

Biodiversity of Earthworm Resources in Gangetic Plain of Uttar Pradesh, India

DEEPSHIKHA VERMA, SHACHI BHARTI AND YADAV SHWETA *

Vermiculture Research Station, Department of Zoology, D.S. College, Aligarh – 202001, INDIA

*Corresponding author. E-mail: kmshweta3@yahoo.com

Received: 8 October 2009; Accepted: 30 December 2009

ABSTRACT.— Based on an extensive survey of Gangetic Plain of Uttar Pradesh during August – October 2008, the communication reports 11 taxa of earthworms, namely, *Eutyphoeus incommodus*, *E. orientalis*, *E. pharpingianus*, *E. waltoni*, *Lampito mauritii*, *Metaphire anomala*, *M. birmanica*, *M. posthuma*, *Pellogaster bengalensis*, *Perionyx sansibaricus*, *Polypheretima elongata* belonging to 6 genera and 2 families that were commonly found in the study area. This constitutes 2.6 per cent of total Indian earthworm fauna. Of these, 4 taxa are exotic with extra-Indian origin. Collection and environmental information on each occurrence of a species are given. The study contributes first-hand material on earthworm fauna of the study area, thus far neglected, and likely to add more native species to the existing ones, which are very specific for vermicomposting processes.

KEY WORDS: biodiversity, earthworm, agro-climatic zones, Gangetic Plain, India

INTRODUCTION

Earthworms (folk names, include dew-worm, rain worms, night crawler, angle worm, and Kechua, Giduala, in Uttar Pradesh) are important biological resources that have a tremendous potential in agro-ecosystems because they significantly affect soil physical structures and organic matter 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 105 per cent of the total known global earthworm diversity, estimated at 4000 species.

The Indian earthworm fauna is predominantly composed of native species, which 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 communities in different agro-climatic regions of the country (Blanchart and Julka, 1997; Behera et al., 1999; Bhadauria et al., 2000). Native species are threatened because of rapid and extensive destruction of their natural habitats.

During the last few decades, the earthworms of the Indian subregion have been studied to some extent, such as the Eastern Himalayas (Julka, 1975a, 1976a, 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); Andaman and Nicobar Islands (Julka and Halder, 1975a; Sotta and Halder, 1980). However, the Gangetic Plains of Uttar Pradesh have been more or less neglected as compared to other

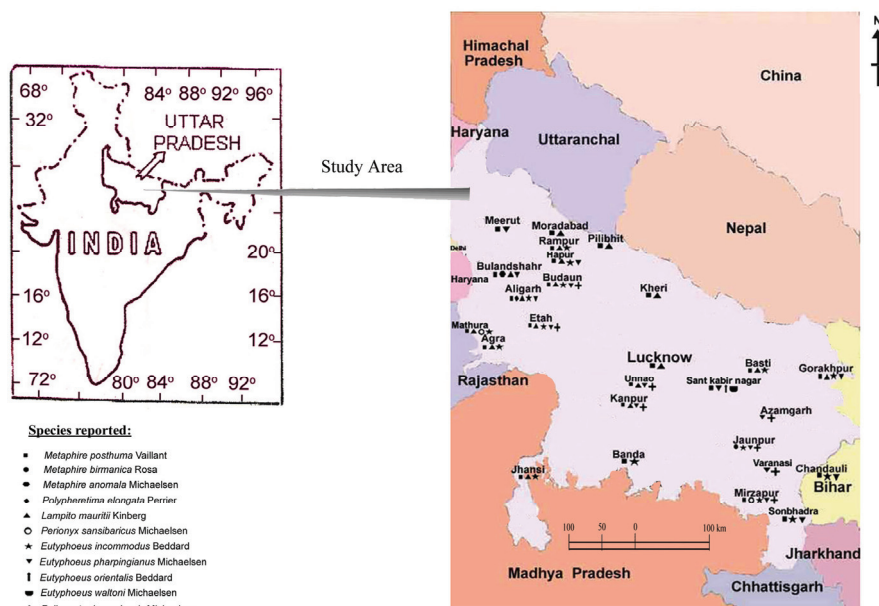


FIGURE 1. Study area: Gangetic Plain of U.P., India.

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 sources 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 be used for vermicomposting; (iii) contributing material for preparation of an earthworm inventory of the study area and; (iv) suggest 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 provide a preliminary inventory of the

contemporary earthworm fauna of the study area.

The Indo-Gangetic Alluvial plains (IGP) is 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 subregions. The area of the IGP is nearly 13% of the total geographical area of the country (Pal et al., 2009).

The Gangetic Plain of Uttar Pradesh from which data were derived is situated between 23° 52' and 31° 28' N latitudes and 77° 3' and 84° 39' E longitudes (Fig.1) 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 ranging from 200 to 550 metre. The minimum and maximum temperature ranges from 3°C to 4°C and 43

TABLE 1. Survey record of Earthworm biodiversity in Gangetic Plain of U.P.

Date(s) of survey	Zone	Collection no.	Districts covered
18.08.08 to 25.08.08	South-western semidry region	D/01 to D/42	Aligarh, Agra, Etah, Mathura
21.08.08 to 03.09.08	Western plain	B/43 to B/57	Bulandshahar, Hapur, Meerut
03.09.08 to 04.09.08	Mid western	E/58 to E72	Badaun, Bareilly, Moradabad
08.09.08 to 10.09.08	Mid region	C/73 to C/87	Kanpur, Lucknow, Unnao
09.09.08 to 12.09.08	Eastern region	H/88 to H102	Azamgarh, Jaunpur, Varanasi
10.09.08 to 19.09.08	Vidarb	I/103 to I/117	Chandoli, Mirzapur, Sonbhadra
18.09.08 to 21.09.08	North east	G/18 to G/132	Basti, Gorakhpur, Santkabirnagar
14.10.08 to 16.10.08	Tarai	A/133 to A/147	Lakheempur kheri, Pilibhit, Rampur
16.10.08 to 18.10.08	Bundelkhand region	F/148 to F/162	Banda, Chitrakut, Jhansi

to 45°C for the months of January and May respectively, with mean annual rainfall 120-160 cm falling mostly in the monsoon season from June to September. The area is bound in the west by the Indus river and on the south by the Vindhya mountain range. The vegetation of area is mainly dry deciduous (Khan, 2002; Kumar et al., 2002). The preferential habitat types from which collections were made included grasslands (grazed and ungrazed), mixed forests, river banks, dung heap, orchards and cultivated fields in the plots located in 236, 286 square kilometers of study area.

MATERIALS AND METHODS

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, Vidarb, North east, Tarai, and Bundelkhand region of the study area during August – October 2008 (Table 1).

Earthworm sampling.— Earthworm for taxonomic studies were collected by the digging and hand sorting method. Samples were taken from diverse ecological niches of the study area.

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 and necessary field data such as habitat, locality, soil texture, colour and occurrence recorded.

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

TABLE 2. Results of soil samples analysis.

Sl. no.	Collection sites	Results of soil analysis			
		Soil texture	Moisture %	Organic carbon content %	pH
1.	Aligarh	Loamy	25-30	4.01	6.94
2.	Basti	Sandy	20-25	3.15	7.02
3.	Banda	Sandy	28-30	3.82	7.52
4.	Badaun	Clay	40-42	4.58	6.63
5.	Chandauli	Loamy	28-30	1.55	7.73
6.	Etah	Sandy	20-25	3.14	7.18
7.	Gorakhpur	Clay	25-30	2.52	7.11
8.	Hapur	Loamy	25-30	6.68	6.80
9.	Jaunpur	Clay	25-30	3.49	7.13
10.	Jhansi	Sandy	28-30	1.76	7.31
11.	Mathura	Sandy-Loam	28-30	1.54	6.76
12.	Mirzapur	Clay	26-28	2.39	7.68
13.	Rampur	Loamy	28-30	3.90	6.69
14.	Sonbhadra	Loamy	20-25	2.14	7.71

examined and reported in the present work are deposited in the Museum of VRS, for future reference and study.

Analysis of soil samples.— Soil samples collected from various study sites 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.

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.

- 1) *Eutyphoeus incommodus*; Octochaetidae
Locality and collection no.: Rampur: A/143, A/144; Hapur: B/48; Aligarh: D/01, D/05; Etah: D/09 to D/13;

Mathura: D/16, D/17; Badaun: E/63 to E/65; Jhansi: F/149; Banda: F/153, F/154; Basti: G/118, G/119, G/122; Gorakhpur: G/129, G/130, G/132; Jaunpur: H/94, H/97; Mirzapur: I/103, I/104; Sonbhadra: I/108, I/111; Chandoli: I/116.

Date of collection: 18.08.08 to 17.10.08.

General habitat: Grassland (unglazed), cultivated land (paddy crop).

- 2) *Eutyphoeus orientalis*; Octochaetidae
Locality and collection no.: Santkabirnagar G/124.

Date of collection: 19.09.08.

General habitat: Grassland (ungrazed).

- 3) *Eutyphoeus pharpingianus*; Octochaetidae

Locality and collection no.: Bulandshahar: B/46; Hapur: B/49, B/50, B/52; Meerut: B/53, B/56; Kanpur: C/75, C/77; Unnav: C/80; Aligarh: D/04; Etah D/14; Badaun: E/65, E/67; Bareilly: E/72; Gorakhpur: G/128; Santkabirnagar: G/123, G/125; Varanasi: H/88, H/89, H/91; Jaunpur: H/95, H/96; Azamgarh:

H/100; Mirzapur: I/107; Sonbhadra: I/110, I/112; Chandoli: I/114.

Date 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*; Octochaetidae

Locality and collection no.: Santkabirnagar G/127.

Date of collection: 19.09.08.

General habitat: River bank.

5) *Lampito mauritii*; Megascolecidae

Localilty and collection no.: Pilibhit: A/135; Lakhimpurkheri: A/138, A/140, A/142; Bulandshahr: B/43 to B/46, B/51; Kanpur: C/74; Unnav: C/78 to C/81; Lucknow: C/183; Aligarh: D/02, D/03, D/21, D/23, D/24, D/38, D/39, D/42; Agra: D/33, D/34, D/36, D/37; Etah: D/07, D/08; Mathura: D/20, D/21, D/23, D/24; Moradabad: E/58, E/59, E/61; Badaun: E/67; Bareilly: E/68, E/70; Basti: G/120; Jhansi: F/148, F/151; Gorakhpur: G/130.

Date of collection: 18.08.08 to 16.10.08.

General habitat: Garden land (ungrazed), cultivated land (paddy crop), river bank.

6) *Metaphire anomala*; Megascolecidae

Locality and collection no.: Bulandshahr B/43.

Date of collection: 21.08.08.

General habitat: Cultivated land.

7) *Metaphire birmanica*; Megascolecidae

Locality and collection no.: Jaunpur: H/96.

Date of Collection: 11.09.08.

General habitat: River bank.

8) *Metaphire posthuma*; Megascolecidae

Locality and collection no.: Pilibhit: A/133, A/134, A/136; Kheri: A/138, A/139; Rampur: A/143, A/144, A/146; Bulandsahar: B/44 to B/47; Hapur: B/49; Meerut: B/54 to B/57; Kanpur: C/73 to C/76; Unnav: C/78 to C/82; Lucknow: C/83, C/85 to C/87; Aligarh: D/01, D/03, D/04, D/23, D/25 to D/27, D/29, D/38 to D/41; Agra: D/30 to D/32, D/34, D/36, D/37; Etah: D/06, D/08, D/11 to D/13, D/15; Mathura: D/16, D/17, D19;; Moradabad: E/59, E/61; Badaun: E/64, E/66, E/67; Jhansi: F/149, F/150, F/152; Banda: F/153 to F/156; Chittrakut: F/155, F/159 to F/162; Basti: G/120 to G/122; Sant kabirnagar: G/126, G/127; Gorakhpur: G/128, G/130 to G/132; Mirzapur: I/104, I/106; Sonbhadra: I/108, I/109, I/110, I/112; Chandoli: I/113, I/115, I/117.

Date of collection: 18.08.08 to 18.10.08.

General Habitat: Garden (ungrazed), cultivated land, river bank.

9) *Pellogaster bengalensis*; Octochaetidae

Locality and collection no.: Kanpur: C/73, C/74; Unnav: C/82; Etah: D/14; Badaun: E/65; Varanasi: H/88, H/90 to H/92; Jaunpur: H/93, H/95; Azamgarh: H/98, H/94, H/100 to H/102; Mirzapur: I/106.

Date of collection: 20.08.08 to 10.09.08.

General habitat: Grassland (ungrazed), cultivated land (paddy crop), river bank.

10) *Perionyx sansibaricus*; Megascolecidae

Locality and collection no.: Mathura: D/20; Mirzapur: I/107.

Date of collection: 20.08.08 to 10.09.08.

General habitat: Grassland (ungrazed), cultivated land.

11) *Polypheretima elongata*; Megascolecidae

TABLE 3. Contributions made by different workers on earthworm survey in Gangetic plain of Uttar Pradesh, India from 1907 to 2009.

Species	Beddard	Michaelsen	Stephenson	Perrier	Vaillant	Rosa	Gates	Julka	Tripathi	Bisht	Joshi	Present Study
<i>Eutyphoeus incommodus</i>	+(1907)							+(1993)			+(2009)	+(2009)
<i>Eutyphoeus orientalis</i>	+(1883)	+(1907)	+(1914)					+(1993)			+(2009)	+
<i>Eutyphoeus pharpingianus</i>		+(1910)						+(1993)		+(2003)		+
<i>Eutyphoeus waltoni</i>		+(1907)						+(1993)			+(2009)	+
<i>Lampito mauritii</i>			+(1913)									+
<i>Metaphire anomala</i>		+(1907)	+(1923)				+(1925)	+(1995)				+
<i>Metaphire birmanica</i>						+(1888)	+(1972)					+
<i>Metaphire posthuma</i>	+(1912)			+(1872)	+(1888)			+(1988)	+(2003)	+(2003)		+
<i>Perionyx sansibaricus</i>		+(1891)						+(1988)	+(2008)			+
<i>Pellogaster bengalensis</i>		+(1910)						+(1988)				+
<i>Polypheretima elongata</i>	+(1890)			+(1872)			+(1926)	+(1988)				+

Locality and collection no.: Aligarh D/04.

Date of collection: 18.08.08.

General habitat: Grazed grassland.

RESULT AND DISCUSSION

Of the 236 field samples of earthworms collected and identified from certain districts of Uttar Pradesh (Fig.1), encompassing various agro-climatic zones of the Gangetic Plain of India, the present study has brought to light 11 species including 4 exotics with extra-Indian origins. It has been observed that *Metaphire posthuma* is a 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 revised the Indian members of the family Octochaetidae in the publication '*Fauna of India*' providing illustrated descriptions of 154 taxa including 6 new genera and 16 new 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), 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 1989-2009 except for few fragmentary reports (Table 3). The 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. Further, collection of an epigeic species *Eutyphoeus pharpingianus* from dung heap in this survey is a significant contribution. This species could be potentially useful in the vermicomposting and investigations in this direction are under progress.

ACKNOWLEDGEMENTS

The authors are thankful to the Department of Biotechnology, Ministry of Science & Technology, Government of

India, New Delhi, for financial support for this study.

LITERATURE CITED

- Behera, B., Giri, S., Dash, N.C. and Senapati, B.K. 1999. Earthworm bio-indicators of forest land use pattern. *Indian Forester*. 124: 273-281.
- Bhadauria, T., Ramakrishnan, P.S. and Srivastava, K.N. 2000. Diversity and distribution of endemic and exotic earthworms in natural and regeneration ecosystems in the central Himalaya, India. *Soil Biology and Biochemistry*. 32: 2045-2054.
- Blanchart, E. and Julka, J.M. 1997. Influences of forest disturbance on earthworm communities in Western Ghat, South India. *Soil Biology and Biochemistry*. 29: 303-306.
- Gates, G.E. 1972. Burmese earthworms. An introduction to the systematic and biology of megadrile Oligochaets with special references to southeast Asia. *Transactions of the American Philosophical Society*. 62: 1-326.
- Halder, K.R., 1980. Annelida. In: Fauna of Nanda Devi Biosphere Reserve; Fauna of Conservation Areas 9. Zoological Survey of India, Calcutta, pp. 31-34.
- Jamieson, B.G.M. 1977. Preliminary description of Indian earthworms (Megascolecidae: Oligochaeta) from the Palni Hills. *Bulletins du Museum National d'Histoire Naturelle, Paris (Series 3)*, 313: 477-502.
- Julka, J.M. 1975a. Notes on the earthworms fauna of Darjeeling district with descriptions of two new species. *Minesto Zoological Museum in Berlin*. 52: 19-27.
- Julka, J.M. 1975b. Abnormal variations in *Perionyx millardi* Stephenson (Megascolecidae: Oligochaeta). *Newsletter of Zoological Survey of India*. 1: 26-27.
- Julka, J.M. 1976a. Studies on the earthworms collected during the Daphabum expedition in Arunachal Pradesh, India. *Record of Zoological Survey of India*. 69: 229-239.
- Julka, J.M. 1976b. Studies on the earthworms fauna of Orissa (India). *Moniligastridae and Ocnodrilidae*. *Minesto Zoological Museum in Berlin*. 52: 32-329.
- Julka, J.M. 1977. Contribution to the knowledge of the earthworm fauna (Oligochaeta: Annelida) of Meghalaya. *Newsletter of Zoological Survey of India*. 3: 398-400.
- Julka, J.M. 1978. Studies on the earthworm fauna of Orissa (India) 2. *Megascolecidae, Octochaetidae and Microchetidae*. *Minesto Zoological Museum in Berlin*. 54: 185-1970.
- Julka, J.M. 1979. First record of *Lumbricus castaneus* Savigny from India (Limbricidae: Oligochaeta). *Journal of Bombay Natural History Society*. 76: 191-192.
- Julka, J.M. 1981. Taxonomic studies on the earthworms collected during the susbansiri expedition in Arunachal Pradesh, India. *Record of Zoological Survey of India*. 26: 1-37.
- Julka, J.M. 1988. The fauna of India and the adjacent countries. *Megascolecidae: Octochaetidae (Earthworms) Haplotaxida, Lumbricina: Megascolecidae : Octochaetidae xiv*, Zoological Survey of India, Calcutta. PP-400.
- Julka, J.M. and Halder, K.R. 1975a. Record of *Pheretima malaca* Gates (Oligochaeta: Megascolecidae) from Andaman Islands. *Newsletter of Zoological Survey of India*. 4: 65-66.
- Julka, J.M. and Halder, K.R. 1975b. On the occurrence of giant earthworm *Perionyx macentoshi* Beddard (Oligochaeta: Megascolecidae) in Bhutan and Arunachal Pradesh (India). *Proceeding of the Zoological Society of Calcutta*. 28: 15-17.
- Julka, J.M. and Paliwal, R. 1994. On a new species of *Plutellus* Perrier (Acanthodrilidae: Oligochaeta) from northwest Himalayas, India. *Indian Research Bulletins of Punjab University*. 44: 217-220.
- Julka, J.M. and Paliwal, R. 2005. Distribution of earthworms in different agro-climatic region of India. In: Ramakrishnan P.S., Saxena K.G., Swift M.J., Raoks, Maikhuri R.K. (eds). *Soil biodiversity, ecological processes and landscape*. Oxford and ABH Publications Co. Pvt. Ltd., New Delhi, pp. 3-13.
- Julka, J.M. and Rao, B.R. 1982. A new earthworm *Mallehulla indica* gen. et. sp. nov. (Oligochaeta: Octochaetidae) from Karnataka, India. *Journal of Soil Biology and Ecology*. 2: 67-72.
- Julka, J.M. and Senapati, B.K. 1987. Records of the Zoological Survey of India. *Miscellaneous Publication*. Occ. Pap. 92 Grafic Printall, Calcutta, India, pp. 1-105.
- Khan, A.A. 2002. The Grasses of Bijnor district, Uttar Pradesh. *Journal of Economics and Taxonomic Botany*. 26: 42-47.
- Kumar, P., Jha, D., Kumar, A., Chaudhary, M.K., Grover, R.K., Singh, R.K., Mitra, A., Joshi, P.K., Singh, A., Badal, P.S., Mittal, S. and Ali, J. 2002. Economic Analysis of total factor productivity of

- crop sector in Indo-Gangetic plain of India by District and Region. Agricultural Economics Research Report. Indian Agricultural Research Institute, New Delhi, India.
- Lavelle, P., Barois, L., Blanchart, E., Brown, G.G., Brussaard, L., Decaens, T., Fragosco, Jimeuez, J., Kajondo, K., Martinez, M.A., Moreno, A.G., Poshanasi, Senapati, B. and Villenane, C. 1988. Earthworms as a resource in tropical agroecosystems. *Natural Resources*. 34: 26-41.
- Lee, K.E. 1985. Earthworms – their ecology and relationship with soil and land use. *Academic press*, Sydney.
- Misra, R. 1968. Ecology work book. Oxford and IBH publishing company, Calcutta. India.
- Pal, D.K., Bhattacharyya, T. Srivastava, P., Chandran, P. and Roy, S.K. 2009. Soils of the Indo-Gangetic plains: their historical perspective and management. *Current Science*. 96: 1193-1202.
- Paliwal, R. and Julka, J.M. 2005. Checklist of earthworms of Western Himalaya, India. *Zoos' Print Journal*. 20: 1972-1976.
- Piper, C.S. 1966. Soil and Plant Analysis. Hans Publishers, Bombay, pp. 368.
- Santhanam, R., Velaycitham, P. and Jegatheesam. 1989. A manual of Fresh water Ecology. Daya Publishing House, Delhi, pp. 134.
- Senapati, B.K., Julka, J.M. and Dash, M.C. 1990. On a new species of *Lenngoster* Gates (Oligochaeta: Oligochaeta) from India. *Review of Ecology and Biology of Soil*. 27: 467-470.
- Sotta, J.D. and Halder, K.R. 1980. Some earthworms from Western Himalayas. *Records of Zoological Survey of India*. 76: 195-205.
- Walkley, A and Black, I.A. 1934. Determination of Organic carbon in Soil. *Soil Science*. 37: 29-31.
-