The Megadrile Fauna (Annelida: Oligochaeta) of Queen Elizabeth Park, South Africa: Species Composition and Distribution within Different Vegetation Types

Author: Nxele, Thembeka C.

Source: African Invertebrates, 53(2) : 543-558

Published By: KwaZulu-Natal Museum

URL: https://doi.org/10.5733/afin.053.0207
The megadrile fauna (Annelida: Oligochaeta) of Queen Elizabeth Park, South Africa: species composition and distribution within different vegetation types

Thembeka C. Nxele
KwaZulu-Natal Museum, P. Bag 9070, Pietermaritzburg, 3200 South Africa; tnxele@nmsa.org.za

ABSTRACT
A recent survey in selected habitat types in Queen Elizabeth Park (protected area for more than 50 years) resulted in the recording of 1127 specimens of nine earthworm species inhabiting the park, of which only one microchaetid *Tritogenia howickiana* is indigenous to South Africa. The other eight species are peregrine, widely introduced, and belong to four families: Megascolecidae (*Amynthas aeruginosus, Amynthas corticis, Amynthas gracilis, Amynthas minimus* and *Amynthas rodericensis*), Glossoscolecidae (*Pontoscolex corethrurus*), Lumbricidae (*Octolasion lacteum*) and Acanthodrilidae, Benhamiinae (*Dichogaster saliens*). The most abundant are megascolecids (883 specimens), dominating in all vegetation types. Although coexistence of exotic species with indigenous species is noted, a decline in the endemics and dominance by exotics was observed.

KEY WORDS: Oligochaeta, earthworms, South Africa, protected area, indigenous species, introduced species.

INTRODUCTION
It is widely known and accepted that earthworms are supportive environmental components and play an important role in the functioning of ecosystems (Lavelle et al. 1997; Bhadauria et al. 2000; Shuster et al. 2002), thus being regarded as soil ecosystem engineers (Jouquet et al. 2006). The role of earthworms in soil ecosystems and their sensitivity to disturbances (thus acting as bio-indicators) depends on the earthworm species diversity. Beneficial effects of earthworms on soils are well documented. According to Lavelle (1988) and Salome et al. (2011), food supply, soil texture, vegetation type and pH values play a major role in governing the earthworm densities. The quality and amount of above and below ground litter produced by plants influence earthworm populations and this may be observed in some forests and native grasslands (Campana et al. 2002; Whalen 2004). Due to their relationship to soil ecosystem function, earthworm populations depict spatial and temporal heterogeneity in patches and their population structure may be influenced by a change in vegetation and soil characteristics, as well as biotic and abiotic interactions (Margerie et al. 2001; Whalen 2004; Fey 2010; Valekx et al. 2011). From one vegetation type to the other, earthworm species composition may change (Margerie et al. 2001).

Another significant factor that affects the earthworm species composition is disturbance, the major contributor being human activities (Callaham et al. 2003; Winsome et al. 2006). Land conversion or habitat transformation lead to decreased native assemblages and an increase in exotic species, since native species prefer less disturbed habitats (Winsome et al. 2006).

Knowledge of the South African megadrile fauna is still incomplete. At present, 142 Microchaetidae species and 107 acanthodrilids (Acanthodrilidae: Acanthodrilinae) are known, all claimed as being indigenous to this country. Fifty species belonging to Acanthodrilidae (Acanthodrilinae, Benhamiinae), Eudrilidae (Eudrilinae, Pareudrilinae),...
Glossoscolecidae, Lumbricidae, Megascolecidae and Ocnerodrilidae are known to be introduced (Plisko 2010). It is expected that yet more endemics and also alien species might be found in this part of the African continent. Researchers have undertaken work on South African earthworms since the late 1800s (Kimberg 1867; Beddard 1897; Michaelsen 1899), and there are numerous recent and current studies on different aspects of earthworms (e.g. Horn et al. 2007; Plisko 2010). However, the diversity, range and ecology of this special pedofaunal group still need attention.

In protected areas in South Africa, the size and composition of earthworm communities are not well known. Furthermore, the extent of invasions by introduced earthworms and their possible effects on indigenous earthworm species in protected areas have not been investigated. Research by Plisko (1995, 2000) shows the role of nature reserves in the protection of endemics, revealing that indigenous species are mostly limited to natural habitats. Michaelsen (1913), Ljungström (1972a), Dlamini (2002) and Plisko (2010) reported on a large number of introduced species in South Africa, most of which originated from Europe, India or Asia. These alien species are common in all biotopes, agricultural land, grasslands, compost and forests, as well as in nature reserves.

The purpose of this paper is to extend study on earthworms in protected areas, observing co-existence between indigenous species and exotics. According to other surveys conducted in the Kruger National Park (Reinecke & Ackerman 1977; Plisko 1995) and Dlinza Forest (Plisko 2000), and occasional observations from Vernon Crookes Nature Reserve by Plisko (1992, 1998), endemics may survive by being protected from agricultural and industrial practices, even in presence of exotics.

![Fig. 1. A map of Queen Elizabeth Park, showing the different vegetation types.](https://bioone.org/journals/African-Invertebrates)
MATERIAL AND METHODS

Site description

The study was carried out in Queen Elizabeth Park, Pietermaritzburg, KwaZulu-Natal. It is a small (93 ha) park located on a north-facing hill of the Midlands mistbelt extension, in close proximity to the Pietermaritzburg city centre (ca 8 km north-west). The reserve was proclaimed in 1960 as a protected area; it had been an open park for public use (Anonymous 1989). The park contains research offices and laboratories, and conservation and administration departments of Ezemvelo KwaZulu-Natal Wildlife. This park is widely used as an outdoor education venue. The area has a sub-humid climate with wet summers and dry winters (average rainfall of 3.16 mm in January and 1.54 mm in February and average temperature of 15.7–27.64 °C; weather data are not available from the study area, so data from Cedara weather station were used instead (Botes pers. comm. 2012)). Sampling was undertaken during the rainy season (January–February 2012). The elevation of the sampled area ranges from 2996 feet (913.2 m) to 3149 feet (959.8 m).

According to Le Roux (1988), the reserve consists of six main vegetation types, i.e. Grassland, Woodland, Lawn, Indigenous bush, Exotic Plantation and Lanes, and Mixed Scrub (Fig. 1). Being a protected area, this site was chosen to provide benchmark information because of minimal anthropogenic disturbance. It is possible that the park will retain its standard over time and remain suitable for further studies.

Material

Collections were made in all six vegetation types; five 1×1m quadrates were selected within each vegetation type, totalling 30 plots altogether. Earthworms were collected by digging and hand sorting. The average depth of digging was 0.5 m due to the presence of roots or rocks in the ground, and the soil was sorted for earthworms. All earthworms were narcotized using 45 % ethanol and then fixed in 4 % formaldehyde and preserved in 70 % ethanol. Specimens, except for juveniles, were examined and identified to species level using a Wild Heerbrugg microscope. For identifying Tritogenia, Plisko (1992) was used; and for Megascolecidae, Blakemore’s (2004b) classification was followed. The material obtained was incorporated into the KwaZulu-Natal Museum collection. For comparison, type material borrowed from the Zoological Museum, Hamburg, was examined.

Synonymy/chresonymy and species descriptions

Introduced earthworm species are widely distributed, being known from all over the world, and they have numerous synonyms. In this paper, only distributional information and synonymy/chresonymy relevant to South Africa, are given. The descriptions of species are limited to the most important characters.

Acronyms and abbreviations

TAXONOMY

Family Microchaetidae Beddard, 1895
Genus Tritogenia Kinberg, 1867
Tritogenia howickiana (Michaelsen, 1913)

Figs 2–5


Type locality: South Africa, KwaZulu-Natal, Howick.

Description:

External: Body length 57–80 mm, width 6–8 mm. Number of segments, 81–103. Prostomium prolobous, small. Segmentation, preclitellar segments with secondary annulations: segments 1–3 simple with horizontal grooves, segments 4–8 with two ringlets of equal size, 9 with second ringlet smaller, from 10 and postclitellar simple and randomly annulated. Setae ab only visible from 7, 9 or 10, other setae may be seen from 10. Male pores not observed. Female pores minute, on anterior part of segment 14 near ab setae. Spermathecal pores minute, in 11/12 and 12/13 intersegmental furrows. Clitellum saddle-shaped, on 13–21; segmented, dorsal borders well marked. Tubercula pubertatis on 18, 19–21, nearly square glandular swellings (Fig. 3). Genital papillae on 11–18, 22, 23, paired or single, variable in size, round swellings on ab setae.

Internal: Septa 4/5, 5/6, 6/7 strongly thickened; 7/8, 8/9 are also thickened but less so than the anterior ones (Fig. 4); other septa thin. Gizzard well developed in 6–7, globular, muscular. Calciferous glands in 9–10, stalked. Intestinal origin in 12. Dorsal blood vessel double in the anterior segments, double even when crossing septa; simple in the posterior segments. Nephridia, in posterior segments two pairs per segment, coiled; the dorsal pair larger and the ventral smaller, this varying between segments, in some the dorsal smaller and the ventral larger. Holandric. Testes funnels are closely paired with the second pair somewhat differently shaped and smaller, both pairs iridescent. Seminal vesicles small in 10 and 11; one pair per segment. Spermathecae variable in shape in 12 and 13, more than one pair per segment (Fig. 5).


Remarks: The only indigenous species collected, with its type locality in Howick (ca 15 km north of QEP), and possibly endemic to narrow midlands area of KZN. Placed

---

Fig. 2. Tritogenia howickiana Kinberg, 1867, the whole body of the lectotype. Scale bar = 5 mm.
in the *T. sulcata* species-group, to which the following belong: *T. sulcata* Kinberg, 1867, *T. howickiana* (Michaelsen, 1913), *T. debbieae* Plisko, 2003, and *T. hiltonia* Plisko, 2003, all occurring in close proximity. The similar/distinguishing characters noted in these species are shown in Table 1. Because the type material of *sulcata* and *howickiana* (Fig. 2) is in poor condition internally and comparative anatomical study may be not productive, the published data (Michaelsen 1899, 1913; Plisko & Zicsi 1991)

![Image](https://bioone.org/journals/African-Invertebrates)
<table>
<thead>
<tr>
<th>Characters</th>
<th>Tritogenia sulcata Kinberg, 1867</th>
<th>Tritogenia sulcata var. howickianus Michaelsen, 1913</th>
<th>Tritogenia debbieae Plisko, 2003</th>
<th>Tritogenia hiltonia Plisko, 2003</th>
<th>Current specimens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions</td>
<td>55 mm</td>
<td>80–85 × 6–6.5 mm</td>
<td>58–60 × 4–6 mm</td>
<td>38–56 × 4–6 mm</td>
<td>57–80 × 6–8 mm</td>
</tr>
<tr>
<td>Segment description</td>
<td>biannulate</td>
<td>4–9 with ringlets</td>
<td>1–3 simple, 4–9 divided into 2 equal ringlets, 8 &amp; 9 with front larger than back, 10 and rest are simple</td>
<td>1–3 simple with longitudinal grooves, 4–9 with 2 simple ringlets, similar in size &amp; appearance, post clitellar simple</td>
<td>1–3 simple, 4–8 with 2 ringlets, similar in size &amp; appearance, 9: second ringlet shorter, rest simple</td>
</tr>
<tr>
<td>No. of segments</td>
<td>80</td>
<td>80–82</td>
<td>90–91</td>
<td>73–94</td>
<td>70–97</td>
</tr>
<tr>
<td>Clitellum</td>
<td>15–21</td>
<td>13–22, 14–22</td>
<td>13–23</td>
<td>13–23</td>
<td>13–21</td>
</tr>
<tr>
<td>Tubercula pubertatis</td>
<td>17–19</td>
<td>18–21, square-shaped, round medially</td>
<td>18,1/n18–1/n22, oval glandular pads randomly grooved, widely separated ventrally</td>
<td>18–22, nearly square, grooved randomly, on 21–22 separated by narrow triangular invagination</td>
<td>18, 19–21, almost square</td>
</tr>
<tr>
<td>Spermathecal pores</td>
<td>11/12–12/13</td>
<td>11/12, 12/13</td>
<td>11/12, 12/13</td>
<td>11/12, 12/13</td>
<td>11/12, 12/13</td>
</tr>
<tr>
<td>Papillae</td>
<td>15, 16, 17, 23, glandular</td>
<td>12 ab, cd, 23</td>
<td>10–18, paired or single, swellings encircling ab setae</td>
<td>10–14, paired or single</td>
<td>11–18, 22, 23, 25, paired or single</td>
</tr>
<tr>
<td>Septa</td>
<td>4/5–6/7 a little thickened, 7/8 8/9?</td>
<td>4/5 a little thickened, 6/7 &amp; 7/8 much thickened, 5/6 &amp; 8/9 slightly thickened</td>
<td>all thin</td>
<td>4/5 a little thickened, 5/6 &amp; 6/7 muscular, 7/8 &amp; 8/9 less thickened, 9/10 absent</td>
<td>4/5, 5/6 &amp; 6/7 strongly thickened, 7/8 &amp; 8/9 less thick</td>
</tr>
<tr>
<td>Gizzard</td>
<td>7</td>
<td>7, partly in 6</td>
<td>6–7</td>
<td>6</td>
<td>6–7</td>
</tr>
<tr>
<td>Calci ferous glands</td>
<td>9</td>
<td>9–10, paired dorsolaterally, large, globular</td>
<td>9–10, large dorsolaterally, ventrally widely separated</td>
<td>9–10, stalked</td>
<td>9–10, stalked</td>
</tr>
<tr>
<td>Spermathecae</td>
<td>11/12 &amp; 12/13, multiple</td>
<td>11/12 &amp; 12/13, multiple</td>
<td>11/12 &amp; 12/13 paired, large</td>
<td>12 &amp; 13 have 1–2 at each side, close to genital glands</td>
<td>12 &amp; 13, one pair per segment</td>
</tr>
</tbody>
</table>
are considered. Material from QEP differs from type material of *debbieae* and *hiltonia* kept at the NMSA in thickness of the septa, shape and position of papillae, and number of spermathecae, indicating a close resemblance to the description of *howickiana*. Therefore, the specimens from QEP are assigned to this species. However, the known characters of the taxa in the *sulcata*-group are closely related (Table 1); a systematic revision based on molecular study is suggested.

Family Acanthodrilidae Claus, 1880
Subfamily Benhamiinae Michaelsen, 1897
Genus *Dichogaster* Beddard, 1888

*Microdrilus saliens*: Beddard 1893: 683.
*Dichogaster crawi* Eisen, 1900: 228; Michaelsen 1913: 418.

Type locality: Undesignated. The type material supposedly originated from Malaysia, Singapore and Indonesia, but obtained from earth at the Kew Gardens (UK) (Gates 1972).

Description:


Material examined: 5 cl.: Mixed Scrub, between plantation and grassland (29°33.683'S 30°18.992'E), 3149 ft, 24.ii.2012, 5 cl., NMSA/Olig.06144.

Remarks: It was previously collected from LP, KZN and EC (NMSAD). Some authors have collected this species in various habitats, ranging from nature reserves to grasslands and forests (Dlamini 2002; Horn et al. 2007).

Family Glossoscolecidae Michaelsen, 1900
Genus Pontoscolex Schmarda, 1861
Pontoscolex corethrurus (Müller, 1857)


*Pontoscolex* (*Pontoscolex*) *corethrurus:* Moreno 2004: 163.

Type locality: Possibly in Amazonian Brazil.

Description:

External: Body length 60–75 mm, width 3–4 mm. Number of segments 193–210. Prostomium epilobous, often invaginated inside first segment. Setae closely paired in four rows on anterior part; the distance between ab or cd setae showed some variation on the posterior part of the body; approximately the last quarter of the body showed a quincunx arrangement. Clitellum-saddle shaped on 15–21. Tubercula pubertatis as smooth bands on 19–21. Female and male pores not seen.


Remarks: This species is known to be widely distributed all over the world, having been spread intentionally by man or unintentionally by passive transport or natural dispersal into acceptable biotopes. It has been commonly recorded in agricultural fields (Fragoso et al. 1999). In South Africa, it was reported from seven provinces: LP, MP, KZN, EC, WC, GP, NW (NMSAD). It occurs in most habitats (Plisko 2001, 2010), and Ljungström (1972a) noted large populations in coastal sugarcane plantations.

Family Megascolecidae Rosa, 1891
Genus Amynthas Kinberg, 1867
Amynthas aeruginosus Kinberg, 1867


*Amynthas aeruginosus* species group: Sims & Easton 1972: 234.

Type locality: Guam.
Description:


Remarks: The species has been found in grasslands, agricultural land, farms and nature reserves and it is known from KZN and GP only; there are no records from other South African provinces (Plisko 2010).

**Amynthas corticis** (Kinberg, 1867)

*Perichaeta corticis* Kinberg 1867: 102.
*Megascolex diffringens* Baird, 1869: 40; Blakemore 2004b: 127, table 1.
*Pheretima heterochaeta* (Michaelsen, 1891); Michaelsen 1913: 417.

Type locality: Hawaii, Oahu.

Description:

**External:** Body length 60–150 mm, width 3–4 mm. Number of segments 80–118. Prostomium epilobous. Setae absent in clitellum in some specimens but present in others. First dorsal pore in 10/11. Clitellum circular on 14–16 with distinct anterior and posterior borders at intersegmental furrows 13/14 and 16/17, mostly orangy in preserved material. Spermathecal pores paired, minute in the four intersegmental furrows 5/6–8/9, ca 0.3 of body circumference apart. Female pore single, minute, on 14. Male pores paired on 18, with swollen porophores. Genital markings on 7–9, paired, small and round-shaped, appearing paler than the body.

**Internal:** Septa 5/6, 6/7 and 7/8 are somewhat thickened but not to the extent of being muscular, 8/9 and 9/10 missing. Gizzard well developed in 8–10. Intestinal origin in 15. Caeca simple in 27, extending forward to 24. Holandric. Spermathecae paired in 5/6–8/9, large and triangular with simple diverticulum, duct shorter than ampulla, which is triangular. Seminal vesicles big, in 11–12. Prostates in 16–18, missing in 20 specimens.

**Amynthas gracilis** (Kinberg, 1867)


*Perichaeta hawayana*: Rosa, 1891: 396.


**Type locality:** Brazil, Rio de Janeiro.

**Description:**

**External:** Body length 100–130 mm, width 3–5 mm, number of segments 85–95. Prostomium epilobous. First dorsal pore in 10/11. Clitellum circular on 14–16. Spermathecal pores paired in intersegmental furrows 5/6–7/8, ca 0.25–0.30 of body circumference apart. Female pore single on 14, minute. Male pores paired on 18. Genital markings: three pairs near the male pores on 18, forming the shape of a semicircle.


**Remarks:** The species occurs in six South African provinces (Plisko 2010), namely LP, MP, GP, NW, KZN and EC. It is common in natural as well as agricultural habitats (Ljungström 1972a; Reynolds & Reinecke 1976).

**Amynthas minimus** (Horst, 1893)

*Perichaeta minima*: Horst 1893: 66.


**Type locality:** Indonesia, Java, Tijbodas.

**Description:**

**External:** Body length 20–40 mm, with width 1–2 mm. Number of segments 70–80. Prostomium epilobous. Clitellum circular on 14–16. Spermathecal pores not observed. Female pore minute on 14. Male pores paired on 18, on very raised but small porophores. Genital markings not observed.


Remarks: The large population of athecate specimens collected in QEP indicates parthenogenetic reproduction. Ljungström (1972a) likewise collected parthenogenetic morphs with spermathecae and seminal vesicles reduced or absent, and also with an abnormally placed or shaped clitellum. However, thecate specimens have been recorded in this country as well (Plisko 2010; NMSAD). The species is known from various biotopes: grassland and meadows; and forested, natural and cultivated land (Zicsi 1998; Plisko 2010).

It should be mentioned that thecate degeneration is a known phenomenon, attributed to parthenogenetic reproduction. Few species exhibiting it have been described (Gates 1932, 1972; Tsai et al. 2002), although their systematic position has been discussed (Blakemore 2003; Gates 1972; Sims & Easton 1972). Some of the species have been imprecisely accredited to a ‘species group’.

Amynthas rodericensis (Grube, 1879)

Perichaeta rodericensis: Grube 1879: 554.

Type locality: Republic of Mauritius, Rodrigues.

Description:


Remarks: The species is known from LP, KZN, EC and MP (Plisko 2010). It is common in natural and agricultural fields (Ljungström 1972a; Zicsi & Reinecke 1992; Horn et al. 2007; Plisko 2010).

Family Lumbricidae Rafinesque-Schmaltz, 1815
Genus Octolasion Örley, 1885
*Octolasion lacteum* (Örley, 1881)

Type locality: Hungary.

Description:


Remarks: This species is widely distributed in South Africa, being known in all provinces from more than 200 samplings (NMSAD). Occurs in a wide range of habitats: forests, pastures, cultivated fields, banks of rivers, fallow grounds, gardens, and composting heaps. The small size of the collected specimens suggests parthenogenetical reproduction.

**DISCUSSION**

The results from this survey add to understanding of the earthworm species composition in protected areas. Nine species were collected in Queen Elizabeth Park, one of which (*Tritogenia howickiana*) is indigenous, belonging to the family Microchaetidae. There is no history of its previous collection in the park, although in the close neighbourhood it was recorded in more than 20 sites. The 44 specimens (3.9% of the total number collected) of *T. howickiana* were found in three of the six vegetation types (Table 2). These findings are in accordance with previous observations by other authors (i.e. Cal-
laham et al. 2003; Winsome et al. 2006), who noted that indigenous earthworm species are limited in their distribution. The other 96.1% of species belong to eight introduced species of the families Acanthodrilidae (Benhamiinae), Glossoscolecidae, Megascolecidae, and Lumbricidae. These eight species are well known among the world’s widely distributed peregrine species (Hendrix & Bohlen 2002).

In QEP, seven species occur in large numbers in the indigenous bush and woodland; five species in mixed scrub, grassland and plantation each; and only four species in the lawn (Table 2). Species assemblages were dominated by *Amynthas rodericensis*, which appears to be by far the most common and widespread taxon, present in large numbers in all vegetation types, making up 34.4% of the total number of earthworms (Table 2). *Amynthas minimus* was the next most common species (18.0% of the total number of earthworms), present in all vegetation types but in smaller numbers than *A. rodericensis. Pontoscolex corethrurus* was found in three vegetation types, whereas *Dichogaster bolaui* was seen in only one area in mixed scrub and was the least common. Introduced species dominated in the present study, comprising 96.1% of found earthworms. The exotic species might be abundant due to their ability to reproduce parthenogenetically. According to Ljungström (1972a), as well as Reynolds and Reinecke (1976), parthenogenetic species may have an advantage as regards colonizing of new habitats.

The number of species collected in this study is similar to that previously recorded from other nature reserves (NMSAD); and according to Curry (1998), most earthworm communities are species-poor. Reynolds and Reinecke (1976) carried out an earthworm survey of the Kruger National Park and, surprisingly, found no native but only introduced species. Zicsi and Reinecke (1992) recovered *Nemertodrilus kruegeri* and *N. transvaalensis* but their endemism to South Africa is not clear (Plisko 2010). It is therefore of great interest that one indigenous species in QEP still survives, though in limited patches. The discovery of such an overwhelming abundance of introduced species in this protected area is not unanticipated after the findings of Reynolds and Reinecke (1976), particularly given the fact that Kruger National Park is a protected territory of national standard. During the course of extensive work on indigenous megadrile earthworms in South Africa, Plisko has noted a decline in the number of earthworm species due to

<table>
<thead>
<tr>
<th>Taxon</th>
<th># collected</th>
<th>% of total</th>
<th>W</th>
<th>L</th>
<th>IB</th>
<th>P</th>
<th>MS</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Tritogenia howickiana</em></td>
<td>44</td>
<td>3.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Pontoscolex corethrurus</em></td>
<td>153</td>
<td>13.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Octolasion lacteum</em></td>
<td>42</td>
<td>3.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Dichogaster saliens</em></td>
<td>5</td>
<td>0.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Amynthas aeruginosus</em></td>
<td>14</td>
<td>1.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Amynthas corticis</em></td>
<td>37</td>
<td>3.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Amynthas gracilis</em></td>
<td>43</td>
<td>3.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Amynthas minimus</em></td>
<td>203</td>
<td>18.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Amynthas rodericensis</em></td>
<td>388</td>
<td>34.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Amynthas juveniles</em></td>
<td>198</td>
<td>17.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
change in the environment, be it development, agriculture or any other human activities that alter the natural habitats (Plisko pers. comm. 2012). Microchaetids occur mainly in grasslands and forests (Plisko 1997, 2000, 2003) and indigenous acanthodrilines are commonly restricted to soil that grows indigenous bushes (Pickford 1937; Ljungström 1972b; Plisko 2000). Introduced species have the ability to adapt in habitats that may be unfavourable, thus increasing their chances of being sampled.

ACKNOWLEDGEMENTS

I would like to thank A. Armstrong, H. Snyman, I. Rushworth, P. Mahlaba and B. Nxele (all at Ezemvelo KZN Wildlife), who assisted in various ways while sampling in QEP took place. L. Bambalele, S. Mkhize and A. Malamlela are acknowledged for technical support during fieldwork. M. Botes (ARC–Cedara Agricultural College) is thanked for weather data, Dr J.D. Plisko (NMSA) for her tireless help with identification of earthworm species and help with the manuscript, and Dr M. Mostovski (NMSA) for guidance and editing the manuscript. Drs I. Muratov and B. Muller (both at NMSA) are acknowledged for their help with photographs; Dr R.J. Blakemore (National Institute of Biological Resources in Incheon, South Korea) is thanked for information on A. minimus; Helma Roggenbuck (Zoological Museum, Hamburg) is thanked for the loan of T. howickiana lectotype; and Dr E. Sigvaldadottir (Swedish Museum of Natural History, Stockholm) for providing photographs of the type specimen of T. sulcata. Dr Cs. Csuzdi (Hungarian Natural History Museum) and Prof. P.F Hendrix (University of Georgia, USA) are gratefully thanked for their valuable comments in reviewing this manuscript. The work is based upon research supported by the National Research Foundation (NRF) and Department of Science and Technology under the SABI Programme, as well as NRF incentive funding for rated researchers to Dr J.D. Plisko.

REFERENCES


The role of nature reserves in the protection of the terrestrial earthworm fauna (Oligochaeta), based on the material from Dlinza Forest Nature Reserve (KwaZulu-Natal, South Africa). Lammergeyer 46: 75–80.


Competitive interactions between native and exotic earthworm species as influenced by habitat quality in a California grassland. Applied Soil Ecology 32: 38–53.

