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New records of earthworms (Oligochaeta) from Madagascar

M. RAZAFINDRAKOTO[1], CS. CSUZDI[2], S. RAKOTOFIRINGA[3] and E. BLANCHART[4]

Abstract. New records of earthworms from Madagascar are presented. This is the first taxonomic report on the earthworm fauna of Madagascar since the last paper of Michaelsen (1931). Altogether data on 14 peregrine earthworm species belonging to five families are summarized. Together with the native taxa, 33 valid earthworm species have so far been recorded from Madagascar of which 18 (55%) are endemic in the Island and 15 (45%) introduced.

INTRODUCTION

The first earthworm record from Madagascar is the enigmatic species *Acanthodrilus verticillatus* Perrier, 1872 (probably belongs to the endemic genus *Kynotus*). Several years later the German zoologist and traveller Dr. Conrad Keller published a natural history overview of the island including description of a new species, *Geophagus darwinii* Keller, 1887 (= *Kynotus darwini*) (Keller, 1887). Since these early records only a few papers dealt with the earthworm fauna of Madagascar, including two syntheses by Michaelsen (1897, 1907), and it was also Michaelsen (1931) who presented the last report on Malagasy earthworms. Since then, hardly any data were published on the earthworm fauna of Madagascar.

During this short period (between 1872 and 1931), 31 earthworm species were collected in Madagascar, belonging to six families including the endemic family Kynotidae with 13 valid species. Apart from the kynotids, the native fauna consists of the endemic genus *Howascolex* Michaelsen, 1901 of the family Octochaetidae (with a single described species), three endemic species belonging to the South African – South American – Australasian *Acanthodrilus* / *Eodriloides* / *Diplotrema* genus complex, and the doubtfully endemic *Gordiodrilus madagascariensis* Michaelsen, 1907 (Ocnerodrilidae).

In April 2008, a project entitled *Global Change and Diversity of Soil Macrofauna in Madagascar* (Faune-M) was launched. The main goal of this project is to explore the soil macrofauna of Madagascar in order to create a database and set up a museum collection for earthworms and other soil invertebrates (termites, Scarabaeoidea larvae). In this paper, we present the peregrine earthworm occurrences recorded during this project including three new records for the Island.

MATERIALS AND METHODS

Study area

The sites were selected by using the climate and soil data of Madagascar. Altogether 11 sites were selected all around Madagascar; however earthworms were also collected occasionally alongside the roads where it was possible. The samples were taken in various ecosystem types from highly degraded anthropogenic places to native forests (Fig. 1).

Methods

Earthworms were collected by using the diluted

[1]*Malalatiana Razafindrakoto,* Department of Animal Biology, University of Antananarivo, Madagascar and Laboratory of Radio-Isotopes, University of Antananarivo, Madagascar. E-mail: malalasraz@yahoo.fr

[2]*Dr. Csaba Csuzdi,* Systematic Zoology Research Group of Hungarian Academy of Sciences, and Hungarian Natural History Museum, Budapest, Baross str. 13, H-1088, Hungary.

[3]*Sylvère Rakotofiringa,* Department of Animal Biology, University of Antananarivo, Madagascar.

[4]*Dr. Eric Blanchart*, Institute of Research for Development (IRD), UMR Eco&Sols, 2 Place Viala, Montpellier, France.

formaldehyde method (Raw, 1957) combined with digging and hand-sorting. In several places the villagers did not allow us using formaldehyde because of taboo or other reasons, in such cases earthworms were collected only by digging.

Worms collected were killed in 50% alcohol and preserved either in 96% ethanol or 4% formaldehyde solution.

Samples were identified in the Laboratory of Functional Ecology and Biogeochemistry of Soils (UMR Eco&Sols) Montpellier, France and are deposited in the collection of the Zoological Museum of University of Antananarivo (ZMUA).

From several species, parallel materials are deposited in the earthworm collection of the Hungarian Natural History Museum, Budapest (HNHM AF) as well.

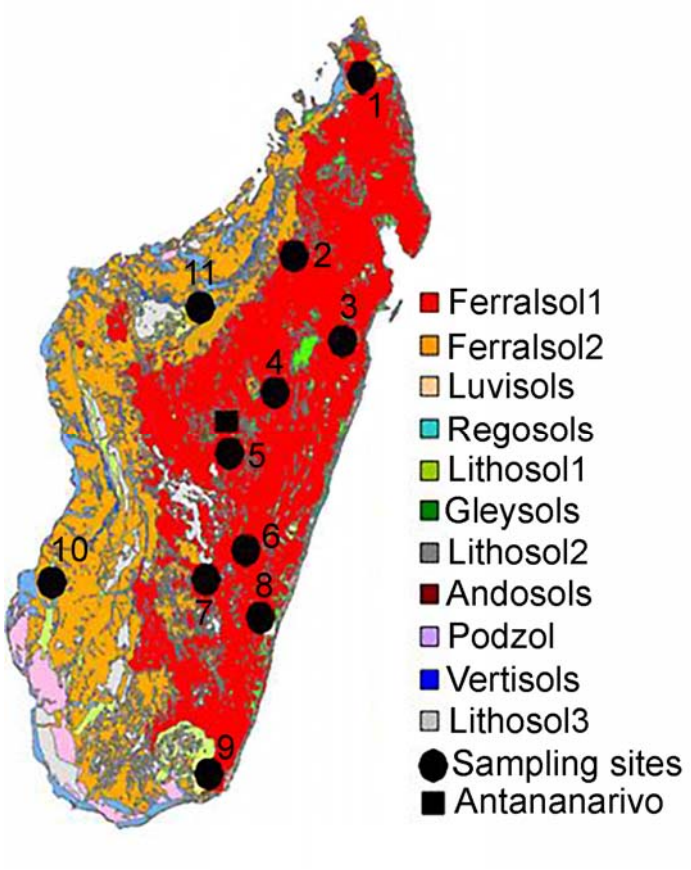

Figure 1. Sampling sites in Madagascar: *1* = Diego suerez, *2* = Sofia region, *3* = Fénérive East, *4* = Ambatondrazaka, *5* = Antsirabe, *6* = Ranomafana, *7* = Andrigitra, *8* = Atsimo Antsinanana region, *9* = Fort Dauphin, *10* = Morondava, *11* = Ankarafantsika (Majunga)

RESULTS

ACANTHODRILIDAE

Dichogaster (Diplothecodrilus) bolaui (Michaelsen, 1891)

Benhamia bolavi Michaelsen, 1891: 9., Michaelsen 1897: 224.

Dichogaster bolaui: Michaelsen 1900: 340., Michaelsen 1901: 205., Michaelsen 1907 46., Blakemore 2002: 108 (for complete synonymy.

Dichogaster (Diplothecodrilus) bolaui: Csuzdi 1996: 358., Csuzdi 2000: 60., Csuzdi, Pavlíček & Nevo 2008: 199.

Material examined. HNHM AF/5204 2 ex., AF/5206 1 ex. Andranomanelatra. Leg. Blanchart,

E. 2005., HNHM AF/5211 4 ex. Bemasoandro. Leg. Blanchart, E. 2005.

Previous records. Majunga (Michaelsen 1897), Andrahomana (Michaelsen 1901), Sakani, Tamatave, Ile aux Prunes (Michaelsen 1907).

Dichogaster (Diplothecodrilus) modiglianii (Rosa, 1896)

Benhamia modiglianii Rosa, 1896: 510.
Dichogaster modiglianii: Michaelsen 1900: 346., Blakemore 2002: 113 (for complete synonymy).
Dichogaster (Diplothecodrilus) modiglianii: Csuzdi 1996: 358., Csuzdi 2000: 65.

Material examined. ZMUA-019, 1 ex. Ankarafantsika Park. Leg. Razafindrakoto M., 11.12. 2008.

Remarks. *D. (Dt.) modiglianii* is a new record for the fauna of Madagascar.

Dichogaster (Diplothecodrilus) saliens (Beddard, 1893)

Microdrilus saliens Beddard, 1893a: 683.
Dichogaster saliens: Michaelsen 1900: 346., Blakemore 2002: 114 (for complete synonymy).
Dichogaster (Diplothecodrilus) saliens: Csuzdi 1996: 358.

Material examined. ZMUA-020, 2 ex. Ankarafantsika Parc, Antsirabe. Leg. Razafindrakoto, M. 06.01.2009., HNHM AF/5205 37 ex., AF/5207 5 ex. Andranomanelatra. Leg. Blanchart, E. 2005., HNHM AF/5208 1 ex., AF/5212 7 ex. Bemasoandro. Leg. Blanchart, E. 2005.

Remarks. *D. (Dt.) saliens* is a new record for the fauna of Madagascar.

EUDRILIDAE

Eudrilus eugeniae (Kinberg, 1867)

Lumbricus eugeniae Kinberg, 1967: 98.
Eudrilus eugeniae: Michaelsen 1900: 402., Michaelsen 1897. 238., Michaelsen 1907: 48., Blakemore 2008: 451 (for complete synonymy).

Material examined. ZMUA-018, 5 ex. Antsiradava, Andreba, compost. Leg. Razafindrakoto M., 26.11.2008., ZMUA-038, 9 ex. Mandritsara, compost. Leg. Razafindrakoto M., 09.11. 2009., ZMUA-043, 11 ex. Mandritsara, Post office. Leg. Razafindrakoto M., 09.11.2009.

Previous records. Nossi-Bé (Michaelsen 1897), Fénérivo, Tamatave, Sainte Marie (Ambodifotra) (Michaelsen 1907).

GLOSSOSCOLECIDAE

Pontoscolex corethrurus Müller, 1857

Lumbricus corethrurus Müller, 1857: 113.
Pontoscolex corethrurus: Michaelsen 1897: 250, Michaelsen 1900: 425., Michaelsen 1901: 205., Michaelsen 1907: 48., Blakemore 2008: 443 (for complete synonymy).

Material examined. ZMUA-021, 8 ex. Tampolo forest. Leg. Razafindrakoto M., 29.10.2008., ZMUA-044, 24 ex. Antanimanga, Mandritsara. Leg. Razafindrakoto M., 09.11.2009., ZMUA-048, 8 ex. Ankosihosilava. Bealanana. Leg. Razafindrakoto M., 05.11.2009. ZMUA-060, 27ex. Ankarafantsika park. Leg. Razafindrakoto M., 11. 12.2008., HNHM AF/5209 4 ex. Bemasoandro. Leg. Blanchart, E. 2005.

Previous records. N.-W- Madagascar, Nossi-Bé (Michaelsen 1897), Andrahomana (Michaelsen 1901), Sainte Marie (Ambodifotra and Sahasifotra), Fénérivo, Alaotra Lake, (Michaelsen 1907).

MEGASACOLECIDAE

Amynthas corticis (Kinberg, 1867)

Perichaeta corticis Kinberg, 1867: 102.
Perichaeta indica Horst, 1883: Michaelsen 1897: 226.
Pheretima indica: Michaelsen 1900: 275 (part?).
Pheretima heterochaeta (Michaelsen, 1891): Michaelsen 1901: 205., Cognetti 1906: 2., Michaelsen 1907: 44.
Amynthas corticis: Easton 1982: 726., Blakemore 2008: 273 (for complete synonymy).

Material examined. ZMUA-002, 7. ex. Antananivo, Ankarafantsika. Leg. Razafindrakoto M., 10.12.2008., ZMUA-034, 7 ex. Montsaborymena, Leg. Razafindrakoto M., 05.11.2009., ZMUA-040, 5 ex. Antanimanga, Mandritsara. Leg. Razafindrakoto M., 09.11.2009., ZMUA-045, 3 ex.

Analakivoho, Bealanana. Leg. Razafindrakoto M., 06.11.2009.11.06., ZMUA-046, 23 ex. Ankosihosilava, Bealanana. Leg. Razafindrakoto M., 05.11. 2009., ZMUA-047, 15 ex. Mantsaborimena II & III. Leg. Razafindrakoto M., 05.11.2009

Previous records. Antananarivo (Michaelsen 1897), Andrahomana (Michaelsen 1901), Moramanga, Ankarahara (Cognetti, 1906); Fianarantsoa, Alaotra-See, Ikongo (Michaelsen 1907).

Amynthas robustus (Perrier, 1872)

Perichaeta robusta Perrier, 1872: 112.
Pheretima robusta: Michaelsen 1900: 299., Michaelsen 1907: 44.
Amynthas robustus: Sims & Easton 1972: 234., Blakemore 2008: 314 (for complete synonymy).

Material examined. ZMUA-005 13 ex. Fénérive Est, Andreba. Leg. Razafindrakoto M., 26.11. 2008., ZMUA-055, 13 ex. Andreba., Leg. Razafindrakoto M, 26.11.2008, ZMUA-057, 3 ex, Ambatosoratra. Leg. Razafindrakoto M., 26.11. 2008.

Previous record. Sainte Marie (Michaelsen 1907).

Amynthas rodericensis (Grube, 1879)

Perichaeta rodericensis Grube, 1879: 554.
Perichaeta dyeri Beddard, 1892: Michaelsen 1897: 230.
Pheretima rodericensis: Michaelsen, 1900: 299., Michaelsen 1907: 44.
Amynthas rodericensis: Sims & Easton, 1972: 235., Blakemore 2008: 318 (for complete synonymy).

Material examined. ZMUA-012 10 ex. Tampolo. Leg. Razafindrakoto, M., 28.10.2008., ZMUA-036, 8 ex. Tanambe sud, Leg. Razafindrakoto, M., 12.03.2010.

Previous records. Nossi-Bé (Michaelsen 1897), Sainte Marie, Fénérive (Michaelsen 1907).

Lampito mauritii Kinberg, 1867

Lampito mauritii Kinberg, 1867: 103., Blakemore 2008: 237 (for complete synonymy)
Megascolex mauritii: Michaelsen, 1900: 227., Michaelsen 1897: 225., Michaelsen 1907: 44.
Megascolex armatus (Beddard, 1883): Michaelsen 1897: 224.

Material examined. ZMUA-007 5 ex., Antananivo Ankarafantsika. Leg. Razafindrakoto M., 10.12.2008., ZMUA-050, 22 ex. Ambodimanga, Ankarafantsika. Leg. Razafindrakoto M., 09.12. 2008., ZMUA-051, 4 ex. Ankarafantsika Park. Leg. Razafindrakoto M., 11.12.2008., ZMUA-052, 5 ex. Tampolo/Bemailaka compost. Leg. Razafindrakoto M., 10.12.2008., ZMUA-033, 8 ex. Allée de baobab. Leg. Razafindrakoto M., 10.02.2010.

Previous records. N.-W. Madagascar (Michaelsen 1897), Tamatave (Michaelsen 1907).

Metraphire houlleti (Perrier, 1872)

Perichaeta houlleti Perrier, 1872: 99., Michaelsen 1897: 234.
Pheretima houlleti: Michaelsen, 1900: 273., Blakemore 2002: 201 (for complete synonymy).

Material examined. ZMUA-006, 2 ex. Antananivo, Ankarafantsika. Leg. Razafindrakoto M., 10.12.2008., ZMUA-037, 4 ex. Antanambe sud. Leg. Razafindrakoto M., 12.03.2010.

Previous record. Nossi-Bé (Michaelsen 1897)

Perionyx excavatus Perrier, 1872

Perionyx excavatus Perrier, 1872: 126., Michaelsen, 1900: 208., 43., Blakemore 2002: 133 (for complete synonymy).
Perionyx sp. Michaelsen 1897: 225.

Material examined. ZMUA-022, 1 ex. Tampolo village, Leg. Razafindrakoto M., 30.10. 2008.

Previous records. Farandrana (Michaelsen 1897); Alaotra-See, Fénérivo, (Michaelsen 1907)

Polypheretima elongata (Perrier, 1972)

Perichaeta elongata Perrier, 1872: 124.
Perichaeta biserialis Perrier, 1875: Michaelsen 1897: 226.

Material examined. ZMUA-015, 4 ex Mahavanona/Fénérive Est. Leg. Razafindrakoto M., 31. 10.2008., ZMUA-032, 1 ex. Antatatra. Leg. Razafindrakoto M., 06.11.2009., ZMUA-039, 9 ex. Mandritsara, compost. Leg. Razafindrakoto M.,

09.11.2009., ZMUA-041, 18 ex. Antatatra, Mandritsara. Leg. Razafindrakoto M., 08.11.2009., ZMUA-042, 27 ex. Mandritsara, post office. Leg. Razafindrakoto M., 09.11.2009.

Previous records. Madagascar (Michaelsen, 1897).

***Polypheretima taprobane* (Beddard, 1892)**

Perichaeta taprobanae Beddard, 1892: 163.
Pheretima taprobanae: Michaelsen, 1900: 308., Michaelsen 1907: 46.

Material examined. ZMUA-017, 1 ex. Tampolo forest. Leg. Razafindrakoto, M., 29.10. 2008.

Previous record. Sainte Marie, Sahasifotra (Michaelsen 1907).

OCNERODRILIDAE

***Nematogenia lacuum* (Beddard, 1893)**

Pygmaeodrilus lacuum Beddard, 1893b: 259.
Nematogenia lacuum: Michaelsen 1900: 376.

Material examined. ZMUA-009, 4 ex. Andreba. Leg. Razafindrakoto, M., 26.11.2008.

Remarks. *N. lacuum* is a new record for the fauna of Madagascar.

DISSCUSSION

The separation of Madagascar from Africa and the formation of the Mozambique channel goes back to 170 Mya and the subsequent isolation of the island from India took place around 80–90 Mya. Since that time Madagascar has not been connected to any other landmasses, which has allowed it to evolve a unique flora and fauna. Consequently, Madagascar and the surrounding islands in the Indian Ocean constitute one of the 25 biodiversity hotspots in the world with extremely high endemism rates; 60% of the birds, 90% of the mammals, 96% of the reptiles and 90% of the flora are endemic in the island.

Among the 33 valid earthworm species reported so far, 18 (55%) seem to be endemic in Madagascar and 15 (45%) are introduced, however there are numerous native acanthodrilid and kynotid species waiting for description which substantially will increase the rate of endemic worms.

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