Earthworm resources in the Gangetic Plain of Uttar Pradesh, India

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Based on an extensive survey of Gangetic Plain of Uttar Pradesh during August - October 2008, the communication reports first-hand information on 11 taxa of earthworms belonging to 6 genera and 2 families that were commonly found in the study area. This constitutes 26.3% of total Indian earthworm fauna. Of these, 04 taxa are exotic with extra Indian origin. The information on their scientific names, family, distribution, locality and voucher specimen no(s), habitat, soil texture etc are given for each species enumerated in the text. The study contributes first-hand material on earthworm fauna of the study area, thus for neglecting and likely to add more native species to the existing ones which are very specific for vermicomposting process.

Key words: Biodiversity, earthworm, agro-climatic zones, Gangetic plain, India.

INTRODUCTION

Earthworms (folk names include dew-worm, rain worms, night crawler and angle worm) are important biological resources that have a tremendous potential in agro-ecosystems because they significantly affect soil physical structures and organic matter and nutrient dynamics, and promote plant growth (Lee, 1985; Lavelle et al., 1988). India is a diverse country harbouring a very high diversity of earthworms, mostly concentrated in Western Ghats and Eastern Himalayas both of which are recognized as biodiversity ‘hot spots’. Although this area is only 2% of the world’s land mass, it supports about 10.5% of the total known global earthworm diversity, estimated at 4000 species.

Indian earthworms fauna predominantly represented by native species, constitute about 89% of total earthworm diversity in the country (Julka and Paliwal, 2005). Forests in India have been cleared on a large scale primarily for agricultural practices, construction and other developmental activities. Changes in land use pattern have directly affected the composition and population structure of earthworm species in different agro-climatic regions of the country (Blanchart and Julka, 1997; Behera et al., 1999; Bhadouria et al., 2000). Native species are threatened because of rapid and extensive destruction of their natural habitats.

Review of literature and present work

During the last few decades, the earthworms of Indian subregion have been studied to some extent viz. Eastern Himalayas (Julka, 1975a, 1976a and 1977, 1981), Khasi and Garo hills (Julka, 1977), Orissa (Julka, 1976b, 1978), South India (Jamieson, 1977), Eastern Himalayas (Julka and Rao, 1982), Western Himalayas (Julka, 1979; Halder, 1980) and Andaman and Nicobar island (Julka and Halder, 1975a; Sotta and Halder, 1980). However, Gangetic Plain of Uttar Pradesh (U.P) has been more or less neglected as compared to other parts of the country. Further, earthworms have gained renewed scientific attention in India and abroad because of their wide application in the production of vermicompost, and as a source of animal protein for domesticated animals. However, out of 418 species of earthworms known from the country (Julka and Paliwal, 2005), only half a dozen are frequently used for vermiculture and vermicomposting. Therefore, there is an urgent need to undertake extensive survey of earthworms in such unexplored areas with a view to: (i) study their biodiversity; (ii) search for more native species which may come out very specific and could be used for vermicomposting; (iii) contribute material for preparation of earthworm inventory of the study area and (iv) suggest

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measures for their conservation and protection, particularly, the species which are either threatened or on the verge of extinction. The present attempt, therefore, is to scientifically update investigation, identification and documentation of contemporary earthworm fauna of the study area.

Study area

The Indo-Gangetic Alluvial Plains (IGP) are among the most extensive fluvial plains of the world and cover several states of the northern, central and eastern part of India. The IGP occupies total area of approximately 43.7 m hectare and represent eight agro-ecological regions (AER) and 14 agro-ecological sub regions. The area of the IGP is nearly 13% of the total geographical area of the country.

The Gangetic Plain of Uttar Pradesh from which data were derived is situated between 23° 52' N latitudes and 77° 3' and 84° 39'E longitudes (Figure 1) and are highly fertile with alluvial soils having flat topography broken by numerous ponds, lakes and rivers slopes. Climate of the area is tropical with wide variation because of dissimilarity in altitudes. The minimum and maximum temperature ranges from 01 to 47°C for the months of January and May respectively, with mean annual rainfall 120 - 160 cm. The area is bound in the west by the Indus river and on the south by the Vindhya mountain range. The vegetation is tropical dry and dry deciduous.

METHODOLOGY

In the course of fieldwork, the authors visited different districts encompassing the various agro-climatic zones of the study area viz, South western semidry region, Western plain, Mid western, Mid region, Eastern region, Vidorv, North east, Tarai and Bundelkhand region of the study area during August - October 2008 (Table 1).

Earthworm sampling

Earthworm for taxonomic studies was collected by digging and hand sorting method. Samples were taken from diverse ecological niches at 300 - 1000 m from study area.

Analysis of soil samples

Soil samples were analyzed for soil texture by international pipette method (Piper, 1966), moisture by oven drying method (Santhanam et al. 1989), pH by digital meter (Misra, 1968) and total organic matter by Walkley and Black’s method (1934) and the data is presented in Table 2.

The methodology adopted for earthworm collection was based on Julka (1988). Collected worms were washed in fresh water and stored in test tubes in the field. Ethyl alcohol was gradually added.
Table 1. Survey record of earthworms’ biodiversity in Gangetic plain of U.P.

<table>
<thead>
<tr>
<th>Date(s) of survey</th>
<th>Zone</th>
<th>Altitude</th>
<th>Collection no.</th>
<th>Districts covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>18.08.08 - 25.08.08</td>
<td>South-Western semidry region</td>
<td>554.2</td>
<td>D/01 to D/42</td>
<td>Aligarh, Agra, Etah, Mathura 4</td>
</tr>
<tr>
<td>21.08.08 - 03.09.08</td>
<td>Western plain</td>
<td>606.3</td>
<td>B/43 to B/57</td>
<td>Bulandshahar, Hapur, Meerut 3</td>
</tr>
<tr>
<td>03.09.08 - 04.09.08</td>
<td>Mid Western</td>
<td>514.5</td>
<td>E/58 to E72</td>
<td>Badaun, Bareilly, Moradabad 3</td>
</tr>
<tr>
<td>08.09.08 - 10.09.08</td>
<td>Mid region</td>
<td>227.0</td>
<td>C/73 to C/87</td>
<td>Kanpur, Lucknow, Unnao 3</td>
</tr>
<tr>
<td>09.09.08 - 12.09.08</td>
<td>Eastern region</td>
<td>265.6</td>
<td>H/88 to H102</td>
<td>Azamgarh, Jaunpur, Varanasi 3</td>
</tr>
<tr>
<td>10.09.08 - 19.09.08</td>
<td>Vidarv</td>
<td>269.2</td>
<td>I/103 to I/117</td>
<td>Chaudauli, Mirzapur, Sonbhadra 3</td>
</tr>
<tr>
<td>18.09.08 - 21.09.08</td>
<td>North-East</td>
<td>238.3</td>
<td>G/18 to G/132</td>
<td>Basti, Gorakhpur, Santakabirnagar 3</td>
</tr>
<tr>
<td>14.10.08 - 16.10.08</td>
<td>Tarai</td>
<td>304.3</td>
<td>A/133 to A/147</td>
<td>Lakhempur kheri, Pilibhit, Rampur 3</td>
</tr>
<tr>
<td>16.10.08 - 18.10.08</td>
<td>Bundelkhand region</td>
<td>859.6</td>
<td>F/148 to F/162</td>
<td>Banda, Chitrakut, Jhansi 3</td>
</tr>
</tbody>
</table>

Table 2. Results of soil samples analysis.

<table>
<thead>
<tr>
<th>S/no.</th>
<th>Collection sites</th>
<th>Soil texture</th>
<th>Moisture (%)</th>
<th>Organic carbon content (%)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Aligarh</td>
<td>Loamy</td>
<td>25 - 30</td>
<td>4.01</td>
<td>6.94</td>
</tr>
<tr>
<td>2.</td>
<td>Agra</td>
<td>Sandy</td>
<td>20 - 25</td>
<td>4.01</td>
<td>7.34</td>
</tr>
<tr>
<td>3.</td>
<td>Azamgarh</td>
<td>Loamy</td>
<td>25 - 30</td>
<td>3.87</td>
<td>7.13</td>
</tr>
<tr>
<td>4.</td>
<td>Badi</td>
<td>Sandy</td>
<td>20 - 25</td>
<td>3.15</td>
<td>7.02</td>
</tr>
<tr>
<td>5.</td>
<td>Banda</td>
<td>Sandy</td>
<td>28 - 30</td>
<td>3.82</td>
<td>7.52</td>
</tr>
<tr>
<td>7.</td>
<td>Bareilly</td>
<td>Sandy loam</td>
<td>28 - 30</td>
<td>3.46</td>
<td>7.13</td>
</tr>
<tr>
<td>8.</td>
<td>Bulandshar</td>
<td>Sandy</td>
<td>25 - 28</td>
<td>1.54</td>
<td>6.76</td>
</tr>
<tr>
<td>9.</td>
<td>Chaudauli</td>
<td>Loamy</td>
<td>28 - 30</td>
<td>1.55</td>
<td>7.73</td>
</tr>
<tr>
<td>11.</td>
<td>Etah</td>
<td>Sandy</td>
<td>20 - 25</td>
<td>3.14</td>
<td>7.18</td>
</tr>
<tr>
<td>12.</td>
<td>Gorakhpur</td>
<td>Clay</td>
<td>25 - 30</td>
<td>2.52</td>
<td>7.11</td>
</tr>
<tr>
<td>15.</td>
<td>Jhansi</td>
<td>Sandy</td>
<td>28 - 30</td>
<td>1.76</td>
<td>7.31</td>
</tr>
<tr>
<td>16.</td>
<td>Kanpur</td>
<td>Sandy</td>
<td>24 - 30</td>
<td>3.82</td>
<td>7.52</td>
</tr>
<tr>
<td>17.</td>
<td>Lakempur</td>
<td>Clay</td>
<td>25 - 30</td>
<td>3.82</td>
<td>7.15</td>
</tr>
<tr>
<td>18.</td>
<td>Lucknow</td>
<td>Sandy</td>
<td>24 - 36</td>
<td>4.45</td>
<td>7.61</td>
</tr>
<tr>
<td>19.</td>
<td>Mathura</td>
<td>Sandy-Loam</td>
<td>28 - 30</td>
<td>1.54</td>
<td>6.76</td>
</tr>
<tr>
<td>21.</td>
<td>Mirzapur</td>
<td>Clay</td>
<td>26 - 28</td>
<td>2.39</td>
<td>7.68</td>
</tr>
<tr>
<td>22.</td>
<td>Moradabad</td>
<td>Clay</td>
<td>24 - 26</td>
<td>4.20</td>
<td>7.29</td>
</tr>
<tr>
<td>23.</td>
<td>Pilibhit</td>
<td>Loamy</td>
<td>28 - 30</td>
<td>2.81</td>
<td>7.10</td>
</tr>
<tr>
<td>24.</td>
<td>Rampur</td>
<td>Loamy</td>
<td>28 - 30</td>
<td>3.90</td>
<td>6.69</td>
</tr>
<tr>
<td>25.</td>
<td>Santakabir nagar</td>
<td>Sandy</td>
<td>24 - 28</td>
<td>4.12</td>
<td>7.02</td>
</tr>
<tr>
<td>26.</td>
<td>Sonbhadra</td>
<td>Loamy</td>
<td>20 - 25</td>
<td>2.14</td>
<td>7.71</td>
</tr>
<tr>
<td>27.</td>
<td>Unnao</td>
<td>Sandy</td>
<td>24 - 28</td>
<td>6.72</td>
<td>8.0</td>
</tr>
<tr>
<td>28.</td>
<td>Varanasi</td>
<td>Loamy</td>
<td>24 - 26</td>
<td>3.49</td>
<td>7.13</td>
</tr>
</tbody>
</table>

to the test tube and then transferred to the dish containing a solution of 5% formalin for fixation and kept for a period 6 - 8 h, followed by their preservation in 70% ethyl alcohol or 5% formalin. All specimens were serially numbered and necessary field data were recorded.

Field plots

The habitat preference was taken in the following plots located in 236, 286 sq. km of study area. South Western semi-dry region, Western plain, Mid-Western, Mid region, Eastern region, Vidarv,
Northeast, Tarai and Bundelkhand region.

i. Grassland (ungrazed): Soil texture, silty clay loam (sand 33.0%; silt 37.5% and clay 29.5%), moisture 25 - 30%; temperature 25 to 30°C; pH 7.5 - 8.0; organic matter 5.05%.

ii. Grassland (grazed): Soil texture, clay loam (sand 46.0%; silt 20.0% and clay 34.0%), moisture 20.25%; temperature, 22 - 25°C; pH 6.87 - 7.0; organic matter 1.89%.

iii. Mixed forests: Soil texture, clay loam (clay 48%; sandy loam 40% and loam 12%), moisture 40 - 42%; temperature, 30 - 38°C; pH 7.0 - 7.2; organic matter 4.48%.

iv. River Bank: Nearby vegetation comprises of mainly grasses and weeds. Soil texture, clay loam; temperature, 15 - 18°C; pH 8.0 - 8.2; organic matter 0.42%.

v. Dung heap: Major physico-chemical characteristics of the dung heap is large amount of decomposed vegetable material; moisture 28 - 30%; temperature 25 - 30°C; pH 6.94 - 7.0; organic matter 2.35%.

Earthworms were identified with the help of monographs and other available literature on the subject (Stephenson, 1923; Gates; 1972, Julka, 1988) at the Vermiculture Research Station (VRS), D.S. College, Aligarh and later confirmed by experts at Zoological Survey of India, Kolkata. Voucher specimens of all specimens examined and reported in the present work are deposited in the Museum of VRS, for future reference and study.

Systematic enumeration

Adverting shortly to the presentation of data, the earthworm species collected from the study area are arranged in alphabetical order. Each entry gives the information (in a format): Earthworm’s scientific name, family, distribution, locality and voucher specimen number, date of collection, general habitat etc. It is important to know the species are native or exotic

1) Eutyphoeus incommodus Beddard
   Family: Octochaetidae
   Origin: Exotic
   Date(s) of collection: 18.08.08 to 17.10.08
   General habitat: Grassland (ungrazed), cultivated land (paddy crop).

2) Eutyphoeus orientalis Stephens
   Family: Octochaetidae
   Origin: Native
   Locality and collection no: Santkabirnagar G/124.
   Date of collection: 19.09.08
   General habitat: Grassland (ungrazed)

3) Eutyphoeus pharpingianus Michaelsen
   Family: Octochaetidae
   Origin: Exotic
   Date(s) of collection: 18.08.08 to 20.09.08
   General habitat: Grassland (grazed and ungrazed) river bank, cultivated land (paddy and pulses), dung heap.

4) Eutyphoeus waltoni Michaelsen
   Family: Octochaetidae
   Origin: Native
   Locality and collection no: Santkabirnagar G/127.
   Date of collection: 19.09.08
   General habitat: River bank

5) Lampito mauritii Kinberg
   Family: Megascolecidae
   Origin: Native
   Locality and collection no: Bulandshahar B/43.
   Date of collection: 21.08.08
   General habitat: Cultivated land

7) Metaphire anomala Rosa
   Family: Megascolecidae
   Origin: Native
   Locality and collection no: Jaunpur: H/96.
   Date of Collection: 11.09.08
   General habitat: River bank

8) Metaphire posthuma Vaillant
   Family: Megascolecidae
   Origin: Native
   Date(s) of collection: 18.08.08 to 16.10.08
   General habitat: Garden land (ungrazed), cultivated land (paddy crop) and river bank.

9) Pellogaster bengaleus Michaelson
   Family: Octochaetidae
   Origin: Exotic
Table 3. Contributions made by different workers on earthworm survey in Gangetic plain of Uttar Pradesh, India from 1907 to 2009.

<table>
<thead>
<tr>
<th>Species</th>
<th>Beddard</th>
<th>Michaelsen</th>
<th>Stephenson</th>
<th>Perrier</th>
<th>Vaillant</th>
<th>Rosa</th>
<th>Gates</th>
<th>Julka</th>
<th>Tripathi</th>
<th>Bisht</th>
<th>Joshi and Swati</th>
<th>Present study</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. incommodus</td>
<td>+(1907)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+(1993)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. orientalis</td>
<td>+(1883)</td>
<td>+(1907)</td>
<td>+(1914)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+(1933)</td>
<td>+(2009)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L. mauritii</td>
<td></td>
<td>+(1913)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M. biramnica</td>
<td></td>
<td></td>
<td>+(1888)</td>
<td>+(1972)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. bingalensis</td>
<td>+(1910)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>+(1988)</td>
<td></td>
<td></td>
<td></td>
<td>+</td>
</tr>
</tbody>
</table>

Date(s) of collection: 20.08.08 to 10.09.08
General habitat: Grassland (ungrazed), cultivated land (paddy crop), river bank.

10) Perionyx sansibaricus Michaelsen
Family: Megascolecidae
Origin: Native
Locality and collection no.s: Mathura: D/20; Mirzapur: I/107.
Date(s) of collection: 20.08.08 to 10.09.08
General habitat: Grassland (ungrazed), cultivated land

11) Polypheretima elongata Kinberg
Family: Megascolecidae
Origin: Exotic
Locality and collection no: Aligarh D/04.
Date of collection: 18.08.08
General habitat: Grazed grassland

RESULTS AND DISCUSSION

Of the 236 field samples of earthworms collected and identified from certain districts of Uttar Pradesh (Figure 1), encompassing various agro-climatic zones of the Gangetic Plain of India, the present study has brought to light 11 species including 04 exotic with extra Indian origins. It has been observed that Metaphire posthuma Vaillant is predominant species with wide distribution within the study area.

In recent years, the diversity of Indian earthworms has been mainly studied by Julka (1988). He described the family Octochaetidae in the publication ‘Fauna of India’ providing illustrated descriptions of 154 taxa including 6 new genera and 16 species. The knowledge on the earthworm fauna of India has also been enriched by Julka and Senapati (1987), Senapati et al. (1990), Julka and Paliwal (1994) and Paliwal and Julka (2005). However, a close review of literature on the study of earthworms in U.P. indicates that the first report appeared in 1912. Subsequently, many workers contributed to the study until 1988. Thereafter, the taxonomical studies in the region have been more or less neglected between 1989 and 2009 except for few fragmentary reports (Table 3). Present work, therefore, is a humble attempt in this direction and contributes to update our contemporary knowledge on the biodiversity of earthworms’ resources in the study area.

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