



ENDEMIC ANNELIDS (EARTHWORMS) OF DARJEELING DISTRICT, WEST BENGAL, INDIA

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INTRODUCTION

Earthworms occur in diverse habitats all over the world. However, they rarely survive in deserts, marine environments, areas under constant snow and ice, and areas devoid of soil and vegetation. They possess limited means of active dispersal. High mountain ranges and seas are the effective barriers for extension of their natural distribution. The origin of earthworms is unclear due to absence of any fossil records. Therefore, their phylogeny has been derived by the analysis of distribution, ecology, and comparative anatomy of the extant species. Stephenson (1930) considered their appearance in the Cretaceous, coinciding with dicotyledonous plants. Michaelsen (1903) and Arldt (1908) estimated their origin much earlier during Upper Jurassic and Upper Triassic periods, respectively. Sims (1980) believed that ancestors of present day earthworms were prevalent in the undivided palaeocontinent of Pangaea that existed during the Palaeozoic. Later, Bouché (1983) ascertained their origin in Palaeozoic period, and believed that the Oligochaeta acquired the characters adapted to true terrestrial life at the end of Palaeozoic or during early Mesozoic. Plate tectonics, in addition to special physiological and developmental strategies evolved during the past, influenced the speciation events that resulted in modern distribution of earthworm taxa (Michaelsen, 1922; Omodeo, 1963, 2000). Bouché (1983) also inferred the present-day

distribution of earthworms as an outcome of three factors *viz.*, the origin of founders, their migratory capacity and their ability to survive. Some species are distributed over wide areas in different regions of the world owing to anthropogenic actions. Anthropochorous or peregrine species are capable of colonizing disturbed environments in contrast to endemic species. These species are, therefore, disregarded for distributional considerations of earthworms (Julka, 1993).

Endemic taxa occur naturally and are restricted to a specific geographical region; therefore, the area where endemics live is wholly irreplaceable. Endemics may be categorized on the basis of their spatial distribution, inferred evolutionary age and affinities, and abundance. From spatial distribution perspective, endemics may occupy limited geographical ranges, *i.e.* have a limited 'extent of occurrence' and also have a limited 'area of occupation' within their geographical range (Gaston, 1991). In practice, endemics are loosely and commonly categorized in four contexts (Hawksworth and Kalin-Arroyo, 1995) as: (a) site or restricted area endemic (b) biotope endemic (c) biogeographical region endemic, and (d) political area endemic, also called national endemic. Range sizes for defining local endemism of species endemic to a given geographical area are often arbitrarily set varying from less than 50,000 km² for birds and plants (Terborgh and Winter, 1982; Gentry, 1986; ICBP, 1992) to 2000 km² for locally endemic plants in the

Cape Floristic Region of South Africa (Cowling and Holmes, 1992). Harvey (2002) suggested a nominal distribution range of less than 10,000 km² as a working definition for species with naturally small distribution ranges, termed as short-range endemic (SRE) species. Eberhard *et al.* (2009) recommended a smaller area of less than 1,000 km² for stygofauna.

PHYSIOGRAPHY

Darjeeling, the northern most district of West Bengal, lies between 26°27' to 27°13' N and 88°53' to 87°59' E, stretches out in an area of 3149 km². The Hill areas of the district are located within the Lesser and Sub-Himalayan belts of the Eastern Himalaya. The Sikkim Himalaya in the north, the Bhutan Himalaya in the east and Nepal Himalaya in the west bound the area. The altitude in the district varies significantly from 100 msl to mighty snow clad Kanchenjunga (8579 msl). The variations in topographical features due to three primary attributes (i.e., latitude: south-north; longitude: east-west; altitude: low-high) bring on diversity in climate and habitat conditions within the region (O'Malley, 2001).

The temperature in the district fluctuates greatly depending upon the location and altitude. It ranges from 24°C in the plains to 15°C on the ridge during summer and drops from (-)5°C to 10°C during winter. There is no distinct correlation between total rainfall and altitude. The southern slopes of the ridges get much higher (4000-5000mm) precipitation than the leeward sides (2000-2500mm). The next main ridge with Tiger Hill gets 3000mm while to the north the Great Rangit valley receives about 2000mm of rainfall. The annual total rainfall in Darjeeling district fluctuates between 3040-4570mm (O'Malley, 2001).

Soils of Darjeeling hill areas are extremely varied, depending on elevation, degree of slope, vegetative cover and geolithology. The soils in the Kalimpong area are predominantly reddish in color with occasional dark soils; in the highlands stretching from the west to the east are mainly mixed sandy loams and loamy, while on the southern slopes of Mirik and Kurseong are mainly

clayey loam and reddish in color. Sandy soils are mainly found in the east of the river Tista (O'Malley, 2001).

Due to vast altitudinal variation, the forest type varies in different altitudinal ranges, *viz.* tropical moist deciduous forest (300-1000m), tropical evergreen lower montane forest (1000-2000m), tropical evergreen upper montane forest (2000-3000m), temperate forest (3000-3500m), and sub temperate forest (above 3500m). However, major tracts of the forests are found at elevations of 2000m and above. The area located between 1000-2000m is transformed either into tea gardens or agriculture fields (O'Malley, 2001).

The vegetation in the district is very rich in diversity as well as density. These include about 4,000 species of flowering plants, 300 species of ferns including tree ferns, 283 species of orchids (Yonzon *et al.*, 2012), and several species of moss, algae and fungi. The trees of *Shorea robusta*, *Acacia catechu*, *Dalbergia sissoo*, *Terminalia* sp., *Albizia* sp., *Dendrocalamus* sp., etc., are growing in the tropical zone; *Magnolia* sp., *Michelia* sp., *Quercus* sp., *Pyrus* sp., *Synplocos* sp., *Eugenia* sp. and conifers (*e.g.* *Juniperus* sp., *Cryptomeria* sp., *Abies* sp., *Pinus* sp., *Larix* sp., *Tsuga* sp.), *Salix* sp., *Rhododendron* sp., *Arundinaria* sp. in the temperate zone; junipers, *Rhododendron* sp., etc. in the alpine zone are among commonly occurring plants. The understory of shrubs, herbs and climbers comprises mostly species of *Acanthaceae*, *Melastomataceae*, *Apocynaceae*, *Rubiaceae*, *Malvaceae*, *Urticaceae*, *Polygonaceae*, *Vitaceae*, *Cucurbitaceae*, *Convolvulaceae*, *Smilax*, *Dioscorea*, *Rhaphidophora*, etc., and several species of orchids, ferns and grasses in the tropical zone; and *Clematis*, *Berberis*, *Ilex*, *Rosa*, *Potentilla*, *Cotoneaster*, *Spiraea*, *Aucuba*, *Lonicera*, *Osbeckia*, *Vaccinium*, *Agapetes*, *Polygonum*, *Aconitum*, *Viola*, *Chrysosplenium*, *Fragaria*, *Gentiana*, *Campanula*, balsam, lilies, etc., in the temperate zone. About 30% of the forest covers found in the lower hills are deciduous. Evergreen forest constitutes only about 6% of the total forest area. *Shorea robusta* is the most prominent species of tropical moist deciduous forest along with heavy undergrowth. Tropical lower montane evergreen forests are

found on steep higher slopes with good drainage condition, whereas, tropical upper montane evergreen forests are found in high humidity areas, along with dense fog and less sunlight. Undergrowth is dense and contains nettles, raspberries, ferns and bamboos. On the steep ridges, rhododendrons and bamboos are abundant (O'Malley, 2001).

Earthworm Diversity

India is identified as mega biodiversity country representing vast area of two major hotspots, viz., Himalaya and the Western Ghats. Both the regions hold a rich biological wealth with especially high number of endemic species. Earthworm diversity (Megadrili) in Indian territory, including islands of Andaman & Nicobar, and Lakshadweep, is known by 418 species belonging to 70 genera spread over 9 families displaying high diversity concentrations in these hotspots (Julka *et al.*, 2009). Endemism among Indian earthworms at genus and species level is enumerated around 71 and 89 percent respectively. Eastern Himalaya including northeast hill Ranges and hills of Darjeeling district and Sikkim harbour rich biological wealth due to their varied physiography and geological history. Earthworms of Darjeeling and Sikkim Himalayan region have been studied by Michaelsen (1907), Stephenson (1916, 1917, 1920, 1931), Gates (1972), Julka (1975), Soota and Halder (1981), Halder (1999) and Halder *et al.* (2007). Rich earthworm diversity of Darjeeling district is represented by 47 species spread over 6 families exhibiting about 11% of the Indian species. Most diverse family Megascolecidae is represented by 30 species followed by Lumbricidae (8 spp.), Octochaetidae (5 spp.), Acanthodrilidae (2 spp.), and Moniligastridae and Glossoscolecidae by one species each. Wide-ranging physiographic features of the district provide appropriate ecological requirements for the proliferation and sustenance of these species.

Distribution

Family-wise details of earthworm fauna recorded from Darjeeling district is given below. Species marked with an asterisk (*) are also distributed elsewhere outside Darjeeling district.

Family **Moniligastridae** : *Drawida nepalensis**.

Family **Lumbricidae** : *Aporrectodea rosea rosea**, *Bimastos parvus**, *Dendrobaena hortensis**, *Dendrodrilus rubidus**, *Eisenia fetida**, *Eiseniella tetraedra tetraedra**, *Octolasion cyaneum**, *Octolasion tyrtaeum**.

Family **Glossoscolecidae** : *Pontoscolex corethrurus**.

Family **Acanthodrilidae** : *Plutellus* (= ?*Argilophilus*) *ghumensis*, *Plutellus* (= ?*Argilophilus*) *sikkimensis*.

Family **Octochaetidae** : *Dichogaster modigliani**, *Dichogaster saliens**, *Eutyphoeus gammiei**, *Octochaetona beatrix**, *Scolioscolides bergtheili**.

Family **Megascolecidae** : *Amyntas alexandri**, *Amyntas corticis**, *Amyntas gracilis**, *Amyntas morrissi**, *Amyntas robustus**, *Lampito mauritii**, *Metaphire anomala**, *Metaphire californica**, *Metaphire houletti**, *Metaphire planata**, *Perionyx alatus*, *Perionyx annandalei*, *Perionyx excavatus**, *Perionyx gravellyi**, *Perionyx heterochaetus*, *Perionyx himalayanus*, *Perionyx inornatus*, *Perionyx jorpokriensis*, *Perionyx macintoshii**, *Perionyx nanus*, *Perionyx pallidus*, *Perionyx pincerna*, *Perionyx pokhrianus*, *Perionyx pokhrianus affinis*, *Perionyx pulvinatus*, *Perionyx rimatus*, *Perionyx setnai*, *Perionyx sikkimensis*, *Perionyx variegatus**, *Tonoscolex monarchis**.

Moniligastridae family belongs to primitive earthworms with genus *Drawida* being the largest one in terms of species diversity. Natural distribution of the genus extends to the southeast and eastern Asia. In India, the natural range of the genus is in eastern Himalaya, northeast Ranges, and Peninsula. Anthropochorus *Drawida nepalensis* is distributed in western and eastern Himalaya, northeast hill region, and Andaman and Nicobar Islands. The original home of the species is believed likely in Himalaya, and wide distribution is attributable to transportation (Gates, 1972).

Members of the family Lumbricidae are endemic throughout the Palearctic region and eastern North America. However, a number of anthropochorous lumbricids have successfully

colonized in other zoogeographical regions of the world. All lumbricids occurring in the district are exotic and distributed in the Himalaya and other hilly regions due to their inherent ability to survive in their climatic boundaries and soil types.

Glossoscolecidae family forms a dominant group in tropical South America. *Pontoscolex corethrurus* is a circummundane species that is also widely distributed in many parts of India and acquiring newer domains.

Acanthodrilidae family is well represented in its home range in South America, some parts of North America, Africa, southeast Asia and Australasia. Three genera occur in India, viz. *Plutellus*, *Microscolex*, and *Pontodrilus*, the later two being peregrines. Twenty two species of *Plutellus s. lat.* (=?*Argilophilus*, generic definition under revision) are distributed in southern hills, Gangetic plain, eastern and western Himalaya, and northeast hill Ranges, showing discontinuous distribution in India.

Distribution of Octochaetidae family is exhibited in New Zealand, Australia, Indian Subcontinent (excluding Sri Lanka and other islands) through tropics of America and Africa, including Madagascar. Indian Octochaetids comprise 140 species distributed under 30 genera, including exotic Ethiopian genus *Dichogaster* represented by 5 species. *Eutyphoeus* and *Scolioscolides* genera are distributed in north and northeastern region of Indian subcontinent, whereas, *Octochaetona* is widespread in its home range in peninsular India. The monotypic *Scolioscolides* earlier known from its type locality Sandakphu in Darjeeling district has been found widespread in the forested areas of eastern Nepal (Julka *et al.*, 2009).

Distributional range of family Megascolecidae extends between warm temperate Asia and Australasia. Pheretimid *Amyntas* and *Metaphire* belong to the Indo-Malayan zoogeographical sub-region (Gates, 1972). These are represented by peregrine species on the Indian mainland. Native *Lampito* known by 8 species has its home range in southern hills of Peninsula including a widely distributed *Lampito mauritii* that frequently occurs in almost all types

of agro-ecosystems (Julka and Paliwal, 2005). *Tonoscolex* occurs in eastern Himalaya, northeastern hill Ranges and Myanmar, with 7 species discovered in India. *Perionyx* is native in Peninsula, eastern and western Himalaya and Myanmar, though, *Perionyx excavatus* and *Perionyx sansibaricus* have acquired wide range of distribution.

Endemism

Harvey (2002) noted several life history features that are characteristic, and may be central to the evolution of short-range endemism, including poor powers of dispersal, ecological confinement to discontinuous or rare habitats, slow growth and low fecundity. Diversity, distribution and abundance of earthworms, in general, are closely related with the soil characteristics, vegetation and precipitation. Earthworms have limited power of active dispersal as most of the species can move generally less than 10m per year, except those known to migrate large distances.

The distribution of *Plutellus s. lat.* and *Perionyx* extends from Deccan peninsula to eastern and northeastern region. A few species are also discovered from western Himalaya and Gangetic Plains. Majority of species in these genera has been found in the Deccan region, and eastern Himalaya and northeast hill Ranges. Similar trend of high species diversity in these taxa has also been documented in the, somewhat congruent, Myanmar (Gates, 1972). These areas are the centres of high rainfall, rich vegetation cover and so the soil organic matter. Stephenson (1923) has stated the chief home of *Perionyx* is the eastern Himalaya. Ancestors of *Plutellus s. lat.*, and *Perionyx* arose in peninsular India (Gates, 1972). It appears that peninsular India passed on these genera to northeast Hills and eastern Himalaya, over the Miocene land-Bridge (Julka and Paliwal, 2005). A high level speciation seems to have occurred in eastern Himalaya and adjacent Myanmar contributing to the evolution of the endemic species.

Studies revealed occurrence of 17 short-range endemic species of earthworm belonging to *Plutellus s. lat.* (2 species) and *Perionyx* (15 species).

These are known exclusively from the hills of Darjeeling district and have not been recorded anywhere else, even in the same biogeographic region, and flanking Myanmar. Soil characteristics, native floral cover and high rainfall that define suitability of habitat for these endemic species, coupled with their dispersal capacity may be determinants of species range.

It is noteworthy that concept of endemism is particularly influenced by taxonomic impediment and poor regional survey. Endemic status of a given species may change with the expansion of geographical distribution range.

List of earthworms endemic to Darjeeling district

Family : ACANTHODRILIDAE

1. *Plutellus* (= ?*Argilophilus*) *ghumensis* Julka, 1975
2. *Plutellus* (= ?*Argilophilus*) *sikkimensis* Michaelsen, 1907

Family : MEGASCOLECIDAE

3. *Perionyx alatus* Stephenson, 1920
4. *Perionyx annandalei* (Michaelsen, 1907)
5. *Perionyx heterochaetus* (Stephenson, 1917)
6. *Perionyx himalayanus* Michaelsen, 1907
7. *Perionyx inornatus* Stephenson, 1916
8. *Perionyx jorpokriensis* Julka, 1975
9. *Perionyx nanus* Stephenson, 1917
10. *Perionyx pallidus* Stephenson, 1917
11. *Perionyx pincerna* Stephenson, 1916
12. *Perionyx pokhrianus* Stephenson, 1920
13. *Perionyx pokhrianus affinis* Stephenson, 1920
14. *Perionyx pulvinatus* Stephenson, 1916
15. *Perionyx rimatus* Stephenson, 1920
16. *Perionyx setnai* Stephenson, 1931
17. *Perionyx sikkimensis* (Michaelsen, 1907)

SYSTEMATIC ACCOUNT

Phylum : ANNELIDA

Sub-phylum : CLITELLATA

Class : OLIGOCHAETA

Order : HAPLOTAXIDA

Sub-order : LUMBRICINA

Family : ACANTHODRILIDAE

1. *Plutellus* (= ?*Argilophilus*) *ghumensis* Julka, 1975.

1975. *Plutellus ghumensis* Julka, *Mitt. zool. Mus. Berlin*, 51(1): 24.

Diagnosis: Length 27-54 mm, diameter 1-1.5mm, 61-109 segments. Prostomium epilobic, tongue open, unpigmented. First dorsal pore at 6/7. Setae lumbricine, $AB < CD < BC < AA$, $DD < \frac{1}{2}C$. Clitellum saddle-shaped, $\frac{1}{2}13-17/18$, dorsal pores and intersegmental furrows lacking, setae retained. Male pores minute, at centre of conspicuously raised circular porophores in AB on 18. Female pores paired, on 14, in A lines. Spermathecal pores at 7/8/9, on or slightly median to C lines. Genital markings small, nearly circular, in transversely placed rows of 2-5, intersegmental in some of 8/9/10, 11/12/13, 14/15/16/17/18, 19/20, 21/22/23/24.

Septa 5/6 slightly muscular, 6/7-8/9 muscular. Gizzard in 5, intestinal origin in 15, typhlosole absent. Last pair of hearts in 12, those of 10-12 latero-oesophageal. Holandric, male funnels apparently free; seminal vesicles small, in 11 and 12, those of 11 touching each other dorsally. Prostates tubular, coiled, may extend up to 21; duct short, slender, nearly straight; vasa deferentia unrecognizable anteriorly, in 17 it passes into anterior face of prostatic duct just ental to parietes. Penial setae 0.464 to 0.532 mm long, 0.012 mm thick; shaft slightly bow-shaped with a notch at the tip, ornamentation of 8-12 circles of fine rather triangular teeth. Quadrithecal; spermathecae fairly large; ampulla ovoid; duct about as long as ampulla, straight, thick, slightly tapering before entering parietes; bidiverticulate; with laterally and mesially, slenderly club-shaped diverticula. Diverticulum close to parietes, as long as or slightly longer than spermathecal duct. Ovisacs in 14. Genital marking glands unrecognizable internally.

Distribution: Jorpokri, Hima Falls, Ghum Bhanjang, Darjeeling district, West Bengal, India.

2. *Plutellus* (= ?*Argilophilus*) *sikkimensis* Michaelsen, 1907

1907. *Plutellus sikkimensis* Michaelsen, *Jb. hamb. wiss. Anst.*, 24: 147.

1972. *Plutellus sikkimensis* Gates, *Trans. Am. phil. Soc.*, 62(7): 45.

Diagnosis: Length 42mm, diameter 1mm, 90 segments. Prostomium epilobic, tongue open. First dorsal pore at 6/7. Setae widely spaced, $DD < \frac{1}{2}C, A, B/18$ penial. Male pores paired, on 18, at *B*, within a median field that reaches into 17 and 19. Spermathecal pores at 4/5/6/7/8/9, just median to *B* line. Genital markings paired, transversely elliptical, in *AB* and across 12/13.

Gizzard small, in 5; intestinal origin in 14. Last pair of hearts in 12. Holandric; seminal vesicles apparently in 9, 11 and 12. Penial setae *ca.* 0.33mm long and 9 μ thick at middle, ectal portion of shaft bent at an obtuse angle, tip sharply pointed, slender, slightly curved, ornamentation of 9 oblique circles with about 9 very large teeth in each circle.

Distribution: Sandakphu, Darjeeling district, West Bengal, India.

Remarks: The species is known from only immature specimens. The description of the species is inadequate due to unrecognizable specific characteristics.

Family : MEGASCOLECIDAE

3. *Perionyx alatus* Stephenson, 1920

1920: *Perionyx alatus* Stephenson, *Mem. Indian Mus.*, 7: 212.

Diagnosis: Length 84mm, diameter 3mm, 123 segments. Prostomium epilobic, tongue open. First dorsal pore at 4/5. Setal rings closed dorsally as well as ventrally, setae rather closer set ventrally. Clitellum in segments 13- $\frac{1}{2}$ 17. Genital papillae one pair, on 18, large, transversely elongated, joined in the middle line by a narrow neck, with crenulated margins; the conjoined papillae surrounded by a deep groove. Male pores as transverse grooves in the broader inner part of the papillae. Spermathecal pores two pairs, in 6/7/8, in line with setal interval *DE*.

Gizzard large, cylindrical, in 5; intestinal origin in 20. Last pair of hearts in 13. Nephridia end all in the same line. Holandric; testis sacs in 10 and 11; seminal vesicles in 11 and 12, fused dorsally over the alimentary canal in each segment. Prostates large, in 17-19, duct irregularly

twisted, widest at its ectal end. Penial setae 1mm long, 20 μ thick; shaft almost straight but curved like hockey-stick at the proximal end; tip bluntly pointed, shaft distally ornamented by minute irregularly scattered spines. Quadrithecal; posterior pair larger; ampulla sac-like, duct stout shorter than ampulla, separated from ampulla by a constriction, swollen upper part of the duct corresponds to diverticulum, devoid of definite seminal chambers.

Distribution: Sitong Ridge, Darjeeling district, West Bengal, India.

4. *Perionyx annandalei* (Michaelsen, 1907)

1907. *Perionychella annandalei* Michaelsen, *Mitt. naturh. Mus. Hamb.*, 24: 154.

1923. *Perionyx annandalei* (part), Stephenson, *Fauna Br. India, Oligochaeta*: 324. (Excluding specimens from Cherrapunji (Meghalaya).

Diagnosis: Length 160-280mm, diameter 6-10mm, 170-215 segments. Prostomium proepilobic, shortly epilobous or half epilobous. First dorsal pore at 6/7. Setae very small in anterior part of the body, more closed ventrally, rings complete or shortly interrupted dorsally. Clitellum in segments 12-24. Male genital field depressed or elevated, occupying the whole length of 18, the area elevated in the setal zone forming a ridge; male pores in the lateral parts of the area in the setal zone, a few setae on the ridge between male pores. Spermathecal pores two pairs in 7/8/9, near middle line.

Gizzard moderately large, in 6; calciferous glands absent. Holandric; male funnels apparently free, in 10 and 11; seminal vesicles in 11 and 12 or 11, 12 and 13, compact and grape-like. Prostates occupying 18 and 19; duct short and thick. Penial setae absent. Quadrithecal; ampulla sac-like or irregular; duct half as long as ampulla; seminal chambers two or three, papilla-like or as many small knobs, on the duct.

Distribution: Kurseong, Darjeeling district, West Bengal, India.

5. *Perionyx heterochaetus* (Stephenson, 1917)

1917. *Perionyx aborensis* var. *heterochaetus* Stephenson, *Rec. Indian Mus.*, 13: 379.

1923. *Perionyx heterochaetus*, Stephenson, *Fauna Br. India, Oligochaeta*: 335.

Diagnosis: Length 60mm, diameter 2.5mm, 100 segments. Prostomium epilobic, tongue open behind. First dorsal pore at 5/6. Setae on dorsal surface in anterior part of body much larger and set further apart than posterior region. Clitellum in segments 13-17. Male genital field a whitish patch taking up the whole length of 18, lateral margins rather swollen, the centre rather concave; male pores as transverse grooves in the setal zone, ca. 2/15 body circumference apart. Spermathecal pores two pairs in 6/7/8, in line with E, 1/6 body circumference apart.

Gizzard vestigial, in 5; oesophagus swollen in 11-13; intestinal origin behind the prostates. Last pair of hearts in 12. Holandric; testes and male funnels free, in 10 and 11; seminal vesicles in 11 and 12, meeting dorsally. Prostates squarish, confined to 18; duct slightly muscular, curled and twisted. Penial setae absent. Quadrithecal; ampulla irregular in shape, about as broad as long, duct 2/3 as long as ampulla; diverticulum single, knob-like, sessile, at the ental end of duct with a few indistinct seminal chambers.

Distribution: Pashok, Darjeeling district, West Bengal, India.

6. *Perionyx himalayanus* Michaelsen, 1907

1907. *Perionyx himalayanus* Michaelsen, *Mitt. naturh. Mus. Hamb.*, **24**: 158.

1909. *Perionyx himalayanus*, Michaelsen, *Mem. Indian Mus.*, **1**: 176.

Diagnosis: Length 56-62mm, diameter 2.5-3mm, 86-95 segments. Prostomium epilobic, tongue open behind. First dorsal pore at 8/9, if not 7/8 or 6/7. Setae moderately large; circles nearly complete, indistinctly interrupted in the middorsal line. Clitellum in segments 13-17. Male pores rather post setal, ca. 1/5 body circumference apart, on small transversely oval papillae, each situated in the central depression of a large nearly circular glandular protuberance. Spermathecal pores two pairs, in 6/7/8, about 1/8 body circumference apart.

Gizzard vestigial, in 6(?); calciferous glands absent. Nephridia end apparently in the same line. Holandric; male funnels apparently enclosed in unpaired sacs, in 10 and 11; seminal vesicles three pairs, in 10-12. Prostates small, compact irregularly glandular, in 18; duct moderately thick, irregularly bent or coiled. Penial setae absent. Quadrithecal; ampulla large, ovoid, obliquely placed; duct narrowed abruptly at ectal end, half as long as ampulla; diverticula two, sessile, very small, at ental end of the duct, nearly opposite to each other.

Distribution: Sandakphu, Darjeeling district, West Bengal, India.

7. *Perionyx inornatus* Stephenson, 1916

1916. *Perionyx inornatus* Stephenson, *Rec. Indian Mus.*, **12**: 320.

Diagnosis: Length 96mm, diameter 5mm, 124 segments. Prostomium apparently proepilobic. First dorsal pore at 6/7. Setae closer ventrally than dorsally, setal rings unbroken ventrally, a small and irregular dorsal break behind the genital region. Male pores in DE, on the sides of a shallow transversely oval depression with shelving sides in transverse extent equal to 1/9 body circumference. Spermathecal pores two pairs, in 6/7/8, apart about equal to the distance between male pores.

Gizzard soft, squarish, in 5; intestinal origin in 14. Last pair of hearts in 12. Holandric; testes and male funnels free, in 10 and 11; seminal vesicles in 11 and 12, large, situated dorsally over the gut. Prostates small, confined to 18; duct soft, comparatively narrow, straight. Penial setae 0.92mm long, 30 μ thick at the middle, shaft straight, distal end ornamented with about 14 irregular and interrupted rings of very minute sculpturings. Quadrithecal; ampulla small, ovoid; duct short, stout, not marked off, diverticula absent.

Distribution: Sandakphu, Darjeeling district, West Bengal, India.

8. *Perionyx jorpokriensis* Julka, 1975

1975. *Perionyx jorpokriensis* Julka, *Mitt. zool. Mus. Berlin*, **51**(1): 21.

Diagnosis: Length 58-62mm, diameter 3mm, 99-106 segments. Prostomium epilobic, tongue open. First dorsal pore at 4/5. Setae closely spaced ventrally, more widely separated dorsally, circles with a ventral gap. Clitellum 13-17, dorsal pores occluded, setae retained. Nephropores in a single irregular rank, near mL. Male genital field a little depressed rectangular area, slightly raised along mV, reaching anteriorly to 17/18 and posteriorly to 18/19, laterally to FG or GH; male pores postsetal, on the centre of two circular, short, porophores, in line with D or E. Spermathecal pores three pairs, in 6/7/8/9, transverse slits, with protuberant and annular lips, in line with F or G.

Gizzard small, in 5; oesophagus widened and bead-shaped, in 13. Last pair of hearts in 12. Nephridia avesculate; ducts long and slender, passing into parietes in a slightly irregular rank on each side. Holandric; testes and male funnels free; seminal vesicles in 11 and 12. Prostates squarish, confined to 18; duct slender, straight, forming a loop before entering parietes. Penial setae absent. Sexthecal; spermathecae medium-sized; ampulla globular; duct muscular, slightly shorter than ampulla, widens before entering parietes; a distinct ridge with two or three iridescent lobes present on the anterior face of duct just beneath ampulla.

Distribution: Sukiapokri, Jorpokri, Palmazoa, Darjeeling district, West Bengal, India.

9. *Perionyx nanus* Stephenson, 1917

1917. *Perionyx nanus* Stephenson, *Rec. Indian Mus.*, 13: 381.

Diagnosis: Length 53mm, diameter 1.5mm, 100 segments. Prostomium epilobic, tongue open. First dorsal pore at 5/6. Setal ring almost closed dorsally and ventrally. Clitellum 14-17, conspicuous. Male pores in a transverse groove, slightly prolonged towards middle line, in line with G or GH, slightly behind setal zone, ¼ body circumference apart; each pore surrounded by a whitish thickened patch, taking up the whole ventral surface of 18. Spermathecal pores two pairs in 6/7/8, widely apart.

Gizzard vestigial, in 5; oesophagus protuberant in 9; intestinal origin in 19. Last pair of hearts in 12. Holandric; testes and male funnels free, in 10 and 11; seminal vesicles large, in 11 and 12, of 11 fusing together. Prostates extending in to 17 and 19; duct thin, soft and bent. Penial setae absent. Quadrithecal; ampulla pear-shaped; duct broad and short, not sharply marked off; diverticulum single, wart-like, sessile, at the junction of ampulla and duct.

Distribution: Pashok, Darjeeling district, West Bengal, India.

10. *Perionyx pallidus* Stephenson, 1917

1917. *Perionyx pallidus* Stephenson, *Rec. Indian Mus.*, 13: 376.

Diagnosis: Length 80mm, diameter 3.25mm, 118 segments. Prostomium epilobic. First dorsal pore at 4/5. Setae set closer ventrally, rings closed ventrally, almost so dorsally. Clitellum 13-16, slightly swollen. Male pores in transverse grooves, on 18, small cracks, 1/10 body circumference apart. Spermathecal pores two pairs in 6/7/8, small, slit-like, same distance apart as the male pores.

Gizzard vestigial, in 6; intestinal origin in 17. Last pair of hearts in 13. Nephridial ducts terminating in the same line. Holandric; testes and male funnels free, in 10 and 11; seminal vesicles in 11 and 12, united dorsally in each segment. Prostates very small; duct straight. Penial setae 0.175mm long, 17µ thick; a few fine sculpturing on distal half. Quadrithecal; ampulla small, sac-like, rather constricted in the middle; duct short, scarcely separately distinguishable, diverticulum lacking(?).

Distribution: Kalimpong, Darjeeling district, West Bengal, India.

11. *Perionyx pincerna* Stephenson, 1916

1916. *Perionyx pincerna* Stephenson, *Rec. Indian Mus.*, 12: 319.

Diagnosis: Length 45mm, diameter 3mm, 88 segments. Prostomium epilobous, tongue cut off behind. First dorsal pore at 4/5. Setal ring with small and irregular dorsal and ventral break, ventral break may be lacking in front of clitellum,

setae set closer ventrally than dorsally. Clitellum indistinguishable. Male genital field a transversely oval depression on 18, deepest towards margin, so that middle of its floor somewhat raised above its periphery; a thick whitish lip surrounds the whole and extends over the posterior half of 17 and anterior half of 19; male pores in C or D lines. Penial setae present. Spermathecal pores two pairs in 6/7/8, small slits, near middle line, *ca.* 1/10 body circumference apart.

Gizzard of moderate size, in 5; intestinal origin in 18. Last pair of hearts in 12. Nephridia opening in the same line. Holandric; testes and male funnels free, in 10 and 11; seminal vesicles in 11 and 12, single in each segment, overarching dorsal vessel and gut. Prostates limited to 18, small, lobed; duct soft, narrow, slightly wavy. Penial setae 0.63mm long, 24 μ thick at the middle; shaft straight, tip slightly curved and blunt; ornamentation of about a dozen, irregular broken circles of faint sculpturing near the tip appearing as fine points. Quadrithecal; ampulla oval sac, sessile on the parietes; duct indistinguishable; diverticulum absent.

Distribution: Near Ghoom, Darjeeling district, West Bengal, India.

12. *Perionyx pokhrianus* Stephenson, 1920

1920. *Perionyx pokhrianus* Stephenson, *Mem. Indian Mus.*, 7: 208.

Diagnosis: Length 65mm, diameter 3mm, 96 segments. Prostomium epilobous, tongue open. First dorsal pore at 4/5. Setal rings almost closed dorsally and ventrally, setae closer set ventrally. Clitellum 13-16. Male genital papillae one pair, on 18, mid-ventral, touching each other, taking up the greater part of the length of the segment, not delimited from rest of the surface on their outer sides, bounded in front and behind by a common transverse groove; male pores on the posterior part of the papillae, near the middle line. Spermathecal pores two pairs in 6/7/8, very close together, nearly in line with B.

Gizzard large, barrel-shaped, in 5; intestinal origin in 18. Last pair of hearts in 13. Nephridia

apparently terminate in the same line. Holandric; testis sacs in 10 and 11; seminal vesicles in 11 and 12, meeting together dorsally in each segment. Prostates large, much indented, in 17-19; duct short, soft and thin, irregularly twisted, somewhat dilated at the ectal end. Penial setae absent. Quadrithecal; ampulla irregularly lobed; duct short, marked off from ampulla by a constriction; diverticula in the form of three small swellings on the upper half of the duct.

Distribution: Sitong, Darjeeling district, West Bengal, India.

13. *Perionyx pokhrianus affinis*

Stephenson, 1920

1920. *Perionyx pokhrianus* var. *affinis* Stephenson, *Mem. Indian Mus.*, 7: 210.

Diagnosis: Length 55mm, diameter 2.25mm, 105 segments. Prostomium epilobous, tongue open. First dorsal pore at 4/5. Setal rings almost unbroken dorsally and ventrally. Clitellum 13-16. Male genital field on 18, as a depression with sloping sides, on these sides are placed male pore papillae facing somewhat inwards, papillae rather wider transversely, are delimited by grooves in front and behind, separated in the middle line by a slight interval, laterally fade away without definite delimitation; male pores transverse slits on the papillae, in line with C, D or E. Spermathecal pores two pairs in 6/7/8, in line with interval CD.

Gizzard moderate size, in 5; intestinal origin in 18. Last pair of hearts in 12. Nephridial ducts terminate at different levels without regular alternation. Holandric; testis sacs in 10 and 11; seminal vesicles in 11 and 12, those in 11 continuous with testis sac, united dorsally in each segment. Prostates large, in 17-19; duct moderately long, bent, soft and rather thin in its ental portion, thicker and shining ectally. Penial setae absent. Quadrithecal; ampulla large, irregularly lobed; duct short, well marked off, considerably longer than ampulla; diverticulum a rounded knob with two seminal chambers on the ental end of duct.

Distribution: Sitong, Sitong Ridge, Darjeeling district, West Bengal, India.

14. *Perionyx pulvinatus* Stephenson, 1916

1916. *Perionyx pulvinatus* Stephenson, *Rec. Indian Mus.*, 12: 317.

1975. *Perionyx pulvinatus*, Julka, *Mitt. zool. Mus. Berlin*, 51(1): 22.

Diagnosis: Length 57-93mm, diameter 3-3.5mm, 121-126 segments. Prostomium epilobous, tongue closed, a median dorsal groove on prostomium extending posteriorly a little beyond setal ring of 2. First dorsal pore at 4/5. Setae more closely set ventrally than on dorsum. Clitellum 11, 12-19, intersegmental furrows indistinct, setae retained, dorsal pores occluded. Nephropores in a single irregular rank on dorsum. Male genital field a conspicuous depression, rectangular with rounded corners, on 18, dislocating anteriorly 17/18 and posteriorly 18/19; male pores large, slightly postsetal, on longitudinal oval-shaped cushions. Spermathecal pores two pairs in 7/8/9, large transverse slits in line with J-K, slightly posterior to intersegmental furrows.

Gizzard small, in 5; oesophagus widened in 12; intestinal origin in 15; typhlosole lacking. Last pair of hearts in 12. Nephridia avesculate, duct slender and long. Holandric; testes and male funnels free, in 10 and 11; seminal vesicles in 11 and 12, pair of 12 extending back and fusing each other in 14 and 15. Prostates large, lobed, in 18 and 19; duct stout, muscular, straight. Penial setae absent. Quadrithecal; ampulla irregularly shaped, roughly pyramidal, with nodular surface; duct as long and almost as wide as ampulla; no diverticulum.

Distribution: Jorpokri, nr. Ghoom, Darjeeling district, West Bengal, India.

15. *Perionyx rimatus* Stephenson, 1920

1920. *Perionyx rimatus* Stephenson, *Mem. Indian Mus.*, 7: 206.

1975. *Perionyx rimatus*, Julka, *Mitt. zool. Mus. Berlin*, 51(1): 23.

Diagnosis: Length 75-80mm, diameter 4-4.5mm, 105-107 segments. Prostomium epilobous, tongue open. First dorsal pore at 4/5. Setal rings closed or almost so dorsally and

ventrally; setae smaller and closer set ventrally. Clitellum 13-16, dorsal pores and intersegmental furrows indistinct, setae retained. Nephropores near mL in a single rather irregular rank. Male genital field transversely elliptical, a glandular dermal thickening, dislocating anteriorly 17/18 and posteriorly 18/19, extending laterally into region of IJ; male pores in deep transverse furrow across the middle of 18. Spermathecal pores two pairs in 6/7/8, small slits, close together in line with C, or the space CD.

Gizzard small, in 5; oesophagus widened in 13-14; intestinal origin behind the prostates. Last pair of hearts in 12. Nephridia avesculate, ducts slender and straight. Holandric; testes and male funnels free; seminal vesicles in 11 and 12, each pair fused dorsally above the alimentary canal; sperm duct passes through the anterior lobe of prostate to open into ental end of prostatic duct. Prostates large, 17-18/18-19; duct narrow at ental end, much twisted, ectal end muscular and broader than ental end. Penial setae absent. Quadrithecal; ampulla a large irregular sac; duct stout, a little shorter than ampulla; diverticula in the form of iridescent swellings near the junction of ampulla and duct.

Distribution: Sitong, Daw Hill (Kurseong), Darjeeling district, West Bengal, India.

16. *Perionyx setnai* Stephenson, 1931

1931. *Perionyx setnai* Stephenson, *Proc. zool. Soc. Lond.*, 1931: 63.

Diagnosis: Length 85-130mm, diameter 3-3.5mm, 124 segments. Prostomium epilobous, tongue not cut off behind. First dorsal pore at 4/5. Setae more closely set ventrally, setal circle slightly irregularly broken dorsally. Clitellum 13-1/217, setae retained, dorsal pores not apparent. Nephropores almost in the same rank on each side. Male genital field sharply defined deeply sunk rectangular depression, half as wide again as long, situated mid-ventrally on 18; taking up whole length of the segment, floor is flat; male pores small, on the floor of the depression, near the middle line. Spermathecal pores two pairs in 6/7/8, moderately close together, but not quite as close as the male pores.

Gizzard very small, vestigial, in 5; intestinal origin behind the prostates, in 19. Last pair of hearts in 12. Holandric; testes and male funnels free, in 10 and 11; seminal vesicles in 11 and 12, fused in the middle line and taking up whole of the space in their segments. Prostates small, confined to 18; ducts short, thin and soft, bent; ectal portion rather wider than ental. Penial setae absent. Quadrithecal; ampulla regularly ovoid sacs, lying on the body wall; duct short wide; no diverticulum.

Distribution: Darjeeling, West Bengal, India.

17. *Perionyx sikkimensis* (Michaelsen, 1907)

1907. *Perionychella sikkimensis* Michaelsen, *Jb. hamb. wiss. Anst.*, **24**: 156.

1909. *Perionychella sikkimensis*, Michaelsen, *Mem. Indian Mus.*, **1**: 170.

1910. *Perionyx sikkimensis* (part), Michaelsen, *Abh. Geb. Naturw. Hamburg*, **19**(5): 60.

1923. *Perionyx sikkimensis*, Stephenson, *Fauna Br. India, Oligochaeta*: 358.

Diagnosis: Length ca. 120mm, diameter 4-5mm, 109 segments. Prostomium epilobous. First dorsal pore at 6/7 or 7/8. Setal circles nearly complete, only slightly and irregularly broken dorsally; setae more closely set dorsally than ventrally. Clitellum 13-17, ringed-shaped in the middle, interrupted ventrally in front and behind. Male pores on small papillae, ca. 1/8 body

circumference apart, surface between pores somewhat depressed. Spermathecal pores two pairs in 6/7/8, ca. 1/7 body circumference apart, inconspicuous.

Gizzard small, in 6(?). Last pair of hearts in 12(?). Holandric; testes and male funnels free, in 10 and 11; seminal vesicles large, in 11 and 12, meeting dorsally covering oesophagus. Prostates small and compact, in 18; duct fairly thick, nearly straight, about as long as the glandular part. Penial setae ca. 0.9mm long and 28 μ thick; almost straight, slightly bent at distal end; narrowing distally, with fairly sharp tip; distal part ornamented with irregular, sometimes oblique, transverse rows of small triangular teeth. Quadrithecal; ampulla fairly large, almost cylindrical; duct slightly shorter and thinner, not set off from ampulla; no diverticulum.

Distribution: Sandakphu, Kurseong, Darjeeling district, West Bengal, India.

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