

Current distribution of the invasive earthworm *Pontoscolex corethrurus* (Müller, 1857) after a century of its first report from Kerala state, India

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Abstract. *Pontoscolex corethrurus* (Müller, 1857) is an important peregrine earthworm species in the humid tropics and is found in land disturbed by human activities. Its presence in Kerala state was first reported by Michaelsen in 1910. So far the occurrence of 14 exotic earthworm species has been reported from Kerala state. However present distribution status of any of these exotic species is not yet thoroughly studied. Now *P. corethrurus* is naturalized in forests, degraded areas, and agroecosystems from the higher altitude areas to the coastal zones. Here, the current distribution pattern of *P. corethrurus* in the state after a period of 100 years is highlighted.

Keywords. *Pontoscolex corethrurus*, exotic, earthworm, naturalized

INTRODUCTION

Earthworms are one of the important soil macro invertebrates and they function as consumers, decomposers, soil modulators, and food resources for other animals (Lee 1985, Lavelle *et al.* 1994, Edwards 2004, Zhang *et al.* 2007). 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 2002, 2009, 2012). When an exotic earthworm is naturalized in a new area it can seriously alter the structural properties of the soil, organic matter and nutrient dynamics, as well as plant and animal communities above and below ground (Hendrix *et al.* 2008). But the effects and implications of invasive species in below ground terrestrial ecosystems are not well known as compared to above ground terrestrial and marine ecosystems (Gonzalez *et al.* 2006). At present, peregrines are found to occur in every continent including Antarctica, on oceanic islands, every biogeographic

region and in nearly all types of ecosystems including desert oases. Most importantly, this spread mainly happened through human activities (Blakemore 2002, Hendrix *et al.* 2008). As per Blakemore (2008) and Julka (2014), there are 505 earthworms in India and 51 are exotic species. *Eisenia fetida* (Savigny, 1826), *Pontoscolex corethrurus* (Müller, 1857), *Eudrilus eugeniae* (Kinberg, 1867), *Nematogena panamaensis* (Eisen, 1900), *Metaphire houletti* (Perrier, 1872), *Polypheretima elongata* (Perrier, 1872), *Polypheretima taprobanae* (Beddard, 1892), *Ocnodrilus occidentalis* (Eisen, 1878), *Pontodrilus litoralis* (Grube, 1855), *Dichogaster affinis* (Michaelsen, 1890), *Dichogaster annae* (Horst, 1893), *Dichogaster bolau* (Michaelsen, 1891), *Gordiodrilus elegans* (Beddard, 1892), and *Pithemera bicincta* (Perrier, 1875) are the exotic earthworms so far reported from Kerala state (Stephenson 1923, Aiyer 1929, Julka & Paliwal 1990, Kathireswari *et al.* 2005, Narayanan *et al.* 2012). However, the entire diversity and distribution pattern of alien earthworm species of Kerala state is still not fully understood.

Pontoscolex corethrurus (Müller, 1857) of the Rhinodrilidae family (James & Davidson 2012; James 2012) is one of the peregrine and invasive species of earthworms found in the state. But it can be easily identified by the following characters; setae lumbricine, usually present from segments 1-2 in which they are very closely paired, AB and CD gradually wider from 3, one rank after another becoming more and more irregular until the quincunx arrangement is attained, towards the posterior end enlarged and ornamented ectally by transverse rows of fine teeth, one or both setae of ventral couples in some of 14–22 genital and ornamented ectally with longitudinal rows of gouges; clitellum saddle-shaped; male pores and tubercula pubertatis in clitellar region; septa all present at least from segments 5/6; digestive system with paired solid calciferous glands in 7–9, a well developed typhlosole but without intestinal caeca and supra-intestinal glands; metandric; spermathecae 3 pairs, pores are present on the intersegmental furrows of 6/7–8/9; seminal vesicles long, extending from 12 back through several segments; metagynous. It is an endogeic and meso-humic species, which has a highly efficient digestion system and exceptional demographic traits, and has colonized in various habitats and also in secondary forests due to its great tolerance for different habitats and wide range of soil conditions (edaphic plasticity) especially in the tropics (Lavelle *et al.* 1987, Lavelle & Pashanasi 1989, Lavelle *et al.* 1992, Tapia-Coral *et al.* 2006). *P. corethrurus* was first described by the German naturalist Fritz Müller in 1857 from individuals collected from Itajaí (now Blumenau) in Santa Catarina state of Brazil (Brown *et al.* 2006). The centre of origin of the genus *Pontoscolex* is the Guyana Shield region, including northern Brazil and the southern portions of Venezuela, Guyana, Surinam and French Guyana (Righi 1984). As per Lavelle *et al.* (1987), its expansion seems to be limited only by temperature and soil moisture values.

Michaelsen (1910) was the first person mentioning the occurrence of *P. corethrurus* in Kerala, he recorded it from Calicut (now Kozhikode), Cheyayur, Kerumaadi (Karumadi), Pallode (Palo-

de), Quilon (Kollam), Shasthancottah (Sasthamkotta), Tiruvallur and Trivandrum (Thiruvananthapuram). Later Cognetti (1911) mentioned about its presence in Travancore; Michaelsen (1913) and Stephenson (1916) reported its presence from Neyyattinkara (7 July 1911), Vellany (Vellayani), on 8 June 1911, Chimunga (Chemmunji) on 26 December 1911 and Bonaccord (Bonacaud) on 28 December 1911, based on the specimens collected by the taxidermist Shunkara Narayanan Pilley of the Trivandrum Museum. Even at that time a good number of specimens were collected from Vellayani and Neyyattinkara (Stephenson 1916). The two sites Kozhikode and Tiruvallur mentioned above are located in northern Kerala while rests of the sites are in southern Kerala. Later, Aiyer (1929) did an extensive survey on the Oligochaetes of the Travancore Kingdom. As part of this, he covered different forested regions as well as human inhabited areas like Kottayam, Thiruvalla, Kayamkulam etc., but he didn't find any individual of *P. corethrurus* from Travancore. He made a list of the earthworm species recorded from Travancore region by him and by former workers, but interestingly, *P. corethrurus* is not mentioned in that list. Nath and Chaudhari (2010) studied human induced biological invasion of *P. corethrurus* in rubber plantations of Tripura state of India. But information on the basic distribution pattern of *P. corethrurus* in Kerala is absent. This paper is aimed to address the current distribution pattern of *P. corethrurus* in the state, based on the data generated from the collections carried out as part of our ongoing study on the earthworm diversity of Kerala state.

MATERIALS AND METHODS

Kerala can be physiographically subdivided into lowlands (<75m above msl), midlands (75–500m above msl) and highlands (>750m above msl) (Balakrishna Pillai *et al.* 1991). Since 2010, as part of the ongoing taxonomical study on the earthworms of Kerala state, we have collected earthworm samples from all the districts, with various habitats like agricultural fields, various types of natural forests, plantations, homestead, grasslands, etc., of the state using the digging and

hand sorting method (Senapati & Sahu 1993). Being a part of the taxonomical studies on the earthworms of the state, physical attributes such as soil temperature, moisture content, pH and chemical characteristics of soil were not evaluated. *P. corethrurus* collected were identified using the key prepared by Julka (2008) and specimens examined were deposited in the earthworm laboratory of the Advanced Centre of Environmental Studies and Sustainable Development, Mahatma Gandhi University, Kottayam, Kerala, India.

RESULTS

In the present study a sizeable number of *P. corethrurus* were collected from 129 sites from all the 14 districts of the state (Figure 1). The name of the collection locality with altitude is given in Appendix 1. Interestingly, it has been recorded from various Wildlife Sanctuaries of the state such as Neyyar, Peppara, Shendurney, Chinnar, Malabar, Aralam and Periyar Tiger Reserve (Appendix 1). It has also been recorded from various sacred groves of northern Kerala. Collection sites ranged from high altitude Lockhart Marsh (1533m) near Munnar to low land areas like Kuttanad wetlands (below mean sea level). It is found that *P. corethrurus* thrives in various edaphic conditions like sandy coastal, alluvial wetlands, laterite formations and forest soils of the state.

DISCUSSION

From the present study it is clear that *P. corethrurus* has naturalized and invaded almost all disturbed areas of the state within a time span of 100 years. After independence, there were only a handful of records of this species available from Kerala. The reported places were Alappuzha (Gates 1973), Kanjikode (Kathireswari *et al.* 2005), Thiruvananthapuram (Killipalam, Vanchiyoor and Vellayambalam) (Nair *et al.* 2007), Silent Valley National Park and Wayanad Wildlife Sanctuary (Mohan *et al.* 2011). It is assumed that the species would have come to the state

either through the introduction of cassava (*Manihot esculenta*) or rubber (*Hevea brasiliensis*) plantation activities. Cassava is a popular root crop of Kerala and it was introduced into India by the Portuguese merchants in the 17th century. Later King Visakhram Thirunal Rama Varma of Travancore introduced and popularized cassava in Kerala during his time of reign from 1880 to 1885 (George *et al.* 2000). The first commercial rubber plantation of India was established at Thattekkadu in 1902. But Michaelsen's (1910) specimens were from all over the state; hence the mode of introduction appears to be more through cassava rather than rubber cultivation.

Aiyer (1929) has collected samples from 14 locations within the present day boundary of the state. Of these 14 locations, we have resurveyed eight sites, viz., Kumily, Peerumedu, Vandiperiyar, Kottayam, Thiruvalla, Chengannur, Kayamkulam and Ponmudi and collected *P. corethrurus*. The presence of this species in Thiruvananthapuram was already confirmed by Nair *et al.* (2007). Hence, it is clear that *P. corethrurus* has established itself in the above mentioned localities mainly after 1930's. All the recorded places of *P. corethrurus* in the 20th century were from midlands except Bonacaud of Thiruvananthapuram district, which is in the high lands. But now it is found to have spread over all the physiographical subdivisions of the state from the high altitude Munnar regions of Idukki district to the coastal regions. Change of land use pattern for agricultural purposes consequent to increased population pressure and migration has led to large scale deforestation, especially after World War II, in response to famine (Govindaru 1994). A major portion of the original forest land was also cleared for plantation crops such as teak, eucalyptus and cashew in the earlier years (Govindaru 1994). All these activities would have created a perfect niche for *P. corethrurus* for invasion and naturalizing in the new areas. Present study revealed its presence in five protected areas of the state. Before this, Wayanad Wildlife Sanctuary was the only protected area in the state from where its presence was confirmed (Mohan *et al.* 2011).

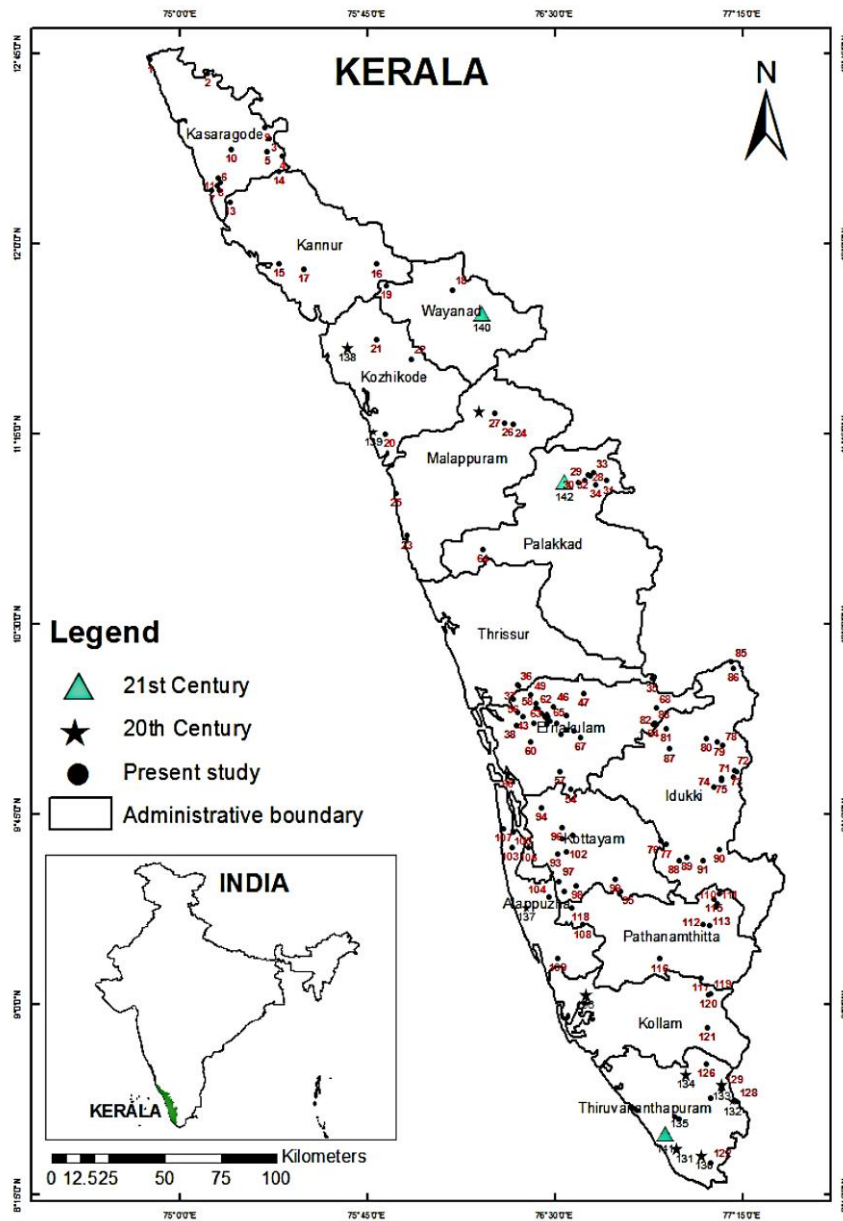


Figure 1. Distribution of *Pontoscolex corethrurus* in the Kerala state

As per Julka (2008), *P. corethrurus* is frequently found in human influenced habitats like cultivated land, garden soils, coconut and rubber plantations, manure and compost heaps, under rotten tree trunks and disturbed forest. This species has high edaphic plasticity, which also helped them to widely colonize in various habitats which we have surveyed. Now, it has been collected from various soil conditions such as sandy

coastal regions, alluvial wetlands, laterite formations, and higher altitude forest soils. Lavelle (1987) stated that *P. corethrurus* has narrow microclimatic requirements and because of this, it is tolerant to a wide range of soil conditions. It was found principally in pastures and fallows, and rarely in natural forests (Kathireswari et al. 2005). The species has a strong association with man-made ecosystems (Lavelle & Pashanasi 1989,

Barros et al. 2003, Marichal et al. 2010, Rossi et al. 2010). The present study revealed the presence of *P. corethrurus* in various forested regions of the state, but all those regions are disturbed areas due to anthropogenic activities. Tapia-Coral et al. (2006) reported the conspicuous presence of *P. corethrurus* in plant residue-rich tropical soils and Marichal et al. (2010) mentioned that land use may determine its occurrence and coexistence with other species.

Authors have reported that *P. corethrurus* has the ability to enhance nutrient release in soil (Lavelle et al. 1987, Lopez-Hernandez et al. 1993, Chapuis-Lardy et al. 1998), promoting plant growth and tolerance to phyto-parasitic nematodes (Pashanasi et al. 1996, Lafont et al. 2007). It has also been recorded that when this species is established in an area it can affect soil physical properties (soil compaction) (Hallaire et al. 2000, Chauvel et al. 1999), modify biogeochemical processes (Gonzales & Zou, 1999, Barros et al. 2001, Liu & Zou 2002), and affect plant (Zou 1993) and microbial communities (McLean et al. 2006).

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Online supporting material: Appendix 1 (http://opuscula.elte.hu/PDF/Tomus47_1/Narayanan_Appendix1.PDF)