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Updated list of Collembola species currently recorded from South Africa

Charlene Janion-Scheepers¹³, Louis Deharveng², Anne Bedos², Steven L. Chown³

¹ Centre for Invasion Biology, Department of Botany and Zoology, Stellenbosch University, Private Bag X1, Matieland 7602, South Africa ² Institut de Systématique, Évolution, Biodiversité ISYEB - UMR 7205 - CNRS, MNHN, UPMC, EPHE, Muséum national d’Histoire naturelle, Sorbonne Universités, 45 rue Buffon, F-75005, Paris, France ³ School of Biological Sciences, Monash University, Clayton, Victoria, Australia

Corresponding author: Charlene Janion-Scheepers (charlene.janionscheepers@monash.edu)

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Abstract
Understanding the abundance and richness of species is one of the most fundamental steps in effecting their conservation. Despite global recognition of the significance of the below-ground component of diversity for ecosystem functioning, the soil remains a poorly studied terrestrial ecosystem. In South Africa, knowledge is increasing for a variety of soil faunal groups, but many still remain poorly understood. We have started to address this gap in the knowledge of South African soil biodiversity by focusing on the Collembola in an integrated project that encompasses systematics, barcoding and ecological assessments. Here we provide an updated list of the Collembola species from South Africa. A total of 124 species from 61 genera and 17 families has been recorded, of which 75 are considered endemic, 24 widespread, and 25 introduced. This total number of species excludes the 36 species we consider to be dubious. From the published data, Collembola species richness is high compared to other African countries, but low compared to European countries. This is largely a consequence of poor sampling in the African region, as our discovery of many new species in South Africa demonstrates. Our analyses also show that much ongoing work will be required before a reasonably comprehensive and spatially explicit picture of South Africa’s springtail fauna can be provided, which may well exceed 1000 species. Such work will be necessary to help South Africa meet its commitments to biodiversity conservation, especially in the context of the 2020 Aichi targets of the Convention on Biological Diversity.

Keywords
Biodiversity, endemicity, soil fauna, introduced species, taxonomy
Introduction

The documentation of biodiversity is an essential first step for its conservation. A major barrier to so doing for invertebrates is a lack of taxonomic information on various groups. This taxonomic impediment and its implications for biodiversity studies have been widely discussed (Godfray 2002, Samper 2004). Despite these challenges, taxonomic knowledge continues to increase globally (Nilsson-Örtman and Nilsson 2010, Joppa et al. 2011, Platnick 2014, van Noort 2014). Nonetheless, given rapid environmental change and its effects on biodiversity (Butchart et al. 2010), it is unclear what the rate of extinction is for many groups (Pimm et al. 2010, Costello et al. 2013), complicating conservation efforts and assessments of their efficacy, thus underscoring the urgency to further document global biodiversity (Dirzo and Raven 2003, Bacher 2012).

This situation is as true for southern Africa as it is elsewhere. Knowledge of the South African fauna is increasing rapidly, especially in the case of a wide range of invertebrate groups (Foord et al. 2002, Robertson 2000, 2002, Parr et al. 2003, Dippenaar-Schoeman et al. 2006, Dippenaar-Schoeman and González Reyes 2006, Haddad and Dippenaar-Schoeman 2006, Hlavac 2007, Rousse and van Noort 2013). Nonetheless, many groups still remain relatively poorly studied, especially soil-dwelling taxa, which are essential for both above- and below-ground ecosystem functioning (Wardle et al. 2004, Hugo-Coetzee and Avenant 2011, Janion et al. 2011a). At the same time, considerable impacts on biodiversity continue to be documented as a consequence of habitat modification for agriculture and urban development, biological invasions, pollution, and climate change (Erasmus et al. 2002, Rouget et al. 2003, Biggs et al. 2008, Chown 2010, Pryke and Samways 2010, Huntley and Barnard 2012, Liu et al. 2012). In consequence, much need exists for documenting and understanding biodiversity and the processes underlying its variation across a wide range of groups, and especially the soil fauna.

Collembola are amongst the most widespread and abundant soil arthropods (Petersen and Luxton 1982, Hopkin 1997). Despite their obvious significance in soil systems, their utility as bioindicators (Lawrence 1953, Hopkin 1997, van Straalen 1998), their significance in the alien species faunas of many areas (Roques et al. 2009, Terauds et al. 2011), and the current growth in both morphological (Deharveng 2004) and molecular (Hogg and Hebert 2004, Rougerie et al. 2009) means to assess their diversity, they remain poorly known in South Africa. Indeed, by comparison with other regions of the world (Deharveng 2004), and other invertebrate taxa in the country (Scholtz and Chown 1995, Robertson 2000, Foord et al. 2011, Dippenaar-Schoeman 2014), knowledge of the group can be considered scanty.

The first attempt to collate all taxonomic information on the Collembola of South Africa was undertaken by Paclt (1959), listing ca. 65 species. Subsequently, an unpublished list entitled “Aquatic Collembola of South Africa” was made available online (P. Greenslade, no date), while Thibaud (2013) listed most publications until 2013. To date there are 38 publications on Collembola recorded or described from South Africa, the earliest by Börner (1908). Most notably, comprehensive descriptions were made by
Yosii (1959), Paclt (1959, 1964, 1965, 1967), Coates (1968a, 1968b, 1969), Weiner and Najt (1991, 1998, 1999), and later Barra (1994, 1995, 1997, 1999, 2001, 2002, Barra and Weiner 2009). However, little other work has been done and the current list of species for the country is clearly an underestimate, with an incomplete understanding of which species might be introduced and thus might have substantial impacts, despite the fact that such impacts have been suggested for the country (Annecke and Moran 1982, Liu et al. 2012).

To address this substantial gap in the knowledge of soil biodiversity, a collaborative project was established in 2008 (Janion et al. 2011a, Bengtsson et al. 2011, 2012). Besides large-scale sampling and systematic assessments, which have resulted in new discoveries and species descriptions (Janion et al. 2011b, Potapov et al. 2011, Janion et al. 2012, 2013), a major component of the project has comprised the compilation of all currently available information on Collembola recorded from South Africa. Here we present this compilation as an updated checklist. It will provide a starting point for understanding the diversity of this group, as has been done for other geopolitical regions (e.g. Culik and Zeppelini 2003, Abrantes et al. 2010, 2012), and will assist South Africa to meet its obligations under the Convention on Biological Diversity (see for example Aichi Target 9 on identifying invasive alien species, and Aichi Target 17 on a national biodiversity strategy, http://www.cbd.int/sp/targets).

**Methods**

All publications on Collembola species described or recorded from South Africa were collated from Salmon (1964) and Thibaud (2013). The list was checked and completed using the website “Checklist of the Collembola of the World” (Bellinger et al. 2014), the bi-annual bibliographical lists issued by the Museum National d’Histoire Naturelle (Paris, France), Zoological Record, Web of Science™ (full date range of 1900 to 2014), and genus or species revisions from taxonomic journals sourced from the references identified using the original search methods. Nomenclature follows Bellinger et al. (2014), as it may have changed for certain taxonomic groups since the original description of the species. All published papers and webpages were examined and the following information was recorded when available: collection details including date, collector, province, place, nearest town, habitat type, and collection method, type locality and accession number if given. Only species with full species names were included in the species list of Table 2, thus excluding morphospecies identified to genus or to suspected species (e.g. Seira sp. or Isotomurus cf. maculatus). However, every record from the literature is listed in the Supplementary material (Suppl. material 1). The species were assigned a South African province from the locality recorded. From these points a species richness map was produced in ArcMap V10.2 (ESRI 2014).

The species were also divided into the following categories based on their distribution: 1) endemic if they were described from South Africa and have not been recorded elsewhere, 2) introduced if there is evidence from the literature that the species was
introduced from another place, 3) widespread if the species is also present outside of South Africa but its origin is unknown, thus not considered introduced, or 4) dubious, when the species name given in the literature is considered a misidentification based on current taxonomic knowledge or if subsequent taxonomic work suggested this is the case (see Suppl. material 1).

To make an estimate of expected species richness, we used data collected from extensive sampling in the Western Cape Province of South Africa, which has been the main focus of much work on the group. The dataset comprises a total of 217 samples we obtained using several sampling techniques (see below) in as many localities and different microhabitats as possible throughout the Western Cape, including Afromontane forest, different fynbos vegetation types (see Mucina and Rutherford 2006), intertidal habitats, caves, and disturbed areas such as gardens and agricultural areas. Leaf litter, moss, rotten wood and soil samples were taken at different sampling sites over the duration of the project (2008–2012), and occasionally sieving and pit-fall traps were also used. Typically, samples were extracted using a Berlese-Tullgren approach for five to seven days, or until dry (Berlese 1905, Tullgren 1918, Hopkin 1997). In addition, active searching was done in the field. Riparian soil was washed for water-dependent species, which were collected with a fine brush on the surface of water. Fine sand such as sea sand was washed in the laboratory and animals were also collected with a brush. Vegetation such as branches from bushes, fynbos shrubs, and grasses was beaten over a tray and animals were collected by means of an aspirator.

Results

According to the literature, a total of 160 species from 61 genera and 17 families have been recorded from South Africa (Table 1), with a relatively steady increase in descriptions since the first records in the early 1900s (Fig. 1). Of the recorded species, 36 are considered dubious, most of them misidentified records from Paclt (1959, 1967). Of the other species, 75 are endemic, 25 are thought to be alien species introduced to the country by human activity, and 24 have a widespread distribution, at least so far as current sampling indicates (Table 2). The majority of species have been recorded from
Table 1. A summary of the Collembola species recorded from South Africa based on the literature.

| Group          | Number of species recorded from literature | Number of species accepted from literature | Introduced | Endemic | Widespread |
|----------------|-------------------------------------------|-------------------------------------------|------------|---------|------------|
| **PODURMORPHA** |                                           |                                           |            |         |            |
| Hypogastruridae | 19                                        | 11                                        | 4          | 5       | 2          |
| Brachystomellidae | 6                                          | 6                                         | 1          | 5       | 0          |
| Neanuridae      | 16                                        | 15                                        | 2          | 10      | 3          |
| Odontellidae    | 3                                         | 2                                         | 0          | 1       | 1          |
| Onychiuridae    | 5                                         | 1                                         | 0          | 1       | 0          |
| Tullbergiidae   | 8                                         | 7                                         | 1          | 3       | 3          |
| **TOTAL**       | **57**                                    | **42**                                    | **8**      | **25**  | **9**      |
| **ENTOMOBRYOMORPHA** |                                          |                                           |            |         |            |
| Isotomidae      | 23                                        | 19                                        | 5          | 8       | 6          |
| Entomobryidae   | 49                                        | 36                                        | 8          | 25      | 3          |
| Cyphoderidae    | 10                                        | 9                                         | 0          | 8       | 1          |
| Paronellidae    | 1                                         | 1                                         | 0          | 0       | 1          |
| Tomoceridae     | 1                                         | 1                                         | 0          | 1       | 0          |
| **TOTAL**       | **84**                                    | **66**                                    | **13**     | **42**  | **11**     |
| **NEELIPLEONA**  |                                           |                                           |            |         |            |
| Neelidae        | 1                                         | 1                                         | 0          | 0       | 1          |
| **TOTAL**       | **1**                                     | **1**                                     | **0**      | **0**   | **1**      |
| **SYMPHYPLEONA** |                                           |                                           |            |         |            |
| Sminthurididae  | 2                                         | 1                                         | 0          | 0       | 1          |
| Katiannidae     | 5                                         | 4                                         | 1          | 1       | 2          |
| Dicyrtomidae    | 2                                         | 2                                         | 1          | 1       | 0          |
| Bourletiellidae | 7                                         | 7                                         | 1          | 6       | 0          |
| Sminthuridae    | 2                                         | 1                                         | 1          | 0       | 0          |
| **TOTAL**       | **18**                                    | **15**                                    | **4**      | **8**   | **3**      |
| **TOTAL**       | **160**                                   | **124**                                   | **25**     | **75**  | **24**     |

the Western Cape (67 species), Kwazulu-Natal (46 species) and the Eastern Cape (20 species) (Fig. 2). Records from the other provinces are sparse (1–10 species), with the North West Province and Limpopo having the lowest recorded richness (three and one species, respectively). Although many authors did not indicate the habitat type where collections took place (Supplementary Material Suppl. material 1), the majority mentioned were from sites that are within the forest biome (see Mucina and Rutherford 2006 for full details of South Africa’s biomes and vegetation types). However, other vegetation types mentioned include those of the grassland biome and disturbed areas such as gardens, orchards and plantations.

The sample-based species rarefaction curve for the Western Cape did not reach an asymptote (Fig. 3). The two richness estimators (Jacknife2: 348 species, Chao1 with 95% Confidence Intervals: 323, lower CI: 270, upper CI: 416) suggest that at least 6–7 times more than the number of species currently recorded from the literature will be found in the province, given the steep slope of the non-asymptotic curve.
Table 2. Collembola species recorded from South Africa, with “Current species name” as confirmed name (Bellinger et al. 2014), and “Name published in source” as name used in the original source when different from current species name. Abbreviations used: South Africa (SA), Western Cape (WC), Eastern Cape (EC), Kwazulu-Natal (KZN), Gauteng (G), Limpopo (L), Free State (FS), Northern Cape (NC), Mpumalanga (MP), North West Province (NWP), Lesotho (Les), endemic (E), introduced (I), dubious record (D) or widespread (W, species present outside of South Africa but not considered introduced). Genera endemic to South Africa are indicated by an asterisk (*). See Suppl. material 1: Table S1 for full collection and citation details.

| Current species name | Source | Province recorded from in SA | Status | Habitat if given in source | Name published in source if different from the current one | Comments |
|----------------------|--------|-------------------------------|--------|-----------------------------|------------------------------------------------|----------|
| **PODUROMORPHA**     |        |                               |        |                             |                                                              |          |
| Acherontiella thibaudi | Barra, 1994 | KZN | W | Beach sand | | South Africa and several tropical regions of East Africa and Southeast Asia (Thibaud 2010) |
| Austrogastrura lobata  | Yosii 1959 | WC | E | | Choreutinula lobata Yosii, 1959 |          |
| Centophyrella armata   | Womersley 1934, Paclt 1959, 1967, Coates 1970 | WC, KZN, EC, FS, G, NC | D | Damp soil, moss, litter | Hypogastrura armata Nicolet, 1842 | Western palearctic distribution. |
| Ceratophyrella armata trispina | Womersley 1934 | WC | D | | Hypogastrura armata var. trispina Womersley, 1934 | Described from a single specimen with three anal spines, could also have been Triacanthella sp. |
| Ceratophyrella longispina | Womersley 1934 | NC, KZN, WC | D | | Hypogastrura longispina Tullberg, 1876 | Northern hemisphere circumpolar distribution (Fjellberg 1998) |
| Hypogastrura manubralis | Womersley 1934, Paclt 1959, 1967 | NC, KZN, WC | I | Wet habitat | Hypogastrura manubralis var. neglecta (Börner, 1901) | Distributed worldwide, considered introduced in the Southern hemisphere |
| Hypogastrura manubralis neglecta | Womersley 1934 | WC | D | | | Dubious: lacks two anal spines, no more information provided. |
| Hypogastrura purpureascens | Womersley 1934, Paclt 1959, 1967 | WC | I | Wet leaves | Hypogastrura pseudopurpureascens Womersley, 1928 in Womersley 1934 Hypogastrura (Hypogastrura) purpureascens Lubbock, 1868 in Paclt 1959, 1967 | The species can be considered as introduced from Northern hemisphere, as has recently been confirmed for Australia (Greenslade et al. 2014). |
| Hypogastrura sablbergii | Paclt 1959 | WC | D | Near stream | | Dubious record: holarctic distribution (Bellinger et al. 1996–2014). |
| Hypogastrura sablbergii mexia | Womersley 1934 | WC | D | Damp rocks | Hypogastrura sablbergii var. mexia (Reuter, 1895) | Agrees with sablbergii s. str. except for colour. Species inquirenda. |
| Current species name                  | Source                                      | Province recorded from in SA | Status | Habitat if given in source | Name published in source if different from the current one | Comments                                                                 |
|--------------------------------------|---------------------------------------------|------------------------------|--------|-----------------------------|------------------------------------------------------------|--------------------------------------------------------------------------|
| *Hypogastrura viatica* (Tullberg, 1872) | Womersley 1934, Paclt 1959                  | WC                           | I      | Littoral                    |                                                           | Nordic countries and Arctic, considered introduced in southern hemisphere (Greenslade 2002). |
| *Mesogastura libyca* (Caroli, 1914) | Paclt 1959                                  | WC                           | D      | Forest litter               | *Choreutinula libyca* Caroli, 1914                       | Probably *Austrogastrura lobata* (Yosii, 1959), present in the same locality. |
| *Triacanthella madiba* Janion, D’Haese & Deharveng, 2012 | Janion et al. 2012                          | WC                           | E      | Cave guano                  |                                                           |                                                                                   |
| *Willemia triobata* Barra, 1995      | Barra 1995                                  | KZN                          | E      | Beach sand                  |                                                           |                                                                                   |
| *Xenylla capensis* Weiner & Naji, 1991 | Weiner and Naji 1991                        | WC                           | E      | Forest leaf litter          |                                                           |                                                                                   |
| *Xenylla maritima* Tullberg, 1869    | Paclt 1959, 1967                            | WC, EC, KZN, NWP             | I      | Wet habitat, forest         |                                                           | Cosmopolitan distribution (Fjellberg 1998), probably introduced in the Southern hemisphere |
| *Xenylla rhodesiensis* Womersley, 1929 | Coates 1970                                 | MP                           | E      | Wet habitat                 |                                                           |                                                                                   |
| *Xenylla schillii* Börner, 1903      | Paclt 1959                                  | Les                          | D      | At stream                   |                                                           | Only recorded from Europe, while the collection locality in South Africa is very isolated and at a high altitude |
| *Xenylla yucatana* Mills, 1938       | Barra 1995                                  | KZN                          | W      | Forest soil                 |                                                           | Pan-tropical distribution (Deharveng et al. 2011)                           |

**Brachystomellidae**

| *Brachystomella africana* Yosii, 1959 | Yosii 1959                                 | WC                            | E      |                             |                                                           | *Brachystomella parvula africana* Yosii, 1959                        |
| *Brachystomella coatesi* Weiner & Naji, 1991 | Weiner and Naji 1991                         | WC                            | E      | Forest leaf litter          |                                                           |                                                                                   |
| *Brachystomella gorgensis* Weiner & Naji, 1991 | Weiner and Naji 1991                         | WC                            | E      | Forest leaf litter          |                                                           |                                                                                   |
| *Brachystomella parvula* (Schäffer, 1896) | Womersley 1934, Paclt 1959, 1967, Coates 1970 | MP, WC, KZN, EC, FS           | I      | Wet litter                  |                                                           | Cosmopolitan distribution (Fjellberg 1998)                           |

**Probrachystomellidae nicoli* Weber & Naji, 1991* | Weiner and Naji 1991 | WC | E | Forest leaf litter | | |

**Setanodosa capitata** (Womersley, 1934) | Womersley 1934 | WC | E | *Brachystomella capitata* Womersley, 1934 | | |

**Neanuridae** | | | | | | |
| Current species name | Source | Province recorded from in SA | Habitat if given in source | Status | Comments |
|----------------------|--------|-----------------------------|---------------------------|--------|----------|
| Aethiopella capensis  | Womersley 1934, Paclt 1959 | WC, KZN | E | Scenic stream | W | Described and previously only known from Ethiopia (Massoud 1967). |
| Aethiopella handschini | Denis, 1924 | Paclt 1959 | WC | Under stone, litter | D | Described and previously only known from Ethiopia (Massoud 1967). |
| Anurida maritima       | Womersley 1934, Paclt 1959, Yosii 1959, Lawrence 1953 | WC, KZN | W | Littoral | E | Cosmopolitan distribution (Fjellberg 1998). |
| Ectonura barrai       | Janion, Bedos & Deharveng, 2011 | WC | E | Forest leaf litter | | |
| Ectonura coatesi       | Barra 1994 | KZN | E | Litter on dunes | | |
| Ectonura monochaeta    | Janion, Bedos & Deharveng, 2011 | WC | E | Forest leaf litter | | |
| Ectonura natalensis    | Womersley, 1934 | KZN, WC, EC | E | Litter | | |
| Ectonura oribiensis    | Coates 1968 | KZN | E | Soil, litter | | |
| Ectonura versabilis    | Barra 1995 | KZN | W | Under vegetation | | |
| Friesea claviseta      | Womersley 1934 | WC | I | Litter | | |
| Friesea versabilis     | Barra 1995 | KZN | E | Dune litter | | |
| Najtafrica riebi       | Barra 1994 | KZN | E | Dune litter | | |
| Najtafrica riebi       | Coates 1968a | EC | | Litter | | |
| Neanura muscorum       | Templeton, 1855 | Coates 1968a | | | | |
| Neanura natalensis     | Womersley & Nait 1991 | KZN | W | Forest leaf litter | | |
| Odontellidae           | Weiner & Nait 1991 | KZN | W | Forest leaf litter | | |
| Current species name                        | Source                        | Province recorded from in SA | Status | Habitat if given in source | Name published in source if different from the current one | Comments                                                                                                                                                                                                 |
|-------------------------------------------|-------------------------------|------------------------------|--------|-----------------------------|-------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| *Odontella sylvatica* Weiner & Najt, 1991 | Weiner and Najt 1991          | WC                           | E      | Forest leaf litter          | Odontella empodialis Stach, 1934                 | Recorded from South Africa and Madagascar (Thibaud 2008)                                                                                                                                               |
| *Odontellina deharvengi* Barra, 1995      | Barra 1995                    | KZN                          | W      | Soil                        |                                                  | Dubious identification, European distribution                                                                                                                                                         |
| *Superodontella empodialis* (Stach, 1934) | Padt 1959                     | KZN                          | D      |                              | *Odontella empodialis* Stach, 1934               |                                                                                                                                                                                                           |
| **Onychiuridae**                          |                               |                              |        |                              |                                                  |                                                                                                                                                                                                           |
| *Deutaphorura inermis* (Tullberg, 1869)   | Womersley 1934, Padt 1959     | WC                           | D      | Under stones                | Onychiurus fimetarius (Linné, Lubbock) (sic) in Womersley 1934 Onychiurus pseudinermis Börner, Börner 1903 in Pack 1959 | Given the confusion around the species *fimetarius, inermis* and *pseudinermis*, and the age of the specimen slides, the identification given by authors (following Bellinger et al. 1996-2014) is uncertain. |
| *Orthonychiurus camerunensis* (Schött, 1926) | Padt 1967                     | G                            | D      | Soil                        | Onychiurus camerunensis Schött, 1926             | The Schött description is insufficient to recognize the species.                                                                                                                                       |
| *Orthonychiurus saasveldensis* (Weiner & Najt, 1991) | Weiner and Najt 1991 | WC                           | E      | Forest, on bark             | Onychiurus saasveldensis Weiner & Najt, 1991     | A holarctic distribution. Southern records of *Protaphorura* are usually *Thalassaphorura* species, or possible introductions. *Protaphorura armata* Kinoshita, 1923, only recorded so far from Japan. |
| **Tullbergiidae**                          |                               |                              |        |                              |                                                  |                                                                                                                                                                                                           |
| *Delamarephorura capensis* Janion, Weiner & Deharveng, 2013 | Janion et al. 2013 | WC                           | E      | Soil                        |                                                  | Dubious identification, most *Mesaphorura* have been identified as *M. krausbaueri* before the split of this species by Rusek (1971). Older records are not reliable (Fjellberg 1998). |
| *Delamarephorura szepyckii* Barra & Weiner, 2009 | Barra and Weiner 2009 | EC                           | E      | Dry grassland                |                                                  |                                                                                                                                                                                                           |
| *Fissuraphorura miscellanea* Barra, 1995   | Barra 1995                    | KZN                          | E      | Soil                        |                                                  | Dubious identification, most *Mesaphorura* have been identified as *M. krausbaueri* before the split of this species by Rusek (1971). Older records are not reliable (Fjellberg 1998). |
| *Mesaphorura krausbaueri* (Börner, 1901)   | Womersley 1934, Padt 1959     | WC, EC, FS                    | D      | Soil, under stones          | Tullbergia krausbaueri Börner, 1901             | Dubious identification, most *Mesaphorura* have been identified as *M. krausbaueri* before the split of this species by Rusek (1971). Older records are not reliable (Fjellberg 1998). |
| Current species name                                      | Source | Province recorded from in SA | Status | Habitat if given in source | Name published in source if different from the current one | Comments |
|----------------------------------------------------------|--------|------------------------------|--------|----------------------------|-------------------------------------------------------------|----------|
| *Mesaphorura yosii* (Rusek, 1967)                        | Barra 1995 | KZN         | W      |                            |                                                             | Cosmopolitan distribution |
| *Paratullbergia callipygos* (Börner, 1902)               | Womersley 1934 | WC     | I      |                            | *Tullbergia callipygos* Börner, 1902                         | Holarctic distribution |
| *Tullbergia meridionalis* Casagnau & Rapoport, 1962      | Barra 1995 | KZN         | W      | Dune sand                  |                                                             | Described from Argentina and later recorded from South Africa. |
| *Tullbergia kilimanjarica* (Delamare Deboutteville, 1953)| Paclt 1959, 1967, Coates 1970 | WC, KZN, MP | W | Forest leaf litter, garden soil | *Mesaphorura kilimanjarica* Delamare Deboutteville, 1953 | Described from Tanzania and later recorded from South Africa. |

**ENTOMOBRYOMORPHA**

**Isotomidae**

| Archisotoma sabulosa Barra, 1997                          | Barra 1997 | KZN         | E      | Littoral dune sand         |                                                             |          |
|----------------------------------------------------------|--------|--------------|--------|---------------------------|-------------------------------------------------------------|----------|
| Arlea tridens Barra, 1997                                | Barra 1997 | KZN         | E      | Dune litter               |                                                             |          |
| *Ballistum schoetti* (Dalla Torre, 1895)                 | Womersley 1934, Yosii 1959, Paclt 1959, 1967 | WC, EC | I | Vegetation, rain pools    | *Proisotoma schoetti* (Dalla Torre, 1895) in Womersley 1934 and Paclt 1959, 1967 | Cosmopolitan distribution |
| *Clavisotoma africana* (Womersley, 1934)                 | Womersley 1934, Paclt 1959 | WC | E | Wet leaves, rain pools    | *Proisotoma africana* (Womersley, 1934)                      |          |
| *Folsomides americanus* Denis, 1931                      | Paclt 1959, Barra 1997 | KZN | W | From dry leaves           |                                                             | Cosmopolitan distribution |
| *Folsomina onychiurina* Denis, 1931                      | Barra 1997 | KZN         | W      |                            |                                                             | Pantropical distribution |
| *Hemisotoma thermophila* (Axelson, 1900)                 | Womersley 1934, Paclt 1959, Coates 1970 | KZN, WC | W | Under rotting leaves      | *Isotoma bituberculata* Wahlgren, 1906 in Womersley 1934 and in Paclt 1959 |
| *Isotoma finitima* Scherbakov, 1899                      | Paclt 1959 | KZN | D      |                            | *Isotoma bituberculata* Wahlgren, 1906 in Womersley 1934 and in Paclt 1959 | Cosmopolitan distribution. *Isotoma bituberculata* is proposed as a synonym of either *Hemisotoma thermophila* or *H. orientalis* (Stach, 1947) in Potapov (2001). We provisionally consider it as a synonym of *H. thermophila*, the most widespread species of the genus *Hemisotoma*. |
| *Sorensia finitima* (Scherbakov, 1899)                   | Paclt 1959 | KZN | D      |                            |                                                             |          |
| Current species name                  | Source          | Province recorded from in SA | Status | Habitat if given in source | Name published in source if different from the current one | Comments                                                                                                                                 |
|--------------------------------------|-----------------|------------------------------|--------|-----------------------------|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| *Isotoma mauretanica* Handschin, 1926| Womersley 1934  | WC                           | D      |                             |                                                           | *Species inquirenda.* Stach (1947) considered this Algerian species as a possible member of the genus *Isotomurus*, but the description is too brief to support such a statement. See also *Isotomurus palustris*. |
| *Isotomiella sodwana* Barra, 1997    | Barra 1997      | KZN                          | E      | Litter and humus on sand dunes |                                                           |                                                                                                                                 |
| *Isotomodes productus* (Axelson, 1906)| Womersley 1934  | WC                           | I      | Under stones                |                                                           | Subcosmopolitan, records from southern hemisphere scattered.                                                                                         |
| *Isotomurus balteatus* (Reuter, 1876)| Womersley 1934  | WC                           | D      |                             | *Isotomurus palustris var. balteata* (Reuter, 1876).      | *I. balteatus* is a species of Europe recognizable by its transversal stripes on tergites. We have seen such a colour pattern in South African Isotomidae of an undetermined genus which is not *Isotomurus*. The record of this species for South Africa is therefore dubious. |
| *Isotomurus palustris* (Müller, 1776)| Womersley 1934, Paclt 1959, 1967 | WC, EC, G, KZN               | I      |                             |                                                           | Specimens of *Isotoma mauretanica* Handschin, 1926 recorded in Womersley 1934 were re-identified as *I. palustris* by Paclt (1959). This change is probably wrong, as Paclt states that specimens lack bothriotrichia. |
| *Isotomurus tricuspis* Bömer, 1906   | Paclt 1959, 1967 | WC                           | D      | Damp moss                   |                                                           | Specimens of *Isotomurus palustris* var. *balteata* cited by Womersley (1934) are considered as *I. tricuspis* by Paclt (1959), based on similar pattern, of transversal stripes on tergites. However, these South African forms need to be examined morphologically to confirm their congeneric status with *I. tricuspis* from Java. |
| *Micranurophorus musci* Bernard, 1977| Barra 1997      | KZN                          | W      | Humid sand 20 cm under pioneer vegetation |                                                           | Subcosmopolitan interstitial species.                                                                                                          |
| Current species name                          | Source          | Province recorded from in SA | Status | Habitat if given in source                                                                 | Name published in source if different from the current one | Comments                                                                                           |
|----------------------------------------------|-----------------|------------------------------|--------|-------------------------------------------------------------------------------------------|------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| *Mucrosomia caeca* (Wahlgren, 1906)          | Paclt 1959      | KZN, WC                      | W      | From wet debris                                                                            | *Cryptopygus caecus* Wahlgren, 1906                        | Current name after Potapov (2001).                                                               |
| *Parisotoma mossopi* (Womersley, 1934)       | Paclt 1959      | FS                           | E      | From soil containing organic material                                                      | *Isotoma notabilis* ssp. *mossopi* Womersley, 1934         |                                                                                                   |
| *Parisotoma notabilis* (Schäffer, 1896)      | Paclt 1959, 1967| WC                           | I      | Wet leaves, leaf litter,                                                                  | *Isotoma notabilis* Schäffer, 1896 in Paclt 1959, 1967     |                                                                                                   |
| *Parisotoma obscurcellata* Potapov, Janion & Deharveng, 2011 | Potapov et al. 2011 | WC                           | E      | Litter under plants, coastal                                                             |                                                            |                                                                                                   |
| *Parisotoma sessetosa* Potapov, Janion & Deharveng, 2011 | Potapov et al. 2011 | WC                           | E      | Forest leaf litter                                                                         |                                                            |                                                                                                   |
| *Psamopygus causascabi* (Thibaud, 1996)     | Barra 1997      | KZN                          | W      | Littoral sand                                                                              | *Cryptopygus riebi* Barra, 1997                           | Synonymy after Potapov, Gao and Deharveng 2013. On the coasts of Indian and Atlantic Oceans  |
| *Proisotoma davidi* Barra, 2001             | Barra 2001      | EC                           | E      | Grassland soil                                                                            |                                                            |                                                                                                   |
| *Proisotoma minutia* (Tullberg, 1871)       | Paclt 1959, 1967| WC, KZN, FS, EC              | I      | Litter                                                                                    |                                                            | Cosmopolitan species.                                                                           |
| **Entomobryidae**                            |                 |                              |        |                                                                                           |                                                            |                                                                                                   |
| *Capibrya marshalli* Barra, 1999*           | Barra 1999      | EC                           | E      | Grassland                                                                                 |                                                            |                                                                                                   |
| *Capibrya themeda* Barra, 1999*             | Barra 1999      | EC                           | E      | Grassland                                                                                 |                                                            |                                                                                                   |
| *Coecobrya caeca* (Schött, 1896)            | Goto 1953       | WC                           | D      | In cave                                                                                   | *Sinella caeca* (Schött, 1896)                            |                                                                                                   |
| *Coecobrya hoeffi* (Schäffer, 1896)         | Paclt 1959      | WC                           | D      | In cave                                                                                   |                                                            | Extra-European records are dubious (Jordana 2012). The Paclt specimens, from the same locality as the Goto (1953) specimens, may rather belong to the cosmopolitan species *C. tenebricosa* (Zhang et al. 2009) |

*C. caeca is restricted to northern America according to Chen and Christiansen (1997), and unlikely to have been introduced in South African caves. The South African species might be the cosmopolitan *C. tenebricosa* (Folsom, 1902) (Zhang et al. 2009).
| Current species name | Source | Province recorded from in SA | Status | Habitat if given in source | Name published in source if different from the current one | Comments |
|----------------------|--------|-----------------------------|--------|----------------------------|---------------------------------------------------------|----------|
| *Entomobrya atricincta* Schött, 1897 | Paclt 1967 | WC | ? | Litter |  | The large distribution of the species makes it difficult to determine from which region it may have been introduced. In addition, most colour patterns described in the literature do not fit the original and clear description of Schött (1897). |
| *Entomobrya decemfasciata* (Packard, 1873) | Womersley 1934 | WC | D |  |  | Contrary to the claim of Womersley, *E. decemfasciata* does not occur in "most temperate parts of the world, including Europe". Reliable records are restricted to North America. The colour pattern given by Womersley is different from that given by Christiansen and Bellinger (1998) for specimens of the USA. |
| *Entomobrya lanuginosa* (Nicolet, 1842) | Womersley 1934 | WC | ? |  | Entomobrya nivalis Linnaeus, 1758 f. immaculata Schäffer, 1896 | The cited form is tentatively reported to *E. lanuginosa*. In that case it would be an introduced species. |
| *Entomobrya minima* Brown, 1926 | Brown 1926 | KZN | E | Under stone |  |  |
| *Entomobrya multifasciata* (Tullberg, 1871) | Paclt 1967 | WC, NC, G | I | Litter, next to stream |  | Widespread in the holarctic region. |
| *Entomobrya nicoleti* (Lubbock, 1876) | Womersley 1934 | WC | ? |  | Entomobrya nivalis f. maculata Schäffer, 1896 | The cited form is tentatively reported to *E. nicoleti*. In that case it would be an introduced species. |
| *Entomobrya nivalis* (Linnaeus, 1758) | Paclt 1959, 1967, Coates 1970 | WC, EC, FS, KZN | I | Litter, rainwater pool |  | Cosmopolitan distribution, but most reliable records are in the holarctic region. |
| *Lepidocyrtus cyanus* Tullberg, 1871 | Paclt 1959 | KZN, EC | ? | Dry leaves, damp soil |  | Cosmopolitan distribution, but considered introduced in southern hemisphere where other related species are absent. |
| *Lepidocyrtus ferruginus* (Schött, 1893) | Paclt 1959 | KZN | D | Dry leaves |  | Described from Africa, the species needs a modern redescription to be recognizable. |
| *Lepidocyrtus lanuginosus* (Gmelin, 1788) | Womersley 1934, Paclt 1967 | WC | D | Litter |  | Records of this species from the southern hemisphere need to be checked. |
| Current species name | Source | Province recorded from in SA | Status | Habitat if given in source | Name published in source if different from the current one | Comments |
|----------------------|--------|-----------------------------|--------|---------------------------|--------------------------------------------------------|----------|
| Lepidokrugeria meyerei Coates, 1969* | Coates 1969 | MP | E | Dead leaves | | |
| Orchesella hexfasciata (Harvey, 1896) | Paclt 1959 | FS, G | D | Litter | Entomobrya hexfasciata Harvey, 1896 | Assigned to the genus Entomobrya by Paclt (1959), today considered as an Orchesella (Christiansen and Bellinger 1998). All reliable records are from the USA. |
| Pseudosinella alba (Packard, 1873) | Paclt 1959 | WC, EC | I | Litter | | Cosmopolitan distribution, but most reliable records are in the holarctic region. |
| Pseudosinella biguttata Barra 1997 | Barra 1997 | KZN | E | Sand forest litter | | |
| Pseudosinella immaculata (Lie-Pettersen, 1897) | Paclt 1959 | KZN | D | | | All reliable records of this species are from Western Europe (Gisin and Da Gama 1972), following major taxonomic changes in species delimitations introduced in the 60'. |
| Pseudosinella octopunctata Börner, 1901 | Paclt 1959 | WC, FS | E? | Wet litter | | Subcosmopolitan distribution, but most tropical and southern hemisphere records need confirmation. |
| Seira addoensis Coates, 1968 | Coates 1968 | EC | E | Soil and vegetation | | |
| Seira angulicornis (Börner, 1903) | Yosi 1959, Coates 1968, 1970 | WC, MP, G, FS, KZN | W | | Seira (Lepidocyrtinus) amudicornis (Börner, 1903) in Yosii 1959 | African distribution |
| Seira annulipes (Handschin, 1929) | Womersley 1934 | KZN, WC | W | On vegetation | Lepidocyrtinus anudipes, mispelling for Lepidocyrtinus anudipes Handschin, 1929 | African distribution. Redescription needed on modern standards. |
| Seira annulosa (Wahlgren, 1906) | Womersley 1934 | WC | D | Shore vegetation | Lepidocyrtinus flavovires var. annulosa Wahlgren, 1906 | Species previously known from Sudan; morphological features given by Wahlgren and Womersley do not allow reliable identification. |
| Seira barnardi (Womersley, 1934) | Womersley 1934, Yosi 1959, Paclt 1959, 1967, Coates 1968, 1970 | WC, NWP | E | Wet leaves | Lepidocyrtinus cooperi var. barnardi Womersley, 1934 Seira (Lepidocyrtinus) barnardi (Womersley, 1933) (sic) | |
| Current species name | Source | Province recorded from in SA | Status | Habitat if given in source | Name published in source if different from the current one | Comments |
|----------------------|--------|-----------------------------|--------|---------------------------|--------------------------------------------------------|----------|
| Seira capensis       | Womersley 1934, Yosii 1959, Coates 1968 | WC, EC | E | On vegetation | Lepidocyrtinus capensis Womersley, 1934; Seira (Seira) capensis (Womersley, 1934) in Yosii 1959 |          |
| Seira damerella      | Coates 1968, 1970 | L, MP | E | Litter | |          |
| Seira dayi           | Yosii 1959, Coates 1968 | WC | E | | Seira (Lepidocyrtinus) dayi Yosii, 1959 | Also recorded from Mozambique by Coates (1968) and from Yemen by Barra (2004) |
| Seira elegans        | Coates 1968, 1970 | MP | W | From dry vegetation | |          |
| Seira flavovirens    | Womersley 1934, Yosii 1959, Coates 1968 | WC | D | | Lepidocyrtinus flavovirens Börner, 1903 in Womersley 1934; author should be (Börner, 1903); Seira (Seira) flavovirens (Börner, 1903) in Yosii 1959 | May correspond to several whitish species of Seira. |
| Seira grisea         | Womersley 1934, Coates 1968 | WC | E | From vegetation | Pseudosira grisea Womersley, 1934 | Possibly a synonym of Seira flavovirens according to Yosii (1959). |
| Seira grisea annulata| Womersley 1934 | WC | D | | Pseudosira grisea var. annulata Womersley, 1934 | The taxonomic value of this form is uncertain. This variety might be synonym of S. flavovirens after Yosii (1959). |
| Seira incerta        | Womersley 1934 | WC | D | Estuary | Lepidocyrtinus incertus Handschin, 1926 | The species has a characteristic colouration, but is only known from the Mediterranean region where it is uncommon, so unlikely to have been introduced to South Africa. |
| Seira laeta          | Börner 1908 | NC | E | | Pseudosira (Mesira) laeta Börner, 1908 |          |
| Seira biedei         | Coates 1968 | EC, WC | E | Wet litter | |          |
| Seira marephila      | Coates 1968 | EC, WC | E | Litter | |          |
| Seira matheusii      | Coates 1968 | EC, WC | E | From vegetation | |          |
| Seira metasimia      | Coates 1968 | FS, NC | E | From grass | |          |
| Seira munroi         | Padt 1959 | NC | E | In ants’ nest | Diamantinum munroi Padt, 1959 | Transferred to Seira by Salmon (1964) |
| Seira nagatai        | Yosii 1959 | WC | E | | Seira (Seira) nagatai Yosii, 1959 |          |
| Seira pallens        | Börner 1908 | NC | E | | Pseudosira nyasica var. pallens Börner, 1908 |          |
| Current species name | Source | Province recorded from in SA | Status | Habitat if given in source | Name published in source if different from the current one | Comments |
|----------------------|--------|-----------------------------|--------|---------------------------|-------------------------------------------------------------|----------|
| *Seira pseudocoerulea* (Denis, 1924) | Womersley 1934, Yosii 1959 | WC | D | Estuary | *Lepidocyrtinus pseudocoeruleus* (Denis, 1924) in Womersley 1934 | African species. A study of the chaetotaxy of Ethiopian specimens would be however necessary to confirm identification (Yosii 1959). |
| *Seira rowani* Yosii, 1959 | Yosii 1959, Coates 1968, 1970 | WC | E | On vegetation | *Seira (Afroseira) rowani* Yosii, 1959 |
| *Seira rykei* Coates, 1968 | Coates 1968 | WC | E | On vegetation | |
| *Seira squamoornata* (Scherbakov, 1898) | Paclt 1959, 1967 | KZN, WC, FS, G, NC | D | Soil and vegetation | |
| *Seira tsikama* Coates, 1968 | Coates 1968, 1970 | WC | E | Forest leaf litter | |
| *Seira vaneedeni* Coates, 1968 | Coates 1968 | KZN | E | From shrub and grass | |
| **Cyphoderidae** | | | | | |
| *Calobatina rhadinopus* (Bömer, 1913) | Bömer 1913, Paclt 1967 | KZN, G | E | Termite nest | *Calobatella rhadinopus* Börner, 1913 |
| *Gyphoda colura* (Börner, 1908) | Börner 1908 | NC | E | Termite nest | *Gyphoderus colurus* Börner, 1908 |
| *Gyphoda limbaciphia* (Bömer, 1913) | Bömer 1913, Paclt 1967 | KZN, G | E? | Termite nest | *Gyphoderus limbaciphius* Börner, 1913 |
| *Gyphoda natalensis* (Bömer, 1913) | Bömer 1913, Womersley 1934 | KZN, WC | E | Termite nest | *Gyphoderus natalensis* Börner, 1913 |
| *Gyphoderus assimilis* (Bömer, 1906) | Paclt 1959 | KZN | W | Ant nest | Cosmopolitan distribution |
| *Gyphoderus bidenticulatus* Pardon, 1888 | Börner 1913 | KZN | E | Termite nest | |
| *Gyphoderus omoensis* Delamare Deboutteville, 1945 | Paclt 1959, Womersley 1934 | WC | D | In cave | *Gyphoderus arcuatus var. aethiopicus* Hanschin, 1929 in Womersley 1934, Wrong identification of Womersley after Paclt (1959) |
| *Gyphoderus squamidives* Silvestri, 1918 | Silvestri 1918, Paclt 1959, 1967 | KZN, WC, G | E? | Termite nest | *Gyphoderus arcuatus var. squamidives* in Silvestri 1918 |
| *Gyphoderus trinervoidis* Paclt, 1965 | Paclt 1965 | G | E | Termite nest | |
| *Pseudocyphoderus uasmanni* Bömer, 1913 | Bömer 1913, Paclt 1967 | KZN, G | E | Termite nest | |
| Current species name | Source | Province recorded from in SA | Status | Habitat if given in source | Name published in source if different from the current one | Comments |
|----------------------|--------|-----------------------------|--------|-----------------------------|-------------------------------------------------------------|----------|
| **Paronellidae**     |        |                             |        |                             |                                                             |          |
| *Dicranocentruga nigromaculata* (Schött, 1903) | Paclt 1959 | KZN | W | *Paronella nigromaculata* Schött, 1903 in Paclt 1959 | African species. The generic name *Dicranocentruga* Wray, 1953 was reactivated by Mitra (2002) |
| **Tomoceridae**      |        |                             |        |                             |                                                             |          |
| *Neophorella dubia* Womersley, 1934* | Womersley 1934 | WC | E |                                                             |                                                             |          |
| **NEELIPLEONA**      |        |                             |        |                             |                                                             |          |
| **Neelidae**         |        |                             |        |                             |                                                             |          |
| *Megalothorax minimus* (Willem, 1900) | Paclt 1967 | WC | W | Damp soil, moss | Cosmopolitan species, currently in course of splitting. South Africa specimens will have to be re-examined. |
| **SYMPHYPLEONA**     |        |                             |        |                             |                                                             |          |
| **Sminthuritidae**   |        |                             |        |                             |                                                             |          |
| *Denisiella serroseta* (Bömer, 1908) | Bömer 1908, Paclt 1959 | NC | W | *Sminthurides* (Stenacidia) *serroseta* in Bömer 1908; *Sminthurides* (Denisiella) *serroseta* in Paclt 1959 | African species |
| *Sphaeridia minima* (Schött, 1893) | Paclt 1959, 1967 | FS, WC | D | From soil | *Sminthurides* (Sphaeridia) *minimus* (Schött, 1893) | S. *minima* is distributed in western Africa. It is very similar, if not identical, to the cosmopolitan species *S. pumilis* Krausbauer, 1898. Bretfeld (1999) considers that the Paclt specimens may belong to *S. pumilis*, but that those from Cameroon may represent distinct species. A revision of these tropical *Sphaeridia* is clearly needed. |
| **Katiannidae**      |        |                             |        |                             |                                                             |          |
| *Katianna kerguelenensis* Denis, 1947 | Paclt 1959 | KZN | D |                                                             | The South African records of this sub-Antarctic species need confirmation. |
| *Sminthurinus mime* (Bömer, 1907) | Womersley 1931, Paclt 1959, Paclt 1967 | WC | W | Beneath vegetation | *Sminthurinus terrestris* Womersley, 1931 | Pacht (1959) mentions differences between the two species, that are nevertheless synonymized by Greenslade (1994). Widely distributed in the southern hemisphere and in tropical Asia. |
| Current species name                                      | Source                          | Province recorded from in SA | Status | Habitat if given in source       | Name published in source if different from the current one | Comments                                                                                     |
|-----------------------------------------------------------|---------------------------------|------------------------------|--------|----------------------------------|-----------------------------------------------------------|----------------------------------------------------------------------------------------------|
| *Sminthurinus niger* (Lubbock, 1873)                      | Womersley 1931, Paclt 1959      | WC                           | I      | Under loose bark                 |                                                            | Mostly holarctic. Tropical and Australian records may be the result of introductions.        |
| *Sminthurinus pallidus* Womersley, 1931                   | Womersley 1931, Paclt 1959      | WC                           | E      | Beneath vegetation              | *Sminthurinus terrestris* Womersley, 1931 in Paclt 1959   | The synonymy of *S. pallidus* Womersley 1931 with *S. terrestris* proposed by Paclt (1959) is based on insufficient grounds and not accepted here. |
| *Stenognathellas stenognathus* (Börner, 1907)              | Paclt 1959                       | WC, KZN                      | W      | Litter                           | *Sminthurinus stenognathus* (Börner, 1907)                 | Asia and Argentina.                                                                        |
| **Dicyrtomidae**                                          |                                 |                              |        |                                  |                                                           |                                                                                             |
| *Dicyrtomina africana* Womersley, 1931                    | Womersley 1931                   | WC                           | E      | On vegetation                    | *Dicyrtomina minuta* form africana Womersley, 1931         | The validity of this form needs confirmation.                                                 |
| *Dicyrtomina minuta* (O. Fabricius, 1783)                 | Paclt 1959, 1967                 | WC                           | I      | At stream, on vegetation         |                                                           | Northern hemisphere, probably introduced in southern regions. Paclt considered *Dicyrtomina minuta* form africana as identical with *D. minuta*. |
| **Bourletiellidae**                                        |                                 |                              |        |                                  |                                                           |                                                                                             |
| *Bourletiella arvalis* (Fitch, 1863)                      | Paclt 1959                       | WC                           | I      | Lucerne pasture                  | *Bourletiella* (Bourletiella) arvalis (Fitch, 1863)       | Northern hemisphere, with local occurrence in southern hemisphere where it has been probably introduced. |
| *Prostriaopes barnardi* (Womersley, 1931)                 | Womersley 1931, Paclt 1959       | WC                           | E      | Amongst grass                    | *Deuterosminthurus marmoratus* var. barnardi Womersley, 1931 | A colour form of *P. marmoratus*. Paclt (1959) synonymized this form with *R. schultzei* on insufficient evidence. |
| *Prostriaopes marmoratus* (Womersley, 1931)               | Womersley 1931, Paclt 1959       | WC                           | E      | Rainwater pools                  | *Deuterosminthurus marmoratus* Womersley, 1931             | Paclt (1959) synonymized this species with *R. schultzei* on insufficient evidence.         |
| *Prostriaopes schultzei* (Börner, 1908)                   | Börner 1908                      | WC, G, NC                    | E      | Among vegetation, wet habitat    | *Bourletiella* schultzei in Börner, 1908                  | Generic assignation after Bensch (1980). Paclt (1959) proposes to synonymize *P. marmoratus*, *P. barnardi* and *P. schultzei* with *R. lineata* on weak morphological evidence as all these species are too briefly described. The same author considers in 1967 that his previous citation of *schultzei* (in Paclt 1959) as *Rastriopes lineatus* (here *R. lineata*). |
| Current species name                  | Source                        | Province recorded from in SA | Status | Habitat if given in source                                                                 | Name published in source if different from the current one | Comments                                                                                                                                 |
|--------------------------------------|-------------------------------|------------------------------|--------|--------------------------------------------------------------------------------------------|------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| Prorastriopes webbi Paclt, 1964      | Paclt 1964, Coates 1970       | KZN, MP, EC                  | E      | On vegetation, litter                                                                      |                                                            | Paclt (1959) synonymized this species with *R. schultzei*, but in 1967 considered that the specimen he identified as *schultzei* in Paclt (1959) was in fact *R. lineata*, bona species. |
| Rastriopes lineata Womersley, 1931   | Womersley 1931, Paclt 1959, 1967 | WC, NC, G                    | E      | Under a fallen twig and on rainwater pool (Womersley 1931), on vegetation (Paclt 1959), moss and rotten leaves, grass on river banks (Paclt 1967) |                                                            | Rastriopes schultzei in Paclt 1959                                                                                                                                                                  |
| Tritosminthurus schuhi               | Snider 1988                   | WC                           | E      |                                                                                             |                                                            |                                                                                                                                                                                                 |
| Sminthuridae                         |                               |                              |        |                                                                                             |                                                            |                                                                                                                                                                                                 |
| Papirinus prodigiousum Yosii, 1954   | Paclt 1959                    | KZN                          | D      |                                                                                             | Sphyrotheca prodigiosa (Yosii, 1954)                      | The genus *Papirinus*, placed among Katiannidae in Bretfeld (1999), is considered here as closer to Sminthuridae. This species is only known from Japan. Other species exist in Madagascar, Sumatra, Thailand and Congo. The South African species is probably new (Betsch 1980). |
| Sminthurus viridis (Linnaeus, 1758)  | Lawrence 1953, Paclt 1959     | WC                           | I      | On vegetation                                                                               |                                                            | Mainly boreal species, thought to have been introduced from Europe (via Australia) as eggs in soil through the importation of clover seed (Wallace 1968, Wallace and Walters 1974). |

Updated list of Collembola species currently recorded from South Africa
Figure 1. The cumulative number of Collembola species described from South Africa. The three major increases in described species are indicated by the author names (Womersley, Coates and Barra).

Discussion

The number of Collembola species recorded for South Africa is low compared to well-studied regions such as Europe (Deharveng 2007), but is the highest of all African countries south of Sahara (Thibaud 2013). Low sampling intensity in Africa seems to be the main reason for this pattern. Based on new records and species discovered during recent systematic sampling in the Western Cape Province alone (Janion et al. 2011a, b, Potapov et al. 2011, Janion et al. 2012, Liu et al. 2012, Janion et al. 2013), it is clear that many species remain to be recorded and described for this province. Given low richness documented elsewhere in South Africa the same situation is likely to be the case both there and in other African countries. The spatial distribution of species richness records also suggests that incomplete sampling coverage lies at the heart of the current diversity patterns. Most records to date have come from those provinces where taxonomists were either based or hosted such as in Cape Town of the Western Cape Province (Womersley 1934, Paclt 1959, Yosii 1959), and in Pretoria of the Gauteng Province (Coates 1969), reflecting a recurrent bias in geographic patterns of diversity of poorly known groups (Deharveng et al. 2000). Although Collembola do generally prefer moist environments (Hopkin 1997), which may mean lower diversity in arid provinces such as the Northern Cape and North-West Provinces (see Mucina and Rutherford 2006),
Figure 2. Number of Collembola species recorded for each degree square grid in South Africa.

low species richness in provinces such as Limpopo and Kwazulu-Natal is at odds with most other groups in the country (see e.g. Davis 1997 for dung beetles, Erasmus et al. 2000 for antlions, Foord et al. 2002 for spiders, Evans et al. 2006 for amphibians and birds, Schoeman and Foord 2012 for ants). The only exception to the poor knowledge of the fauna is for the sub-Antarctic Prince Edward Island group (consisting of Marion Island and the smaller Prince Edward Island), which is geopolitically a part of South Africa, and for which the fauna has been thoroughly investigated (Table 3, Gabriel et al. 2001, Hugo et al. 2006, Chown and Froneman 2008). Such a general situation of poor knowledge is typical for the Collembola in many parts of the world (e.g. Cicconardi et al. 2013), and will hamper efforts both to conserve this diversity (Cardoso et al. 2011) and to understand which components of it are non-indigenous and may be having impacts on the indigenous fauna (see discussion in Roques et al. 2009).

With the caveat in mind of undersampling, both in many parts of Africa and country-wide, it is worth considering what the current information on species in the country suggests. It appears that endemcity is likely to be high (currently 65%). This value is similar to that found for other invertebrate groups and plants in South Africa, with
Figure 3. A sample-based rarefaction curve for the Western Cape, for observed species richness, and the Chao1 and Jacknife2 Estimators.

an extraordinary high number of endemic species found in the south-western Cape (see Colville et al. 2002, Goldblatt and Manning 2002, Herbert and Kilburn 2004, Rebelo et al. 2006, Pryke and Samways 2010). Endemicity is expected to increase with local sampling, but will likely decline if sampling is undertaken in neighbouring countries where information on the group is similarly low (e.g. Namibia, see Thibaud and Massoud 1988). Currently, sampling in the southern part of Africa mostly concerns sites within South Africa, generating a rapid increase in species richness and endemicity, as many additional endemic species have been obtained from samples as little as a few kilometres from already well sampled areas (Janion-Scheepers, Bedos and Deharveng unpublished results).

Currently, six genera are thought to be endemic to South Africa: *Najtafrica* Barra, 2002 (one species, Pseudachorutinae), *Probrachystomellides* Weiner & Najt, 1991 (one species, Brachystomellidae), *Capbrya* Barra, 1999 (two species, Entomobryidae), *Lepidokrugeria* Coates, 1969 (one species, Lepidocyrtinae), *Neophorella* Womersley, 1934 (one species, Tomoceridae) and *Tritosminthurus* Snider, 1988 (one species, Bourletiellidae). *Neophorella dubia* was described from a single specimen by Womersley (1934) and is the only endemic species of the family Tomoceridae to occur in South Africa.
**Table 3.** Species recorded from the Prince Edward Islands, an island group geopolitically part of South Africa. Abbreviations used: E = endemic to Marion Island, S = sub-Antarctic distribution, I = introduced, D = dubious.

| Current species name | Source | Status | Name in source and comments |
|----------------------|--------|--------|-----------------------------|
| **PODUROMORPHA**     |        |        |                             |
| Hypogastruridae       |        |        |                             |
| *Ceratophyella dentichata* (Bagnall, 1941) | Deharveng (1981) | I | *Ceratophyella cf. dentichata* (Bagnall, 1941) |
| Hypogastrura viatica (Tullberg, 1872) | Deharveng (1981) | D | Not found again since 1981, possible contamination (CJS pers. obs.) |
| **Neanuridae**       |        |        |                             |
| *Friesea tillbrookii* Wise, 1970 | Deharveng (1981) | S | *Friesea viennei* Deharveng, 1981 (syn Greenslade 1986) |
| **Tullbergiidae**    |        |        |                             |
| Tullbergia bisetosa Börner, 1902 | Deharveng (1981) | S |                             |
| **ENTOMOBRYOMORPHA** |        |        |                             |
| Isotomidae            |        |        |                             |
| Cryptopygus antarcticus travel Deharveng, 1981 | Deharveng (1981) | E |                             |
| Cryptopygus dubius Deharveng, 1981 | Deharveng (1981) | S |                             |
| Cryptopygus triquerti Enderlein, 1909 | Deharveng (1981) | S |                             |
| Folsomotoma marionensis (Deharveng, 1981) | Deharveng (1981) | E | *Isotoma (Sorensia) marionensis* Deharveng, 1981 |
| Isotomurus maculatus Müller, 1876 | Deharveng (1981) | I | *Isotomurus cf. palustris*, confirmed as I. maculatus by Greenslade (2010) |
| *Macrostrongylus caeca* Wahlgren, 1906 | Deharveng (1981) | S | *Cryptopygus caeca* Wahlgren, 1906 (new comb. after Potapov 2001) |
| *Parisotoma notabilis* (Schäffer, 1896) | Deharveng (1981) | I | *Isotoma (Parisotoma) notabilis* |
| **Tomoceridae**       |        |        |                             |
| Pogonognathellus flavescens (Tullberg, 1871) | Gabriel et al. (2001) | I |                             |
| **NEELIPLEONA**       |        |        |                             |
| Neelidae              |        |        |                             |
| *Megalothorax minimus* Willem, 1900 | Deharveng (1981) | I | *Megalothorax cf. minimus* Willem, 1900, identification confirmed by C. Schneider (pers. comm.) |
| **SYMPHYPLEONA**      |        |        |                             |
| Katiannidae           |        |        |                             |
| *Sminthurinus granulosus* Enderlein, 1909 | Deharveng (1981) | S | *Sminthurinus cf. granulosus* Enderlein, 1909 in Deharveng (1981) |
| *Sminthurinus tuberculatus* Delamare Deboutteville & Massoud, 1963 | Gabriel et al. (2001) | S | *Sminthurinus cf. kerguelensis* Salmon, 1964 in Deharveng (1981) |
| Katianna sp.          | Chown and Froneman (2008) | E |                             |

Paclt (1959) mentioned that besides the single holotype specimen, this species was not found again and he synonymised it with the Paronellidae *Dicranocentruca nigromaculata* (Schött, 1903). Ireson and Greenslade (1990) re-examined the type specimen and re-assigned the species to Tomoceridae, stressing however its similarity with Isotomidae.
(Skaife 1954). In spite of intensive sampling in its type locality of Table Mountain (Janion-Scheepers, Bedos and Deharveng unpublished results), the species was not retrieved in any of our samples, and is considered here as a species inquirenda.

The current information also suggests that approximately 20% of the Collembola species found in South Africa may have been introduced by humans to the region and should therefore be considered alien (see Pyšek et al. 2004 for terminology). Understanding what the proportion of introduced species in the fauna actually is will depend on additional comprehensive sampling, and on further consideration of species currently though to be alien. Thus, several species resembling well-known European taxa had previously been mistakenly assigned to these taxa. For example, Seira squamoornata, which was originally described from the Ukraine, was thought to be a common polymorphic species in South Africa after Paclt (1959). However, Yosii (1959) did not even include this species in his list, while Coates (1968b) found that specimens labelled as one species (S. squamoornata) by Paclt (1959), could actually be identified as several endemic species described by Yosii (1959) or Coates (1968b), and concluded that this European species does not occur in South Africa. Indeed, to date 25 indigenous species of Seira have been described from South Africa (Yosii 1959, Coates 1968b), and the richness of the genus is likely much larger.

Nonetheless, that several alien species are present, especially of European origin, is not surprising given the close historical links between South Africa and Europe (Gilio-mee and Mbenga 2007). Most of the invasive species were collected in disturbed environments, in gardens or close to human settlements (Supplementary Material Suppl. material 1) bearing out findings for a range of other groups that disturbance may favour alien species establishment (Chytrý et al. 2005, MacDougall and Turkington 2005, Richardson and Pyšek 2006). Perhaps the best known of the alien species is Sminthurus viridis, also known as the Lucerne flea (Wallace 1964, Wallace and Walters 1974), which received considerable attention in South Africa during the late 1960s due to its pest status. It is thought to have arrived from Australia as eggs in soil through the importation of clover seed (Walters 1968, Wallace and Walters 1974). It was first collected in 1951 near Somerset West and by 1959 over 50 000 hectares of Lucerne were infested (Wallace and Walters 1974). The problem now appears largely to have been resolved, although the species is still listed as a pest of Lucerne (Annecke and Moran 1982).

In conclusion, based on published knowledge only, the Collembola species richness of South Africa is high compared with other African countries (Thibaud 2013), but low compared with non-African countries (Deharveng 2007) and with the richness of other invertebrate groups in the South African region (Scholtz and Chown 1995). This is likely due to undersampling, as recent discoveries (e.g. Janion et al. 2011b, Potapov et al. 2011, Janion et al. 2012, 2013) have indicated. Owing to a recent, large and comprehensive ecological and systematic study, accompanied by DNA Barcoding (Porco et al. 2012) largely focused on the country’s Western Cape Province (Bengtsson et al. 2010, Janion et al. 2011a, Liu et al. 2012), a substantial increase in the number of species is expected. With 67 species recognised for the Western Cape from the recorded literature, the richness estimates indicating at least 6–7 times that
number being present, and based on experience in other undersampled countries such as Thailand (Bedos 1994), we expect that species richness for the country will exceed 1000. Improvement of systematic knowledge through studies such as these, and improvements in ecological understanding of the impacts of both landscape change and invasive species on the springtail fauna (e.g. Gabriel et al. 2001, Liu et al. 2012), will help South Africa meet its commitments to biodiversity conservation especially as set out in the 2020 Aichi Biodiversity Targets.

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Supplementary material 1

Table S1
Authors: Charlene Janion-Scheepers, Louis Deharveng, Anne Bedos, Steven L. Chown
Data type: occurrence
Explanation note: Collection details of Collembola recorded from continental South Africa.
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