africa	KwaZulu-Natal	Pinetown	3.ii.1909	Leigh	-29.820677	30.88674
3240318	*Phymeurus illepidus*	South Africa	KwaZulu-Natal	Pinetown	9.ii.1909	Leigh	-29.820677	30.88674
I1566	*Phymeurus illepidus*	South Africa	Northern Cape	Kenhandt	22.viii.1946	F.S.W. Schumann	-29.820677	30.88674
3242784	*Platacanthoides bituberculatus bituberculatus*	South Africa	Mpumalanga	Machadodorp, Mareskop	May-96	A.J. Armstrong	-25.687283	28.133377
3243365	*Plegmapteroides minutus*	South Africa	Northern Cape	4 km E Kamieskroon	2.x.1972	H.D. Brown, E. Koster, A. Prinsloo	-30.591665	17.993443
3243366	*Plegmapteroides minutus*	South Africa	Northern Cape	6 mi WSW Kamieskroon	15.ix.1967	H.D. Brown	-30.591665	17.993443
3243367	*Plegmapteroides minutus*	South Africa	Northern Cape	3 mi S Kamieskroon	4.ix.1961	H.D. Brown, W. Furst	-30.3397	17.8409
3243368	*Plegmapteroides minutus*	South Africa	Northern Cape	18 mi S Springbok	4.ix.1961	H.D. Brown, W. Furst	-30.456684	17.946051
3243369	*Plegmapteroides minutus*	South Africa	Northern Cape	2 km NE Okiep	7.x.1972	H.D. Brown, E. Koster, A. Prinsloo	-28.86079	17.231325
3243370	*Plegmapteroides minutus*	South Africa	Northern Cape	Spektakel Pass 29 km W Springbok	4.x.1972	H.D. Brown, E. Koster, A. Prinsloo	-29.99842	18.292943
3243371	*Plegmapteroides minutus*	South Africa	Northern Cape	2 mi N Kalkfontein, Richtersveld	12.ix.1961	H.D. Brown, W. Furst	-30.597692	18.110627
3243372	*Plegmapteroides minutus*	South Africa	Western Cape	Bitterfontein	14.ix.1967	H.D. Brown	-30.428798	17.937971
3243373	*Plegmapteroides minutus*	South Africa	Western Cape	14 km W Bitterfontein	29.ix.1972	H.D. Brown, E. Koster, A. Prinsloo	-29.952484	17.599077
3243374	*Plegmapteroides minutus*	South Africa	Northern Cape	1 mi S Garies	3.ix.1961	H.D. Brown, W. Furst	-29.070064	17.579427
3243375	*Plegmapteroides minutus*	South Africa	Northern Cape	12 mi N Garies	4.ix.1961	H.D. Brown, W. Furst	-29.070064	17.579427
3243376	*Plegmapteroides minutus*	South Africa	Northern Cape	Sandkopdrift, 28 km S Garies	30.ix.1972	H.D. Brown, E. Koster, A. Prinsloo	-31.041937	18.120809
3243377	*Plegmapteroides minutus*	South Africa	Northern Cape	3 mi SW Stinkfontein, Richtersveld	1.xii.1962	H.D. Brown, W. Furst	-29.122895	17.58583
3243378	*Plegmapteroides minutus*	South Africa	Northern Cape	8 km S Nababeep	7.x.1972	H.D. Brown, E. Koster, A. Prinsloo	-29.930674	17.886601
3243379	*Plegmapteroides minutus*	South Africa	Northern Cape	2 mi W Lekkersing, Richtersveld	30.xi.1962	H.D. Brown, W. Furst	-29.579515	17.890411
3243380	*Plegmapteroides minutus*	South Africa	Northern Cape	9 mi W Steinkopf	17.xi.1962	H.D. Brown, W. Furst	-28.975958	17.23079
3243381	*Plegmapteroides minutus*	South Africa	Northern Cape	8 mi W Steinkopf	6.ix.1961	H.D. Brown, W. Furst	-29.0023	17.066511
3243382	*Plegmapteroides minutus*	South Africa	Northern Cape	8 km N Niewoudtville	28.ix.1972	H.D. Brown, E. Koster, A. Prinsloo	-29.20032	17.575748
3243384	*Plegmapteroides minutus*	South Africa	Western Cape	6 mi SE Vredendal	30.ix.1967	H.D. Brown	-29.20032	17.575748
3243385	*Plegmapteroides minutus*	South Africa	Western Cape	8 mi NW Vredendal	13.ix.1967	H.D. Brown	-29.20032	17.575748

3243386	*Plegmapteroides minutus*	South Africa	Northern Cape	1 mi S Nuwerus	14.ix.1967	H.D. Brown	-29.308211	17.578513
3243408	*Plegmapteroides minutus*	South Africa	Western Cape	4 mi N Bitterfontein	3.ix.1961	H.D. Brown, W. Furst	-28.446483	17.036647
3243409	*Plegmapteroides minutus*	South Africa	Northern Cape	Buffels River, 22 mi SW Springbok	18.ix.1961	H.D. Brown, W. Furst	-30.521602	17.99373
3243410	*Plegmapteroides minutus*	South Africa	Northern Cape	9 mi N Okiep	17.xi.1962	H.D. Brown, W. Furst	-30.240366	17.913286
3243411	*Plegmapteroides minutus*	South Africa	Northern Cape	Coboop, 22 mi N Pofadder	8.iii.1969	H.D. Brown	-28.85556	17.219866
3243412	*Plegmapteroides minutus*	South Africa	Northern Cape	Wolfberg, 55 km W Springbok	4.x.1972	H.D. Brown, E. Koster, A. Prinsloo	-30.207324	17.974033
3243413	*Plegmapteroides minutus*	South Africa	Northern Cape	12 mi N Soebatsfontein	8.ix.1961	H.D. Brown, W. Furst	-30.979385	18.267323
3243414	*Plegmapteroides minutus*	South Africa	Northern Cape	10 mi N Kalkfontein, Richtersveld	30.xi.1962	H.D. Brown, W. Furst	-29.755269	17.534607
3243415	*Plegmapteroides minutus*	South Africa	Northern Cape	3 mi N Garies	15.ix.1967	H.D. Brown	-29.665395	17.984934
3243416	*Plegmapteroides minutus*	South Africa	Northern Cape	10 mi N Garies	15.ix.1967	H.D. Brown	-28.984062	17.573894
3243417	*Plegmapteroides minutus*	South Africa	Northern Cape	1 mi S Garies	3.ix.1961	H.D. Brown, W. Furst	-29.989581	18.37537
3243418	*Plegmapteroides minutus*	South Africa	Northern Cape	15 mi S Vioolsdrif	5.ix.1961	H.D. Brown, W. Furst	-31.717832	18.593669
3243419	*Plegmapteroides minutus*	South Africa	Northern Cape	27 mi S Vioolsdrif	16.ix.1961	H.D. Brown, W. Furst	-30.245376	17.840424
3243420	*Plegmapteroides minutus*	South Africa	Northern Cape	6 m S Vioolsdrif	15.ix.1961	H.D. Brown, W. Furst	-31.297238	19.114006
3243421	*Plegmapteroides minutus*	South Africa	Northern Cape	6 m SSW Gamoep, Kamiesberg	17.ix.1967	H.D. Brown	-29.666778	17.784299
3243422	*Plegmapteroides minutus*	South Africa	Northern Cape	10 mi SW Gamoep	17.ix.1967	H.D. Brown	-31.565081	18.428656
3243423	*Plegmapteroides minutus*	South Africa	Northern Cape	3 mi E Koeboes, Richtersveld	28.xi.1962	H.D. Brown, W. Furst	-29.259908	17.597607
3243424	*Plegmapteroides minutus*	South Africa	Northern Cape	Anenous Pass 12 km W Steinkopf	8.x.1972	H.D. Brown, E. Koster, A. Prinsloo	-29.259908	17.597607
3243425	*Plegmapteroides minutus*	South Africa	Northern Cape	4 mi NE Komaggas, Kamiesberg	28.ix.1967	H.D. Brown	-29.460787	17.870915
3243426	*Plegmapteroides minutus*	South Africa	Northern Cape	8 mi W Steinkopf	6.ix.1961	H.D. Brown, W. Furst	-29.263371	17.579769
3243590	*Plegmapteroides minutus*	South Africa	Northern Cape	Namaqua NP, Skilpad	26-28.xi.2009	P. Naskrecki and C. Bazelet	-29.266181	17.606973
TMOR 7279	*Plegmapteroides minutus*	South Africa	Northern Cape	12 mi S of Vioolsdrif	9.viii.1961	G. van Son and Vari	-29.237953	16.906777
TMOR 7280	*Plegmapteroides minutus*	South Africa	Northern Cape	20 mi S of Vioolsdrif	10.viii.1961	G. van Son and Vari	-29.237953	16.906777
TMOR 7301	*Plegmapteroides minutus*	South Africa	Northern Cape	12 mi S of Vioolsdrif	9.viii.1961	G. van Son and Vari	-29.898971	17.64527
TMOR 7303	*Plegmapteroides minutus*	South Africa	Northern Cape	5 mi E of Springbok	11-12.viii.1961	G. van Son and Vari		

TMOR 7309	*Plegmapteroides minutus*	South Africa	Northern Cape	12 km E Garies, Doringkraal Road	25.viii.1993	R. Toms and S. Green	-29.686148	17.949329
TMOR 7310	*Plegmapteroides minutus*	South Africa	Northern Cape	Goegap NR, Springbok	18-20.viii.1993	R. Toms and S. Green	-29.686148	17.949329
TMOR 7329	*Plegmapteroides minutus*	South Africa	Northern Cape	Aninas Pass, Port Nolloth	21.viii.1993	R. Toms and S. Green	-29.669667	17.633935
3242738	*Plegmapteropsis gracilis*	South Africa	Northern Cape	Aachenys	Oct-39	SAM museum expedition	-28.267475	16.882027
3243297	*Plegmapteropsis gracilis*	South Africa	Northern Cape	10 mi N Annisfontein, Richtersveld	27.xi.1962	H.D. Brown, W. Furst	-28.321863	17.012916
3243298	*Plegmapteropsis gracilis*	South Africa	Northern Cape	8 mi W Annisfontein, Richtersveld	26.xi.1962	H.D. Brown, W. Furst	-30.43388	18.238891
3243299	*Plegmapteropsis gracilis*	South Africa	Northern Cape	13 km N Annisfontein, Richtersveld	11.x.1972	H.D. Brown, E. Koster, A. Prinsloo	-28.297198	16.88378
3243300	*Plegmapteropsis gracilis*	South Africa	Northern Cape	6mi N Annisfontein, Richtersveld	8.ix.1961	H.D. Brown, W. Furst	-28.290854	16.906725
3243301	*Plegmapteropsis gracilis*	South Africa	Northern Cape	10 mi NE Annisfontein, Richtersveld	21.ix.1967	H.D. Brown	-29.0023	17.066511
3243302	*Plegmapteropsis gracilis*	South Africa	Northern Cape	Annisfontein, Richtersveld	9.x.1974	H.D. Brown	-28.446483	17.036647
3243303	*Plegmapteropsis gracilis*	South Africa	Northern Cape	2 mi W Lekkersing, Richtersveld	30.xi.1962	H.D. Brown, W. Furst	-28.781148	17.255577
3243305	*Plegmapteropsis gracilis*	South Africa	Northern Cape	11 mi S Sendelingsdrif, Richtersveld	26.xi.1962	H.D. Brown, W. Furst	-28.763815	17.256253
3243307	*Plegmapteropsis gracilis*	South Africa	Northern Cape	3 mi E Koeboes, Richtersveld	28.xi.1962	H.D. Brown, W. Furst	-28.935393	17.019722
3243308	*Plegmapteropsis gracilis*	South Africa	Northern Cape	4 mi W Brakfontein, Richtersveld	29.xi.1962	H.D. Brown, W. Furst	-28.329165	16.884156
3243309	*Plegmapteropsis gracilis*	South Africa	Northern Cape	4 mi N Stinkfontein, Richtersveld	1.xii.1962	H.D. Brown, W. Furst	-28.415825	16.752279
3243310	*Plegmapteropsis gracilis*	South Africa	Northern Cape	The Koei W.H., Richtersveld	22.ix.1967	H.D. Brown		
3243312	*Plegmapteropsis gracilis*	South Africa	Northern Cape	Numees Mine, Richtersveld	21.ix.1967	H.D. Brown	-28.41674	16.8833
3243313	*Plegmapteropsis gracilis*	South Africa	Northern Cape	Brand Kaross, Richtersveld	20.ix.1967	H.D. Brown	-28.47841	16.68422
3243314	*Plegmapteropsis gracilis*	South Africa	Northern Cape	3 mi N Stinkfontein, Richtersveld	13.ix.1961	H.D. Brown, W. Furst	-28.327798	17.036627
3243315	*Plegmapteropsis gracilis*	South Africa	Northern Cape	Hellskloof Pass, Richtersveld	12.x.1972	H.D. Brown, E. Koster, A. Prinsloo	-28.449055	16.992506
3243320	*Plegmapteropsis gracilis*	South Africa	Northern Cape	19 mi NE Brand Kaross, Richtersveld	10.x.1972	H.D. Brown, E. Koster, A. Prinsloo	-28.292402	16.969617
3243321	*Plegmapteropsis gracilis*	South Africa	Northern Cape	Koeboes, Richtersveld	10.ix.1961	H.D. Brown, W. Furst	-28.285497	17.010793
3242664	*Plegmapterus fernandezi*	South Africa	Western Cape	Lammerskraal, Prince Albert Dist.	Sep.1947	SAM museum expedition	-29.326003	21.986522
3242665	*Plegmapterus fernandezi*	South Africa	Eastern Cape	Middelburg	Nov.1935	SAM museum	-28.291612	16.903175

						expedition		
3242666	*Plegmapterus fernandezi*	South Africa	Northern Cape	Kamieskroon	Sep.1930	SAM museum expedition	-29.754594	24.118352
3242667	*Plegmapterus fernandezi*	South Africa		Koupfiding	Nov.1939	SAM museum expedition	-31.443029	21.034951
3242668	*Plegmapterus fernandezi*	South Africa	Free State	Goedemoed nr. Orange R.	Nov.1939	SAM museum expedition	-31.805747	21.38914
3242669	*Plegmapterus fernandezi*	South Africa	Western Cape	Merweville Dist.	Feb-41	H. Linn	-29.545011	20.930999
3242670	*Plegmapterus fernandezi*	South Africa	Western Cape	Jeunberg Burghersdorp	Nov-39	SAM museum expedition	-31.744594	21.340768
3242671	*Plegmapterus fernandezi*	South Africa	Northern Cape	Mynardo Kraal Letulenbosch	Oct-41	SAM museum expedition	-31.497707	21.10544
3242672	*Plegmapterus fernandezi*	South Africa	Western Cape	Murraysburg Dist.	Mar-31	SAM museum expedition	-32.463164	20.200559
3242675	*Plegmapterus fernandezi*	South Africa	Western Cape	Laingsburg Dist.	Oct-64	P. Pretorius	-29.623343	17.822473
3242676	*Plegmapterus fernandezi*	South Africa	Western Cape	nr. Doornbosch	Spe 1961	SAM museum expedition	-30.712551	25.102423
3242677	*Plegmapterus fernandezi*	South Africa		Hauvree?	1905	D. Purcell	-30.652473	24.010663
3242678	*Plegmapterus fernandezi*	South Africa	Northern Cape	Hutchinson	Apr-20	M. Marshall	-32.900002	21.366668
3242679	*Plegmapterus fernandezi*	South Africa	Northern Cape	De Aar	10.iii.1902		-31.91316	21.51406
3242680	*Plegmapterus fernandezi*	South Africa	Northern Cape	Bushmanland Jakkals Water	Oct-11	R. Lightfoot		
3242681	*Plegmapterus fernandezi*	South Africa	Eastern Cape	Fraserburg	Apr 1884		-30.567475	26.407801
3242683	*Plegmapterus fernandezi*	South Africa	Western Cape	Perdewater, Prince Albert Dist.	Sep-47	SAM museum expedition	-30.567475	26.407801
3242684	*Plegmapterus fernandezi*	South Africa	Western Cape	Mooredenaars Karoo Lammerfontein	Oct-52			
3242685	*Plegmapterus fernandezi*	South Africa	Western Cape	Dikbome Merweville Dist. Koup	Oct-52		-31.497731	23.189021
3243394	*Plegmapterus fernandezi*	South Africa	Northern Cape	25 km SE Williston	26.ii.1974	H.D. Brown		
3243395	*Plegmapterus fernandezi*	South Africa	Northern Cape	16 km SE Williston	26.ii.1974	H.D. Brown	-30.209366	17.933853
3243396	*Plegmapterus fernandezi*	South Africa	Eastern Cape	19 km NW Fraserburg	26.ii.1974	H.D. Brown		
3243397	*Plegmapterus fernandezi*	South Africa	Eastern Cape	11 mi NNW Fraserburg	26.ii.1969	H.D. Brown	-33.194954	20.858724
3243398	*Plegmapterus fernandezi*	South Africa	Eastern Cape	25 km NW Fraserburg	27.ii.1974	H.D. Brown	-32.81537	22.313991
3243399	*Plegmapterus fernandezi*	South Africa	Northern Cape	7 mi SE De Aar	7.i.1963	M.J.D. White	-32.667558	21.515542
3243400	*Plegmapterus fernandezi*	South Africa	Northern Cape	19 mi SW Kenhardt	15.xi.1962	H.D. Brown, W. Furst	-31.506917	25.017263
3243401	*Plegmapterus fernandezi*	South Africa	Eastern Cape	Teekloof Pass, 30 km S Fraserburg	25.ii.1974	H.D. Brown	-31.960457	23.76204
3243402	*Plegmapterus fernandezi*	South Africa	Northern Cape	13 km S Hopetown	4.xii.1960	H.D. Brown, W. Furst, Haacke	-31.960457	23.76204

3243403	*Plegmapterus fernandezi*	South Africa		Frausenhof	25.xi.1957	A.L. Reyneke	-30.921091	23.925011
3243404	*Plegmapterus fernandezi*	South Africa	Northern Cape	Vanwyksvlei	Mar-56	H.D. Brown	-31.974202	19.232742
3243405	*Plegmapterus fernandezi*	South Africa	Northern Cape	10 mi NW Marydale	10.xii.1962	H.D. Brown, W. Furst	-32.920985	22.302102
3243406	*Plegmapterus fernandezi*	South Africa	Northern Cape	3 mi NW Blouheuvel, Tankwa Karoo	2.ix.1968	H.D. Brown	-29.234811	21.873143
TMOR 7366	*Plegmapterus fernandezi*	South Africa	Northern Cape	Putzonderwater	18.iii.1958	G. van Son.	-29.891311	30.256302
TMOR 7635	*Plegmapterus fernandezi*	South Africa	Northern Cape	Colesberg	14.iii.1957	W. Marais	-32.190277	21.623109
TMOR 7637	*Plegmapterus fernandezi*	South Africa	KwaZulu-Natal	Richmond	29.iii.1957	C.G.C. Dickson	-30.349709	21.824611
3240278	*Plegmapterus irisus*	South Africa		"Transvaal"	-..			
3243322	*Plegmapterus irisus*	South Africa	Western Cape	3 mi SW Seekoegat	12.xii.1961	H.D. Brown, W. Furst, F. Pick	-33.124566	22.04191
3243323	*Plegmapterus irisus*	South Africa	Northern Cape	30 mi NNW Sutherland	21.ix.1966	H.D. Brown	-23.944679	30.37111
3243324	*Plegmapterus irisus*	South Africa	Western Cape	4 mi N Merweville	6-7.xii.1961	H.D. Brown, W. Furst, F. Pick	-31.640899	22.544566
3243325	*Plegmapterus irisus*	South Africa	Western Cape	10 km N Prince Albert	28.ii.1974	H.D. Brown	-31.937933	20.244365
3243326	*Plegmapterus irisus*	South Africa	Western Cape	8 km S Prince Albert	28.ii.1974	H.D. Brown	-32.246839	20.491508
3243327	*Plegmapterus irisus*	South Africa	Northern Cape	16 mi SE Loxton	23.ii.1969	H.D. Brown	-32.679164	20.395728
3243328	*Plegmapterus irisus*	South Africa	Northern Cape	6 km SW Sutherland	25.ix.1972	H.D. Brown, E. Koster, A. Prinsloo	-31.60873	20.627066
3243329	*Plegmapterus irisus*	South Africa	Northern Cape	11 km SW Sutherland	25.ix.1972	H.D. Brown, E. Koster, A. Prinsloo	-32.011748	20.468446
3243330	*Plegmapterus irisus*	South Africa	Northern Cape	24 km NW Sutherland	25.ix.1972	H.D. Brown	-32.606222	21.51507
3243331	*Plegmapterus irisus*	South Africa	Northern Cape	25 mi SW Sutherland	20.ix.1966	H.D. Brown	-32.437772	20.613518
3243332	*Plegmapterus irisus*	South Africa	Western Cape	Ruiterskop Sta. 30 km NNE Laingsburg	23.ii.1974	H.D. Brown	-33.303011	22.053851
3243333	*Plegmapterus irisus*	South Africa	Northern Cape	2 mi S Middelpos nr. Tankwa Karoo NP	3.ix.1968	H.D. Brown	-33.142491	21.115528
3242663	*Plegmapterus saturatus*	South Africa		Torquiz R.	no label	Purcell	-31.416583	19.585256
3242736	*Plegmapterus saturatus*	South Africa	Western Cape	Uitko Mtns., Tulbagh	Jan.1950	J.H. Linn	-32.392862	24.297276
3242737	*Plegmapterus saturatus*	South Africa	Western Cape	Wit River Valley Bain's Kloof	Dec.1949	SAM museum expedition	-31.119866	19.238292
3242740	*Plegmapterus saturatus*	South Africa	Western Cape	Rust En Vrede Oudtshoorn	Oct-51	SAM museum expedition	-32.77191	24.054898
3242741	*Plegmapterus saturatus*	South Africa	Western Cape	Oudtshoorn Zebra	Oct.1951	SAM museum expedition	-33.275582	23.872133
3243334	*Plegmapterus saturatus*	South Africa	Eastern Cape	Rhenosterberg, Middelburg, East Karroo	8.xi.1956	H.D. Brown	-32.972188	22.322419
3243335	*Plegmapterus saturatus*	South Africa	Northern Cape	19 mi NNE Niewoudtville	6.ix.1968	H.D. Brown	-30.604169	18.035093

3243336	*Plegmapterus saturatus*	South Africa	Northern Cape	8 km N Niewoudtville	28.ix.1972	H.D. Brown, E. Koster, A. Prinsloo	-30.207324	17.974033
3243337	*Plegmapterus saturatus*	South Africa	Northern Cape	12 mi WNW Calvinia	6.ix.1968	H.D. Brown	-29.665395	17.984934
3243338	*Plegmapterus saturatus*	South Africa	Eastern Cape	20 mi S Aberdeen	14.xii.1961	H.D. Brown, W. Furst, F. Pick	-29.665395	17.984934
3243339	*Plegmapterus saturatus*	South Africa	Eastern Cape	7 mi SE Willowmore	13.ii.1958	H.D. Brown	-33.714936	24.779037
3243340	*Plegmapterus saturatus*	South Africa	Eastern Cape	50 mi SE Steytlerville, Great Karoo	21.ii.1958	H.D. Brown	-30.763666	24.094606
3243341	*Plegmapterus saturatus*	South Africa	Eastern Cape	15 mi ENE Aberdeen, Great Karoo	12.xi.1918	H.D. Brown	-31.297238	19.114006
3243342	*Plegmapterus saturatus*	South Africa	Western Cape	24 mi NE Prince Albert	12.xii.1961	H.D. Brown, W. Furst, F. Pick	-33.968626	19.079452
3243343	*Plegmapterus saturatus*	South Africa	Northern Cape	Botterkloof Pass 56 km S Niewoudtville	27.ix.1972	H.D. Brown, E. Koster, A. Prinsloo	-31.87996	19.113805
3243344	*Plegmapterus saturatus*	South Africa	Western Cape	Doorn Riv. 32 km NW Wuppertal	27.ix.1972	H.D. Brown, E. Koster, A. Prinsloo	-30.394189	18.484078
3243345	*Plegmapterus saturatus*	South Africa	Northern Cape	3m SE Garies	15.ix.1967	H.D. Brown	-32.1857	18.8945
3243347	*Plegmapterus saturatus*	South Africa	Northern Cape	4 km E Kamieskroon	2.x.1972	H.D. Brown, E. Koster, A. Prinsloo	-32.075794	18.976721
3243348	*Plegmapterus saturatus*	South Africa	Eastern Cape	22 mi E Willowmore	13.xi.1958	H.D. Brown	-33.969357	18.936351
3243349	*Plegmapterus saturatus*	South Africa	Northern Cape	Bushmanland, Farm Banke	22.x.1990	J.D. Arbuthnot, E.T. Butler	-33.969357	18.936351
3243350	*Plegmapterus saturatus*	South Africa	Western Cape	Rooiberg Pass 18 m NE Van Wyksdorp	9.ii.1961	H.D. Brown, W. Furst, F. Pick	-33.23083	20.582212 9
3243351	*Plegmapterus saturatus*	South Africa	Northern Cape	Van Rhyn's Pass, 6 mi W Niewoudtville	21.ix.1961	H.D. Brown, W. Furst	-33.23083	20.582212 9
I1567	*Plegmapterus saturatus*	South Africa	Western Cape	Jonkershoek	Feb.1, 1980	C.H.G. Schlettwein	-33.23083	20.582212 9
TMOR 7337	*Plegmapterus saturatus*	South Africa	Northern Cape	5 mi E of Springbok	11-12.viii.1961	G. van Son and Vari	-33.3819	19.667618
TMOR 7338	*Plegmapterus saturatus*	South Africa	Western Cape	Clanwilliam	11-13.xi.1968	G. van Son.	-33.763701	22.315524
TMOR 7339	*Plegmapterus saturatus*	South Africa	Western Cape	Welbedacht, Oudtshoorn	Nov.1940	G. van Son.	-30.444914	24.026859
TMOR 7340	*Plegmapterus saturatus*	South Africa	Western Cape	Assegaibos, La Motte	Oct.1940	G. van Son.	-33.648074	21.645916
TMOR 7341	*Plegmapterus saturatus*	South Africa	Western Cape	Matroosberg	18.x.1967	Vari and Potgieter	-33.39007	22.345901
TMOR 7343	*Plegmapterus saturatus*	South Africa	Eastern Cape	Willowmore	15.ix.1916	Dr. Brauns		
TMOR 7344	*Plegmapterus saturatus*	South Africa		Woodb. Vill.	Apr.1915	C.J. Swierstra	-33.279179	19.136614
TMOR 7348	*Plegmapterus saturatus*	South Africa	Eastern Cape	Willowmore	Sept.1916	Dr. Brauns	-33.074982	25.018168
TMOR 7349	*Plegmapterus saturatus*	South Africa	Eastern Cape	Willowmore	1.xii.1916	Dr. Brauns	-33.613688	22.022332
TMOR 7350	*Plegmapterus saturatus*	South Africa	Western Cape	Matjiesfontein	17.xii.1958	C.G.C. Dickson	-33.613688	22.022332

TMOR 7352	*Plegmapterus saturatus*	South Africa	Eastern Cape	Willowmore	1.x.1916	Dr. Brauns	-33.284216	23.492517
TMOR 7353	*Plegmapterus saturatus*	South Africa	Eastern Cape	Willowmore	Oct-11	Dr. Brauns	-33.284216	23.492517
TMOR 7355	*Plegmapterus saturatus*	South Africa	Western Cape	Matjiesfontein	17.xii.1958	C.G.C. Dickson	-33.284216	23.492517
TMOR 7357	*Plegmapterus saturatus*	South Africa	Western Cape	Jonkersberg	Nov.1941	G. van Son.	-33.284216	23.492517
TMOR 7359	*Plegmapterus saturatus*	South Africa	Eastern Cape	Waterford	21.x.1961		-33.616667	19.1
TMOR 7360	*Plegmapterus saturatus*	South Africa	Western Cape	Matjiesfontein	22-26.ix.1940	G. van Son.		
3242653	*Plegmapterus sinuosus*	South Africa	Western Cape	Cederberg nr. Sanddrif, Valley of the Red Gods	15.x.1995	S. van Noort	-32.460356	-32.460356
3242654	*Plegmapterus sinuosus*	South Africa	Northern Cape	O'Kiep	1985			
3242655	*Plegmapterus sinuosus*	South Africa	Northern Cape	Springbok	Oct-90	R. Lightfoot	-28.872666	16.69531
3242656	*Plegmapterus sinuosus*	South Africa	Western Cape	Franschhoek	1913	E. P. Phillips	-31.431527	18.782549
3242657	*Plegmapterus sinuosus*	South Africa	Northern Cape	O'Kiep	Sep-90	R. Lightfoot	-30.521602	17.99373
3242660	*Plegmapterus sinuosus*	South Africa		Gedanbergen	1921	K. Lamberth	-30.604169	18.035093
3242662	*Plegmapterus sinuosus*	South Africa	Western Cape	Riviersonderend Mtns.	Nov-Dec 1928	K.H. Barnard	-30.207324	17.974033
3242739	*Plegmapterus sinuosus*	South Africa	Western Cape	Papendorp, Olifant's R.	Oct.1950	SAM museum expedition	-30.979385	18.267323
3243352	*Plegmapterus sinuosus*	South Africa	Northern Cape	11 mi SE Leliesfontein, Kamiesberge	6.ix.1968	H.D. Brown	-24.894421	31.598388
3243353	*Plegmapterus sinuosus*	South Africa	Western Cape	8 mi NW Vredendal	13.ix.1967	H.D. Brown	-31.565081	18.428656
3243354	*Plegmapterus sinuosus*	South Africa	Northern Cape	Paradysberg, Richtersveld	23.ix.1967	H.D. Brown	-29.259908	17.597607
3243355	*Plegmapterus sinuosus*	South Africa	Northern Cape	3m SE Garies	15.ix.1967	H.D. Brown	-29.266181	17.606973
3243356	*Plegmapterus sinuosus*	South Africa	Northern Cape	3 mi N Garies	15.ix.1967	H.D. Brown	-31.037308	18.265443
3243357	*Plegmapterus sinuosus*	South Africa	Northern Cape	23 mi. N Van Rhynsdorp	27.ix.1968	H.D. Brown	-32.488189	19.266218
3243358	*Plegmapterus sinuosus*	South Africa	Northern Cape	8 mi W Steinkopf	6.ix.1961	H.D. Brown, W. Furst	-33.913564	19.122933
3243359	*Plegmapterus sinuosus*	South Africa	Western Cape	4 mi N Bitterfontein	3.ix.1961	H.D. Brown, W. Furst		
3243360	*Plegmapterus sinuosus*	South Africa	Northern Cape	22 mi S Alexander Bay	18.ix.1962	H.D. Brown, W. Furst	-29.591103	17.875198
3243361	*Plegmapterus sinuosus*	South Africa	Northern Cape	Anenous Pass 12 km W Steinkopf	8.x.1972	H.D. Brown, E. Koster, A. Prinsloo	-29.591103	17.875198
3243362	*Plegmapterus sinuosus*	South Africa	Northern Cape	4 km E Kamieskroon	2.x.1972	H.D. Brown, E. Koster, A. Prinsloo	-31.691474	18.195117
3243363	*Plegmapterus sinuosus*	South Africa	Western Cape	Bitterfontein	14.ix.1967	H.D. Brown	-28.327712	17.037199
3243364	*Plegmapterus sinuosus*	South Africa	Northern Cape	7 mi N Van Rhynsdorp	3.ix.1961	H.D. Brown, W. Furst	-34.141571	19.918921

TMOR 7368	*Plegmapterus sinuosus*	South Africa	Western Cape	11 km NW of Vredendal	29.viii.1993	R. Toms and S. Green	-29.664336	17.886495
3242614	*Plegmapterus splendens*	South Africa	Northern Cape	Goegap NR, bush huts, nr. main entrance	2-4.x.2008	P. Naskrecki and C. Bazelet	-29.673371	17.911706
3242687	*Plegmapterus splendens*	South Africa	Western Cape	Cape Hex R.	Mar 1882		-30.657413	18.007527
3242688	*Plegmapterus splendens*	South Africa		Jon. Sc. Hist. 2	16.ix.1889		-33.665134	23.353959
3242689	*Plegmapterus splendens*	South Africa	Northern Cape	Port Nolloth	1897		-33.337803	18.521815
3242690	*Plegmapterus splendens*	South Africa	Western Cape	Prince Albert Dist.	Sep.1896	D. Purcell	-32.189277	18.893995
3242691	*Plegmapterus splendens*	South Africa	Western Cape	Cape Hex R.	Dec 1884		-33.50605	19.529408
3242692	*Plegmapterus splendens*	South Africa	Western Cape	Matjiesfontein	Oct.1891	R. Triman	-33.50605	19.529408
3242693	*Plegmapterus splendens*	South Africa	Northern Cape	Victoria West	-..		-32.1857	18.8945
3242695	*Plegmapterus splendens*	South Africa	Western Cape	Franschhoek	-..	E. Sehabb	-30.712551	25.102423
3242696	*Plegmapterus splendens*	South Africa	Northern Cape	6 m S of Garies	Oct-67	F. W. Gass	-32.80001	26.650004
3242698	*Plegmapterus splendens*	South Africa	Western Cape	Bosiesveld Bergen	Feb-40		-33.913564	19.122933
3242699	*Plegmapterus splendens*	South Africa	Northern Cape	Outiep Garies	Sep-53	J. du Toit		
3242700	*Plegmapterus splendens*	South Africa	Western Cape	Lammerskraal, Prince Albert Dist.	Sep-47	SAM museum expedition	-32.707145	26.295239
3242701	*Plegmapterus splendens*	South Africa		Fowesdorp	Nov-31	SAM museum expedition	-30.567475	26.407801
3242702	*Plegmapterus splendens*	South Africa	Western Cape	Clanwilliam	27.ix.1977	V.B. Whitehead	-29.686148	17.949329
3242703	*Plegmapterus splendens*	South Africa	Northern Cape	Colesberg	Nov-39	SAM museum expedition	-33.19721	20.861265
3242704	*Plegmapterus splendens*	South Africa	Free State	Goedemoed nr. Orange R.	Nov.1939	SAM museum expedition	-29.61956	24.08693
3242717	*Plegmapterus splendens*	South Africa	Western Cape	Michell's Pass, Ceres District	Oct.1934	SAM museum expedition	-30.209366	17.933853
3242718	*Plegmapterus splendens*	South Africa	Western Cape	Olifants R. between Citrusdal/ Clanwilliam	Oct-Nov 1931	SaM museum expedition	-28.021584	18.748026
3242719	*Plegmapterus splendens*	South Africa	Western Cape	Bokouga - Uniondale Dist.	Mar-54	SAM museum expedition	-29.345736	21.157857
3242720	*Plegmapterus splendens*	South Africa	Western Cape	Leipoldtville, Eland's Bay	Nov.1948	SAM museum expedition	-32.81537	22.313991
3242721	*Plegmapterus splendens*	South Africa	Western Cape	Bulhoek Klaver, Clanwilliam	Oct.1950	SAM museum expedition	-32.222301	18.481105
3242722	*Plegmapterus splendens*	South Africa	Northern Cape	O'Kiep	Sep.1890		-33.23083	20.582212 9
3242723	*Plegmapterus splendens*	South Africa	western Cape	Upper Sources Oliphant's R. Ceres	Dec.1949	SAM museum expedition	-33.378797	19.296497
3242724	*Plegmapterus splendens*	South Africa	Western Cape	Wit River Valley Bain's Kloof	Dec.1949	SAM museum	-26.187744	25.576621

						expedition		
3242725	*Plegmapterus splendens*	South Africa	Western Cape	Gouph Lainsberg Dist.	Sep.1937	SAM museum expedition	-29.591103	17.875198
3242726	*Plegmapterus splendens*	South Africa	Western Cape	Oudtshoorn Zebra	Oct.1951	SAM museum expedition	-32.457583	18.966963
3242727	*Plegmapterus splendens*	South Africa	Eastern Cape	Gardiner's Drift, Adelaide	Mar.1954	SAM museum expedition	-33.763701	22.315524
3242728	*Plegmapterus splendens*	South Africa	Eastern Cape	Fort Beaufort "Umdala"	Mar-54	SAM museum expedition	-30.593784	17.851427
3242729	*Plegmapterus splendens*	South Africa	Western Cape	Papendorp, Olifant's R.	Oct.1950	SAM museum expedition	-31.691474	18.195117
3242730	*Plegmapterus splendens*	South Africa	Western Cape	Perdewater, Prince Albert's D.	Sep.1947	SAM museum expedition	-32.920985	22.302102
3243287	*Plegmapterus splendens*	South Africa	Northern Cape	30 mi Springbok	1.ix.1967	J. Munting	-29.128299	19.394915
3243291	*Plegmapterus splendens*	South Africa		Frausenhof	25.xi.1957	A.L. Reyneke	-29.128299	19.394915
3243292	*Plegmapterus splendens*	Namibia		Karasburg	Aug.1950	J.J.L.	-33.229239	22.027357
TMOR 7331	*Plegmapterus splendens*	South Africa	Northern Cape	Hopetown	13-18.ix.1940	G. van Son.	-33.15423	19.239973
TMOR 7332	*Plegmapterus splendens*	South Africa	Northern Cape	Pofadder	22.viii.1950	G. van Son.	-31.417434	23.119959
TMOR 7333	*Plegmapterus splendens*	South Africa	Northwest	Naauwport	26.x.1948	G. van Son.	-31.417434	23.119959
TMOR 7334	*Plegmapterus splendens*	South Africa	Northern Cape	Kenhardt	3.x.1954	G. van Son.	-33.616667	19.1
3240200	*Rhachitopis crassus*	South Africa	Free State	Bloemfontein	16.v.1919	Ch. K. Brain	-29.657833	23.751794
3240201	*Rhachitopis crassus*	South Africa	Free State	Herbert	15.v.1917		-31.44085	20.43228
3240206	*Rhachitopis crassus*	South Africa	Northern Cape	Williston	12.v.1925	C.S. Eckard	-29.128425	20.224753
3240211	*Rhachitopis crassus*	South Africa	Western Cape	Stellenbosch	13.iv.1940		-29.117693	26.21782
3240215	*Rhachitopis crassus*	South Africa	Northern Cape	Calvinia	3.iv.1973	J. de Kock	-31.46852	19.77315
3240216	*Rhachitopis crassus*	South Africa	Free State	Petrusburg	16.iv.1947		-31.46852	19.77315
3240263	*Rhachitopis crassus*	South Africa	Western Cape	Middleburg	7.iv.1955		-31.46852	19.77315
3240264	*Rhachitopis crassus*	South Africa	Western Cape	Middleburg	16-18.v.1955	D.H. Botha	-31.46852	19.77315
3240268	*Rhachitopis crassus*	South Africa	Free State	Petrusburg	26-27.iv.1917	J.C. Faure	-25.868804	29.223776
3240290	*Rhachitopis crassus*	South Africa	Northern Cape	40 mi. E. of Calvinia	18.iii.1939	E.R. Helwig	-25.868804	29.223776
3240291	*Rhachitopis crassus*	South Africa	Northern Cape	Calvinia	19.iii.1939	E.R. Helwig	-31.91316	21.51406
3240298	*Rhachitopis crassus*	South Africa	Eastern Cape	Fraserburg	19.iii.1939	E.R. Helwig	-32.902986	26.787928
3240299	*Rhachitopis crassus*	South Africa	Northern Cape	20 miles west of Hopetown	25.iii.1928	H.K. Munro	-29.658901	24.663591

3240300	*Rhachitopis crassus*	South Africa	Northern Cape	Hopetown	27.i.1930	H.K. Munro	-29.658901	24.663591
3240301	*Rhachitopis crassus*	South Africa	Mpumalanga	De La Rey	Jan.1917	Dr. Brauns	-29.658901	24.663591
3240311	*Rhachitopis crassus*	South Africa	Northern Cape	Kimberley	-..		-29.61956	24.08693
3240312	*Rhachitopis crassus*	South Africa	Eastern Cape	Richmond	9.iv.1935		-29.61956	24.08693
3240348	*Rhachitopis crassus*	South Africa	Northern Cape	Hopetown	27.i.1930	H.K. Munro	-29.61956	24.08693
3241189	*Rhachitopis crassus*	South Africa	Northern Cape	Bethulie	28.iv.1915		-28.74321	24.766157
3241190	*Rhachitopis crassus*	South Africa	Eastern Cape	Willowmore	Jan-22	Dr. Brauns	-31.506917	25.017263
3242942	*Rhachitopis crassus*	South Africa	Eastern Cape	Great Fish River Game Reserve, Buffalo Camp North	2.vi.2001	M. Pareja	-31.506917	25.017263
I1586	*Rhachitopis crassus*	South Africa	Free State	Herbert	May 15, 1917		-26.187744	25.576621
I1587	*Rhachitopis crassus*	South Africa	Northern Cape	Calvinia	Apr.3, 1973	J. De Kock	-29.115975	25.414347
I1588	*Rhachitopis crassus*	South Africa	Northern Cape	Williston	May 12, 1925	C.S. Eckard	-29.115975	25.414347
I1590	*Rhachitopis crassus*	South Africa	Free State	Petrusburg	Apr.16, 1947		-29.115975	25.414347
I1593	*Rhachitopis crassus*	South Africa	Free State	Herbert	May 15, 1917		-29.717562	22.743384
I1595	*Rhachitopis crassus*	South Africa	Free State	Bloemfontein	6.v.1919	Ch. K. Brain	-29.234811	21.873143
I1596	*Rhachitopis crassus*	South Africa	Northern Cape	Williston, Cape Prov.	May 12, 1925	C.S. Eckard	-29.234811	21.873143
TMOR 7221	*Rhachitopis crassus*	South Africa	Free State	Petrusburg	26-27.iv.1917	J.C. Faure	-33.934621	18.859209
TMOR 7224	*Rhachitopis crassus*	South Africa	Mpumalanga	De La Rey	Jan.1917	Dr. Brauns	-26.473052	20.577997
TMOR 7226	*Rhachitopis crassus*	South Africa	Northern Cape	Putzonderwater	18.iii.1958	G. van Son.	-26.473052	20.577997
TMOR 7234	*Rhachitopis crassus*	South Africa	Eastern Cape	Willowmore	Dec.1917		-31.34028	20.91548
TMOR 7235	*Rhachitopis crassus*	South Africa	Northern Cape	Hopetown	13-18.ix.1940	G. van Son.	-31.34028	20.91548
TMOR 7236	*Rhachitopis crassus*	South Africa	Northern Cape	Mynfontein Farm, 20 mi S of de Aar	10-15.vi.1971	A. Strydom	-31.34028	20.91548
TMOR 7237	*Rhachitopis crassus*	South Africa	Northern Cape	50 mi E of Pofadder	18.iii.1958	G. van Son.	-31.34028	20.91548
TMOR 7238	*Rhachitopis crassus*	South Africa	Northern Cape	Twee Rivieren, S. Kalahari, Auob River	11-20.ii.1958	G. van Son.	-31.34028	20.91548
TMOR 7242	*Rhachitopis crassus*	South Africa	Northern Cape	Twee Rivieren, S. Kalahari, Auob River	24.v.1955	V. Fitzsimmons	-33.284216	23.492517
TMOR 7243	*Rhachitopis crassus*	South Africa	Northern Cape	Prieska	May-73		-33.284216	23.492517
TMOR 7215	*Rhachitopis curvipes curvipes*	South Africa	Free State	Smithfield District	9.v.1917		-28.233021	28.308668
TMOR 7216	*Rhachitopis curvipes curvipes*	South Africa	Eastern Cape	Steytlersville	Mar.1934		-29.658901	24.663591

TMOR 7218	*Rhachitopis curvipes curvipes*	South Africa	Free State	Bethlehem	25.iii.1922		-29.115975	25.414347
TMOR 7220	*Rhachitopis curvipes curvipes*	South Africa	Free State	Petrusburg	26-27.iv.1917	J.C. Faure	-30.201691	26.525934
TMOR 7222	*Rhachitopis curvipes curvipes*	South Africa	Free State	Herbert	15.v.1917		-33.320767	24.323589
TMOR 7223	*Rhachitopis curvipes curvipes*	South Africa	Northern Cape	Namaqualand	-..		-33.320767	24.323589
3240202	*Rhachitopis nigripes*	South Africa	Western Cape	Stellenbosch	28.x.1934		-33.934621	18.859209
3240203	*Rhachitopis nigripes*	South Africa	Western Cape	Stellenbosch	28.x.1937		-33.934621	18.859209
3240204	*Rhachitopis nigripes*	South Africa	Western Cape	Stellenbosch	25.x.1934		-33.934621	18.859209
I1600	*Rhachitopis nigripes*	South Africa	Western Cape	Stellenbosch	Oct.28, 1937		-33.934621	18.859209
TMOR 7244	*Rhachitopis nigripes*	South Africa	Western Cape	Stellenbosch	Oct.1926		-33.934621	18.859209
3240265	*Rhachitopis sanguinipes*	South Africa	Western Cape	Langkloof V. 3m N Isuberana	17.ii.1958	H.D. Brown	-33.950479	24.293841
3240313	*Rhachitopis sanguinipes*	South Africa	Western Cape	Langkloof V., 11m W of Kareedouw	18.ii.1958	H.D. Brown	-33.950479	24.293841
3243121	*Rhodesiana maculata*	South Africa	Limpopo	Langjan	27.ii.1988	K. Kappmeier	-22.842198	29.243016

Supplement 3

Field collected specimens collected in the southern Karoo

Specimen code	*Species*	Country	Province	Locality	Date	Collector	Storage	Latitude	Longitude	BOLD accession number
BGPT1032	*Amblyphymus rubidus*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Tshililo	SAM	-30.98139703	25.69878596	
BGPT1213	*Amblyphymus rubidus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Tshililo	SAM	-32.89379102	26.01819003	
BGPT0817	*Calliptamicus semiroseus*	South Africa	Western Cape	Popelierbos, Ceres	16-Nov-16	C.Bazelet	SAM	-32.78462503	20.11978802	
BGPT0827	*Calliptamicus semiroseus*	South Africa	Western Cape	Popelierbos, Ceres	16-Nov-16	P.Tshililo	SAM	-32.78486903	20.12298999	
BGPT0850	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Strauss	SAM	-31.82084396	24.49835401	
BGPT0863	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Tshililo	SAM	-31.82084396	24.49835401	
BGPT0874	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Strauss	SAM	-31.82084396	24.49835401	
BGPT0881	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Strauss	SAM	-31.82084396	24.49835401	
BGPT0965	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Modderfontein, Tarka	04-Mar-17	P.Strauss	SAM	-31.86206801	26.163004	
BGPT0968	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Modderfontein, Tarka	04-Mar-17	P.Strauss	SAM	-31.86206801	26.163004	
BGPT0975	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Strauss	SAM	-32.48231602	23.61438199	
BGPT0977	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Strauss	SAM	-32.48231602	23.61438199	
BGPT0978	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Strauss	SAM	-32.48231602	23.61438199	
BGPT0979	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Strauss	SAM	-32.48231602	23.61438199	
BGPT0981	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Strauss	SAM	-32.48231602	23.61438199	
BGPT0983	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Strauss	SAM	-32.48231602	23.61438199	
BGPT0994	*Calliptamicus semiroseus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Strauss	SAM	-31.55376099	23.99671496	
BGPT0997	*Calliptamicus semiroseus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Strauss	SAM	-31.55376099	23.99671496	
BGPT1076	*Calliptamicus semiroseus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Tshililo	SAM	-31.55027697	23.996981	
BGPT1077	*Calliptamicus semiroseus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Tshililo	SAM	-31.55027697	23.996981	
BGPT1078	*Calliptamicus semiroseus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Tshililo	SAM	-31.55027697	23.996981	
BGPT1081	*Calliptamicus semiroseus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Tshililo	SAM	-31.55027697	23.996981	

BGPT1082	*Calliptamicus semiroseus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Tshililo	SAM	-31.55027697	23.996981
BGPT1089	*Calliptamicus semiroseus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Strauss	SAM	-31.55186299	23.99457397
BGPT1090	*Calliptamicus semiroseus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Strauss	SAM	-31.55186299	23.99457397
BGPT1098	*Calliptamicus semiroseus*	South Africa	Northern Cape	Mesfontein, Richmond	08-Mar-17	P.Tshililo	SAM	-31.10894999	24.04637799
BGPT1099	*Calliptamicus semiroseus*	South Africa	Northern Cape	Mesfontein, Richmond	08-Mar-17	P.Tshililo	SAM	-31.10894999	24.04637799
BGPT1125	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Tshililo	SAM	-32.48231602	23.61438199
BGPT1126	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Tshililo	SAM	-32.48231602	23.61438199
BGPT1127	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Tshililo	SAM	-32.48231602	23.61438199
BGPT1203	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Waterval Safaris, Cradock	01-Mar-17	P.Strauss	SAM	-32.44776196	25.70137102
BGPT1207	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Tshililo	SAM	-32.89379102	26.01819003
BGPT1325	*Calliptamicus semiroseus*	South Africa	Northern Cape	Mesfontein, Richmond	08-Mar-17	P.Tshililo	SAM	-31.106264	24.04644102
BGPT1333	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Tshililo	SAM	-32.48587598	23.61843296
BGPT1335	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Tshililo	SAM	-32.48587598	23.61843296
BGPT1339	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Tshililo	SAM	-32.48587598	23.61843296
BGPT1340	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Tshililo	SAM	-32.48587598	23.61843296
BGPT1341	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Tshililo	SAM	-32.48587598	23.61843296
BGPT1342	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Tshililo	SAM	-32.48587598	23.61843296
BGPT1343	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Tshililo	SAM	-32.48587598	23.61843296
BGPT1344	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Tshililo	SAM	-32.48587598	23.61843296
BGPT1345	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Tshililo	SAM	-32.48587598	23.61843296
BGPT1346	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Tshililo	SAM	-32.48587598	23.61843296
BGPT1351	*Calliptamicus semiroseus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Tshililo	SAM	-31.55376099	23.99671496
BGPT1352	*Calliptamicus semiroseus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Tshililo	SAM	-31.55376099	23.99671496
BGPT1355	*Calliptamicus semiroseus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Tshililo	SAM	-31.55376099	23.99671496
BGPT1356	*Calliptamicus semiroseus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Tshililo	SAM	-31.55376099	23.99671496
BGPT1357	*Calliptamicus semiroseus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Tshililo	SAM	-31.55376099	23.99671496
BGPT1358	*Calliptamicus semiroseus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Tshililo	SAM	-31.55376099	23.99671496
BGPT1359	*Calliptamicus semiroseus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Tshililo	SAM	-31.55376099	23.99671496

BGPT1387	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Strauss	SAM	-32.889372	26.01079501
BGPT1412	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Modderfontein, Tarka	04-Mar-17	P.Tshililo	SAM	-31.86206801	26.163004
BGPT1413	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Modderfontein, Tarka	04-Mar-17	P.Tshililo	SAM	-31.86206801	26.163004
BGPT1415	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Modderfontein, Tarka	04-Mar-17	P.Tshililo	SAM	-31.86206801	26.163004
BGPT1420	*Calliptamicus semiroseus*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Tshililo	SAM	-30.98139703	25.69878596
BGPT1426	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Waterval Safaris, Cradock	01-Mar-17	P.Tshililo	SAM	-32.58044899	26.27273804
BGPT1450	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Strauss	SAM	-32.48587598	23.61843296
BGPT1452	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Strauss	SAM	-32.48587598	23.61843296
BGPT1456	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Strauss	SAM	-32.48587598	23.61843296
BGPT1457	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Strauss	SAM	-32.48587598	23.61843296
BGPT1460	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Strauss	SAM	-32.48587598	23.61843296
BGPT1463	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Strauss	SAM	-32.48587598	23.61843296
BGPT1489	*Calliptamicus semiroseus*	South Africa	Northern Cape	Marseilles, Victoria West	23-Mar-17	P.Strauss	SAM	-32.51371002	20.88276803
BGPT1495	*Calliptamicus semiroseus*	South Africa	Northern Cape	Marseilles, Victoria West	23-Mar-17	P.Strauss	SAM	-32.51371002	20.88276803
BGPT1500	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Blackhill, Adelaide	28-Feb-17	P.Tshililo	SAM	-32.57980702	26.27242204
BGPT1503	*Calliptamicus semiroseus*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Tshililo	SAM	-30.97790203	25.70530096
BGPT1505	*Calliptamicus semiroseus*	South Africa	Western Cape	Landsig, Murraysburg	14-Mar-17	P.Tshililo	SAM	-31.982063	23.54723004
BGPT1507	*Calliptamicus semiroseus*	South Africa	Western Cape	Landsig, Murraysburg	14-Mar-17	P.Tshililo	SAM	-31.982063	23.54723004
BGPT1508	*Calliptamicus semiroseus*	South Africa	Western Cape	Landsig, Murraysburg	14-Mar-17	P.Tshililo	SAM	-31.982063	23.54723004
BGPT1513	*Calliptamicus semiroseus*	South Africa	Northern Cape	Mesfontein, Richmond	08-Mar-17	P.Strauss	SAM	-31.106264	24.04644102
BGPT1518	*Calliptamicus semiroseus*	South Africa	Northern Cape	Mesfontein, Richmond	08-Mar-17	P.Strauss	SAM	-31.106264	24.04644102
BGPT1520	*Calliptamicus semiroseus*	South Africa	Northern Cape	Mesfontein, Richmond	08-Mar-17	P.Strauss	SAM	-31.106264	24.04644102
BGPT1528	*Calliptamicus semiroseus*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Tshililo	SAM	-30.98310996	25.70317397
BGPT1531	*Calliptamicus semiroseus*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Tshililo	SAM	-30.98310996	25.70317397
BGPT1538	*Calliptamicus semiroseus*	South Africa	Eastern Cape	Waterval Safaris,	01-Mar-17	P.Strauss	SAM	-30.98310996	25.70317397

				Cradock					
BGPT1542	*Calliptamicus semiroseus*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Strauss	SAM	-30.98310996	25.70317397
BGPT1543	*Calliptamicus semiroseus*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Strauss	SAM	-30.98310996	25.70317397
BGPT1551	*Calliptamicus semiroseus*	South Africa	Northern Cape	Besiesbult, Victoria West	16-Mar-17	P.Strauss	SAM	-31.10897203	22.76842601
BGPT1588	*Calliptamicus semiroseus*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Strauss	SAM	-30.98310996	25.70317397
BGPT1608	*Calliptamicus semiroseus*	South Africa	Northern Cape	Rietfontein, Colesburg	07-Mar-17	P.Strauss	SAM	-30.90778196	25.01246701
BGPT0839	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Tshililo	SAM	-31.82084396	24.49835401
BGPT0840	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Tshililo	SAM	-31.82084396	24.49835401
BGPT0841	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Tshililo	SAM	-31.82084396	24.49835401
BGPT0842	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Tshililo	SAM	-31.82084396	24.49835401
BGPT0843	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Tshililo	SAM	-31.82084396	24.49835401
BGPT0844	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Tshililo	SAM	-31.82084396	24.49835401
BGPT0845	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Tshililo	SAM	-31.82084396	24.49835401
BGPT0846	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Tshililo	SAM	-31.82084396	24.49835401
BGPT0847	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Strauss	SAM	-31.82084396	24.49835401
BGPT0848	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Strauss	SAM	-31.82084396	24.49835401
BGPT0851	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Strauss	SAM	-31.82084396	24.49835401
BGPT0856	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Tshililo	SAM	-31.82084396	24.49835401
BGPT0857	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Tshililo	SAM	-31.82084396	24.49835401
BGPT0858	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Tshililo	SAM	-31.82084396	24.49835401
BGPT0859	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Tshililo	SAM	-31.82084396	24.49835401
BGPT0860	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Tshililo	SAM	-31.82084396	24.49835401

BGPT0861	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Tshililo	SAM	-31.82084396	24.49835401
BGPT0862	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Tshililo	SAM	-31.82084396	24.49835401
BGPT0866	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Tshililo	SAM	-31.82084396	24.49835401
BGPT0873	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Strauss	SAM	-31.82084396	24.49835401
BGPT0876	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Strauss	SAM	-31.82084396	24.49835401
BGPT0878	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Strauss	SAM	-31.82084396	24.49835401
BGPT0879	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Strauss	SAM	-31.82084396	24.49835401
BGPT0880	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Strauss	SAM	-31.82084396	24.49835401
BGPT1206	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Tshililo	SAM	-32.89379102	26.01819003
BGPT1208	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Tshililo	SAM	-32.89379102	26.01819003
BGPT1209	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Tshililo	SAM	-32.89379102	26.01819003
BGPT1210	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Tshililo	SAM	-32.89379102	26.01819003
BGPT1211	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Tshililo	SAM	-32.89379102	26.01819003
BGPT1212	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Tshililo	SAM	-32.89379102	26.01819003
BGPT1215	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Tshililo	SAM	-32.89379102	26.01819003
BGPT1217	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Strauss	SAM	-32.89379102	26.01819003
BGPT1221	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Strauss	SAM	-32.892435	26.01496803
BGPT1222	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Strauss	SAM	-32.892435	26.01496803
BGPT1223	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Strauss	SAM	-32.892435	26.01496803
BGPT1224	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Strauss	SAM	-32.892435	26.01496803
BGPT1225	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Strauss	SAM	-32.892435	26.01496803
BGPT1229	*Platacanthoides*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Strauss	SAM	-32.89379102	26.01819003

	bituberculatus									
BGPT1375	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Strauss	SAM	-32.889372	26.01079501	
BGPT1377	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Strauss	SAM	-32.889372	26.01079501	
BGPT1380	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Strauss	SAM	-32.889372	26.01079501	
BGPT1381	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Strauss	SAM	-32.889372	26.01079501	
BGPT1383	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Strauss	SAM	-32.889372	26.01079501	
BGPT1395	*Platacanthoides bituberculatus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Strauss	SAM	-32.889372	26.01079501	
BGPT1544	*Platacanthoides bituberculatus*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Strauss	SAM	-30.98310996	25.70317397	
BGPT1545	*Platacanthoides bituberculatus*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Strauss	SAM	-30.98310996	25.70317397	
BGPT0928	*Calliptamuloides minimus*	South Africa	Northern Cape	Portugals rivier, Sutherland	23-Mar-17	P.Tshililo	SAM	-32.51862701	20.88527396	
BGPT0988	*Calliptamuloides minimus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Strauss	SAM	-31.55376099	23.99671496	
BGPT0995	*Calliptamuloides minimus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Strauss	SAM	-31.55376099	23.99671496	
BGPT1001	*Calliptamuloides minimus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Strauss	SAM	-31.55376099	23.99671496	
BGPT0883	*Calliptamulus natalensis*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Strauss	SAM	-31.82084396	24.49835401	
BGPT1031	*Calliptamulus natalensis*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Tshililo	SAM	-30.98139703	25.69878596	
BGPT1033	*Calliptamulus natalensis*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Tshililo	SAM	-30.98139703	25.69878596	
BGPT1034	*Calliptamulus natalensis*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Tshililo	SAM	-30.98139703	25.69878596	
BGPT1051	*Calliptamulus natalensis*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Tshililo	SAM	-32.58044899	26.27273804	
BGPT1052	*Calliptamulus natalensis*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Tshililo	SAM	-32.58044899	26.27273804	
BGPT1053	*Calliptamulus natalensis*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Tshililo	SAM	-32.58044899	26.27273804	
BGPT0078b	*Euryphymus sp.1*	South Africa	Western Cape	Riet kuil, Beaufort West	11-Oct-16	P.Tshililo	SAM	-32.46419803	22.13961102	
BGPT0350	*Euryphymus sp.1*	South Africa	Eastern Cape	Saltpans drift trust, Cradock	27-Sep-16	C.Bazelet	SAM	-31.86546503	25.47238003	
BGPT0617	*Euryphymus sp.1*	South Africa	Eastern Cape	Saltpans drift trust, Cradock	27-Sep-16	C.Bazelet	SAM	-32.18824198	24.79368098	KBGP059
BGPT0093	*Euryphymus sp.10*	South Africa	Northern Cape	Marseilles, Victoria	13-Oct-16	P.Strauss	SAM	-31.34331596	23.14624398	

				West					
BGPT0094	*Euryphymus sp.10*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Strauss	SAM	-31.34331596	23.14624398
BGPT0095	*Euryphymus sp.10*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Strauss	SAM	-31.34331596	23.14624398
BGPT0096	*Euryphymus sp.10*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Tshililo	SAM	-31.34038104	23.15273803
BGPT0097	*Euryphymus sp.10*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Tshililo	SAM	-31.34038104	23.15273803
BGPT0103	*Euryphymus sp.10*	South Africa	Western Cape	Riet kuil, Beaufort West	11-Oct-16	P.Tshililo	SAM	-32.46419803	22.13961102
BGPT0104	*Euryphymus sp.10*	South Africa	Western Cape	Riet kuil, Beaufort West	11-Oct-16	P.Tshililo	SAM	-32.46419803	22.13961102
BGPT0105	*Euryphymus sp.10*	South Africa	Western Cape	Riet kuil, Beaufort West	11-Oct-16	P.Tshililo	SAM	-32.46419803	22.13961102
BGPT0106	*Euryphymus sp.10*	South Africa	Western Cape	Riet kuil, Beaufort West	11-Oct-16	P.Tshililo	SAM	-32.46419803	22.13961102
BGPT0107	*Euryphymus sp.10*	South Africa	Western Cape	Riet kuil, Beaufort West	11-Oct-16	P.Tshililo	SAM	-32.46419803	22.13961102
BGPT0118	*Euryphymus sp.10*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Strauss	SAM	-32.96931599	22.355067
BGPT0130	*Euryphymus sp.10*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Tshililo	SAM	-32.96396297	22.35213099
BGPT0142	*Euryphymus sp.10*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Tshililo	SAM	-32.96931599	22.355067
BGPT0143	*Euryphymus sp.10*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Tshililo	SAM	-32.96931599	22.355067
BGPT0144	*Euryphymus sp.10*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Tshililo	SAM	-32.96931599	22.355067
BGPT0145	*Euryphymus sp.10*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Tshililo	SAM	-32.96931599	22.355067
BGPT0146	*Euryphymus sp.10*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Tshililo	SAM	-32.96931599	22.355067
BGPT0157	*Euryphymus sp.10*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Tshililo	SAM	-31.34331596	23.14624398
BGPT0158	*Euryphymus sp.10*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Tshililo	SAM	-31.34331596	23.14624398
BGPT0159	*Euryphymus sp.10*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Tshililo	SAM	-31.34331596	23.14624398
BGPT0162	*Euryphymus sp.10*	South Africa	Western Cape	Riet kuil, Beaufort West	11-Oct-16	P.Tshililo	SAM	-32.45944097	22.13559701
BGPT0164	*Euryphymus sp.10*	South Africa	Western Cape	Riet kuil, Beaufort West	11-Oct-16	P.Tshililo	SAM	-32.45944097	22.13559701

BGPT0175	*Euryphymus sp.10*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Tshililo	SAM	-31.34038104	23.15273803	
BGPT0176	*Euryphymus sp.10*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Tshililo	SAM	-32.96931599	22.355067	
BGPT0209	*Euryphymus sp.10*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Tshililo	SAM	-32.96396297	22.35213099	
BGPT0222	*Euryphymus sp.10*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Strauss	SAM	-31.34038104	23.15273803	
BGPT0229	*Euryphymus sp.10*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Strauss	SAM	-31.34038104	23.15273803	
BGPT0257	*Euryphymus sp.10*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Strauss	SAM	-31.34331596	23.14624398	
BGPT0258	*Euryphymus sp.10*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Strauss	SAM	-31.34331596	23.14624398	
BGPT0263	*Euryphymus sp.10*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Strauss	SAM	-31.34331596	23.14624398	
BGPT0267	*Euryphymus sp.10*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Tshililo	SAM	-31.34331596	23.14624398	
BGPT0269	*Euryphymus sp.10*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Tshililo	SAM	-31.34331596	23.14624398	
BGPT0347	*Euryphymus sp.10*	South Africa	Eastern Cape	Saltpans drift trust, Cradock	27-Sep-16	C.Bazelet	SAM	-31.86546503	25.47238003	
BGPT0349	*Euryphymus sp.10*	South Africa	Eastern Cape	Saltpans drift trust, Cradock	27-Sep-16	P.Tshililo	SAM	-31.86740804	25.47298	KBGP068
BGPT0351	*Euryphymus sp.10*	South Africa	Eastern Cape	Saltpans drift trust, Cradock	27-Sep-16	P.Tshililo	SAM	-31.86546503	25.47238003	
BGPT0356	*Euryphymus sp.10*	South Africa	Western Cape	Saltpans drift trust, Cradock	27-Sep-16	P.Tshililo	SAM	-31.86740804	25.47298	
BGPT0361	*Euryphymus sp.10*	South Africa	Western Cape	Kalk dam, Beaufort West	04-Oct-16	P.Tshililo	SAM	-32.80631203	23.31824298	
BGPT0371	*Euryphymus sp.10*	South Africa	Eastern Cape	Saltpans drift trust, Cradock	27-Sep-16	C.Bazelet	SAM	-31.86546503	25.47238003	
BGPT0377	*Euryphymus sp.10*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Strauss	SAM	-32.48587598	23.61843296	
BGPT0379	*Euryphymus sp.10*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Strauss	SAM	-32.48587598	23.61843296	
BGPT0501	*Euryphymus sp.10*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Tshililo	SAM	-32.55382497	25.19256896	KBGP081
BGPT0567	*Euryphymus sp.10*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Tshililo	SAM	-32.48587598	23.61843296	
BGPT0579	*Euryphymus sp.10*	South Africa	Eastern Cape	Hope well, Beaufort West	05-Oct-16	P.Tshililo	SAM	-32.30744898	23.11293396	
BGPT0591	*Euryphymus sp.10*	South Africa	Western Cape	Landsig, Murraysburg	29-Sep-16	P.Strauss	SAM	-31.98253297	23.54720003	

BGPT0597	*Euryphymus sp.10*	South Africa	Eastern Cape	Saltpans drift trust, Cradock	27-Sep-16	P.Tshililo	SAM	-31.86546503	25.47238003	
BGPT0599	*Euryphymus sp.10*	South Africa	Eastern Cape	Saltpans drift trust, Cradock	27-Sep-16	P.Tshililo	SAM	-31.86546503	25.47238003	KBGP066
BGPT0609	*Euryphymus sp.10*	South Africa	Eastern Cape	Saltpans drift trust, Cradock	27-Sep-16	P.Tshililo	SAM	-31.86546503	25.47238003	
BGPT0613	*Euryphymus sp.10*	South Africa	Western Cape	Landsig, Murraysburg	29-Sep-16	P.Tshililo	SAM	-31.98253297	23.54720003	
BGPT0616	*Euryphymus sp.10*	South Africa	Eastern Cape	Goodluck, Jansenville	30-Sep-16	P.Strauss	SAM	-33.04218398	24.96153496	
BGPT0628	*Euryphymus sp.10*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Tshililo	SAM	-32.55055703	25.19461599	
BGPT0888	*Euryphymus sp.10*	South Africa	Northern Cape	Marseilles, Victoria West	17-Mar-17	P.Tshililo	SAM	-31.33515299	23.14751501	
BGPT0901	*Euryphymus sp.10*	South Africa	Northern Cape	Marseilles, Victoria West	17-Mar-17	P.Strauss	SAM	-31.33515299	23.14751501	
BGPT0971	*Euryphymus sp.10*	South Africa	Eastern Cape	Modderfontein, Tarka	04-Mar-17	P.Tshililo	SAM	-31.86206801	26.163004	
BGPT0972	*Euryphymus sp.10*	South Africa	Eastern Cape	Modderfontein, Tarka	04-Mar-17	P.Tshililo	SAM	-31.86206801	26.163004	
BGPT1561	*Euryphymus sp.10*	South Africa	Northern Cape	Rietfontein, Colesburg	07-Mar-17	P.Strauss	SAM	-30.90778196	25.01246701	
BGPT1563	*Euryphymus sp.10*	South Africa	Northern Cape	Rietfontein, Colesburg	07-Mar-17	P.Strauss	SAM	-30.90778196	25.01246701	
BGPT0078a	*Euryphymus sp.11*	South Africa	Western Cape	Riet kuil, Beaufort West	11-Oct-16	P.Tshililo	SAM	-32.46419803	22.13961102	KBGP019
BGPT1565	*Euryphymus sp.12*	South Africa	Northern Cape	Rietfontein, Colesburg	07-Mar-17	P.Strauss	SAM	-30.90778196	25.01246701	
BGPT1437	*Euryphymus sp.13*	South Africa	Northern Cape	Rietfontein, Colesburg	07-Mar-17	P.Tshililo	SAM	-31.211908	20.53180802	
BGPT1547	*Euryphymus sp.13*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Strauss	SAM	-30.98310996	25.70317397	
BGPT1590	*Euryphymus sp.13*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Strauss	SAM	-30.98310996	25.70317397	
BGPT1598	*Euryphymus sp.13*	South Africa	Northern Cape	Rietfontein, Colesburg	07-Mar-17	P.Strauss	SAM	-30.90778196	25.01246701	
BGPT1599	*Euryphymus sp.13*	South Africa	Northern Cape	Rietfontein, Colesburg	07-Mar-17	P.Strauss	SAM	-30.90778196	25.01246701	
BGPT0046	*Euryphymus sp.2*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Tshililo	SAM	-32.48587598	23.61843296	
BGPT0047	*Euryphymus sp.2*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Tshililo	SAM	-32.48587598	23.61843296	
BGPT0049	*Euryphymus sp.2*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Tshililo	SAM	-32.48587598	23.61843296	
BGPT0050	*Euryphymus sp.2*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Tshililo	SAM	-32.48587598	23.61843296	

BGPT0051	*Euryphymus sp.2*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Tshililo	SAM	-32.48587598	23.61843296	KBGP014
BGPT0053	*Euryphymus sp.2*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Tshililo	SAM	-32.48587598	23.61843296	
BGPT0056	*Euryphymus sp.2*	South Africa	Western Cape	Kalk dam, Beaufort West	04-Oct-16	P.Strauss	SAM	-32.79987498	23.320275	KBGP056
BGPT0067	*Euryphymus sp.2*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Tshililo	SAM	-32.48922103	23.61545102	KBGP018
BGPT0068	*Euryphymus sp.2*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Tshililo	SAM	-32.48922103	23.61545102	
BGPT0394a	*Euryphymus sp.2*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Tshililo	SAM	-32.48231602	23.61438199	
BGPT0394b	*Euryphymus sp.2*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Tshililo	SAM	-32.48231602	23.61438199	
BGPT0395	*Euryphymus sp.2*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Tshililo	SAM	-32.48231602	23.61438199	
BGPT0396	*Euryphymus sp.2*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Tshililo	SAM	-32.48231602	23.61438199	
BGPT0449	*Euryphymus sp.2*	South Africa	Western Cape	Kalk dam, Beaufort West	04-Oct-16	P.Strauss	SAM	-32.80722398	23.31559799	
BGPT0473	*Euryphymus sp.2*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Tshililo	SAM	-32.48231602	23.61438199	
BGPT0479	*Euryphymus sp.2*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Tshililo	SAM	-32.48231602	23.61438199	
BGPT0480	*Euryphymus sp.2*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Tshililo	SAM	-32.48231602	23.61438199	KBG015
BGPT0486	*Euryphymus sp.2*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Strauss	SAM	-32.48231602	23.61438199	
BGPT0487a	*Euryphymus sp.2*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Strauss	SAM	-32.48231602	23.61438199	KBGP016
BGPT0487b	*Euryphymus sp.2*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Strauss	SAM	-32.48231602	23.61438199	
BGPT0568	*Euryphymus sp.2*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Tshililo	SAM	-32.48587598	23.61843296	
BGPT0601	*Euryphymus sp.2*	South Africa	Eastern Cape	Saltpans drift trust, Cradock	27-Sep-16	P.Tshililo	SAM	-31.86546503	25.47238003	
BGPT0607	*Euryphymus sp.2*	South Africa	Eastern Cape	Saltpans drift trust, Cradock	27-Sep-16	C.Bazelet	SAM	-31.86546503	25.47238003	
BGPT0651	*Euryphymus sp.2*	South Africa	Eastern Cape	Rooidraai, Aberdeen	06-Oct-16	P.Tshililo	SAM	-32.48922103	23.61545102	KBGP017
BGPT0781	*Euryphymus sp.2*	South Africa	Eastern Cape	Rooidraai, Aberdeen	06-Oct-16	P.Strauss	SAM	-32.48922103	23.61545102	
BGPT0782	*Euryphymus sp.2*	South Africa	Eastern Cape	Rooidraai, Aberdeen	06-Oct-16	P.Strauss	SAM	-32.48922103	23.61545102	
BGPT0976	*Euryphymus sp.2*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Strauss	SAM	-32.48231602	23.61438199	
BGPT1128	*Euryphymus sp.2*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Tshililo	SAM	-32.48231602	23.61438199	
BGPT0077	*Euryphymus sp.3*	South Africa	Western Cape	Riet kuil, Beaufort West	11-Oct-16	P.Tshililo	SAM	-32.46419803	22.13961102	
BGPT0168	*Euryphymus sp.3*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Tshililo	SAM	-31.33515299	23.14751501	
BGPT0348	*Euryphymus sp.3*	South Africa	Western Cape	Landsig, Murraysburg	29-Sep-16	P.Tshililo	SAM	-31.98253297	23.54720003	

BGPT0374	*Euryphymus sp.3*	South Africa	Eastern Cape	Landsig, Murraysburg	29-Sep-16	P.Strauss	SAM	-31.98253297	23.54720003	
BGPT0382	*Euryphymus sp.3*	South Africa	Western Cape	Kalk dam, Beaufort West	04-Oct-16	P.Strauss	SAM	-32.80631203	23.31824298	
BGPT0516	*Euryphymus sp.3*	South Africa	Eastern Cape	Hope well, Beaufort West	05-Oct-16	P.Tshililo	SAM	-32.30744898	23.11293396	
BGPT0611	*Euryphymus sp.3*	South Africa	Western Cape	Landsig, Murraysburg	29-Sep-16	P.Strauss	SAM	-31.98253297	23.54720003	
BGPT0620	*Euryphymus sp.3*	South Africa	Eastern Cape	Hope well, Beaufort West	05-Oct-16	P.Tshililo	SAM	-32.30744898	23.11293396	KBGP023
BGPT0663	*Euryphymus sp.3*	South Africa	Western Cape	Hopewell, Beaufort West	05-Oct-16	P.Tshililo	SAM	-32.30134796	23.11290001	
BGPT0691	*Euryphymus sp.3*	South Africa	Western Cape	Hopewell, Beaufort West	05-Oct-16	P.Tshililo	SAM	-32.30631399	23.11545901	KBGP025
BGPT0695	*Euryphymus sp.3*	South Africa	Western Cape	Hopewell, Beaufort West	05-Oct-16	P.Tshililo	SAM	-32.30631399	23.11545901	
BGPT0754	*Euryphymus sp.3*	South Africa	Western Cape	Hopewell, Beaufort West	05-Oct-16	P.Tshililo	SAM	-32.30134796	23.11290001	
BGPT0763	*Euryphymus sp.3*	South Africa	Western Cape	Hopewell, Beaufort West	05-Oct-16	P.Strauss	SAM	-32.30631399	23.11545901	KBGP024
BGPT0811	*Euryphymus sp.3*	South Africa	Western Cape	Landsig, Murraysburg	29-Sep-16	P.Tshililo	SAM	-31.98018302	23.55174696	KBGP022
BGPT1317	*Euryphymus sp.3*	South Africa	Western Cape	Taaiboschfontein, beaufort West	10-Mar-17	P.Strauss	SAM	-31.92964199	22.891226	
BGPT1318	*Euryphymus sp.3*	South Africa	Western Cape	Taaiboschfontein, beaufort West	10-Mar-17	P.Strauss	SAM	-31.92964199	22.891226	
BGPT1485	*Euryphymus sp.3*	South Africa	Western Cape	Landsig, Murraysburg	14-Mar-17	P.Strauss	SAM	-31.98018302	23.55174696	
BGPT1511	*Euryphymus sp.3*	South Africa	Western Cape	Landsig, Murraysburg	14-Mar-17	P.Tshililo	SAM	-31.982063	23.54723004	
BGPT0054	*Euryphymus sp.4*	South Africa	Western Cape	Kalk dam, Beaufort West	04-Oct-16	P.Strauss	SAM	-32.79987498	23.320275	
BGPT0399	*Euryphymus sp.4*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Tshililo	SAM	-32.55382497	25.19256896	
BGPT0500	*Euryphymus sp.4*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Tshililo	SAM	-32.55382497	25.19256896	
BGPT0502	*Euryphymus sp.4*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Tshililo	SAM	-32.55382497	25.19256896	
BGPT0505	*Euryphymus sp.4*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Tshililo	SAM	-32.55382497	25.19256896	
BGPT0506	*Euryphymus sp.4*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Strauss	SAM	-32.55391398	25.19606003	
BGPT0507	*Euryphymus sp.4*	South Africa	Eastern Cape	Plains of Camdeboo,	03-Oct-16	P.Strauss	SAM	-32.55391398	25.19606003	

				Pearston						
BGPT0527	*Euryphymus sp.4*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Strauss	SAM	-32.55055703	25.19461599	KBGP077
BGPT0625	*Euryphymus sp.4*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Tshililo	SAM	-32.55055703	25.19461599	
BGPT0626	*Euryphymus sp.4*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Tshililo	SAM	-32.55055703	25.19461599	KBGP082
BGPT0627	*Euryphymus sp.4*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Tshililo	SAM	-32.55055703	25.19461599	
BGPT0629	*Euryphymus sp.4*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Tshililo	SAM	-32.55055703	25.19461599	
BGPT0630	*Euryphymus sp.4*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Tshililo	SAM	-32.55055703	25.19461599	
BGPT0632	*Euryphymus sp.4*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Tshililo	SAM	-32.55055703	25.19461599	KBGP074
BGPT0633	*Euryphymus sp.4*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Tshililo	SAM	-32.55055703	25.19461599	KBGP075
BGPT0703	*Euryphymus sp.4*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Tshililo	SAM	-32.55391398	25.19606003	KBGP083
BGPT0705	*Euryphymus sp.4*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Tshililo	SAM	-32.55391398	25.19606003	
BGPT0707	*Euryphymus sp.4*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Tshililo	SAM	-32.55391398	25.19606003	
BGPT0710	*Euryphymus sp.4*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Tshililo	SAM	-32.55391398	25.19606003	
BGPT0711	*Euryphymus sp.4*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Tshililo	SAM	-32.55391398	25.19606003	
BGPT0712	*Euryphymus sp.4*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Tshililo	SAM	-32.55391398	25.19606003	
BGPT0057	*Euryphymus sp.5*	South Africa	Western Cape	Kalk dam, Beaufort West	04-Oct-16	P.Strauss	SAM	-32.79987498	23.320275	KBGP057
BGPT0076	*Euryphymus sp.5*	South Africa	Western Cape	Riet kuil, Beaufort West	11-Oct-16	P.Tshililo	SAM	-32.46419803	22.13961102	
BGPT0340	*Euryphymus sp.5*	South Africa	Western Cape	Kalk dam, Beaufort West	04-Oct-16	P.Tshililo	SAM	-32.80631203	23.31824298	KBGP053
BGPT0341	*Euryphymus sp.5*	South Africa	Western Cape	Kalk dam, Beaufort West	04-Oct-16	P.Tshililo	SAM	-32.80631203	23.31824298	
BGPT0724	*Euryphymus sp.5*	South Africa	Western Cape	Kalk dam, Beaufort West	04-Oct-16	P.Strauss	SAM	-32.80631203	23.31824298	
BGPT0728	*Euryphymus sp.5*	South Africa	Western Cape	Kalk dam, Beaufort West	04-Oct-16	P.Strauss	SAM	-32.80722398	23.31559799	
BGPT0779	*Euryphymus sp.5*	South Africa	Western Cape	Kalk dam, Beaufort West	04-Oct-16	P.Tshililo	SAM	-32.80722398	23.31559799	KBGP055

BGPT0398	*euryphymus sp.6*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Tshililo	SAM	-32.55382497	25.19256896	KBGP078
BGPT0501A	*Euryphymus sp.6*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Strauss	SAM	-32.55391398	25.19606003	KBGP080
BGPT0503	*Euryphymus sp.6*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Tshililo	SAM	-32.55382497	25.19256896	KBGP076
BGPT0509	*Euryphymus sp.6*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Strauss	SAM	-32.55391398	25.19606003	KBGP080
BGPT0709	*Euryphymus sp.6*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Tshililo	SAM	-32.55391398	25.19606003	
BGPT0344	*Euryphymus sp.7*	South Africa	Eastern Cape	Goodluck, Jansenville	30-Sep-16	P.Strauss	SAM	-33.04218398	24.96153496	KBGP060
BGPT0373	*Euryphymus sp.7*	South Africa	Eastern Cape	Saltpans drift trust, Cradock	27-Sep-16	P.Tshililo	SAM	-31.86546503	25.47238003	KBGP064
BGPT0375	*Euryphymus sp.7*	South Africa	Eastern Cape	Saltpans drift trust, Cradock	27-Sep-16	P.Tshililo	SAM	-31.86740804	25.47298	KBGP065
BGPT0345	*Euryphymus sp.8*	South Africa	Eastern Cape	Goodluck, Jansenville	30-Sep-16	P.Strauss	SAM	-33.04218398	24.96153496	KBGP060
BGPT0590	*Euryphymus sp.8*	South Africa	Eastern Cape	Goodluck, Jansenville	30-Sep-16	P.Strauss	SAM	-33.042043	24.96443803	
BGPT0595	*Euryphymus sp.8*	South Africa	Eastern Cape	Goodluck, Jansenville	30-Sep-16	P.Tshililo	SAM	-33.04218398	24.96153496	KBGP061
BGPT0084	*Euryphymus sp.9*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Tshililo	SAM	-32.96396297	22.35213099	KBGP069
BGPT0802	*Euryphymus sp.9*	South Africa	Eastern Cape	Saltpans drift trust, Cradock	27-Sep-16	P.Strauss	SAM	-31.86546503	25.47238003	
BGPT0821	*Euryphymus sp.9*	South Africa	Western Cape	Popelierbos , Ceres	16-Nov-16	P.Tshililo	SAM	-32.78462503	20.11978802	KBGP071
BGPT0824	*Euryphymus sp.9*	South Africa	Western Cape	Popelierbos , Ceres	16-Nov-16	C.Bazelet	SAM	-32.78486903	20.12298999	KBGP072
BGPT0826	*Euryphymus sp.9*	South Africa	Western Cape	Popelierbos , Ceres	16-Nov-16	P.Tshililo	SAM	-32.78486903	20.12298999	KBGP073
BGPT0832	*Euryphymus sp.9*	South Africa	Western Cape	Popelierbos , Ceres	16-Nov-16	P.Tshililo	SAM	-32.784734	20.12604402	KBGP070
BGPT0833	*Euryphymus sp.9*	South Africa	Western Cape	Popelierbos , Ceres	16-Nov-16	P.Tshililo	SAM	-32.784734	20.12604402	
BGPT0920	*Euryphymus sp.9*	South Africa	Northern Cape	Rietvlei, Fraserburg	22-Mar-17	P.Tshililo	SAM	-32.205748	21.86230799	
BGPT0923	*Euryphymus sp.9*	South Africa	Northern Cape	Rietvlei, Fraserburg	22-Mar-17	P.Tshililo	SAM	-32.205748	21.86230799	
BGPT0924	*Euryphymus sp.9*	South Africa	Northern Cape	Rietvlei, Fraserburg	22-Mar-17	P.Tshililo	SAM	-32.205748	21.86230799	
BGPT0929	*Euryphymus sp.9*	South Africa	Northern Cape	Portugals rivier, Sutherland	23-Mar-17	P.Tshililo	SAM	-32.51862701	20.88527396	
BGPT0945	*Euryphymus sp.9*	South Africa	Northern Cape	Titusfontein, Sutherland	20-Mar-17	P.Tshililo	SAM	-31.89314802	20.79513699	
BGPT0946	*Euryphymus sp.9*	South Africa	Northern Cape	Titusfontein, Sutherland	20-Mar-17	P.Tshililo	SAM	-31.89314802	20.79513699	

BGPT0947	*Euryphymus sp.9*	South Africa	Northern Cape	Titusfontein, Sutherland	20-Mar-17	P.Tshililo	SAM	-31.89314802	20.79513699	
BGPT0949	*Euryphymus sp.9*	South Africa	Northern Cape	Titusfontein, Sutherland	20-Mar-17	P.Tshililo	SAM	-31.89314802	20.79513699	
BGPT1029	*Euryphymus sp.9*	South Africa	Western Cape	Taaiboschfontein , beaufort West	10-Mar-17	P.Strauss	SAM	-31.92762597	22.89559398	
BGPT1073	*Euryphymus sp.9*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Tshililo	SAM	-31.55027697	23.996981	
BGPT1130	*Pachyphymus carinatus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Tshililo	SAM	-32.48231602	23.61438199	
BGPT1572	*Pachyphymus carinatus*	South Africa	Western Cape	Hopewell, beaufort West	15-Mar-17	P.Tshililo	SAM	-32.30631399	23.11545901	
BGPT0060	*Pachyphymus cristulifer*	South Africa	Western Cape	Kalk dam, Beaufort West	04-Oct-16	P.Tshililo	SAM	-32.80631203	23.31824298	
BGPT0108	*Pachyphymus cristulifer*	South Africa	Western Cape	Riet kuil, Beaufort West	11-Oct-16	P.Tshililo	SAM	-32.46419803	22.13961102	
BGPT0120	*Pachyphymus cristulifer*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Strauss	SAM	-32.96931599	22.355067	
BGPT0147	*Pachyphymus cristulifer*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Tshililo	SAM	-32.96931599	22.355067	
BGPT0153	*Pachyphymus cristulifer*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Tshililo	SAM	-31.34331596	23.14624398	
BGPT0163	*Pachyphymus cristulifer*	South Africa	Western Cape	Riet kuil, Beaufort West	11-Oct-16	P.Tshililo	SAM	-32.45944097	22.13559701	KBGP09
BGPT0165	*Pachyphymus cristulifer*	South Africa	Western Cape	Riet kuil, Beaufort West	11-Oct-16	P.Tshililo	SAM	-32.45944097	22.13559701	KBGP08
BGPT0225	*Pachyphymus cristulifer*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Strauss	SAM	-31.34038104	23.15273803	KBGP07
BGPT0227	*Pachyphymus cristulifer*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Strauss	SAM	-31.34038104	23.15273803	KBGP010
BGPT0298	*Pachyphymus cristulifer*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Strauss	SAM	-32.96396297	22.35213099	KBGP04
BGPT0301	*Pachyphymus cristulifer*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Strauss	SAM	-32.96396297	22.35213099	KBGP05
BGPT0368	*Pachyphymus cristulifer*	South Africa	Western Cape	Kalk dam, Beaufort West	04-Oct-16	P.Tshililo	SAM	-32.80631203	23.31824298	
BGPT0369	*Pachyphymus cristulifer*	South Africa	Western Cape	Kalk dam, Beaufort West	04-Oct-16	P.Tshililo	SAM	-32.80631203	23.31824298	
BGPT0556	*Pachyphymus cristulifer*	South Africa	Eastern Cape	Goodluck, Jansenville	30-Sep-16	P.Tshililo	SAM	-33.042043	24.96443803	KBGP06
BGPT1554	*Pachyphymus cristulifer*	South Africa	Northern Cape	Besiesbult, Victoria West	16-Mar-17	P.Strauss	SAM	-31.10897203	22.76842601	
BGPT1133	*Plegmapterus fernandezi*	South Africa	Western Cape	Hopewell, beaufort West	15-Mar-17	P.Strauss	SAM	-32.30134796	23.11290001	

BGPT1580	*Plegmapterus fernandezi*	South Africa	Western Cape	Taaiboschfontein, beaufort West	10-Mar-17	P.Strauss	SAM	-31.92964199	22.891226
BGPT0698	*Plegmapters saturatus*	South Africa	Western Cape	Hopewell, Beaufort West	05-Oct-16	P.Tshililo	SAM	-32.30631399	23.11545901
BGPT0086	*Plegmapterus fernandezi*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Strauss	SAM	-31.34331596	23.14624398
BGPT0131	*Plegmapterus fernandezi*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Tshililo	SAM	-32.96396297	22.35213099
BGPT0149	*Plegmapterus fernandezi*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Tshililo	SAM	-31.34331596	23.14624398
BGPT0174	*Plegmapterus fernandezi*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Tshililo	SAM	-31.34038104	23.15273803
BGPT0180	*Plegmapterus fernandezi*	South Africa	Western Cape	Landsig, Murraysburg	29-Oct-16	P.Tshililo	SAM	-31.982063	23.54723004
BGPT0181	*Plegmapterus fernandezi*	South Africa	Western Cape	Landsig, Murraysburg	29-Oct-16	P.Tshililo	SAM	-31.98716297	23.54998802
BGPT0182	*Plegmapterus fernandezi*	South Africa	Western Cape	Landsig, Murraysburg	29-Oct-16	P.Tshililo	SAM	-31.98716297	23.54998802
BGPT0183	*Plegmapterus fernandezi*	South Africa	Western Cape	Landsig, Murraysburg	29-Oct-16	P.Tshililo	SAM	-31.98716297	23.54998802
BGPT0266	*Plegmapterus fernandezi*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Tshililo	SAM	-31.34331596	23.14624398
BGPT0268	*Plegmapterus fernandezi*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Tshililo	SAM	-31.34331596	23.14624398
BGPT0334	*Plegmapterus fernandezi*	South Africa	Western Cape	Landsig, Murraysburg	29-Sep-16	P.Tshililo	SAM	-31.98018302	23.55174696
BGPT0475	*Plegmapterus fernandezi*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Tshililo	SAM	-32.48231602	23.61438199
BGPT0612	*Plegmapterus fernandezi*	South Africa	Eastern Cape	Saltpans drift trust, Cradock	27-Sep-16	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT0665	*Plegmapterus fernandezi*	South Africa	Western Cape	Hopewell, Beaufort West	05-Oct-16	P.Tshililo	SAM	-32.30134796	23.11290001
BGPT0666	*Plegmapterus fernandezi*	South Africa	Western Cape	Hopewell, Beaufort West	05-Oct-16	P.Tshililo	SAM	-32.30134796	23.11290001
BGPT0755	*Plegmapterus fernandezi*	South Africa	Western Cape	Hopewell, Beaufort West	05-Oct-16	P.Tshililo	SAM	-32.30134796	23.11290001
BGPT0898	*Plegmapterus fernandezi*	South Africa	Northern Cape	Marseilles, Victoria West	17-Mar-17	P.Strauss	SAM	-31.33515299	23.14751501
BGPT0931	*Plegmapterus fernandezi*	South Africa	Northern Cape	Besiesbult, Victoria West	16-Mar-17	P.Tshililo	SAM	-31.11278202	22.77281896
BGPT0955	*Plegmapterus fernandezi*	South Africa	Northern Cape	Mesfontein, Richmond	08-Mar-17	P.Strauss	SAM	-31.106264	24.04644102
BGPT1066	*Plegmapterus fernandezi*	South Africa	Northern Cape	Besiesbult, Victoria West	16-Mar-17	P.Tshililo	SAM	-31.10897203	22.76842601

BGPT1083	*Plegmapterus fernandezi*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Tshililo	SAM	-31.55027697	23.996981	
BGPT1323	*Plegmapterus fernandezi*	South Africa	Northern Cape	Mesfontein, Richmond	08-Mar-17	P.Tshililo	SAM	-31.106264	24.04644102	
BGPT1327	*Plegmapterus fernandezi*	South Africa	Northern Cape	Mesfontein, Richmond	08-Mar-17	P.Tshililo	SAM	-31.106264	24.04644102	
BGPT1328	*Plegmapterus fernandezi*	South Africa	Northern Cape	Mesfontein, Richmond	08-Mar-17	P.Tshililo	SAM	-31.106264	24.04644102	
BGPT1331	*Plegmapterus fernandezi*	South Africa	Northern Cape	Mesfontein, Richmond	08-Mar-17	P.Tshililo	SAM	-31.106264	24.04644102	
BGPT1348	*Plegmapterus fernandezi*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Tshilibo	SAM	-31.55376099	23.99671496	
BGPT1582	*Plegmapterus fernandezi*	South Africa	Western Cape	Taaiboschfontein, beaufort West	10-Mar-17	P.Strauss	SAM	-31.92964199	22.891226	
BGPT1583	*Plegmapterus fernandezi*	South Africa	Western Cape	Taaiboschfontein, beaufort West	10-Mar-17	P.Strauss	SAM	-31.92964199	22.891226	
BGPT0046a	*Plegmapterus irisus*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Tshililo	SAM	-32.48587598	23.61843296	
BGPT0059	*Plegmapterus irisus*	South Africa	Western Cape	Kalk dam, Beaufort West	04-Oct-16	P.Strauss	SAM	-32.79987498	23.320275	
BGPT0087	*Plegmapterus irisus*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Strauss	SAM	-31.34331596	23.14624398	
BGPT0125	*Plegmapterus irisus*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Tshililo	SAM	-32.96396297	22.35213099	
BGPT0129	*Plegmapterus irisus*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Tshililo	SAM	-32.96396297	22.35213099	
BGPT0132	*Plegmapterus irisus*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Tshililo	SAM	-32.96396297	22.35213099	
BGPT0133	*Plegmapterus irisus*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Tshililo	SAM	-32.96396297	22.35213099	
BGPT0134	*Plegmapterus irisus*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Tshililo	SAM	-32.96396297	22.35213099	
BGPT0135	*Plegmapterus irisus*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Tshililo	SAM	-31.34331596	23.14624398	
BGPT0136	*Plegmapterus irisus*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Tshililo	SAM	-31.34331596	23.14624398	
BGPT0137	*Plegmapterus irisus*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Tshililo	SAM	-31.34331596	23.14624398	
BGPT0150	*Plegmapterus irisus*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Tshililo	SAM	-31.34331596	23.14624398	
BGPT0151	*Plegmapterus irisus*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Tshililo	SAM	-31.34331596	23.14624398	
BGPT0152	*Plegmapterus irisus*	South Africa	Northern Cape	Marseilles, Victoria West	13-Oct-16	P.Tshililo	SAM	-31.34331596	23.14624398	KBGP020

BGPT0216	*Plegmapterus irisus*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Tshililo	SAM	-32.96931599	22.355067	
BGPT0217	*Plegmapterus irisus*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Tshililo	SAM	-32.96931599	22.355067	
BGPT0242	*Plegmapterus irisus*	South Africa	Northern Cape	Portugal's rivier, Sutherland	15-Oct-16	P.Tshililo	SAM	-32.51862701	20.88527396	KBGP027
BGPT0276	*Plegmapterus irisus*	South Africa	Northern Cape	Portugal's rivier, Sutherland	15-Oct-16	P.Tshililo	SAM	-32.51862701	20.88527396	
BGPT0277	*Plegmapterus irisus*	South Africa	Northern Cape	Portugal's rivier, Sutherland	15-Oct-16	P.Tshililo	SAM	-32.51862701	20.88527396	
BGPT0296	*Plegmapterus irisus*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Strauss	SAM	-32.96396297	22.35213099	
BGPT0297	*Plegmapterus irisus*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Strauss	SAM	-32.96396297	22.35213099	
BGPT0306	*Plegmapterus irisus*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Tshililo	SAM	-32.96865097	22.351385	
BGPT0307	*Plegmapterus irisus*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Tshililo	SAM	-32.96865097	22.351385	
BGPT0308	*Plegmapterus irisus*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Tshililo	SAM	-32.96865097	22.351385	
BGPT0314	*Plegmapterus irisus*	South Africa	Northern Cape	Portugal's rivier, Sutherland	15-Oct-16	P.Tshililo	SAM	-32.51539998	20.88812599	KBGP030
BGPT0317	*Plegmapterus irisus*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Tshililo	SAM	-32.96865097	22.351385	
BGPT0318	*Plegmapterus irisus*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Tshililo	SAM	-32.96865097	22.351385	
BGPT0333	*Plegmapterus irisus*	South Africa	Western Cape	Klein waterval, Prince Albert	10-Oct-16	P.Strauss	SAM	-32.96396297	22.35213099	
BGPT0353	*Plegmapterus irisus*	South Africa	Western Cape	Landsig, Murraysburg	29-Sep-16	P.Strauss	SAM	-31.98018302	23.55174696	
BGPT0460	*Plegmapterus irisus*	South Africa	Eastern Cape	Hope well, Beaufort West	05-Oct-16	P.Strauss	SAM	-32.30134796	23.11290001	
BGPT0461	*Plegmapterus irisus*	South Africa	Eastern Cape	Hope well, Beaufort West	05-Oct-16	P.Strauss	SAM	-32.30134796	23.11290001	
BGPT0462	*Plegmapterus irisus*	South Africa	Eastern Cape	Hope well, Beaufort West	05-Oct-16	P.Strauss	SAM	-32.30134796	23.11290001	
BGPT0468	*Plegmapterus irisus*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Tshililo	SAM	-32.48231602	23.61438199	
BGPT0469	*Plegmapterus irisus*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Tshililo	SAM	-32.48231602	23.61438199	
BGPT0657	*Plegmapterus irisus*	South Africa	Western Cape	Hopewell, Beaufort West	05-Oct-16	P.Tshililo	SAM	-32.30134796	23.11290001	
BGPT0658	*Plegmapterus irisus*	South Africa	Western Cape	Hopewell, Beaufort West	05-Oct-16	P.Tshililo	SAM	-32.30134796	23.11290001	

BGPT0659	*Plegmapterus irisus*	South Africa	Western Cape	Hopewell, Beaufort West	05-Oct-16	P.Tshililo	SAM	-32.30134796	23.11290001
BGPT0660	*Plegmapterus irisus*	South Africa	Western Cape	Hopewell, Beaufort West	05-Oct-16	P.Tshililo	SAM	-32.30134796	23.11290001
BGPT0661	*Plegmapterus irisus*	South Africa	Western Cape	Hopewell, Beaufort West	05-Oct-16	P.Tshililo	SAM	-32.30134796	23.11290001
BGPT0664	*Plegmapterus irisus*	South Africa	Western Cape	Hopewell, Beaufort West	05-Oct-16	P.Tshililo	SAM	-32.30134796	23.11290001
BGPT0684	*Plegmapterus irisus*	South Africa	Eastern Cape	Saltpans drift trust, Cradock	27-Sep-16	P.Tshililo	SAM	-32.18824198	24.79368098
BGPT0695a	*Plegmapterus irisus*	South Africa	Western Cape	Hopewell, Beaufort West	05-Oct-16	P.Tshililo	SAM	-32.30631399	23.11545901
BGPT0713	*Plegmapterus irisus*	South Africa	Eastern Cape	Plains of Camdeboo, Pearston	03-Oct-16	P.Tshililo	SAM	-32.55391398	25.19606003
BGPT0714	*Plegmapterus irisus*	South Africa	Western Cape	Hopewell, beaufort West	05-Oct-16	P.Strauss	SAM	-32.30134796	23.11290001
BGPT0715	*Plegmapterus irisus*	South Africa	Western Cape	Hopewell, beaufort West	05-Oct-16	P.Strauss	SAM	-32.30134796	23.11290001
BGPT0717	*Plegmapterus irisus*	South Africa	Western Cape	Hopewell, beaufort West	05-Oct-16	P.Strauss	SAM	-32.30134796	23.11290001
BGPT0719	*Plegmapterus irisus*	South Africa	Western Cape	Hopewell, beaufort West	05-Oct-16	P.Strauss	SAM	-32.30134796	23.11290001
BGPT0725	*Plegmapterus irisus*	South Africa	Western Cape	Kalk dam, Beaufort West	04-Oct-16	P.Strauss	SAM	-32.80722398	23.31559799
BGPT0752	*Plegmapterus irisus*	South Africa	Eastern Cape	Saltpans drift trust, Cradock	27-Sep-16	C.Bazelet	SAM	-31.86546503	25.47238003
BGPT0753	*Plegmapterus irisus*	South Africa	Western Cape	Hopewell, Beaufort West	05-Oct-16	P.Tshililo	SAM	-32.30134796	23.11290001
BGPT0756	*Plegmapterus irisus*	South Africa	Western Cape	Hopewell, Beaufort West	05-Oct-16	P.Tshililo	SAM	-32.30134796	23.11290001
BGPT0757	*Plegmapterus irisus*	South Africa	Western Cape	Hopewell, Beaufort West	05-Oct-16	P.Tshililo	SAM	-32.30134796	23.11290001
BGPT0800	*Plegmapterus irisus*	South Africa	Western Cape	Hopewell, beaufort West	05-Oct-16	P.Strauss	SAM	-32.30744898	23.11293396
BGPT0825	*Plegmapterus irisus*	South Africa	Western Cape	Popelierbos , Ceres	16-Nov-16	P.Tshililo	SAM	-32.78486903	20.12298999
BGPT0470	*Plegmapterus saturatus*	South Africa	Eastern Cape	Rooi draai, Aberdeen	06-Oct-16	P.Tshililo	SAM	-32.48231602	23.61438199
BGPT0815	*Plegmapterus saturatus*	South Africa	Western Cape	Popelierbos , Ceres	16-Nov-16	P.Tshililo	SAM	-32.78486903	20.12298999
BGPT0890	*Rhachitopis crassus*	South Africa	Northern Cape	Marseilles, Victoria West	17-Mar-17	P.Strauss	SAM	-31.33515299	23.14751501
BGPT0966	*Rhachitopis crassus*	South Africa	Eastern Cape	Modderfontein, Tarka	04-Mar-17	P.Strauss	SAM	-31.86206801	26.163004
BGPT0967	*Rhachitopis crassus*	South Africa	Eastern Cape	Modderfontein, Tarka	04-Mar-17	P.Strauss	SAM	-31.86206801	26.163004

BGPT0980	*Rhachitopis crassus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Strauss	SAM	-32.48231602	23.61438199
BGPT1096	*Rhachitopis crassus*	South Africa	Northern Cape	Mesfontein, Richmond	08-Mar-17	P.Tshililo	SAM	-31.10894999	24.04637799
BGPT1111	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1115	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1116	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1117	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1122	*Rhachitopis crassus*	South Africa	Western Cape	Hopewell, beaufort West	15-Mar-17	P.Tshililo	SAM	-32.30134796	23.11290001
BGPT1163	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1168	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1172	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1173	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1175	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1178	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1179	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1180	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1181	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1182	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1188	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1190	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1192	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1194	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1269	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003

BGPT1274	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1280	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1281	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1287	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1288	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1289	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1291	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1292	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT0852	*Rhachitopis crassus*	South Africa	Northern Cape	Marseilles, Victoria West	17-Mar-17	P.Tshililo	SAM	-31.33515299	23.14751501
BGPT0853	*Rhachitopis crassus*	South Africa	Northern Cape	Marseilles, Victoria West	17-Mar-17	P.Tshililo	SAM	-31.33515299	23.14751501
BGPT0855	*Rhachitopis crassus*	South Africa	Northern Cape	Marseilles, Victoria West	17-Mar-17	P.Tshililo	SAM	-31.33515299	23.14751501
BGPT0864	*Rhachitopis crassus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Tshililo	SAM	-31.82084396	24.49835401
BGPT0865	*Rhachitopis crassus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Tshililo	SAM	-31.82084396	24.49835401
BGPT0868	*Rhachitopis crassus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Tshililo	SAM	-31.82084396	24.49835401
BGPT0869	*Rhachitopis crassus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Tshililo	SAM	-31.82084396	24.49835401
BGPT0870	*Rhachitopis crassus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Tshililo	SAM	-31.82084396	24.49835401
BGPT0872	*Rhachitopis crassus*	South Africa	Eastern Cape	Doornberg, Graaff Reinet	18-Mar-17	P.Strauss	SAM	-31.82084396	24.49835401
BGPT0892	*Rhachitopis crassus*	South Africa	Northern Cape	Marseilles, Victoria West	17-Mar-17	P.Strauss	SAM	-31.33515299	23.14751501
BGPT0893	*Rhachitopis crassus*	South Africa	Northern Cape	Marseilles, Victoria West	17-Mar-17	P.Strauss	SAM	-31.33515299	23.14751501
BGPT0922	*Rhachitopis crassus*	South Africa	Northern Cape	Rietvlei, Fraserburg	22-Mar-17	P.Tshililo	SAM	-32.205748	21.86230799
BGPT0954	*Rhachitopis crassus*	South Africa	Northern Cape	Mesfontein, Richmond	08-Mar-17	P.Strauss	SAM	-31.106264	24.04644102
BGPT0964	*Rhachitopis crassus*	South Africa	Eastern Cape	Modderfontein, Tarka	04-Mar-17	P.Strauss	SAM	-31.86206801	26.163004

BGPT0982	*Rhachitopis crassus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Strauss	SAM	-32.48231602	23.61438199
BGPT0986	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Strauss	SAM	-31.55376099	23.99671496
BGPT0989	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Strauss	SAM	-31.55376099	23.99671496
BGPT0990	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Strauss	SAM	-31.55376099	23.99671496
BGPT0991	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Strauss	SAM	-31.55376099	23.99671496
BGPT0992	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Strauss	SAM	-31.55376099	23.99671496
BGPT0996	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Strauss	SAM	-31.55376099	23.99671496
BGPT0998	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Strauss	SAM	-31.55376099	23.99671496
BGPT0999	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Strauss	SAM	-31.55376099	23.99671496
BGPT1000	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Strauss	SAM	-31.55376099	23.99671496
BGPT1010	*Rhachitopis crassus*	South Africa	Western Cape	Hopewell, beaufort West	15-Mar-17	P.Tshililo	SAM	-32.30631399	23.11545901
BGPT1011	*Rhachitopis crassus*	South Africa	Western Cape	Hopewell, beaufort West	15-Mar-17	P.Tshililo	SAM	-32.30631399	23.11545901
BGPT1012	*Rhachitopis crassus*	South Africa	Western Cape	Hopewell, beaufort West	15-Mar-17	P.Strauss	SAM	-32.30631399	23.11545901
BGPT1013	*Rhachitopis crassus*	South Africa	Western Cape	Hopewell, beaufort West	15-Mar-17	P.Strauss	SAM	-32.30631399	23.11545901
BGPT1023	*Rhachitopis crassus*	South Africa	Northern Cape	Mesfontein, Victoria West	08-Mar-17	P.Strauss	SAM	-31.103661	24.04763301
BGPT1028	*Rhachitopis crassus*	South Africa	Northern Cape	Mesfontein, Victoria West	08-Mar-17	P.Strauss	SAM	-31.103661	24.04763301
BGPT1039	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-32.18824198	24.79368098
BGPT1040	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-32.18824198	24.79368098
BGPT1041	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-32.18824198	24.79368098
BGPT1042	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-32.18824198	24.79368098
BGPT1043	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-32.18824198	24.79368098
BGPT1044	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-32.18824198	24.79368098
BGPT1045	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-32.18824198	24.79368098
BGPT1046	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-32.18824198	24.79368098

BGPT1047	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-32.18824198	24.79368098
BGPT1048	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-32.18824198	24.79368098
BGPT1054	*Rhachitopis crassus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Tshililo	SAM	-32.58044899	26.27273804
BGPT1058	*Rhachitopis crassus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Tshililo	SAM	-32.58044899	26.27273804
BGPT1067	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Tshililo	SAM	-31.55027697	23.996981
BGPT1069	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Tshililo	SAM	-31.55027697	23.996981
BGPT1071	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Tshililo	SAM	-31.55027697	23.996981
BGPT1072	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Tshililo	SAM	-31.55027697	23.996981
BGPT1079	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Tshililo	SAM	-31.55027697	23.996981
BGPT1088	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Strauss	SAM	-31.55186299	23.99457397
BGPT1091	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Strauss	SAM	-31.55186299	23.99457397
BGPT1094	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Strauss	SAM	-31.55186299	23.99457397
BGPT1100	*Rhachitopis crassus*	South Africa	Northern Cape	Mesfontein, Richmond	08-Mar-17	P.Tshililo	SAM	-31.10894999	24.04637799
BGPT1101	*Rhachitopis crassus*	South Africa	Northern Cape	Mesfontein, Richmond	08-Mar-17	P.Tshililo	SAM	-31.10894999	24.04637799
BGPT1102	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1104	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1105	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1107	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1108	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1109	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1110	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1113	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1118	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1120	*Rhachitopis crassus*	South Africa	Northern Cape	Rietfontein, Colesburg	07-Mar-17	P.Strauss	SAM	-31.211908	20.53180802

BGPT1129	*Rhachitopis crassus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Tshililo	SAM	-32.48231602	23.61438199
BGPT1147	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Strauss	SAM	-31.55027697	23.996981
BGPT1149	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Strauss	SAM	-31.55027697	23.996981
BGPT1150	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Strauss	SAM	-31.55027697	23.996981
BGPT1151	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Strauss	SAM	-31.55027697	23.996981
BGPT1162	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1165	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1166	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1167	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1169	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1170	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1171	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1174	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1176	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1177	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1184	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1185	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1189	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1191	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1193	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1214	*Rhachitopis crassus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Tshililo	SAM	-32.89379102	26.01819003
BGPT1220	*Rhachitopis crassus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Strauss	SAM	-32.892435	26.01496803
BGPT1232	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-32.18824198	24.79368098

BGPT1233	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-32.18824198	24.79368098
BGPT1234	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-32.18824198	24.79368098
BGPT1235	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-32.18824198	24.79368098
BGPT1236	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-32.18824198	24.79368098
BGPT1237	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-32.18824198	24.79368098
BGPT1238	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-32.18824198	24.79368098
BGPT1239	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-32.18824198	24.79368098
BGPT1240	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-32.18824198	24.79368098
BGPT1241	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-32.18824198	24.79368098
BGPT1242	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-32.18824198	24.79368098
BGPT1243	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-32.18824198	24.79368098
BGPT1244	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-32.18824198	24.79368098
BGPT1245	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-32.18824198	24.79368098
BGPT1246	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-32.18824198	24.79368098
BGPT1247	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-32.18824198	24.79368098
BGPT1248	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-32.18824198	24.79368098
BGPT1249	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-32.18824198	24.79368098
BGPT1250	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-32.18824198	24.79368098
BGPT1251	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-32.18824198	24.79368098
BGPT1252	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-32.18824198	24.79368098
BGPT1253	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-32.18824198	24.79368098
BGPT1254	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust,	03-Mar-17	P.Tshililo	SAM	-32.18824198	24.79368098

				Cradock					
BGPT1256	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1257	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1258	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1259	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1261	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1262	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1263	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1264	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1265	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1266	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1267	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Strauss	SAM	-31.86546503	25.47238003
BGPT1270	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1271	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1273	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1276	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1284	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1285	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1311	*Rhachitopis crassus*	South Africa	Western Cape	Hopewell, beaufort West	15-Mar-17	P.Tshililo	SAM	-32.30631399	23.11545901
BGPT1312	*Rhachitopis crassus*	South Africa	Western Cape	Hopewell, beaufort West	15-Mar-17	P.Tshililo	SAM	-32.30631399	23.11545901
BGPT1313	*Rhachitopis crassus*	South Africa	Western Cape	Hopewell, beaufort West	15-Mar-17	P.Tshililo	SAM	-32.30631399	23.11545901
BGPT1324	*Rhachitopis crassus*	South Africa	Northern Cape	Mesfontein, Richmond	08-Mar-17	P.Tshililo	SAM	-31.106264	24.04644102

BGPT1326	*Rhachitopis crassus*	South Africa	Northern Cape	Mesfontein, Richmond	08-Mar-17	P.Tshililo	SAM	-31.106264	24.04644102
BGPT1329	*Rhachitopis crassus*	South Africa	Northern Cape	Mesfontein, Richmond	08-Mar-17	P.Tshililo	SAM	-31.106264	24.04644102
BGPT1330	*Rhachitopis crassus*	South Africa	Northern Cape	Mesfontein, Richmond	08-Mar-17	P.Tshililo	SAM	-31.106264	24.04644102
BGPT1349	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Tshililo	SAM	-31.55376099	23.99671496
BGPT1350	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Tshililo	SAM	-31.55376099	23.99671496
BGPT1353	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Tshililo	SAM	-31.55376099	23.99671496
BGPT1354	*Rhachitopis crassus*	South Africa	Northern Cape	Rockdale, Richmond	09-Mar-17	P.Tshililo	SAM	-31.55376099	23.99671496
BGPT1388	*Rhachitopis crassus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Strauss	SAM	-32.889372	26.01079501
BGPT1392	*Rhachitopis crassus*	South Africa	Eastern Cape	Alstonfield, Bedford	02-Mar-17	P.Strauss	SAM	-32.889372	26.01079501
BGPT1402	*Rhachitopis crassus*	South Africa	Eastern Cape	Rietfontein, Colesburg	07-Mar-17	P.Strauss	SAM	-31.211908	20.53180802
BGPT1404	*Rhachitopis crassus*	South Africa	Eastern Cape	Rietfontein, Colesburg	07-Mar-17	P.Tshililo	SAM	-31.211908	20.53180802
BGPT1416	*Rhachitopis crassus*	South Africa	Eastern Cape	Modderfontein, Tarka	04-Mar-17	P.Tshililo	SAM	-31.86206801	26.163004
BGPT1424	*Rhachitopis crassus*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Tshililo	SAM	-30.98139703	25.69878596
BGPT1425	*Rhachitopis crassus*	South Africa	Eastern Cape	Waterval Safaris, Cradock	01-Mar-17	P.Tshililo	SAM	-32.58044899	26.27273804
BGPT1427	*Rhachitopis crassus*	South Africa	Eastern Cape	Waterval Safaris, Cradock	01-Mar-17	P.Tshililo	SAM	-32.58044899	26.27273804
BGPT1453	*Rhachitopis crassus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Strauss	SAM	-32.48587598	23.61843296
BGPT1458	*Rhachitopis crassus*	South Africa	Eastern Cape	Rooidraai, Aberdeen	13-Mar-17	P.Strauss	SAM	-32.48587598	23.61843296
BGPT1478	*Rhachitopis crassus*	South Africa	Northern Cape	Rietfontein, Colesburg	07-Mar-17	P.Strauss	SAM	-30.90778196	25.01246701
BGPT1479	*Rhachitopis crassus*	South Africa	Northern Cape	Rietfontein, Colesburg	07-Mar-17	P.Strauss	SAM	-30.90778196	25.01246701
BGPT1488	*Rhachitopis crassus*	South Africa	Western Cape	Landsig, Murraysburg	14-Mar-17	P.Strauss	SAM	-31.98018302	23.55174696
BGPT1515	*Rhachitopis crassus*	South Africa	Northern Cape	Mesfontein, Richmond	08-Mar-17	P.Strauss	SAM	-31.106264	24.04644102
BGPT1521	*Rhachitopis crassus*	South Africa	Northern Cape	Mesfontein, Richmond	08-Mar-17	P.Strauss	SAM	-31.106264	24.04644102
BGPT1525	*Rhachitopis crassus*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Tshililo	SAM	-30.98310996	25.70317397
BGPT1526	*Rhachitopis crassus*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Tshililo	SAM	-30.98310996	25.70317397

BGPT1527	*Rhachitopis crassus*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Tshililo	SAM	-30.98310996	25.70317397
BGPT1529	*Rhachitopis crassus*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Tshililo	SAM	-30.98310996	25.70317397
BGPT1533	*Rhachitopis crassus*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Tshililo	SAM	-30.98310996	25.70317397
BGPT1534	*Rhachitopis crassus*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Tshililo	SAM	-30.98310996	25.70317397
BGPT1546	*Rhachitopis crassus*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Strauss	SAM	-30.98310996	25.70317397
BGPT1548	*Rhachitopis crassus*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Strauss	SAM	-30.98310996	25.70317397
BGPT1549	*Rhachitopis crassus*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Strauss	SAM	-30.98310996	25.70317397
BGPT1550	*Rhachitopis crassus*	South Africa	Northern Cape	Besiesbult, Victoria West	16-Mar-17	P.Strauss	SAM	-31.10897203	22.76842601
BGPT1556	*Rhachitopis crassus*	South Africa	Northern Cape	Rietfontein, Colesburg	07-Mar-17	P.Strauss	SAM	-30.90778196	25.01246701
BGPT1557	*Rhachitopis crassus*	South Africa	Northern Cape	Rietfontein, Colesburg	07-Mar-17	P.Strauss	SAM	-30.90778196	25.01246701
BGPT1560	*Rhachitopis crassus*	South Africa	Northern Cape	Rietfontein, Colesburg	07-Mar-17	P.Strauss	SAM	-30.90778196	25.01246701
BGPT1562	*Rhachitopis crassus*	South Africa	Northern Cape	Rietfontein, Colesburg	07-Mar-17	P.Strauss	SAM	-30.90778196	25.01246701
BGPT1568	*Rhachitopis crassus*	South Africa	Western Cape	Hopewell, beaufort West	15-Mar-17	P.Tshililo	SAM	-32.30631399	23.11545901
BGPT1569	*Rhachitopis crassus*	South Africa	Western Cape	Hopewell, beaufort West	15-Mar-17	P.Tshililo	SAM	-32.30631399	23.11545901
BGPT1586	*Rhachitopis crassus*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Strauss	SAM	-30.98310996	25.70317397
BGPT1587	*Rhachitopis crassus*	South Africa	Northern Cape	Ezelfontein, Steynsburg	06-Mar-17	P.Strauss	SAM	-30.98310996	25.70317397
BGPT1597	*Rhachitopis crassus*	South Africa	Northern Cape	Rietfontein, Colesburg	07-Mar-17	P.Strauss	SAM	-30.90778196	25.01246701
BGPT1600	*Rhachitopis crassus*	South Africa	Northern Cape	Rietfontein, Colesburg	07-Mar-17	P.Strauss	SAM	-30.90778196	25.01246701
BGPT1601	*Rhachitopis crassus*	South Africa	Northern Cape	Rietfontein, Colesburg	07-Mar-17	P.Strauss	SAM	-30.90778196	25.01246701
BGPT1602	*Rhachitopis crassus*	South Africa	Northern Cape	Rietfontein, Colesburg	07-Mar-17	P.Strauss	SAM	-30.90778196	25.01246701
BGPT1603	*Rhachitopis crassus*	South Africa	Northern Cape	Rietfontein, Colesburg	07-Mar-17	P.Strauss	SAM	-30.90778196	25.01246701
BGPT1604	*Rhachitopis crassus*	South Africa	Northern Cape	Rietfontein,	07-Mar-17	P.Strauss	SAM	-30.90778196	25.01246701

				Colesburg					
BGPT1605	*Rhachitopis crassus*	South Africa	Northern Cape	Rietfontein, Colesburg	07-Mar-17	P.Strauss	SAM	-30.90778196	25.01246701
BGPT1610	*Rhachitopis crassus*	South Africa	Western Cape	Landsig, Murraysburg	29-Sep-16	P.Tshililo	SAM	-31.98247396	23.54777302
BGPT1611	*Rhachitopis crassus*	South Africa	Western Cape	Landsig, Murraysburg	29-Sep-16	P.Tshililo	SAM	-31.98247396	23.54777302
BGPT1620	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1621	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1622	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1625	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003
BGPT1626	*Rhachitopis crassus*	South Africa	Eastern Cape	Saltpansdrift trust, Cradock	03-Mar-17	P.Tshililo	SAM	-31.86546503	25.47238003