

First Report of the Earthworm *Pontoscolex corethrurus* (Müller, 1857) from Punjab, India

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Keywords: Endogeic, Oligochatae, Rhinodrilidae, Taxonomy

Abstract: The earthworm *Pontoscolex corethrurus* (Müller, 1857) is reported for the first time from Punjab, India. This species was first described by German naturalist Fritz Müller in 1857 from Santa Catarina state of Brazil. It is commonly found in gardens, cropland and fallow lands. It tolerates wide range of climatic and edaphic factors due to its endogeic ecological category. *P. corethrurus* has high efficiency for organic matter assimilation and has ability to live in new habitat due to which it can survive even in very poor soil. The life cycle of this species is well documented and this species has economic importance due to its use in waste management.

1. Introduction

There are total 505 earthworm's species present in India; out of which 51 are exotic species [1, 2]. *Pontoscolex corethrurus* [3] of the Rhinodrilidae family [4, 5] is an exotic earthworm species which belongs to endogeic ecological category [6, 7]. This species was first described by German naturalist Fritz Müller in 1857 from Santa Catarina state of Brazil [8]. *P. corethrurus* is also known as "brush-tail worm" due to quincunx arrangement of setae in the tail part [3]. Michaelsen [9] was the first who reported *P. corethrurus* from India (in Kerala state). Narayanan et al. [10] presumed that this species might have come to India by the introduction of cassava (*Manihot esculenta*) or rubber (*Hevea brasiliensis*) plantation activities, among these former were introduced by the Portuguese merchants in 17th century. Exotic species are transferred to new areas by man with the introduction of soil containing materials such as plant, agricultural and horticultural products. These exotic species settle successfully due to their ability to withstand in disturbance and interference [11]. Sakai et al. [12] put four hypothesis to explain the success of invasive species a) they have trait that favour the each stage of invasive process b) invasive species exploit empty niches c) they are positively favoured by anthropogenic activities d) they are no longer under parasitic, predatory or competitive pressure. Change in land use pattern for commercial and agricultural purposes may result in increased pressure on population causing some earthworm to migrate to new localities and replace the native species at a particular region [13, 14]. Parthenogenesis is also an important characteristic of many invasive species to establish a population from single individual [15]. *P. corethrurus* is commonly found in gardens, cropland and fallow lands, which are having wide range of tolerance to climatic and edaphic factors [16] and also having high organic matter assimilation efficiency [6, 7]. According to Lavelle et al. [17] and Hendrix et al. [18], the peregrine species are well adapted in human activity and also colonize in disturbed habitat. It is also considered as a bioindicator for the assessment of soil quality and ecosystem disturbance [6].

Dhiman and Battish [19] reported thirty species of earthworms from northern Indian states, out of which twenty species have been recorded from Punjab. Paliwal [20] reported nine species of earthworms from wetlands of Gobindsagar and Nangal Dams while Koul and Kocher [21] reported

only three species of earthworms from vegetables field near Buddha Nullah, District Ludhiana, Punjab, India. Singh et al. [22] described two species *Metaphire houlleti* and *Eutyphoeus waltoni* from Amritsar (Punjab, India) which was first time reported. Singh et al. [23] reported 5 species of earthworms from different land use patterns in northwestern parts of Punjab and correlate their distribution with physico-chemical properties of the soil. In this study, earthworms were collected from all over the state and after critical examination of earthworm's specimens and other references material have resulted that species *P. corethrurus* being reported for the first time in Punjab. This is the addition of a new species into the checklist of earthworms from Punjab, India.

2. Materials and Methods

The present study was carried out in Punjab, India. Punjab is bounded by Pakistan on the west, Jammu and Kashmir on the north, Himachal Pradesh on the northeast and Haryana and Rajasthan on the south. Most of the Punjab lies in a fertile, alluvial plain with many rivers and an extensive irrigation canal system. Punjab is influenced by three seasons: summer, monsoon and winter. In summer (April to June) temperature typically rise as high as 43°C, in monsoon season (July to September) a majority of rainfall occurs, and in winter (December to February) temperatures typically fall as low as 4°C. There are total 22 districts in Punjab and earthworms were sampled from all the district of the state from different land use pattern like agricultural land, along river canal side, road side, forest, gardens and nurseries by the hand-sorting method up to 30 cm deep by using quadrates (30 × 30 cm² area). A global positioning system (GPS) (Garmin, Gpsmap 78s) was also used to mark the latitude and longitude of each sampling site. Moisture content was measured with a digital soil moisture meter (Micro make). The collected samples of earthworms with appropriate amount of soil were placed in polythene bags labelled with place name, date of collection, surrounding soil biota etc. and brought to the research lab for further study. Earthworms were washed in fresh water and sorted on the presence or absence of clitellum. Earthworms were narcotized in 70% ethyl alcohol and fixed in 5% formalin for 6-8 hours and finally preserved in 5% formalin. The preserved samples of earthworms were identified and confirmed by Dr J.M. Julka (Former Scientist, Zoological Survey of India), Shoolini University, Solan (Himachal Pradesh). These preserved samples were deposited into the zoological museum, Department of Zoology, Khalsa College, Amritsar (India).

Soil was analysed for texture, pH, electrical conductivity (EC), total dissolved salts (TDS), nitrogen (N), phosphorus (P), organic carbon (OC) and organic matter (OM) to know the habitat preference of *P. corethrurus*. Soil texture was measured by using method of Bouyoucos [24]. pH, EC and TDS was measured by using a digital meter (Eutech Instruments, PCSTestr 35 series). The method of Bremner and Mulvaney [25] was used for estimation of Total Kjeldhal Nitrogen. Content of organic carbon and organic matter was measured by the method of Walkley and Black [26]. Phosphorus was estimated by the method of John [27] by using Systronics UV/Visible spectrophotometer-117.

3. Results and Discussions

Earthworms were sampled from all 22 districts (370 sampling sites) of state of Punjab but *P. corethrurus* was first time reported from the garden of Nurpur Bedi (N 31° 10' 21", E 076° 28' 21"), District Roopnagar (Fig. 1). The Noorpur Bedi is situated near Hills of Shivalik with maximum area under the forest. The surrounding of sampling site was covered with grass and leaf litter. Total 24 earthworms individual were collected from sampling site, out which only 6 earthworms were *P. corethrurus* while others earthworms belongs to species *Metaphire posthuma* and *Amyntas morissi*. The coexistence of this species with other native species had been observed in several sites of Brazil, India, Thailand and Singapore [28, 29]. Dash and Saxena [30] compiled the earthworm diversity from Himalayan and Western Ghats regions of India and reported that *P. corethrurus* were present only in eastern Himalayan and Western Ghats regions but absent in the western Himalayan region. Sinha et al. [31] also reported *P. corethrurus* in Jharkhand and also mentioned its

distribution in Andhra Pradesh, Maharashtra, Gujrat, Karnataka, Tamilnadu states of India. Stephenson [32], Tripathi and Bhardwaj [33], Sathianarayanan and Khan [34] and Halder et al. [35] reported this species from Andaman & Nicobar, Rajasthan, Puducherry and West Bengal respectively. Dhiman and Battish [19] also studied the earthworm diversity from northern states viz Punjab, Haryana, Himachal Pradesh, Uttrakhand, Delhi and its adjoining areas. They reported 30 species of earthworms belonging to 6 different families but there is no report for the presence of *P. corethrurus* in Punjab. Thus present study adds a new species to the checklist of earthworms from Punjab.

The important morphological diagnostic characters of *P. corethrurus* are shown in Fig. 2. The setae of *P. corethrurus* is lumbricine, usually present from segments 1-2 in which they are very closely paired, one rank after another becoming more and more irregular until the quincunx arrangement at tail end, 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. In *P. corethrurus*, male reproductive organs are absent or reduced [36, 37]. Their cocoons viable without mating and showing parthenogenesis [38] while Dupont et al. [39] suggested the occurrence of sexual reproduction on the basis of population genetics.

The detailed physico-chemical characteristics of soil are given in Table 1. pH of soil at sampling site was 8.02, N (0.23 g/kg), P (0.02 g/kg), OC (3.54%) and organic matter (7.02%). According to Garcia and Faroso [40], *P. corethrurus* tolerates wide range of soil pH, but Teng et al. [41] observed that this species often found in acidic soil i.e. 4.5 to 6.8, but it also favours soil with high pH range. Tripathi and Bhardwaj [33] also observed pH range from 7-8 at *P. corethrurus* sampling site. The soil nitrogen also acts as a limiting factor for the presence of earthworms in the soil. Presence of leaf litter at the collection site was the main source for nitrogen, organic carbon and organic matter for this species. Increasing nitrogen input to the soil with grasses increases earthworm abundance [42]. Piotrowska et al. [43] also reported that the earthworm biomass and number also increases in fast growing grasses and legumes. The presence of nitrogen rich residue supports high earthworm demand for nitrogen and produces less and bigger cocoon in soil with high nitrogen availability [44]. Liu and Zou [45] and Ganihar [46] reported that this species prefer soils rich in terms of organic matter and leaf litter content. The present study also corroborates with finding of Ortiz-Gamino et al. [47] and reported 8 to 8.4% range of organic matter. Ayala and Barois [48] observed that *P. corethrurus* was unable to grow in soil with 75-100% organic matter content. The soil texture of the collection site was Sandy Loam (Clay 9%, Sand 63%, Silt 28%). Hureta et al. [49] also observed that this species prefers soil with high silt content while Marichal et al. [50] observed positive relationship between clay content and *P. corethrurus*. The *P. corethrurus* were found in high density in a sandy soil having low organic matter content [29]. High abundance of this species in sandy soil may be due to assimilation of carbon released in the soil from plant roots [51].

4. Conclusion

P. corethrurus was reported for the first time from the Punjab and is an addition to species checklist of earthworms from this state. Till now *P. corethrurus* was registered from different parts of India. Also this invasive peregrine species is expected to be found in other parts of the country. More detailed investigation is needed because large areas of India have not been yet explored properly for earthworm biodiversity.

Acknowledgement

We are thankful to Science and Engineering Research Board (SERB), Department of Science and Technology, Government of India, New Delhi for financial assistance in the form of a Major research project letter No SR/SO/AS-030/2013. We are also highly thankful to Dr. J.M. Julka, Shoolini University, Solan, Himachal Pradesh, India for identification of earthworm species.

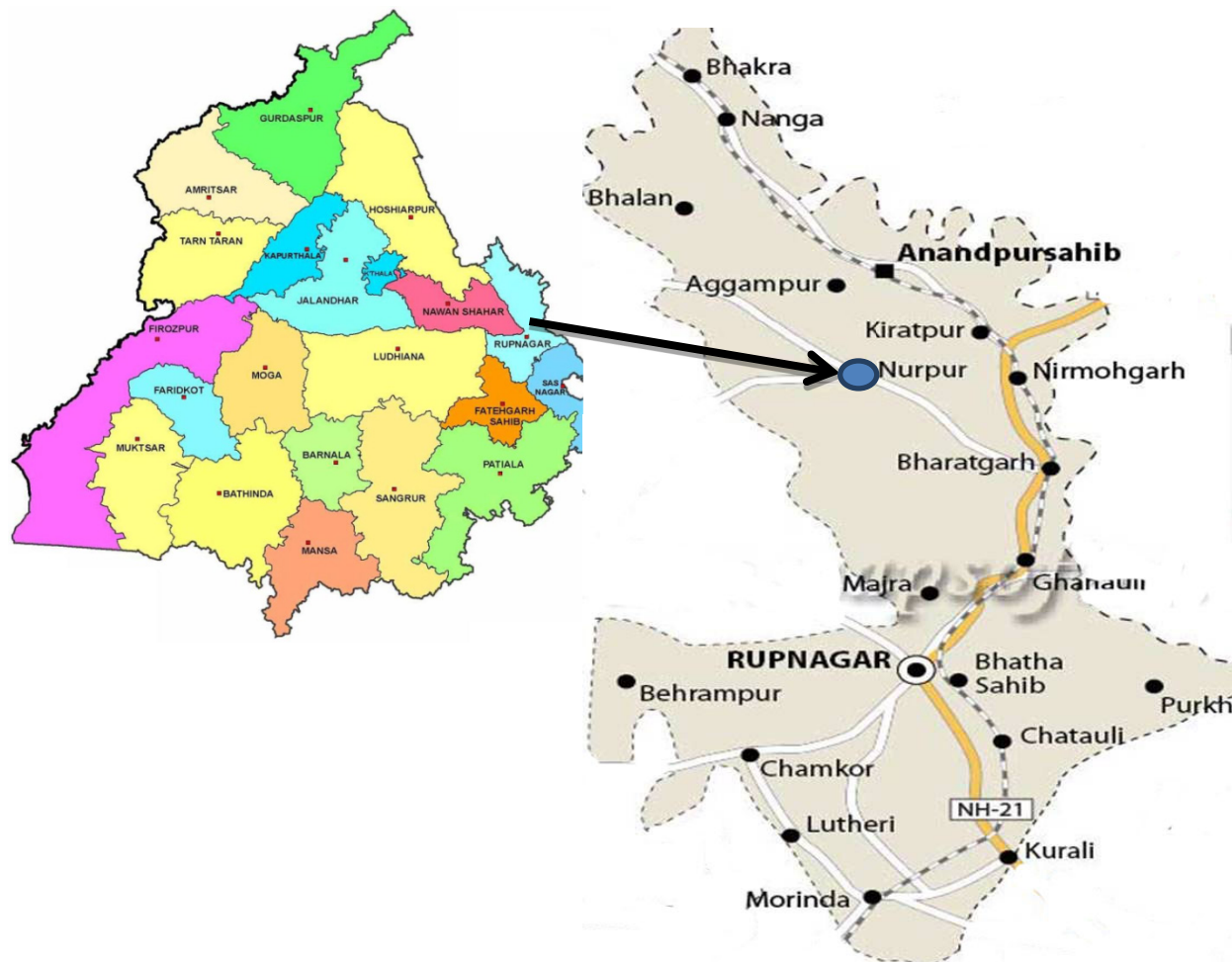


Figure 1. Map showing location of sampling site.

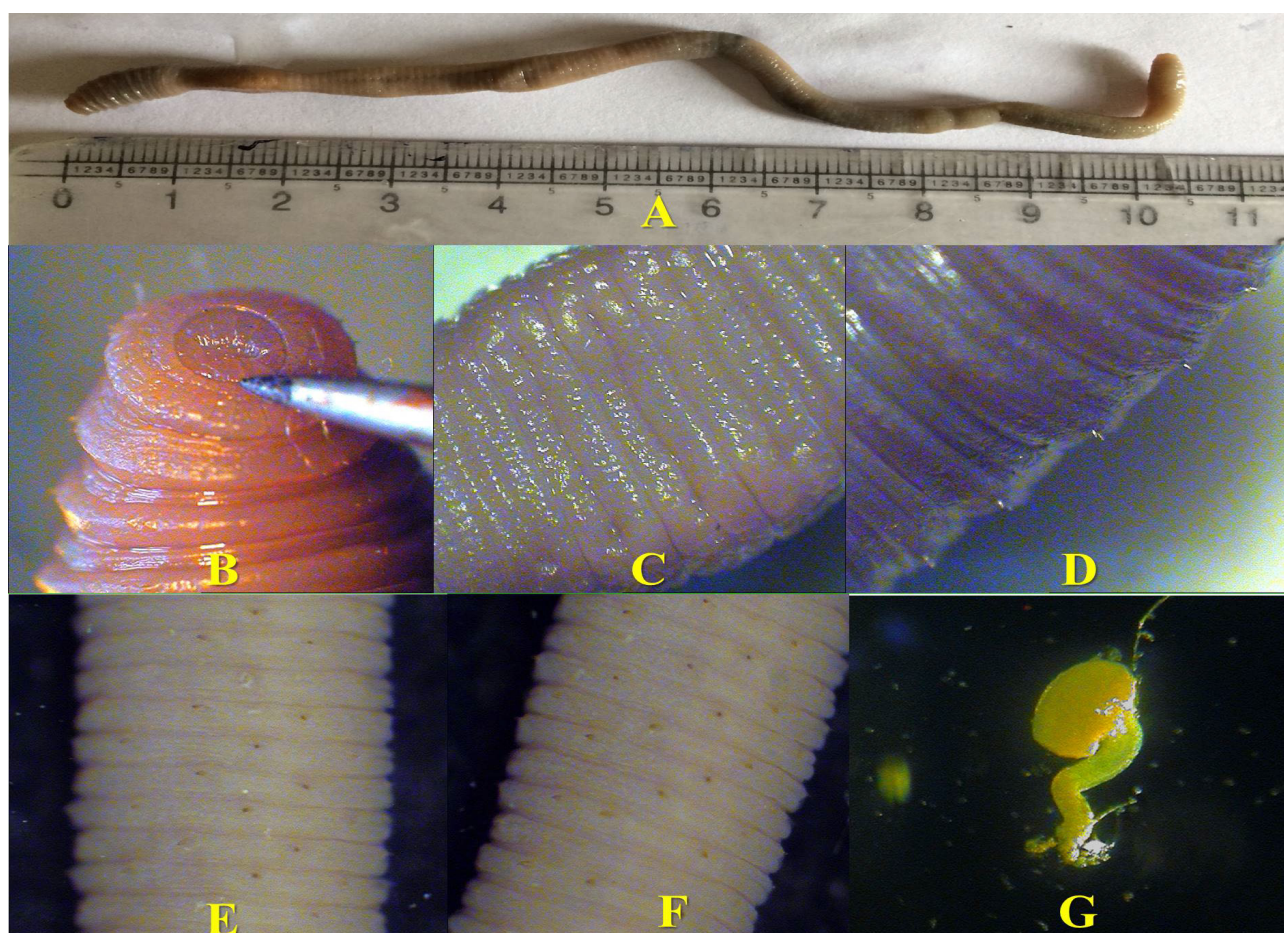


Figure 2. Earthworm *Pontoscolex corethrurus*. (A) Earthworm; (B) Prostomium; (C) Male Pore with Saddle shaped clitellum; (D) Spermathecae pore; (E & F): Quincunx arrangement of Seate in Posterior segments; (G) Spermathecae.

Table 1. Physico-chemical characteristics of sampling site.

S. No.	Parameters	Values*
1	pH	8.02 ± 0.24
2	Electrical Conductivity (μS)	112.5 ± 1.7
3	Total Dissolved Solids (mg/L)	76.75 ± 0.95
4	Organic Carbon (%)	3.54 ± 0.03
5	Organic Matter (%)	7.09 ± 0.07
6	Nitrogen (g/Kg)	0.23 ± 0.01
7	Phosphorous (g/Kg)	0.026 ± 0.00
8	Soil Texture	Sandy Loam (Clay 9%, Sand 63%, Silt 28%)

*Data is mean ± S.E. of triplicates

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