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DIVERSITY OF EARTHWORMS (ANNELIDA: OLIGOCHAETA) IN KONNI, A PART OF THE WESTERN GHATS OF KERALA, INDIA.

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ABSTRACT

The survey study on earthworms of Konni, a part of Western Ghats of Kerala, India revealed the presence of 13 species belonging to five families. One endemic species *Megascolex polytheca uniuquus*, and two near endemic species *Moniligaster deshayesi* and *Glyphidrilus annandalei* were found confined to the natural forest ecosystems of Konni, whereas the other endemics namely *Drawida ghatensis* and *Megascolex travancorensis bonaccordensis* were recorded from forest, teak and rubber plantations as well as home gardens. Native peregrine species includes *Megascolex konkanensis* and *Perionyx excavatus* which are widespread in distribution and *Octochaetona beatrix* was recorded from a single location along the banks of Achenkovil River. Exotic species identified in the area includes *Pontoscolex corethrurus*, *Metaphire houlleti*, *Dichogaster affinis* and *Amyntas alexandri*. Present study lead to the rediscovery of *Megascolex travancorensis bonaccordensis* after over a century of its original description.

Key Words: India, Kerala, Pathanamthitta, Kollam, Oligochaeta, Rhinodrilidae, exotic, peregrine, rediscovery, *Megascolex travancorensis bonaccordensis*.

സംഗ്രഹം

കേരളത്തിലെ പശ്ചിമഘട്ട മലനിരകളുടെ ഒരു ഭാഗമായ കോന്നിയിലെ മണ്ണിരകളെക്കുറിച്ചുള്ള പഠനത്തിൽ അഞ്ചു കുടുംബത്തിൽ പെട്ട 13 സ്ത്രീഷിസുകളെ കണ്ടെത്തി. ദേശ്യ ജാതിയായ *Megascolex polytheca uniuquus*, കേരളം കൂടാതെ സമീപ സംസ്ഥാനങ്ങളിലും കാണപ്പെടുന്ന *Moniligaster deshayesi* ഉം *Glyphidrilus annandalei* എന്നിവ കോന്നിയിൽ കാടുകളിൽ മാത്രമാണ് കാണപ്പെടുന്നത്. *Drawida ghatensis*, *Megascolex travancorensis bonaccordensis* തുടങ്ങിയവ കാടുകൾ കൂടാതെ, റബ്ബർ, തേക്കു തോട്ടങ്ങൾ, മനുഷ്യ ആവാസ മേഖലകളിലും കാണപ്പെട്ടു. ഇന്ത്യയിൽ വ്യാപകമായി കാണപ്പെടുന്ന മണ്ണിരകളായ *Megascolex konkanensis*, *Perionyx excavatus* തുടങ്ങിയവ കോന്നിയിലും ധാരാളമായി കാണപ്പെടുന്നു എന്നിരുന്നാലും *Octochaetona beatrix* എന്ന ഇനത്തെ ഒരു സ്ഥലത്തു നിന്ന് മാത്രമേ കണ്ടെത്തിയുള്ളൂ. *Pontoscolex corethrurus*, *Metaphire houlleti*, *Dichogaster affinis*, *Amyntas alexandri* തുടങ്ങിയവയാണ് കോന്നിയിൽ സ്ഥിരവാസികളായി മാറിയ വിദേശ മണ്ണിരകൾ. *Megascolex travancorensis bonaccordensis* എന്ന ഇനം മണ്ണിര ഒരു നൂറ്റാണ്ടിനു മുൻപ് തിരുവനന്തപുരത്തെ ബോണക്കാട് നിന്നും കണ്ടെത്തി വിവരണം ചെയ്യപ്പെട്ടതാണ്. അതിനുശേഷം അവയെ ആദ്യമായി കണ്ടെത്തുന്നത് ഈ പഠനത്തിൽ ആണ്.

പ്രധാന പദങ്ങൾ: കേരളം, പത്തനംതിട്ട, കൊല്ലം, ഒലിഗോകീറ്റ, റെയ്നോഡ്രില്ലിടെ, എക്സോട്ടിക്, പെരിഗ്രിൻ, റീഡിസ്കവറി, *Megascolex travancorensis bonaccordensis*

RÉSUMÉ

L'étude sur les vers de terre de Konni, une partie des Ghâts occidentaux du Kerala, en Inde, a révélé la présence de 13 espèces appartenant à cinq familles. Une espèce endémique, *Megascolex polytheca uniuus*, et deux espèces quasi-endémiques, *Moniligaster deshayesi* et *Glyphidrilus annandalei*, ont été trouvées confinées aux écosystèmes forestiers naturels de Konni, tandis que les autres espèces endémiques, *Drawida ghatensis* et *Megascolex travancorensis bonaccordensis*, ont été observées dans des plantations forestières de teck et de caoutchouc ainsi que dans des jardins potagers. Les espèces pèlerinères indigènes comprennent *Megascolex konkanensis* et *Perionyx excavatus* qui sont très répandues. *Octochaetona beatrix* a été observée à 'un seul endroit le long des rives de la rivière Achenkovil. Les espèces exotiques identifiées dans la région comprennent *Pontoscolex corethrurus*, *Metaphire houlleti*, *Dichogaster affinis* et *Amyntas alexandri*. La présente étude a conduit à la redécouverte de *Megascolex travancorensis bonaccordensis* après plus d'un siècle de sa description originale.

Mots-clé: Inde, Kerala, Pathanamthitta, Kollam, Oligochaeta, Rhinodrilidae, exotique, pèlerin, redécouverte, *Megascolex travancorensis bonaccordensis*.

RESUMEN

El estudio sobre lombrices de tierra de Konni, una parte de Western Ghats of Kerala, India, reveló la presencia de 13 especies pertenecientes a cinco familias. Una especie endémica, *Megascolex polytheca uniuus*, y dos especies casi endémicas, *Moniligaster deshayesi* y *Glyphidrilus annandalei*, se encontraron confinadas a los ecosistemas forestales naturales de Konni, mientras que las otras endémicas, *Drawida ghatensis* y *Megascolex travancorensis bonaccordensis*, también se registraron en plantaciones forestales, de teca y de caucho así como jardines caseros. Las especies nativas peregrinas incluyen *Megascolex konkanensis* y *Perionyx excavatus*, que están ampliamente distribuidas y *Octochaetona beatrix* se registró solamente a lo largo de las orillas del río Achenkovil. Las especies exóticas identificadas en el área incluyen *Pontoscolex corethrurus*, *Metaphire houlleti*, *Dichogaster affinis* y *Amyntas alexandri*. El presente estudio condujo al redescubrimiento de *Megascolex travancorensis bonaccordensis* después de más de un siglo de su descripción original.

Palabras clave: India, Kerala, Pathanamthitta, Kollam, Oligochaeta, Rhinodrilidae, exótico, peregrino, redescubrimiento, *Megascolex travancorensis bonaccordensis*.

ZUSAMMENFASSUNG

Die Vermessungsstudie über Regenwürmer von Konni, einem Teil von Western Ghats of Kerala, Indien, zeigte die Anwesenheit von 13 Arten, die zu fünf Familien gehören. Eine endemische Art, *Megascolex polytheca uniuus* und zwei nahe endemische Arten, *Moniligaster deshayesi* und *Glyphidrilus annandalei*, wurden in den natürlichen Waldökosystemen von Konni gefunden, während die anderen endemischen Arten, nämlich *Drawida ghatensis* und *Megascolex travancorensis bonaccordensis*, auch in Wald-, Teak- und Kautschukplantagen nachgewiesen wurden als Hausgärten. Zu den einheimischen Wanderfalken gehören *Megascolex konkanensis* und *Perionyx excavatus*, die im Verbreitungsgebiet weit verbreitet sind, und *Octochaetona beatrix* wurde an einem einzigen Ort entlang des Achenkovil-Flusses registriert. Exotische Arten, die in diesem Gebiet identifiziert wurden, sind *Pontoscolex corethrurus*, *Metaphire houlleti*, *Dichogaster affinis* und *Amyntas alexandri*. Die vorliegende Studie führte zur Entdeckung von *Megascolex travancorensis bonaccladensis* nach über einem Jahrhundert ihrer ursprünglichen Beschreibung.

Schlüsselwörter: Indien, Kerala, Pathanamthitta, Kollam, Oligochaeta, Rhinodrilidae, exotisch, Wanderfalken, Wiederentdeckung, *Megascolex travancorensis bonaccordensis*.

INTRODUCTION

Earthworms are important biological resources that have a tremendous potential in agro-ecosystems, because they significantly affect soil physical structures and organic matter dynamics, and promote plant growth (Lee, 1985; Lavelle, 1988). At present more than 6000 species have been described; among these around 3000–3,500 are valid (Csuzdi, 2012) and about 150 species are considered as peregrine on a global scale

(Blakemore, 2012). The regional earthworm biodiversity and species dispersal patterns are influenced by a variety of biotic and abiotic factors such as soil properties, surface vegetation type and dynamics, local or regional climate, and other anthropogenic factors (Suthar, 2011). As well, the species diversity and earthworm community structure are significantly influenced by land-use and land-cover changes (Blanchart and Julka, 1997; Bhaduria and Ramakrishnan, 2005).

Previously, 423 species of earthworms have been recorded from India (Julka, 2014; Ahmed and Julka, 2017; Narayanan *et al.*, 2017). Endemism, both at the generic and species level, is very high in India. The Western Ghats and Western coastal plains are recognized as the regions with the highest level of earthworm species richness in the country (Julka and Paliwal, 2005). Earthworm diversity, community structure and distribution patterns across the tropical parts of the world are not well documented currently, hence little is known about the regional taxonomic richness of the earthworms in these regions (Blanchart and Julka, 1997; Senapati, 1980; Suthar, 2011). The great variety of vegetation types, coupled with high rainfall, moderate temperature and altitudinal variation provide many different niches, which made Kerala a cradle of high earthworm diversity (Narayanan *et al.*, 2016a). Taxonomic studies of the earthworms of the state of Kerala began with the description of *Drawida nilamburensis* by Alfred G. Bourne (1894). Later Fedarb (1897), Michaelsen (1910), Aiyer (1929), Gates (1940), Julka and Chandra (1986), Julka *et al.* (1997), Nair *et al.* (2007), Narayanan *et al.* (2017) *etc.* contributed to the taxonomic studies of the earthworm fauna of the state. The Konni area of the Kerala state is an integral part of the Western Ghats, but no information is available on the earthworm fauna of this region. Hence, the present study was undertaken to look into the earthworm diversity of this unique region.

MATERIAL AND METHODS

Study area

The Konni Forest Division falls under Karunagappally and Pathanapuram Taluks of Kollam District and portions of Kozhencherry and Adoor Taluks of Pathanamthitta District (Fig. 1). The division area lies between 9°3' and 9°15' North latitude and 76°4' and 77°6' East longitude. The forest tracts form part of the Western Ghats and are situated mainly on its western slopes. The elevation varies from 60 m (plains) to 997 m. The area receives an average rainfall of 3464 mm from both the South-West monsoon (June to mid August), and the North-East monsoon (mid September to mid November).

Sample collection and preservation

Earthworm sampling was done in 56 randomly selected locations within the Konni Forest Division from May 2015 to November 2017. The selected land-use types are natural forest, teak, rubber plantations, and home gardens. Earthworms were collected following the

digging and hand sorting method (Julka, 1990). The collected earthworm specimens were washed and preserved in 5 % formalin for taxonomic identification. Anatomical details were examined under stereo-zoom binocular microscope. Specimens collected were identified with the help of standard references such as Stephenson (1923), Gates (1972), Julka (1988) and other publications. Collected specimens were identified and deposited in the earthworm systematics laboratory of the Advanced Centre of Environmental Studies and Sustainable Development, Mahatma Gandhi University, Kottayam District, Kerala, India.

RESULTS

Thirteen species of earthworms belonging to five families (*viz.*, Moniligastridae, Almididae, Rhinodrilidae, Octochaetidae and Megascolecidae) were recorded from the Konni region. Species identified are: *Drawida ghatensis* Michaelsen, 1910, *Moniligaster deshayesi* Perrier, 1872, *Glyphidrilus annandalei* Michaelsen, 1910, *Pontoscolex corethrurus* (Müller, 1857), *Dichogaster affinis* (Michaelsen, 1890), *Octochaetona beatrix* (Bedard, 1902), *Amyntas alexandri* (Bedard, 1901), *Megascolex konkanensis konkanensis* Fedarb, 1898, *Megascolex polytheca uniuquus* Aiyer 1929, *Megascolex ratus* Cognetti, 1911, *Megascolex travancorensis bonaccordensis* Michaelsen, 1913, *Metaphire houlleti* (Perrier, 1872) and *Perionyx excavatus* Perrier, 1872. Megascolecidae is the most dominant family in the study area, represented by seven species followed by Moniligastridae and Octochaetidae groups with two species each and finally the Almididae and Rhinodrilidae group with one species each. A major portion of the species identified belong to the endogeic ecological category, which have a very important role in soil nutrient dynamics. Among the species recorded *Drawida ghatensis*, *Megascolex travancorensis bonaccordensis*, and *Megascolex polytheca uniuquus* are endemic and species such as *Moniligaster deshayesi*, *Megascolex ratus* and *Glyphidrilus annandalei* are near-endemic species. The last three species are confined only to the forests of the region. Species such as *Pontoscolex corethrurus*, *Metaphire houlleti*, *Amyntas alexandri* and *Dichogaster affinis* are naturalized exotic species. It is interesting to note that the native peregrine earthworm, *Perionyx excavatus* was confined only to the rubber plantations and home gardens in Konni. *Octochaetona beatrix* was recorded from a single location along the bank of the Achenkovil River.

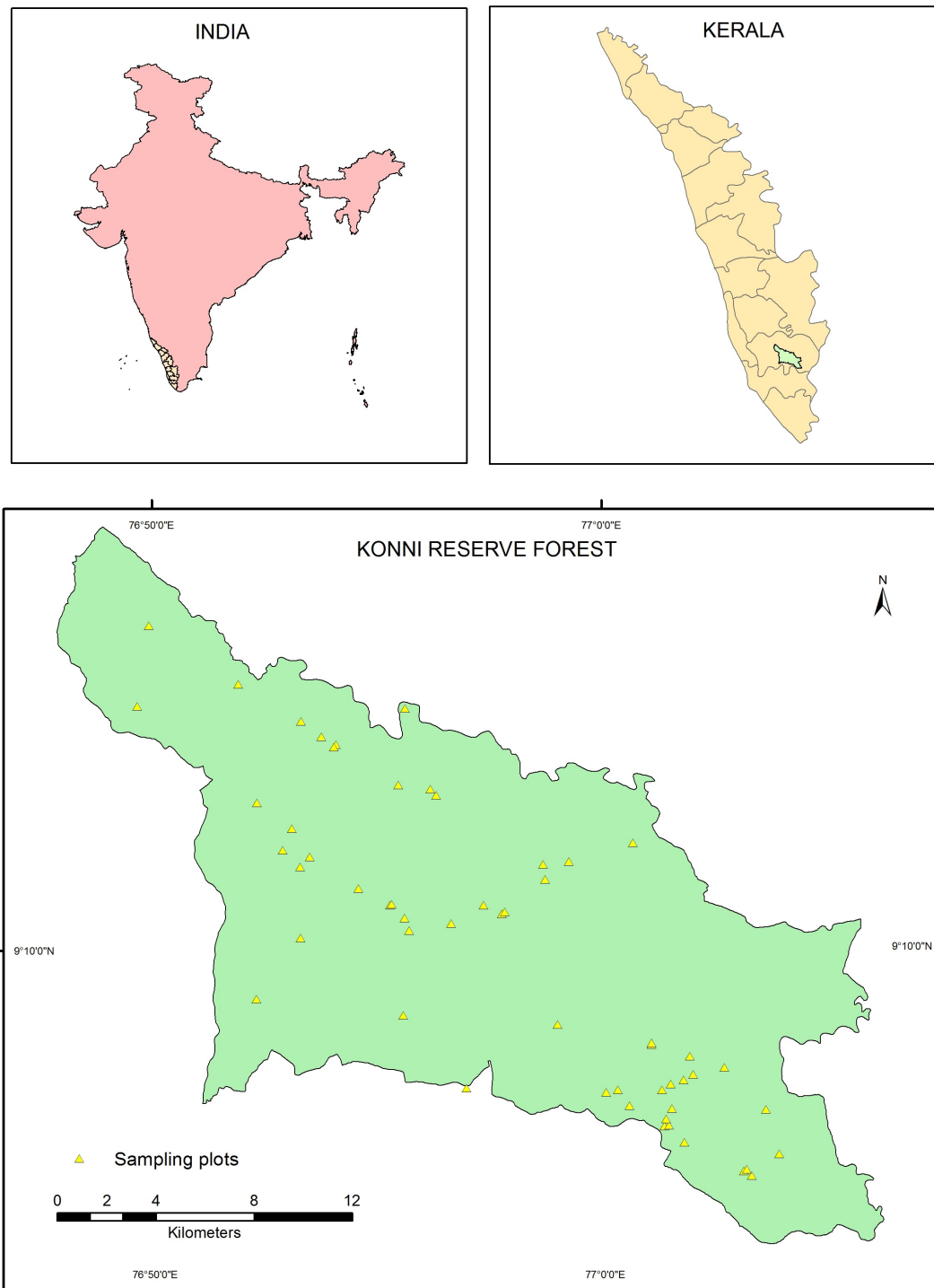


Figure 1. Map showing the sampling locations in Konni Reserve Forest.

Family Moniligastridae

1. *Drawida ghatensis* Michaelsen, 1910

1910. *Drawida ghatensis* Michaelsen, Abh. Ver. Hamb. 19(5): 52; ZMUH 3596. [types from Reynolds and Wetzel, 2018]

Diagnosis: Setae lumbricine; prostomium prolobic; clitellum 10–13; spermathecal pore paired, large transverse slits in intersegmental furrow 7/8, in *C* setal line; male pores paired in intersegmental furrow 10/11, tumescences present, slightly anterior and posterior to the male pores; gizzards 5 in 14–18; testis sac paired; vas deferens coiled in mass of hairpin loops; prostates paired, mushroom shaped (from the side), glandular, shortly stalked, erect and prostatic capsule ovoid; spermathecae paired in segment 8, ampulla pear-shaped, duct pierces through the septum 7/8 to enter on the dorsal surface at about centre of the atrium in 7, atrium oval, sessile slightly projecting into 8; genital markings absent.

Material examined: **0-0-5¹**, (ACESSD/EW/492), Orekar, Pathanamthitta Dist., Kerala (N 9°10'33.9", E 76°56'36.6"), asl² 46 m, home garden, 03 May 2015, coll. S. Sathrumithra and J.K. Joseph; **0-0-2**, (ACESSD/EW/590), Pinangathodu, Pathanamthitta Dist., Kerala (N 9°13'37.4", E 76°55'26.8"), asl 105 m, teak plantation, 10 June 2016, coll. S. Sathrumithra; **0-1-0**, (ACESSD/EW/661), Kalleli, Pathanamthitta Dist., Kerala (N 9°12'3.0", E 76°53'28.2"), asl 45 m, rubber plantation, 23 August 2016, coll. S. Sathrumithra; **0-2-0**, (ACESSD/EW/696), Njaloore, Pathanamthitta Dist., Kerala (N 9°15'2.7", E 76°53'17.6"), asl 385 m, home garden, 27 October 2016, coll. S. Sathrumithra; **0-2-0**, (ACESSD/EW/698), Kakkara, Pathanamthitta Dist., Kerala (N 9°14'28.2", E 76°54'01.1"), asl 365 m, teak plantation, 28 October 2016, coll. S. Sathrumithra; **0-1-0**, (ACESSD/EW/699), Aruvapulam, Pathanamthitta Dist., Kerala (N 9°12'12.1", E 76°52'52.3"), 62 m, home garden, 28 October 2016, coll. S. Sathrumithra; **0-1-0**, (ACESSD/EW/798), Charupara, Kollam Dist., Kerala (N 9°05'25.7", E 77°03'52.1"), asl 266 m, semi evergreen forest, 18 August 2017, coll. S. Sathrumithra and V.T. Kurien; **0-0-3**, (ACESSD/EW/802), Kurichi, Pathanamthitta Dist., Kerala (N 9°12'17.8", E 77°00'36.3"), asl 534 m, evergreen forest, 31 August 2017, coll. S. Sathrumithra.

Remarks: Endemic to Kerala (Narayanan *et al.*, 2016a).

¹ age classification formula: the series of numbers following the species' name separated by dashes indicates the number of juveniles-acitellate adults-clitellate adults.

² asl = (altitude) above sea level.

2. *Moniligaster deshayesi* Perrier, 1872

1872. *Moniligaster deshayesi* Perrier, N. Arch. Mus. Paris 8: 130. [types unknown from Reynolds and Wetzel, 2018]

Diagnosis: Setae lumbricine; clitellum 10–13, intersegmental furrows distinct; male pores in 10/11, between *B* and *C* setal lines; female pores are in 11/12 in *ab*; spermathecal pores in 7/8 in *CD* setal lines; gizzards 5, from 15–19; prostate glandular, long, prostatic capsule rod-like; vas deferens long with numerous leaflet like bodies.

Material examined: **0-0-4**, (ACESSD/EW/488), Kurichi, Pathanamthitta Dist., Kerala (N 9°12'17.8", E 77°00'36.3"), asl 534 m, evergreen forest, 03 May 2015, coll. S. Sathrumithra, J.K. Joseph and A. Sasi; **0-1-0**, (ACESSD/EW/794), Njandukombu, Kollam Dist., Kerala (N 9°06'25.1", E 77°03'34.6"), asl 146 m, semi evergreen forest, 18 August 2017, coll. S. Sathrumithra and V.T. Kurien; **0-1-3**, (ACESSD/EW/748), Charupara, Kollam Dist., Kerala (N 9°05'25.7", E 77°03'52.1"), asl 266 m, semi evergreen forest, 04 May 2017, coll. S. Sathrumithra and V.T. Kurien.

Remarks: Near endemic to Kerala (Narayanan *et al.*, 2016a).

Family Almididae

3. *Glyphidrilus annandalei* Michaelsen, 1910

1910. *Glyphidrilus annandalei* Michaelsen, Abh. Ver. Hamb. 19(5): 101; ZMUH 3600, 3601, 3607; lectotype - ZMUH V3600, paralectotype - ZMUH V3600.1. [types from Reynolds and Wetzel, 2018]

Diagnosis: Setae lumbricine, widely paired as far as 12; prostomium zygalobous; clitellum ring shaped, 17/18–36, wings run from 25, 27, 28–32, 33, wing ridges are bent downwards somewhat towards the body wall; male pores are two point like depressions in 29/30; spermathecal pores in groups of one to six, with the arrangement characteristic of the genus; septa 6/7–11/12 thickened; gizzard in segment 8, fairly large, anterior end apparently getting into 7; last pair of heart in 11; prostates apparently absent; ovisacs may be present in 14; spermathecae simple, thickly pear shaped or spherical, with short and narrow stalk, sessile in appearance, the duct being embedded in the body wall.

Material examined: **0-4-7**, (ACESSD/EW/752); Kurichi, Pathanamthitta Dist., Kerala (N 9°12'17.8", E 77°00'36.3"), asl 534 m, sides of water logged pond in evergreen forest, 16 May 2017, coll. S. Sathrumithra.

Remarks: Near endemic to Kerala (Narayanan *et al.*, 2016a).

Family Rhinodrilidae

4. *Pontoscolex corethrurus* (Müller, 1857)

1857. *Lumbricus corethrurus* Müller, *Pontoscolex*, *Eurydame*, *Urochaeta*, *Titanus*; Abh. Naturg. Ges. Halle 4: 26. [types unknown from Reynolds and Wetzel, 2018]

Diagnosis: Setae lumbricine at the anterior portion and gradually irregular and becoming quincunx towards the posterior end; dorsal pore absent; clitellum saddle shape, 14, 15–22, tubercula pubertatis longitudinal bands in 18–21.

Material examined: **0-0-5**, (ACCESSD/EW/491), Orekar, Pathanamthitta Dist., Kerala (N 9°10'33.9", E 76°56'36.6"), asl 46 m, home garden, 03 May 2015, coll. S. Sathrumithra and J.K. Joseph; **0-0-7**, (ACCESSD/EW/587), Thanithodumoozhy, Pathanamthitta Dist., Kerala (N 9°15'19.0", E 76°55'36.4"), asl 94 m, semi evergreen forest, 10 June 2016, coll. S. Sathrumithra; **0-0-1**, (ACCESSD/EW/659), Karakakuzhy, Pathanamthitta Dist., Kerala (N 9°08'54.5", E 76°52'16.2"), asl 100 m, home garden, 21 August 2016, coll. S. Sathrumithra; **0-2-1**, (ACCESSD/EW/660), Chengara, Pathanamthitta Dist., Kerala (N 9°17'10.6", E 76°49'55.2"), asl 165 m, home garden, 21 August 2016, coll. S. Sathrumithra; **0-1-0**, (ACCESSD/EW/683), Kalleli, Pathanamthitta Dist., Kerala (N 9°12'3.0", E 76°53'28.2"), asl 45 m, rubber plantation, 23 August 2016, coll. S. Sathrumithra; **0-5-8** (ACCESSD/EW/690), Kummanoor, Pathanamthitta Dist., Kerala (N 9°13'15.1", E 76°52'18.5"), asl 33 m, home garden, 26 October 2016, coll. S. Sathrumithra; **0-3-6**, (ACCESSD/EW/694), Vettoor, Pathanamthitta Dist., Kerala (N 9°15'23.7", E 76°49'39.3"), asl 23 m, home garden, 26 October 2016, coll. S. Sathrumithra; **0-2-2**, (ACCESSD/EW/697), Chempanaruvi, Kollam Dist., Kerala (N 9°07'51.8", E 77°01'2.6"), asl 47 m, stream side with riparian vegetation, 28 October 2016, coll. S. Sathrumithra; **0-0-10**, (ACCESSD/EW/700), Aruvapulam, Pathanamthitta Dist., Kerala (N 9°12'12.1", E 76°52'52.3"), asl 62 m, home garden, 28 October 2016, coll. S. Sathrumithra; **0-0-12**, (ACCESSD/EW/793), Sahyaseema, Kollam Dist., Kerala (N 9°06'48.5", E 77°00'02.0"), asl 183 m, rubber plantation, 17 August 2017, coll. S. Sathrumithra and V.T. Kurien; **0-5-4**, (ACCESSD/EW/814), Manneera, Pathanamthitta Dist., Kerala (N 9°15'4.2", E 76°55'32.6"), asl 89 m, teak plantation, 29 September 2017, coll. S. Sathrumithra; **0-0-6**, (ACCESSD/EW/817), Padam, Pathanamthitta Dist., Kerala (N 9°08'32.0", E 76°55'31.9"), asl 52 m, semi evergreen forest, 01 September 2017, coll. S. Sathrumithra; **0-0-3**, (ACCESSD/EW/818), Kadiyar, Kollam Dist., Kerala (N

9°10'24.7", E 76°55'40.6"), asl 55 m, teak plantation, 01 September 2017, coll. S. Sathrumithra; **0-3-8**, (ACCESSD/EW/819), Kokkathodu, Pathanamthitta Dist., Kerala (N 9°11'51.4", E 76°58'39.2"), asl 103 m, rubber plantation, 01 September 2017, coll. S. Sathrumithra and A. Sasi; **0-0-2**, (ACCESSD/EW/823), Chem-pala, Kollam Dist., Kerala (N 9°07'36.2", E 77°01'54.0"), asl 53 m, stream side with riparian vegetation, 16 September 2017, coll. S. Sathrumithra, J.K. Joseph and V.T. Kurien.

Remarks: Exotic (Narayanan *et al.*, 2016a, 2016b), cosmopolitan species (Blakemore, 2012), indigenous to Guyanan Shield region (Righi, 1984) of the Neotropics.

Family Octochaetidae

5. *Dichogaster affinis* (Michaelsen, 1890)

1890. *Benhamia affinis* Michaelsen, *Dichogaster*; Mitt. Mus. Hamb. 7: 9; ZMUH 303. [types from Reynolds and Wetzel, 2018]

Diagnosis: Length 30-32; setae lumbricine, closely paired; prostomium epilobous; first dorsal pore at intersegmental furrow 5/6; clitellum saddle-shaped, 13/14–21/22; prostatic pores, two pairs, on 17 and 19, in line ab setal line; seminal grooves almost straight, each included by a whitish wall, which also includes the prostatic pores; spermathecal pores two pairs, in line with setae a; gizzards in 6 and 7; calciferous glands three pairs, kidney-shaped, in 15–17, the most anterior the smallest; prostates straight; spermathecae with very thick, fairly long duct, which bears immediately below its middle a small club-shaped diverticulum; penial setae thin, gently undulating, with knob like distal end.

Material examined: **0-0-7**, (ACCESSD/EW/490), Orekar, Pathanamthitta Dist., Kerala (N 9°10'33.9", E 76°56'36.6"), asl 46 m, home garden, 03 May 2015, coll. S. Sathrumithra and J.K. Joseph.

Remarks: Exotic (Narayanan *et al.*, 2016a), cosmopolitan species (Blakemore, 2012).

6. *Octochaetona beatrix* (Beddard, 1902)

1902. *Octochaetus beatrix* Beddard, *Octochaetona*; Proc. Zool. Soc. London, 1902, p. 456; BMNH 1904: 10:5:242. [types from Reynolds and Wetzel, 2018]

Diagnosis: Setae perichaetine; prostomium epilobous; first dorsal pore at intersegment 12/13; clitellum annular, covering segments 13–16, 17, 18, setae retained, furrows obscured; male genital field slightly depressed; male pores minute, at or just median to A

setal line; prostatic pores minute, median to *A*; seminal grooves concave between setal arcs of segments 16 and 19; female pores paired; spermathecal pores minute, on or slightly anterior to the setal arcs of segments 8 and 9; combined male and prostatic pores superficial on segment 18; female pore single at middle of segment 14; discrete genital markings absent, but paired oval to circular slightly thickened areas present, lateral to seminal grooves, on segments 18 and 19; septa 4/5, 8/9–11/12 muscular, 5/6/7/8 absent; gizzard between septa 4/5 and 8/9; intestine begins in 16 or 17; typhlosole, large bifid lamelliform; metandric; penial setae ornamented with sparse triangular teeth; spermathecae two pairs, each with a spheroidal, shortly pyriforme, oval or flattened and shelf-like, diverticulum shortly stalked, iridescent.

Material examined: **0-0-1**, (ACCESSD/EW/822), Chempala, Kollam Dist., Kerala (N 9°07'36.2", E 77°01'54.0"), asl 53 m, stream side with riparian vegetation, 16 September 2017, coll. S. Sathrumithra, J.K. Joseph and V.T. Kurien.

Remarks: Native peregrine (Narayanan *et al.*, 2016a), widespread in different parts of the world (Blakemore, 2012).

Family Megascolecidae

7. *Megascolex konkanensis konkanensis* Fedarb, 1898

1898. *Megascolex konkanensis konkanensis* Fedarb, J. Bombay Soc. 11: 434. *Megascolex* Fedarb, 1898; J. Bombay Soc. 11: 434. [types unknown from Reynolds and Wetzel, 2018]

Diagnosis: Long worm; anterior end truncate; setae perichaetine; prostomium epilobous; first dorsal pore at intersegmental furrow 4/5; clitellum annular, 14–16½, 17; male pores are oval disc shaped area; female pore paired; spermathecal pores two pairs, in 7/8 and 8/9; gizzard large in segment 6; calciferous glands absent; prostates paired mop like, duct thick and fairly long, muscular and thinner at the ends; spermathecae with stalked pear shaped main pouch, diverticulum given off from main pouch where this joins body wall; penial setae absent.

Materials examined: **0-1-0**, (ACCESSD/EW/684), Kalleli, Pathanamthitta Dist., Kerala (N 9°12'3.0", E 76°53'28.2"), asl 45 m, rubber plantation, 23 August 2016, coll. S. Sathrumithra; **0-1-0**, (ACCESSD/EW/691), Kummanoor, Pathanamthitta Dist., Kerala (N 9°13'15.1", E 76°52'18.5"), asl 33 m, home garden, 26 October 2016, coll. S. Sathrumithra; **0-0-2**, (ACCESSD/EW/693), Vettoor, Pathanamthitta Dist., Kerala (N 9°15'23.7", E 76°49'39.3"), asl 23 m, home garden, 26

October 2016, coll. S. Sathrumithra; **0-0-7**, (ACCESSD/EW/812), Manneera, Pathanamthitta Dist., Kerala (N 9°15'4.2", E 76°55'32.6"), asl 89 m, semi evergreen forest, 29 September 2017, coll. S. Sathrumithra; **0-0-6**, (ACCESSD/EW/816), Pinangathodu, Pathanamthitta Dist., Kerala (N 9°13'37.4", E 76°55'26.8"), asl 105 m, teak plantation, 10 June 2016, coll. S. Sathrumithra; **0-0-1**, (ACCESSD/EW/824), Chempala, Kollam Dist., Kerala (N 9°07'36.2", E 77°01'54.0"), asl 53 m, stream side with riparian vegetation, 16 September 2017, coll. S. Sathrumithra, J.K. Joseph and V.T. Kurien; **0-0-3**, (ACCESSD/EW/760), Kokkathodumoozhy, Pathanamthitta Dist., Kerala (N 9°10'41.4", E 76°55'34.3"), asl 51 m, rubber plantation, 17 May 2017, coll. S. Sathrumithra, V.T. Kurien and E. Thomas.

Remarks: Native peregrine species, wide spread in west coast of India (Narayanan *et al.*, 2014, 2016a).

8. *Perionyx excavatus* Perrier, 1872

1872. *Perionyx excavatus* Perrier, N. Arch. Mus. Paris 8: 126; MNHN. [types from Reynolds and Wetzel, 2018]

Diagnosis: Small to medium sized; setae perichaetine; prostomium epilobous, tongue open; first dorsal pore in intersegmental furrow 2/3–5/6; clitellum annular in 13–17; male pores on a small papillae in a single male field, each papilla with 4–9 peni-setal follicles contained in a transverse groove; spermathecal pores paired, near mid-ventral line in 7/8/9; genital markings absent; gizzard absent or slightly developed in 5; intestine begins in 15 or 16; last pair of hearts in 12; holandric, testis and male funnels free in 10 and 11, seminal vesicles in 11 and 12; penial setae present; spermathecae paired, large, in 8 and 9, each with intramural seminal chambers near ental end of duct.

Material examined: **0-0-6**, (ACCESSD/EW/489), Orekar, Pathanamthitta Dist., Kerala (N 9°10'33.9", E 76°56'36.6"), asl 46 m, home garden, 03 May 2015, coll. S. Sathrumithra and J.K. Joseph; **0-0-4**, (ACCESSD/EW/591), Thalamanam, Pathanamthitta Dist., Kerala (N 9°13'31.6", E 76°56'9.6"), asl 329 m, home garden, 11 June 2016, coll. S. Sathrumithra; **0-0-13**, (ACCESSD/EW/682), Kalleli, Pathanamthitta Dist., Kerala (N 9°12'3.0", E 76°53'28.2"), asl 45 m, rubber plantation, 23 August 2016, coll. S. Sathrumithra; **0-1-0**, (ACCESSD/EW/692) Vettoor, Pathanamthitta Dist., Kerala (N 9°15'23.7", E 76°49'39.3"), asl 23 m, home garden, 26 October 2016, coll. S. Sathrumithra.

Remarks: Native peregrine (Narayanan *et al.*, 2016a), widespread in different parts of the world (Blakemore, 2012).

9. *Metaphire houlleti* (Perrier, 1872)

1872. *Perichaeta houlleti* Perrier, *Amyntas*, *Megascolex*, *Pheretima*, *Metaphire*; N. Arch. Mus. Paris 8: 99; MNHN. [types from Reynolds and Wetzel, 2018]

Diagnosis: Setae perichaetine; clitellum annular, at segments 15–16; male pores in copulatory pouches on segment 18; spermathecal pores 3 pairs, at intersegmental furrows 6/7–8/9; intestinal caeca, simple, 27–22; typhlosole present; prostates racemose, in 16–22; holandric, testis sacs unpaired, ventral; seminal vesicles, in 11, 12; pseudovesicles quite rudimentary; spermathecae, duct ectal to diverticular junction with narrow lumen that opens into parietal invaginations without externally recognizable demarcation from the duct itself, diverticulum with short, slender stalk and wider, elongate seminal chamber that is variously looped.

Material examined: **0-0-5**, (ACESSD/EW/844), Kadambupara, Kollam Dist., Kerala (N 9°06'59.5", E 77°01'28.2"), asl 128 m, home garden, 10 November 2017, coll. S. Sathrumithra and E. Thomas.

Remarks: Exotic (Narayanan *et al.*, 2016a), cosmopolitan species (Blakemore, 2012).

10. *Amyntas alexandri* (Beddard, 1901)

1901. *Amyntas alexandri* Beddard, *Pheretima*, *Amyntas*; Proc. Zool. Soc. London, 1900, p. 988; BMNH 1904:10:5:757. [types from Reynolds and Wetzel, 2018]

Diagnosis: Setae perichaetine; first dorsal pore, at intersegmental furrow 12/13; prostomium, rudimentary; octothecal, pores minute, superficial, more than 1/3C apart, at 5/6–8/9; male pores, in 18, minute, superficial, each in a rather circular area (often slightly depressed) between arms of a U-shaped ridge that is open mesially; female pore, median; genital markings absent; clitellum 14–16 occasionally reaching into 17, setae unrecognizable externally; intestinal origin, in 15; caeca, simple, in 27–20; typhlosole, lamelliform; hearts in 8 unaborting dorsal portions to gizzard; holandric, testis sacs, paired and vertical or unpaired and horseshoe-shaped; seminal vesicles, large, especially the posterior pair, in 11, 12; prostates, large, in 16–22, duct muscular and variously looped or coiled; spermathecae, rather small, duct markedly narrowed in the parietes, diverticulum from median face of duct at parietes, longer than main axis, with slender stalk and a variously looped wider portion entally.

Material examined: **0-0-2**, (ACESSD/EW/821), Chempala, Kollam Dist., Kerala (N 9°07'36.2", E 77°01'54.0"), asl 53 m, stream side with riparian vegetation, 16 September 2017, coll. S. Sathrumithra, J.K. Joseph and V.T. Kurien.

Remarks: Exotic, cosmopolitan species (Blakemore, 2012).

11. *Megascolex ratus* Cognetti, 1911

1911. *Megascolex ratus* Cognetti, Ann. Mag. Nat. Hist. (8), 7: 500; BMNH 1911:4:16:9–10, ZSIC 4782. [types from Reynolds and Wetzel, 2018]

Diagnosis: Length 230–315 mm; setae perichaetine; dorsal pores begins in intersegmental furrow 6/7; genital markings present, 16/17, 19/20 and 20/21; prostomium tanylobous; clitellum saddle shaped in segment 14–17; spermathecal pores two pairs in 7/8 and 8/9; septa 7/8–12/13 muscular; gizzard is in segment 6; calciferous glands absent; oesophagus with four pairs of vascular caeca in segments 11–14, prostates in 19–22, duct strong cylindrical; spermathecal ampulla ovoid and transversely striped; large numbers of minute micronephridia are attached to the parietes from segment 4 and backwards.

Material examined: **0-0-1**, (ACESSD/EW/695), Avolikuzhy, Pathanamthitta Dist., Kerala (N 9°14'31.5", E 76°54'04.3"), asl 385 m, home garden, 27 October 2016, coll. S. Sathrumithra; **0-0-1**, (ACESSD/EW/746), Njandukombu, Kollam Dist., Kerala (N 9°06'25.1", E 77°03'34.6"), asl 146 m, semi evergreen forest, 04 May 2017, coll. S. Sathrumithra and V.T. Kurien.

Remarks: Near endemic to Kerala (Narayanan *et al.*, 2016a), it is also recorded from Tamil Nadu state, both in Western Ghats biodiversity hotspot.

12. *Megascolex travancorensis bonaccordensis* Michaelsen, 1913

1913. *Megascolex travancorensis* var. *bonaccordensis* Michaelsen, Jahrbuch der hamburgischen wissenschaftlichen Anstalten 30: 84. [types unknown from Reynolds and Wetzel, 2018]

Diagnosis: Length 210–250 mm; setae perichaetine, ventral setae in anterior region enlarged; clitellum ring shaped, 1/2 13–1/2 17; male field trapeze shaped extending from a little behind the setal zone of 17 to a little behind that of 18; female pore single; spermathecal pores two pairs, in 7/8 and 8/9; septa 5/6–14/15

thickened; gizzard large in segment 5; prostates lobed and uneven, in 17–21, much constricted by the septa; duct S-shaped, fairly thick and muscular in its ectal, thinner and not shining in its ental part; spermathecal ampulla sac-like in its ental, narrow in its ectal portion; duct small, a little thinner than the ectal part of the ampulla; diverticulum narrowly club shaped, opening into the duct, about half as long as main pouch; genital markings and penial setae absent.

Material examined: **0-3-9**, (ACESSD/EW/706), Vayakkara, Pathanamthitta Dist., Kerala (N 9°10'52.6", E 76°55'17.8"), asl 62 m, teak plantation, 30 December 2016, coll. S. Sathrumithra and K.J. Sajithkumar; **0-0-2**, (ACESSD/EW/744), Palakuzhy, Kollam Dist., Kerala (N 9°08'19.0", E 76°58'57.9"), asl 50 m, stream side riparian vegetation, 03 May 2017, coll. S. Sathrumithra and V.T. Kurien; **0-0-2**, (ACESSD/EW/808), Thalamanam, Pathanamthitta Dist., Kerala (N 9°13'31.6", E 76°56'9.6"), asl 329 m, home garden, 29 September 2017, coll. S. Sathrumithra; **0-0-5**, (ACESSD/EW/810), Thanithodumoozhy, Pathanamthitta Dist., Kerala (N 9°15'19.0", E 76°55'36.4"), asl 94 m, semi evergreen forest, 29 September 2017, coll. S. Sathrumithra; **0-0-2**, (ACESSD/EW/825), Pancharamukku, Dist. Kollam, Kerala (N 9°05'42.0", E 77°01'46.1"), asl 210 m, teak plantation, 16 September 2017, coll. S. Sathrumithra, J.K. Joseph and V.T. Kurien; **0-0-4**, (ACESSD/EW/825), Kulathumannu, Pathanamthitta Dist., Kerala (N 9°10'15.2", E 76°53'15.5"), asl 135 m, home garden, 24 September 2017, coll. S. Sathrumithra and J.R. Thomas; **0-0-1**, (ACESSD/EW/758), Kalleli, Pathanamthitta Dist., Kerala (N 9°12'3.0", E 76°53'28.2"), asl 45 m, rubber plantation, 17 May 2017, coll. S. Sathrumithra, V.T. Kurien and E. Thomas; **0-0-2**, (ACESSD/EW/706), Vayakkara, Pathanamthitta Dist., Kerala (N 9°10'59.5", E 76°55'17.2"), asl 53 m, rubber plantation, 18 May 2016, coll. S. Sathrumithra, V.T. Kurien and E. Thomas.

Remarks: Endemic to Kerala (Narayanan *et al.*, 2016a).

13. *Megascolex polytheca uniuus* Aiyer, 1929

1929. *Megascolex polytheca var. uniuus* Aiyer, Rec. Indian Mus. 31: 71. [types unknown from Reynolds and Wetzell, 2018]

Diagnosis: Setae perichaetine, setae closely set; prostomium epilobous, tongue open behind; dorsal pore begins in intersegmental furrow 6/7; clitellum annular on 14–16; male pores are on segment 18, in line B setal line, in two depressions; septum 5/6 is thin; gizzard in segment 5; intestine begins in segment 19; last heart is in 13; testis and sperm funnels are free in segments 10 and 11; seminal vesicles are grape-like in segments 11

and 12; prostates confined to segments 18; ectal portion of the duct is nearly three times as thick as the ental part; calciferous glands and penial setae absent.

Material examined: **0-0-1**, (ACESSD/EW/796), Charupara, Kollam Dist., Kerala (N 9°05'25.7", E 77°03'52.1"), asl 266 m, semi evergreen forest, 18 August 2017, coll. S. Sathrumithra and V.T. Kurien; **0-0-2**, (ACESSD/EW/799), Palakuzhy, Kollam Dist., Kerala (N 9°08'19.0", E 76°58'57.9"), asl 50 m, stream side riparian vegetation, 19 August 2017, coll. S. Sathrumithra and E. Thomas; **0-0-3**, (ACESSD/EW/801), Chempanaruvi, Kollam Dist., Kerala (N 9°07'51.8", E 77°01'2.6"), asl 47 m, stream side riparian vegetation, 19 August 2017, coll. S. Sathrumithra and E. Thomas.

Remarks: Endemic to Kerala (Narayanan *et al.*, 2016a).

DISCUSSION

The exotic neotropical earthworm *Pontoscolex corethrurus* has colonized even in the natural forest ecosystems of Konni. According to Narayanan *et al.* (2016b), *P. corethrurus* entered the state either through the plantation activities of cassava (*Manihot esculanta*) or rubber (*Hevea brasiliensis*) and it is now almost widespread throughout the state. In Konni region, a large portion of the land is under rubber plantations and this might have contributed to its spread. The exotic peregrine *Amyntas alexandri* was recorded for the first time from the Kollam District. Its presence in the state was recently reported by Narayanan *et al.* (2016c). Therefore, the present record from Kollam District indicates that this particular species is expanding its range in the state. The study recorded three 'native peregrine' species such as *Megascolex konkanensis konkanensis*, *Perionyx excavatus* and *Octochaetona beatrix*. Among these, the first two are widespread in different parts of Kerala. Before the present record, *O. beatrix* was reported from only four locations in the state, *viz.*, Trivandrum (now Thiruvananthapuram) (Michaelsen, 1910), Karakulam (Stephenson, 1916) (Thiruvananthapuram District), Karicode and Kollamkundu in Shendurney Wildlife Sanctuary (Kollam District) (Narayanan *et al.*, 2016d). Near endemic *Megascolex ratus* expanded its range; previously it was known only from Thiruvananthapuram District in Kerala (Stephenson 1916; Aiyer 1929). Hence, records from Pathanamthitta District become its known northernmost distribution. Endemic species such as *Moniligastrer deshayesi* and *Megascolex polytheca uniuus* were confined to the forest ecosystems of Konni. In comparison, with the other endemic species such as

Drawida ghatensis and *Megascolex travancorensis bonaccordensis* which were recorded from the forest as well as disturbed teak, rubber plantations and home gardens. *Megascolex travancorensis bonaccordensis*, was rediscovered after 104 years since its description by Michaelsen (1913) from Bonacaud (Thiruvananthapuram District). Similarly, *Megascolex polytheca uniuus* described by Aiyer (1929) from Kumily is only known from its type locality.

CONCLUSION

A total of 13 earthworm species belonging to five families were recorded from Konni. Here, large areas of natural forest have been converted to teak and rubber plantations, and the remaining forest patches are under high anthropogenic stress. This has accounted for the presence of many exotic earthworm species in the region. However, this study showed the presence of certain native earthworm species still confined to the forest ecosystems of Konni. The present work is a pioneer study in the area, hence the data is of great significance both from an academic and conservation point of view.

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A catalogue of names, descriptions, and type specimens of the Oligochaeta:

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