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## Biodiversity Threats to Earthworms in Cultivated Lands of Tamil Nadu, India

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### KEYWORDS

Earthworm diversity, earthworm diversity conservation, threats to earthworms, earthworms of Tamil Nadu

### A B S T R A C T

The study presents comprehensive survey of earthworms of cultivated agriculture land (694 samples of 180 sites) Tamil Nadu, South India and brought to light, the presence of only eleven species namely, *Glyphidrilus annandalei*; *Lampito mauritii*; *Metaphire birmanica*; *M.posthuma*; *M. suctorica*; *Perionyx sansibaricus*; *Polypheretima elongata*; *Drawida modesta*; *D. pellucida*; *Octochaetona serrata*; *Ochtochaetoides aitkeni* in agriculture fields. However, Blakemore (2006) updated the checklist of 100 earthworms to South India. Study alarmed threats to diversity of earthworms in chemically cultivated agriculture lands.

### Introduction

Nature lovers Indian Tamil Scholar Manonmanian Sundaranar during the nineteenth century described the contribution of earthworms of Southern plateau & hills region of Tamil Nadu in their poetries (Balasubramanian, 1970). This precious organism is now being threatened with extinction in arable soils which are exposed to non-judicious application of chemicals in the form of complex fertilizers and biocides.

Earthworms originated about 600 million years ago, during the Precambrian and bore

silent witness to plant and animal evolution through several millions of years. The basic design of earthworms has not changed much since their origin and also does not seem large variation between the species. Soil bioresearches have been recognized as the foundation for sustainable livelihood and food security. The importance of earthworms cannot be ignored because they have enormous potential to improve soil condition on a sustainable basis. Earthworm contributes at large to the biomass of soil invertebrates particularly in the temperate and the tropical regions of the world. Their

role in the turning over of the soil drew the attention of Aristotle (Shipley, 1970) who called the earthworms' *intestines of the earth*. Charles Darwin (1881) expressed the role of earthworms in the breakdown of dead plant and animal material in soil and forest litter, and in the maintenance of soil structure, aeration and fertility

Well documented reports and Oligochaete taxonomic monographs on the majority of Indian earthworms have been provided by Stephenson (1923), Gates (1972) and Julka (1988). There are sporadic reports available on the study of earthworm fauna from several unexplored regions (Verma *et al.*, 2010, Verma and Shweta, 2010; Julka and Palwal, 2005; Dash *et al.*, 1988; Dash, 1999; Bano and Kale, 1991). The checklist of 100 earthworms of South India (Tamil Nadu) developed by Blackmore (2006). Since, the earthworms of cultivated lands of Tamil Nadu of India remain largely unexplored, the present study was carried out in this direction.

### **Materials and Methods**

Field work was carried out in June – July 2011. The methodology adopted for earthworm collection was based on Gates (1972). Collected worms were washed in 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 6-8h followed by their preservation in 4% formalin. All specimens were serially numbered. Earthworms were identified with the help of monographs and other available literature on the subject (Stephenson, 1923; Gates, 1972; Julka, 1988) at Vermiculture Research Station (VRS), D.S. College, Aligarh and confirmed with the help of Dr. J.M. Julka, Zoological Survey of India (ZSI), Solan (HP), India. Voucher specimens collected

and examined in the present work were deposited in the Museum of VRS for future reference and study.

### **Study Site**

Study site Tamil Nadu (13.09°N 80.27°E) covers an area of 130,058 Km<sup>2</sup> (50.216 Sq m) and is the eleventh largest state in India. The bordering states are Kerala to the west, Karnataka to the North West and Andhra Pradesh to the north. To the east is Bay of Bengal and Union territory of Pondicherry. The eastern parts are fertile coastal plains and the northern parts are a mix of hills and plains. The central and the south Central regions are arid plains and receive less rainfall than the other regions.

### **Systematic Enumeration**

#### **Family: Almidae**

#### ***Glyphidrilus annandalei* Michaelsen**

Locality of collection(s) with voucher specimen no(s) and date of collection(s): Kanyakumari (A1 to A4; 18.06.2011); Ramanathapuram (C1 to C3, C5; 20.06.2011); Virudhnagar (B2, B4, B6; 19.06.2011).

Diagnostic Characters: Setae lumbricine and arranged in regular rows throughout the body; male pore inconspicuous difficult to recognize; clitellum occupied 14-40 segment and laterally flared into wings on 25-33 segment (figure 1).

General Habitat: Submerged paddy fields.

#### **Family : Megascolecidae**

#### ***Lampito mauritii* Kinberg**

Locality of collection(s) with voucher specimen no(s) and date of collection(s):

Chennai (S1 to S7; 18.06.11); Vellore (Q1 to Q4; 04.07. 2011); Kanchipuram (T4 to T6; 07.07.2011); Tiruvannamalai (R1 to R3; 05.07. 2011); Vlluppuram(N1 to N7; 01.07. 2011); Dharampuri (P1 to P4; 03.07. 2011); Tiruper (J1, J3, J4; 27.06. 2011); Karur (I7; 26.06. 2011); Trichy (H1, H2; 25.06. 2011); Thiruvarur: K1 to K3(28.06. 2011); Nagapattinam(M1 to M7; 30.06. 2011); Ramanathapuram (C1 to C3; 20.06. 2011); Virudhnagar(B1 to B4; 19.06. 2011); Madurai( D1 to D4; 21.06. 2011); Theni (E1 to E3; 22.06. 2011);Dinduque (F1 to F4; 23.06. 2011); Sivaganga (G2, G3; 24.06. 2011).

Diagnostic Characters: Prostomium epilobic; first dorsal pore in 10/11 or 11/12; clitellum annular xiii-xvii; setae perichaetine; male pores in xviii on slightly raised porophores, at or lateral to *b*. Spermathecal pores paired 6/7/8/9 (3 pairs). Genital markings absent. Pineal setae ornamented with closely crowded circles of triangular teeth. Digestive system, with a single gizzard in v segment (figure 2).

General Habitat: Grassland and agriculture cultivated land.

### ***Metaphire birmanica* Rosa**

Locality of collection(s) with voucher specimen no(s) and date of collection(s): Kanyakumari (A1 to A9; 18.06.11); Virudhnagar (B3; 19.06. 2011); Ramanathapuram (C2, C3, C5, C6; 20.06. 2011); Madurai(D1 to D6; 21.06. 2011); Teni (E2;22.06. 2011); Dinduqul (F6; 23.06. 2011); Sivaganga (G2; 24.06. 2011); Trichy (H2; 25.06. 2011); Karur (I7; 26.06. 2011); Tiruppur (J7, J8; 27.06. 2011); Cuddalor: L1 to L3(29.06. 2011).

Diagnostic Characters: Length 100-150 mm; Prostomium epilobic; first dorsal pore in

12/13; clitellum annular xiv-xvi; setae perichaetine; male pores in xviii, in longitudinal groove. Spermathecal pores paired 5/6-7/8 (3 pairs). Genital markings absent. Pineal setae conical. Septa 5/6-6/7 aborted. Caecae manicate; typhlosole lamellifom. Prostates in xvi-xx ducts with U-shaped loop (figure 3).

General Habitat: Cultivated agriculture land.

### ***Metaphire posthuma* Vaillant**

Locality of collection(s) with voucher specimen no(s) and date of collection(s):: Kanyakumari (A1 to A9; 18.06.2011); Virudhnagar (B1 to B9; 19.06.2011); Ramanathapuram (C1 to C9; 20.06.2011); Madurai(D1 to D9; 21.06.2011); Teni(E1 to E9; 22.06.2011); Dinduqul (F1 to F9; 23.06.2011); Sivaganga (G1 to G9; 4.06.2011); Trichy (H1 to H9; 25.6.2011); Karur (I1 to I9; 26.06.2011);Tiruppur (J1, J2, J5; 27.06.2011);Thiruvarur(K2, K3; 28.06.2011); Cuddalor (L1, L2, L4; 29.06.2011); Vllupuram (N1 to N9; 01.07.2011); Salem (O1 to O5; 02.07.2011); Dharampuri (P1 to P3; 03.07. 2011); Vellore (Q1 to Q5; 04.07. 2011);Tiruvannamalai (R1 to R3; 05.07. 2011); Chennai (S1 to S3, S9; 06.07. 2011); Kanchipuram (T1, T2, T4; 07.07. 2011).

Diagnostic Characters: Length 60-140 mm; Prostomium epilobic; first dorsal pore in 12/13; clitellum xiii-xvii; setae perichaetine; male pores in xviii, in small disc near roof of a slight eversible invagination with longitudinal crescentic aperture. Spermathecal pores paired 5/6-7/8 (3 pairs). Genital markings present and genital glands sessile on parietes. Septa 5/6-6/7 aborted. Caecae simple xxvii-xxiv; typhlosole lamellifom. Prostates in xvi-xxi ducts with U-shaped loop (figure 4).

General Habitat: Cultivated agriculture land.

***Metaphire suctoria* Michaelsen**

Locality of collection(s) with voucher specimen no(s) and date of collection(s): Chennai (S1 to S7; 06.07.2011); Vellore (Q2, to Q6; 04.07. 2011); Kanchipuram (T1, T2; 07.07.2011); Tiruvannamalai (R2 to R5; 05.07. 2011); Dharmपुर (P1, P2; 03.07. 2011); Salem(O3 to O6. 03.07. 2011).

Diagnostic Characters: Length 70-140 mm; Prostomium epilobic; first dorsal pore in 12/13; clitellum xiv-xvi; setae perichaetine; male pores in xviii, minute spherical in a small disc. Genital markings present and genital glands sessile. Septa 8/9-9/10 aborted. Caecae simple; typhlosole absent. Prostates in xvii-xix ducts short straight. Spermathecae duct shorter than ampullae (figure 5).

General Habitat: Cultivated agriculture land.

***Perionyx sansibaricus* Michaelsen**

Locality of collection(s) with voucher specimen no(s) and date of collection(s):: Chennai (S1, S2; 06.07.2011); Tiruvannamalai (R1 to R3; 05.07. 2011); Kanchipuram (T1, T2, T4; 07.07. 2011); Dharmपुर (P1 to P9; 03.07. 2011); Villuppuram (N1, N2, N4; 01.07. 2011); Cuddalor (L1, L2; 25.06. 2011); Tiruppur (J1, J2, J4; 27.06. 2011); Dindique (F1, F4; 23.06. 2011).

Diagnostic Characters: Length 60-90 mm; body segments 110-165. Colour purple dorsally, pale ventrally. Prostomium epilobic. First dorsal pore in any furrows 3/4/5/6. Setae many per segments. Clitellum annular from segment xiii-xvii. Male pore on segment xviii, close together in a median depressed area. Female pore single median, presetal on segment xiv. Spermathecal pores

3 pairs on 6/7/8/9 close to mid ventral line. Nephridiopores at two levels regularly alternating between dorsolateral and ventrolateral positions on each side. Holonephric nephridia stomate with preseptal funnel. Penial setae absent (figure 6).

General Habitat Dung heap and upper layer of soil in agriculture land.

***Polypheretima elongata* Perrier**

Locality of collection(s) with voucher specimen no(s) and date of collection(s):Kanyakumari (A1 to A9; 18.06.2011); Ramanathapuram (C1 to C9; 20.06.2011); Madurai (D1 to D9; 21.06.2011); Teni (E1 to E9; 22.06.2011); Sivaganga (G1 to G9; 4.06.2011); Trichy (H1 to H9; 25.6.2011); Tiruppur (J1, J2, J5; 27.06.2011); Thiruvarur (K2, K3; 28.06.2011); Cuddalor (L1, L2, L4; 29.06.2011); Salem (O1 to O5; 02.07.2011).

Diagnostic Characters: Colour greyish yellow; prostomium without dorsal process. First dorsal pore in 12/13. Setal rings closed dorsally, ventral setae enlarged in anterior part of the body, but diminishing regularly from the middle line. Male pores about ¼ of circumference apart on xviii segment. Spermathecal pores mostly two pairs, in 5/6-6/7, about 4/9 of circumference apart (figure 7).

General Habitat: Cultivated agriculture land.

**Family: Moniligastridae**

***Drawida modesta* Rao**

Locality of collection(s) with voucher specimen no(s) and date of collection(s): Kanyakumari (A1 to A9; 18.06.2011); Virudhnagar (B1 to B9; 19.06.2011);

Ramanathapuram (C1 to C9;20.06.2011); Chennai (S1 to S9;04.07.2011); Kanchipuram (T1 to T3; 14.07.2011); Vellore (Q1 to Q5; 12.07.2011); Tiruvannamalai (R1, R2;10.07.2011); Vlluppuram (N1 to N5); Dharamapuri (P1 to P7; 03.07.2011); Salem(O1 to O5; 02.07.2011).

Diagnostic Characters: Length 75 mm; dorsal pores absent; setae closely paired ; clitellum inconspicuous; spermathecal pores outside the line of setae b; two gizzards; prostate small and oval; ovarian chamber present; spermathecal atrium absent (figure 8).

General habitat: Grassland and agriculture cultivated land.

#### ***Drawida pellucida* Stephenson**

Locality of collection(s) with voucher specimen no(s) and date of collection(s): Chennai (S1 to S9; 06.07.2011); Kanchipuram (T1 to T9; 07.07.2011); Vellore (Q1 to Q; 9.04.07.2011); Tiruvannamalai (R1 to R9; 05.07.2011); Vlluppuram (N1 to N9; 01.07.2011); Salem(O1 to O5;02.07.2011); Dharmapuri (P1, P2 ;03.07.2011); Cuddalor (L1 to L3;29.06.2011); Kannyakumari(A1 to A3; 18.06.2011); Virudhnagar (B7; 19.06.2011); Ramanathapuram (C4; 20.06.2011); Madurai (D3; 21.06.2011); Teni (E1 to E4; 22.06.2011); Nagapattinum (M3 to M6; 30.06.2011).

Diagnostic Characters: Length 75-100 mm; four or five gizzards; testis sac spherical; prostate flattened hemispheres; ovarian chamber absent; spermathecal atrium present and is oval; nephridiopore in *cd*; male pores between *b* and *c*. spermathecal pore at *c* (figure 9).

General Habitat: Cultivated land (especially from paddy fields).

#### **Family: Octochaetidae**

#### ***Octochaetona serrata* Gates**

Locality of collection(s) with voucher specimen no(s) and date of collection(s): Chennai(S1, S2; 06.07.2011); Kanchipuram (T1; 07.07.2011)

Diagnostic Characters: Length 80-150mm; prostomium, epilobic; first dorsal pores 12/13;clitellum xii-xvi; male genital field depressed; male pores minute; penial setae ornamented with circles of triangular teeth, tip bluntly rounded; spermathecal with a broadly clavate ental diverticulum; genital marking glands absent (figure 10).

General Habitat: Grassland and agriculture land.

#### ***Ochtochaetoides aitkeni* Gates**

Locality of collection(s) with voucher specimen no(s) and date of collection(s): Chennai (S1, S2; 06.07.2011); Kanchipuram (T1; 07.07.2011).

Diagnostic Characters: Length 119mm;first dorsal pore 19/20;clitellum xiii-xiv; male pores paired on xviii; spermathecal pores paired small close together in 7/8/9;genital marking absent; gizzards two; calciferous glands discrete extramural and two pairs. Prostates paired in xvii and xiv; seminal vesicles in ix and xi; penial setae smooth. Spermathecal paired in vii and ix with tubular diverticulum (figure 11).

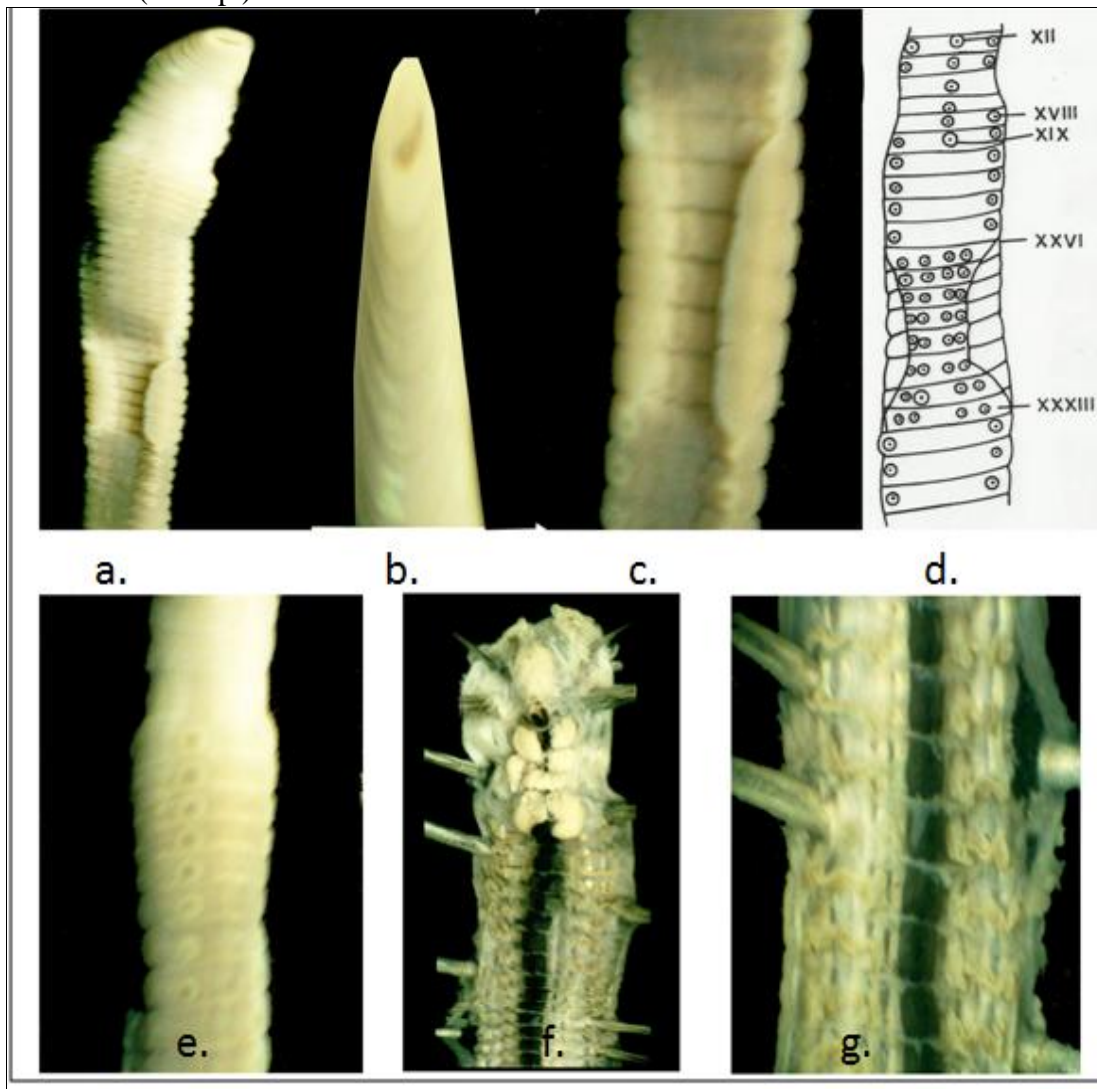
General Habitat: Paddy fields.

#### **Results and Discussion**

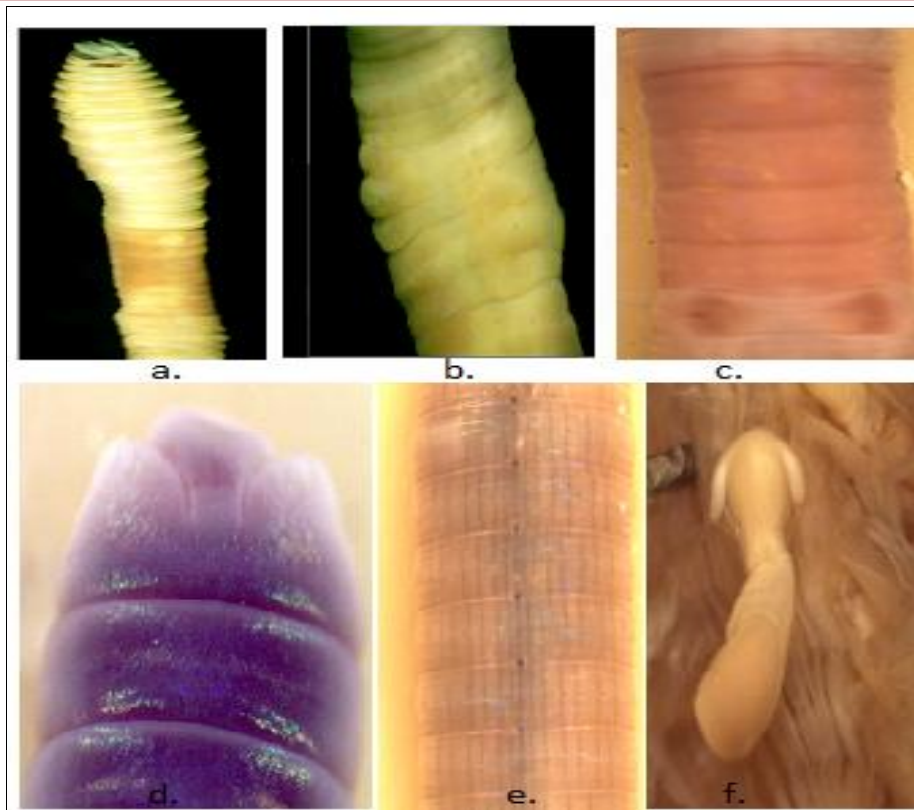
Zoological survey of India has been involved with inventorying of soil fauna diversity for a long period of time, with survey efforts focused largely on presence/

absence of different taxa in different environments. Nevertheless, the efforts of this organization devoted exclusively for survey and inventorying of the faunal wealth of the country are augmented by many researchers. Nine families of earthworms with 69 genera and 510 species have been reported from India. Dash and Saxena (2012) revealed Western Ghats and coastal plains harbor about 52 % (218 species) of the total number of Indian species (418 sp.) and about 52% (195 sp.) of all native Indian

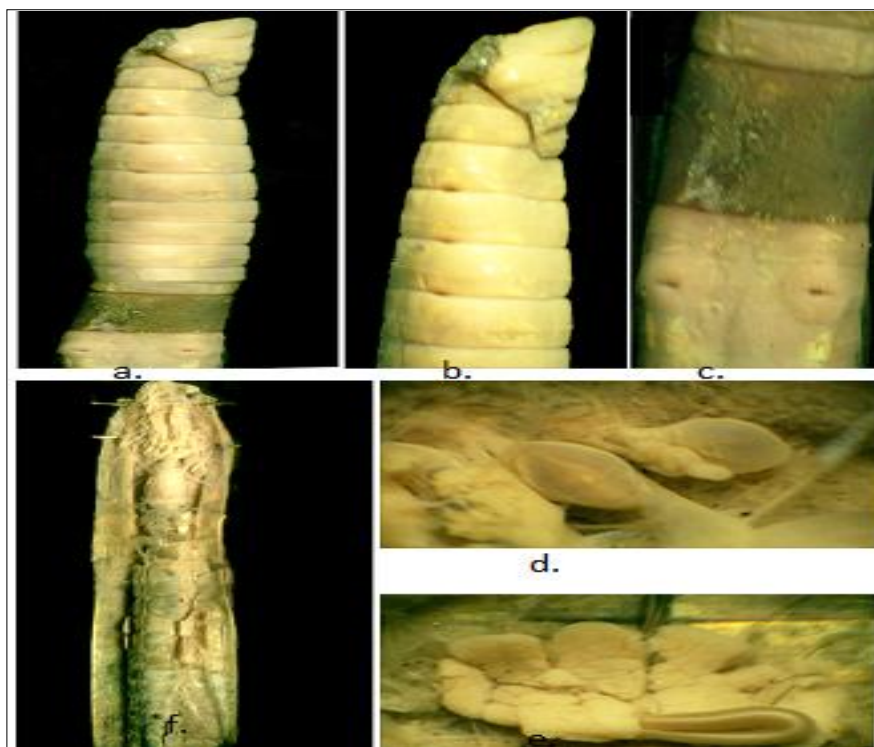
species (374 sp.) followed by Himalayas region (38.2 %; 160 sp.) of the total Indian species and 22 % (83 sp.) of total number of the native species. The southern Hill regions and plateau harbor about 14 % (59 sp.) of the total Indian species and 10% (38 sp.) of native Indian species, those are endemic to this area. The Malabar mountain area has its own unique earthworm genera like *Celeriella*, *Lampito*, *Moniligaster*, *Notoscolex* and *Troyia*.



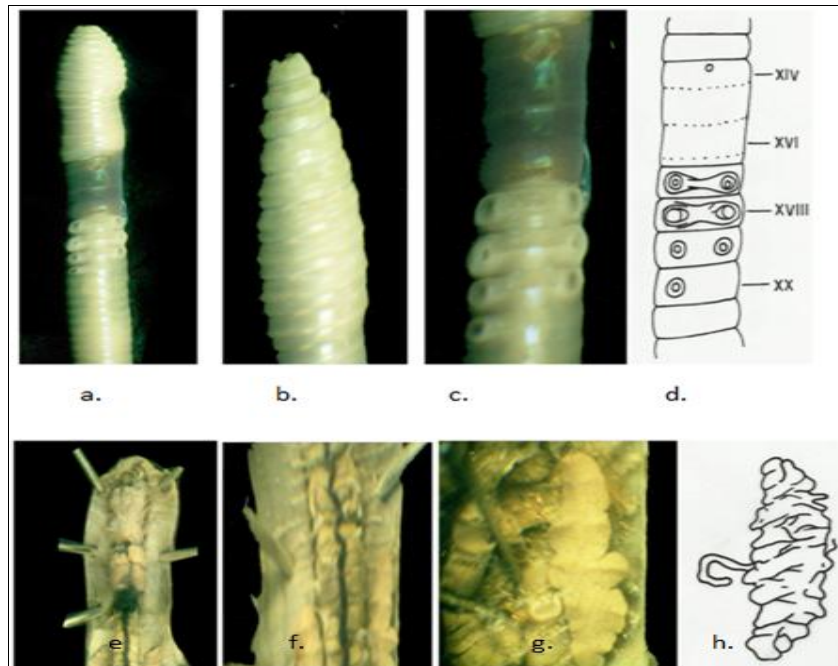
**Figure.1** Diagnostic characters of *Glyphidrilus annandalei*: a, clitellar region; b, prostomium; c flared wing like clitellum; d, diagrammatic sketch of ventral view; e, genital marking; f, view of internal structures; g, nephridial arrangement.



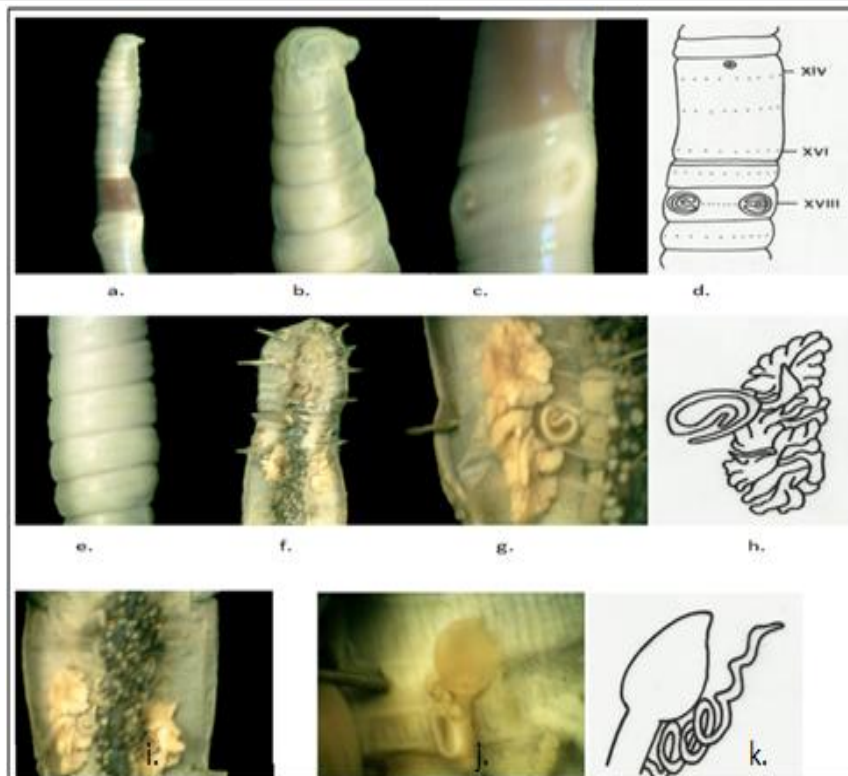
**Figure.2** Diagnostic characters of *Lampito mauritii*: a, ventral view of clitellum; b, view to show spermathecal pores; c, genital region; d, prostomium; e, dorsal pores; f, bidervticate spermathecae.



**Figure.3** Diagnostic characters of *Metaphire birmanica*: a, ventral view; b, view to show spermathecal pores; c, genital region; d, spermathecae; e, prostate; f, intestinal caecae.

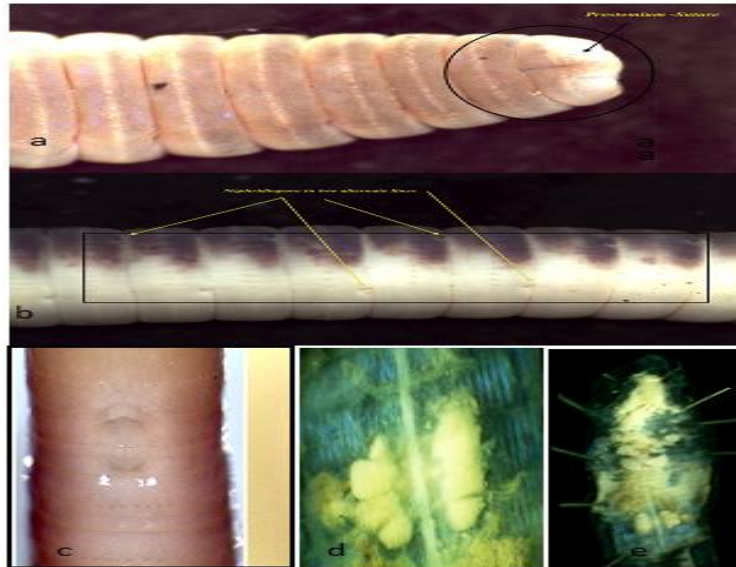


**Figure.4** Diagnostic characters of *Metaphire posthuma*: a, ventral view; b, lateral view; c, genital markings; d, diagrammatic sketch of ventral view; e, seminal vesicle; f, typhlosole; g, prostate; h, diagrammatic sketch of prostate.

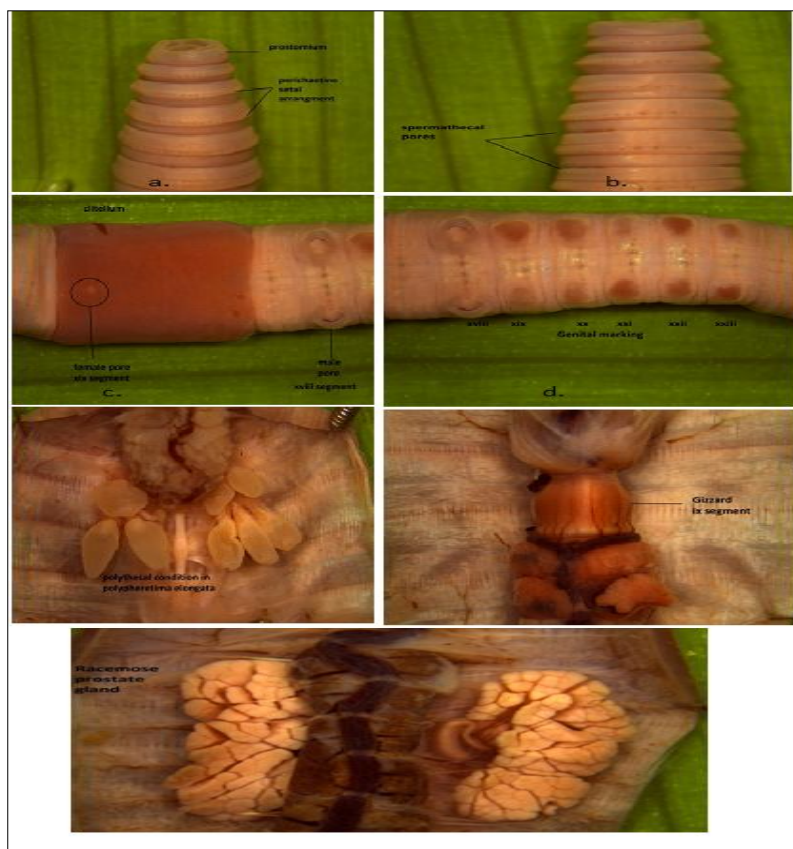


**Figure.5** Diagnostic characters of *Metaphire suctoria*: a, ventral view; b, lateral view; c, genital region; d, diagrammatic sketch of ventral view; e, setal arrangement; f, seminal vesicle; g, prostate; h, diagrammatic sketch of prostate; i, prostate in-situ; j, spermathecae; k, diagrammatic sketch of spermathecae.

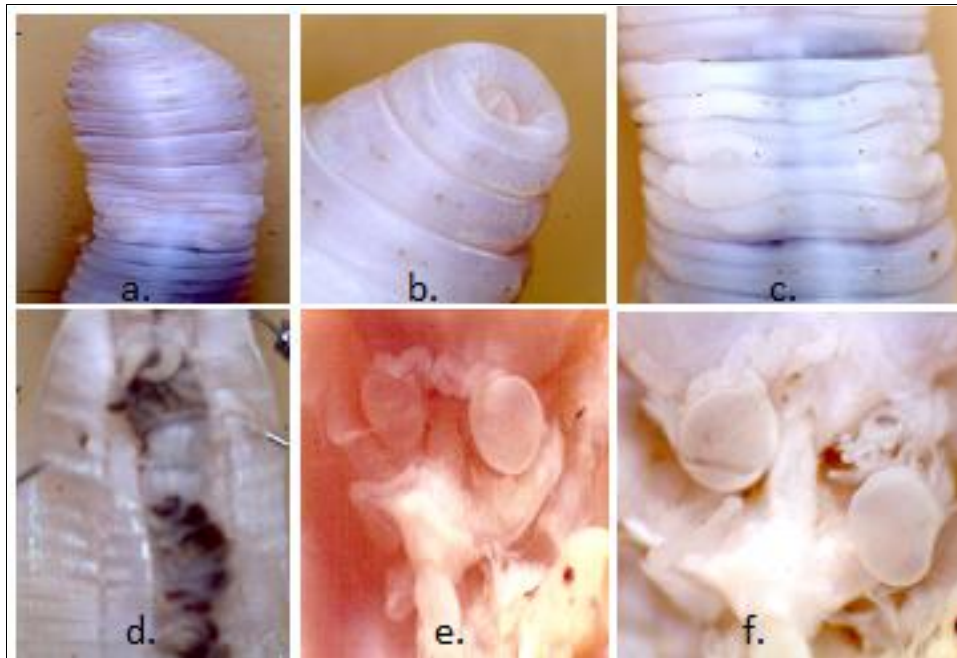




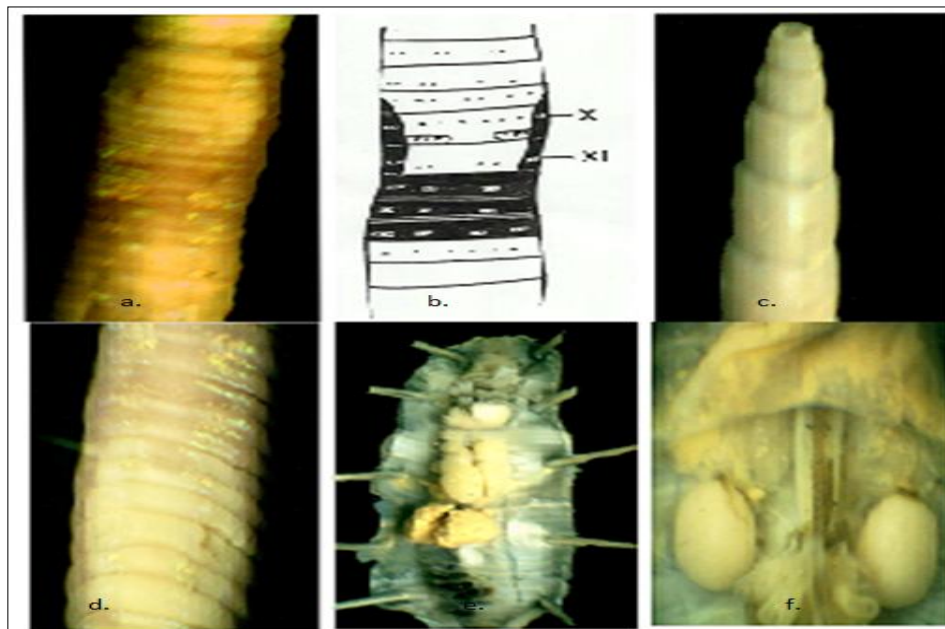
**Figure.6** Diagnostic characters of *Perionyx sansibaricus*: a, genital region; b, spermathecal pores; c, male pore; d, alternate arrangement of nephridiopore; e, stomata nephridia; f, different parts of nephridium



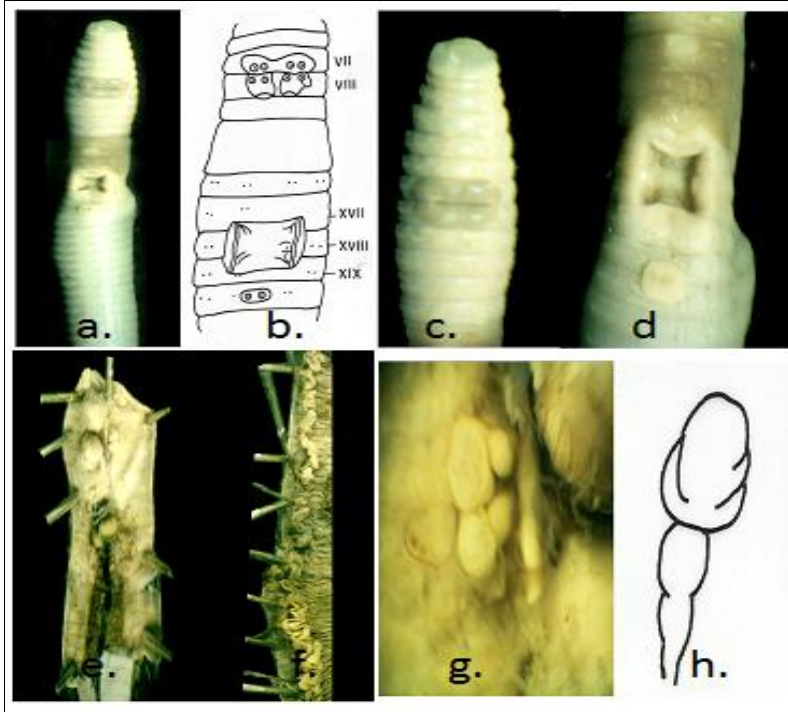
**Figure.7** Diagnostic characters of *Polypheretima elongata*: a, dorsal view; b, spermathecal pores; c, genital region; d, genital markings; e, spermathecae; f, gizzard;g, prostate



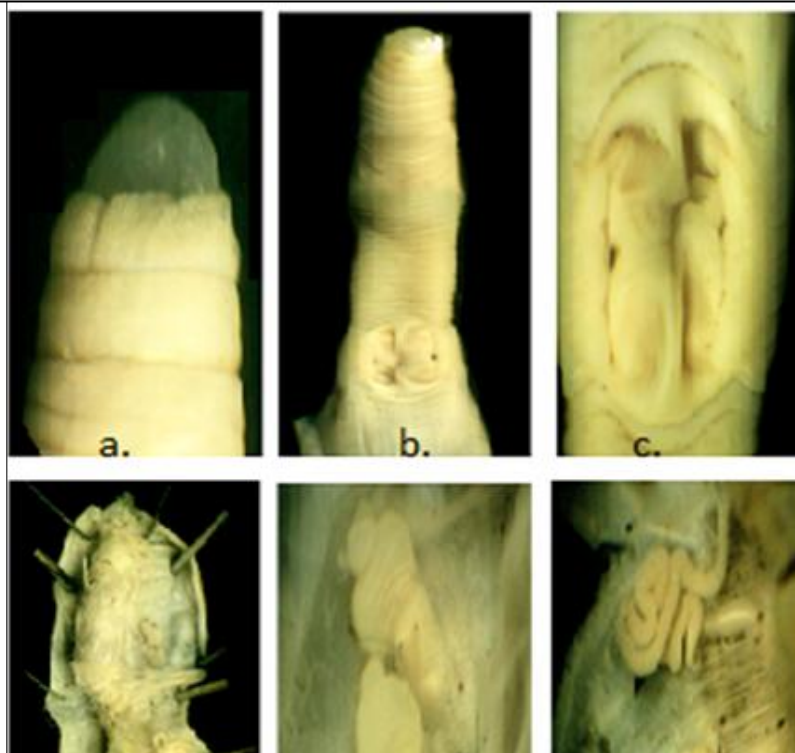
**Figure.8** Diagnostic characters of *Drawida modesta*: a, genital region; b, setal arrangement; c, genital region; d, gizzards; e, spermathecae; f, spermathecal duct



**Figure.9** Diagnostic characters of *Drawida pellucida*: a, ventral view; b, diagrammatic sketch of clitellar region; c, prostomium; d, spermathecal pores; e, gizzards; f, prostate.



**Figure.10** Diagnostic characters of *Octochaetona serrata*; a, ventral view to show spermathecal pores and genital region; b, diagrammatic sketch of ventral view; c, a view of spermathecal pores; d, genital region; e, typhlosole region ; f, lateral view of typhlosole; g, spermathecae; h, diagrammatic sketch of spermathecae



**Figure.11** Diagnostic characters of *Octochaetona aitkeni*; a, prostomium; b, genital region; c, male region; d, typhlosole e, spermathecae; f, prostate

In present study 694 field samples of earthworms of 180 sites collected from cultivated lands of different districts of Tamil Nadu, India and study brought to light 11 species. It has been observed *Drawida pellucida* and *Drawida molesta* were predominant species with wide distribution within study area. However, Julka and Paliwal (2005) harbored about 7% (30 sp.) from this area and out of them 5% (19 sp.) were of native in origin and stated that family Octochaetidae were the most frequent (30 genera) family found in Indian ecosystems *Pontoscolex corethrurus*, an endogeic and exotic species, were observed in all land-uses of Southern plateau & hills region by Mishra and Dash (1984). Surprisingly, this species was not recorded in present comprehensive survey. On the basis of the available data, the earthworm diversity may be generalized as follows: Western Ghats and West Coastal Plains > Eastern Himalayan Region > Southern Plateau > Western Himalayan Region > Eastern Coastal Plains and Eastern Ghats > Gangetic Plains > Gujarat plains > Islands > Trans-Gangetic regions > Western dry Regions (Julka and Mukharjee, 1984; Julka and Paliwal, 2005; Dash and Dash, 2008). Based on the above study some generalization may be made. Conversion of natural forests to shifting agriculture and plantations results in some loss of earthworm species richness together with changes in composition of soil fauna community structure and function. Present work, therefore, is a humble attempt in this direction and contributes to update our contemporary knowledge on the biodiversity of earthworms' resources of cultivated lands of Tamil Nadu, India.

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