A Contribution to the Earthworm Survey Fauna of Doon Valley in Uttarakhand, India with Special Reference to a Search for Vermicomposting Species

Deepshikha Verma • Shweta*

Vermiculture Research Station, Department of Zoology, D.S. College (Dr. B.R.A. University), Aligarh – 202001, UP, India

Corresponding author: * kmsshweta3@yahoo.com

ABSTRACT

Based on a survey of earthworms in Doon valley of Western Himalayan region conducted in September 2009, the present report enlists 12 species belonging to 7 genera and 4 families. Information on earthworms’ scientific name, family, origin, locality & voucher specimen number, date of collection, general habitat are given for each species discussed in the text. Drawida nepalensis, Entyphoeus orientalis, Lampito mauritii and Perionyx sansbaricus have been identified as potential species for vermicomposting with a preference for dung heap. The study provides contemporary information on earthworm biodiversity in the study area with particular reference to vermicomposting species.

Keywords: biodiversity, relative density, relative frequency, species diversity, vermicompost, western Himalaya

INTRODUCTION

Indian earthworm fauna is predominantly represented by native species, which constitutes about 89% of total earthworm diversity in the country (Julka and Paliwal 2005; Verma et al. 2010). Earthworm explorations in Western Himalaya dates back to 1889 when Bourne described the earthworm species of Typhoeus masoni (syn. Eutyphoeus orientalis) for the first-time from Dehradun (Uttarakhand). Subsequently, Fedar (1898) discovered Lennogaster parvus from the same area. Michaelson (1907, 1909) and Stephens (1914, 1916, 1922) significantly added to the knowledge on earthworm diversity in Western Himalaya. Stephens (1923) listed 28 species of earthworms from this region in the publication “Fauna of British India” (Volume on Oligochaeta). Information on diversity of earthworms of this region was further enriched by Cernosvitov (1931), Gates (1945, 1951), Soota (1970), Sharma and Kaul (1974), Soota and Halder (1980), Julka (1979, 1981, 1988, 1995), Halder and Ghosh (1997), Julka and Paliwal (2000) and Paliwal and Julka (2005). Thereafter, the taxonomical studies in this region have been more or less neglected. However, some reports are available on earthworm systematics of Western Ghats (Blakemore 2006), West Bengal (Chaudhuri and Saxena 2010) and Gangetic plains (Verma et al. 2010) of India.

Large-scale developmental activities like rapid industrialization and urbanization has eventually caused degradation of forests (Kabzoglu 2008). Therefore, the native species are threatened because of extensive destruction of their natural habitats (Aryal et al. 2009). Conservation of earthworm biodiversity can only be achieved through protection of biological habitats that require a detailed periodical survey (Eisenhauer et al. 2008) and inventory of the existing bioresources (Zirbes et al. 2009). The present investigation is based on this rationale and updates existing knowledge about the earthworm diversity in the study area.

MATERIALS AND METHODS

Field work was carried out in September 2009. 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 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 hrs, followed by their preservation in 70% ethyl alcohol or 5% formalin. All specimens were serially numbered. 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. Voucher specimens collected and examined in the present work are deposited in the Museum of VRS, for future reference and study.

Study site

Uttarakhand, a newly created State in India, is surrounded by Nepal in the East, China in the North, Himachal Pradesh in West and UP in South. The area from which data were derived is situated at 23.5° North-East of Delhi, between 30° 19’ N latitude and 78° 04’ E longitude (Fig. 1). The areas and their surroundings visited include Dehradun, Mussoori and Rishikesh rural and forest pockets. Doon valley is surrounded by the Mussoori in the north and the Shiwalik hills in the south west, the rivers Ganga and Yamuna in the east and west respectively. The entire valley is drained by the river Song. Climate of the area is temperate and humid. Temperature ranges between 36° and 16.7°C during summer (March – June) and 23.4 to 5.2°C (November – February); mean annual rainfall is 15.23 cm (July – October). Forest types are diverse ranging from temperate to dry deciduous (Table 1).

Earthworm and soil sampling

Earthworms and soil samples for taxonomic studies were collected by digging and hand sorting method. Samples were collected from diverse ecological niches viz. dense forest; grass land (ungrazed); grass land (grazed); cultivated land (maize crop); dung heap; stream bank; under stones; and bank of river.

Received: 6 July, 2010. Accepted: 30 August, 2010.
Analysis of soil samples

Soil samples were analyzed for soil texture by international pipette method (Piper 1966); pH by a digital meter (Misra 1968) (Table 2).

Experimental design and statistical analyses

On each sampling site (dense forest, grassland, cultivated land, dung heap, stream bank and bank of river), earthworms were hand-sorted from three soil monoliths (50 x 50 x 20 cm) placed at the apices of a 10-m side triangle. Specimens were preserved in formalin, then identified and counted. Relative diversity and frequency were calculated following Cousins (1991).

RESULTS AND DISCUSSION

Systematic enumeration

The earthworm species collected and identified from the study area are arranged family-wise in alphabetical order. Each entry gives the information in sequence: earthworms’ scientific name, voucher specimen no, date of collection and general habitat. A brief introductory note on each family is also preceded before the text.
Moniligasteridae

A family of primitive earthworms in East and south Asia. A few species are hydrophilous and some are common in arable soils but most are confined to primary forests. Of the few species are hydrophilous and some are common in A family of primitive earthworms in East and south Asia. A Moniligasteridae

1. Drawida nepalensis Michaelsen

Origin: Native
Locality and collection no(s): Kalsi: d/02, d/03, d/04, d/05; Vikasnagar: e/01, e/02, e/03, e/04; Harbatpur: f/01; Shaspur: g/01, g/02, g/03; Jhajra: h/01, h/02; h/03; Majra: k/01, k/02; Clementown: l/01; Dehradun: n/01, n/04.
Date(s) of collection: 05.09.09 to 08.09.09
General habitat: dense forest (grazed), dung heap.

2. Octolasion tyrateum Savigny

Origin: Exotic
Locality and collection no(s): Doiwala: c/01, c/03; Kalsi: d/02, d/03, d/04, d/05; Vikasnagar: e/01, e/02, e/03, e/04; Harbatpur: f/02, f/03; Shaspur: i/03; Jhajra: h/01, h/02; h/03; Majra: k/01, k/02; Clementown: l/01; Dehradun: n/01, n/04.
Date(s) of collection: 05.09.09 to 09.09.09
General habitat: under high mountains, stream bank above water line, leaf litter, grassland (ungrazed), stones embedded under stream line.

3. Eutyphoeus incommodus Beddard

Origin: Native
Locality and collection no(s): Vikasnagar: e/02, e/03
Date(s) of collection: 05.09.09
General habitat: under stones embedded in stream water, grass land (ungrazed).

4. Eutyphoeus orientalis Stephensen

Origin: Native
Locality and collection no(s): Clementown: e/01
Date(s) of collection: 07.09.09
General habitat: dense forest (grazed), dung heap.

5. Eutyphoeus pharpingianus Michaelsen

Origin: Exotic
Locality and collection no(s): Shahaspur: g/02, g/03; Jhajra: h/01; Dehradun: n/02
Date(s) of collection: 05.09.09 to 08.09.09
General habitat: cultivated land (sugarcane), mixed forest.

6. Eutyphoeus nicholsoni Beddard

Origin: Native
Locality and collection no(s): Doiwala: c/01, c/03; Kalsi: d/02, d/03, d/04, d/05; Vikasnagar: e/01, e/02, e/04; Harbatpur: f/02, f/03; Shaspur: i/03; Jhajra: h/01, h/02; h/03; Dehradun: n/04, n/05.
Date(s) of collection: 04.09.09 to 09.09.09
General habitat: agriculture land (maize crop), garden (ungrazed), dense forest (grazed), river bank.

7. Octochaetona betarix Beddard

Origin: Native
Locality and collection no(s): Rishikesh: a/01, a/02, a/03; Ranipokhri: b/02, b/03; Clementown: e/01;
Date(s) of collection: 04.09.09 to 09.09.09
General habitat: cultivated land, grassland (ungrazed), stones embedded under stream line.

8. Eutyphoeus waltoni Michaelsen

Origin: Native
Locality and collection no(s): Doiwala: c/01, c/03; Kalsi: d/02, d/03, d/04, d/05; Vikasnagar: e/01, e/02, e/04; Harbatpur: f/02, f/03; Shaspur: i/03; Jhajra: h/01, h/02; h/03; Mussoori: i/01, i/02; Bhadraj: j/01, j/02, j/03; Majra: k/01, k/02; Clementown: l/01; Dehradun: n/01, n/02, n/03.
Date(s) of collection: 04.09.09 to 06.09.09
General habitat: under high mountains, stream bank above water line, leaf litter, grassland (ungrazed).

Megascoleidae

Its distributional range extends between warm-temperate Asia and Australia. Native species of Lampito mauritii have been recorded from almost all western Himalayan districts in Uttarakhand. Metaphire anomala is well known inhabitant of litter and Metaphire posthuma inhabits in gravelly soils near water line. Endemic Megascoleids in this region belong to the genus Perionyx. Species explosion seems to have occurred in the Eastern Himalaya, a region with considerable and regular rainfall and high organic matter in the soil.

9. Lampito mauritii Kinberg

Origin: Native
Locality and collection no(s): Rishikesh: a/01, a/02, a/03; Ranipokhri: b/02, b/03; Kalsi: d/01, d/02, d/03, d/04, d/05; Vikasnagar: e/01, e/02, e/03; Harbatpur: f/02, f/03; Shaspur: g/01, g/02; Mussoori: i/01, i/02; Bhadraj: j/01, j/02, j/03; Majra: k/01, k/02; Clementown: l/01; Dehradun: n/01, n/02, n/03, n/04.
Date(s) of collection: 04.09.09 to 09.09.09
General habitat: cultivated land (maize crop), sewage, garden (ungrazed), leaf litter, river bank, under stones embedded in streams, under high mountain, dense forest (graize), grass land (grazed), dung heap.

Table 2 Analyses of soil samples.

<table>
<thead>
<tr>
<th>Collection sites</th>
<th>Soil texture</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rishikesh</td>
<td>Balui</td>
<td>5.42</td>
</tr>
<tr>
<td>Ranipokhri</td>
<td>Balui domat</td>
<td>5.74</td>
</tr>
<tr>
<td>Doiwala</td>
<td>Stony balui</td>
<td>6.72</td>
</tr>
<tr>
<td>Kalsi</td>
<td>Balui domat</td>
<td>5.84</td>
</tr>
<tr>
<td>Vikasnagar</td>
<td>Balui</td>
<td>7.37</td>
</tr>
<tr>
<td>Harbatpur</td>
<td>Balui domat</td>
<td>5.42</td>
</tr>
<tr>
<td>Sahaspur</td>
<td>Clay</td>
<td>5.58</td>
</tr>
<tr>
<td>Jhajra</td>
<td>Balui</td>
<td>6.14</td>
</tr>
<tr>
<td>Mussoori</td>
<td>Stony</td>
<td>6.17</td>
</tr>
<tr>
<td>Bhamaraj</td>
<td>Stony</td>
<td>5.85</td>
</tr>
<tr>
<td>Majra</td>
<td>Baludomat</td>
<td>7.19</td>
</tr>
<tr>
<td>Clementown</td>
<td>Baluisable</td>
<td>6.33</td>
</tr>
<tr>
<td>Rajpur</td>
<td>Stony balui blakish</td>
<td>6.80</td>
</tr>
<tr>
<td>Dehradun</td>
<td>Baluisoil</td>
<td>6.52</td>
</tr>
</tbody>
</table>
10. Metaphire anomala Michaelsen

Origin: Native
Locality and collection no(s): Rishikesh: a/01, a/02, a/03; Ranipokhri: b/03; Kalsi: d/04; Harbatpur: f/02, f/03; Mussoori: i/02; Majra: k/01; Clementown: l/01; Rajpur: m/02, m/03; Dehradun n/04, n/05
Date(s) of collection: 04.09.09 to 09.09.09
General habitat: leaf litter, cultivated land, dense forest, river bank, under high mountains and grassland (grazed).

11. Metaphire posthuma Vaillant

Origin: Exotic
Locality and collection no(s): Ranipokhri: b/02; Doiwala: c/01, c/02, c/03; Kalsi: d/02, d/05; Vikasnagar: e/01, e/02, e/03, e/04; Harbatpur: f/01, f/03; Shasupuri: g/01, g/02, g/03; Jhajra: h/02, h/03; Majra: k/01, k/03; Clementown: l/01, l/02, l/03; Rajpur: m/01, m/02, m/03; Dehradun: n/05, Mussoori: i/02, i/03, Bhabraj: j/02
Date(s) of collection: 04.09.09 to 09.09.09.
General habitat: sloped ground, riverbank, under stone embedded in streams, cultivated land (paddy crop), dense forest and grassland (ungrazed).

12. Perionyx sansibaricus Michaelsen

Origin: Native
Locality and collection no(s): Sahaspur: g/02
Date of collection: 05.09.09
General habitat: river bank, dung heap, dense forest.

The present study records 12 species of earthworms from Doon valley of Uttarakhand State in India, representing 7 genera and 4 families. Of these, Megascolecidae represents the most active earthworms and Lampito mauritii and Metaphire posthuma are predominant species with wide distribution in the study area at all sites (Table 3). The moderately active earthworms of the family Octochaetidae and Moniligastridae move over short distances.

**Diversity of earthworms**

High diversity of earthworms at moderate altitudes may be due to soils rich in organic matter, and subtropical and mild temperate climate (Somniyam and Suwanwaree 2009). However, Tondoh (2006) have reported low number of species at higher elevations is possibly due to extreme cold, and unfavorable soil conditions. The present observations agree with the species-altitudes relationship studies in other parts of the world (Mileu et al. 2008; Eisenhauer et al. 2009; Postma et al. 2010). Lee (1959) recorded an inverse relationship between number of species of Megascolecidae and altitude on mountains in North Island of New Zealand. Cernosvitov (1937) and Bouche (1972) have also opined that the number of Lumbricid species decrease with rise in altitude in Russia and France respectively.

**Potential vermicomposting species**

The study indicates that of the species recorded from the study area, 9 are native to Indian subcontinent and the remaining 3 are well known peregrine of extra Indian origin. Drawilda nepalensis, Eutyphoeus orientalis Lampito mauritii and Perionyx sansibaricus have been identified as potential species for vermicomposting, with a preference for dung heap comprising very high organic matter (Table 4). Since these species thrive well in cattle dung and soils rich...
Density of earthworms

The majority of native species of earthworms have been recorded from 1000 to 2000 m altitudes whereas exotic species are found between 300 and 4000 m. Species from other biogeographical regions occur primarily at elevations between 300 and 2000 m. Further, the peregrine exotic species in Western Himalaya are suspected to have been introduced to Doon hills, possibly as a result of their transportation in soil around roots of exotic plants and through other agencies (Julkal and Paliwal 2005; Kouadio et al. 2008). Introduction of peregrines in soil around roots of plants or otherwise has also been recognized by Gates (1972) during his studies on the oligochaetes intercepted by U.S. Bureau of Plant Quarantine. Out of 50 exotic species so recorded by Gates, incidentally, 20 species were reported in Western Himalaya.

Species-habitat preference

Table 4 indicates the species habitat preference for each of the 12 species collected from the study area. This shows that three species viz. Drawida nepalensis, Octochaetona betarix and Lampito mauritii show preference for a wide range of ecosites. D. nepalensis is the most eurytopic (able to adapt to a wide range of environmental conditions) species, recorded in cultivated land, grassland (ungrazed and grazed), mixed forest, stream bank and dung heap but with higher frequencies in ungrazed grassland. Kouadio et al. (2008) also reported the distribution of this species in different habitats in West Africa. Among lesser eurytopics, E. nicholsoni was recorded in cultivated land, ungrazed grassland and mixed forest, while E. waltioni thrives best in cultivated and ungrazed grassland, stream bank and dung heap. Since these species thrive well in cattle dung and soils rich in organic matter, they could be best suited and used in vermicomposting because of their affinities for high organic matter.

Table 4 Relative density (RD %) and Relative frequency (RF %) of earthworms in different habitats in Western Himalaya, (Doon valley) India.

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Cultivated land</th>
<th>Grassland (ungrazed)</th>
<th>Grassland (grazed)</th>
<th>Mixed forest</th>
<th>Stream bank</th>
<th>Dung heap</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RD</td>
<td>RF</td>
<td>RD</td>
<td>RF</td>
<td>RD</td>
<td>RF</td>
</tr>
<tr>
<td>Drawida nepalensis</td>
<td>4.4</td>
<td>80</td>
<td>5.2</td>
<td>20</td>
<td>6.6</td>
<td>40</td>
</tr>
<tr>
<td>Octochaetona tytaeum</td>
<td>6.5</td>
<td>20</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Eutyphoeus incommodus</td>
<td>-</td>
<td>-</td>
<td>6.5</td>
<td>20</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>E. orientalis</td>
<td>6.5</td>
<td>10</td>
<td>9.4</td>
<td>40</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>E. pharpingianus</td>
<td>9.4</td>
<td>40</td>
<td>9.4</td>
<td>40</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>E. nicholsoni</td>
<td>9.4</td>
<td>60</td>
<td>6.5</td>
<td>40</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Octochaetona betarix</td>
<td>41.4</td>
<td>60</td>
<td>9.4</td>
<td>60</td>
<td>6.8</td>
<td>60</td>
</tr>
<tr>
<td>Lampito mauritii</td>
<td>40.4</td>
<td>80</td>
<td>52.5</td>
<td>100</td>
<td>16.8</td>
<td>40</td>
</tr>
<tr>
<td>Metapion anomala</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>33.6</td>
<td>20</td>
</tr>
<tr>
<td>M. posithuma</td>
<td>80.0</td>
<td>60</td>
<td>56.4</td>
<td>60</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Perionyx sansibaricus</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

CONCLUDING REMARKS

The study indicates that of the species recorded from the study area, 9 are native to Indian subcontinent and the remaining 3 are well known peregrine of extra Indian origin. Drawida nepalensis, Eutyphoeus orientalis, Lampito mauritii and Perionyx sansibaricus have been identified as potential species for vermicomposting, with a preference for dung heap comprising very high organic matter (Table 4). Since these species thrive well in cattle dung and soils rich in organic matter, they could be best suited and used in vermicomposting because of their affinities for high organic matter.

ACKNOWLEDGMENTS

The authors are thankful to the Department of Biotechnology, Ministry of Science and Technology, Government of India, New Delhi, for financial assistance.

REFERENCES

Bouche MB (1972) Lombriciens de France Ecologie et Systematique. Institute National de la Recherche Agronomique, Paris, 671 pp
Bourne AG (1889) On certain earthworms from the Western Himalayas and Dehradun. The Journal of Asiatic Society of Bengal 58, 110-117
Cernosvitov L (1931) Revision des lumbricidae submontane Veedovjek. Zoologi- gischer Anzeiger 95, 59-62
Cernosvitov L (1937) Zur Kenntnis der oligochaeta fauna des Balkans. Zoologi- gischer Anzeiger 95, 312-27
Cousins SH (1991) Species diversity measurement choosing the right index. Trends in Ecology and Evolution 6, 190-192
Gates GE (1945) Another species of Pherecuta from India. Science and Culture 10, 403-404
Gates GE (1951) On the earthworms of Saharanpur, Dehradun and some Himalayan hill stations. Proceedings of the Natural Academy of Sciences India (Part F) 21, 16-22

Survey to identify vermicomposting species in Doon Valley, India. Verma and Shweta

85


Piper CS (1966) Soil and Plant Analysis, Hans Publishers, Bombay, 368 pp


Michaelsen W (1909) The Oligochaeta of India, Nepal, Ceylon, and the Andaman Islands. Indian Museum 1, 103-253


Piper CS (1966) Soil and Plant Analysis, Hans Publishers, Bombay, 368 pp


Stephenson J (1923) Oligochaeta: The Fauna of British India Including Ceylon and Burma, Taylor and Francis, London, 518 pp


Verma D, Bharti S, Yadav S (2010) Biodiversity of earthworm resources in gangetic plain of Uttar Pradesh, India. Tropical Natural History 10 (1), 53-60