An inventory of epigeal ants of the western Soutpansberg Mountain Range, South Africa

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Dates:
Received: 22 July 2014
Accepted: 20 Nov. 2014
Published: 30 Mar. 2015

How to cite this article:
Munyai, T.C. & Foord, S.H., 2015, 'An inventory of epigeal ants of the western Soutpansberg Mountain Range, South Africa', *Koedoe* 57(1), Art. #1244, 12 pages. http://dx.doi.org/10.4102/koedoe.v57i1.1244

The distribution, abundance and sensitivity of invertebrates to habitat change are largely unknown. Long-term monitoring of ecological gradients with standardised and comparable protocols can form the basis of a better understanding. Altitudinal gradients are particularly relevant within this context. Here we provide a check list and baseline data for ant species collected over a 5-year period across the Soutpansberg Mountain Range, South Africa. Standardised pitfall surveys across 11 sites yielded a total of 133 species in 38 genera and 6 subfamilies. Sample coverage of epigeal ants was 0.98 for the transect as a whole. Of these species, 21% were restricted to the southern slope of the mountain and 14% to the northern slope. Extrapolated richness estimates reached an asymptote for all, except for three sites. These were the only sites impacted by bush encroachment. Observed richness was the highest at a low-altitude mesic site that is exposed to considerable disturbance by megaherbivores and mechanical clearing of woody vegetation. Structural classification of vegetation was predictive of a broad-scale ant assemblage structure. On a smaller scale, however, structure was a function of elevation, space and temperature.

Conservation implications: Future monitoring should target indicator taxa associated with bush encroachment, particularly with reference to their impacts on grasslands. Bush encroachment could endanger several ant species associated with mesic grasslands and woodlands on the mountain, as well as ant diversity, as these were the habitats with the highest ant diversity.

Introduction

Although invertebrates comprise the bulk of diversity in an ecosystem, they are often excluded from conservation initiatives. Cardoso *et al.* (2011) identified seven reasons for this. Three of the shortfalls had to do with: (1) the distribution of invertebrate species is unknown (Wallacean), (2) invertebrate abundance and their changes in space and time are unknown (Prestonian) and (3) invertebrates' way of life and sensitivity to habitat types are largely unknown (Hutchinsonian). These three shortfalls are particularly relevant to how ecologists practise their science, as the distribution, abundance in time and space, and sensitivities to habitat change are largely unknown for most species. These constraints can be resolved through inventories that follow standardised and comparable protocols (Cardoso *et al.* 2011).

Ants respond to the environment at small scales and considerable support exists for their use as indicators of disturbance and habitat degradation (see Andersen & Majer [2004] for review). Ants are easily collected and species or morpho-species level determination are aided through readily available taxonomic expertise (Ward 2010). In addition to being diverse, abundant and a dominant component of animal biomass in terrestrial ecosystems (Hölldobler & Wilson 1990), they also perform important functions in ecosystems, including pollination, myrmechory and nutrient cycling, among others (Wielgoss *et al.* 2014).

The Soutpansberg Mountain Range is a centre of endemism (Hahn 2002) and is the focal point for the newly proclaimed Vhembe Biosphere Reserve, one of the United Nations Educational, Scientific and Cultural Organisation (UNESCO) World Network of Biosphere Reserves (www.unesco.org). It has the highest plant generic and family level diversity among the 18 recognised Centres of Plant Endemism in southern Africa (Van Wyk & Smith 2001). Recent results suggest that this diversity and endemism is mirrored by spiders (Foord 2008) and reptiles (Kirchhof *et al.* 2010). As an inselberg that rises 1000 m above the surrounding plains, the Soutpansberg Mountain Range has provided a refuge for several taxa during periods of climate change and will once more play a biogeographic role in the region as regional climate changes take effect in response to elevated global greenhouse gases (Tshiala *et al.* 2011).

Transects can provide valuable diversity, distribution and abundance information as well as population trends. Altitudinal transects are particularly relevant within the context of contemporary climate changes. Here we summarise the results of a standardised inventory of epigeal ants over a 5-year period (2009–2013), along a transect across the western Soutpansberg Mountain Range. We provide a checklist of epigeal ants with a sample coverage of 0.98 for the whole transect. *A posteriori* defines distinct ant assemblages across the transect and tests for differences between these groups.

Materials and methods

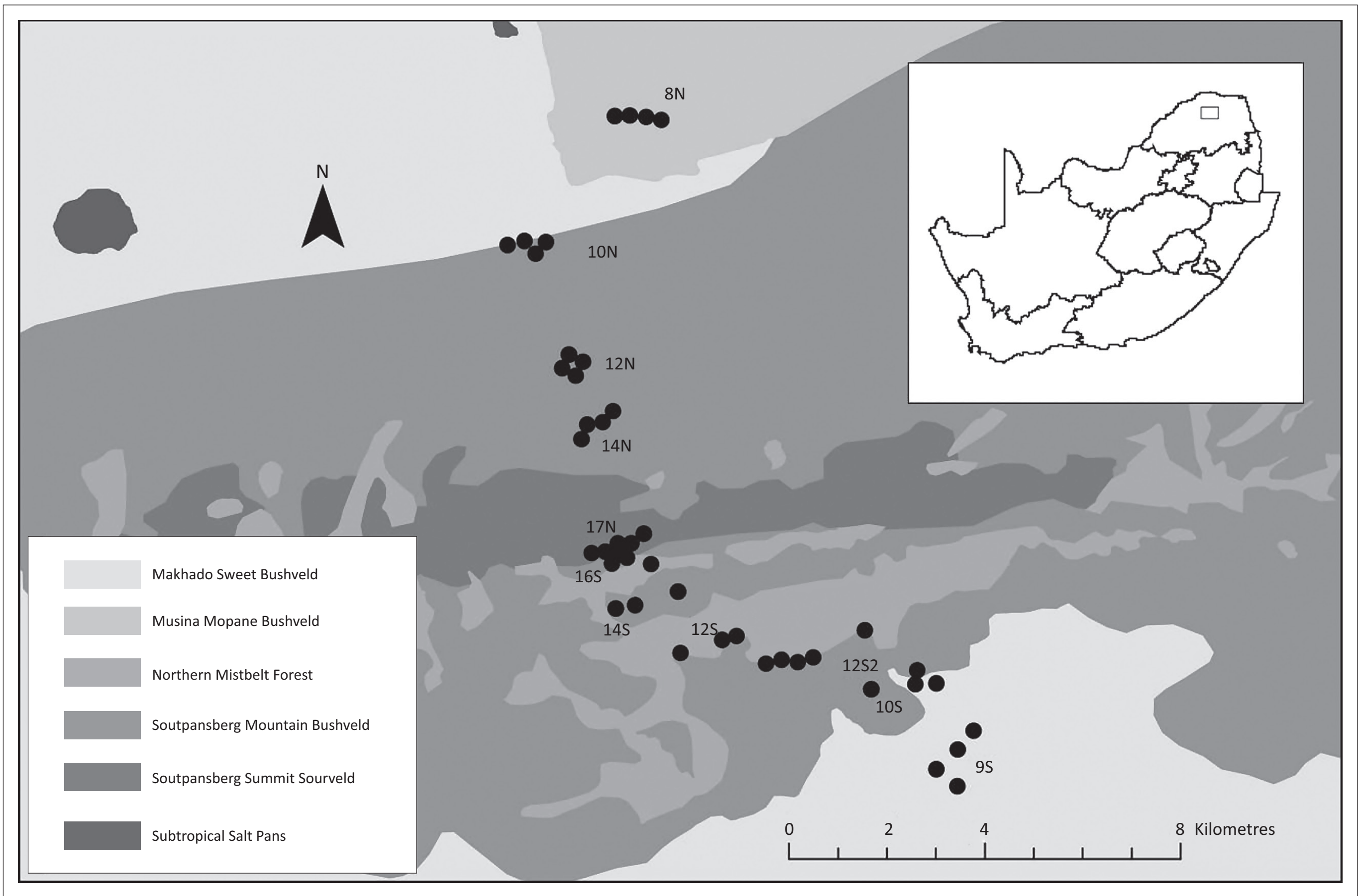
Study area

The 16.5 km altitudinal transect extends over the highest point of the Soutpansberg Mountain Range, Lajuma (1748 m), in the Luvhondo Nature Reserve. It includes the northern and southern slopes of the mountain and consists of 11 sites, spaced at 200 m altitudinal intervals. It starts at 800 m a.s.l. in the Limpopo valley to the north of the mountain, ascends 900 m to Lajuma, and descends another 800 m to the plains south of the range (Figure 1).

The study area stretches across five broad structural vegetation types, namely woodland, sedgeland-herbland, forest, thicket and shrubland. All the sites on the northern aspect are woodland (total tree cover 0.1% – 75%; shrub cover < 10%; mean crown-gap ratio > 0.1). They can be characterised as low (1 m – 5 m-tall trees), open (crown-gap ratio of 2–8.5) and woodland (Figures 2a–2d), mostly on shallow quartzitic soils (Figures 2b–2d). One site is characterised by deep sandy soils (Figure 2a). Dominant trees species include *Burkea africana, Ochna pulchra, Diospyros dichrophylla, Rhus magalismontanum, Boscia albitrunca, Adansonia digitata, Acacia nigrescens* and *Terminalia sericea*.

Vegetation types along the plains and lower southern foothills are largely thicket (Figure 3d) and shrubland (Figure 3e), located on red loamy-clay soils dominated by woody species such as *Dichrostachys cinerea*, *Acacia caffra* and *Olea europaea*.

Structurally, the lowest site on the southern aspect (Figure 3e) is tall, closed shrubland (< 0.1% tree cover). It is dominated by a *D. cinerea* matrix with patches that are mechanically cleared of all woody plants. Site 10S (Figure 3d) is low thicket (10% – 100% tree cover and > 10% shrub cover). The forests are found at mid-elevation, between 1200 m a.s.l. and 1400 m a.s.l. on the southern slope and include both short (Figure 3c) and tall (Figure 3b) forest sites with a crown-gap ratio of < 0.1. They are dominated by woody species such as *Croton sylvaticus* and *Ekebergia capensis*. The higher elevational zones of the southern aspect and summit consist of a sedgeland-herbland matrix with low shrubland patches that grow on shallow rocky soils on quartzite, dominated by *Coleochloa* species (Figures 2e–3a).



Northern aspect: 800 m a.s.l. (8N), 1000 m a.s.l. (10N), 1200 m a.s.l. (12N), 1400 m a.s.l. (14N), 1700 m a.s.l. (17N/summit); southern aspect: 1600 m a.s.l. (16S), 1400 m a.s.l. (14S), 1200 m a.s.l.. (12S), 1200 m a.s.l. (12S2), 1000 m a.s.l. (10S), 900 m a.s.l. (9S).

FIGURE 1: Location of the Soutpansberg transect in South Africa (inset) and the position of the 44 replicates with the 5 structural habitat types.

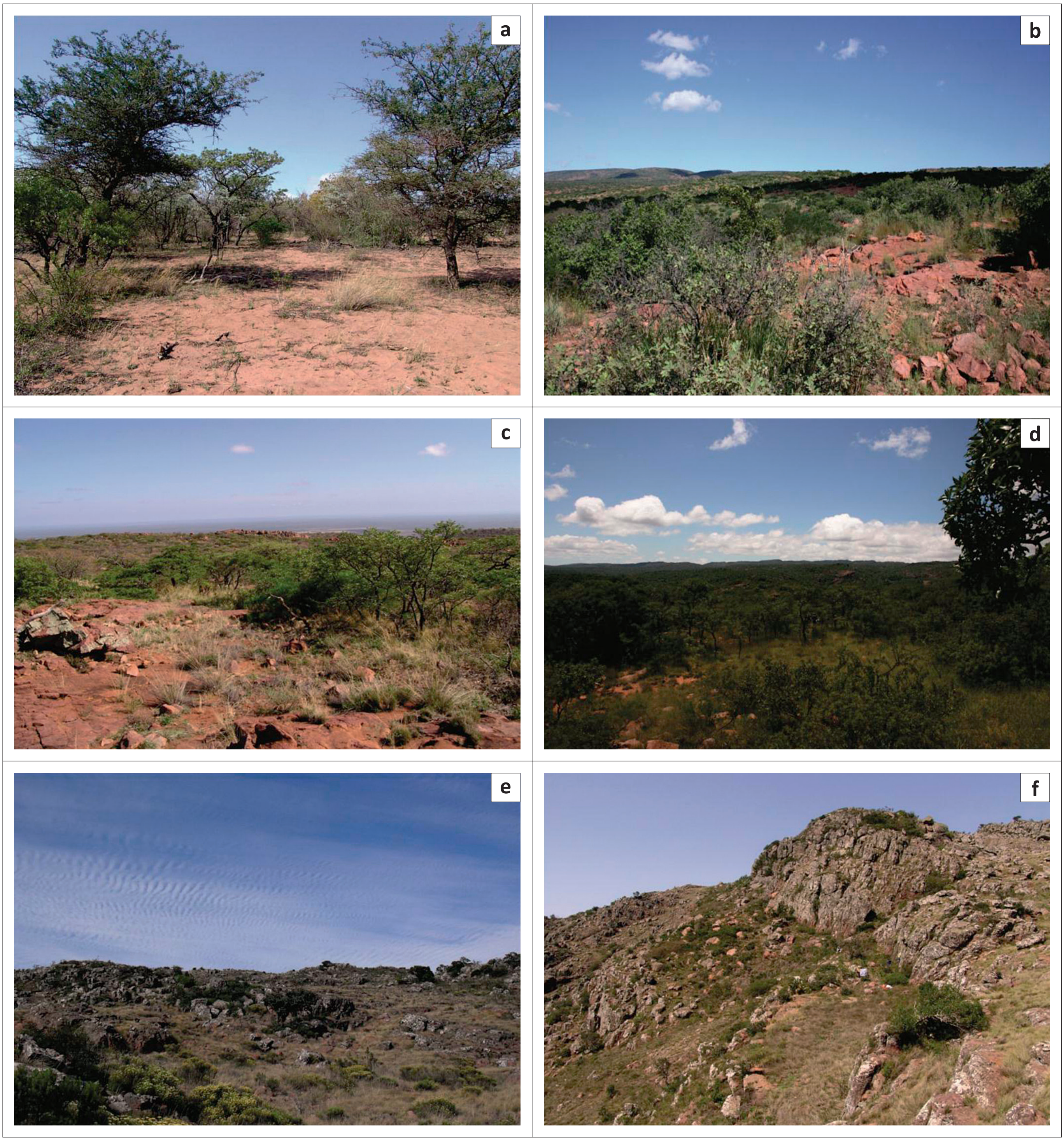


FIGURE 2: (a) 08N and (b) 12N deep sandy soils characterised by trees such as *Adansonia digitata, Acacia nigrescens* and *Terminalia sericea*. (c) 10N and (d) 14N are on shallow quartzitic soils and include *Burkea africana, Ochna pulchra, Diospyros dichrophylla, Rhus magalismontanum, Boscia albitrunca* and *Terminalia sericea*. Higher elevation sites (e) 17N and (f) 16S low shrubland patches with shallow rocky soils on quartzite, dominated by *Coleochloa* species.

Soil temperature extremes were the highest on the summit of the mountain (mean annual range 10 °C – 55 °C) and the lowest in the tall forests of the southern aspect (14 °C – 32 °C).

Ant sampling

Ants were sampled through standardised pitfall trapping (Munyai & Foord 2012) at each of the 11 sites. Sample units consisted of 10 pitfall traps (ø 62 mm) laid out in a sampling grid (2 x 5) with 10 m spacing between traps. Pitfall traps were left open for 5 days, since it is considered representative and does not sample excessive ants (see Munyai & Foord [2012] and references therein). From September 2009 onwards (Appendix 1), sampling units were spatially replicated four times at each site. Replicates were separated by < 300 m to avoid pseudo-replication (Ness *et al.* 2004). The traps contained a 50% solution of propylene glycol because it neither attracts nor repels ants (Abensperg-Traun & Steven 1995).

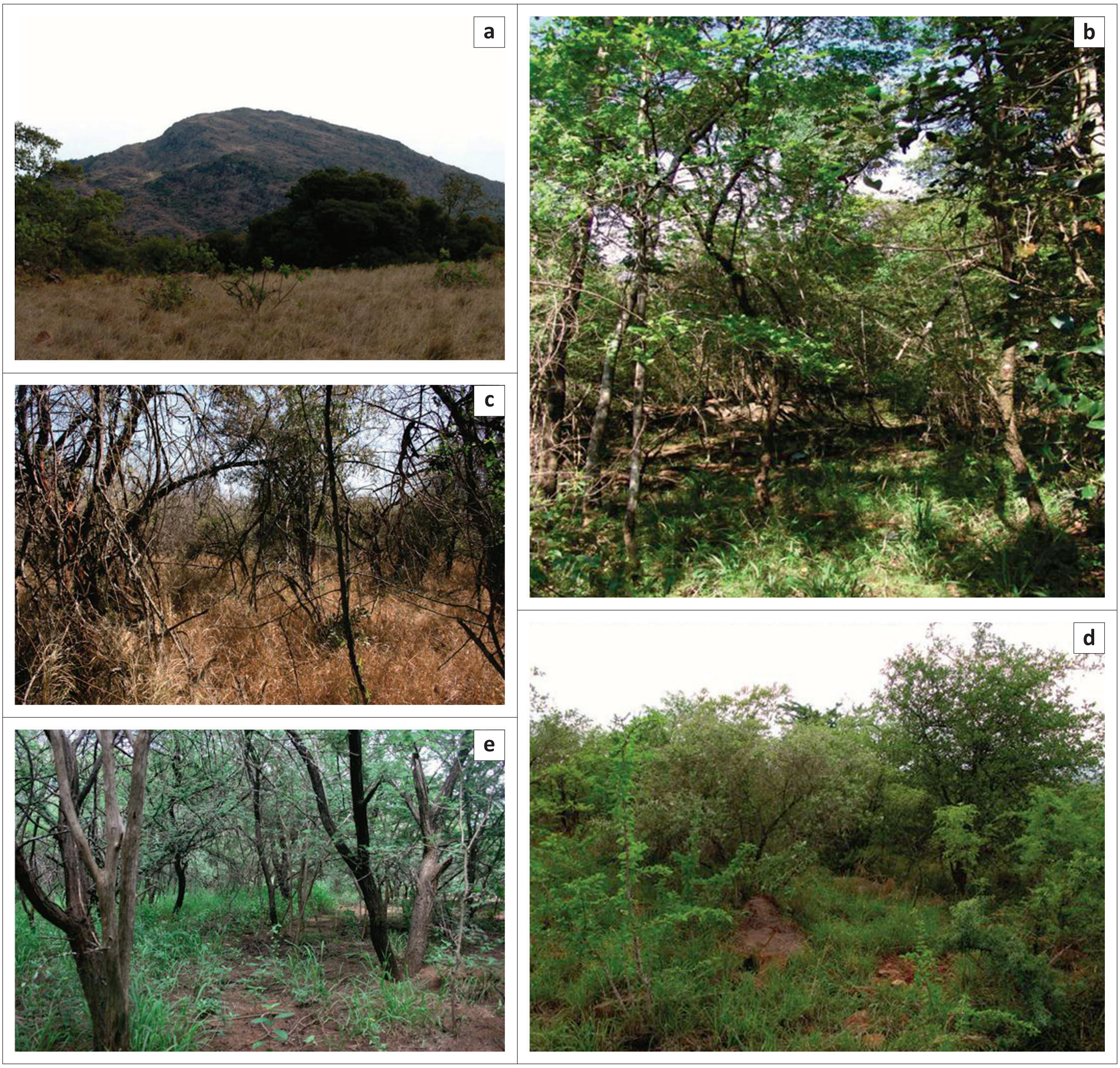


FIGURE 3: (a) Low shrubland patches (14S) with shallow rocky soils on quartzite, dominated by *Coleochloa* species. (b) Tall forest (12S) dominated by woody species of *Croton sylvaticus* and *Ekebergia capensis*. (c) Short forest (12S2). Low elevation sites: (d) Thicket site (10S) on clay soils dominated by woody species such as *Acacia caffra* and *Olea europaea*. (e) Shrubland (09S) on clay soils dominated by woody species such as *Dichrostachys cinerea*.

The ant samples were washed in a laboratory and stored in 70% ethanol. They were sorted to morpho-species and, where possible, identified to species by comparison with reference collections housed in the Kruger National Park in South Africa and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Tropical Ecosystems Research Centre in Darwin, Australia. Bolton (1994) was used to identify some specimens to genus level, while valid names were confirmed using AntCat (http://www.antcat.org) and AntWeb (http://www.antweb.org). The unidentified (morpho) species were given the following number codes: University of Venda Collection_01, 02, etc. (i.e. UVOC_01, 02, etc.).

Bothroponera, *Mesoponera*, *Ophthalmopone* and *Pseudoponera* were considered valid genera rather than being subsumed under *Pachycondyla* (Schmidt & Shattuck 2014). Subfamilies Aenictinae and Cerapachyinae were both considered invalid and therefore subsumed under Dorylinae, as treated by Brady *et al.* (2014). Reference collections are housed at the University of Venda and CSIRO Tropical Ecosystems Research Centre (Darwin, Australia).

Data analysis

Chao 2 and ICE, in EstimateS version 9.1.0 (Colwell 2013), were used to estimate species richness. Sample coverage at each site and the transect as a whole was done with

TABLE 1: Observed number of species, abundance, richness estimates (Chao 2 and ICE, available in EstimateS 9.1.0 package) and sample coverage for broad structural vegetation types and 11 sites with their geographical coordinates along the Soutpansberg transect.

Vegetation types	Obs	Abundance	Site	Geographical coordinates	Obs	Chao 2	ICE	Sample coverage
Shrubland	77	4966	9S	23 03.846 °S, 29 29.400 °E	77	87.9	85.5	0.974
Thicket	60	16 192	10S	23 02.961 °S, 29 28.680 °E	60	79.3	75.1	0.968
Forest	68	8578	12S2	23 02.661 °S, 29 27.869 °E	56	74.9	72.9	0.958
	-	-	12S	23 02.417 °S, 29 27.033 °E	52	58.1	57	0.955
Sedgeland-herbland	85	15 948	14S	23 02.071 °S, 29 25.863 °E	63	79.1	80	0.968
	-	-	16S	23 01.355 °S, 29 26.033 °E	55	75.9	85.5	0.959
	-	-	17N	23 01.445 °S, 29 25.745 °E	41	49.8	48.5	0.963
Woodland	92	40 023	14N	23 00.018 °S, 29 25.545 °E	63	84.4	84	0.969
	-	-	12N	22 59.504 °S, 29 25.421 °E	64	71	67.7	0.98
	-	-	10N	22 58.157 °S, 29 24.979 °E	57	70	68.1	0.972
	-	-	8N	22 56.683 °S, 29 26.359 °E	57	68	64.3	0.982

Obs, observed number of species.

sample-based rarefaction and extrapolation of the incidence matrix. Sample coverage represents the proportion of the total number of individuals in the ant assemblage along the transect that belong to the species represented in our sample (Chao & Jost 2012).

Both interpolation and extrapolation of samples was based on the Bernoulli product model as well as unconditional variance estimates for the rarefaction (interpolation) (Chao & Jost 2012) and extrapolation curves. This sample-based estimation provides both unconditional variance abundance data of this study and species richness predicted by a 1000 pitfall samples and were considered to be a fair reflection of the richness at a site.

Samples within each replicate were pooled over the period of the study for multivariate analysis. Ant assemblage structure was mapped using non-metric multidimensional scaling of Bray–Curtis similarity measures (Clarke & Gorley 2006). *A posteriori* groups of ant assemblages were defined based on hierarchical clustering with group average linking. Support for these groups was tested with the permutational procedure SIMPROF in PRIMER version 6.1.6 (Clarke & Gorley 2006).

Results

In total, 85 759 ant specimens were collected during the 13 sampling periods (Appendix 2), comprising 133 species in 38 genera and 6 subfamilies.

Myrmicinae (with 72 species, 86% of the total abundance and 15 genera) was the most diverse and abundant subfamily, followed by Formicinae (27 species and 6 genera). Ponerinae (12 genera) had the second highest generic diversity.

The most specious genera were *Tetramorium* (22 species), *Camponotus* (19 species), *Monomorium* (13 species), *Pheidole* (9 species), *Crematogaster* (6 species), *Meranoplus* (4 species), and *Ocymyrmex*, *Anochectus*, *Bothroponera* and *Plectroctena*, each with 3 species (Appendix 2).

Sample-based species rarefaction and extrapolation curves for the transect as a whole approximated an asymptote, indicating that most of the epigeal species were collected with a sample coverage of 0.98. Sample coverage for all sites was > 0.95, while the forest site 12S coverage was the lowest, at 0.955. Based on richness estimations (Table 1) and species richness extrapolations (Figures 4 and 5), ant richness peaked at mid-elevations on the northern aspect. Only at woodland site 14N was species richness significantly greater that of 17N, the summit (Figure 4).

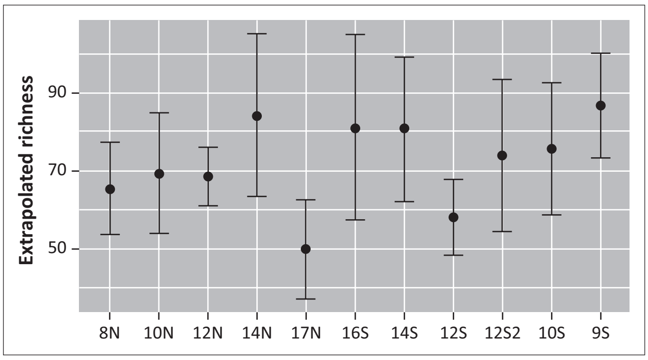


FIGURE 4: Extrapolated species richness for each site and 95% confidence intervals based on unconditional variance, from 1000 pitfall samples for each of the 11 sites across the Soutpansberg Mountain Range.

The pattern on the southern aspect was more complex, with richness decreasing significantly from shrubland site 9S to forest site 12S (Figure 4) and then increasing at sedgeland sites 14S and 16S before decreasing again towards the summit (Figure 4). Based on predicted richness of sites (Figure 5), the ranking of sites changes only for 14N. Notably, the predicted curve for 16S also suggests a considerable increase in richness with increased sampling. The sites with the highest and lowest variation in mean annual temperature variation (17N and 12S) also had the lowest species richness.

In total, 104 species were collected along the northern slope and 117 species on the southern slope. Twenty-eight species were restricted to the southern slope and nineteen species to the northern slope. Ten species, *Camponotus* UOVC_18 (*maculatus* gp.), *Lepisiota* UOVC_01 (*capensis* gp.), *Monomorium albopilosum* Emery, *Monomorium* UOVC_07, *Monomorium_08* (*monomorium* gp.), *Pheidole* UOVC_01 (*megacephala* gp.), *Tetramorium cf. setigerum* Mayri, *Tetramorium* UOVC_01 (*squaminode* gp.), *Tetramorium* UOVC_08 (*simillimum* gp.)

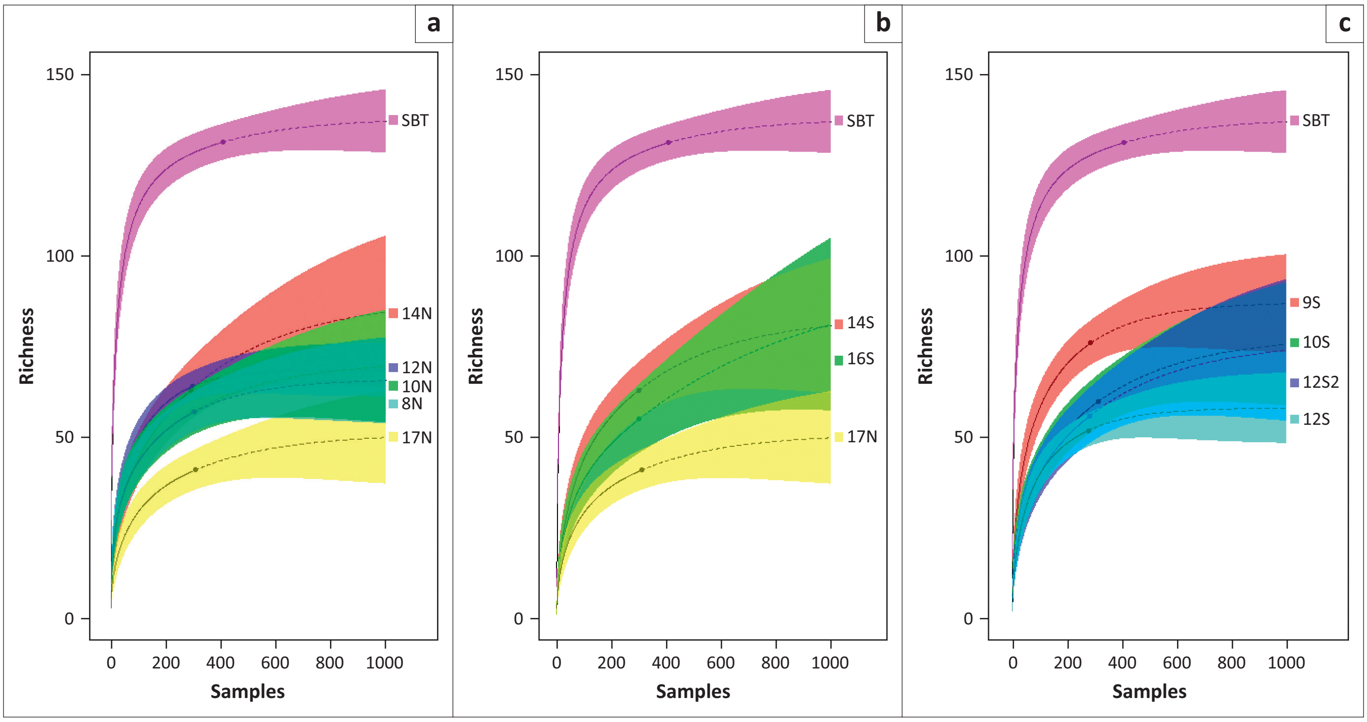
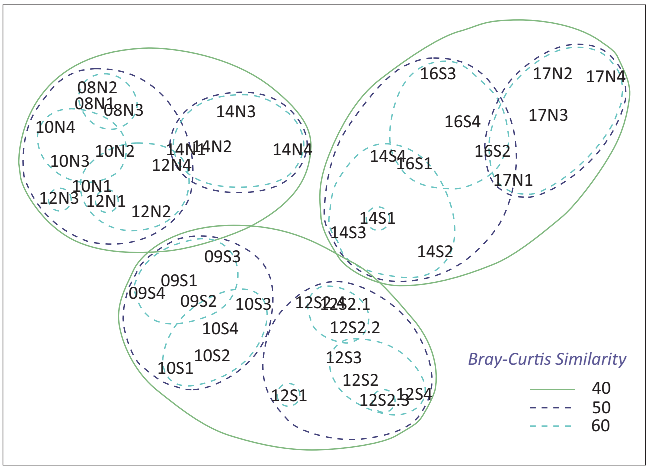


FIGURE 5: Species accumulation curves and their 95% confidence intervals for 1000 samples per site. The solid circles represent reference samples; solid lines are rarefied samples and dashed lines are extrapolation based on Mau Tau estimation. (a) Northern aspect, (b) higher elevational sites and (c) low to mid-elevation southern aspect. SBT, accumulation curve for the whole transect.



Stress = 0.12.

FIGURE 6: Non-metric multidimensional scaling of ant assemblages for samples pooled within each of the 44 replicates across 11 sampling sites in the Soutpansberg Mountain Range.

and *Technomyrmex pallipes* Smith, occurred at all the sites (Appendix 2).

A total of 20 Ponerine species were sampled from both the southern and the northern aspects. Fifty per cent of all Ponerine species, namely *Anochectus* UOVC_01, *Bothroponera ?strigulosa* Emery, *Bothroponera* UOVC_02, *Bothroponera* UOVC_03, *Hypoponera* UOVC_01, *Leptogenys intermedia* Emery, *Leptogenys schwabi* Forel, *Ophthalmopone* UOVC_01, *Plectroctena* UOVC_02 and *Pseudoponera* UOVC_01, were restricted to the southern slope of the mountain. The other 10 species occurred on both slopes of the mountain.

The non-metric multidimensional scaling plot identified three major groupings: the high elevation sedgeland-herbland sites (14S – summit); woodlands (08N – 14N); and shrubland, thicket and forest sites (09S – 12S) (Figure 6). At Bray–Curtis similarity measures of 50, each of the 3 groups divides into 2 (Figure 6). The groupings reveal distinct assemblages associated with the summit (17N) at higher elevations, while 14N was distinct from all the lower elevation sites on the northern aspect. Low elevation (shrubland and thicket sites 09S – 10S) and mid-elevation (forest sites 12S2 – 12S) of the southern aspect formed a distinct grouping.

Discussion

The level and higher taxon diversity of this study compares favourably with that of similar studies in the Cederberg and Drakensberg mountains, both of which employ a protocol similar to this study. The Cederberg transect located in the Cape Floristic Kingdom includes 17 sites over a distance of 160 km. That study recorded 86 species in 24 genera (Botes *et al*. 2006). The transect in the grasslands of the Drakensberg, with 9 elevational sites over a distance of 104 km along the Sani Pass, collected 98 species in 28 genera and 7 subfamilies (Bishop *et al*. 2014). Only one other study of ants along an altitude exists for the Savanna Biome in South Africa, where Schoeman & Foord (2012) found 104 species in 29 genera along a 1000 m elevational range in the Marakele National Park. With a higher generic plant diversity than the Cape Floristic Kingdom (Hahn 2006) and 90% of all spider families found in the Savanna Biome (Foord *et al*. 2011), the Soutpansberg is characterised by rich, higher taxon diversity.

Myrmicinae and Formicinae were the most diverse subfamilies. The most speciose genera were *Tetramorium*, *Camponotus*, *Pheidole* and *Monomorium*. This conforms to results from other studies in South Africa (Botes *et al.* 2006). *Monomorium* is very diverse in Australia, while *Camponotus* and *Pheidole* are the most diverse in Brazil (Campos *et al.* 2011), although the highly diverse genus in Australia, *Polyrhachis*, is only represented by two species along this transect. Except for *Lepisiota*, genera found throughout the transect belong to cosmopolitan genera (*Camponotus*, *Monomorium*, *Pheidole* and *Tetramorium*).

Most of the species accumulation curves of predicted richness based on 1000 pitfall samples reached an asymptote. There were two exceptions: a woodland site 14N and sedgeland site 16S, both of which also had the lowest coverage. Although 14N is in the woodland vegetation type, it is near the ecotone between sedgeland and woodland. The large turnover of taxa at this site could be the result of mass effects from taxa found in sedgeland. The steep slope of the 16S accumulation curve might suggest a temporal change in the ant assemblages of this site. Based on photographic records at each of the pitfalls, the *Coleochloa* species that dominate this site are being invaded by short woody shrubs. Turnover at this site might be linked to this encroachment and could probably lead to increased abundance of taxa associated with sites that are structurally more complex, such as forest sites 12S and 12S2 and shrubland site 9S. This has particularly important implications for the management of the few remaining grassland habitats in the Soutpansberg.

The high diversity of Ponerinae species at the base of southern aspect might be due to more productive ecosystems associated with the basalt intrusions, and higher rainfall. Disturbance also seems to positively impact Ponerine richness, which peaks in shrubland site 9S. This site is inside a wildlife sanctuary that is stocked with buffalo and where the bush is mechanically cleared. The three major groupings of ant assemblages across the study area conform to the broad structural classification of the vegetation used in this study (Edwards 1983).

Conclusion

This study provides a thorough inventory of ground-dwelling ants, with a sample coverage of 0.98. The sample coverage represents the proportion of the total number of individuals in the ant assemblage along the transect that belongs to the species represented in our sample (Chao & Jost 2012). Extrapolated richness for most sites reached an asymptote, except for three sites. All three of these sites can be considered to be sites that have experienced increased levels of bush encroachment. This is particularly concerning at 16S, which represents some of the last remaining grassland habitats in the Soutpansberg.

Ant taxa that act as indicators of bush encroachment should be identified in order to monitor the rate of these impacts. A single site on the lowest elevation of the southern aspect (09S) yielded 57% of the total ant species. This site experiences higher levels of disturbance through herbivory and bush clearing and provides support for the important role of disturbance as a driver of ant diversity in the Savanna Biome. The structural classification of vegetation in this study is a good predictor of broad-scale ant assemblage structure. Finer scale distinctions were linked to elevation, structural elements and temperature.

Acknowledgments

Special thanks to Alan Andersen and Hendrick Sithole for verifying ant identifications. We are grateful to Ian Gaigher (Lajuma Research Centre), Steven Fick (Koedoesvlei Farm) and Dave Dewsnap (Goro Nature Reserve) for providing access to their farms. Several volunteers from the University of Venda and Lajuma Research Centre are thanked for their assistance in the field. This study was funded by the DST-NRF Center of Excellence for Invasion Biology and the University of Venda.

Competing interests

The authors declare that they have no financial or personal relationships which may have inappropriately influenced them in writing this article.

Authors' contributions

T.C.M. (University of Venda) and S.H.F. (University of Venda) were responsible for the project design. T.C.M. identified the specimens. T.C.M. and S.H.F. performed the analysis and wrote the manuscript.

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Appendix 1

TABLE A1: Summary of the number of replicates set out at each of the 11 sites during each of the 13 surveys along the Soutpansberg Mountain Range. A replicate within a site consisted of 10 pitfalls in a 2 × 5 grid. Pitfalls were separated by 10 m and replicates within a site were separated by at least 300 m to ensure independence.

Site	Survey												
	Dec. 2008	Feb. 2009	Apr. 2009	May 2009	July 2009	Sept. 2009	Jan. 2010	Sept. 2010	Jan. 2011	Sept. 2011	Jan. 2012	Sept. 2012	Jan. 2013
08N	1	1	1	1	1	4	4	4	4	4	4	4	4
10N	1	1	1	1	1	4	4	4	4	4	4	4	4
12N	1	1	1	1	1	4	4	4	4	4	4	4	4
14N	1	1	1	1	1	4	4	4	4	4	4	4	4
17N	1	1	1	1	1	4	4	4	4	4	4	4	4
16S	1	1	1	1	1	4	4	4	4	4	4	4	4
14S	1	1	1	1	1	4	4	4	4	4	4	4	4
12S	1	1	1	1	1	4	4	4	4	4	4	4	4
12S2	1	1	1	1	1	4	4	4	4	4	4	4	4
10S	1	1	1	1	1	4	4	4	4	4	4	4	4
09S	1	1	1	1	1	4	4	4	4	4	4	4	4

Appendix 2

TABLE A2: Checklist of subfamilies and ant species collected during 13 surveys in different broad structural vegetation types across an elevational transect in the western Soutpansberg Mountain Range in South Africa.

Subfamilies and species	Five broad structural vegetation types					
	Woodland	Sedgeland-herbland	Forest	Thicket	Shrubland	Total
Dolichoderinae						
Tapinoma sp.01 *?luteum* Emery	121	15	5	0	1	142
Technomyrmex pallipes Smith	1143	748	27	44	40	2002
Dorylinae						
Aenictus rotundatus Mayr	787	0	0	0	7	794
Cerapachys UOVC_01	1	5	1	0	0	7
Cerapachys wroughtoni Forel	0	0	0	3	0	3
Dorylu shelvolus Linnaeus	0	79	2104	2	193	2378
Dorylus UOVC_02	45	0	0	0	0	45
Formicinae						
Anoplolepis cf. custodiens	92	1	0	0	3	96
Camponotus cf. niveosetosus	2	9	1	24	6	42
Camponotus dofleini Forel	1	1	0	0	0	2
Camponotus fulvopilosus De Geer	463	0	0	0	0	463
Camponotus mayri Forel	35	1	0	2	2	40
Camponotus UOVC_02 (*rufoglaucus* gp.)	25	8	7	59	23	122
Camponotus UOVC_03 (*niveosetosus* gp.)	0	22	0	0	5	27
Camponotus UOVC_04 (*etiolipes* gp.)	3	4	3	0	0	10
Camponotus UOVC_05	168	9	0	1	9	187
Camponotus UOVC_06 (*maculatus* gp.)	1	10	6	0	4	21
Camponotus UOVC_07 (*empedocles* gp.)	1	59	0	0	1	61
Camponotus UOVC_08 (*mystaceus* gp.)	0	1	0	0	0	1
Camponotus UOVC_11 (*cinctellus* gp.)	5	10	14	58	56	143
Camponotus UOVC_12 (*cinctelus* gp.)	1	16	0	2	20	39
Camponotus UOVC_17	0	0	1	0	0	1
Camponotus UOVC_18 (*maculatus* gp.)	54	14	16	18	32	134
Camponotus UOVC_20 (*niveosetosus* gp.)	11	0	0	0	0	11
Camponotus UOVC_21 (*cuneiscapus* gp.)	7	0	6	0	0	13
Camponotus UOVC_22	2	0	0	0	0	2
Lepisiota cf. longinoda Arnold	1	35	0	0	0	36
Lepisiota crinita Mayr	0	1	42	5	1	49
Lepisiota UOVC_01 (*capensis* gp.)	476	303	79	232	110	1201
Lepisiota UOVC_02 (*spinosior* gp.)	57	2	2	0	3	64
Lepisiota UOCV_08 (*capensis* gp.)	72	0	0	0	0	78
Lepisiota UOVC_09 (*capensis* gp.)	0	15	0	0	1	16
Lepisiota UOVC_10 (*capensis* gp.)	6	1	440	0	0	441
Lepisiota UOVC_11	0	0	1	0	0	1
Plagiolepis UOVC_02	40	39	16	1	0	96
Plagiolepis UOVC_03	15	29	18	1	0	63
Polyrhachis schistacea Gerstäcker	18	0	0	61	20	99

Table A2 continues on the next page →

TABLE A2 (Continues...): Checklist of subfamilies and ant species collected during 13 surveys in different broad structural vegetation types across an elevational transect in the western Soutpansberg Mountain Range in South Africa.

Subfamilies and species	Five broad structural vegetation types					
	Woodland	Sedgeland-herbland	Forest	Thicket	Shrubland	Total
Polyrhachis spinicola Forel	0	0	0	1	0	1
Tapinolepis UOVC_01	2325	0	0	0	25	2350
Myrmicinae						
Cardiocondyla UOVC_01	3	0	0	0	5	8
Cardiocondyla UOVC_02	4	0	0	0	0	4
Carebara UOVC_01	0	5	6	15	2	28
Cataulacus UOVC_01	4	0	1	0	0	5
Cataulacus wissmannii Forel	6	0	0	0	1	7
Crematogaster UOVC_01 subgenus *Sphaerocrema*	359	16	13	2	34	424
Crematogaster UOVC_02 (*rufigena* gp.)	37	13	7	3	1	61
Crematogaster UOVC_03 (*rufigena* gp.)	46	4	36	3	10	101
Crematogaster UOVC_04 subgenus *Sphaerocrema*	31	5	8	0	15	59
Crematogaster UOVC_05	8	0	0	0	0	8
Crematogaster UOVC_06 (*custanea* complex)	13	3	0	0	0	16
Meranoplus ?peringueyi	0	218	0	0	0	218
Meranoplus cf. glaber Arnold	128	0	0	0	0	128
Meranoplus inermis Emery	0	0	1	4	13	18
Meranoplus magrettii André	214	0	0	0	7	221
Messor UOVC_01	0	0	0	42	0	42
Monomorium ?fastidium Bolton	163	23	0	0	0	186
Monomorium ?notulum Forel	1110	83	0	2	1	1535
Monomorium albopilosum Emery	1384	2627	254	118	192	4575
Monomorium cf. drapenum Bolton	4870	19	54	12	57	5328
Monomorium cf. junodi Forel	0	0	0	785	278	1063
Monomorium damarense Forel	1772	17	9	429	389	2666
Monomorium emeryi Mayr	22	0	0	0	0	128
Monomorium UOVC_01	8	0	19	0	0	27
Monomorium UOVC_07	20	87	142	11	1	261
Monomorium UOVC_08 (*monomorium* gp.)	176	34	28	11	22	278
Monomorium UOVC_10 (*salomonis* gp.)	334	0	0	28	32	782
Monomorium UOVC_12 (*monomorium* gp.)	13	36	0	1	0	50
Monomorium UOVC_13	47	19	94	3	2	165
Myrmicaria natalensis Smith	1375	41	96	512	456	2480
Ocymyrmex flaviventris Santschi	153	0	0	0	0	153
Ocymyrmex fortior Santschi	2956	0	0	0	74	3030
Ocymyrmex UOVC_03	39	0	0	0	0	39
Pheidole UOVC_01 (*megacephala* gp.)	6097	940	1248	765	654	9704
Pheidole UOVC_02 (*liengmei*gp)	2788	20	11	17	42	2878
Pheidole UOVC_03 (*megacephala* gp.)	2857	92	1537	11 738	962	17 186
Pheidole UOVC_05 (*megacephala* gp.)	1	4807	0	0	0	4808
Pheidole UOVC_06 (*crassinoda* gp.)	305	21	1	331	107	765
Pheidole UOVC_07	1396	27	13	0	0	1436
Pheidole UOVC_09 (*crassinoda* gp.)	882	0	0	16	3	901
Pheidole UOVC_10 (*megacephala* gp.)	0	2835	0	0	0	2835
Pheidole UOVC_11	0	0	0	0	28	28
Pheidole UOVC_12	5	0	0	0	0	5
Rhoptromyrmex UOVC_02	0	14	0	0	0	14
Rhoptromyrmex transversinodis Arnold	0	2	11	32	1	46
Solenopsis UOVC_01	1	103	115	0	0	235
Solenopsis UOVC_02	6	9	80	8	0	149
Strumigenys ?arnodi Forel	0	1	0	0	0	1
Strumigenys pretoriae Arnold	0	2	0	0	0	2
Strumigenys UOVC_01	2	1	1	5	0	9
Strumigenys UOVC_02	0	0	1	0	0	1
Tetramorium baufra Bolton	1480	20	0	0	14	1514
Tetramorium cf. setigerum Mayr	64	197	67	49	28	405
Tetramorium notiale Bolton	0	4	18	27	16	65
Tetramorium sepositum Santschi	489	0	0	0	0	489
Tetramorium setuliferum Emery	315	38	0	0	2	355

Table A2 continues on the next page →

TABLE A2 (Continues...): Checklist of subfamilies and ant species collected during 13 surveys in different broad structural vegetation types across an elevational transect in the western Soutpansberg Mountain Range in South Africa.

Subfamilies and species	Five broad structural vegetation types					
	Woodland	Sedgeland-herbland	Forest	Thicket	Shrubland	Total
Tetramorium UOVC_01 (*squaminode* gp.)	310	111	137	23	2	583
Tetramorium UOVC_04 (*gabonense* gp.)	14	0	2	15	87	118
Tetramorium UOVC_05 (*sericeiventre* gp.)	0	3	0	0	131	134
Tetramorium UOVC_07 (*weitzeckeri* gp.)	201	219	445	447	391	1703
Tetramorium UOVC_08 (*simillimum* gp.)	91	96	185	2	31	405
Tetramorium UOVC_10 (*squaminode* gp)	0	174	0	0	0	174
Tetramorium UOVC_11 (*squaminode* gp.)	6	229	0	10	0	245
Tetramorium UOVC_12 (squaminode gp.)	3	201	969	0	5	1178
Tetramorium UOVC_13	0	14	13	13	0	40
Tetramorium UOVC_14 (*sericeiventre* gp.)	0	527	1	0	0	528
Tetramorium UOVC_16 (*sericeiventre* gp.)	0	459	75	0	27	561
Tetramorium UOVC_17 (*simillimum* gp.)	0	0	3	0	0	3
Tetramorium UOVC_18 (*simillimum* gp.)	27	2	0	0	0	29
Tetramorium UOVC_19 (*simillimum* gp.)	32	8	22	2	10	74
Tetramorium UOVC_20	0	1	0	0	0	1
Tetramorium UOVC_21 (*squaminode* gp.)	0	6	4	0	0	10
Tetramorium UOVC_22	0	0	0	0	3	3
Ponerinae						
Anochectus cf. traegaordhi Mayr	6	0	0	1	0	7
Anochectus UOVC_01	0	0	5	0	1	6
Anochectus UOVC_02	0	0	1	0	0	1
Bothroponera ?strigulosa Emery	1	2	15	116	8	142
Bothroponera UOVC_02	0	0	1	18	1	20
Bothroponera UOVC_03	0	0	0	0	9	9
Hypoponera UOVC_01	0	1	4	0	2	7
Leptogeny sintermedia Emery	0	49	8	11	11	79
Leptogenys schwabi Forel	0	7	0	39	8	54
Mesoponera ?caffraria Santschi	2	6	6	39	159	212
Odontomachus troglodytes Santschi	35	0	0	0	12	47
Ophthalmopone UOVC_01	0	0	0	0	4	4
Platythyrealamellosa Roger	93	1	1	1	2	98
Platythyrea shultzei Forel	27	0	0	2	0	29
Plectroctena ?mandibularis Smith	2	4	10	0	3	19
Plectroctena UOVC_02	0	0	2	1	0	3
Plectroctena ?subterranean Arnold	1	0	0	1	0	2
Ponera UOVC_01*	1	0	2	0	0	3
Pseudoponera UOVC_01	7	4	0	0	4	15
Pseudoponera UOVC_02	0	0	0	0	4	4
Psedomyrmecinae						
Tetraponera UOVC_01	2	1	0	0	0	3

UOVC, University of Venda Collection.
*, Introduced species.

Appendix 3

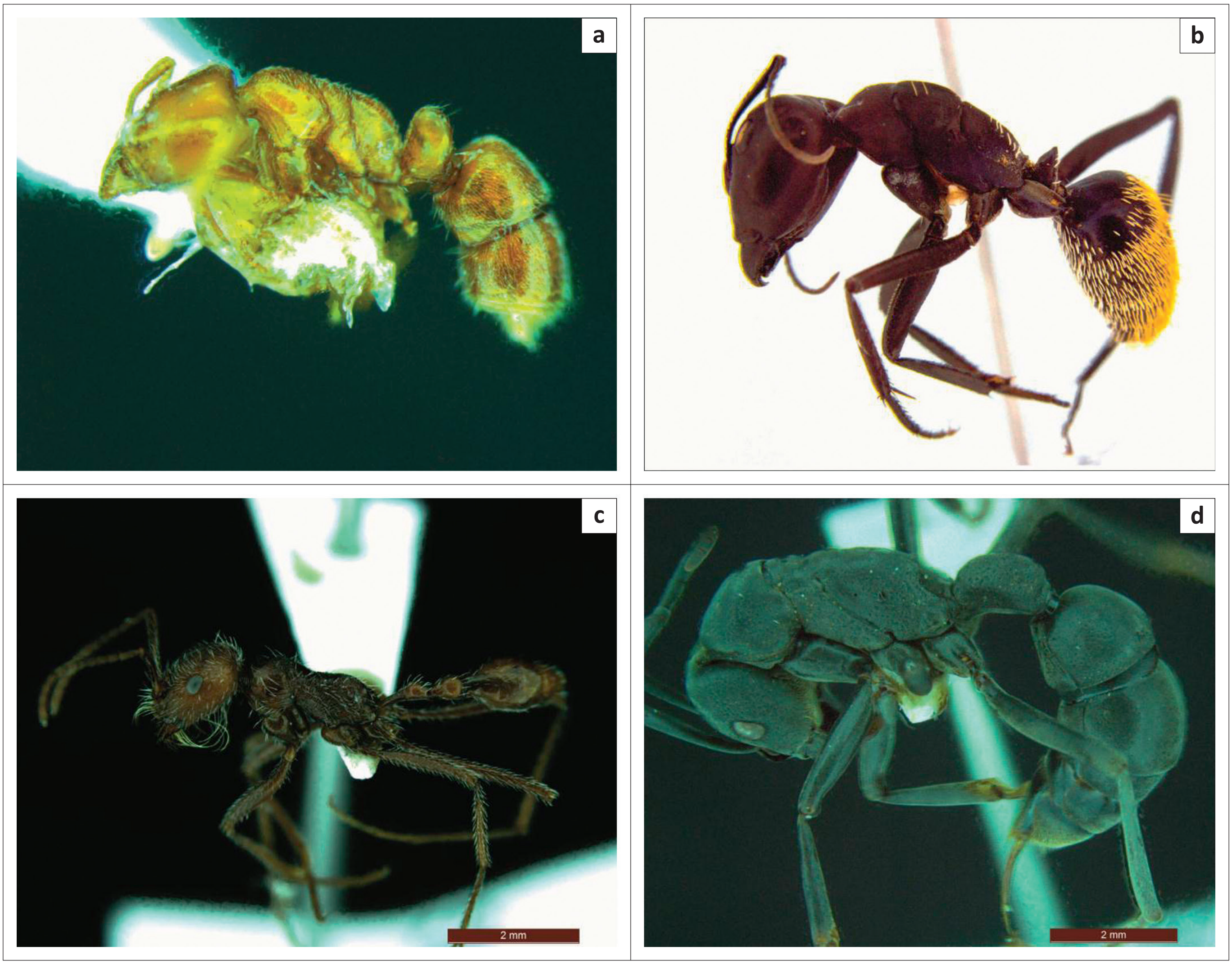

FIGURE A1: Images of some notable and interesting species collected during 13 surveys: (a) Introduced species *Ponera* UOVC_01, (b) *Camponotus fulvopilosus* De Geer, (c) *Ocymyrmex flaviventris* Santschi and (d) *Platythyrea lamellosa* Roger.