Earthworm diversity and distribution in district Mandi, Himachal Pradesh of Northwest Himalaya, India

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Abstract
The present survey of diversity and distribution of earthworms in District Mandi of Northwest Himalayan region conducted in two years from May 2013 to April 2015. Based on study reported 17 species belonging to 4 families. Information on earthworms scientific name, family, number, locality and general habitat are given for each species discussed in the text. Out of these 17 species, six native and 11 exotic species are recorded. There are three species which are firstly recorded in the study area these includes Eisenia fetida, Arglaphilus sp. and Aminthus morrisi. The study provided extended information on earthworms’ diversity in the study area with special reference to change in species along with change in vegetation and altitude.

Keywords: Diversity, Earthworms, habitat preference, Northwest Himalayas

Introduction
The great Himalayan mountain ranges on northern border of the Indian subcontinent hold key to the ecological security of the region (Negi, 2009) [55]. Rampant deforestation in these mountains, especially in the low and mid hills, has led to severe ecological imbalance in the entire subcontinent (Giri et al., 2003; Bolland et al., 2007; Kohli et al., 2009) [28, 11]. Furthermore, Pandit et al. (2009) [57] have estimated that dense forests (> 40% canopy) in the Himalayas would decrease to 10% of its geographical area by the end of this century. Because of extensive ecological degradation and loss of native vegetation, the Himalayas are included in the list of biodiversity hotspots for priority conservation (Myers et al., 2000; Mittermeier et al., 2004) [54, 53].

The state of Himachal Pradesh in the northwestern Himalayas, the area of present studies, has undergone rapid changes in the land use systems (Shah and Sharma, 2015) [62]. These changes not only affect the aboveground communities, but also a thriving rich belowground biodiversity, which is crucial for functioning of soil ecosystem (Saxena et al., 2005; Decaens, 2010; Eisenhauer et al., 2019) [61, 20, 22]. Earthworms are one of the most abundant soil macro fauna involved in the formation of soil and maintenance of soil fertility. The present investigations are aimed to update our knowledge on the diversity and distribution of these organisms in some selected land use systems of mid Himalayan hills.

Earthworms are well known invertebrate distributed throughout the world and play an important eco-functional role in soil ecosystem by influencing physical, chemical, biological properties of the soil. Earthworms play an essential role in carbon turnover, nitrogen mineralization, soil formation, cellulose degradation and humus accumulation etc (Ansari and Ismail 2012) [41]. Approximately 4,400 different species of earthworms have been identified worldwide (Sinha 2003) [65], with reports on diversity of earthworms in various parts of the world including those of Tasi et al. (2000); Blakemore (2003); Blakemore et al. (2006) [8]. Julka et al. (2009) reported 590 species of earthworms from India and although earthworm are well studied in other parts of India (Chaudhuri et al.2008; Karmegam & Daniel 2007; Sathianarayanan & Khan 2006; Tripathi & Bhardwaj 2004; Bist et al. 2003) [60, 8, 72].

Earthworms from the West Himalayan ranges had been explored by various oligochaete taxonomists (Bourne, 1889; Fedarb, 1898; Michaelsen, 1907b, 1909; Stephenson, 1914, 1916, 1922) [12, 24, 51, 52, 69, 70, 71].
Various studies, during the last ninety years or so, had brought to light additional species of earthworms from the area (Cernosvitov, 1937; Gates, 1945c, 1951; Soota and Julka, 1970; Sharma and Kaul, 1974; Soota and Halder, 1980; Julka, 1979, 1981, 1988, 1995; Halder and Ghosh, 1997; Julka and Paliwal, 1993a, 1994, 1995, 2000) [14, 25, 26, 66, 63, 54]. Paliwal and Julka (2005) [30] included 51 species in their checklist of earthworms of the Western Himalayas. Recently, new records of two species more species had been added to the list, raising the number to 53 species from these mountains (Kumari et al., 2017; Ahmed & Julka, 2017) [46, 2, 47]. The latest figures for the earthworm diversity of India showed the existence of 421 species (Julka, 2014; Ahmed & Julka, 2017) [2], which constituted to about 10.5% of world’s known species estimated at 4,000 by Reynolds (1995) [39].

Material and Method

Study site

The study area is located in the Himalayan state of Himachal Pradesh between 30.2240° N to 33.1240° N latitude and 75.4555°E to 79.0420° E longitude. The present investigations were carried out at Karsog in District Mandi, Himachal Pradesh. Located at an altitude of 1404 m amsl, Karsog is a small town at a distance of about 120 km from Mandi and 109 km from Shimla. It is situated between 31°15´ 42''N and 77° 6́ 15̋ E to 77°23́ 25̋ E longitude. The area experiences four seasons viz., winter (December - February), spring (March – May), summer (June –August) and autumn (September - November). Earthworms were collected by digging and hand sorting method. Earthworms were sampled following the standard technique as described by Anderson and Ingram (1993) [39]. A plot of 10 m x 10 m was randomly selected for earthworms and soil sampling. Sampling was done bimonthly for two years (May 2013 – May 2015).

All the earthworms were dropped directly into 5-10% formalin. After 5-6 hours of fixation these were preserved in 70% ethanol. Directly fixed worms get uniformly contracted and provide useful characteristics of external region. The preserved earthworms were sealed in vials before being transported to the laboratory and later identified in the laboratory, counted and weighed. Each lot of preserved earthworms was accompanied by a label indicating collection locality and date of collection.

Soil samples of depth 0-30 cm were collected; plant residue gravel and other foreign matter were discarded. The soil sample was air dried on a clean sheet of paper and kept in a polythene bags for further soil physical and chemical analysis. Soil temperature of the habitat was recorded by using soil thermometer, soil moisture by using gravimetric method, soil pH by digital pH meter and organic carbon by wet digestion method as described by Walkley and Black (1934) [73]. Available nitrogen was analyzed by Micro-Kjeldahl method (Bremner, 1996). Available phosphorus was analyzed by Olsen’s and Bray’s method. Available potassium was analyzed by using flame photometer (Stanford and English, 1949) [68].

Results

The earthworm survey conducted in district Mandi revealed that the occurrence of seventeen species of earthworms belonging to four families namely Moniligastridae, Lumbricidae, Octochaetidae and Megascolecidae. Earthworm were collected from different habitat such as forest area, grassland, land near shallow water, road side, vegetative garden, cultivation land and orchard. The different species of earthworms are given in table 1.

Table 1: List of Earthworm Species, Families and Ecological Categories

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Species</th>
<th>Below 1500</th>
<th>1500-2500</th>
<th>2500-3500</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Moniligastridae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Drawida japonica (Michaelsen, 1892)</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>2</td>
<td>Drawida nepalensis Michaelsen, 1907 [51]</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lumbricidae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Bimastos parvus Eisen, 1874</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>4</td>
<td>Aporrectodea caliginosa caliginosa (Savigny 1826)</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>5</td>
<td>Aporrectodea caliginosa trapezoids (Duges, 1828)</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>6</td>
<td>Aporrectodea rosea rosea (Savigny 1826)</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>7</td>
<td>Dendrodrilus rubidus (Savigny 1826)</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>8</td>
<td>Eisenia fetida* (Savigny 1826)</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>9</td>
<td>Octolasion tyrtaeum (Savigny 1826)</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Acanthodrilidae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Argilophilus raigarhensis**</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Octochaetidae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Lennogaster pusillus (Stephenson, 1920)</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>12</td>
<td>Octochaetona Beatrice (Beddard, 1902)</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Megascolecidae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Amythys corticis (Kimberg, 1867)</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>14</td>
<td>Amythys morrisii* (Beddard, 1892)</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>15</td>
<td>Metaphire houfleti (Perrier, 1872)</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>16</td>
<td>Perionyx barotensis Julka and Paliwal, 1993</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>17</td>
<td>Perionyx excavatus Perrier, 1872</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

*First record from Mandi
** New species

Diagnostic account and distribution of earthworm species

Moniligastridae

1. **Drawida japonica** (Michaelsen, 1892)

Material Examined - 4ex., Pangana alt 1482 m; 6ex., Dhawas alt 1540 m; 2ex., Kamrunag alt 2790 m; 3ex., 4ex., Jagot alt 1450 m; 5ex., Bakhrot alt 1929 m; 7ex., Dhamoon alt 2420 m; 3ex., Kuyrgi alt 1450 m; General Habitat - Cultivation land, Vegetative Garden,
2. *Drawida nepalensis* Michaelsen, 1907 [51]
   Material Examined Locality – 3ex., Dhawas alt 1540 m; 4ex., Nagara alt 1865 m; 2ex., Jagot alt 1450 m; 3ex., Kutachi alt 1785 m; General Habitat - Cultivation land, Mixed Forest

Lumbricidae

3. *Bimastos parvus*
   Material Examined – 2ex., Chakra alt 1765 m; 3ex., Surachi alt 1665 m; 6ex., Raigarh alt 2710 m; 5ex., Nahrinala alt 2650 m; 2ex., Shikaridhar alt 3145 m; 5ex., Buhulal alt 2670 m; General Habitat - Mixed Forest, Cultivation, Shallow water bank

4. *Aporrectodea caliginosa caliginosa*
   Material Examined – 4ex., Bakhrot alt 1929 m; 5ex., Kamrunag alt 2790 m; 3ex., Restadhar alt 1920 m; General Habitat – Grassland, Deodar Forest, Ban Forest

5. *Aporrectodea caliginosa trapezoides* (Duges)
   Material Examined - 5ex., Sayanj alt 2018 m; 4ex., Kamrunag alt 2790 m; 7ex., Shankardehra alt 1750 m; 6ex., Katanda alt 2570 m; 4ex., Pandar alt 2550 m; 6ex., Dhamoon alt 2420 m; 4ex., Restadhar alt 1910 m; 5ex., Bakhrot alt 1929 m; General Habitat - Grassland, Mixed forest, Steam bank

6. *Aporrectodea rosea rosea* (Savigny)
   Material Examined-6ex., Restadhar alt 1910 m; 3ex., Seribanglo 2087 m; 4ex., Shikaridhar 3145 m; General Habitat - Orchard, Mixed Forest

7. *Dendrodrilus rubidus* (saviy)
   Material Examined-4ex., Nagara alt 1865 m; 3ex., Katanda alt 2578 m; 5ex., Pandar alt 2550 m; General habitat - Cultivation land, Mixed Forest

8. *Eisenia fetida*
   Material Examined-4ex., Pangana alt 1482 m; 7ex., Churag alt 1895 m; 5ex., Seribanglo alt 2080 m; 4ex., Monala Narash and Monala alt 2110 m; 5ex., Kamru nag alt 2790 m; 11 ex., Chatri alt 1840 m; 8ex., Janjhali alt 2100 m; 7ex., 5ex., Nahr nala alt 2600 m; 5ex., Kandi alt 2100 m; 9ex., Raigarh alt 2760 m; 4ex., Nagara alt 1865 m; 6ex.; Kayragi alt 1450 m; General Habitat-Cultivation land, Orchard, Forest, Veg. Gardan

9. *Octolasion tyrtaeum* (Savigny)
   Material Examined-5ex., Pangana alt 1482 m; 3ex., Churag alt 1840 m; 2ex., Monalnarash and Monala alt 2110 m; 4ex., Kamrunag alt 2790 m; 4ex., Pander alt 2550 m; 5ex., Katanda alt 2200 m; 6ex., Magroo alt 2880 m; 3ex., Dhamoon alt 2420 m; 5ex., Chowki alt 1848 m; General habitat-Orchard, Grassland, Mixed Forest, Road side area

Octochaetidae

10. *Lennogaster pusillus* (Stephenson)
    Material Examined-4ex., Dhawas alt 1540 m; 5ex. Jagot alt 1450 m; General Habitat - Cultivation land

11. *Octochaetona beatrix*
    Material Examined-6ex., Jagot alt 1450 m; General Habitat-Cultivation land

Megascoleidae

12. *Amynthas corticis*
    Material Examined-5ex., Karsog alt 1450 m; 4ex., Jarli alt 1450 m; 3ex., Kutachi alt 1785 m; General Habitat-Orchard, Cultivation land

13. *Amynthas morrisi* (Beddard)
    Material Examined-5ex., Jarli alt 1450 m; 1ex., Nagara alt 1865 m; General Habitat-Orchard, Cultivation land

14. *Metaphire houletti*
    Material Examined-5ex., Shankerdehra alt 1750 m; 4ex., Jarli alt 1450 m; 4ex., Jagot alt 1450 m; General Habitat-Orchard, Orchard, Cultivation

15. *Perionyx excavatus* (Perrier)
    Material Examined-4ex., Kamrunag alt 2790 m; 3ex., Seribanglo alt 2080 m; 4ex., Kandi alt 1880 m; 3ex., Raigarh alt 2760 m; 4ex., Katanda alt 2200 m; 6ex., Dhamoon alt 2420 m; 4ex., Chatri alt 1840 m; 5ex., Shankardehra alt 1750 m; 7ex., Kayargi alt 1450 m; General Habitat-Cultivation land, Veg. Gardan, Orchard, Grassland, Mixed forest

16. *Perionyx barotensis*
    Material Examined – 4ex., Katanda alt 2200 m; 2ex., Surachi alt 1665 m; 4ex., Kamrunag alt 2790 m; 3ex., Janjhali alt 2034 m; 2ex., Jakhralna alt 2680 m; General Habitatate – Forest, Grassland

Acanthodrilidae

17. *Argilophilus sp.
    Material Examined-3ex., Raigarh alt 2710 m; 5ex., Shikaridhar alt 3145 m; 2ex., Jhakrinala alt 2680 m; 4ex., Nagara alt 2650 m; General Habitat-Fir and Spruce Forest

Discussion

The earthworm diversity in present studies comprised of exotic and native peregrine species. Habitat fragmentation was primarily responsible for establishment and predominance of exotic earthworms at places occupied by native species (Kalisz and Wood, 1995). Reynolds (1995) [59] and Julka (2014) attributed global spread of exotic species to rise in various anthropogenic activities. Blanchart and Julka (1997) [10] opined that changes in land use pattern directly affected species composition of earthworms. Studies showed that, native earthworms were threatened due to rapid and extensive destruction of their natural habitats (Julka et al., 2007) [33]. At the same time, intense disturbances in primary forests caused loss of native and proliferation of exotic species (Lavelle et al., 1987; Barros et al., 2003; Geissen et al., 2009) [14, 5, 27]. Addison (2009) [1] indicated that climate changes due to global warming were responsible for the establishment of exotic earthworms. Range expansion of some exotic species was linked to changing climatic
conditions (Melody and Schmidt, 2012; Kumari et al., 2017; Ahmed and Julka, 2017) [20, 2, 46, 47].

Functional categories of earthworms are modified by changes in land cover and edaphic parameters. In present studies show that both natural and impacted land use types were dominated by endogeic earthworms. Bhadaura et al. (2000) [46] also recorded similar results for Central Himalayan land use systems. Endogeic earthworms were found to be most resistant to disturbance in impacted habitats (Jouquet, et al., 2010) [18]. Endogeic species Aporrectodea rosea around occurs in all land use types; Drawida japonica in all land use types except in mixed forest; Octochaetona beatrix, Drawida nepalensis and Lennogaster pusillus only in cropland; Aporrectodea caliginosa trapezoidea restricted to grassland. High population of endogeic earthworms in croplands and vegetable could be due to increased food resource due to incorporation and inversion of organic materials in soil during ploughing and tilling (Chan, 2001; Curry, 2004; Ernst and Emmerling, 2009) [16, 19, 23]. Epi-endogeic earthworms, consuming leaf litter and top mineral soil, were found in all land use types except in grasslands. Shartell et al. (2015) [64] opined that epi-endogeic worms had strong association with human impacted habitats and ability to coexist with other functional groups.

Anecic functional group of earthworms was not found in any of the land use types under the present study that were either degraded or highly disturbed. According to Lee (1985) [49] and Curry (2004) [19], population of anecic worms tended to be low in croplands as tillage damaged their vertical burrows. Transformation of forests into agroecosystems led to elimination of anecic species and predominance of endogeic worms (Blanchart and Julka, 1997; Zou et al., 2006; Gonzalez et al., 2008) [10, 29]. Studies show that anecics worms were strongly affected by disturbance as they required stable environment (Norgrove et al. 2009) [56]. No earthworms of epigeic functional group were encountered in any of the five land use types of this study, Curry and Good (1992) [18] attributed decline in number of epigeic earthworms due to the disappearance of surface litter after deforestation and degradation of forests.

References


38. Julka JM. Anthropochorous earthworms of Lahaul Valley (Himalach Pradesh) with notes on their ecology. UAS tech series-India, University of Agricultural Sciences, Bangalore, 1981, 6976.
59. Reynolds JW. Status of exotic earthworm systematics and biogeography in north America; in Hendrix PF, ed.
Earthworm ecology and Biogeography in North America


