Earthworm (Clitellata, Megadrili) fauna of Kuttanad wetland, southern part of Vembanad-Kol Ramsar site, India


1Sasankan Prasanth Narayanan, Advanced Centre of Environmental Studies and Sustainable Development, Mahatma Gandhi University, Priyadarssini Hills, Kottayam – 686560, Kerala, India. E-mail: narayannkc@gmail.com; https://orcid.org/0000-0002-7765-9570. Corresponding author
2Vijo Thomas Kurien Department of Zoology, C.M.S College, Kottayam – 686001, Kerala, India. https://orcid.org/0000-0001-8943-7522
3Rajagopal Anuja, Advanced Centre of Environmental Studies and Sustainable Development, Mahatma Gandhi University, Priyadarssini Hills, Kottayam – 686560, Kerala, India. https://orcid.org/0000-0001-7838-222X
4Vivek Hasyagar, Department of Applied Zoology, Mangalore University, Mangalagangothri, Mangalore – 574199, Karnataka, India. https://orcid.org/0000-0003-4046-9885
5Ambattu Paili Thomas, Advanced Centre of Environmental Studies and Sustainable Development, Mahatma Gandhi University, Priyadarssini Hills, Kottayam – 686560, Kerala, India. https://orcid.org/0000-0002-8815-2759
6Rahul Paliwal, House No 77/62, Mansarovar, Jaipur – 302020, Rajasthan, India. https://orcid.org/0000-0002-6531-7303
7Jatinder Mohan Julka, School of Biological and Environmental Sciences, Faculty of Basic Sciences, Shoolini University, Solan -173 212, Himachal Pradesh, India. https://orcid.org/0000-0002-8787-2447

Abstract. The earthworm fauna of the wetlands of India is highly undocumented. We have carried out a survey of earthworms in the Kuttanad wetland, an integral part of the Vembanad-Kol Ramsar Site, India’s largest wetland of international importance. Current investigation has documented 17 species belonging to 7 families. Megascolex travancorenis pentagonalis Stephenson, 1916 and Glyphidrilus fluviatilis Rao, 1922 were reported for the first time since their original descriptions. Based on the current study, M. t. pentagonalis is raised to species rank as M. pentagonalis from the subspecies status. G. fluviatilis and Lensogaster chitagonensis (Stephenson, 1917) are new records for the state of Kerala. Present results provide a more complete picture of the earthworm fauna of Kuttanad wetland.

Keywords. Drawida, Megascolecidiae, Megascolex, Moniligasteridae, Kerala.

INTRODUCTION

The earthworm fauna of India is highly diverse and is well reported as compared to other Asian countries (Julka et al. 2009) with around 451 species (Narayanan et al. 2020a, 2021, Tiwari et al. 2021). The Indian state of Kerala is a small and narrow strip of land spreading over an area of 38,863 km along the southwest corner of the Indian subcontinent and the earthworm fauna of the state is very rich and fairly well documented compared to other states of India. Various workers have documented the earthworm fauna of the state since the end of 19th century (Fedarb 1898, Michaelsen 1910, Cognetti 1911, Stephenson 1915, Aiyer 1929 etc.). About 80% of the currently known species were recorded in the early part of the last century (Narayanan et al. 2016a). At present, 120 species of earthworms representing 31 genera in 9 families are recorded from Kerala state (Narayanan et al. 2016a, b, c, 2017, 2019a, b, c, 2020b, 2021, 2022, Anuja et al. 2020, Lone et al. 2022). Wetlands are often termed as ‘biological supermarkets’ because of the extensive food chains and rich biodiversity they support, providing unique habitats for a wide
range of flora and fauna (Mitsch & Gosselink 2000). The earthworm fauna of Ramsar wetlands of India is not well documented (Chandra et al. 2021), except Renuka wetland, Pong Dam and Chander Lake (Julka & Paliwal 2000, Paliwal & Julka 2009, Paliwal 2018). Kuttanad wetland is one of the best-known backwater ecosystems of India and an integral part of India’s largest wetland of international importance, the Vembanad-Kol Ramsar site (Narayanan et al. 2011). A recent study by the Zoological Survey of India did not report any earthworm species from this wetland (Anon. 2009). Albeit, eight species of earthworms were randomly reported from the various regions of this wetland (Michaelsen 1910, Aiyer 1929, Narayanan et al. 2015, 2016d, Anuja et al. 2020, 2023). They are Drawida impertusa Stephenson, 1920, Pontoscolex corethrurus (Müller, 1857), Argilophilus variabilis (Aiyer, 1929), Eukerria kuekenthali (Michaelsen, 1908), Lampito mauritii Kinberg, 1867, Metaphire houlleti (Perrier, 1872), Megascolex insignis Michaelsen, 1910 and M. konkanensis Fedarb, 1898. Among these seven were reported before independence. Here we provide new earthworm records from the Kuttanad wetland, based on collections carried out between 2010 and 2022.

**MATERIALS AND METHODS**

Kuttanad is a highly complex wetland ecosystem, primarily a deltaic formation of four-river systems, namely, Achencovil, Pamba, Manimala and Meenachil, located in the fertile low-lying areas of Vembanad estuarine system in the Kerala state of southwest India (Fig. 1) (John et al. 2009). This region lies between 9°8’ – 9°52’N and 76°9’ – 76°44’E, with a geographical area of 1,100 km² which spreads over Alappuzha, Kottayam and Pathanamthitta districts and separated from the Arabian Sea by a narrow strip of land (Shari & Chitra 2005, John et al. 2009, Narayanan et al. 2011). Kuttanad wetlands has many characteristic features compared to the other wetlands of the world, one distinct feature is that it lies 0.6 to 2.5 m below mean sea level, receives nearly 3,200 mm of annual rainfall through two monsoon seasons, with uniform high air and water temperature (22–35°C), having humidity ranges between 70–80% throughout the year (John et al. 2009).

The area comprises flood plains, coastal alluvial belt, river networks, numerous canals, large paddy fields, lakes, and remains water-logged almost throughout the year, subjected to continued flood submergence during monsoon and saline water ingression during the summer months (John et al. 2009, Narayanan et al. 2011). Kuttanad wetland has 53,639 ha of paddy fields and is known as the ‘rice bowl of Kerala’. Most of these paddy fields remain submerged in water during the non-crop season and water has to be pumped out to the backwaters before the commencement of the cultivating season (Sashikumar & Palot 1996). Based on the soil, pH, geomorphology and salinity intrusion, Kuttanad is subdivided into six agro-ecological zones viz., Vaikom Kari, North Kuttanad, Kayal lands, Lower Kuttanad, Upper Kuttanad, and Purakkad Kari (Indo-Dutch Mission 1989).

Earthworms were collected primarily by digging and hand sorting method (Julka 1990) from various habitats, such as dykes, home surroundings, paddy fields, recently reclaimed wetlands by filling the lateritic soils from the midland hills, grassy patches, wooded areas, in detritus and other natural substrates, also handpicked from soils under logs, branches, rocks, stones etc. Collected five specimens were placed in small plastic bags along with the substrate. Later collected specimens were washed and preserved in 5% formalin, if possible in the field itself. All anatomical observations were made by dorsal dissection under binocular stereomicroscope (Nikon SMZ800 N). Specimens were identified following standard literatures (Stephenson 1923, Aiyer 1929, Gates 1972, Julka 1988, Blakemore 2012, Chanabun et al. 2013). Identified specimens were deposited in the earthworm laboratory of the Advanced Centre of Environmental Studies and Sustainable Development (ACESSD), Mahatma Gandhi University, Kerala, India.
Narayanan et al.: Earthworm fauna of Kuttanad wetland, India

TAXONOMY

Family Moniligastridae Claus, 1880

Drawida ghatensis Michaelsen, 1910

Drawida ghatensis Michaelsen, 1910: 52.

Material examined. 1 aclitellate (ACESSD/EW/1030), Aymanam, Kottayam Dist., Kerala, home garden, 03.01.2018, leg. G. Sreekumar; 1 aclitellate (ACESSD/EW/1072), Kumarakom (9.6175°N 76.4301°E), Kottayam Dist., Kerala, near pond, 07.03.2019, leg. G. Sreekumar; 2 juveniles, 9 aclitellates, 1 clitellate (ACESSD/EW/1520), Vadayar (9°45’29”N 76°26’50”E), Kottayam Dist., Kerala, edge of paddy field, 12.10.2022, leg. S.P. Narayanan, V.T. Kurien.

Distribution in Kerala. Aymanam, Kumarakom, Vadayar (new records), Anikadu, Aruva-

Remarks. Endemic to India. Thakur et al. (2021), reported D. ghatensis from Neyyar Wildlife Sanctuary of Kerala and as per the description provided, prostate is ovoid or thickly pear-shaped, as stated by Stephenson (1923). But later Julka & Chandra (1986) described the prostate as shortly stalked and ovoidal that means ‘mushroom-shaped’ with a figure. In Thakur et al.’s figure (4C) vas deferens joins the prostate at its lateral side. But in Stephenson (1915) vas deferens joins the prostate at its anterior face. Therefore, this record needs further corroboration. D. ghatensis is a species complex, shows great variation with respect to the shape of the spermathecal atrium (Stephenson 1915, 1923; Aiyer, 1929; Julka & Chandra, 1986). But Thakur et al. (2021) present initiation of the DNA barcode signatures (COI) of this group will be helpful in future to resolve taxonomical problems in this species complex.

Drawida impertusa Stephenson, 1920


*Drawida barwelli* var. *impertusa*: Stephenson 1923: 134.

*Drawida impertusa* (Stephenson) Gates 1965: 87.

Material examined. 1 juvenile, 6 clitellates (ACESSD/EW/1094), Perumthuruthu (9°41’22.7"N 76°27’49.5"E), Kottayam Dist., Kerala, paddy field, 21.12.2018, leg. R. Anuja; 2 aclitellates, 2 clitellates (ACESSD/EW/1482), Illichira (9°20’ 23”N 76°23’7”E), Alappuzha Dist., Kerala, dyke with grass patch close to *Pandanus* stand, 15.08.2022, leg. S.P. Narayanan, V.T. Kurien; 2 juveniles, 7 aclitellates (ACESSD/EW/1487), Edathua (9°21’47”N 76°28’52”E), Alappuzha Dist., Kerala, home surrounding, 15.08.2022, leg. S.P. Narayanan, V.T. Kurien; 1 juvenile, 2 aclitellates, 2 clitellates (ACESSD/EW/1488), Mepral (9°21’47” N 76°28’52” E), Pathanamthitta Dist., Kerala, home surroundings in paddy field, 15.08.2022, leg. S.P. Narayanan, V.T. Kurien; 7 aclitellates, 10 clitellates (ACESSD/EW/1491), Karumudi (9°22’48”N 76°23’12”E), Alappuzha Dist., Kerala, open grassy (*Axonopus compressus*) area in a dyke, 15.08.2022, leg. S.P. Narayanan, V.T. Kurien; 2 aclitellates (ACESSD/EW/1502), Chenntihala (9°16’43”N 76°30’10” E), Alappuzha Dist., Kerala, home surrounding in a reclaimed land within paddy field, 15.08.2022, leg. S.P. Narayanan, V.T. Kurien; 3 clitellates (ACESSD/EW/1524), Pattassery near Neelamperoor (9°31’3”N 76°30’32”E), Kottayam Dist., Kerala, home surroundings within paddy field, 07.12.2022, leg. S.P. Narayanan, V.T. Kurien; 2 aclitellates (ACESSD/EW/1526), Kainady (9°30’ 4”N 76°28’28”E), Alappuzha Dist., Kerala, bund between paddy field and lake, 07.12.2022, leg. S.P. Narayanan, V.T. Kurien; 2 juveniles, 1 clitellate (ACESSD/EW/1529), Paral (9°26’57”N 76°31’32”E), Kottayam Dist., Kerala, reclaimed land in wetland, 07.12.2022, leg. S.P. Narayanan, V.T. Kurien; 4 aclitellates (ACESSD/EW/1537), Kainakari (9°29’4”N 76°23’3”E), Alappuzha Dist., Kerala, bund with tree near river, 07.12.2022, leg. S.P. Narayanan, V.T. Kurien; 1 aclitellate, 1 clitellates (ACESSD/EW/1562), Cheepungal (9°38’26.2”N 76°25’16.9”E), Kottayam Dist., Kerala, paddy field, 11.12.2017, leg. R. Anuja, S. Sathrumithra, V.T. Kurien.

Distribution in Kerala. Cheepungal, Chenntihala, Edathua, Illichira, Kainady, Kainakari, Karumudi, Mepral, Paral, Pattassery near Neelamperoor, Perumthuruthu (new records), Anikadu, Kanjikode, Kanjirapally, Karimbinthodu, Kerumadi (Karumady, Karumadi), Marangatupally, Monipally, Munnilavu, Pallikkathodu, Peppara Wildlife Sanctuary, Perumthuruthu, Thiruvella (Thiruvalla), Vandiperiyar (Michaelsen 1910,
Remarks. Native peregrine (Narayanan et al. 2016a). Thakur et al. (2021) records from Peppara Wildlife Sanctuary of Kerala state needs further corroboration. Since, certain key characters given and the figures provided are not matching. Genital markings are very rare in Drawida (Gates 1972). Thakur et al. (2021) themselves stated same in paper (Thakur et al. 2021: 123). Hence, the presence of genital marking is of great importance in species level identification of Drawida. In D. impertusa genital markings are always present (Gates 1965), as a pair of fairly large, oval whitish papillae on segment 10 in front of the male pores (Stephenson 1923, Aiyer 1929, Gates 1965, Blakemore 2012). Thakur et al. mentioned the presence of whitish papillae in front of the male pores, but such papillae are not shown in the figure of the species provided. Thakur et al. described the prostate as spherical or sometimes pear-shaped, glandular, duct (vas deferens?) joins at the anterior end. But as per Stephenson (1923), Aiyer (1929) and Blakemore (2012) and our personal observations, prostates are glandular, sessile and circular (spheroidal), and the vas deferens joins the prostate at its antero-median side (Aiyer 1929, Gates 1965).

**Drawida travancorensis** Michaelsen, 1910

*Drawida travancorensis* Michaelsen, 1910: 46.

**Material examined.** 2 aclitellates (ACESSD/EW/1376), Neelamperoor (9°29'48"N 76°30'21"E), Alappuzha Dist., Kerala, home surroundings in lateritic soil within Kuttanad, 08.10.2021, leg. Sreehari Mohan.


**Remarks.** Endemic to southwest India. Often misspelled as *D. travancorense* (Thakur et al. 2021, Reynolds & Wetzel 2023).

**Family Acanthodrilidae** Claus, 1880

**Lennogaster chittagongensis** (Stephenson, 1917)


**Material examined.** 5 clitellates (ACESSD/EW/1076), Ramankary (9°25′27″N 76°27′55″E), Alappuzha Dist., Kerala, homestead, 11.08.2019, leg. S.P. Narayanan.

**Distribution in Kerala.** Ramankary (new record for the state).

**Remarks.** Subendemic species. As of now it is known only from this site in the state.

**Family Almidae** Duboscq, 1902

**Glyphidrilus annandalei** Michaelsen, 1910

*Figure 2*


**Material examined.** 1 juvenile (ACESSD/EW/861), Neendoor (9°41′33.8″N 76°29′29.2″E), Kottayam Dist., Kerala, paddy field, 12.12.2018, leg. R. Anuja, S. Sathrumithra, V. T. Kurien; 1 juvenile, 1 clitellate (Fig. 2) (ACESSD/EW/1525), Kainady (9°30′4″N 76°28′28″E), Alappuzha Dist., Kerala, paddy field, 07.12.2022, leg. S.P. Narayanan, V.T. Kurien.
Material examined. 4 juveniles, 1 clitellate (ACESSD/EW/1494), Mukkada (9°20'29"N 76°25'5"E), Alappuzha Dist., Kerala, paddy field, 15.08.2022, leg. S.P. Narayanan, V.T. Kurien.

Description. Dimension: Clitellate – length 173 mm, width 3.5 mm (at segment 25), segment number 332. Setae lumbricine, body cylindrical in the anterior region, quadrangular behind clitellum. Clitellum annular in segments 13–38; ventro-lateral clitellar wing (Fig. 3A) is in segments 25–31. Dorsal pores absent, male pores, female pores, spermathecal pores invisible. Genital markings present (Fig. 3B), in segments 13–24, 33, 34, 35 paired on bc setal lines; median single one on segments 12–22, 37–39 on aa setal lines.

Distribution in Kerala. Mukkada (new record).

Remarks. Endemic to India. New addition to the Kerala state, previously it was known only from Madapur (= Madapura), Fraserpett (Kushalnagar), Shimoga (Shivamogga) of Karnataka state and Narayan of Vordevia Dicu (Karnataka state?) (Rao 1922, Chanaban et al. 2013).

Family Benhamiidae Michaelsen, 1897

Dichogaster bolaui (Michaelsen, 1890)

Dichogaster (Diplothecodrilus) bolaui: Csuzdi 2010: 102 (for complete synonymy).

Material examined. 1 juvenile, 1 aclitellate, 13 clitellates (ACESSD/EW/9), Ramankary (9°25′27″N 76°27′55″E), Alappuzha Dist., Kerala, roof top of house, 30.12.2010, leg. S.P. Narayanan; 2 clitellates (ACESSD/EW/9), Ramankary (9°25′27″N 76°27′55″E), homestead, 08.06.2016, leg. S.P. Narayanan; 18 clitellates (ACESSD/EW/1319), Ramankary (9°25′27″N 76°27′55″E), from decaying leaf litter on roof top, 19.09.2021, leg. S.P. Narayanan.

Distribution in Kerala. Ramankary (new record), Athirampuzha, Ernakulam, Kanjikode, Kottikal, Monipally, Neyyattinkara, Periya, Trivand
Family Megascolecidae Rosa, 1891

Amyntas alexandri Beddard, 1901

Amyntas alexandri Beddard, 1901: 999. 
Amyntas alexandri: Blakemore 2012: 331 (for complete synonymy).

Material examined. 1 juvenile (ACESSD/EW/1122), Ramankary (9°25’27”N 76°27’55”E), Alappuzha Dist., Kerala, road side, 11.08.20 19, leg. S.P. Narayanan; 4 clitellates (ACESSD/EW/1517), Neendoor (9°41’33.8”N 76°29’29.2”E), Kottayam Dist., Kerala, roadside in paddy field, 12.10.2022, leg. S.P. Narayanan, V.T. Kurien; 1 clitellate (ACESSD/EW/1533), Veliyanadu (9°26’43”N 76°2’49”E), Alappuzha Dist., Kerala, reclaimed land in wetland, beneath decaying tree trunk, 07.12.2022, leg. S.P. Narayanan, V.T. Kurien.


Remarks. Exotic species, widely distributed in the world (Blakemore 2012). Narayanan et al. (2016b) reported this species for the first time from the state. Now its range is expanding within the state.

Lamprolis mauritii Kinberg, 1857

Lamprolis mauritii Kinberg, 1867: 103; Blakemore 2012: 331 (for complete synonymy).

Material examined. 1 clitellate (ACESSD/EW/866), Neendoor (9°41’33.8”N 76°29’29.2”E), Kottayam dist., Kerala, paddy field, 11.12.2017, leg. R. Anuja, S. Sathrumithra, V.T. Kurien; 4 aclitellates, 1 clitellate (ACESSD/EW/
Material examined. 1 clitellate (ACESSD/EW/870), Perumthuruthu (9°41′22.7″N 76°27′49.5″E), Kottayam dist., Kerala, paddy field, 11.12.2017, leg. R. Anuja, S. Sathrumithra, V.T. Kurien; 1 juvenile, 6 clitellates (ACESSD/EW/1095), Perumthuruthu (9°41′22.7″N 76°27′49.5″ E), Kottayam dist., Kerala, paddy field, 21.12.2018, leg. R. Anuja; 2 clitellate (ACESSD/EW/1480), Illichira (9°20′23″N 76°23′7″E), Alappuzha Dist., Kerala, dyke with grass patch close to Pandanus stand, 15.08.2022, leg. S.P. Narayanan, V.T. Kurien; 1 juvenile (ACESSD/EW/1492), Karumadi (9°22′48″N 76°23′12″E), Alappuzha Dist., Kerala, open grassy (Axonopus compressus) area in a dyke, 15.08.2022, leg. S.P. Narayanan, V.T. Kurien; 5 clitellates (ACESSD/EW/1532), Veliyanadu (9°26′43″N 76°27′49″E), Alappuzha Dist., Kerala, reclaimed land in wetland, 07.12.2022, leg. S.P. Narayanan, V.T. Kurien.


Megascolex konkanensis Fedarb, 1898

Megascolex konkanensis Fedarb, 1898: 434.

Material examined. 1 clitellate (ACESSD/EW/867), Perumthuruthu (9°41′22.7″N 76°27′49.5″E), Kottayam dist., Kerala, paddy field, 11.12.2017, leg. R. Anuja, S. Sathrumithra, V.T. Kurien; 3 clitellates (ACESSD/EW/1073), Kumarakom (9.6175′N 76.4301′E), near pond, 07.03.2019, leg. Sidharth Mohan; 1 juvenile, 1 aclitellate, 1 clitellate (ACESSD/EW/557), Ramankary (9°25′27″N 76°27′55″E), Alappuzha Dist., Kerala, homestead, 18.01.2016, leg. S.P. Narayanan; 3 juveniles (ACESSD/EW/1377), Neelamperoor (9°29′48″N 76°30′21″E), home surroundings in lateritic soil within Kuttanad, 08.10.2021, leg. Sreehari Mohan; 1 clitellate (ACESSD/EW/1483), Eramathoor (9°18′27″N 76°31′27″E), Alappuzha Dist., Kerala, homestead near paddy field, 15.08.2022, leg. S.P. Narayanan, V.T. Kurien; 1 juvenile, 1 clitellate (ACESSD/EW/1515), Neendoor (9°41′33″N 76°29′29″E), Kottayam Dist., Kerala, roadside in paddy field, 12.10.2022, leg. S.P. Narayanan, V.T. Kurien; 1 clitellate (ACESSD/EW/1530), Paral (9°26′57″N 76°31′32″E), Kottayam Dist., Kerala, reclaimed land in wetland, 07.12.2022, leg. S.P. Narayanan, V.T. Kurien.

**Remarks.** Endemic to India. Intestine origin is of species specific importance in the identification of *Megascolex* species. In this species the intestine begins in segment 16 (Fedarb 1898, Stephenson 1923), whereas in Lone et al. (2022) specimens it starts from segment 18. Moreover Lone et al. (2022) figures (5a and 5b) depicting the genital region and spermathecae of *M. konkanensis* is not corresponding with the actual description of *M. konkanensis*. The provided genital region figure is matching with the description of *M. cochinensis* Stephenson, 1915 and not with *M. konkanensis*. Hence due to Lone et al. (2022) contradicting anatomical features and figures provided, the identity of the species from Parambikulam road – Muthalamada, Thenmala Reservoir – Shendurney Wildlife Sanctuary, Mlappara in Periyar National Park needs further corroboration.

*Megascolex pentagonalis* Stephenson, 1916

*stat. rev.*

(Figure 4)

*Megascolex travancorensis* var. *pentagonalis* Stephenson: Stephenson 1923: 278.

*Material examined.* 7 clitellates and 2 juveniles, (ACESSD/EW/1501), Chennithala (9°16' 43"N 76°30'10"E), Alappuzha Dist., Kerala, home surrounding in a reclaimed land within paddy field, 15.08.2022, leg. S.P. Narayanan, V.T. Kurien; 1 juvenile, 1 clitellate (ACESSD/EW/1504), Eramatheor (9°18'27"N 76°31'27"E), Alappuzha Dist., Kerala, homestead close to paddy field, 15.08.2022, leg. S.P. Narayanan, V.T. Kurien.

*Description.* Dimension: clitellate – length 274 mm, width 6 mm, segments 331, and juvenile – length 272 mm, width 5.5 mm, segments 417. Colour a uniform medium grey. Secondary annulations present in segments 7–9. Anterior end truncated. Setae enlarged at the anterior portions. Prostomium combined pro-epipodial. First dorsal pore in intersegmental furrow 5/6, indication present in furrow 4/5. Ventral setae in regular longitudinal lines, dorsal setae are not. Clitellum light pinkish cream colour (in life), in segments 14–1/417 (3/4). Male field on segment 18, pentagonal in shape, with the base forwards, the whole occupying the anterior 2/3rd of segment; lateral area to outwards, the whole area surrounded by a groove and marked by an inverted T-shaped depression (Fig. 4A). Spermathecal pores small, in intersegmental furrows 7/8/9, in line with b (Fig. 4B). Septa 6/7–10/11 thickened, following septa are moderately thickened, gradually thinner as far as 16/17. Gizzard barrel-shaped, in segment 5. Last heart in segment 13. Holandric, testes and funnels free in segment 10 and 11, seminal vesicles in segments 11, and 12. Intestine begins in segment 16. Prostates racemose, large, elongate band-like or irregularly rectangular, incised, in segments 17–20; prostatic duct muscular, shiny, ectal end thicker, transversely placed, gradually thinner at ental end, sinuous, with a bent and twisted before entering the gland. Spermathecal ampulla large, sausage-shaped, bent, ental end slightly dilated (Fig. 4C); duct short, half as thick as ampulla; spermathecal diverticulum arising from the ental end of the duct, more than half as long as ampulla, tubular, thin, with a slight dilatation at ental end.

*Distribution in Kerala.* Chennithala, Eramatheor (new records), Trivandrum (Thiruvananthapuram) (Stephenson 1916).

*Remarks.* Endemic (Narayanan et al. 2016a). Earlier it was known only from the type locality. One clitellate and 1 juvenile worms are in full length the rest lost posterior portion while collecting. *M. pentagonalis* initially described at species rank by Stephenson (1916), but later he treated it as a subspecies of *M. travancorensis* Michaelsen, 1910 (Stephenson 1923). There are considerable differences in the male field, dimensions and shape of spermathecae in all the five subspecies of *M. travancorensis*. Due to these facts and based on the present study, *M. t. pentagonalis* is elevated to species rank as *M. pentagonalis* Stephenson, 1916.

*Metaphire houlleti* (Perrier, 1872)

*Perichaeta houlleti* Perrier, 1872: 99.
*Metaphire houlleti*: Blakemore 2012: 478 (for complete synonymy).

*Material examined.* 2 clitellates (ACESSD/EW/70), Ramankary (9°25′27″N 76° 27′55″E), Alappuzha Dist., Kerala, home surroundings, 12.10.2012, leg. S.P. Narayanan; 1 clitellate (ACESSD/EW/868), Perumthuruthu (9°41′22.7″ N 76°27′49.5″E), Kottayam dist., Kerala, paddy field, 11.12.2017, leg. R. Anuja, S. Sathrumithra, V. T. Kurien; 13 clitellate (ACESSD/EW/1485), Eramathoor (9°18′27″N 76°31′27″E), Alappuzha Dist., Kerala, homestead near paddy field, 15.08.2022, leg. S.P. Narayanan, V.T. Kurien; 4 clitellate (ACESSD/EW/1486), Edathua (9°21′...
47°N 76°28′52″E), Alappuzha Dist., Kerala, home surrounding, 15.08.2022, leg. S.P. Narayanan, V.T. Kurien; 6 clitellates (ACESSD/EW/1489), Mepral (9°21′47″N 76°29′29″E), Kottayam Dist., Kerala, home surrounding in paddy field, 15.08.2022, leg. S.P. Narayanan, V.T. Kurien; 3 clitellates (ACESSD/EW/1516), Neendoor (9°41′33″ N 76°29′29″ E), Kottayam Dist., Kerala, roadside in paddy field, 12.10.2022, leg. S.P. Narayanan, V.T. Kurien; 1 clitellate (ACESSD/EW/1531), Veliyanadu (9°26′43″ N 76°27′49″ E), Alappuzha Dist., Kerala, reclaimed land in wetland, 07.12.2022, leg. S.P. Narayanan, V.T. Kurien.


**Remarks.** Exotic species (Narayanan et al. 2016a) with cosmopolitan distribution (Blakemore 2012).

**Perionyx ceylanensis** Michaelson, 1903


**Material examined.** 1 aclitellate, 1 clitellate (ACESSD/EW/719), Kidangara, paddy field, 28.12.2016, leg. S.S. Nair.

**Distribution in Kerala.** Kidangara (new record), Pozhuthana, Pulpally, Silent Valley National Park, Wayanad Wildlife Sanctuary (Mohan et al. 2011, John et al. 2019).

**Remarks.** Subendemic species (Narayanan et al. 2016a), outside India it is known only from Sri Lanka.

**Perionyx excavatus** Perrier, 1872

*Perionyx excavatus* Perrier, 1872: 126; Blakemore 2012: 283 (for complete synonymy).

**Material examined.** 2 clitellates (ACESSD/EW/588), Ramankary (9°25′27″N 76°27′55″E), Alappuzha Dist., Kerala, homestead, 08.06.2016, leg. S.P. Narayanan; 1 clitellate (ACESSD/EW/1268), Ramankary (9°25′27″N 76°27′55″E), Alappuzha Dist., Kerala, from bathroom wall, 16.01.2021, leg. S.P. Narayanan; 1 clitellate (ACESSD/EW/1305), Ramankary (9°25′27″N 76°27′55″E), alt. 0 m asl, 18.07.2021, leg. S.P. Narayanan; 2 juveniles, 3 clitellates (ACESSD/EW/1534), Veliyanadu (9°26′43″N 76°27′49″E), Alappuzha Dist., Kerala, reclaimed land in wetland, 07.12.2022, leg. S.P. Narayanan, V.T. Kurien.


**Remarks.** Native peregrine species (Narayanan et al. 2016b), it acquired wide global distribution.

**Family Ocnerodrilidae** Beddard, 1891

**Eukerria kuekenthali** (Michaelson, 1908)


*Eukerria kuekenthali* Michaelson, 1908: 24 (for complete synonymy).


Remarks. Exotic species. As of now in Kerala, it is known only from the Kuttanad wetlands.

_Ocnerodrilus occidentalis_ Eisen, 1878

_Ocnerodrilus occidentalis_ Eisén, 1878:10
_Ocnerodrilus occidentalis_: Blakemore 2012: 195 (for complete synonymy).

Material examined. 6 clitellates (ACESSD/EW/592), Ramankary (9°25’27"N 76°27’55"E), Alappuzha Dist., Kerala, homestead, 29.06.2016, leg. S.P. Narayanan.


_Family Rhinodrilidae_ Benham, 1890

_Pontoscolex corethrurus_ (Müller, 1857)

_Lumbricus corethrurus_ Müller, 1857: 113.
_Pontoscolex corethrurus_: Blakemore 2012: 554 (for complete synonymy).

Material examined. 1 juvenile, 2 clitellates (ACESSD/EW/24), Ramankary (9°25’27"N 76°27’55"E), Alappuzha Dist., Kerala, homestead, 20.12.2010, leg. S.P. Narayanan; 3 aclitellates, 5 clitellates (ACESSD/EW/864), Mannanam (9°38’37.66"N 76°30’42.19"E), Kottayam Dist., Kerala, 2 m asl, paddy field, 11.12.2017, leg. R. Anuja, S. Sathrumithra, V.T. Kurien; 9 clitellates (ACESSD/EW/865), Neendoor (9°41’33.8"N 76°29’29.2"E), Kottayam Dist., Kerala, paddy field, 11.12.2017, leg. R. Anuja, S. Sathrumithra, V.T. Kurien; 9 clitellates (ACESSD/EW/869), Perumthuruthu (9°41’22.7"N 76°27’49.5"E), Kottayam Dist., Kerala, paddy field, 11.12.2017, leg. R. Anuja, S. Sathrumithra, V.T. Kurien; 1 juvenile (ACESSD/EW/1375), Neelamperoor (9°29’48"N 76°30’21"E), Alppuzha Dist., Kerala, home surroundings in lateritic soil within Kuttanad, 08.10.2021, leg. Sreehari Mohan; 1 clitellate (ACESSD/EW/1481), Illichira (9°20’23"N 76°23’7"E), Alappuzha Dist., Kerala, dyke with grass patch close to Pandanus stand, 15.08.2022, leg. S.P. Narayanan, V.T. Kurien; 1 juvenile, 1 clitellate (ACESSD/EW/1484), Eramathoor (9°18’ 27"N 76°31’27"E), Alappuzha Dist., Kerala, homestead near paddy field, 15.08.2022, leg. S.P. Narayanan, V.T. Kurien; 1 juvenile, 1 clitellate (ACESSD/EW/1495), Mukkada (9°20’29"N 76°25’55"E), Alappuzha Dist., Kerala, dyke in paddy field, 15.08.2022, leg. S.P. Narayanan, V.T. Kurien; 2 juveniles, 1 aclitellate, 2 clitellates (ACESSD/EW/1518), Vadayar (9°45’29"N 76°26’50"E), Kottayam Dist., Kerala, edge of paddy field, 12.10.2022, leg. S.P. Narayanan, V.T. Kurien; 3 juveniles (ACESSD/EW/1613), Neendoor (9°41’33.7"N 76°29’29.1"E), Kottayam Dist., Kerala, roadside in paddy field, 12.10.2022, leg. S.P. Narayanan, V.T. Kurien; 1 juvenile (ACESSD/EW/1527), Kainady...


**Remarks.** Invasive exotic species, wide spread within India. Most widely distributed earthworm species (Gates 1972) in tropical and sub-tropical regions of the world (Taheri et al. 2018).

**DISCUSSION**

This study enhanced the knowledge available on the megadrile fauna of Kuttanad wetland. Current investigation has documented 17 species, before only 8 species of earthworms were known from this wetland. Species such as *Drawida ghatensis*, *D. travancorenensis*, *Glyphidrilus annandalei*, *G. fluviatilis*, *Ocnerodrilus occidentalis*, * Dichogaster bolai*, *Lennogaster chittagonensis*, *Amyntas alexandri*, *Megascolex pentagonalis*, *Perionyx ceylanensis*, *Perionyx excavatus* were recorded for the first time from Kuttanad wetland. The study also noticed the absence of two species, *Argilophilus variabilis* (from North Kuttanad zone) and *Megascolex insignis* (Upper Kuttanad zone) which were previously recorded from this place (Michaelsen 1910, Aiyer 1929). Now, altogether 19 species of earthworms are known to inhabit this ecosystem. Among the earthworm species recorded, native peregrine and exotic species together forms the major portion (52.94%) of the earthworm fauna of this wetland.

In a broadly generalized approach, Kerala can be divided into three distinct physiographic regions, namely the coastal lowlands (< 75 m a.s.l.), midlands (75 – 500 m a.s.l.), and high ranges (500 – 2000 m a.s.l.) (Iype et al. 1991). *D. ghatensis* is mainly a species of the midlands and high ranges of the state (Narayanan, unpublished observations), but it has been recorded from Aynaman, Kumarakom and Vadayar, of this wetland. Among these, Aynaman is located in the eastern boundary, where Kuttanad wetland meets the midland areas of the Kerala state. However, it would have been introduced to the other two localities, as part of the wetland reclamation activities.

Exotic, invasive *Pontoscolex corethrurus* is the most widespread species followed by the native peregrine *D. impertusa*. Among the various agro-ecological zones maximum species number were recorded from the Lower Kuttanad (10 species), followed by Upper Kuttanad and North Kuttanad (9 species each), whereas Vaikom Kari has the lowest species diversity (2 species) (Table 1). This difference is mainly due to the differential exploration frequency.

*Megascolex pentagonalis* was previously known only from the type locality Trivandrum (Thiruvananthapuram) (Stephenson 1916). In the present study, collections from two more additional sites (Chennithala and Eramathoor) indicated the expansion of its range to further north.
Table 1. Earthworm species recorded from various agro-ecological zones of Kuttanad wetland during the present study

<table>
<thead>
<tr>
<th>Species</th>
<th>Vaikom Kari</th>
<th>North Kuttanad</th>
<th>Kayal lands</th>
<th>Lower Kuttanad</th>
<th>Upper Kuttanad</th>
<th>Purakkad Kari</th>
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</thead>
<tbody>
<tr>
<td>Moniligastridae</td>
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<tr>
<td>Drawida ghatensis</td>
<td>+</td>
<td>+</td>
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<tr>
<td>Drawida impertusa</td>
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<td>+</td>
<td>+</td>
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<td>+</td>
</tr>
<tr>
<td>Drawida travancorensis</td>
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<tr>
<td>Acanthodrilidae</td>
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<tr>
<td>Lennogaster chittagongensis</td>
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<tr>
<td>Almidae</td>
<td></td>
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<tr>
<td>Glyphidrilus annandalei</td>
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<tr>
<td>Glyphidrilus fluviatilis</td>
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<td>Benhamiidae</td>
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<td>Dichogaster bolai</td>
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<td>Amyntas alexandri</td>
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<td>Lampito mauritii</td>
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<td>Megascolex konkanensis</td>
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<tr>
<td>Megascolex pentagonalis</td>
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<tr>
<td>Metaphire houletti</td>
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</tr>
<tr>
<td>Perionyx ceylanensis</td>
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<td>Perionyx excavatus</td>
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<td>Ocnerodrilidae</td>
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<td>Eukerria kuekenthali</td>
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<tr>
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<tr>
<td>Pontoscolex corethrurus</td>
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</tr>
</tbody>
</table>

Previously, *Glyphidrilus fluviatilis* was considered endemic to 4 locations, Madapur (= Madapura), Fraserpett (Kushalnagar), Shimoga (Shivamogga) in Karnataka state and Narayan of Vordeviu Dicu (Karnataka state?) (Rao 1922, Chanabun et al. 2013). Present record of *G. fluviatilis* from Kerala state is the first record after its original collection.

Ramsar sites like Renuka wetland and Pong Dam have 11 species each. Thus the Kuttanad wetland with its 19 species recorded proved to be earthworm rich among the wetlands of India. This is mainly due to geographical location of this wetland. Further investigation may add more species into the faunal list.

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