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SHORT COMMUNICATION

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A checklist of ants (Formicidae), spiders (Araneae) and millipedes (Spirostreptida) of the savannah in Mpumalanga Province, South Africa

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1 | INTRODUCTION

The savannah biome covers half of the land area in Africa and a third of South Africa (Mucina & Rutherford, 2006). Mpumalanga Province, South Africa, is part of the savannah. The species composition of flightless macroinvertebrates in Mpumalanga is incompletely known. However, occurrence of some spiders (Dippenaar-Schoeman, Berg, Berg, & Foord, 2005; Dippenaar-Schoeman, Berg, Haddad, & Lyle, 2013; Dippenaar-Schoeman, Berg, Berg, & Berg, 2001) and millipedes (Hamer, 1998, 2000) in Mpumalanga has been reported. Checklists of flightless invertebrates have also been produced for some protected areas in the neighbouring Limpopo Province (Druce, Hamer, Slotow, & Prendini, 2004; Foord et al., 2016; Munyai & Foord, 2015; Schoeman & Foord, 2012). In addition, Janion-Scheepers et al. (2016) published a review and species lists of soil fauna of South Africa.

The savannah is understudied in terms of the diversity, relative dominance and distribution of flightless macroinvertebrates. As such, the paucity of faunistic data compromises conservation efforts and understanding of their ecological role. Soil macroinvertebrates (SMI) are important in ecosystem processes, such as, leaf litter decomposition, soil turnover and soil structure formation (Lavelle et al., 2006). The limited ability to disperse of SMI leads to isolation and speciation. As such, several flightless SMI are endemics and/or unknown to science. Given the lack of faunistic data, increasing habitat loss and fragmentation associated with anthropogenic disturbances and changing climate, recording the species composition of SMI in unsurveyed habitats is a priority in South Africa. Furthermore, because invertebrates are potential indicators of ecosystem health (Kime & Golovatch, 2000), studying them has become even more important. Without baseline data, the effect of disturbances on flightless SMI will not be understood fully and conservation initiatives would be difficult to implement. As such, we undertook to survey nonvolant SMI and produce checklists for the savannah biome in Mpumalanga. Given the changing climatic conditions, encroaching invasive plants and increasing disturbances, recording flightless macroinvertebrates is critical because they are affected negatively by habitat transformation. The data will contribute to other biodiversity studies and could be used in modelling occurrence and facilitate identification of bioindicators of habitat change. Therefore, our objective was to produce an inventory of ants, spiders and millipedes in disturbed and undisturbed habitats in the savannah in Mpumalanga.

2 | MATERIALS AND METHODS

The study was undertaken in 2017, in 2 protected areas and in disturbed sites (which had *Lantana camara*) near human settlements (<3 km) in Mpumalanga Province, South Africa. Sampling took place in Sterkspruit (S25°09.729', E30°33.842') and Barberton (S25°36.294', E030°58.680') Nature Reserves and in disturbed areas, which were between Mbombela (S25°26.180', E030°59.051') and White River (S25°22.911', E030°58.705'). The disturbed areas had isolated granite rock outcrops (average size 2,500 m^2) on which vegetation grows (Figure 1). Vegetation around Mbombela is mixed bushveld and thornveld (dominated by *Acacia* trees) with medium to tall trees and succulents (Mucina & Rutherford, 2006). Vegetation around the rock outcrops is grassland with scattered trees (including *Combretum* sp., *Erythrina* sp., *Syzygium* sp., *Ficus* sp., *Lantana camara* and *Acacia*) and invasive

FIGURE 1 Rock outcrops in the savannah in Mpumalanga [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 1 Occurrence of millipedes in Mpumalanga Province

TAXON	SNR	BNR	RS	NRS
ODONTOPYGIDAE				
Chaleponcus sp.1			X	
Chaleponcus sp. 2			X	
Odontopygidae sp. 1		X		
Odontopygidae sp. 2	X			
Odontopygidae sp. 3				X
Odontopygidae sp. 4			X	
Odontopygidae sp. 5			X	
SPIROSTREPTIDAE				
Doratogonus sp. 1		X		
Doratogonus sp. 2	X			
Doratogonus sp. 3				X
Doratogonus sp. 4	X			
Doratogonus sp. 5	X			
Doratogonus rugifrons				X
Doratogonus flavifilis	X		X	
Orthoporoides tabulanus	X			
Spirostreptidae sp. 1	X			
Spirostreptidae sp. 3	X			
HARPAGOPHORIDAE				
Harpagophoridae sp. 1	X		X	
SPECIES RICHNESS	9	2	6	3

Abbreviations: BNR, Barberton Nature Reserve; NRS, Nonrocky vegetation; RS, Rock Outcrops; SNR, Sterkspruit Nature Reserve.

shrubs. Mbombela has warm weather, with infrequent frost and mostly summer precipitation, with average midday temperatures of 21°C in June and 28°C in January (https://www.worldweatheronline.com/nelspruit-weather-averages/mpumalanga/za.aspx). Sampling took place in winter (June) and summer (December) in 16 sites (eight nonrocky and eight rocky). The four sites in the nature reserves were nonrocky. Sites were at least 300 m apart and were visited twice in each season, to set up pitfall traps and to do active searching.

Pitfall trapping and active searching were used to sample flightless SMI. Using different sampling methods in combination ensured that more taxa were recorded, despite their different activity patterns. Samples collected in winter and in summer were pooled. Polythene jars (open-end diameter 6 cm, depth 10 cm) quarter-filled with 100% ethylene glycol were inserted in vertical holes. The open end of the jars was flush with the soil surface. Twenty-four pitfall traps, in four sets of 6, were set up in each 10 m by 10 m site. The subsites were in the corners of each site. Adjacent pitfall traps in each subsite were approximately 2 m apart. The traps were left open for 7 days during each sampling event. Active searching along two 50 m × 2 m transects was done in each site and involved 2 people, one on either side of each transect, for 30 min. In the laboratory, Fisher and Bolton (2016) and Slingsby (2017) were used to identify ants; other specimens were identified by specialists. All voucher specimens will be deposited in the KwaZulu-Natal Museum, Pietermaritzburg, South Africa.

3 | RESULTS AND DISCUSSION

Of the 18 species of millipedes recorded, there were ten spirostreptids, 7 odontopygids and one harpagophorid (Table 1). No species was recorded at more than two sites. Although the Odontopygidae occurred at all the sites, no species was found at all the sites. Four odontopygids were collected on rock outcrops and a species each in Sterkspruit Nature Reserve (SNR), Barberton Nature Reserve (BNR) and disturbed nonrocky sites. *Chaleponcus*, with 2 species, was the most speciose odontopygid. Spirostreptids were dominated by *Doratogonus* (7 species). Although *Doratogonus* occurred at all the sites, the charismatic zebra millipede, *D. flavifilis*, was the only species recorded at 2 sites (SNR and on rock outcrops).

Ant subfamilies (Formicinae, Myrmicinae, Dolichoderinae and Ponerinae) with 37 species were recorded (Table 2). Formicinae was the most speciose (17 species) followed by Myrmicinae with 11 species. Among the genera, *Camponotus* (12 species) was the most speciose. 5 genera, *Camponotus*, *Monomorium*, *Pheidole*, *Crematogaster* and *Tetramorium*, were recorded at all the sites. A species of *Camponotus*, *Bothroponera* and *Tapinolepis* were recorded in SNR only. A species of *Odontomachus* occurred in BNR only and *Linepithema* and *Tapinoma* were recorded in disturbed nonrocky sites only. A species of *Crematogaster*, *Ocymyrmex*, *Lepisiota* and 5 species of *Camponotus* were collected on rock outcrops and disturbed nonrocky sites only.

Out of the 30 families of spiders, 13 had a single species each (Table 3). Interestingly, 12 families (Agelenidae, Corinnidae, Ctenidae, Cyrtaucheniidae, Linyphiidae, Eresidae, Hersiliidae, Mimetidae, Philodromidae, Scytodidae, Sparassidae and Trachelidae) were not recorded in SNR and BNR. The most speciose families were the Lycosidae (19), Salticidae (15) and Gnaphosidae (14). Although no species occurred in all the sites, 2 families (Salticidae and Zodariidae) were recorded at all the sites. Most species (62) occurred on rock outcrops, and the least number was recorded at BNR (15). 15 of the 19 species of lycosids, 10 salticids and 6 gnaphosids were recorded on rock outcrops. Unlike in the disturbed sites where the lycosids and salticids dominated, the gnaphosids (6 species) were most speciose in SNR. BNR was represented by one species per family, except for the lycosids (3 species) and amaurobiids (2 species). Compared with pristine sites (SNR and BNR), 2 times more spider species were recorded in disturbed sites (rock outcrops and nonrocky sites). 9 species only were recorded in both pristine and disturbed sites, with the lycosids (4 species) being common (Table 3).

Our results highlight the importance of local checklists in conservation of flightless SMI. Given that no species of ants, spiders and millipedes occurred in all the sites, these results demonstrate that some flightless arthropods are site-specific. These observations are consistent with taxa having limited dispersal ability and specific habitat preferences. Although the millipede genus *Doratogonus* occurred widely, most species, except *D. flavifilis*, were recorded at one site. Millipedes are notoriously habitat specific and respond to changes in habitat (Kime & Golovatch, 2000; Mwabvu, 2006). As such, the lower species richness of millipedes in disturbed sites was expected. However, the fact that *D. flavifilis* occurred at 2 sites suggests that the species is distributed widely, especially considering the distance (approximately 100 km) between SNR and the rock outcrops. Previous records of the *D. flavifilis* in Mpumalanga were from KNP only (Hamer, 1998, 2000). That more odontopygids (4 species) were recorded on rock outcrops was not surprising because of the limited dispersal ability of these relatively small millipedes and that the rock outcrops are islands in the savannah. As reported by Hamer and Slotow (2002), most narrow endemic millipedes have small bodies and low mobility unlike larger species. As such, larger millipedes, such as, *D. flavifilis*, would occur widely and may tolerate diverse habitat conditions.

Species richness of ants was one and half times greater in disturbed areas than in pristine habitats. Greater species richness on and around rock outcrops could be attributed to the occurrence of more generalists in disturbed habitats. Mauda, Joseph, Seymour, Munyai, and Foord (2017) reported differences in species composition of ants under different land uses in African savannah. Mauda et al. (2017) recorded the same genera (*Camponotus*, *Lepisiota*, *Mesoponera*, *Pheidole*, *Ocymyrmex* and *Tetramorium*) that dominated disturbed sites in our study. As was the case in Mauda et al. (2017) and Melliger, Braschler, Rusterholz, and Baur (2018), disturbed sites

TABLE 2 Occurrence of ants in Mpumalanga Province

TAXON	SNR	BNR	RS	NRS
MYRMICINAE				
Crematogaster custanea	X	X	X	X
Crematogaster sp. 1	X	X	X	X
Crematogaster sp. 2			X	X
Monomorium albopilosum	X	X	X	X
Monomorium sp. 1	X		X	X
Myrmicaria natalensis		X	X	X
Myrmicaria sp. 1		X	X	
Ocymyrmex sp. 1			X	X
Pheidole sp. 1	X	X	X	X
Tetramorium sp. 1		X	X	X
Tetramorium squaminode	X	X	X	X
DOLICHODERINAE				
Linepithema sp. 1				X
Tapinoma sp. 1				X
PONERINAE				
Bothroponera sp. 1	X			
Bothroponera sp. 2			X	
Odontomachus sp. 1		X	X	X
Odontomachus troglodytes		X		
Mesoponera sp.		X	X	X
Paltothyreus sp.	X	X		X
FORMICINAE				
Anololepis custodiens			X	X
Camponotus cinctellus	X			
Camponotus maculatus	X	X	X	X
Camponotus niveosetosus	X	X	X	X
Camponotus etiolepis			X	X
Camponotus sp. 1	X		X	X
Camponotus sp. 2			X	X
Camponotus sp. 3	X		X	X
Camponotus sp. 4			X	X
Camponotus sp. 5			X	X
Camponotus sp. 6	X		X	X
Lepisiota sp. 1			X	X
Lepisiota longinoda	X	X		
Lepisiota sp. 2	X	X		X
Polyrhachis schistacea				X
Tapinolepis sp. 1	X			
SPECIES RICHNESS	17	16	25	28

Abbreviations: BNR, Barberton Nature Reserve; NRS, Nonrocky vegetation; RS, Rock Outcrops; SNR, Sterkspruit Nature Reserve.

TABLE 3 Occurrence of spiders in Mpumalanga Province

TAXON	SNR	BNR	RS	NRS
AGELENIDAE				
Agelenidae sp. 1			X	
Agelena sp.			X	
ARANEIDAE				
Hypsosinga sp. 1 cf *rubens*			X	
Mahembea sp.			X	
Neoscona sp.			X	
Pararaneus cyrtoscapus			X	
Singa sp.	X			
AMAUROBIIDAE				
Caponia sp. 1		X		
Pseudauximus sp. 1	X	X		X
CLUBIONIDAE				
Clubiona godfreyi		X		
Clubiona sp.			X	
CORINNIDAE				
Copa flavoplumosa			X	X
CTENIDAE				
Ctenus gulosus			X	
CYRTAUCHENIIDAE				
Homostola pardalina			X	
LINYPHIIDAE				
Linyphiidae sp. 1			X	
EUTICHURIDAE				
Cheiramiona debeeri	X			
ERESIDAE				
Paradonea parva			X	
PISAURIDAE				
Afropisaura ducis		X		
GALLIENIELLIDAE				
Austrachelas bergi		X		
Austrachelas sp.1	X			
GNAPHOSIDAE				
Anagraphis pallens	X			
Asemesthes sp.				X
Asemesthes decoratus				X
Camillina cordifera				X
Drassodes stationis	X			
Drassodes sesquidentatus	X			
Ibala bilinearis			X	
Nomisia sp.			X	
Nomisia varia			X	
Urozelotes rusticus	X			
Xerophaeus sp.	X		X	
Xerophaeus bicavus	X			
Zelotes sp. 1		X	X	
Zelotes frenchi			X	
HERSILIIDAE				
Tyrotama australis				X
IDIOPIDAE				
Ctenolophus oomi			X	
Idiopidae sp. 2		X		
Idiops nigropilosus	X			
LYCOSIDAE				
Allocosa exserta			X	
Allocosa aurata				X
Allocosa lawrencei			X	
Allocosa umtalica			X	
Allocosa sp. 2			X	
Allocosa sp. 1		X	X	X
Amblyothele ecologica			X	
Amblyothele sp.			X	
Foveosa adunca				X
Geolycosa sp.				X
Hogna spenceri			X	
Minicosa neptuna			X	
Pardosa crassipalpis			X	X
Pardosa sp.1		X		
Proevippa albiventris	X		X	
Pterartoria sp.			X	
Trabea heteroculata	X	X	X	
Trabea purcelli	X		X	
Trabea sp. 1			X	X
MIMETIDAE				
Mimetidae sp.1			X	
OXYOPIDAE				
Hamataliwa sp.	X			
Oxyopes dumonti			X	
Oxyopes jacksoni				X
Oxyopes auriculatus	X			
Oxyopes strandi	X			
Oxyopes sp. 1			X	
PALPIMANIDAE				
Palpimanus sp. 1	X			
Palpimanus sp. 2	X			
PHILODROMIDAE				
Thanatus dorsilineatus			X	
Tibellus minor			X	
PRODIDOMIDAE				
Theuma sp.		X		

(Continues)

TABLE 3 (Continued)

TAXON	SNR	BNR	RS	NRS
SALTICIDAE				
Evarcha prosimilis			X	
Hyllus argyrotoxus			X	
Hyllus dotatus	X			X
Langelurillus minutus	X			X
Langona bethae	X			
Langona tortuosa				X
Langona sp. 1			X	
Pellenes sp.			X	
Phlegra imperiosa				X
Phlegra sp. 1			X	
Rumburak sp.			X	
Stenaelurillus guttiger		X	X	X
Stenaelurillus sp. 1			X	
Tanzania sp.			X	
Thyene sp. 1			X	X
SCYTODIDAE				
Scytodes maritima			X	
SELENOPIDAE				
Anyphops sp. 1		X		
Anyphops sp. 2			X	
Selenops sp.			X	
SICARIIDAE				
Loxosceles simillima		X		
SPARASSIDAE				
Olios sp. 1			X	
Olios sp. 2				X
Olios sp. 3			X	
THOMISIDAE				
Heriaeus crassispinus			X	
Misumenops rubrodecoratus				X
Monaeses gibbus			X	X
Runcinia aethiops				X
Runcinia flavida			X	
Thomisus daradioides			X	
Xysticus natalensis	X			X
THERAPHOSIDAE				
Brachionopus pretoriae	X			
Harpactira gigas	X			
TRACHELIDAE				
Afroceto martini			X	
ZODARIIDAE				
Cydrela spinimana			X	X
Cydrela sp. 1			X	X
Cydrela sp. 2	X			

(Continues)

TABLE 3 (Continued)

TAXON	SNR	BNR	RS	NRS
Diores pauper	X			
Ranops caprivi			X	
Ranops caprivi		X		
SPECIES RICHNESS	27	15	62	26

Abbreviations: BNR, Barberton Nature Reserve; NRS, Nonrocky vegetation; RS, Rock Outcrops; SNR, Sterkspruit Nature Reserve.

in our study had higher species richness of ants which demonstrated that several species are preadapted to structurally simple habitats. Our checklist demonstrates that the simplification of habitats results in changes in dominance and species assemblages. Munyai and Foord (2015) reported the subfamily Myrmicinae as dominant in the western Soutpansberg Mountain range in Limpopo Province. However, in our study the Formicinae, particularly *Camponotus*, was most species-rich followed by the Myrmicinae. Unsurprisingly, the Myrmicinae, which contains generalist species (Miranda, Oliveira, Baccaro, Morato, & Deabie, 2012), occurred frequently at most sites in our study irrespective of the levels of disturbance.

As in ants, the number of families recorded and the species richness of spiders were greater in disturbed sites. Our observations are consistent with Melliger et al. (2018), who recorded an increase in the number of generalist spiders in urbanised areas, which was associated with the sensitivity of spiders to local changes in habitats. In our study, the high species richness is associated with the increased dominance of lycosids and salticids in disturbed than pristine sites. Salticids are generalist predators, which dominate the savannah (Dippenaar-Schoeman et al., 2015; Dippenaar-Schoeman & Leroy, 2003; Foord, Dippenaar-Schoeman, Haddad, Lotz, & Lyle, 2011; Whitmore, Slotow, Crouch, & Dippenaar-Schoeman, 2002) and agro-ecosystems in Limpopo and Mpumalanga (Dippenaar-Schoeman et al., 2005, 2013, 2001, 2015; Foord et al., 2016). As such, the species richness of salticids and lycosids in our study was expected, particularly in disturbed sites.

Some species of ants, spiders and millipedes may not have been sampled because taxa have different activity periods that may have been outside our sampling period. This is true for millipedes whose activity is influenced by high soil moisture (Dangerfield & Telford, 1991). Druce et al. (2004) noted also that more species of SMI could be added to checklists if more habitats were sampled. The large number of single records in our study support the observation by Druce et al. (2004). According to Mac Nally, Fleishman, and Murphy (2004) invertebrates respond to changes in the environments and are influenced by the composition and structure of the vegetation. Therefore, increasing sampling effort by increasing the frequency and duration of sampling and using more sampling techniques could result in more flightless SMI being recorded in the savannah. Although approximately 60% fewer genera and species of millipedes, and 50% fewer ant subfamilies were recorded in our study compared with Janion-Scheepers et al. (2016), there are several new records. Furthermore, given that Janion-Scheepers et al. (2016)

reported fewer (21) spider families for the whole of Mpumalanga compared with the 30 that we recorded in a smaller study area, our results show the need for more surveys in the savannah, particularly in disturbed habitats, where we recorded the greatest diversity of ants and spiders.

Our checklists provide valuable baseline data on macroinvertebrates in southern African savannahs. As such, local checklists should be encouraged in order to record taxa with narrow distribution. Besides distributing research effort among local scientists and reducing research costs, local inventories are critical in effective conservation efforts and training young researchers. Given the paucity of faunistic data and the threats to biodiversity, local checklists could speed up generation of data. Because anthropogenic disturbances affect species assemblages at local scale, more local surveys would enhance how we mitigate loss of biodiversity.

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