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ADDITIONAL NEW RECORD OF EARTHWORMS BELONGING TO FAMILY OCTOCHAETIDAE FROM CHOTANAGPUR PLATEAU REGION OF JHARKHAND

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ABSTRACT

Four species of earthworms belonging to family Octochaetidae (Haplotaxida : Oligochaeta) namely *Lennogaster pusillus* Stephenson, *Dichogaster bolaui* Gates, *Octochaetona surensis* Michaelsen, *Eutyphoeus waltoni* Michaelsen have been collected from different areas of Chhotanagpur plateau of Jharkhand and have been identified and described. Out of the four one species (*Dichogaster bolaui*) is peregrine while rest three are native species. Two species namely *Dichogaster bolaui* and *Lennogaster pusillus* are epigeic while remaining two are endogeic. Occurrence of more native species indicates that the different land use patterns have not affected much the habitat of the earthworms from where they have bbeen sampled.

INTRODUCTION

Biodiversity, above or below the ground, is unquestionably credited for the provision of many ecosystem services which happens to be the base of human well-being. After Convention on Biological Diversity in 1992, biodiversity is defined as the diversity of genes, organisms and ecosystems and has been clearly recognized to support human survival. Presently the cost of the loss of biodiversity in terms of ecosystem services is estimated to be equivalent to 50 billion $ per year (1% of world gross domestic product) which by 2050 will reach 14 000 billion $ (7% of world gross domestic product) (Braat and ten Brink, 2008). An effort is required to develop the understanding of basic and ecological ecosystem services to address the issue. Having such knowledge will properly direct in creating both the management policy and for their preservation and sustenance (Kremen and Ostfeld, 2005). A fundamental question needs to be determined whether all species play equal role in providing ecosystem services or few are more important than others and whether all species should be of similar importance. If so, it would clearly be most relevant to focus especially on the management of specific providers. Review of literature (Schwartz *et al.*, 2000; Thompson and Starzomski, 2007) corroborates the 'Drivers and Passengers' hypothesis of Walker (1992), which advocates that some species (drivers) have very important ecological function while others comparatively very less. These species (drivers) are generally known as keystone species (Power and Mills, 1995) or ecosystem engineers (Jones *et al.*, 1994). Earthworms are typical ecosystem engineers and the most abundant animal biomass in most of the terrestrial ecosystems (Lavelle and Spain, 2001). Their role in providing ecosystem services particularly in soil subsystem is very important (Srivastava *et al.*, 2022).

Both the earthworm population and community are influenced by a number of factors such as synergism, competition, parasitism and predation as well as abiotic variables such as resource availability, soil quality, temperature and moisture regimes. These factors apart from anthropogenic interferences cause spatial and temporal variation in earthworm populations (Edwards and Bohlen, 1996; Curry, 1998; Whalen, 2004, Srivastava *et al.*, 2021). In some forests and grasslands, earthworm populations are associated with the above ground vegetations which provide a favorable microhabitat through their litter shedding and degree of ground cover. The occurrence of earthworm is also influenced by the quality and amount of above or below ground litter they produce (Zaller and Arnone, 1999; Campana *et al.*, 2002; Nachtergale *et al.*, 2002). Occurrence of species and spatial variation in earthworm populations has been reported to be related to soil properties such as organic carbon content and soil hydrology (Hendrix *et al.*, 1992; Poier and Richter, 1992; Nuutinen *et al.*, 1998; 2001; Sturzenbaum *et al.*, 2009; Srivastava *et al.*, 2022). Although the effects of biotic interactions on earthworm spatial distribution are not as well understood, competitive interactions for food and other resources may be the cause of some species geographical dispersion (Nuutinen *et al.*, 1998; Rossi *et al.*, 1997). It is well documented that earthworm distribution is largely dependent on anthropogenic activities and nothing can be said precisely about their occurrence in a habitat (Sturzenbaum *et al.,* 2009). Continuous sampling reveals species richness of earthworm in the habitat. Keeping in view, the various locations have been sampled continuously in Jharkhand to know the earthworm biodiversity of the state.The present communication is an additional new record of earthworms after Sinha *et al.,*(2013) who for the first time have presented the details of earthworm biodiversity of the state. The earthworms belonging to the family Octochaetidae have been enlisted and described for the first time in the present communication.

MATERIALS AND METHODS

Earthworms were sampled by monolith method and hand sorted once per month from an area of 25 X 25 cm during morning hours following Sinha and Srivastava (2001). After sorting worms were separated into different age groups on the basis of length and clitellar development. Earthworms were preserved in 70% ethanol with little amount of glycerine. Apart from sampling the earthworms, the soil samples were also analysed for few physico-chemical characteristics which influences the earthworm population. The pH and temperature was measured by portable digital pH meter and soil thermometer. Moisture content was estimated by oven drying method while Total organic matter and Organic carbon content was estimated following Walkley and Black (1934).

SYSTEMATIC ACCOUNT

Order Haplotaxida belongs to class Oligochaeta of Phylum Annelida.

Order **HAPLOTAXIDA**

Diagnosis. Interseptal testes and male funnels; male funnels at least one segment anterior to that bearing the male pores.

Suborder **LUMBRICINA**

Diagnosis. Multiple layers of cells form Clitellum. Male pores at least 2 segments posterior to testes.

Superfamily **MEGASCOLECOIDEA**

Diagnosis. Ovaries large, fan to rosette-shaped with the oocytes forming several egg strings.

Family **OCTOCHAETIDAE**

Diagnosis. Body cylindrical. Dorsal pores Present. Male pores behind *xvi*. pre-testicular segments bears spermathecae; prostates tubular with central canal. Last pair of hearts posterior to *xi*. Meronephric.

Distribution. India, Burma, Australasia, Tropical America and Africa.

Genus ***Lennogaster*** Gates

Diagnosis. Lumbricine setae. Paired male pores, in seminal grooves in *xviii* or *xvii / xviii*; prostatic pores one pair on *xvii* or 2 pairs on *xvii* and *xix*; female pores paired, in *xiv*. Oesophagus with 2 gizzards, in *v-vi* and presence of 3 pairs of discrete extramural calciferous glands in *x-xii*; Absence of intestinal caeca and supra-intestinal glands; typhlosole simple, lamelliform. Micromeronephridia astomate, enteronephric paired tufts in *iii*, few, exonephric on the body wall in *iv* and posteriad segments, arranged in 3-5 longitudinal rows in post clitellate segments; paired, stomate, exonephric megameronephridia in caudal segments.

Distribution. India, Burma, Bangladesh.

Lennogaster pusillus Stephenson

1920. *Eudichogaster pusillus* Stephenson, *Mem. Indian Mus.*, **7**: 253; 1939. *Lennogaster pusillus* Gates, *Rec. Indian Mus.*, 41: 199; Julka, 1978, *Mitt. Zool. Mus. Berlin.*, **54**: 192.

Diagnosis. Length 20-68 mm, diameter 1-2.5 mm, 105-132

Table: 1: Physico chemical parametes of sampling sites

District	Sampling sites	Latitude	Longitude	pH M±SD	Moisture content (g%)	OC M±SD	OM M±SD
Ranchi	Dhurwa (S1)	23.31°N	85.29°E	6.8±0.64	28.3±1.76	0.81±0.06	1.40±0.30
	Morhabadi (S2)	23.39°N	85.34°E	6.6±0.43	27.5±1.89	0.75±0.06	1.29±0.31
	Bero (S3)	23.29°N	84.97°E	5.8±0.51	25.4±2.03	0.62±0.063	1.07±0.28
Khunti	Karra (S4)	23.12°N	85.13°E	5.5±0.57	25.1±1.33	0.41±0.038	0.71±0.19
	Lodhma (S5)	23.24°N	85.19°E	5.6±0.39	24.5±2.03	0.43±0.036	0.74±0.16
Hazaribagh	Barkagaon (S6)	23.85°N	85.22°E	5.8±0.41	26.4±1.96	0.61±0.052	1.06±0.22
	Ichak (S7)	24.12°N	85.13°E	6.4±0.53	25.8±2.01	0.72±0.058	1.25±0.35
Palamu	Hussainabad (S8)	24.53°N	84.00°E	5.8±0.47	24.8±1.48	0.53±0.057	0.92±0.19
	Patan (S9)	24.20°N	84.18°E	5.6±0.64	24.9±1.57	0.53±0.043	0.92±0.27
Dhanbad	Nirsa (S10)	23.79°N	86.71°E	5.6±0.55	24.3±1.89	0.72±0.048	1.24±0.33
	Topchanchi (S11)	23.79°N	86.43°E	6.5±0.48	24.7±1.32	0.75±0.054	1.30±0.23
Dumka	Berhait (S12)	24.89°N	87.61°E	5.3±0.39	24.9±1.99	0.71±0.061	1.22±0.34
	Kathikund (S13)	24.35°N	87.42°E	6.1±0.58	24.7±1.17	0.57±0.051	0.98±0.12

Units: pH in Unit, OC in mg/ of soil, OM in mg/g of soil

RESULTS

The physico chemical properties of soils of sampling sites have been presented in Table -1 which shows that the soil is slightly acidic in nature having moderate or low amount of total organic matter and organic carbon. Soil moisture was around 25% where earthworms were found. Soil was sandy loam type. At the garbage dumping site where decomposition was going on total organic matter was high ranging from 0.71-1.4 mg/g soil while pH was low.

A total of four species belonging to family Octochaetidae have been identified. A systematic account on the Octochaetide earthworms has been presented.

segments. Prostomium proepilobic, tongue closed. First dorsal pore 11/12, sometimes 12/13. Clitellum annular, *xiii-xvii*. Setae *aa* = 1.6-1.7 *ab*= 0.9 *bc* = 1-1.1 *cd* = 0.12-0.13 *dd* on *xii, aa* = 2.4-2.5 *ab* = 1.3 *bc* = 1.5-1.7 *cd* = 0.14-0.17 *dd* on *xxiv*, no setae copulatory. Male genital field transversely thickened, on *xvii*; male pores paired, minute, in or near 17/18 at posterior ends of seminal grooves, at *b*. Prostatic pores paired, minute, on the setal arc of *xvii* at anterior ends of seminal grooves at *a*. Seminal grooves crescentric, diagonally placed on oval porophores, extending from the setal arc of *xvii* to 17/18, at *ab*. Spermathecal pores paired, minute, on *viii*, at *a*.

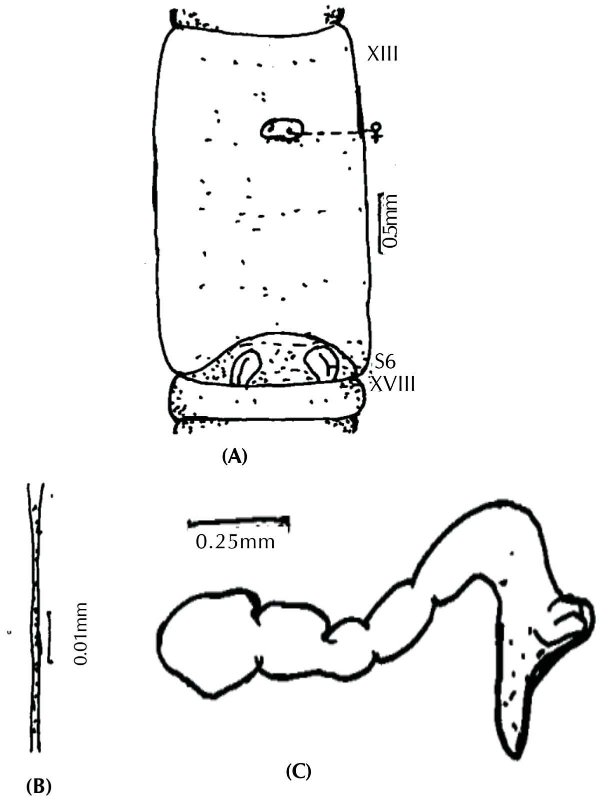

Figure 1: *Lennogaster pusillus* Stephenson (A) Male genital region (B) Penial seta (C) Spermatheca

Septa 4/5-7/8 delicate, 8/9-12/13 slightly muscular. Typhlosole in *xvii-xviii* to *lxx-lxxvi*. Last pair of hearts in *xii*. Proandric but with male funnels in *xi*. Testes and male funnels in *x* enclosed in paired sacs; seminal vesicles absent. Prostates paired, in *xvii*. Penial setae ornamented with scattered small triangular teeth, tip almost membranous, slightly widened with ectal end straight or jagged or concave or deeply indented, 0.53-0.65 mm long, 4-5 μ diameter. Spermathecae paired, in *viii*, elongate, each with a sessile spheroidal to tubular ental diverticulum, ampulla at right angle to the duct.

Distribution. India: Jharkhand (S2, S3, S4, S6, S8, S10, S12), Himachal Pradesh, Karnataka, Orissa, Uttar Pradesh, Chattishgarh, Madhya Pradesh.

Material examined. 17 clitellate specimens from different districts of Jharkhand.

Habitat. Litter dwelling and mainly found within 5 cm of top soil, which is alkaline (pH 7-8) and with high organic matter (>10g%). It also inhabits compost pit near cow shed and in kitchen waste sites.

Biology. 75 – 415 (No m^{-2}) was the density of worm from shorea plantation site at Bero, Ranchi (Gupta, 2006). Activity of worm is restricted to 2-3 months from late June to September. Diapause during unfavourable period is passed in immature stages. 15-20 g% of soil moisture is most favourable. Small and round cocoons with ornamentations which are pale lemon in the initial stage and gradually become greenish-reddish brown. Incubation period of 12-18 days. A single worm hatches from each cocoon. the worm remains active throughout the year if there is availability of sufficient moisture and organic matter . Casts are deposited on the soil surface in the form of small towers with central openings.

Economic importance. This species might be important in the biodegradation of wastes to some extent.

Genus ***Dichogaster*** Beddard

Diagnosis. Setae lumbricine. Male pores paired, in seminal grooves on *xviii* or 17/18; prostatic pores one pair on *xvii* or *xix*, or 2 pairs on *xvii* and *xix*. Oesophagus with 2 gizzards anterior to septum 8/9 and one pair of extramural calciferous glands, each gland trilobed, a vertically reniform lobe in each of segments *xv-xvii* with a common duct opening into gut in *xvi*; intestinal caeca and supra-intestinal glands absent; typhlosole simple, lamelliform, micromeronephridia astomate, enteronephric paired tufts in *ii-iv*, several exonephric on the body wall in *v* and posteriad segments, arranged in longitudinal rows posterior to the prostatic region; paired, stomate, exonephric megameronephridia in a few posterior most segments.

Distribution. Tropical Africa and America, India. The species of *bolaui* has been widely transported to various parts of the world.

Dichogaster bolaui Michaelsen

1891. *Benhamia bolavi,* Michaelsen, *Jb. hamb. wiss. Anst.* **8**:9 (Type locality: Bergedorf, Hamburg, Germany); 1910. *Dichogaster bolaui*,Michaelsen, *Abh. Ver. Hamburg,* **xix**: 98; 1916. *Dichogaster bolaui*, Stephenson, *Rec. Ind. Mus.* **xii**: 348; 1920. *Dichogaster bolaui*, Stephenson, *Mem. Ind. Mus.* **vii**: 257. Stephenson, 1923, *Fauna Br. India, Oligochaeta*: 472-473; 1972. *Dichogaster bolaui*, Gates, *Trans. Am. phil. Soc.,* **62**(7): 279; Righi *et al.*, 1978, *Acta Amazonica*, **8(3)**, suppl. 1: 38.

Diagnosis. 19-43 mm in Length, diameter of 1-3 mm, number of segments 70-98. Epilobic prostomium, tongue closed. First dorsal pore 5/6, sometimes 6/7. Annular clitellum, *xiii, xiv-xviii, xix, xx,* ½ *xxi*. Setae *aa* = 2.5-3.3*ab*= 0.8 *bc*= 2.5-3.3 *cd* = 0.08 - 0.09 *dd* on *xii*, *aa*= 2.3-2.8 *ab* = 0.9 *bc*= 2.3-2.8 *cd* = 0.1 *dd* on *xxiv*. Male pores paired, minute, in seminal grooves linking prostatic pores, in *xviii*, at *a*. Prostatic pores paired, minute, at the ends of slightly concave seminal grooves on *xvii* and *xix*, at *a*. Female pore single, median, presetal. Spermathecal pores paired, in 7/8/9, at or near *a*. Genital markings absent.

Septa 4/5, 7/8-12/13 slightly muscular, 5/6/7 absent. Gizzards between septa 4/5 and 7/8; typhlosole *xxi-xxii* to *lxviii-lxxvi*. Last pair of hearts in *xii*. Holandric; male funnels and testes in unpaired sacs formed by the peripheral apposition of septa 9/10/11/12, in *x* and *xi*; seminal vesicles acinous, vestigial, in *xi* and *xii*. Penial setae unornamented or ornamented with a few to several triangular teeth, tip hooked or widened and then scalpel, oar, spatula or spoon-shaped, 0.22-0.4 mm long, 3 -7.5 μ diameter. Spermathecae paired, in *viii* and *ix*, each with a small digitiform to pyriform ventrally

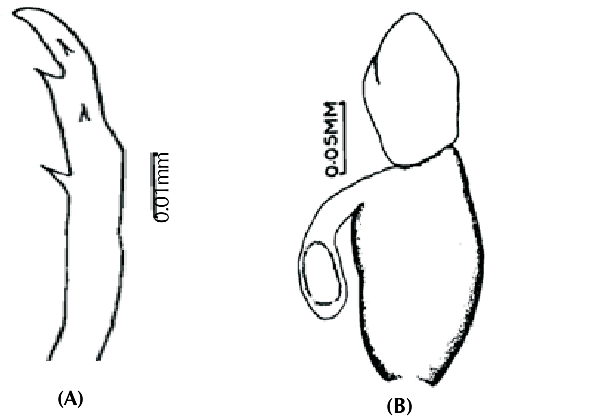

Figure 2 : *Dichogaster bolaui* Michaelsen (A) Penial setae (B) Spermatheca

directed ental diverticulum, duct rather barrel-shaped.

Distribution. India: Jharkhand (S1, S2, S5, S7, S9, S11, S12), Meghalaya, Karnataka, Tamil Nadu, Sikkim, Orissa, Uttar Pradesh, Andaman and Nicobar Islands, Kerala, Arunachal Pradesh, West Bengal, Rajasthan, Himachal Pradesh, Maharashtra; Andhra Pradesh. Sri Lanka, Burma, Pakistan, Australia, Bangladesh, China, Malaya Peninsula, Vietnam, Indonesia, Japan.

Material Examined. 18 clitellate specimens from different districts of Jharkhand.

Habitat. It inhabits top 5 cm soil with high organic matter (>10 g%), kitchen waste, soil around compost pits, rotten wood, among roots of lichen growing on stones, in tree holes in soil around palm and coconut leaves; thatched roof of a house.

Biology. Population in a thatched roof of a house was 800 m^{-2}. Activity is restricted to 2-3 months from early rainy to post rainy period from mid-June to September. An average population of about 1447/m^2 and 1665/ m^2 was noted in the pasture and compost pit site. Peak population of 8038/m^2 in pasture and 12617/m^2 in compost pit was reported by Sahu *et al.,* (1988). Reproduction is bi-parental copulation occurring during heavy rains in July. Cocoons are small, thin-walled, light coloured and oval with ornamentations. Clitellar degeneration during post reproductive period and diapause during unfavourable period are distinct. However, reproduction may continue throughout the year in moist places with high humus. Young worms hatch in about 12-18 days. Casts are deposited on the soil surface in small heaps of tiny globular pellets.

Economic importance. Decomposing enzyme like cellulase has been reported in its gut (Mishra and Dash, 1980) and it might be important in converting organic matter into available nutrients.

Genus ***Octochaetona* Gates**

Diagnosis. Setae lumbricine. Male pores paired, in seminal grooves, on *xviii*. Prostatic pores paired, at the ends of seminal grooves, on *xvii* and *xix*. Oesophagus with a single gizzard and one pair of discrete, extramural, usually asymmetrical calciferous glands close to the attachment of septum 15/16; intestinal caeca and supra-intestinal glands absent, typhlosole ventrally bifid. Micromeronephridiaastomate paired, enteronephric tufts in *iv,* several biramous, exonephric, on the body wall in *v* and posteriad segments, slightly enlarged and stomata in caudal segments with preseptal and intrasegmental funnels; megameronephridia absent.

Distribution. Peninsular India, Pakistan, Nepal, Burma, Malay Peninsula, Philippines.

Octochaetona surensis Michaelsen

1962. *Octochaetona surensis,* Gates, *Ann. Mag. Nat. Hist. (ser. 13),***5**: 213; Gates. 1972. *Trans. Am phil. Soc.* **62** (7): 309.

Diagnosis. Length 60-140 mm, diameter 2.5-6 mm, 111-180 segments. Prostomiumepilobic, tongue closed. First dorsal pore 12/13. Clitellum annular, *xiii-xvi, xvii.* Setae *aa*= 2.7-4.3*ab*=1.1*bc*=1.4-2.5*cd*=0.15-0.16*dd* on *xii*, *aa*=3.3-3.4*ab*=1.2-1.3*bc*=1.9-2.5*cd*=0.16-0.19*dd* on *xxiv,a, b* on *viii* and *ix* copulatory, being surrounded by tumescences. Male genital field *xvi-xx,* with deep transverse depressions on *xvii* and *xix*. Male pores minute, median to *b*. Prostatic pores minute at *b*. Seminal grooves convex. Female pores paired, presetal, within *a* lines, sometimes single and median. Spermathecal pores paired, minute, on or close to the setal arcs of *viii* and *ix,* at *ab*. Genital marking oval, paired or unpaired and median, postsetal on some of *xviii-xxii*, at *aa* or *bb*.

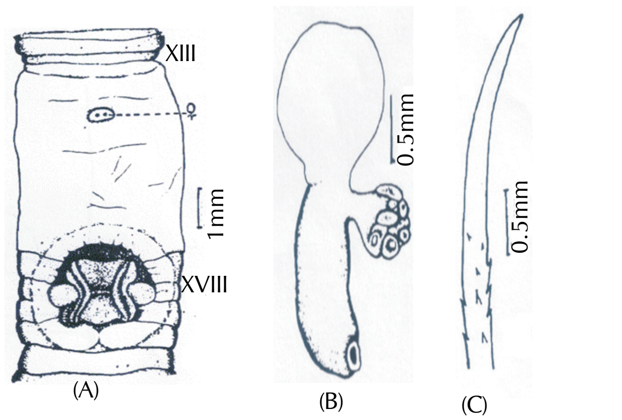

Figure 3: *Octochaetona surensis* Michaelsen (A) Male genital region, (B) Spermatheca, (C) penial seta

Septa 4/5, 8/9-10/11 muscular, 5/6/7/8 absent. Gizzard between septa 4/5 and 8/9. Intestine begins in *xvii*, typhlosole in *xxii-xxiii* to *ci-cxv*. Last pair of hearts in *xiii*. Holandric, testes and male funnels in cylindrical sacs in *x* and *xi*, seminal vesicles in *ix* and *xii*. Penial setae ornamented with a few longitudinal rows of triangular teeth, tip pointed or claw-shaped, 1.2-1.8 mm long, 25-30 μ diameter. Spermathecae paired in *viii* and *ix,* each with a shortly stalked, multiloculate ental diverticulum. Copulatory setae ornamented with longitudinal rows of spikes or thornlike protuberances, tip claw-shaped, 0.85-1.2 mm long, 20-25 μ diameter. Genital marking glands absent.

Distribution: India: Jharkhand (S2, S3, S5, S7, S8, S10, S13), Uttar Pradesh, Bihar, Assam, Orissa, Madhya Pradesh, Chattisgarh.

Material examined: 11 clitellate specimens from different parts of Jharkhand.

Habitat: Generally found in hillocks, upland crop fields, compost pits, grasslands and around roots of potted plants. It is dominant in sandy loam soils with low organic matter (5 g %) content.

Biology: Geophagous in habit. Maximum population density of 186/m^2 and 133/m^2 has been observed in an ungrazed upland pasture and grazed upland pasture respectively (Dash and Senapati, 1980; Senapati, 1980). Cocoons are spherical and thin-walled having an average weight of 31.5 mg, the length and diameter of the cocoon is 5.34 mm and 4.09 mm respectively, cocoon colour initially is pale lemon yellow which gradually changes to deep green to brownish red. Usually one juvenile hatches from each cocoon.

Eutyphoeus Michaelsen

1883. *Typhoeus* Beddard, *Ann. Nat. His. (ser. 5)*, **12**: 219 (non Leach, 1815, *Brewster's Edin Enycy.*, **9**(1):97).1888.*Typhoeus* Beddard, *Q, Jl microsc. Sci.*, **28**: 403. 1900. *Eutyphoeus* Michaelsen, *Tierreich*, **10**: 322.1923. *Eutyphoeus* Stephenson, *Fauna Br. India, Oligochaeta*: 420. 1938. *Eutyphoeus* Gates, *Rec. Indian Mus.,* **40**: 60.1972. *Eutyphoeus* Gates, *Trans. Am. phil. Soc.*, **62**: 281.

Diagnosis. Setae lumbricine throughout the body. Clitellum annular. Prostatic and male pores paired near the setal arc of *xvii*, discharging within vestibula or directly into the body surface; male pores near but slightly posterior to the prostatic pores. Female pores minute, paired, presetal *on xiv*, sometimes the pore of the right side rudimentary or absent. Spermathecal pores large, paired, in 7/8. Genial markings usually present. Nephridiopores not recognized.

Septa 4/5/6, 8/9-10/11 muscular, 6/7/8 absent. A single large oesophageal gizzard between septa 5/6 and 8/9. Discrete calciferous glands onepair, intramural, longitudinally hemiellipsoidal with flat faces mesially, in *xii*, each gland with numerous vertical lamellae, the interlamellar spaces communication dorsally with the oesophageal lumen. Intestine begins in *xv*; typhlosole lamelliform, ending posteriorly with a short series of supra-intestinal glands; unpaired, anteriorly directed, midventral intestinal caeca anterior to supra-intestinal glands present; paired, lateral intestinal caeca sometimes present. Dorsal vessel single, complete or aborted anteriorly; supra-oesophageal vessel single, *x-xiii*; extra-oesophageal and latero-parietal vessels paired, passing to anterior and posterior ends of calciferous glands respectively; subneural vessel absent; lateral hearts with connectives to the dorsal and supra-oesophageal vessels in *xi-xiii*, last pair of hearts in *xiii*. Prostates paired; vas deferens enlarged ectally into bulbs ejaculatrice. Spermathecae paired, diverticulate. Ovisacs absent. Micromeronephridia astomate, 4-5 pairs of enteronephric tufts in *iii*, numerous, biramous and y-shaped, exonephric on the body wall in *v* and posteriad segments; paired stomata, exonephric, megameronephridia in each segment posterior to the supra-intestinal glands, funnels close to the nerve cord.

Distribution. India, Burma, Bangladesh, Nepal, Pakistan.

Eutyphoeus waltoni Michaelsen

1907. *Eutyphoeus waltoni* Michaelsen, *Jb. hamb. wiss. Anst,* **24**:179. *1907. Eutyphoeus bengalensis* Michaelsen, *Jb. hamb. wiss. Anst,* **24**: 183. *1914. Eutyphoeus ibrahimi* Stephenson, *Rec. Indian Mus.,* **10***: 357. 1923. Eutyphoeus ibrahimi* Stephenson, *Fauna Br. India, Oligochaeta:* 438. 1923. *Eutyphoeus waltoni*, Stephenson, Fauna Br. India, Oligochaeta. 455. 1932. *Eutyphoeus sp.*, Thapar, *Curr. Sci.*, **1**:29. 1938. *Eutyphoeus waltoni* Gates, *Rec. Indian Mus.* **40**:112.

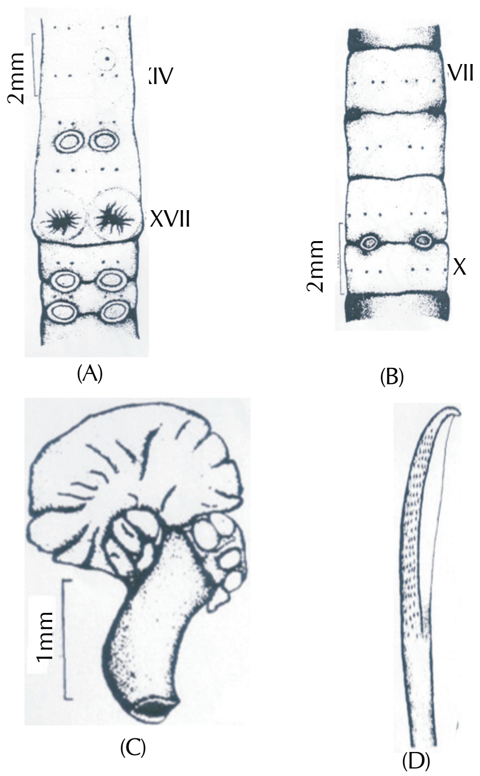

Figure 4*: Eutyphoeus waltoni* Michaelsen (A) Genital region (B) Spermathecal pore region (C) Spermatheca (D) Penial seta

Diagnosis. Length 53-230 mm, diameter 4-8 mm, 115-201 segments Prostomium pro-or tanylobic. First dorsal pore 11/12. Clitellum *xiii*, ½*xiii-xvii*. Setae aa = 1.7–2.4 *ab* = 1 –1.2 *bc* = 1.4-1.9 *cd* = 0.12–0.14 *dd* on *xii*, *aa* = 2.4–3.2 *ab* = 1.2–1.7 *bc* = 2.1–2.8 *cd* = 0.15 *dd* on *xxiv*. Male pores discharge into deep, well-like paired vestibula (bivestibulate) opening onto the body surface through circular apertures or transverse slits, at *ac;* penes elongate tubular, 1 mm long. Female pore single on the left side, presetal, slightly lateral to a. Spermathecal pores small, transverse slits, the centres at or slightly median to *c*. Genital markings paired (sometimes one of the pair absent), postseta1 one *ix,* sometimes on *viii*, *x*, intersegmental on 14/15/16, 18/19, occasionally on 13/14, 16/17, 19/20-22/

23.

Lateral intestinal caeca absent, median ventral intestinal caeca 24-29 in *xxxiii-lxii*, supra-intestinal glands 4-5 pairs in *lxxvi-lxxxvi*, typhlosole begins in xxvii-xxviii. Dorsal vessel terminates posterior to gizzard in vii. Metandric, testis sac ventral, seminal vesicles in *xii*, extending to *xiii-xiv*. Penial setae ornamented with fairly closely crowded circles of small, fine teeth, tip spoon-shaped, 4-5 mm long, 20-30 μ diameter. Each spermatheca with a median and a lateral ental diverticula, often directed posteriorly, sometimes bound together in a connective tissue, duct slender, comparatively long, *c.* 2 mm in length. Genital marking glands sessile.

Distribution. India: Jharkhand (S1, S3, S5, S9, S10, S12) Chandigarh, West Bengal, Punjab, Bihar, Rajasthan, Jammu and Kashmir, Uttar Pradesh, Himachal Pradesh, Madhya Pradesh.

Biology. Its habitats include alluvial soils with pH range of 7.5-8.6, cultivated fields, plant nurseries, gardens, flower pots, manure heaps and banks of a tank. It is found in plains to an elevation of *c.*610 m.

This species is mainly active from July to October in the Indo Gangetic Plains. Breeding is restricted to August-October (Gates, 1945, 1961; Bhatti, 1962; Khan, 1966), and aestivation is probably imposed during the summer drought and winter cold. It wanders aimlessly in large numbers on the soil surface towards the end of the rainy season in October-November, which also results in heavy mortality of the individuals due to heat (Gates, 1945). Feeding, copulation and cast deposition occur above the soil surface. Bioluminescence has been reported in this species.

DISCUSSION

Differences in geographical distribution pattern of taxa and their presence in one location but absence from other location delineates differences in both the evolutionary history of organic life and the planetary history. If a taxon is absent from a habitat it does not question its capability to exploit the local resources rather the more prosaic matter of an inability to reach the habitat (James, 2004; 2009). It has been postulated that the biogeography of the modern taxa of earthworms reflect the history of macro evolution such as continental drift, island formation, global climate change. But in case of earthworms biogeography anthropochory is regarded as a most important factor in dispersal route of peregrine species of earthworm. The distribution of earthworms today is a result of such activities.

As indicated by Reynolds (1994) the occurrence of earthworms in a habitat depends upon certain conditions like adequacy of food, moisture, oxygen and range of temperature in habitat, protection from light and ultra-violet rays; suitable pH, (though some acidity is not a problem, but it is difficult for the earthworms to extract nutrients from a food source under very acidic (low pH) or very basic (high pH) conditions presence of toxic substances (habitats with high concentrations of various salts and insecticides, pesticides eliminates earthworm). The occurrence of the Octochaetid earthworms in the sampled area reflects the habitat suitability for the group of earthworms. The occurrence and the impacts of different species of earthworms have been reported to be related to their ecological functional guild (Bouche, 1977; Brown *et al.,* 2004; Hale *et al.,* 2005). A classiûcatory scheme for earthworm species based on the food, microhabitat in soil, and movement through the soil layers for continued survival has been proposed (Bouche, 1977; Brown *et al.,* 2004; Hale *et al.,* 2005; Zeilingera, 2010), for better understanding about the species as well as its utilization. Following the scheme, out of the four species of the earthworms recorded during the present study two are epigeic and two species are endogeic (Table-2). Of the recorded four species three are native and one is peregrine (Table-2). Their occurrence is associated with their dispersal through anthropogenic activities.

Table 2: Native and Peregrine earthworm genera and species of family Octochaetidae.

Genera	Species	Peregrine / Native	Epigeic / Endogeic
Lennogaster	*Lennogaster pusillus*	Native	Epigeic
Dichogaster	*Dichogaster bolaui*	Peregrine	Epigeic
Octochaetona	*Octochaetona surensis*	Native	Endogeic
Eutyphoeus	*Eutyphoeus waltoni*	Native	Endogeic

The occurrence and biogeography of earthworms primarily depend on their origin and natives and exotics as mentioned above. The land use pattern is also very important factor influencing the occurrence and distribution. Under different land use pattern the capability of a particular species to adapt in modified soils (soils under intensive agricultural practices) leaving its original habitat (forest and grassland) enables it to service in changed habitat and provide power of cosmopolitism. According to Fragoso *et al.*,(1999), apart from the above reasons the availability of earthworms is dependent on their ecological plasticity. Based on such plasticity earthworms are ranked according to their ecological tolerance to edaphic and environmental variables like stenoecic to euryoecic species. The ecological plasticity depends on the niche breadth of the species.

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