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STUDIES ON THE EARTHWORMS COLLECTED DURING THE DAPHABUM EXPEDITION IN ARUNACHAL PRADESH, INDIA

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INTRODUCTION

The Daphabum Scientific Expedition was organised by the Geological Survey of India in November, 1969 — January, 1970 to explore the Lohit District of Arunachal Pradesh. The general topography of the area is of mighty mountains, intersected by large river beds and water courses. The vegetation at lower altitudes consists of tall trees, shrubs, bamboo, cane, wild banana and various kinds of creepers. At higher altitudes, the forest is mostly composed of ferns and rhododendorons. The average annual rainfall is over 300 cm., mainly occurring from April to October. The climate is quite hot in summer with the temperature reaching upto 30°C, and very cold in winter with the temperature varying from 8°C to 17°C and falling below the freezing point at higher elevations during night.

The earthworm fauna of Arunachal Pradesh is not much known, but for a contribution by Stephenson (1914), although the earthworms of neighbouring areas of Burma and Assam have been studied to certain extent by Stephenson (1914, 1923) and Gates (1930, 1931, 1932, 1933, 1936, 1945, 1962). The present article deals with the studies on a part of earthworm fauna collected by the author during the expedition. As a result, twelve species are recorded, of which three species, *Drawida tihunensis*, *Tonoscolex michaelseni* and *Plutellus mishmiensis* are new to science.

SYSTEMATIC ACCOUNT

Family MONILIGASTRIDAE

Drawida kempi Stephenson

1914. *Drawida kempi* Stephenson, *Rec. Indian Mus.*, **8** : 376.
1923. *Drawida kempi* : Stephenson, *Fauna Brit. India, Oligochaeta* : 144.
1934. *Drawida kempi* : Gates, *Rec. Indian Mus.*, **36** : 238.

Material.—2 ex; Chowkham, alt. 242 m., under the bark of a decaying wooden log; 24.xi.1969. 4 ex; Wakro, alt. 515 m., under

stones on the bank of a stream in the North-West of Dak Bungalow; 3.xii.1969. 3 ex; Tihun, alt. 1260 m; 12.xii.1969.

Remarks.—Ectal end of spermathecal duct enlarged into a spindle-shaped thickening.

Drawida nepalensis Michaelsen

1907. *Drawida nepalensis* Michaelsen, *Mitt. naturh. Mus. Hamb.*, **24** : 146.
1909. *Drawida burchardi* Michaelsen, *Mem. Indian Mus.*, **1** : 149.
1916. *Drawida jalpaigurensis* Stephenson, *Rec. Indian Mus.*, **12** : 307.
1923. *Drawida nepalensis* : Stephenson, *Fauna Brit. India, Oligochaeta* : 146.
1962. *Drawida nepalensis* : Gates, *Bull. Mus. comp. Zool. Harv.*, **127** : 331.

Material.—3 ex; Chowkham, alt. 242 m., under bark of a decaying wooden log; 24.xi.1969. 4 ex; Chowkham, alt. 242 m., under stones on the bank of Berang river. 2 ex; Gogoi Camp (near Chowkham); 29.xi.1969. 28 ex; Wakro, alt. 515 m., rocky soil in the forest east of Dak Bungalow; 2.xii.1969. 1 ex; Wakro, under stones on the bank of a stream in north-west of Dak Bungalow; 3.xii.1969. 1 ex; Wakro, under stones near hutments, 4.xii.1969.

Drawida tihunensis n. sp.

External characteristics.—Length, 87-135 mm. Diameter, 4-5 mm. Segments 130-134, 85 (Juvenile). Prostomium, prolobous. Pigmentation, unrecognizable (alcoholic preservation). Satae, begin on II, closely paired; on XX, $AA > BC$, $AB = CD$, $DD = 1/2$ C. Nephropores, first present on III, are dorsal to *D* lines in III-VI, but are irregularly located on the posterior segments; in one specimen, they are on *B* lines in X(L), XI, XIII (R), XIV (L), XVI, XIX, XXII, XXV, XXVIII, XXXI, on *D* lines in VII (L), VIII, XII (L), XIV (R), XVII, XX, XXIII, XXVI, XXIX, XXXII, near mD in VII (R), IX, X (R), XII (R), XIII (L), XV, XVIII, XXI, XXIV, XXVII, XXX; in second specimen ,they are on *B* lines in X, XI, XIV, XVII, XX, XXIII, XXVI, XXIX, XXXII, on *D* lines in XII, XV, XVIII, XXI, XXIV, XXVII, XXX, near mD in XIII, XVI, XIX, XXII, XXV, XXVIII, XXXI; in the third specimen, on *B* lines in XI, XIII (L), XV (R), XVI (L), XVIII (R), XIX (L), XXI (R), XXII (L), XXIV (R), XXV (L), XXVII (R), XXVIII (L), XXX (R) , on *D* lines in VII, VIII, XII, XIII (R), XIV (L), XVI (R), XVII (L), XIX (R), XX (L), XXII (R), XXIII (L), XXV (R), XXVI (L), XXVIII (R), XXIX (L), near mD on IX, X, XIV (R), XV (L), XVII (R), XVIII (L), XX (R), XXI (L), XXIII (R), XXIV (L), XXVI (R), XXVII (L), XXIX (R), XXX (L), Clitellum, not developed.

Spermathecal apertures (secondary) large, transverse slits, at 7/8, near *CD*, pores (primary) minute, on small elliptical papillae

in *C*. Secondary male pores (apertures of copulatory chambers), large, elliptical slits, at 10/11, in m*BC*. An antero-posteriorly compressed papilla slightly protrudes through the secondary male pore. There is a deep depression on the posterior face of the papilla and within this depression is a thin-walled, translucent, tubular penial body, at the tip of which is located a minute male pore. Female pores. minute, on 11/12, close to *B* lines.

Genital markings, median, unpaired, small, circular in outline, presetal on VI-XII or VI-X, XI or IX-XII.

Internal anatomy.—Gizzards, in XIV-XVIII or XV-XIX. Intestinal origin, in XXV. A pair of sac-like structures open into gut in segments XXII and XXIII, each sac-like structure is laterally placed and supplied with a well-developed commissure from the dorsal blood vessel.

Dorsal blood vessel, traceable anteriorly upto IV. Subneural, adherent to parieties, traceable upto VI. Commissures from extra-oesophageals, on the posterior face of 8/9.

Testis sacs, almost entirely in X, with only a slight protuberance in IX, and slightly constricted by 9/10. Vas deferens, slender, closely coiled into a small mass, which is smaller than the testis sac. Vas enteres into the parieties at *B* levels and runs a little posterior below the longitudinal muscle layer to open at the anterior end of the prostate. Prostates, muscular, circular in outline, dome-shaped, partially embedded in the parieties.

Spermathecal ampulla, ovoid; duct, muscular, thick, shining and loosely coiled on the posterior face of 7/8, slightly enlarged at its ectal end, which is embedded in the parieties.

Genital marking glands, pear-shaped, muscular, embedded in the parieties, below the nerve cord.

Holotype.—1 ex; Tihun, alt. 1260 m., under stones near a stream; 12.xii.1969; coll. *J M Julka*; Z. S. I. Regd. No. An. 110/1.

Paratypes.—2 ex; Tihun, alt. 1260 m., 13.xii.1969; coll. *J M Julka*; Z. S. I. Regd. No. An. 111/1.

Remarks.—Spermathecal ampullae are distended with white material and ovisacs are empty, extending upto 12/13.

Relationship.—Drawida tihunensis is closely related to the *beddardi*-complex, but can be distinguished by the median, unpaired location of the genital markings and the location of the primary male pore.

Desmogaster ferina Gates

1943. *Desmogaster ferina* Gates, *Ohio J. Sci.*, **43** : 91.

Material.—4 ex; Gogoi Camp (near Chowkham), alt. 242 m. under wooden logs; 29.xi.1969.

External characteristics.—Length, 145 mm. 117-120 mm. (amputee posteriorly). Diameter, 7-8 mm. Segments, 342 (218 and 295 in amputees). A deep, presetal secondary furrow present on each of segments V-XI or V-XII or V-XXV. Nephropores of III-X, a little dorsal to *D* lines.

Spermathecal pores, minute, circular, on 8/9, on *C* lines; each pore located in the middle of an eye-like demarcated area. Male pores, small, in 11/12 and 12/13, a little ventral to *C* lines.

Internal anatomy.—Gizzards, in XX-XXV (3 specimens). Dorsal blood vessel, double in front of 5/6. Last pair of hearts, in XI.

Vas deferens, drops ventrally, median to heart and after making a long hair-pin loop upto the base of testis sac, passes under the extra-oesophagael trunk, entering the parieties at *AB* muscular gap. After the removal of a thin muscular layer, the vas has been traced running to the base of antero-posteriorly compressed, erect prostate. It runs upwards along the inner margin of prostate to open at the ental end of the latter. The vas deferens is enclosed in a common sheath of the prostate.

Spermathecal duct, muscular, thick ,drops down into 3 or 4 loose coils before entering the posterior face of 8/9 septum, then running diagonally in the muscular layer of the septum, enters the parieties at *CD*.

Remarks.—In one specimen, there is an extra eye-like demarcated area with a minute pore, a little dorsal to the right spermathecal pore. The ovisacs are without any trace of ova.

This species has been recorded earlier only from Burma.

Family MEGASCOLECIDAE

Tonoscolex oneilli (Stephenson)

1914. *Megascolides oneilli* Stephenson, *Rec. Indian Mus.*, **8** : 377.
1923. *Notoscolex oneilli* : Stephenson, *Fauna Brit. India, Oligochaeta* : 212.
1934. *Tonoscolex oneilli* : Gates, *Rec. Indian Mus.*, **36** : 254.
1936. *Tonoscolex oneilli* : Gates, *Rec. Indian Mus.*, **38** : 383.

Materials.—2 ex; Chikrung, alt. 1120 m., under stones; 18.xii.1969.

Remarks.—Length, 185-250 mm. Diameter, 5-7 mm. Segments, 238-306. Setal interval, $AB < CD < BC < AA$, posteriorly, $BC = CD$.

Seminal vesicles of X smaller than those of XI. Prostates, extend through XVII-XVIII. Prostatic duct, muscular, arises from near the anterior end of prostate and after forming two zig-zag loops, runs straight into the parieties under an ovoidal thickening, below the nerve cord. The removal of the muscular layer of the ovoidal body reveals a pear-shaped, sac-like structure, near the ectal end of which, the prostatic duct opens.

Spermathecal ampulla, much shorter than the duct, which is looped, the limbs of the loops are bound together by a tissue.

Abnormality.—The left seminal groove in one specimen is only partially developed.

Tonoscolex michaelseni n. sp.

External characteristics.—Length, 390 mm., 125 mm. (amputee posteriorly), 158-295 mm. (aclitellate). Diameter, 5-8 mm., 3-6 mm. (aclitellate). Segments, 339, 176 (amputee), 280-390 (aclitellate). Unpigmented, very light-greyish white except on clitellum which is brownish red. Prostomium, proepilobous. First dorsal pore, in 10/11. Segments V-XII, with a deep secondary postsetal furrow, VI-XII, in addition with a deep presetal furrow. Setae, lumbricine throughout the body, begin on II, *AB* missing on XVII. Setal interval, on pre-and post-clitellar segments, $AB < CD < BC < AA$. Clitellum, XIII—2/3 XVI, inter-segmental furrows distinct, dorsal pores occluded, setae present.

Male genital shield, extends across XVII and posterior part of XVI. Male pores, large, in setal zone, on XVII, in *AB*, connected by a deep transverse groove, which continues outwards, on either side, a little beyond *B* and then turns forwards as seminal grooves, extending upto the middle of posterior half of XVI. Seminal grooves, straight, deep. Two transverse furrows, a deep and a shallow, are present anterior to male pores in the space between the seminal grooves.

Spermathecal pores, paired, slit-like, in 6/7, 7/8, just ventral to *A* lines.

Internal anatomy.—Septa, 6/7—9/10, thickened, 10/11—11/12, slightly thickened. Gizzard, well-developed, elongate, in VI.

Paired calciferous glands, in IX — XII. Intestinal origin, in XIV. Typhlosole, lamelliform, mD, from XV — CCLXXVII, CCIVC.

Meronephric, exonephric, in posterior segments there are in addition enteronephric nephridia on the dorsal side of intestine, a cluster of micronephridia in VI near 5/6.

Dorsal blood vessel, continued anteriorly onto pharyngeal bulb. Supra-oesophageal, unrecognisable anterior to 10/11, in XI turning off laterally to pass into the calciferous glands. Extra-oesophageals, pass posteriorly into calciferous glands of XII. Latero-parietals, recognisable from XVI anteriorly to 12/13, where they move up to pass into calciferous glands of XII. No subneural. Last hearts, in XII.

Holandric. Seminal vesicles, in X, XI, on the posterior faces of 9/10 and 10/11. Prostates, strap-shaped, extending through XVI-XVIII. Prostatic duct, white, muscular with a little shine, forms a loop near its origin, and then runs straight underneath a well-developed, muscular, ovoidal body, in XVII, below the nerve cord.

Spermathecal ampulla, round ; duct, clearly marked off, narrows towards the ectal end, three times as long as ampulla, forming a loop, two limbs of the loop connected by tissue; diverticulum, smaller than ampulla, stalked, club-shaped, on the anterior face at the ectal end of duct.

Holotype.—1 ex; Wakro, alt. 515 m., rocky soil in a forest east of Dak Bunglow; 2.xii.1969; coll. *J M Julka*; Z.S.I. Regd. No. An. 112/1.

Paratypes.— 2 ex; Wakro, alt. 515 m., rocky soil in a forest east of Dak Bunglow; 2.xii.1969; coll. *J M Julka*; Z.S.I. Regd. No. An. 113/1. 1 ex; Tihun, alt. 1260 m.; 10.xii.1969 ; coll. *J M. Julka*; Z.S.I. Regd. No. An. 114/1.

Relationship.—Tonoscolex michaelseni is closely related to *Tonoscolex conversus* (Gates) and *Tonoscolex parvus* Gates but can be distinguished by the shape of the genital shield and seminal grooves.

Pheretima diffringens (Baird)

1869. *Megascolex diffringens* Baird, *Proc. zool. Soc. Lond.* : 40.
1887. *Perichaeta mirabilis* Bourne, *Proc. zool. Soc. Lond.* : 668.
1900. *Pheretima mirabilis* : Michaelsen, *Das Tierreich*, **10** : 284.
1900. *Amyntas heterochaetus* (part) Beddard, *Proc. zool. Soc. Lond.* : 622.
1909. *Pheretima heterochaeta* : Michaelsen, *Mem. Indian Mus.*, **1** : 110, 189.

1923. *Pheretima heterochaeta* (part) : Stephenson, *Fauna Brit. India, Oligochaeta* : 302.
1937 *Pheretima diffringens* : Gates, *Rec. Indian Mus.*, **39** : 198.

Material.—17 ex; Chowkham, alt. 242 m., under stones; 23.xi.1969. 9 ex; Chowkham, under stones on the bank of Berang river ; 27.xi.1969. 2 ex; Alubari, alt. 242 m., cultivated field; 23.xi.1969. 15 ex; Chakama village, alt. 242 m., under stones on the bank of Berang river; 25.xi. 1969. 6 ex; Wakro, alt. 515 m., under stones; 2.xii.1969. 2 ex; Wakro; 3.xii.1969. 26 ex; Wakro; 4.xii.1969. 1 ex; near Chamba village, under stones on the bank of Kamalang river; 6.xii.1969. 23 ex; Hawai; 9.i.1970. 25 ex; Kharang, under stones; 11.i.1970. 20 ex; Hayuliang; 16.i.1970. 1 ex; Tezu, alt. 275 m.; 20.i.1970.

Remarks.—The variations in the location of the genital markings are recorded in Table 1.

Abnormality.—In a specimen from Chakama village, left heart in XIII, missing ; left spermetheca in IX, absent; an extra male pore on the left side in XVII.

Perionyx excavatus Perrier

1872. *Perionyx excavatus* Perrier, *Nouv. Archs Mus. Hist. nat., Paris*, **8** : 126.
1892. *Perionyx intermedius* Beddard, *Proc. zool. Soc. Lond.* : 689.
1900. *Perionyx excavatus* : Michaelsen, *Das Tierreich*, **10** : 208.
1900. *Perionyx intermedius* : Michaelsen, *Das Tierreich*, **10** : 209.
1916. *Perionyx fulvus* Stephenson, *Rec. Indian Mus.*, **12** : 322.
1916. *Perionyx parvulus* Stephenson, *Rec. Indian Mus.*, **12** : 321.
1923. *Perionyx excavatus* : Stephenson, *Fauna Brit. India, Oligochaeta* : 329.
1923. *Perionyx fulvus* : Stephenson, *Fauna Brit. India, Oligochaeta* : 333.

Material.—14 ex; Chowkham, alt. 242 m., decaying wooden log; 23.xi.1969.

Abnormality.—In one specimen, spermathecal pores are in 8/9, 9/10, and there is an additional pair of male pores in XVII.

Perionyx modestus Stephenson

1922. *Perionyx modestus* Stephenson, *Rec. Indian Mus.*, **24** : 435.
1923. *Perionyx modestus* : Stephenson, *Fauna Brit. India, Oligochaeta* : 344.
1960. *Perionyx modestus* : Gates, *Bull. Mus. comp. Zool. Harv.*, **123** : 231.

Material.—1 ex; Chowkham, alt. 242 m.; 23.xi. 1969.

TABLE 1.—Location of genital markings in *Pheretima diffringens.*

Segment No. on which genital marking is present	No. of specimens
VII	1
VIII	5
VII-VIII	29
VII-VIII. absent on right side of VII	3
VII-VIII. absent on left side of VII	3
VII-VIII. absent on left side of VII, VIII	1
VII-VIII. absent on left side of VIII	1
VIII-IX. absent on right side of VIII	1
VIII-IX. absent on right side of IX	1
VII-IX. absent on right side of VII, left side of IX	1
VII-IX. absent on left side of VII, right side of IX.	1
VII-IX. absent on left side of IX.	6
VII-IX. absent on right side of IX	7
VII-IX. absent on right side of VIII. left side of IX.	1
VII-IX	42
VI-IX.	1
VII-X. absent on right side of X	1
Total :	105

Family ACANTHODRILIDAE

Plutellus mishmiensis n. sp.

External characteristics.—Length, 90-180 mm. Diameter, 3-3.5 mm. Segments, 110-302. Unpigmented (alcoholic preservation). Prostomium, prolobous. Segments, IV-V, with a postsetal secondary furrow, VI-X, with a presetal and a postsetal secondary furrows, VIII-X, in addition with a tertiary furrow in the presetal area. Setae, present from II, on XX, $AB < CD < AA < BC$, DD = 1/2 C, *AB* missing on XVIII. First dorsal pore, in 9/10, Clitellum, not developed.

Spermathecal pores, minute, unpaired, on mid-ventral line, in 5/6, 6/7, 7/8, 8/9. Male pores, apparently unrecognizable, probably minute, located in a transverse groove, on XVIII, near mid-ventral line. Female pores, minute, transverse, slits, paired, presetal, on *A* lines.

Internal anatomy.—Septa, 5/6, thin, 6/7—9/10, slightly muscular. Gizzard, well-developed, in V. Oesophagus, in X-XIII, enlarged, much vascular and has slightly lamelliform, interupted, longitudinal

ridges on its inner wall, in XIV-XVI, narrow tube-like. Intestinal origin, in XVII An apparent typhlosole, lacking, but there is a slightly raised, wrinkled, ridge in mD. On the ventral wall of intestine, there are high, lamelliform, transverse ridges.

Dorsal blood vessel, continuing anteriorly onto the pharyngeal bulb. Supra-oesophageal and extra-oesophageals, unrecognizable. Subneural, absent. Last hearts, in XIII.

Holonephric; nephridia in anterior segments, on the anterior faces of septa, appear to be astomate.

Holandric. Seminal vesicles, in XI, XII, on posterior faces on 10/11, 11/12, lobulated; lobules small. Vas deferens, almost straight, superficial, opening at the enlarged portion of prostatic duct, in line with muscular gap of *B.* Prostates, long, straight, tubular, extending from XIX-XXX (5 specimens), XXXI (2 specimens), XXXIV (2 specimens), XXXVI (1 specimen), in *CD.* The prostatic duct, not clearly demarcated from prostate, probably in XVIII, running diagonally inwards from 18/19, enlarged and thickened before entering parieties, below nerve cord.

Spermathecae, small in mid-ventral line, below the nerve cord; ampulla, a little elongated; duct, indistinct; diverticulum, club-shaped, slightly stalked, opening at the ectal end of duct, on its anterior face. Penial setae, small, smooth, slightly curved towards the tapering end; tip, bluntly rounded to pointed.

Holotype.—1 ex; Tihun, alt. 1260 m.; 12.xii.1969; coll. *J. M. Julka*; Z.S.I. Regd. No. An. 115/1.

Paratypes.—1 ex; Tihun, alt. 1260 m.; 8.xii.1969; coll. *J M Julka*; Z. S. I. Regd. No. An. 116/1. 8 ex; Tihun, alt. 1260 m; 12.xii.1969; coll. *J M Julka*; Z.S.I. Regd. No. An. 117/1. 6 ex; Chikrung, alt. 1120 m; 18.xii.1969; coll. *J M Julka*; Z.S.I. Regd. No. An. 118/1. 2 ex; Tihun, alt. 1260 m.; 10.xii. 1969; coll. *J M Julka*; Z.S.I. Regd. No. An. 119/1.

Relationship.—Plutellus mishmiensis is closely related to *Plutellus affinis* Stephenson, *Plutellus palniensis* Michaelsen and *Plutellus unicus* (Fletcher), but can be distinguished by the presence of median spermathecal pores in 5/6-8/9 and long prostates.

Family OCTOCHAETIDAE

Dichogaster bolaui (Michaelsen)

1891. *Benhamia bolaui* Michaelsen. *Mitt. Mus. naturh. Hamb.*, **8** : 307.

1900. *Dichogaster bolaui* : Michaelsen, *Das Tierreich*, **10** : 340.
1923. *Dichogaster bolaui* : Stephenson, *Fauna Brit. India, Oligochaeta* : 472.

Material.—1 ex; Wakro, alt. 515 m., from a drain and rocky soil; 4.xii.1969.

Dichogaster saliens (Beddard)

1893. *Microdrilus saliens* Beddard, *Proc. zool. Soc. Lond.* : 683.
1900. *Dichogaster saliens* : Michaelsen, *Das Tierreich*, **10** : 343.
1923. *Dichogaster saliens* : Stephenson, *Fauna Brit. India, Oligochaeta* : 478.
1942. *Dichogaster saliens* : Gates, *Bull. Mus. comp. Zool. Harv.*, **89** : 134.

Material.—3 ex; Chowkham, alt. 242 m.; 23.xi.1969. 57 ex ; Wakro, alt. 515 m., from a drain and under stones; 3.xii.1969. 30 ex; Wakro, elephant dung; 4.xii.1970.

Remarks.—A genital marking is present on twenty one specimens, on 15/16. A tail regenerate, in one specimen, at level of segment LXXXVII.

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SUMMARY

The present article deals with the systematic studies on the earthworms collected during the Daphabum Expedition in Arunachal Pradesh (formerly North East Frontier Agency). As a result, twelve species are reported, of which three species, *Drawida tihunensis*, *Tonoscolex michaelseni*, and *Plutellus mishmiensis* are new to science. Some interesting morphological variations in *Desmogaster ferina* Gates, *Tonoscolex oneilli* (Stephenson), *Pheretima diffringens* (Baird) and *Dichogaster saliens* (Beddard) are brought to light.

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