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The megadrile fauna (Annelida: Oligochaeta) of Queen Elizabeth Park, South Africa: species composition and distribution within different vegetation types

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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 (*Amyntas aeruginosus*, *Amyntas corticis*, *Amyntas gracilis*, *Amyntas minimus* and *Amyntas 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 co-existence 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; Valckx *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 (Kinberg 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.

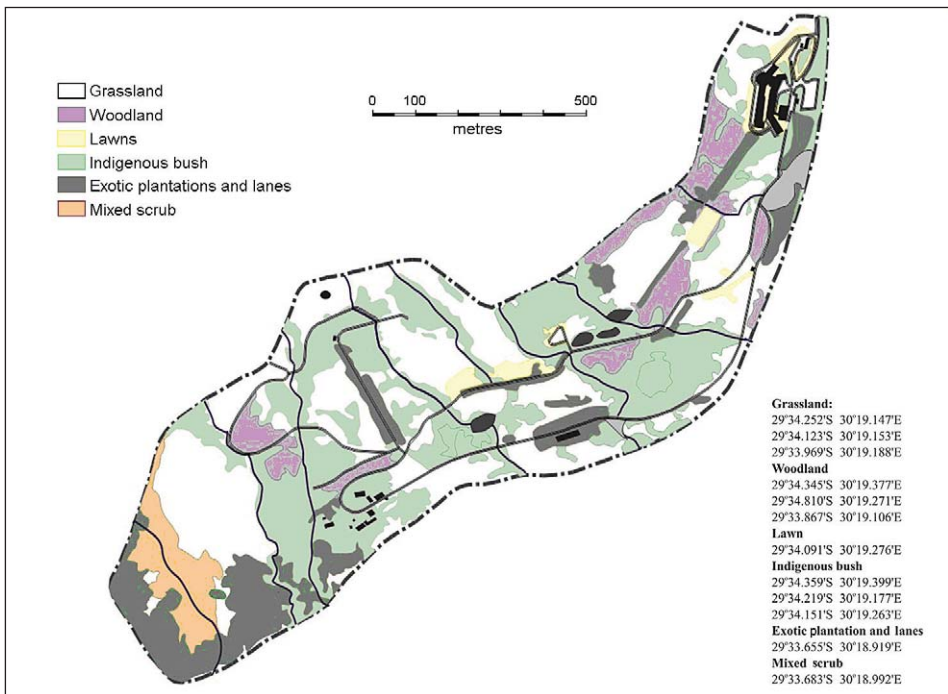


Fig. 1. A map of Queen Elizabeth Park, showing the different vegetation types.

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 × 1 m 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

Cl. (cl.) – clitellate, EC – Eastern Cape Province, FS – Free State, GP – Gauteng Province, juv. – juvenile, KZN – KwaZulu-Natal Province, LP – Limpopo Province, MP – Mpumalanga Province, NC – Northern Cape Province, NMSA – KwaZulu-Natal Museum, NMSAD – NMSA database, NW – North West Province, TN – T. Nxele, QEP – Queen Elizabeth Park, WC – Western Cape Province.

TAXONOMY

Family Microchaetidae Beddard, 1895

Genus *Tritogenia* Kinberg, 1867*Tritogenia howickiana* (Michaelsen, 1913)

Figs 2–5

Microchaetus sulcatus var. *howickianus*: Michaelsen 1913: 432; Reynolds & Cook 1976: 115.*Tritogenia howickiana*: Michaelsen 1918: 333; Plisko & Zicsi 1991: 112; Plisko 1992: 368; 1997: 280; 2003: 317.

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

Description:

External: Body length 57–80 mm, width 6–8 mm. Number of segments, 81–103. Prostomium probolous, 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).

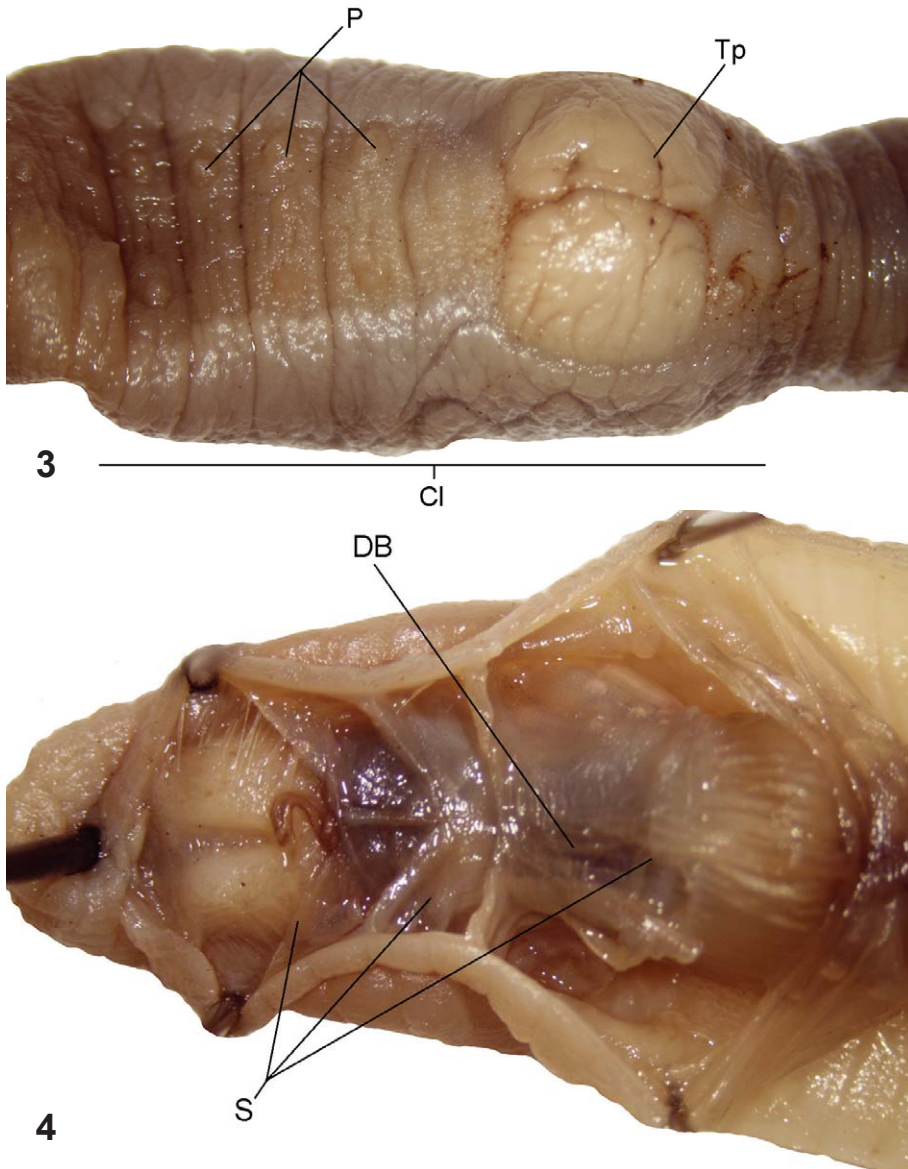
Material examined: 7 cl. and 37 juv. specimens: Woodland, on the side of the road near fence (29°34.810'S 30°19.217'E), 23.ii.2012, 2 cl., NMSA/Olig.06106; Woodland, small grass with bush near road (29°34.345'S 30°19.377'E), 7.i.2012, 1 cl., NMSA/Olig.06094; Mixed Scrub, between plantation and grassland (29°33.683'S 30°18.992'E), 3149 ft, 24.ii.2012, 4 juv., NMSA/Olig.06130; 7 juv., NMSA/Olig.06132; 5 juv., NMSA/Olig.06194; 4 cl., NMSA/Olig.06131; Grassland, medium grass with a few trees (29°34.252'S 30°19.174'E), 7.i.2012, 20 juv., NMSA/Olig.06134 & 06135; Grassland, open patch of grass (29°34.123'S 30°19.153'E), 7.i.2012, 1 juv., NMSA/Olig.06139.

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)



Figs 3, 4. *Tritogenia howickiana*: (3) anterior part of the body, showing papillae and tubercula pubertatis ventrally; (4) dorsal dissection showing thickened septa. Abbreviations: Cl – clitellum, DB – double blood vessel, P – papillae of 15–17, S – septa 4/5–6/7, Tp – tubercula pubertatis, .

TABLE 1
Characteristics of species in the *Tritogenia sulcata* species group.

Characters	<i>Tritogenia sulcata</i> Kinberg, 1867	<i>Tritogenia sulcata</i> sensu Michaelsen, 1899	<i>Tritogenia sulcata</i> var. <i>howickianus</i> Michaelsen, 1913	<i>Tritogenia debbieae</i> Plisko, 2003	<i>Tritogenia hiltonia</i> Plisko, 2003	Current specimens
Dimensions	55 mm	55 × 7 mm	80–85 × 6–6.5 mm	58–60 × 4–6 mm	38–56 × 4–6 mm	57–80 × 6–8 mm
Segment description	biannulate	4–9 with ringlets	1–3 simple, 4–9 divided into 2 equal ringlets, 8 & 9 with front larger than back, 10 and rest are simple	1–3 simple with longitudinal grooves, 4–9 with 2 simple ringlets, similar size & appearance, post cellular simple	1–3 simple, 4–8 with 2 simple ringlets, similar in size & appearance, 9: second ringlet shorter, rest simple	1–3 simple, 4–8 with 2 ringlets, similar in size & appearance, 9: second ringlet shorter
No. of segments	80	80–82	90–91	73–94	70–97	81–103
Clitellum		15–21	13–22; 14–22	13–23	13–23	13–21
Tubercula pubertatis	17–19	18–21, with ridges	19–21, square-shaped, round medially	18, 1/18–1/n22, oval glandular pads randomly grooved, widely separated ventrally	18–22, nearly square, grooved randomly, on 21–22 separated by narrow triangular invagination	18, 19–21, almost square
Spermathecal pores			11/12–12/13	11/12, 12/13	11/12, 12/13	11/12, 12/13
Papillae		15, 16, 17, 23, glandular	12 <i>ab</i> , <i>cd</i> , 23	10–18, paired or single, swellings encircling <i>ab</i> setae	10–14, paired or single	11–18, 22, 23, 25, paired or single
Septa		4/5–6/7 a little thickened, 7/8 8/9?	4/5 a little thickened, 6/7 & 7/8 much thickened, 5/6 & 8/9 slightly thickened	all thin	4/5 a little thickened, 5/6 & 6/7 muscular, 7/8 & 8/9 less thickened, 9/10 absent	4/5, 5/6 & 6/7 strongly thickened, 7/8 & 8/9 less thick
Gizzard		7	7, partly in 6	6–7	6	6–7
Calciferous glands	9	9–10, paired dorsolaterally, large, globular	9–10, large dorsolaterally, ventrally widely separated	9–10, stalked	9–10, stalked	9–10, stalked
Spermathecae		11/12 & 12/13, multiple	11/12 & 12/13, multiple	11/12 & 12/13 paired, large	12 & 13 have 1–2 at each side, close to genital glands	12 & 13, one pair per segment

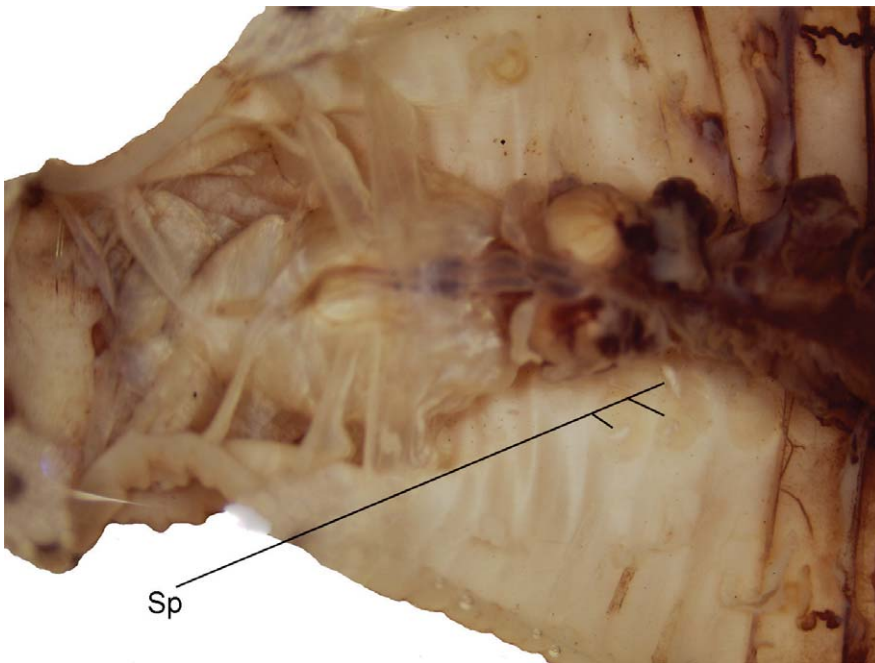


Fig. 5. *Tritogenia howickiana*, position of the spermathecae (Sp) in segments 12 and 13.

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

Dichogaster (Diplotheodrilus) saliens (Beddard, 1893)

Microdrilus saliens: Beddard 1893: 683.

Dichogaster crawi Eisen, 1900: 228; Michaelsen 1913: 418.

Dichogaster saliens: Gates 1972: 281; Ljungström 1972a: 7; Reynolds 1993: 6; Zicsi 1998: 71; Dlamini 2002: 62; Horn *et al.* 2007: 175.

Dichogaster (Diplotheodrilus) saliens: Csuzdi 1995: 108; Plisko 2010: 292; 2012: 49.

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:

External: Length 40–45 mm, width 1–2 mm. Number of segments 100–110. Prostomium epilobous. Setae closely paired. First dorsal pore in 5/6. Clitellum on 13–19, circular, incomplete, interrupted by genital field on 17. Spermathecal and female pores not seen. Male pores paired on 17.

Internal: Gizzards two, in 5 and 6. Calciferous glands ovoid shaped in 15–17. Intestinal origin in 17.

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)

Lumbricus corethrurus: Müller 1857: 113.

Pontoscolex corethrurus: Michaelsen 1913: 422; Ljungström 1972a: 7; Gates 1972: 54; Reynolds & Reinecke 1976: 6; Zicsi & Reinecke 1992: 157; Plisko 1998: 292; 2000: 77; 2001: 323–334; 2003: 290, 292; 2010: 294; Dlamini 2002: 62; Horn *et al.* 2007: 175.

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.

Internal: Septa 6/7–9/10 thickened. Gizzard in 6. Calciferous glands in 7, 8 & 9. Intestinal origin in 15. Holandric. Spermathecae club-shaped, paired in 7–9.

Material examined: 49 cl., 104 juv.: Woodland, on the side of the road near fence (29°34.810'S 30°19.217'E), 23.ii.2012, 1 cl., 2 juv., NMSA/Olig.06163; 10 juv., NMSA/Olig.06164; Woodland, near Nursery (29°33.867'S 30°19.106'E), 3087 ft, 23.ii.2012, 5 cl., 2 juv., NMSA/Olig.06091; 7 cl., 15 juv., NMSA/Olig.06090; Indigenous Bush (29°34.357'S 30°19.399'E), 22.ii.2012, 4 cl., 34 juv., NMSA/Olig.06117; Indigenous Bush, big trees, soft moist soil (29°34.219'S 30°19.177'E), 3105 ft, 22.ii.2012, 15 cl., 19 juv., NMSA/Olig.06165; Indigenous Bush, big trees, wet soil, dense cover, (29°34.151'S 30°19.263'E), 2996 ft, 22.ii.2012, 3 cl., 6 juv., NMSA/Olig.06166; 14 cl., 7 juv., NMSA/Olig.06167; Grassland, patch with shrubs and a few trees (29°33.969'S 30°19.188'E), 7.i.2012, 9 juv., NMSA/Olig.06143.

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 *Amyntas* Kinberg, 1867

Amyntas aeruginosus Kinberg, 1867

Amyntas aeruginosus: Kinberg 1867: 101; Dlamini 2002: 62; Blakemore 2004b: 127, table 1; Plisko 2010: 302.

Amyntas aeruginosus species group: Sims & Easton 1972: 234.

Type locality: Guam.

Description:

External: Body length 74–143 mm, width 3–4 mm. Number of segments 80–114. Prostomium epilobous. Setae numerous, absent at clitellar area, although present in some specimens. First dorsal pore in 10/11. Clitellum circular on 14–16. Spermathecal pores paired, minute in two intersegmental furrows at 7/8 and 8/9. Female pore single, minute on 14. Male pores paired on 18 with swollen conical disc. Genital markings not observed.

Internal: Septa 5/6, 6/7 and 7/8 are slightly thickened; 8/9 and 9/10 missing. Gizzard well developed in 8–10. Intestinal origin in 15. Caeca simple in 27–23, extending forward. Holandric. Spermathecae paired in 8 and 9, with simple diverticulum. Seminal vesicles in 11–12. Prostates in 17–21, 22.

Material examined: 14 cl.: Lawn, at the picnic site (29°34.091'S 30°19.276'E), 3040 ft, 24.ii.2012, 1 cl., NMSA/Olig.06158; 8 cl., NMSA/Olig.06107; Indigenous Bush, big trees, soft moist soil (29°34.219'S 30°19.177'E), 3105 ft, 22.ii.2012, 3 cl., NMSA/Olig.06112; Mixed Scrub, between plantation and grassland (29°33.683'S 30°18.992'E), 3149 ft, 24.ii.2012, 2 cl., NMSA/Olig.06126.

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).

Amyntas 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.

Pheretima diffringens: Gates 1954: 227; 1972: 177; Ljungström 1972a: 46.

Amyntas diffringens: Reynolds & Cook 1976: 94; Reynolds 1993: 5; Dlamini 2002: 62; Horn *et al.* 2007: 175; Plisko 2010: 302.

Amyntas corticis: Zicsi & Pajor 1992: 134; Zicsi & Reinecke 1992: 156; Zicsi 1998: 74; Blakemore 2004b: 127, table 1; Plisko 2010: 302.

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 orangey 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.

Material examined: 37 cl.: Woodland, on the side of the road near fence (29°34.810'S 30°19.217'E), 23.ii.2012, 2 cl., NMSA/Olig.06100; Lawn, at the picnic site (29°34.091'S 30°19.276'E), 3040 ft, 24.ii.2012, 3 cl., NMSA/Olig.06108; 1 cl., NMSA/Olig.06159; Indigenous Bush (29°34.357'S 30°19.399'E), 22.ii.2012, 3 cl., NMSA/Olig.06160; Indigenous Bush, big trees, soft moist soil (29°34.219'S 30°19.177'E), 3105 ft, 22.ii.2012,

1 cl., NMSA/Olig.06161; Indigenous Bush, big trees, wet soil, dense cover (29°34.151'S 30°19.263'E), 2996 ft, 22.ii.2012, 19 cl., NMSA/Olig.06114; Plantation, wattle & pine (29°33.655'S 30°18.919'E), 3106 ft, 23.ii.2012, 3 cl., NMSA/Olig.06162; 5 cl., NMSA/Olig.06121.

Remarks: The species has been reported from almost all over South Africa (MP, GP, NW, FS, KZN, EC, WC and LP). It is common in the upper layer of soil, mostly in rotting litter in plantations (Plisko 2010) and decomposed sugarcane reed (Ljungström 1972a). From NMSAD, it is apparent that this species occupies a wide range of biotopes.

Amyntas gracilis (Kinberg, 1867)

Nitocris gracilis: Kinberg 1867: 102.

Perichaeta hawayana Rosa, 1891: 396.

Pheretima hawayana: Gates 1972: 189; Ljungström 1972a: 51.

Amyntas gracilis: Sims & Easton 1972: 235.

Amyntas hawayanus: Dlamini 2002: 62; Plisko 2010: 303.

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.

Internal: Septa 6/7 and 7/8 slightly thickened, 8/9 and 9/10 missing. Gizzard in 8–10. Intestinal origin in 15. Caeca simple originating in 27 extending forward. Holandric. Spermathecae large and roundish with elongate diverticulum, in 6–8. Seminal vesicles in 11–12. Prostates racemose, large, in 17–21 and 22.

Material examined: 43 cl.: Woodland, on the side of the road near fence (29°34.810'S 30°19.271'E), 23.ii.2012, 8 cl., NMSA/Olig.06102; Woodland, near Nursery (29°33.867'S 30°19.106'E), 3087 ft, 23.ii.2012, 1 cl., NMSA/Olig.06168; 7 cl., NMSA/Olig.06098; Woodland, small grass with bush near road (29°34.345'S 30°19.377'E), 7.i.2012, 2 cl., NMSA/Olig.06096; Indigenous Bush (29°34.357'S 30°19.399'E), 22.ii.2012, 3 cl., NMSA/Olig.06169; Indigenous Bush, big trees, soft moist soil (29°34.219'S 30°19.177'E), 3105 ft, 22.ii.2012, 3 cl., NMSA/Olig.06170; 15 cl., NMSA/Olig.06113; Indigenous bush, big trees wet soil, dense cover (29°34.151'S 30°19.263'E), 2996 ft, 22.ii.2012, 1 cl., NMSA/Olig.06171; Plantation, wattle & pine (29°33.655'S 30°18.919'E), 3106 ft, 23.ii.2012, 2 cl., NMSA/Olig.06120; Grassland, open patch of grass (29°34.123'S 30°19.153'E), 7.i.2012, 1 cl., NMSA/Olig.06137.

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).

Amyntas minimus (Horst, 1893)

Perichaeta minima: Horst 1893: 66.

Pheretima minima: Gates 1972: 201; Ljungström 1972a: 52; Reynolds & Cook 1976: 137.

Amyntas minimus: Zicsi & Reinecke 1992: 157; Reynolds 1993: 5; Zicsi 1998: 74; Dlamini 2002: 62; Blakemore 2004b: 127, table 1; Horn *et al.* 2007: 175; Plisko 2010: 303.

Type locality: Indonesia, Java, Tjibodas.

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.

Internal: Septa 5/6, 6/7 and 7/8 moderately thickened, 8/9 and 9/10 missing. Gizzard in 8–10. Intestinal origin in 15. Caeca simple, originating in 27. Holandric. Spermathecae not observed. Seminal vesicles not observed. Prostates racemose, in 17–19.

Material examined: 203 cl.: Woodland, on road side near fence (29°34.810'S 30°19.271'E), 23.ii.2012, 37 cl., NMSA/Olig.06104; 27 cl., NMSA/Olig.06182; Woodland, near Nursery (29°33.867'S 30°19.106'E), 3087 ft, 23.ii.2012, 12 cl., NMSA/Olig.06105; 6 cl., NMSA/Olig.06183; Lawn, at the picnic site (29°34.091'S 30°19.276'E), 3040 ft, 24.ii.2012, 13 cl., NMSA/Olig.06110; 4 cl., NMSA/Olig.06184; 13 cl., NMSA/Olig.06185; Indigenous Bush (29°34.357'S 30°19.399'E), 22.ii.2012, 21 cl., NMSA/Olig.06118; Indigenous Bush, big trees, soft moist soil (29°34.219'S 30°19.177'E), 3105 ft, 22.ii.2012, 6 cl., NMSA/Olig.06186; Indigenous Bush, big trees, wet soil, dense cover (29°34.151'S 30°19.263'E), 2996 ft, 22.ii.2012, 37 cl., NMSA/Olig.06188; Plantation, wattle & pine (29°33.655'S 30°18.919'E), 3106 ft, 23.ii.2012, 7 cl., NMSA/Olig.06125; 1 cl., NMSA/Olig.06187; 4 cl., NMSA/Olig.06189; 2 cl., NMSA/Olig.06190; 3 cl., NMSA/Olig.06191; Mixed Scrub, between plantation and grassland (29°33.683'S 30°18.992'E), 3149 ft, 24.ii.2012, 1 cl., NMSA/Olig.06192; 2 cl., NMSA/Olig.06183; 4 cl., NMSA/Olig.06129; Grassland, open patch of grass (29°34.123'S 30°19.153'E), 7.i.2012, 3 cl., NMSA/Olig.06140.

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'.

Amyntas rodericensis (Grube, 1879)

Perichaeta rodericensis: Grube 1879: 554.

Pheretima rodericensis: Ljungström 1972a: 55.

Amyntas rodericensis: Gates 1972: 218; Zicsi & Reinecke 1992: 156; Reynolds 1993: 6; Zicsi 1998: 74; Dlamini 2002: 62; Blakemore 2004b: 127, table 1; Horn *et al.* 2007: 175; Plisko 2010: 303.

Type locality: Republic of Mauritius, Rodrigues.

Description:

External: Body length 70–110 mm, width 3–4 mm. Number of segments 80–100. Prostomium epilobous. Setae numerous; absent on clitellar segments. First dorsal pore on 9/10. Clitellum circular, on 14–16. Female pore minute on 14. Male pores paired on 18, on swollen porophore. Spermathecal pores paired, in four intersegmental furrows (5/6, 6/7, 7/8 and 8/9), open dorsally. Genital markings constant on 17–18, disc shaped, paired.

Internal: Septa thin, missing at 8/9 and 9/10. Shape of gizzard roundish, in 8–10. Intestinal origin in 15. Caeca simple, originate in 27, extending forward to 24. Holandric. Spermathecae big and roundish with long, rosary-shaped diverticulum. Seminal vesicles in 11–12, variable in size. Prostates racemose, in 17–21, 22.

Material examined: 388 cl.: Woodland, on the side of the road near fence (29°34.810'S 30°19.271'E), 23.ii.2012, 9 cl., NMSA/Olig.06095; 24 cl., NMSA/Olig.06145; Woodland, near nursery (29°33.867'S 30°19.106'E), 3087 ft, 23.ii.2012, 22 cl., NMSA/Olig.06146; 40 cl., NMSA/Olig.06097; Woodland, small grass with bush near road (29°34.345'S 30°19.377'E), 7.i.2012, 11 cl., NMSA/Olig.06101; Lawn, at the picnic site (29°34.091'S 30°19.276'E), 3040 ft, 24.ii.2012, 2 cl., NMSA/Olig.06147; 5 cl., NMSA/Olig.06148; 21 cl.,

NMSA/Olig.06109; Indigenous Bush (29°34.357'S 30°19.399'E), 22.ii.2012, 37 cl., NMSA/Olig.06149; Indigenous Bush, big trees, soft moist soil (29°34.219'S 30°19.177'E), 3105 ft, 22.ii.2012, 4 cl., NMSA/Olig.06150; 11 cl., NMSA/Olig.06151; Indigenous Bush, big trees, wet soil, dense cover (29°34.151'S 30°19.263'E), 2996 ft, 22.ii.2012, 17 cl., NMSA/Olig.06152; 49 cl., NMSA/Olig.06115; Plantation, wattle & pine (29°33.655'S 30°18.919'E), 3106 ft, 23.ii.2012, 55 cl., NMSA/Olig.06122; 4 cl., NMSA/Olig.06153; 15 cl., NMSA/Olig.06154; 20 cl., NMSA/Olig.06155; 16 cl., NMSA/Olig.06156; Mixed Scrub, between plantation and grassland (29°33.683'S 30°18.992'E), 3149 ft, 24.ii.2012, 5 cl., NMSA/Olig.06127; 3 cl., NMSA/Olig.06157; Grassland, medium grass with few trees (29°34.252'S 30°19.174'E), 7.i.2012, 2 cl., NMSA/Olig.06133; Grassland, open patch of grass (29°34.123'S 30°19.153'E), 7.i.2012, 11 cl., NMSA/Olig.06136; Grassland, patch with shrubs and a few trees (29°33.969'S 30°19.188'E), 7.i.2012, 5 cl., NMSA/Olig.06142.

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)

Lumbricus terrestris var. *lacteus*: Örley 1881: 584; Gates 1972: 118.

Octolasion lacteum: Örley 1885: 21; Plisko 1997: 264; 2002: 196; 2010: 301; Horn *et al.* 2007: 175.

Octolasion tyrtaeum: Gates 1972: 125; Ljungström 1972a: 45.

Octolasion lacteum lacteum: Blakemore 2004a: 109.

Type locality: Hungary.

Description:

External: Body length 40–55 mm, width 3–4 mm. Number of segments 94–101. Prostomium epilobous. Preclitellar *cd* setae closely paired but postclitellar somewhat distantly paired. First dorsal pore in 10/11. Clitellum saddle-shaped, on 30–35, with distinct start and end. Tubercula pubertatis band-like, on 31–34 and 35. Female pore on 14. Male pores paired on 15, with large tumescens.

Internal: Gizzard in 17–18. Intestinal origin in 15. Holandric. Seminal vesicles in 9–12. Spermathecae in 9 and 10.

Material examined: 33 cl., 9 juv.: Woodland, small grass with bush near road (29°34.345'S 30°19.377'E), 7.i.2012, 1 cl., NMSA/Olig.06093; Indigenous Bush, big trees, wet soil, dense cover (29°34.151'S 30°19.263'E), 2996 ft, 22.ii.2012, 28 cl., 3 juv., NMSA/Olig.06119; Plantation, wattle & pine (29°33.655'S 30°18.919'E), 3106 ft, 23.ii.2012, 4 cl., 6 juv., NMSA/Olig.06124.

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-

TABLE 2

Occurrence of earthworms at Queen Elizabeth Park. Abbreviations: W – Woodland, L – Lawn, IB – Indigenous Bush, P – Plantation, MS – Mixed Scrub, G – Grassland.

Taxon	# collected	% of total	W	L	IB	P	MS	G
<i>Tritogenia howickiana</i>	44	3.9	x				x	x
<i>Pontoscolex corethrurus</i>	153	13.6	x		x			x
<i>Octolasion lacteum</i>	42	3.7	x		x	x		
<i>Dichogaster saliens</i>	5	0.4					x	
<i>Amyntas aeruginosus</i>	14	1.2		x	x		x	
<i>Amyntas corticis</i>	37	3.3	x	x	x	x		
<i>Amyntas gracilis</i>	43	3.8	x		x	x		x
<i>Amyntas minimus</i>	203	18.0	x	x	x	x	x	x
<i>Amyntas rodericensis</i>	388	34.4	x	x	x	x	x	x
<i>Amyntas juveniles</i>	198	17.6	x	x	x	x	x	x

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, Megasclolecidae, 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 *Amyntas 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). *Amyntas 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 bolau* 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

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.

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