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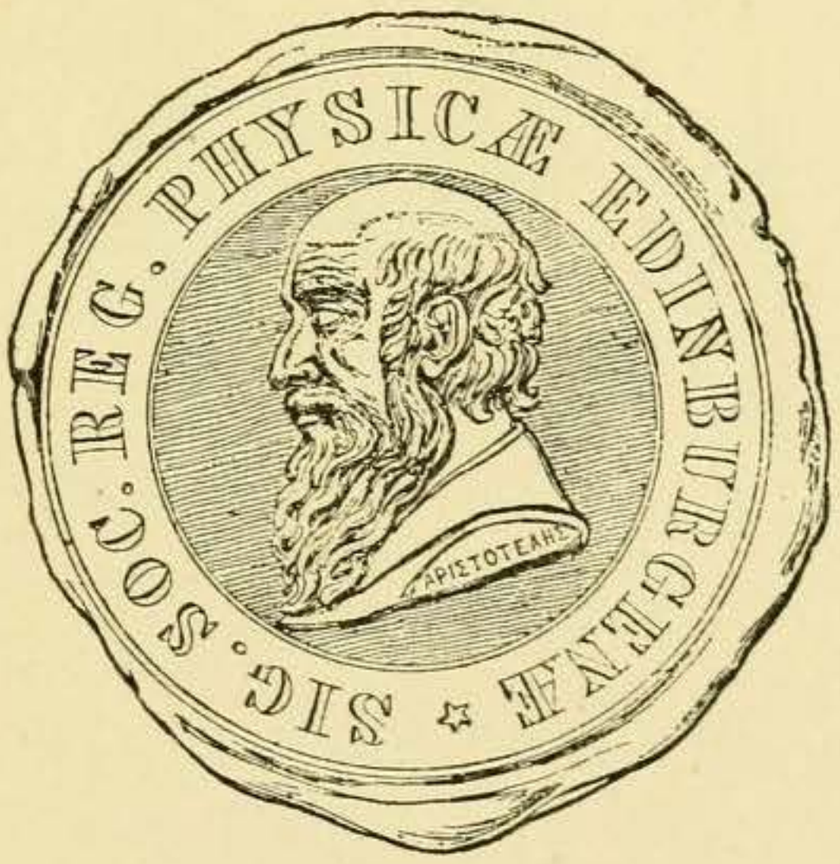

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angles confluent, surface covered by a coarse pustulation. Cornstones, Herefordshire.

In conclusion, my most hearty thanks are due to Mr Smith Woodward for the information he has afforded me regarding the Herefordshire specimens in the British Museum, and to Dr Woodward, F.R.S., for permission to make use of the plaster cast taken from one of these specimens.

Explanation of Plate.

In all the figures the same letters refer to the same things.

P.L. postero-lateral angle. P.E. postero-external angle. A.E. antero-external angle. P.O. post-orbital angle. A.O. ante-orbital angle. *m.o.* median occipital. *e.o.* external occipital. *c.* central. *m.* marginal. *pt.o.* post-orbital. *p.o.* pre-orbital. *e.* ethmoidal.

Fig. 1. Restored outline showing the arrangement of the plates and lateral-line grooves in the cranial shield of *P. Acadicus*, Whiteaves sp.

Fig. 2. The same in another specimen, lateral margins of the shield restored in dotted outline.

Fig. 3. Sketch of a specimen of the cranial shield of *P. Anglicus*, Traquair, from a specimen in the Edinburgh Museum.

Fig. 4. Sketch of a plaster cast of another specimen, contained in the British Museum, the surface ornament being omitted.

XXV. *The Classification and Distribution of Earthworms.* By Frank E. Beddard, M.A., F.R.S.E., F.Z.S., Prosector and Davis Lecturer to the Zoological Society of London; Lecturer on Biology at Guy's Hospital. [Plates XIII., XIV.]

(Read 19th February and 19th March 1890.)

Part I.—Classification.

As I have taken pains—in common with most recent writers—to point out that the Oligochæta cannot be divided into two divisions, it may seem irrational to consider the classification of the "*Terricolous*" forms apart from that of the "*Limicolous.*" But as a matter of fact, it seems to me that, although it is quite impossible to contrast two such groups as "*Oligochæta terricolæ*" and "*Oligochæta limicolæ*," it is

necessary to consider the terricolous forms as forming two groups, which are each equivalent to various groups, such as Tubificidæ, etc., into which the limicolous forms may be suitably divided. To a certain extent, therefore, it will be seen that my views accord with those recently expressed by Rosa ;[1] but before criticising the scheme propounded by the Italian naturalist and expounding my own, it may be useful to give a short *résumé* of previous opinions.

It is impossible to commence earlier than Perrier,[2] whose views were the result of the study of a larger number of forms than had been previously investigated by any one of his predecessors except Kinberg.[3] But Kinberg's scheme of classification cannot be considered seriously, as it took account only of certain external characters, the number and arrangement of the setæ, and one or two other points of even less importance. The reader is therefore referred at once to Kinberg's paper, or to an abstract of it, in vol. iii. of the "Zoological Record" (p. 597).

M. Perrier, distinguishing earthworms as a group equivalent to that of the rest of the Oligochæta,[2] divided them into three divisions, mainly fixed by external characters, which were believed, however, to be in harmony with internal organisation—

(1.) **Lombriciens Anteclitelliens**—
Male reproductive pores *in front of* clitellum.

(2.) **L. Intraclitelliens**—
Male reproductive pores *within* clitellum.

(3.) **L. Postclitelliens**—
Male reproductive pores *behind* clitellum.

To these three a fourth—**L. Aclitelliens**, to include *Moniligaster*, *without* a clitellum—was somewhat doubtfully added.

Later on, M. Perrier[4] expressed himself with regard

[1] Nuova Classificazione dei Terricoli—Boll. Mus. Zool. Torino, No. 41, vol. iii. (1888).

[2] Memoires pour servir à l'histoire des Lombriciens terrestres—Nouv. Arch. d. Mus., t. viii. (1872).

[3] Annulata nova—Œfv. af K. Vet. Akad. Förh., 1866, p. 97.

[4] Études sur l'Organisation des Lombriciens terrestres : iv. Organisation des Pontodrilus [E. P.]—Arch. de Zool. Exp., t. ix., 1881, p. 236, note.

to the connection between the Intraclitellians and Postclitellians as follows:—"*Eudrilus*, which we have placed, in our *Recherches pour servir à l'histoire des Lombriciens terrestres*, among the intraclitellian earthworms, appears to be transitional between this group and that of the *Postclitellians*, if we only consider the extent of the clitellum, which in our species is prolonged beyond so as to reach the male reproductive pores; in reality, their organisation is that of the '*Postclitellians*,' and we should place them at the head of that group immediately after the Intraclitellians."

The points to which M. Perrier refers here are chiefly the atria, which he compares in the text to those of *Pontodrilus*.

Further researches did not tend to confirm the naturalness of Perrier's classification, except as regards the first and fourth groups.[1] I myself have pointed out that *Megascolex cæruleus*,[2] otherwise so closely allied to *Perichæta*, has "intraclitellian" male reproductive apertures.

Acanthodrilus is a genus of which, according to Horst, Perrier, myself, and others, some species ought to be referred to the *second*, others to the *third*, of Perrier's groups as defined above.

Other instances of a like kind show that a hard and fast line cannot be drawn between the Postclitellians and the Intraclitellians as regards the extent of the clitellum.

M. Perrier's classification has been attacked, and, in so far as he laid most stress upon the relations of the male pores to the clitellum, justly attacked, according to my way of thinking.

It will be noticed, however, in the course of the present paper, that all his groups—after removing only the Eudrilidæ—are perfectly natural assemblages if they are regarded from other points of view, to some of which, indeed, such as the presence of atria, he refers himself. One of the principal relations upon which I insist in this paper is the necessary

[1] Dr Rosa himself (*loc. cit.*, p. 9) regards the Moniligastridæ as a distinct family.

[2] On the Anatomy and Histology of *Pleurochæta Moseleyi*—Trans. Roy. Soc. Edin., vol. xxx.

association of the Acanthodrilidæ, Perichætidæ, and Perrier's genera *Digaster* and *Pontodrilus.*

Impressed by these facts, I ventured[1] to contrast the Anteclitellians on the one hand with the Intra- and Post-clitellians on the other. Our increased knowledge of the group does not, as it appears to me, favour such an arrangement.

Professor Claus' classification,[2] being essentially that of Perrier, needs no special mention.

M. L. Vaillant[3] places all earthworms in one family—Lumbricidæ—which includes, besides various rather doubtful genera, *Phreoryctes.* Although this genus has undoubted affinities to earthworms, I do not think it permissible to unite it in the same group with them.[4]

The various genera of Lumbricidæ which Vaillant admits, include a number that are very doubtful, such as *Helodrilus,* Hoffm., *Hypogæon,* Sav., *Pontoscolex,* Schm. As to any further grouping of these genera, he says (p. 60), "La division du groupe ne me paraît pas devoir comporter l'établissement de familles, malgré l'opinion contraire de M. Vejdovsky, lequel y ajoute celles des Pleurochætidæ, Plutellidæ, Criodrilidæ, Pontodrilidæ, les caractères sur lesquels elles sont établies ne peuvent être regardés comme ayant une valeur suffisante, car ils ne conduisent pas à des rapprochements qu'on puisse réellement regarder comme naturels. Aussi, tout on les employant dans l'énumération synoptique ci-contre, je ne crois pas qu'ils puissent encore servir à autre chose, qu'à établir un système pour arriver à la détermination des genres."

Vejdovsky[5] introduced a considerable number of improvements into the current schemes, although, as will be pointed out directly, his scheme is not thoroughly in accord with our present knowledge. His classification is as follows :—

[1] Descriptions of some new or little known Earthworms—P. Z. S., 1886, p. 312.

[2] Grundzüge der Zoologie, 2d ed. Marburg, 1880.

[3] Histoire Naturelle des Annelés, marins et d'eau douce. Paris, 1889.

[4] Beddard, The Anatomy, Histology, and Affinities of *Phreoryctes*—Trans. Roy. Soc. Edin., vol. xxxv.

[5] System und Morphologie der Oligochæten. Prag, 1884, p. 63.

Pontodrilidæ, Vejd.

Pontodrilus, E. P

Criodrilidæ, Vejd.

Criodrilus, Hoffm.

Lumbricidæ, Vejd.

1. *Tetragonurus*, Eis.
2. *Allurus*, Eis.
3. *Dendrobœna*, Eis.
4. *Allolobophora*, Eis.
5. *Lumbricus*, L.

? 6. *Hypogæon*, Sav.

? 7. *Alyattes*, Kinb.

Eudrilidæ, Claus (= *L. intraclitelliens*, E. P.).

1. *Eudrilus*, E. P.
2. *Rhinodrilus*, E. P.
3. *Anteus*, E. P.[1]
4. *Titanus*, E. P.
5. *Geogenia*, Kinb.
6. *Urochæta*, E. P.
7. *Typhæus*, Beddard.

? 8. *Pontoscolex*, Schmarda.

Acanthodrilidæ, Claus.

1. *Acanthodrilus*, E. P.
2. *Digaster*, E. P.

? 3. *Mandane*, Kinb.

Perichætidæ, Claus.

1. *Perichæta* (Schmarda), Beddard.
2. *Perionyx*, E. P.

Plutellidæ, Vejd.

Plutellus, E. P.

Pleurochætidæ, Vejd.

Pleurochæta, Beddard (? = *Megascolex*, Templ.).

Moniligastridæ, Claus.

Moniligaster, E. P.

Rosa has criticised this classification, and for the most

[1] Vaillant (Histoire Naturelle des Annelés, marins et d'eau douce, Paris, 1889, p. 183, *et seq.*) unites *Anteus* and *Microchæta*. The very remarkable spermathecæ of the latter genus, which are also found in *Brachydrilus*, seem to be against such an identification. His generic definition, created for the inclusion of these two forms, seems to me to be not sufficiently precise.

part I agree with his criticisms. But it must be remembered that it expressed the knowledge of the time, in, as I think, a very satisfactory fashion. I reserve further remarks until after writing down Rosa's scheme, which is as follows:—

Lumbricidæ.

Lumbricus, Eis.[1]
Allolobophora, Eis.
Allurus, Eis.
Tetragonurus, Eis.

Geoscolecidæ.

Geoscolex, Leuck.
Anteus, E. P.
Thamnodrilus, F. E. B.
Microchæta, F. E. B.
Urobenus, Benham.
Urochæta, E. P.
Diachæta, Benham.
Hormogaster, Rosa.
Rhinodrilus, E. P.
Geogenia, Kinb.
Tritogenia, Kinb.

Moniligastridæ.

Moniligaster, E. P.

Acanthodrilidæ.

Acanthodrilus, E. P.
Trigaster, Benham.

Eudrilidæ.

Eudrilus, E. P.
Typhæus, F. E. B.
Microscolex, Rosa.
Photodrilus, Giard.
Pontodrilus, E. P.
Digaster, E. P.
Notoscolex, Fletch.[2]
Didymogaster, Fletch.

[1] Only the generic names printed in "Clarendon" in the author's list are given here.

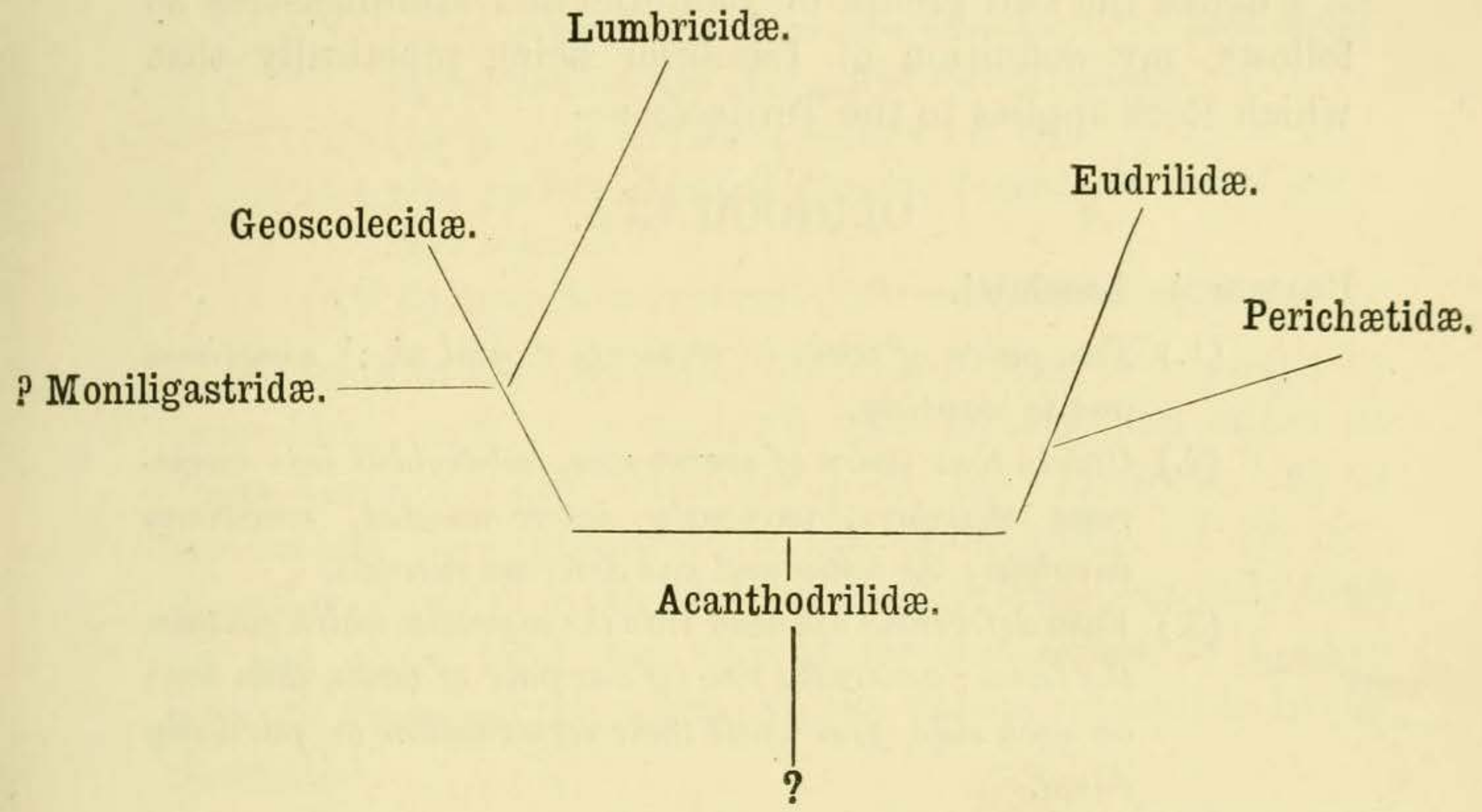
[2] *Notoscolex*, according to Spencer (The Anatomy of *Megascolides australis* —Trans. Roy Soc. Victoria, vol. i., pt. 1), should be replaced by *Megascolides*, M'Coy.

Cryptodrilus, Fletch.
Perissogaster, Fletch.

Perichætidæ.

Megascolex, Templ.
Perichæta, Schm.
Perionyx, E. P.

The classificatory scheme is completed on page 19 by a phylogenetic diagram, which is constructed thus:—



I now propose to examine this scheme in detail, and to give my reasons for objecting to parts of it.

Rosa first of all gives his reasons for regarding *all* earthworms as referable to a single group, Terricolæ, equivalent *not* to a group, Limicolæ, but to *each* of various divisions into which the Limicolæ may be divided, such as Enchytræidæ, Tubificidæ. Dr Rosa does not commit himself, and there is no necessity for his doing so, to the precise definition of these groups. Vejdovsky, on the other hand, regards his families of earthworms, such as Pontodrilidæ, Perichætidæ, as equivalent to families of Limicolæ, such as Phreoryctidæ, Tubificidæ, etc. There is thus an important difference, duly emphasised by Rosa, between his scheme and that of Vejdovsky.

The position that I myself take up in this particular matter is one intermediate between that of the two naturalists. I do not consider it possible to retain a group Terricolæ. I consider that earthworms fall into two groups—(1.) Lumbrici; (2.) Moniligastres—each of which is equivalent to any *one* of the various divisions, such as those enumerated above, into which the aquatic Oligochæta fall. I do not, however, for the present attempt to define what these groups are.

I define the two groups of Lumbrici and Moniligastres as follows, my definition of Lumbrici being practically that which Rosa applies to the Terricolæ:—

OLIGOCHÆTA.

BRANCH A. **Lumbrici.**

(1.) *Two pairs of testes in segments* x. *and* xi.;[1] *sometimes one is wanting.*

(2.) *One to four pairs of sperm sacs, subdivided into numerous chambers, variously interconnected, sometimes involving the testes and vas deferens funnels.*

(3.) *Vasa deferentia opening into the segments which contain the testes; generally two (if one pair of testes, then one) on each side, free until their termination or partially fused.*

(4.) *One pair of ovaries, generally in segment* xiii.[2]

[1] Rosa calls attention to the anomaly in the position of the testes, etc., in *Microchæta*, as recorded by Benham (Studies on Earthworms, No. 1—Q. J. M. S., vol. xxvi., p. 278 *et seq.*). On examining a specimen of this worm (much softened by imperfect preservation) it appeared to me that the funnels of the vasa deferentia were in segments x. and xi. respectively, and not in ix. and x.; and that my original description (On the Anatomy and Systematic Position of a Gigantic Earthworm, etc.—Trans. Zool. Soc., vol. xii., pt. 3) was so far correct. On the other hand, I have satisfied myself that the vasa deferentia open on to the exterior in segment xix., as Benham stated, and *not* on segment xviii., as I stated. Probably, therefore, though I can make no positive statement, the testes are also in x. and xi.

Rosa fixes the position of the testes "contro alla parete anteriore" as distinctive. I have, however, shown that in *Acanthodrilus annectens* they are attached to *hind* wall of segment (*see* On the Anatomy of Three New Species of Earthworms, etc.—Q. J. M. S., vol. xxx.).

[2] One or two exceptions to this statement have been recorded. In *Plutellus* (PERRIER, Étude sur un genre nouveau des Lombriciens (*Plutellus*, E. P.)—

(5.) *One pair of oviducts opening internally into the* xiii*th, externally on to the* xiv*th segment.*

(6.) *One pair* (*rarely two, as in* Perichæta aspergillum) *of egg sacs, minute bodies in segment* xiv.

Branch B. **Moniligastres.**

(1.) *One pair of testes in* ix. *or* x.

(2.) *One pair of sperm sacs in segment* x., *with simple undivided cavity.*

(3.) *Vasa deferentia, one pair opening into* ix*th or* x*th segment* (*according to position of testes*) *internally, and on to intersegmental groove between* x.-xi. *externally, by an atrium like that of the Lumbriculidæ.*

(4.) *One pair of ovaries in segment* xi. (?).

(5.) *One pair of oviducts opening behind the atrial pores into segment* xi.

(6.) *Egg sacs large, extending through several segments.*

It seems to me impossible to regard these two groups as resembling each other so much more closely than either of them resembles any given group of the "Limicolæ" as to necessitate their inclusion in the same group. I do not, however, think it worth while to recapitulate more fully than in the above table my reasons for this belief, as I have already discussed the matter in the papers referred to in the footnote.[1]

Arch. de Zool. Exp., t. i., 1872), the ducts have been stated to open on to the xth segment.

In *Brachydrilus* Benham has stated (Note on a New Earthworm—Zool. Anz., Bd. xi., No. 271) that the ovaries lie in segment xii.—"an unusual position." It is, if no more, a curious coincidence that this should agree exactly with the position of the ovaries in *Microchæta Rappii*, as determined by Benham (Studies on Earthworms, No. 1—Q. J. M. S., vol. xxvi., p. 279) and myself (On the Anatomy and Systematic Position of a Gigantic Earthworm [*Microchæta Rappii*] from the Cape Colony—Trans. Zool. Soc., vol. xii., p. 75), seeing that these genera are allied in other particulars. It is true that both Benham and I myself gave xiii. as the ovarian segment. I myself, however, pointed out later (Descriptions of some new or little known Earthworms, etc.—P. Z. S., 1886, p. 306) that the organ described by us as "ovary" was probably "receptaculum ovorum"—the ovary really lying in segment xii. I have again looked into the matter, and can confirm the above statements with regard to position of ovaries, etc.

[1] For fuller details respecting *Moniligaster*, see my paper On the Structure of a Genus of Oligochæta belonging to the Limicoline Section—Trans. Roy. Soc. Edin., vol. xxxv., and the literature therein cited.

With regard to the subdivisions of the Lumbrici, it is clearly necessary to indicate in the arrangement their probable phylogenetic relationships. This is not indicated by Rosa in his scheme of classification, although he does do so later in his paper in the "Stammbaum," which I have copied into the present communication.

Rosa's classification will doubtless commend itself to many for the reason that it is based upon the total of a large number of characters. If we exclude those which are found in more than one family, we get the following diagnoses of Rosa's families :—

Lumbricidæ—

Male pores in front of clitellum. Gizzard behind sexual organs.

Geoscolecidæ—

Copulatory setæ longer than the others, and of a different form.

Acanthodrilidæ—

Four groups of penial setæ (connected with the four atria).

Eudrilidæ— ?

Perichætidæ—

Setæ very numerous in each segment.

All of these families cannot, as constituted by Rosa, be diagnosed at all. Further research, particularly the discovery of the genus *Deinodrilus* and the species *Perichæta stuarti*, has rendered it at least difficult to distinguish the Perichætidæ and the Acanthodrilidæ.

On the other hand, the Lumbricidæ and Geoscolecidæ appear, so far as we know at present, to be natural families. It is, in fact, necessary, in order to arrive at a tabular expression of the real affinities, to combine some of the groups into larger ones, and to split up others into smaller ones. This is, to a certain extent, done by Rosa in his "Stammbaum."

He places the Acanthodrilidæ quite apart from the others, and at the base of the series.

How far is this justified by our present fuller knowledge of this group and of others ?

Rosa's reasons for regarding the Acanthodrilidæ as the most primitive existing forms are the following:—

(1.) The frequent doubling of the dorsal vessel,[1] which seems, from the observations of Kowalevsky and Vejdovsky, to be a persistent embryonic trait.
(2.) The presence in *A. dissimilis*[2] of two pairs of ovaries corresponding to the two pairs of testes.
(3.) The comparative independence of the two vasa deferentia of each side.
(4.) (This is queried) the presence of 8 nephridia per somite in *A. multiporus.*

As regards (1.) it is undoubtedly true that a good number of species of *Acanthodrilus* (four or five) show the peculiarity mentioned. But this same doubling of the dorsal vessel occurs in *Megascolex cæruleus*[3] and in *Microchæta Rappii*,[4] in *Deinodrilus Benhami*[5] and in *Teleudrilus Ragazzii.*[6] It is, however, more frequent in the Acanthodrilidæ than in other families.

(2.) The rudiment of a second ovary (in segment xii.) seems, from the researches of Bergh,[7] to be so often met with in *Lumbricus*, that I am not disposed to lay much stress upon this character as indicative of the low position of *Acanthodrilus.* Furthermore, I have shown some reasons for thinking that *two* fully developed ovaries are distinctive of *Eudrilus.*[8]

[1] Beddard, On the Specific Characters and Structure of certain New Zealand Earthworms—P. Z. S., 1885, p. 821.

[2] *Ibid.*, p. 828.

[3] Beddard, On the Anatomy and Histology of *Pleurochæta Moseleyi*—Trans. Roy. Soc. Edin., vol. xxx., p. 481.

[4] Beddard, On the Anatomy and Systematic Position of a Gigantic Earthworm from the Cape Colony—Trans. Zool. Soc., vol. xii., p. 70; and Benham, Studies in Earthworms, No. I.—Q. J. M. S., vol. xxvi.

[5] Beddard, On Three New Species of Earthworms, etc.—Q. J. M. S., vol. xxx.

[6] Rosa, Lombrichi delle Scioa—Ann. Mus. Civ. Geneva, ser. 2, vol. vi. (1888), pl. ix., fig. 2.

[7] Geschlechtsorgane der Regenwürmer—Z. wiss. Zool., Bd. xliv., pl. xxi., fig. 10, *s.*

[8] Further Notes upon the Reproductive Organs of *Eudrilus*—Zool. Anz., No. 293 (1888).

(3.) As to the vasa deferentia, it remains to be seen whether there are not two distinct pairs in Bourne's *Perichæta Stuarti*.[1] There are certainly in *Eudrilus*.[2]

(4.) We next come to the nephridia. Rosa, in the course of his remarks, supports my view as to the archaic nature of the excretory system of *A. multiporus*, though evidently with some doubt, as is evinced by the query which precedes his remarks. He concludes these in the following words:—

"Tuttavia bisogna notare que egli considera come ancora più primitiva la disposizione che si ha nell' *A. multiporus* alla parte anteriore del corpo, in cui gli otto canali dei nefridii si ramificano formando un ciclo di pori attorno ad ogni segmento. Il Beddard ritiene che ognuno di questi pori corrispondesse originariamente ad una setola, e perciò che forme primitive avessero un ciclo completo di setole. Ma in tale ipotesi è difficile comprendere come una simile disposizione non si sia trovata in nessuno dei molti Perichetidi che ci son noti."

The suggestion which Rosa quotes in the above passage has been to a large extent confirmed by my discovery of the relations of the nephridia in *Perichæta*.[3]

Deferring for a time the question of the nephridia, it does not seem to me that Rosa's views as to the primitive nature of the Acanthodrilidæ can be regarded as established. They are not so convincing to me as are reasons which will be put forward later for placing *Perichæta* in the position occupied by *Acanthodrilus* in Rosa's scheme.

Turning now to the mutual relationships of the remaining families, we find that Rosa unites the Eudrilidæ and Perichætidæ into one group, and the Geoscolecidæ and Lumbricidæ into another; the Moniligastridæ are doubtfully referred to the latter.

The connection is presumably not regarded as a very close one, seeing that there is no indication of it in the classification on pp. 8-10.

[1] Preliminary Notice of Earthworms from the Nilgiris and Shevaroys—P. Z. S. (1886).

[2] Beddard, Contributions to the Anatomy of Earthworms, etc.—P. Z. S. (1887), p. 372.

[3] On the Presence of Numerous Nephridia, etc.—Q. J. M. S., vol. xxviii.

The first group (that of the Eudrilidæ and Perichætidæ) are affined by the possession of a complete clitellum[1] of a comparatively constant position; the male apertures are either on the 17th or 18th segment, on the hinder part of the clitellum, or upon one of the immediately succeeding segments; the presence of prostates;[2] the presumed absence of typhlosole. The last statement is the only one with which I wish to find fault as being inaccurate, though I desire to point out that Dr Rosa could not be aware of its inaccuracy. As a matter of fact I have found a typhlosole in some species of *Perichæta;* for example, in *P. indica* and *P. affinis.*[3] It is true that in these species the typhlosole is small; but it is not less developed than in such *Acanthodrili* as *A. Nova Zelandiæ.*

The second group (including the Lumbricidæ, Geoscolecidæ, and ?Moniligastridæ) presents the following characters: — A saddle-shaped (incomplete) clitellum, of very variable position and extent; male apertures inconstant in position but always in front of the clitellum, or on the anterior region of the clitellum; no prostates; very general presence of a typhlosole, and (I suppose I may add) absence of penial setæ; presence of only 8 setæ in each segment.

These groups are indeed, as Rosa admits, rather different. The *Acanthodrili*, he thinks, serve to connect them. I append a literal translation of Rosa's view as to this relationship:— "The Acanthodrilidæ have the male pores on the posterior margin of the clitellum, or beyond it; and the clitellum is constituted by a complete girdle, an arrangement which leads to the first group, Eudrilidæ and Perichætidæ. At other times they have the male pores in the median region, or

[1] A "complete" clitellum signifies one in which the glandular substance is developed equally all round the body, instead of only upon the dorsal and lateral regions. As will be seen later (p. 262, footnote), there are reasons, in my opinion, against making any such use of the clitellum in classification.

[2] I prefer to term these structures "atria," in order to fix their identity with the atria in many of the aquatic genera (*Cf.* BEDDARD, On the Structure of Three New Species of Earthworms, etc.—Q. J. M. S., vol. xxix., pt. 2, pp. 117-128.

[3] Contributions to the Anatomy of Earthworms, etc.—Q. J. M. S., vol. xxx., p. 473.

even anterior region, of the clitellum, which is then ventrally incomplete, as, *e.g.*, in *Trigaster Lankesteri.* This arrangement leads to the Geoscolecidæ and Lumbricidæ.

"The Moniligastridæ can, I think, be regarded as modified Geoscolecidæ. The passage between the Geoscolecidæ and the Lumbricidæ is effected by *Criodrilus*, in which the male pores are immediately in front of the clitellum (Benham). According to this way of looking at the matter, the least modified forms of the Perichætidæ will be sought for in *Megascolex*—that is to say, in those Perichætidæ in which the clitellum is not limited to three segments, and in which the setæ still show median intervals. In these forms there are no lateral intestinal cœca, and the nephridia have still the normal form, as I have seen in *Megascolex* (*Perichæta*) *armatus*, Beddard.

"Now it is precisely in *Megascolex* (as thus defined) that bundles of penial setæ are still found, which are wanting in other forms. These are found in *M. armatus*, where they exist in relation to the male pores, and in *Megascolex* (*Perichæta*) *ceylonicus*, Beddard: the latter species would appear, according to Beddard,[1] to possess in front of the usual apertures, two others which lead into a blind tube, which may be regarded as a vestige of the first pair of male openings in the Acanthodrilidæ."

There is an obvious discrepancy here with views expressed on an earlier page. If it be admitted that one of the reasons for regarding the Acanthodrilidæ as the primitive group is the presence of numerous nephridia per somite in *A. multiporus*, it can hardly be said that *Megascolex* (as defined by Rosa) comes nearest to the primitive form *because* it has normal nephridia —that is, one pair per somite! Apparently, however, Dr Rosa was of opinion that the minute nephridia of *Perichæta* (s. str.) were in a degenerate condition, though he quoted (p. 19) Benham's paper, "Studies on Earthworms, pt. i.—Q. J. M. S., vol. xxvi.," in which work Benham refers (at p. 256) to his own and my observations upon *Perichæta*.

[1] Notes on some Earthworms from Ceylon and the Philippine Islands, including a description of two new species—Ann. and Mag. Nat. Hist., ser. 5, vol. 17 (1886), p. 89.

It appears to me, in fact, that **the key to the classification of the group is to be found in the modifications of the excretory system.**

It is obvious that the way in which any group should be classified is that which will indicate its course of development. Clearly, therefore, characters should be chosen which have a relation to lower forms from which the group to be classified has been evolved. Characters peculiar to the group, however much or appropriately they may vary, can only be regarded as of secondary importance. Where, however, it is a question of indicating the affinity of particular species and genera, then characters peculiar to the group are available. Hence it may be perfectly reasonable to sketch the main outlines of a scheme of classification by the modifications of only a single character; and perfectly unreasonable to do so by the use of even a large number of other characters.

It is a common mistake to think that several characters are necessarily better than one.

Now it appears to me that structures like the clitellum, the setæ, the gizzard, and so forth, are so distinctively "Oligochætous," that it is dangerous to *commence* the broad outlines of a classification by using them as diagnostic characters. It seems to me quite conceivable that these characters and others like them may have changed about so greatly during the course of the evolution of the group as to have several times (independently) produced the same result. I do not think, for example, that the Lumbricidæ and Geoscolecidæ are *necessarily* related on account of the *absence* in both of atria and penial setæ, and in the saddle-shaped clitellum. Such a modification may have occurred more than once.

The nephridia, however, are not distinctively Oligochætous structures even in the actual form which they assume in that group.

As long as one species of *Acanthodrilus* (*A. multiporus*)[1] was the only form known with numerous nephridia per segment, it was perfectly legitimate for Eisig to refuse[2] to admit this arrangement as the archaic one. It might readily be supposed, as the Naples zoologist supposed, that the multiplication and interconnection

[1] Beddard, Preliminary Note on the Nephridia of a new Species of Earthworm—Proc. Roy. Soc., June 1885.

[2] Die Capitelliden in Fauna und Flora des Golfes von Neapel.

was the result of the division of an originally single pair of nephridia to each segment. Now, however, numerous genera, including most of those with the largest number of species, have been shown by myself,[1] by Benham,[2] and by Spencer,[3] to possess an excretory system of the same kind. These genera include representatives of three out of six of Rosa's families. As both conditions may occur in the same genera (for example *Acanthodrilus*, *Cryptodrilus*, *Perichæta* [*sensu lato*]), it seems clear that one of the two conditions has been several times independently produced.[4] Thus, after all, it may perhaps be said that Eisig's objections are so far not removed, as there is a simple multiplication of instances. As a question of mere probability it seems to me easier to suppose a reduction than a multiplication of nephridia in a segment, especially as there is at the same time in some genera (in *Perichæta* and *Megascolides* at any rate) a connection between the nephridia not only of the same segment, but also from segment to segment. In these forms, moreover, there is no regularity in the position of the external pores or the cœlomic funnels; they cannot with any approximation to the truth be called "segmental organs." On *a priori* grounds, therefore, the existence of dysmetameric organs in so regularly metameric an animal as an Annelid suggest an inheritance rather than a modification within the group. Another argument for considering the dysmetameric condition as the more primitive is afforded by the genera *Megascolides* and *Acanthodrilus*. In the former genus Spencer[5] has described nephridia opening by numerous ducts into the pharynx; in *A. multiporus* I have myself found[6] that the hinder region of the intestine is furnished with numerous diverticula, which become continuous with tubes indistinguishable from the ordinary nephridia. Now it is more

[1] Preliminary Note on the Nephridia of *Perichæta*—Proc. Roy. Soc., vol. xliii., p. 309. The Nephridia of Earthworms—Nature, vol. xxxviii., p. 221 (1887). On the Presence of Numerous Nephridia, etc.—Q. J. M. S., vol. xxviii., p. 397. On certain Points in the Structure of *Urochæta*, etc.—*Ibid.*, vol. xxix., p. 235. On the Structure of Three New Species of Earthworms, etc.—*Ibid.*, vol. xxix., p. 101.

[2] Studies in Earthworms, No. I.—Q. J. M. S., vol. xxvi., p. 213.

[3] The Nephridia of Earthworms—Nature, vol. xxxviii., p. 221; The Anatomy of *Megascolides australis*—Trans. Roy. Soc. Vict., vol. i., No. 1.

[4] The following have or may have "diffuse" nephridia:—*Perichæta* (and its subdivisions), *Cryptodrilus*, *Megascolides*, *Digaster*, *Didymogaster*, *Dichogaster*, *Acanthodrilus*, *Trigaster*, *Typhæus*, *Deodrilus*, *Deinodrilus*. They include one-half of the known species. There are 19 genera in which the nephridia are always paired.

[5] *Loc. cit.*, pl. iii., fig. 10.

[6] On the possible Origin of the Malpighian Tubules in Arthropods—Ann. and Mag. Nat. Hist., 1889, p. 290.

than probable that the anterior and posterior gut regions into which these nephridia open are stomodæum and proctodæum respectively, *i.e.*, epidermic involutions. Hence the existence of numerous nephridial pores may be regarded as having been established before the involution of epiblast to form the two extremities of the digestive tract. A secondary connection seems more unlikely.

It seems therefore permissible to regard these facts as strengthening the justice of the view that the diffuse or dysmetameric nephridia are the most ancient form of these organs; and, if so, they show a decided resemblance to the excretory system of the Planarians, some of which worms appear to me to represent, more nearly than any other living group, the ancestors of the Oligochæta.

This being so, I would associate together all those earthworms which have a nephridial system built upon the Platyhelminth type into one group, on the assumption that the character in which they agree must be a mark of affinity.

This group will include three of Rosa's families, viz.:—Perichætidæ, Acanthodrilidæ, and Eudrilidæ; and I term it—

Group I. ACANTHODRILINI.[1]

Definition.—*Earthworms generally with a diffuse (dysmetameric) nephridial system; always provided with atria which are either tubular or lobate; often provided with penial setæ. Clitellum commencing in the* xii*th or* xiii*th segment, and of variable extent. Male generative pores on* xvii*th or* xviii*th segment. Spermathecæ always (?) furnished with diverticula.*

This group is divisible into the following families:—

1. Family **Perichætidæ.**

Definition.—*Earthworms with numerous setæ per segment arranged in a continuous ring, sometimes with dorsal and ventral gaps,* 20 *to* 100 *in number. Nephridia nearly always diffuse. Atria lobate or (rarely) tubular; penia setæ generally absent.*

[1] Exception may be taken to this name, particularly as I regard the Perichætidæ as the typical family. I adopt it, however, for the reason that the diffuse nephridia were first made known in *Acanthodrilus*, and that the name may be taken to express the fact that the majority of its members have penial setæ. This led Perrier to apply the name *Acanthodrilus* to the genus.

Genera—*Perichæta* (including *Megascolex* as a sub-genus); *Perionyx*, E. P.; *Diporochæta*, F. E. B.; *Anisochæta*, F. E. B.; *Hoplochæta*, F. E. B.[1]

2. Family **Cryptodrilidæ.**

Setæ 8 *in number per segment, paired or distant. Nephridia diffuse or paired—if paired, symmetrical or alternate. Atria tubular or lobate; penial setæ present or absent.*

Genera—*Cryptodrilus*, Fletcher; *Megascolides*, M'Coy; *Digaster*, E. P.; *Didymogaster*, Fletch.; *Dichogaster*, F. E. B.; *? Plutellus*, E. P.; *Perissogaster*, Fletch.; *Microscolex*, Rosa; *Photodrilus*, Giard; *Pontodrilus*, E. P.; *Rhododrilus*, F. E. B.; *Pygmæodrilus*, Mich.; *Eudriloides*, Mich.; *Callidrilus*, Mich.

3. Family **Deinodrilidæ.**

Setæ 12 *in number per segment. Clitellum occupying three segments* (xiv.-xvi.); *atria two pairs of tubular glands opening on to* xvii. *and* xix.; *male generative pores on* xviii. *Penial setæ present; nephridia diffuse.*

Genus—*Deinodrilus.*

4. Family **Acanthodrilidæ.**

Setæ 8 *in number per segment, paired or distant. Clitellum occupying* 4 *to* 7 *segments,* xii. (xiii.)–xviii. (xix.); *atria and vasa deferentia as in Deinodrilidæ. Penial setæ usually present; nephridia diffuse or paired—if paired, regular or alternate.*

Genera—*Acanthodrilus*,[2] *Trigaster.* (*Clitellum exceptionally extended.*)

[1] These genera, which are very different from those into which the family is usually divided, are defined in my paper (Observations upon an American Species of *Perichæta*, and upon some other Members of the Genus—P. Z. S., 1890, pt. ii.) upon this family. Vaillant (Histoire des Annelés, etc., p. 63) divides *Perichæta* into no less than eight sub-genera, but on the variations of characters, which I do not agree with him in regarding as very important. Among these are Kinberg's five genera—*Nitocris*, *Amyntas*, *Pheretima*, *Lampito*, and *Rhodopis*, which I had hoped had been finally laid to rest.

[2] Michaelsen (Oligochæten des naturhistorischen Museums in Hamburg 1, JB. Hamb. wiss. Anst., vi., 1889) has proposed to separate as a distinct genus *Benhamia* those Acanthodrili with more than one gizzard with diffuse nephridia and an "incomplete" clitellum extending beyond male pores. It will include *Trigaster*. In a later paper (Beschreibung der von Herrn Dr F. Stuhlmann im Mündungsgebiet des Sambesi, etc., *id.*, Bd. vii., 1890) this

Observations.—Apart altogether from the nephridia, it is necessary to include these families in one group: they are in every case so closely connected. The more typical Perichætidæ seem sharply marked off from any others, but *Deinodrilus* is an almost exactly intermediate form between *Perichæta* and *Acanthodrilus*. It has more than eight setæ in each segment, and a clitellum like that of *Perichæta*. The male reproductive apparatus is like that of *Acanthodrilus*, but in *P. stuarti* of Bourne[1]—a form which I have ventured to distinguish generically—we have also *four tubular* atria. Moreover, in *Perichæta ceylonica*,[2] there are indications of an approach to *Acanthodrilus*, though that species requires further investigation.

With regard to the Cryptodrilidæ,[3] such a form as *Pontodrilus* is very distinct from *Perichæta*, and in the absence of any knowledge of intermediate forms would have to be separated into a very distinct family. This has been done by Vejdovsky;[4] but, at the time when he wrote, the two genera *Microscolex* and *Photodrilus*, as well as the Australian genera described by Fletcher,[5] were unknown. These form collectively a family, which is chiefly defined, however, by negative characters. I exclude from this

separation is still adhered to, but the presence of more than one gizzard is dropped out as a part of the definition. It appears to me also necessary to omit the characters of the clitellum as a definition, since in *Acanthodrilus annectens*—a species with *paired* nephridia—the clitellum extends beyond segment xix. It may be useful, however, to adopt Dr Michaelsen's separation of *Acanthodrili* with diffuse nephridia into a distinct genus, as the genus is even now getting inconveniently large.

[1] Preliminary Notes on Indian Earthworms—pt. i. : On Earthworms from the Shevaroys and Nilgiris (Proc. Zool. Soc., 1886).

[2] Notes on some Earthworms from Ceylon and the Philippine Islands, including a description of two new species—Ann. and Mag. Nat. Hist., 1886, p. 89.

[3] I name this family Cryptodrilidæ, though on the grounds of priority it ought to be called Megascolididæ; after the recent discussion in *Nature* (Feb. 13, 1890) about the correct writing of terms borrowed from the Greek, I have not the courage to introduce so awkward a term, and therefore fall back upon Cryptodrilidæ. This word has the advantage of being pronounceable, and in calling attention to the fact that *Cryptodrilus* is the most prominent genus of the family.

[4] *Loc. cit.* (on p. 238).

[5] Notes on Australian Earthworms—Proc. Linn. Soc. N.S.W., 1886-88.

family *Eudrilus* and *Teleudrilus*, about which something will be said presently. This family is, however, closely connected with the Perichætidæ, through the remarkable genus *Anisochæta* made known by Fletcher. In this form, which I regard as distinct from *Perichæta*, the setæ of the first few anterior segments are eight in number in each segment; afterwards they increase until the normal "perichætous" condition is reached. This genus connects the two families in the only direction in which any connection is at all necessary. Apart from the setæ, it is absolutely impossible to draw any line, however slender, between the Cryptodrilidæ and Perichætidæ.

My family Cryptodrilidæ does not include *Eudrilus* and the genus *Teleudrilus*, quite recently described by Rosa,[1] and, as I think, for good reasons.

These two genera are unique among Earthworms (1.) in the structure of the female efferent apparatus; (2.) in the structure of the male efferent ducts. There are also a number of smaller points in which they differ from any of the Cryptodrilidæ.

The two vasa deferentia of each side are separate up to their point of opening, a character hitherto confined to the Deinodrilidæ and Acanthodrilidæ (? as to *Hoplochæta Stuarti* and *Megascolex ceylonicus*); they open into the upper end of a structure obviously identical with the atrium of other forms, though differing in many details of structure. In no other case is there a connection between the vasa deferentia and the *upper* end of atrium, except in *Moniligaster* (which I have already seen reasons for referring to a distinct group, equal to that which includes all other earthworms). These atria are connected with a terminal apparatus of a remarkable nature, which has its nearest analogue in the Tubificidæ.[2]

[1] Lombrichi dello Scioa—Ann. Mus. Civ. Geneva, ser. 2, vol. vi. (1888), p. 571.

[2] All these points are more fully treated of in the following papers by myself:—The Reproductive Organs in the genus *Eudrilus*—Proc. Roy. Soc. Edin., vol. xiii., p. 672; Descriptions of some new or little known Earthworms, etc.—Proc. Zool. Soc., 1886, p. 302; Notes on the Ovaries and Oviducts of *Eudrilus*—Zool. Anz., No. 224, 1886; Contributions to the Anatomy of Earthworms—No. 1: On the Structure of *Eudrilus sylvicola* (Proc. Zool. Soc., 1887, p. 372); Further Notes upon the Reproductive Organs of *Eudrilus*—Zool. Anz., No. 293, 1888.

The female apparatus is unique by reason of the fact that the oviducts are highly muscular tubes, that they are continuous with the ovaries, and that the spermathecæ are diverticula of them. The ova themselves have a somewhat peculiar structure and history.[1]

Teleudrilus is less peculiar than *Eudrilus.*

The minor peculiarities to which I have referred are (1.) the presence of peculiar bodies in the epidermis, possibly identical in their nature with certain problematical structures in *Urochæta* ;[2] (2.) the presence of unpaired calciferous glands, as well as paired ones, lying beneath the œsophagus. It is only by omitting to notice these peculiarities that Rosa has *forced* this genus into his family Eudrilidæ (=my Cryptodrilidæ *minus Eudrilus* and *Teleudrilus*).

It does not appear to me possible to include these two genera in my group Acanthodrilini at all; they are evidently isolated types, whose affinities at present cannot be regarded as certain.[3]

In the meantime, pending the discovery of intermediate forms, I put them in a group by themselves, which will be defined as follows:—

Group II. EUDRILINI.

Definition.—*Earthworms with regularly paired nephridia, furnished with atria and a terminal copulatory apparatus of a peculiar nature. Oviducts continuous with the ovaries, and opening generally in common with the spermathecæ.*

[1] On the Structure and Development of the Ovum in an Annelid (*Eudrilus*) —Jour. Anat. Phys., vol. xxii., p. 9.

[2] PERRIER, Arch. Zool. Exp., t. iii., 1874, p. 331.

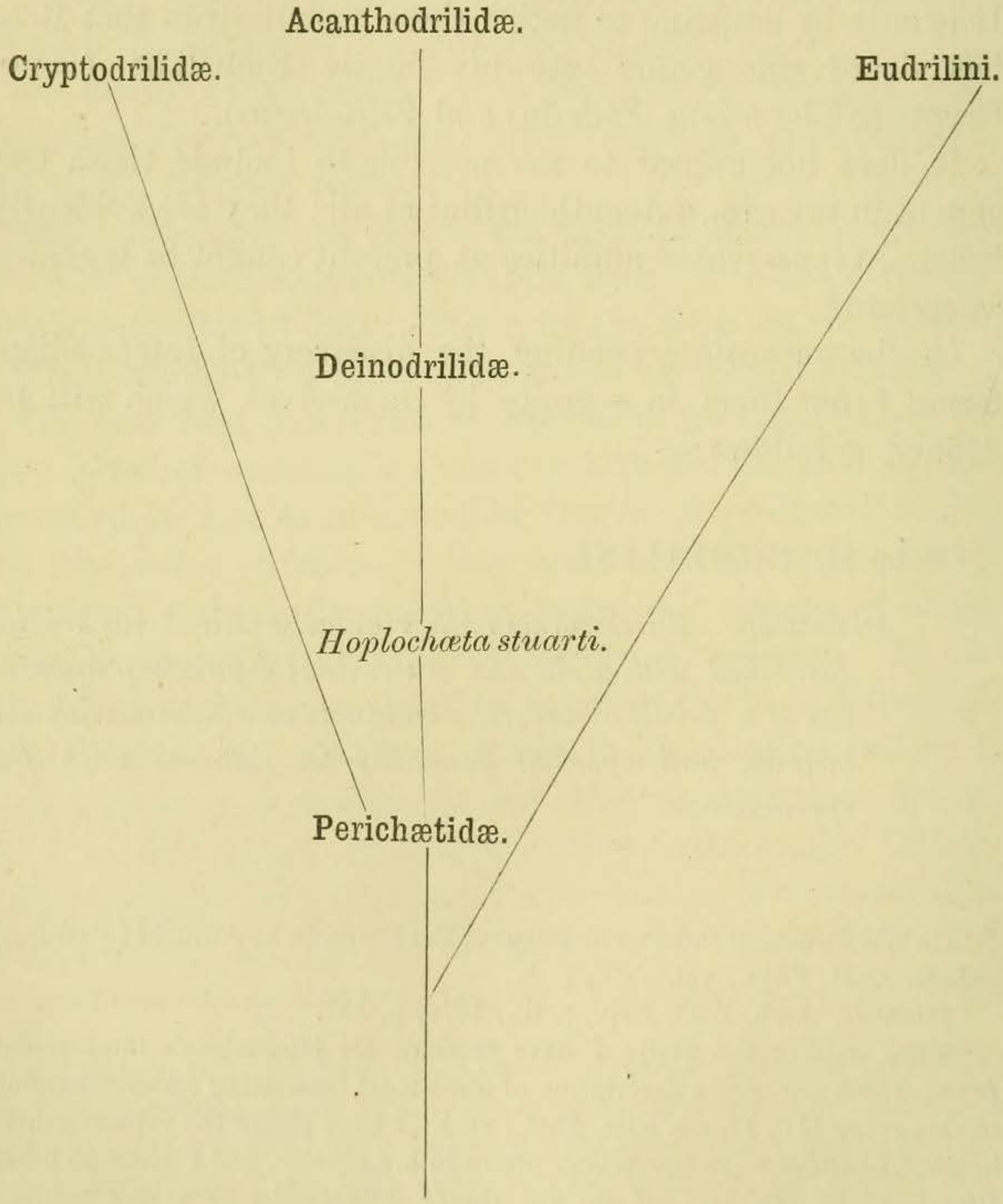
[3] Since writing the above I have received Dr Michaelsen's most recent paper, which contains a description of some most interesting forms belonging to this group (JB. Hamb. wiss. Anst., vii.). I have placed the various genera in what I believe to be the proper places in my scheme, but I make no other alterations in the text. I do not regard *Eudriloides* as a link between Eudrilini and Cryptodrilidæ, although its single unpaired spermatheca is in the ovarian segment. This peculiarity is met with among the Geoscolecini.

1. Family **Eudrilidæ.**[1]

Male apertures single or paired on xviith *segment. Clitellum occupying segments* xiii.–xvii. ; *both oviducts and sperm ducts with a muscular coat.*

Genera—*Eudrilus*, *Teleudrilus*, *Nemertodrilus*, *Polytoreutus*, *Stuhlmannia*.

The mutual relationships of the Acanthodrilini are, I think, fairly clear from what has been seen on the last page. I should regard the following scheme as indicative of their affinities :—



[1] These definitions can, of course, only be regarded as a preliminary attempt. I make no serious effort to decide which are *probably* of family value and which distinguish the group.

I include the Eudrilini in this table, deriving them from a very primitive stock, of which, however, I consider that they are greatly modified members. I do this chiefly on account of the reproductive organs, which show resemblances to those of Leeches and Platyhelminths.

I regard the Perichætidæ as the most archaic family, not wholly on account of the nephridial system, for in *Megascolides* at any rate, if not in other Cryptodrilidæ, the nephridial system is nearly equally archaic. But it will be noticed, from a consideration of the facts of the case, that the connection between the different forms is rather easier if we derive all from *Perichæta*. Moreover, the complete circle of setæ of *Perichæta*, as well as their wide distribution, is a point to be urged in favour of their archaic nature. These matters are more fully discussed in a paper communicated to the Zoological Society of London in January of this year.

We now come to the more difficult task of classifying the remaining earthworms. It is more difficult, because fewer forms are known, and many of these are very imperfectly known, *e.g.*, *Anteus* and *Geoscolex*.

We may clear the ground by at once admitting the naturalness of the family Lumbricidæ, which, as Rosa says, is generally accepted. I should have regarded them, not as a family equivalent to, for example, the Cryptodrilidæ, but as a group corresponding to that of the Acanthodrilini.

Group III. LUMBRICINI.

Definition.—*Earthworms with a paired series of nephridia never furnished with atria or penial setæ. The setæ on clitellum differing from the others by their greater length. Clitellum commencing not earlier than the 22d segment, and occupying* 7-10 *segments. Male pores upon segment* 12, 13, *or* 15. *Gizzard at commencement of intestine; setæ* 8 *in each segment, f-shaped and not ornamented.*

Family **Lumbricidæ.**

(With the characters of the group.)

Genera—*Lumbricus*, L.; *Allolobophora*, Eis.; *Allurus*, Eis.; *Tetragonurus*, Eis.

Observation.—I am doubtful at present about *Criodrilus.* The structure of this worm has been investigated by Vejdovsky,[1] Rosa,[2] Oerley,[3] Benham,[4] and Collin.[5]

Is Rosa's group of the Geoscolecidæ a natural one? It is thus defined by him:—"Male pores within the clitellum between the dorsal and ventral setæ, occupying segments, or intersegmental spaces, very variable in position. Clitellum usually saddle-shaped, varying in length and position. Setæ 8 per segment, disposed in pairs, or distant, or in different arrangements, often varying in the anterior and posterior segments. Copulatory setæ longer than the others, and of a different form. The gizzard (or gizzards) placed anteriorly. Sperm sacs one or two pairs. No prostates or penial setæ."

The following tabular scheme indicates the chief structural points which characterise the ten genera about which alone we have any anatomical knowledge. Rosa refers Kinberg's genera[6]—*Geogenia*, *Tritogenia*, and *Eurydame*, besides Schmarda's[7] *Pontoscolex*—to this group.

[1] System und Morphologie der Oligochæten. Prag, 1884, *passim.*

[2] Sul *Criodrilus lacuum* Studio Zoologico ed Anatomico—Mem. R. Acc. Sci. Torino, ser. 2, t. xxxviii. (1887).

[3] Morphological and Biological Observations on *Criodrilus lacuum*—Q. J. M. S., vol. xxvii. (1887), p. 551.

[4] Studies on Earthworms—III. *Criodrilus lacuum*, Hoffmeister (Q. J. M. S., vol. xxvii., 1887, p. 561).

[5] *Criodrilus lacuum*—Zeitschr. wiss. Zool., Bd. xlvi. (1888).

[6] Annulata nova—Œfv. af K. Vet. Akad. Förh. (1866).

[7] Neue Wirbellose Thiere gesammelt auf einer Reise um die Erde, vol. ii. (1861), p. 11.

	Setæ.	*Clitellar setæ.*	*Clitellum.*	*Prostomium*	*Male pores.*	*Testes.*	*Sperm sacs.*	*Nephridia.*	*Gizzard*	*Calc. glands.*	*Spermathecæ.*	*Dorsal pores.*	*Other Structures.*
Urochæta.	Paired in front; afterwards irregular; bifid at tip.	Ornamented	16–22; saddle-shaped.	O	19/20	One pair in 11.	One long pair.	*Mucous glands* opening on to 2d, paired nephridia from 4th segment with sphincter.	One in 6.	Three pairs in 6, 7, 8.	Three pairs in 7, 8, 9.	O	....
Microchæta.	Paired; anterior ventral setæ modified.	Unornamented.	10–23, or 13–25; saddle-shaped.	+	19	Two pairs in 9, 10, or one pair in 9.	Two pairs in 10, 11, or one in 10.	Anterior set differing in structure from posterior.	One in 6.	One pair in 9, or two in 8, 9.	Several minute pouches in 12, 13, 14, 15, or in 11, 12.	O	Ovaries in 12. (?)
Brachydrilus.	Paired.	Unornamented.	? 16–21.	+	18	Two pairs in 10, 11.	Two pairs in 10, 11.	Two pairs in each segment.	One in 6 or 7.	Two pairs in 8, 9.	Several minute pouches in 11	O	Ovaries in 12. (?)
Diachæta.	Irregular from the first.	Unornamented.	20–33; continuous.	O	22	? in 11.	One pair of long sacs.	Mucous gland; paired nephridia	One in 6.	O	Three pairs in 6, 7, 8.	O	....
Onychochæta.[1]	Irregular from the first; very varied in form; three kinds.	Ornamented	?	O	?	Two pairs in 10, 11.	Two pairs of sacs.	Mucous gland; nephridia with sphincter.	One in 6.	One pair.	Three pairs in 6, 7, 8.	O	....
Rhinodrilus.	Setæ paired; ornamented.	More marked in their ornamentation.	Saddle-shaped; 20–27, or 15–25, or 19–21.	Long.	19/20, or 26 or 18.	Two pairs in 10, 11.	Two in 12,13; (? in 11, 12).	Anterior set of nephridia differ from posterior.	One in 10–12.	Six pairs.	One or three pairs in 6, 7, 8.	O	Penial setæ as in *Photodrilus* occur in *Rh. tenkatei.*
Urobenus.	Paired.	Slightly different.	Saddle-shaped; 14–25.	+	20	Two pairs in 10, 11.	Two pairs in 12, 13, and 14.	Anterior set of nephridia differ.	One in 8.	Three pairs in 9, 10, 11.	Three pairs in 7, 8, 9.	?	Intestinal cœca as in *Perichæta*; posterior glands as in *Urochæta.*
Hormogaster.	Dorsal paired; ventral distant.	Slightly different.	Saddle-shaped; 15–25.	+	15/16	Two in 10,11.	Two pairs in 11, 12.	Paired.	Three in 6, 7, 8.	O	Three pairs in 10, 11, 12.	O	....
Glyphidrilus.	Distant.	?	23–32.	?	27/28	?	?	?	?	?	?	?	....
Geoscolex.	Distant and paired.	?	Saddle-shaped; 14–23.	+	18/19	....	One long pair.	Paired.	Present.	?	?	O	....
Anteus.	Paired.	?	Saddle-shaped; 15–29.	+	?	?	?	Paired.	Present.	?	One pair in 7.	O	....

[1] I describe this form, which I believe to be generically distinct, as a species of *Diachæta* in a forthcoming number of the "Quarterly Journal of Microscopical Science."

It results from the above table that our knowledge of this group is still very incomplete. There are many gaps which require filling up. There appear to be, however, a number of characters in which *all* the genera agree, many of which have been already mentioned by Rosa. These are as follows:—

(1.) Paired nephridia.
(2.) Absence of atria and of penial setæ.[1]
(3.) Spermathecæ without diverticula.
? (4.) Absence of dorsal pores.
(5.) Gizzard (or Gizzards) anterior in position.
(6.) Generative pores within the clitellum.

Considered individually these characters are not, perhaps, very important. There seem to me to be no good reasons why any one of them should not have been independently acquired more than once.

Seeing, however, that they occur in all of a number of genera, which are also interconnected in other ways, it is, in my opinion, necessary for the present to retain this group, which I term

Group IV. GEOSCOLECINI.

Definition.—*Earthworms with paired nephridia; never furnished with atria or penial setæ (? Rhinodrilus). Clitellar setæ often modified; spermathecæ without diverticula. No dorsal pores. Gizzard (or gizzards) anterior in position. Setæ* 8 *in each segment, paired or distant, or irregular in their arrangement. Male pores within the clitellum.*

The differences between the genera which make up this

[1] Horst has described (Descriptions of Earthworms, I.—Notes Leyd. Mus., 1887, p. 101) in *Rhinodrilus tenkatei* the remarkable fact that "the ventral setæ of the 17th, 18th, and 19th segments were replaced by a fascicle of four bristles." This is suggestive of the persistence (and multiplication) of penial setæ, and appears in any case to be a particular point of resemblance to *Photodrilus*, in which worm Giard (Sur un nouveau genre de Lombriciens phosphorescents, etc.—Comptes Rendus, Nov. 7, 1887) has recorded similar structures.

group are so great, that it is requisite to divide it into several families.

1. Family **Urochætidæ.**

Setæ irregular in distribution either throughout the whole body or after the first 10 *segments or so. Prostomium absent. Spermathecæ, three pairs. Calciferous glands, three pairs. Nephridia with sphincter.*[1] *A mucous gland present, being* 1st *nephridium.*

Genera—*Urochæta*, E. P.; *Diachæta*, Benham; *Onychochæta*, F. E. B.

2. Family **Geoscolecidæ.**

Setæ paired or distant (both conditions occurring in the same species); prostomium present. Nephridia all alike.

Genera—*Geoscolex*, Leuck.; *Hormogaster*, Rosa; *? Glyphidrilus*,[2] Horst.

3. Family **Rhinodrilidæ.**

Setæ paired or distant. Anterior set of nephridia different from posterior.

Genera—*Microchæta*, F. E. B.; *Brachydrilus*, Benham; *Urobenus*, Benham; *Rhinodrilus*, E. P.; *? Anteus*, E. P.[3]

I do not regard these families as in any way so satisfactory as those of the Acanthrodrilini.

The Urochætidæ is perhaps the best and most natural. I am quite prepared to admit that the two last might possibly be with advantage broken up still further.

[1] I apply this name to the little muscular cup first described by Perrier, *loc. cit.* (on p. 255), which surrounds the extremity of the muscular sac of the nephridium.

[2] At present our knowledge of this evidently very interesting form is confined to the briefest of abstracts given in the Procès Verbal of the Dutch Zoological Society (Nederl. Dierh. Ver. Verslag der Vergadering vam 26 October 1889, p. 1).

[3] I have already pointed out (On the Structure of a new Genus of Lumbricidæ, *Thamnodrilus Gulielmi*—P. Z. S., 1887, p. 154) the resemblances between *Anteus* and *Rhinodrilus*. I should not be at all surprised to learn that they are congeneric.

Rosa regards his *family* Geoscolecidæ (=my *group* Geoscolecini) as being more nearly related to the Lumbricidæ than to any of the other groups. *Criodrilus*, according to him, is the connecting link. The Acanthodrilidæ he thinks bring them into relations with other forms. Some Acanthodrilidæ have a complete clitellum; these lead to the *Perichætidæ*. In others, as in *Trigaster Lankesteri*, the clitellum is ventrally incomplete; this leads to the Geoscolecidæ and Lumbricidæ. It seems to me that Rosa lays too much stress upon the form of the clitellum,[1] as of classificatory value; a strict adherence to the principle laid down by him would necessitate the removal of *Diachæta* from the Geoscolecidæ; for in this genus, as Benham informs us, the clitellum "completely surrounds the body as in *Perichæta*, *Digaster*, etc."

The entire group **Geoscolecini** is, in fact, intermediate in its characters between the **Acanthodrilini** and the **Lumbricini**, but its relations with the Acanthodrilini are not, I believe, with the family Acanthodrilidæ, but rather with the Cryptodrilidæ. The satisfactory definition of this group and of the Lumbricini is rendered difficult by the fact of its intermediate character; it shades off at one end into the Cryptodrilidæ, and at the other into the Lumbricidæ.

One of the characteristic features of the group (which it shares with the Lumbricini) is the modification of the clitellar setæ, and also the fact that these and sometimes the setæ elsewhere are ornamented. Among the Acanthodrilidæ nothing of the kind has as yet been described; but among other families of the Acanthodrilini such variations in the

[1] The purely saddle-shaped clitellum of the Lumbricidæ (*cf.* Rosa, I lumbricidi del Piemonte, Torino, 1884, figs. 1, 4, and 5) is so far modified in such Geoscolecidæ as *Rhinodrilus* (*cf.* Beddard, On the Structure of a new Genus of Lumbricidæ, *Thamnodrilus Gulielmi*—P. Z. S., 1887, fig. 1, p. 155, fig. 2, p. 157), that the anterior part has a much narrower ventral gland-free area than the posterior part. The next stage, which is exemplified not only in *Acanthodrilus*, but in such "Eudrilidæ" as *Deodrilus*, shows an entire disappearance of the ventral non-glandular area in front, but a broad non-glandular tract is still left behind. Finally, we have the "complete" clitellium of *Perionyx*, etc. Apart altogether from classificatory difficulties which are involved if the modifications of the clitellum, as used by Rosa, are retained, it is impossible to say where the line is to be drawn. The clitellum of *Urochæta* and *Rhinodrilus* appears to be exactly intermediate between those of *Lumbricus* and *Acanthodrilus*.

form of the setæ are occasionally, although not very commonly, met with. In *Perichæta Houlleti* the clitellar setæ are very distinctly different in form from the rest.[1] But the most striking resemblance is shown by *Deodrilus*,[2] in which all the setæ of the body are ornamented, though in a way rather different from that of *Rhinodrilus* and other Geoscolecine genera. It is remarkable also that among the Cryptodrilidæ only—in the genera *Deodrilus* and *Typhæus*—has the prostomium disappeared:[3] this is a character which distinguishes no less than three genera of Geoscolecini—viz., *Urochæta*, *Diachæta*, and *Onychochæta*—and is unknown elsewhere.

If the characters of the clitellum are by any one considered necessary, then *Deodrilus* fulfils the required conditions; for, as I hope to point out later, the clitellum is constructed on a plan which is exactly that of *Acanthodrilus*.[4] The presence of atria is one of the distinguishing features of the Acanthodrilini, being, without any exception, universal in that group. Is it not possible that the so-called atria of *Criodrilus*[5] and *Geoscolex*[6] may represent these same structures in course of degeneration[7]? Unfortunately we have no histological

[1] Beddard, Contributions to the Anatomy of Earthworms—No. III. Note on the Genital Setæ of *Perichæta Houlleti* (P. Z. S., 1887, p. 389). The woodcut illustrating those setæ is not so good as it might be.

[2] A description of this genus, which is a native of Ceylon, will appear in a forthcoming number of the "Quarterly Journal of Microscopical Science."

[3] I have not myself been able to find a prostomium in this genus; but I may possibly have failed to see one, since Bourne (On certain Earthworms from Western Himalayas, etc., J. A. S. B., vol. lviii., p. 110) has lately described and figured a prostomium, capable of being largely retracted in a new species of the genus *T. Masoni*.

[4] *Trigaster Lankesteri* (Benham, Studies on Earthworms, No. II.—Q. J. M. S., vol. xxvii.) has been regarded by Rosa as having an incomplete clitellum. Benham is not perfectly precise upon this point in his paper, but he has informed me since, that in front of the generative pores, as in other Acanthodrilidæ, the clitellum is complete.

[5] Rosa, *loc. cit.* (on p. 258), p. 12, fig. 8, *atr*.

[6] Perrier, Mém. pour servir à l'histoire, etc., *loc. cit.* (on p. 236).

[7] Michaelsen's *Callidrilus* appears also to be a connecting link between the Cryptodrilidæ and Geoscolecini; its general organisation conforms to that of the former group, but it has, as in *Microchæta*, numerous minute spermathecæ in segment xiii. This is one of those facts which point to the Geoscolecini being a composite group derived from several stocks.

data with regard to these structures, which seem also to exist in *Brachydrilus*.[1]

I have already pointed out that in *Allurus*,[2] the structure termed atrium by Rosa,[3] and therefore in all probability the similarly termed structure in *Allolobophora* is really hardly comparable to the atrium in any Acanthodrilini. It consists merely of a thickening of the body wall, or rather of the epidermis only, at the point of opening of the vasa deferentia, similar in structure to the clitellum. This modification may, however, conceivably be a last trace of an atrium; it remains to be seen what is the structure of that of *Geoscolex*, etc.

All these reasons lead to the inference that the Geoscolecini are connected with the Acanthodrilini, and, as it appears to me, more nearly to the Cryptodrilidæ than to any other family. But the fact that most of the genera of Geoscolecini are much specialised in various directions, renders it difficult to say which are the more centralised forms. No genus, to my mind, can claim to be nearer to the base of the series than any other. As to their connection with the Lumbricini, that appears to be as Rosa has suggested, through *Criodrilus* and *Hormogaster*.[4] The clitellum of *Glyphidrilus* in its position and extent approaches that of the Lumbricidæ.

I conclude this part of my paper with a recapitulation of the groups and families, and with a "Stammbaum," which

[1] Benham says of this worm (Note on a new Earthworm—Zool. Anz., No. 271, 1888):—"There is no 'prostate' or glandular diverticulum of the distal end of the sperm duct; but on each side is a very large muscular (? glandular also) 'atrium,' as in *Criodrilus* and *Titanus*: this occupies about six somites (xv. to xx.), and is doubtless due, in part at least, to the contracted condition of the worm, causing the dorsal wall of the above-mentioned fossa to project inwards."

[2] On the Anatomy of *Allurus tetraedrus* (Eisen)—Q. J. M. S., vol. xxviii., p. 365.

[3] I lombrichi del Piemonte, Torino, 1884, p. 52. The species of *Allolobophora* in which the presence of an atrium is specially mentioned are *A. profuga*, *A. minima*, *A. subrubicunda*, *A. chlorotica*, *A. mucosa*, *A. turgida*, *A. alpina*, *A. fœtida*, in fact nearly all. It is also found in *Lumbricus melibœus* and *L. herculeus*. In later papers its presence is mentioned in other species.

[4] Rosa, Sulla Struttura dello *Hormogaster Redii*—Mem. R. Acc. Torino, ser. ii., t. xxxix.

seems to me to best express their mutual relationships in the light of our present knowledge.

BRANCH A—*MONILIGASTRES.*

BRANCH B—*LUMBRICI.*

Group I.—EUDRILINI.

Fam. **Eudrilidæ.**

Genera — *Eudrilus, Teleudrilus, Nemertodrilus, Polytoreutus, Stuhlmannia.*

Group II.—ACANTHODRILINI.

Fam. 1. **Perichætidæ.**

Genera—*Perichæta, Megascolex, Hoplochæta, Anisochæta, Aporochæta, Perionyx.*

Fam. 2. **Deinodrilidæ.**

Genus—*Deinodrilus.*

Fam. 3. **Acanthodrilidæ.**

Genera—*Acanthodrilus, Trigaster, Benhamia.*

Fam. 4. **Cryptodrilidæ.**

Genera—*Cryptodrilus, Megascolides, ? Plutellus, Digaster, Didymogaster, Dichogaster, Perissogaster, Microscolex, Photodrilus, Pontodrilus, Rhododrilus, Typhæus, Deodrilus, Eudriloides, Callidrilus, Pygmæodrilus.*

Group III.—GEOSCOLECINI.

Fam. 1. **Urochætidæ.**

Genera—*Urochæta, Diachæta, Onychochæta.*

Fam. 2. **Geoscolecidæ.**

Genera—*Geoscolex, Hormogaster, ? Glyphidrilus.*

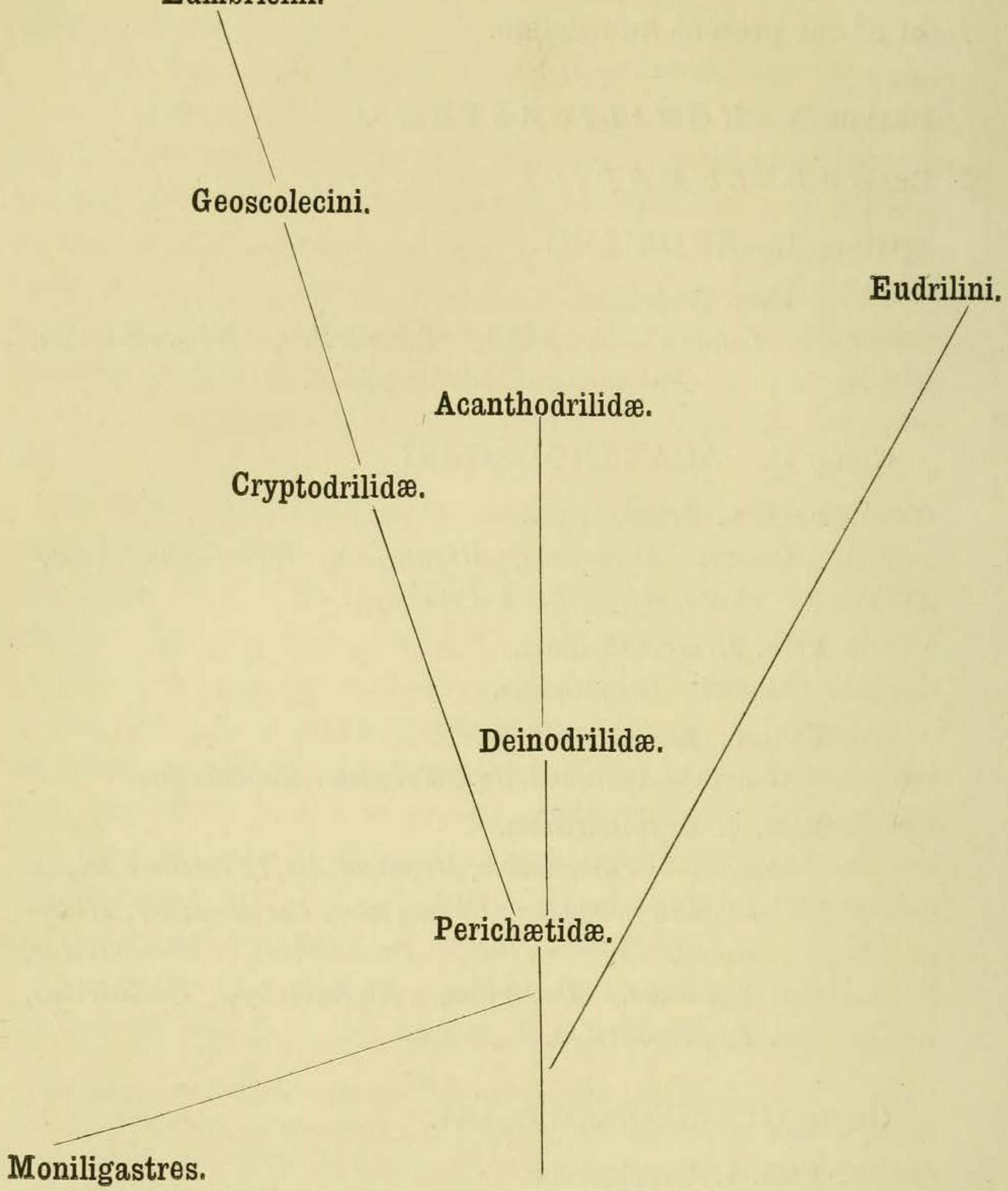
Fam. 3. **Rhinodrilidæ.**

Genera — *Rhinodrilus, Microchæta, Brachydrilus, Urobenus, ? Anteus.*

Group IV.—LUMBRICINI.

Fam. **Lumbricidæ.**

Genera—*Lumbricus, Allolobophora, Allurus, Tetragonurus.*



Part II.—Distribution.

There has been no general account given of the distribution of this group, excepting a short note by Rosa[1] some two years ago. Since that time our knowledge of the group has

[1] Nuova Classificazione dei Terricoli—Boll. Mus. Zool. Torino, vol. iii., 1888, No. 41, pp. 14, 15.

increased to some extent, so that it seems worth while again to collect the available data and to present them in a compact form. The distribution of any group is worth studying as a contribution to the general subject, but the Lumbricidæ are of special interest, and for two principal reasons:—In the *first* place they occur everywhere, and under nearly all conditions. Accordingly, it is possible to test the influence which climate, altitude, and other conditions exercise upon them. In the *second* place, they are eminently land animals, and possess but little power of dispersion through countries which are separated by salt water. The animals themselves are in the highest degree susceptible to salt water, and are killed by a very short immersion. Darwin[1] particularly mentions this fact in relation to their occurrence in Kerguelen and the Falklands.

But in spite of this fact, which seems to be probably of general significance, there are, here and there, exceptions. The most marked exception is the genus *Pontodrilus*. The two species of this genus—*P. littoralis*[2] and *P. Marionis*[3]—live habitually upon the sea-shore among the débris cast up by the waves, but above the high-water mark. Both species occur on the southern French coast near Marseilles, Nice, and Villefranche.

This being the case, it is remarkable that earthworms have not been made more use of in works dealing with geographical distribution. Even so excellent a treatise as Professor Heilprinn's recently published "Distribution of Animals" contains no mention of the group.

The barriers on land to the dispersal and migration of earthworms are not many. They depend, so far as we know, upon no special kind of soil, provided only it be sufficiently damp. Rivers would hardly interfere, as so many (? all) species withstand immersion in fresh water for a long period. Deserts, however, would; and it is to be noted that the

[1] The Formation of Vegetable Mould through Earthworms. London, 1880, p. 120.

[2] Grube, E., Ueber neue oder wenig bekannten Anneliden—Arch. f. Naturg., xli., p. 127.

[3] Perrier, E., Études sur l'organisation des Lombriciens, etc.—Arch. Zool. Exp., t. ix. (1881), p. 176.

earthworm fauna of Africa is very different indeed from that of the warm parts of Europe or of Asia. It seems clear, however, that although special soils are not required for the *existence* of worms, they affect their *numbers* very considerably. Naturally a soil which is rich, and productive of abundant vegetation, will harbour more worms than one which is poor.

It has been noticed by many that cultivation has a great deal to do not only with the abundance but even the presence of worms in the soil at all. Certain districts of North America have been stated to be entirely devoid of earthworms until put under cultivation.

Cultivation of the land has a very marked influence on the abundance of the worms found in it. Mr Fletcher found[1] that in the neighbourhood of Burrawang, N.S.W., the average was 10,000 per acre in virgin soil. Urquhart[2] gives 348,840 and 784,080 as the average in New Zealand districts which had been seventeen years in grass; and Mr W. W. Smith[3] gives an estimate for cultivated lands of 5-16 per square foot.

Before discussing some of the inferences which may be drawn from a study of the distribution of this group of worms, it is requisite to lay before the reader the facts.

I shall only mention those species which have been identified in a trustworthy manner, indicating others with a mark of interrogation. The regions introduced by Mr Sclater will be adopted, the precise habitat of the species being also given, so far as is possible. Those which also occur in other regions have the initial letter of that region appended, and are printed in Clarendon type. In the case of genera occurring in more than one region the generic name only is thus distinguished, and only once for each region.[4]

[1] Notes on Australian Earthworms—Proc. Linn. Soc. N.S.W. (1886), p. 527.

[2] On the Habits of Earthworms in New Zealand—Trans. N.Z. Inst., vol. xvi. (1883), p. 269.

[3] Notes on New Zealand Earthworms—Trans. N.Z. Inst., vol. xix. (1886), p. 133.

[4] In the tables of species the term *Perichæta* is applied to all those species which are included in the subgenera Perichæta and Megascolex as defined by myself (P. Z. S., 1890, pt. ii.). This is done for the sake of uniformity. It would be impossible to apply the terms accurately in some cases.

I. Neotropical Region, N.

1. *Geoscolex maximus*, Leuck. (= *Titanus brasiliensis*, E. P.). Brazil.
2. *Geoscolex Forguesi*, E. P. La Plata.
3. *Anteus gigas*, E. P. Cayenne.
4. *Rhinodrilus paradoxus*, E. P. Venezuela. O.
5. *Rhinodrilus* (*Thamnodrilus*) *Gulielmi*, F. E. B. British Guiana.[1]
6. *Rhinodrilus tenkatei*, Horst. Surinam.
7. **Urochæta corethrura** (Fritz Müller). Brazil, Martinique, Bermuda. O., A.
8. **Acanthodrilus** *georgianus*, Mich. S. Georgia, Falklands. N'., E., A.
9. *Acanthodrilus pictus*, Mich. Valdivia, Chili.
10. *Acanthodrilus Hilgeri*, Mich. Corral, Chili.
11. *Acanthodrilus littoralis* (Kinberg) (= *A patagonica*, Kinb.). Straits of Magellan.
12. *Acanthodrilus Bovei*, Rosa. Puntarenas.
13. *Acanthodrilus Dalei*, F. E. B. Falklands.
14. **Eudrilus peregrinus**, E. P. (? = *E. Lacazii* and *E. decipiens*). Rio Janeiro, Martinique, Bahamas. A.
15. *Eudrilus silvicola*, F. E. B. British Guiana.
16. **Perichæta indica**, Horst. O., A.
17. **Perichæta affinis**, Perrier. O.
18. **Perichæta Houlleti**, E. P. Bahamas. O.
19. *Perichæta aspergillum*, E. P. Bermuda.
20. *Perichæta elongata*, E. P. Peru.
21. *Perichæta dicystis*, E. P. Brazil.
22. *Perichæta tricystis*, E. P. Brazil.
23. *Diachæta Thomasii*, Benh. St Thomas.
24. *Onychochæta Windlei*, F. E. B. Bermuda.
25. *Urobenus brasiliensis*, Benh. Pedza Açu.
26. *Trigaster Lankesteri*, Benh. St Thomas.
27. **Allolobophora subrubicunda**, Eisen. Puntarenas. P., N'.
28. **Allolobophora trapezoides**, Dugès. Corral, Chili. P.
29. **Allolobophora fœtida**, Sav. Lota, Chili. P., N'.
30. **Allurus tetraedrus**, Sav. Valparaiso. P., N'.
31. **Cryptodrilus**[2] (?) *spatulifer*, Mich. Corral, Chili. O., A.

[1] This worm really possesses a long retractile prostomium and ornamented setæ, and should therefore be included in genus *Rhinodrilus*.

[2] The query is that of the describer.

And the following, which need further study, and are at present unrecognisable. Those are queried whose generic name is even doubtfully correct:—

? *Pontoscolex arenicola*, Schmarda. Jamaica.
? *Eurydame insignis*, Kinberg. St Joseph, Panama.
Nitocris (= *Perichæta*) *gracilis*, Kinberg. Rio Janeiro.
? *Hypogæon atys*, Kinb. Buenos Ayres.
? *Hypogæon heterostichon*, Schmarda. Quito.
? *Lumbricus armatus*, Kinb. Buenos Ayres.
? *Lumbricus alyattes*, Kinb. Buenos Ayres.
? *Lumbricus tellus*, Kinb. Buenos Ayres.
? *Lumbricus pampicola*, Kinb. Monte Video.
Mandane (= *Acanthodrilus*) *stagnalis*, Kinb. Monte Video.
? *Lumbricus matutinus*, Weyenberg. Argentine.
? *Lumbricus argentinus*, Weyenb. Argentine.
? *Lumbricus dissidens*, Weyenb. Argentine.
? *Lumbricus corduvensis*, Weyenb.[1] Argentine.
? *Lumbricus luteus*, Gay. Chili.
? *Lumbricus valdiviensis*, Gay. Chili.
? *Lumbricus semifasciatus*, Burmeister.

II. Nearctic Region, N′.

1. Acanthodrilus (*Diplocardia*) *communis*, Garman. Illinois. N., E., A.
2. *Plutellus heteroporus*, E. P. Pennsylvania.
3. Perichæta sp. (in hot-houses). N., O., E., A.
4. *Tetragonurus pupa*, Eisen. Canada.
5. Allurus tetraedrus (?).[2] Canada. P., N.

[1] With regard to the species described by Weyenberg (Descripciones de nuevos gusanos—Boll. Ac. Rep. Arg., pp. 213-218), it is clear that, whatever they may be, the last two are not *Lumbricus*, since the clitellum occupies in *L. dissidens* segments 15-18, and in *L. Corduvensis* 18-22, or 17-21. The former species is said to have no prostomium. The first two species *may* be *Lumbricus*, but it is impossible to identify any of them.

[2] *Allurus tetraedrus* must be regarded as a rather uncertain North American form. I have included it in the list on the strength of a specimen kindly sent to me some time since by Mr Tyrrel of the Canadian Geological Survey. I examined this specimen by means of longitudinal sections, and identified it with *Allurus* on account of the structure of the gizzard (see BEDDARD, On the Anatomy of *Allurus tetraedrus*—Quart. Journ. Micr. Sci., vol. xxviii.). But as *Tetragonurus* has not been anatomised, it is far from impossible that that genus may prove to be identical in this particular with *Allurus*. The sexual organs were not sufficiently developed to permit of any certain con-

6. **Allolobophora bœckii**, Eisen. California. P.
7. **Allolobophora chlorotica**, Hoffm. California. P.
8. **Allolobophora fœtida**, Sav. Illinois, Iowa. P., N., A.
9. **Allolobophora subrubicunda**, Eisen. Canada. P., N.
10. **Allolobophora mucosa**, Eisen. New England, Illinois. P.
11. **Allolobophora trapezoides**, Dugès. New England, Canada, etc. P.
12. **Allolobophora tenuis**, Eisen. New England, etc. P.
13. *Allolobophora tumida*, Eisen. New England. P.
14. *Allolobophora parva*, Eisen. New England. P.
15. **Lumbricus herculeus**, Sav. New England. P.
16. **Lumbricus rubellus**, Hoffm. Newfoundland. P.
17. **Lumbricus castaneus**, Sav. Canada. P.

The following are not recognisable:--

Lumbricus americanus, E. P.
? *Lumbricus Apii*, Kinb. California.
? *Hypogæon hirtum*, Sav. Philadelphia.
Pheretima (= *Perichæta*) *californica*, Kinb. California.

III. Ethiopian Region, E.

1. **Acanthodrilus** *capensis*, F. E. B. Cape of Good Hope. N., N'., A., E.
2. *Acanthodrilus Büttikoferi*, Horst. Liberia.
3. *Acanthodrilus Schlegelii*, Horst. Liberia.
4. *Acanthodrilus Beddardi*, Horst. Liberia.
5. *Acanthodrilus verticillatus*, E. P. Madagascar.
6. *Acanthodrilus scioanus*, Rosa. Let. Marefia, Scioa.
7. *Acanthodrilus Stuhlmanni*, Mich. Zambesi.
8. *Acanthodrilus affinis*, Mich. Zambesi.
9. **Perichæta** *capensis*, Horst. Cape of Good Hope. N., N'., O., E., A.
10. *Perichæta robusta*, E. P. Mauritius.
11. *Teleudrilus Ragazzii*, Rosa. Scioa.
12. *Microchæta Rappii*, F. E. B. Natal.
13. *Microchæta Beddardi*, Benh. Natal.
14. *Pygmæodrilus quilimanensis*, Mich. Zambesi.

clusions, and these are the only organs at present which would enable the question to be decided; the male apertures are on the 12th segment in *Tetragonurus*, on the 13th in *Allurus*.

15. *Eudriloides parvus*, Mich. Zambesi.
16. *Eudriloides gypsatus*, Mich. Zanzibar.
17. *Nemertodrilus griseus*, Mich. Zambesi.
18. *Callidrilus scrobifer*, Mich. Zambesi.
19. *Polytoreutus cœruleus*, Mich. Zanzibar.
20. *Stuhlmannia variabilis*, Mich. Zanzibar.
21. **Perionyx** sp., Mich. Zambesi. O.

The following imperfectly characterised species have been described from this region. The queries signify that the generic name is not certainly correct:—

? *Geogenia natalensis*, Kinb. Natal.
Perichæta rodericensis, Grube. Mauritius.
Lampito (= *Perichæta*) *Mauritii*, Kinb. Mauritius.
Perichæta Sanctæ Helenæ, Baird. St Helena.
? *Lumbricus Josephinæ*, Kinb. St Helena.
? *Lumbricus Eugeniæ*, Kinb. St Helena.
? *Lumbricus Helenæ*, Kinb. St Helena.
? *Lumbricus Hortensiæ*, Kinb. St Helena.
? *Lumbricus infelix*, Kinb. Natal.
? *Lumbricus capensis*, Kinb. Cape Colony.
? *Lumbricus rubrofasciata*, Baird. St Helena.
? *Hegisipyle Hanno*, Kinb. Natal.

IV. Palæarctic Region, P.

1. *Microscolex modestus*,[1] Rosa. Italy. Tenerife.
2. *Photodrilus phosphoreus*, Giard. N. France.
3. *Pontodrilus littoralis*, Grube. S. France.
4. *Pontodrilus Marionis*, Perrier. S. France.
5. *Hormogaster Redii*, Rosa. Italy.
6. *Perichæta Sieboldi*, Horst. Japan. N., N'., O., E., A.
7. *Perichæta japonica*, Horst. Japan.
8. *Perichæta Schmardæ*, Horst. Japan.
9. **Perichæta Houlleti.** France. N'., O.

[1] This species has at present only been recorded by Rosa [*Microscolex modestus*, n. gen. n. sp.—Boll. Mus. Zool. Torino, vol. ii. (1887), No. 19], who received it from Genoa. That the genus occurs in Tenerife I am to state here (for the first time), since I have examined a number of specimens kindly collected for me in that island by Mr E. B. Poulton, F.R.S. They may possibly belong to a distinct species, but I have not yet taken the opportunity of thoroughly working out their anatomy.

10. **Perichæta diffringens** (? = *P. indica*). England, France. N'., O., N.
11. **Lumbricus rubellus**, Hoffm. Europe. N'.
12. *Lumbricus melibœus*, Rosa. Italy.
13. **Lumbricus herculeus**, Sav. Europe. N'.
14. *Lumbricus Eiseni*, Lev. Europe.
15. **Lumbricus castaneus**, Sav. Europe. N'.
16. **Allolobophora fœtida**, Sav. Europe. N'., N., A.
17. *Allolobophora rubicunda*, Eisen. Europe.
18. **Allolobophora trapezoides**, Eisen. Europe. N'.
19. **Allolobophora mucosa**, Eisen. Europe. N'.
20. **Allolobophora chlorotica**, Sav. Europe. N'.
21. *Allolobophora alpina*, Rosa. Italy.
22. *Allolobophora constricta*, Rosa. Italy.
23. *Allolobophora minima*, Rosa. Italy.
24. **Allolobophora Boeckii**, Eisen. Europe. N'.
25. *Allolobophora transpadana*, Rosa. Italy.
26. *Allolobophora profuga*, Rosa. Italy, Spain.
27. *Allolobophora complanata*, Dugès. France, Italy, Spain.
28. *Allolobophora Tellinii*, Rosa. Italy.
29. *Allolobophora celtica*, Rosa. Italy.
30. *Allolobophora veneta*, Rosa. Italy, Portugal.
31. *Allolobophora Ninnii*, Rosa. Italy.
32. *Allolobophora icterica*, Sav. France, Italy.
33. *Allolobophora gigas*, Dugès. France.
34. *Allolobophora Fraissei*, Örley. Balearic Is.
35. *Allolobophora mediterranea*, Örley. Balearic Is.
36. *Allolobophora Molleri*, Rosa. Portugal.
37. **Allolobophora tenuis**, Eisen. Scandinavia. N'.
38. *Allolobophora Hispanica*, Ude. Spain.
39. *Allolobophora Hermanni*, Mich. Germany.
40. *Allolobophora neglecta*, Rosa. Italy.
41. *Allolobophora norvegica*, Eisen. Scandinavia.
42. *Allolobophora Nordenskiöldi*, Eisen. Siberia (?).
43. *Allolobophora limicola*, Mich.
44. **Allolobophora subrubicunda**, Eis. Scandinavia, Italy. N'.
45. *Allolobophora octaedra*, Sav. Europe.
46. *Allolobophora neapolitana*, Örley. Italy.
47. *Allolobophora longa*, Ude.
48. *Allolobophora trapezoides*, Dugès.
49. *Criodrilus lacuum*, Hoffm. Europe.

50. **Allurus tetraedrus**, Sav. N., N'., A.
51. *Allurus dubius*, Mich. Germany.
52. *Allurus hercynius*, Mich. Germany.

The species of *Allolobophora* and *Lumbricus*, which are given in the above lists as occurring in the Palæarctic and Nearctic regions, require some explanation.

In the first place, I have omitted the synonyms. This was done advisedly, as the present paper does not profess to be a revision of the two genera. In the second place, I have accepted, without discussion, Rosa's names so far as possible. But in doing this, I do not necessarily imply that in my opinion Rosa's names are better founded than those of, for example, Vejdovsky. Confining myself to one naturalist's nomenclature, I select that of Rosa because it happens to be more familiar to me. As my purpose is that of comparing the earthworms of different countries, the question of names is obviously of no moment so long as the same name is applied to the same species. The above list is, I am aware, incomplete; but as there is some doubt about many species, I do not see any advantage in mentioning a number of more or less dubious names.[1]

V. Oriental Region, O.

1. *Moniligaster deshayesi*,[2] E. P.
2. *Moniligaster Barwelli*, F. E. B. Manila.
3. *Moniligaster minutus*, Bourne. India.
4. *Moniligaster sapphirinoides*, Bourne. India.
5. *Moniligaster grandis*, Bourne. India.
6. *Moniligaster uniquus*, Bourne. India.
7. *Moniligaster robustus*, Bourne. India.
8. *Moniligaster papillatus*, Bourne. India.

I must, however, refer to two remarkable types recently described by Levinsen (Om to nye Regnormslaegten fra Ægypten—Vid. Medd. nat. For. Kjobenhaven, 1889), viz., *Siphonogaster ægyptiacus* and *Digitibranchus niloticus*. The latter is possibly *Alma nilotica*. Their affinities are uncertain.

[2] Whether these two species are really distinct from each other or from some of those described by Bourne (On Indian Earthworms, etc.—P. Z. S., 1886, pp. 662-672) is uncertain. Horst's *Moniligaster Houteni* (Descriptions of Earthworms, No. I.—Notes Leyd. Mus., ix., p. 97) may turn out also to be identical with one of Bourne's species.

9. *Moniligaster ruber*, Bourne. India.
10. *Moniligaster Houteni*, Horst. Sumatra.
11. **Cryptodrilus** sp. India. A., N'.[1]
12. **Urochæta corethrura**, E. P. (= *U. dubia*, Horst). Malayan Archipelago. N., A.
13. *Glyphidrilus Weberi*, Horst.
14. *Typhœus orientalis*, F. E. B. Burmah.
15. *Typhœus Gammii*, F. E. B. Near Calcutta.
16. *Typhœus Masoni*, Bourne. India.
17. *Perionyx excavatus*[2] (? incl. *P. m'intoshii*, F. E. B.). India and Burmah.
18. *Perionyx saltans*, Bourne. India.
19. *Perichæta cœrulea*, Templ. Ceylon.
20. **Perichæta affinis**, E. P. India, Ceylon, Manilla, Burmah. N.
21. *Perichæta armata*, F. E. B. India, Burmah, Borneo.
22. **Perichæta Houlleti**, E. P. India, Ceylon. N.
23. *Perichæta ceylonica*, F. E. B. Ceylon.
24. *Perichæta Lawsoni*, Bourne. India.
25. *Perichæta bivaginata*, Bourne. India.
26. *Perichæta gracilis*, Bourne. India.
27. *Hoplochæta Stuarti*, Bourne. India.
28. *Perichæta burliarensis*, Bourne. India.
29. *Perichæta hulikalensis*, Bourne. India.
30. *Perichæta mirabilis*, Bourne. India.
31. *Perichæta salettensis*, Bourne. India.
32. **Perichæta indica**, Horst. India, Sumatra, Java. N., A.
33. *Perichæta luzonica*, E. P. Manilla.
34. *Perichæta Vaillanti*, F. E. B. Manilla.
35. *Perichæta annulata*, Horst. Malayan Archipelago.
36. *Perichæta musica*, Horst. Java.
37. *Perichæta Hasselti*, Horst. Sumatra.
38. *Perichæta sumatrana*, Horst. Sumatra.
39. *Perichæta biserialis*, E. P. Manilla.
40. *Perichæta Horsti*, F. E. B. Manilla.
41. *Perichæta quadragenaria*, E. P. East Indies.
42. *Perichæta Feæ*, Rosa. Burmah.

[1] I received some time since from the Botanical Gardens at Seebpore a single example of a worm apparently belonging to this genus. Unfortunately, the specimen is now missing.

[2] I suppose that Rosa is right in uniting these two (*cf.* Rosa, I lombrichi raccolti nell' isola Nias, etc.—Ann. Mus. civ. Geneva, vol. vii., 1889).

43. *Perichæta modigliani*, Rosa. Nias.
44. *Deodrilus Jacksoni*, n. gen., n. sp. Ceylon.

The following insufficiently known species are from this region :—

Perichæta Juliana, E. P. Saigon.
Perichæta cœrulea, E. P. Manilla.
Perichæta bicincta, E. P. Manilla.
Perichæta leucocycla, Schm. Ceylon.
Perichæta viridis, Schm. Ceylon.
Perichæta brachycycla, Schm. Ceylon.
Perichæta cingulata, Schm. Ceylon.
Perichæta javanica, Kinb. Java.

VI. Australian Region, A.

1. Perichæta *exigua*, Fl. Australia. N., O., E.
2. *Perichæta monticola*, Fl. ,,
3. *Perichæta canaliculata*, Fl. ,,
4. *Perichæta stirlingi*, Fl. ,,
5. *Perichæta raymondiana*, Fl. ,,
6. *Perichæta hamiltoni*, Fl. ,,
7. *Perichæta wilsoniana*, Fl. ,,
8. *Perichæta fecunda*, Fl. ,,
9. *Perichæta bakeri*, Fl. ,,
10. *Perichæta dorsalis*, Fl. ,,
11. *Perichæta tenax*, Fl. ,,
12. *Perichæta austrina*, Fl. ,,
13. *Perichæta gracilis*, Fl. ,,
14. *Perichæta barronensis*, Fl. ,,
15. *Perichæta queenslandica*, Fl. ,,
16. *Perichæta darnleiensis*, Fl. ,,
17. *Perichæta peregrina*, Fl. ,,
18. *Perichæta australis*, Fl. ,,
19. *Perichæta coxii*, Fl. ,,
20. *Perichæta newcombei*, F. E. B. ,,
21. *Perichæta upoluensis*, F. E. B. Upolu.
22. *Perichæta Forbesi*, F. E. B. New Guinea.
23. *Perichæta intermedia*, F. E. B. New Zealand.
24. *Perichæta antarctica*, Baird. ,,

25. *Perichæta indica*, Horst. New Caledonia.
26. *Eudrilus dubius*,[1] Fl. Australia.
27. **Eudrilus** *Boyeri*, F. E. B.[2] New Caledonia. N., E.
28. *Perrissogaster excavata*, Fl. Australia.
29. *Anisochæta attenuata*, Fl. ,,
30. *Anisochæta enormis*, Fl. ,,
31. *Anisochæta Coxii*, Fl. ,,
32. **Allolobophora trapezoides**, Dugès. N., P.
33. **Allolobophora fœtida**, Sav. N., N'., P.
34. **Allolobophora profuga**, Rosa. P.
35. **Cryptodrilus** *rubens*, Fl. Australia. O., N.
36. *Cryptodrilus rusticus*, Fl. ,,
37. *Cryptodrilus saccarius*, Fl. ,,
38. *Cryptodrilus mediterreus*, Fl. ,,
39. *Cryptodrilus unicus*, Fl. (= *C. purpureus*, Mich.). Australia.
40. *Cryptodrilus Fletcheri*, F. E. B. Australia.
41. *Cryptodrilus mudgeanus*, Fl. ,,
42. *Cryptodrilus canaliculatus*, Fl. ,,
43. *Cryptodrilus Sloanei*, Fl. ,,
44. *Cryptodrilus oxleyensis*, Fl. ,,
45. *Cryptodrilus manifestus*, Fl. ,,
46. *Cryptodrilus fastigatus*, Fl. ,,
47. *Cryptodrilus tenuis*, Fl. ,,
48. *Cryptodrilus mediocris*, Fl. ,,
49. *Cryptodrilus illawarræ*, Fl. ,,
50. *Cryptodrilus singularis*, Fl. ,,
51. *Digaster Perrieri*, Fl. ,,
52. *Digaster lumbricoides*, E. P. ,,
53. *Perissogaster nunoralis*, Fl. ,,
54. *Perissogaster queenslandica*, Fl. ,,
55. *Megascolides camdenensis*, Fl. ,,
56. *Megascolides grandis*, Fl. ,,
57. *Megascolides gippslandicus*, M'Coy. ,,
58. *Megascolides tasmanianus*, Fl. ,,
59. *Megascolides tuberculatus*, Fl. ,,
60. *Megascolides illawarræ*, Fl. ,,
61. *Megascolides pymæus*, Fl. ,,

[1] This species is considered by Rosa to be a *Microscolex*.

[2] *Eudrilus Boyeri* is not, perhaps, very easily definable as distinct from *E. decipiens*, or either of the other two species of *Eudrilus* described by Perrier from the New World.

62. *Dichogaster Damonis*, F. E. B. Fiji.
63. **Acanthodrilus** *australis*, Mich. Australia. N., N'., E.
64. *Acanthodrilus novæ Zelandiæ*, F. E. B. New Zealand.
65. *Acanthodrilus dissimilis*, F. E. B. ,,
66. *Acanthodrilus neglectus*, F. E. B. ,,
67. *Acanthodrilus multiporus*, F. E. B. ,,
68. *Acanthodrilus Rosæ*, F. E. B. ,,
69. *Acanthodrilus annectens*, F. E. B. ,,
70. *Acanthodrilus antarcticus*, F. E. B. ,,
71. *Rhododrilus minutus*, F. E. B. ,,
72. *Acanthodrilus ungulatus*, Perrier. New Caledonia.
73. *Acanthodrilus Layardi*, F. E. B. ,,
74. **Urochæta** *australiensis*,[1] F. E. B. Australia. N., O.
75. *Deinodrilus Benhami*, F. E. B. New Zealand.
76. *Neodrilus monocystis*, F. E. B. ,,

This list may be increased by the addition of the following forms, which are unrecognisable; in many cases even the generic name is probably wrong; these are queried:—

Acanthodrilus uliginosus, Hutton. New Zealand.
? *Digaster lævis*, Hutton. ,,
? *Digaster campestris*, Hutton. ,,
? *Lumbricus annulatus*, Hutton. ,,
Perichæta sylvestris, Hutton. ,,
Perichæta lineata, Hutton. ,,
Pheretima (= *Perichæta*) *montana*, Kinb. Otaheiti.
Perichæta taitensis, Grube. Otaheiti.
Perichæta subquadrangularis, Grube. Viti.
Perichæta æriginosa, Kinb. Guam.
Perichæta corticis, Kinb. Hawai.
? *Lumbricus tahitanus*, Kinb. Otaheiti.
? *Lumbricus tongaensis*,[2] Grube. Tonga
Eudrilus sp. ? (*fide* Benham). New Zealand.
? *Hypogæon havaicus*, Kinb. Hawai.
? *Hypogæon orthostichon*, Schm. New Zealand.

A glance at the above lists does not at first seem to permit of the deduction of any general statements respecting

[1] I have not yet described this species, but I believe it to be distinct from *U. corethrura*.

[2] Certainly not *Lumbricus*, as clitellum extends from xiith to xviiith segment. ? *Dichogaster*.

the distribution of the group, except that many genera and some species have a world-wide distribution.

This is especially the case with the genera *Lumbricus*, *Allolobophora*, and *Perichæta*.[1]

But it is necessary, in the first place, to clear the ground by removing from the various faunal lists those species which have been accidentally introduced by man's agency. This is obviously not an easy task. The first question which arises is, have we any right at all to suppose that this has been the case? I content myself with urging the general probability, owing to the importation of plants from country to country, and to mentioning one or two instances which are only explicable on this theory. Some years ago the late Dr Baird, of the British Museum, described in the *Proceedings of the Zoological Society* a species of *Perichæta* (*P. diffringens*) which had been sent to him from various parts of England, but always from conservatories or from gardens for the adornment of which plants had been imported from abroad.

In the Jardin des Plantes Perrier met with *Perichæta Houlleti*, a species which has not been met with in any other part of Europe.

Both these cases (and others might be quoted) seem to show that the species of *Perichæta* are in all probability not indigenous, otherwise they would have been met with in other places besides the immediate neighbourhood of plants which had been recently imported from the countries of which the species in question are certainly natives.

Two examples which have come under my own observation may be mentioned as proving beyond a doubt (if indeed there could be any doubt upon the point) that earthworms may be carried from abroad to this country.

[1] With the exception of the doubtful case of *Lumbricus* and *Allolobophora*, the following are the only *species* which are known to occur in more than one region :—

Urochæta corethrura.	Neotropical	and	Oriental.
Perichæta affinis.	,,	,,	
Perichæta Houlleti.	,,	,,	
Perichæta indica.	,,	,,	and Australian.
Eudrilus decipiens.	Neotropical	and	Australian.

Mr Clarence Bartlett kindly presented me with two earthworms, one being an example of *Perichæta indica*, which he had found in the earth surrounding the roots of some orchids which had been recently imported by him from South America.

A package of ferns from New Zealand contained a large number of specimens of *Allolobophora* and *Lumbricus* (I have not identified the species) which had survived the long voyage. For these I am indebted to the same gentleman.

The next matter is to decide which forms have been probably introduced, and which are really indigenous. It is, of course, impossible to do more than make a reasonable assumption, which further progress in our knowledge may prove to be an unwarrantable assumption. Taking into consideration what we know of the occurrence of *Perichæta* in Europe and North America, it may be safely inferred that this genus is *not* indigenous in either of these countries, but that it is indigenous in a portion of the Palæarctic region—viz., in Japan.[1]

With regard to *Lumbricus* and *Allolobophora*, these genera unquestionably form the predominant types in Europe and North America. They far outnumber the other genera not only in variety of species but in number of individuals. It cannot, therefore, be doubted that they are indigenous to these parts of the world. On the other hand, comparatively few species of *Lumbricus* and *Allolobophora* have been recorded from other countries. In New Zealand, for example, the genus *Acanthodrilus* outnumbers *Lumbricus* and *Allolobophora*. In South America the many peculiar genera include a total number of species which is greater than that of the few Anticlitellian worms which have been recorded from that continent. Dr Michaelsen,[2] in an important contribution

[1] Three species have been described by Horst (New Species of the Genus *Megascolex*, etc.—Notes Leyd. Mus., vol. v., p. 182) from Japan. In a collection which Professor Milne made for me at the kind request of Dr Anderson, there were examples of *Perichæta* which were quite as numerous as *Allolobophora fœtida*, the only other species contained in the collection. This is some evidence that the genus *Perichæta* is common in Japan. I have not identified the species.

[2] Oligochæten des naturhistorischen Museums in Hamburg—J. B. Hamb. Wiss. Anstalt vi.

to the earthworm fauna of Chili, places after each of the three Lumbricidæ the word "eingeschleppt," and I am quite disposed to agree with him. Moreover, many of the so-called "*Lumbricus*" which occur in South America and in other extra-European countries, are certainly *not* referable to this genus or to *Allolobophora*. Pending the production of evidence to the contrary, I do not admit that the genera *Lumbricus* and *Allolobophora* are indigenous to any countries but Europe, Northern Asia, and North America.

It is, however, a difficult task to proceed further with the elimination of those facts in geographical distribution which have been caused by the direct, though unconscious, interference of human agency.

There are not many cases, fortunately, which suggest that this explanation should be called in. The most prominent is that of *Eudrilus*. This genus is common in South America, and in some of the West Indian islands (Bahamas); it is also apparently common in New Caledonia, and occurs in New Zealand. It was first recorded by myself from New Caledonia on the strength of some specimens which I received through the kindness of Mr E. L. Layard, H.B.M. Consul at Noumea. These specimens I described as *Eudrilus Boyeri*, but it may be, as Horst has suggested, that this supposed species is not really different from Perrier's *Eudrilus* from South America. I wrote to Mr Layard to inquire if there was such trade between these two distant parts of the world as might reasonably account for the introduction of South American forms. He informed me that there was not, and that the chief trade was with Australia. The genus *Eudrilus* has been described as occurring in this latter country by Fletcher; but I have not included the genus in my list of Australian genera, for the reason that it cannot be considered to be proved that Fletcher's *Eudrilus dubius* is really a member of the genus. Rosa[1] has suggested that it is probably referable to his *Microscolex*. As *Eudrilus* occurs in New Zealand, it *may* also occur in Australia, but the fauna of these two countries differs quite as much in respect of

[1] Nuova Classificazione dei Terricoli—Boll. Mus. Zool. Torino, vol. iii., No. 41, p. 15.

Oligochæta as in other animals. *Eudrilus* also is a genus which is to a certain extent a primitive form. The opening of the vasa deferentia into the atria, and the presence of two pairs of ovaries and oviducts[1] are primitive characters. For the present I regard the presence of *Eudrilus* in the tropical parts of the New World and in New Caledonia and New Zealand as a fact of importance in the geographical distribution of the genus, not caused recently by man's interference.[2] Another doubtful case is *Urochæta*. This genus occurs in South America, the West Indies, the Malay Archipelago, and Western Australia. The fact, however, that the Australian form is specifically different from that of America, lends very strong support to the view that this fact of distribution is also to be regarded as normal.

The following genera exist in more than one geographical region :—

Perichæta, P., World-wide.
Acanthodrilus, E., N., A., N'. *Cryptodrilus*, A., O., N. (?)
Urochæta, N'., O., A.
Eudrilus, N'., A.
Microscolex, P., A.
Lumbricus, World-wide.
Allolobophora, World-wide.
Allurus, N'., P., E.

while the following are limited to their region, with a wider or more restricted range within it.

TABLE OF GENERA PECULIAR TO DIFFERENT REGIONS.

Neotropical.	*Diachæta.*	**Australian.**	*Megascolides.*
	Urobenus.		*Rhododrilus.*
	Trigaster.		*Aporochæta.*
	Anteus.		*Deinodrilus.*
	Geoscolex.		*Dichogaster.*
	Onychochæta.		*Neodrilus.*[3]
	Rhinodrilus.		*Anisochæta.*

[1] BEDDARD, Contributions to the Anatomy of Earthworms, No. 1—P. Z. S., 1887, p. 383.

[2] This opinion is confirmed by Michaelsen's recent description of a closely allied form from Africa.

[3] I do not consider that Fletcher's genus, *Perissogaster*, is well established. My *Neodrilus* is also doubtful (*see* Proc. Roy. Soc. Edin., vol. xiv., 1887, p. 157).

Palæarctic.	*Hormogaster.*		
	Pontodrilus.		
	Photodrilus.		
	Criodrilus.	**Ethiopian.**	*Microchæta.*
Nearctic.	*Tetragonurus.*		*Teleudrilus.*
	Plutellus.		*Pygmæodrilus.*
			Callidrilus.
Oriental.	*Moniligaster.*		*Polytoreutus.*
	Typhæus.		*Stuhlmannia.*
	Glyphidrilus.		*Eudriloides.*
	Hoplochæta.		*Nemertodrilus.*
	Deodrilus.		

How far is the distribution of earthworms in accordance with Mr Sclater's regions ?

It is perfectly clear that the Neotropical region—at least the tropical parts of that region—is very distinct ; it contains as many or more peculiar genera than any other region. An American region (Andrew Murray), or a Boreal region (including the Palæarctic and Nearctic regions of Mr Sclater, with Central and a good portion of South America), such as that proposed by Mr Blyth, will not be at all in accordance with the facts of this paper. *Plutellus* may be a Neotropical form, which has made its way northwards, and *Acanthodrilus communis* certainly has done so ; but the facies of the two faunas is *very* distinct. Except *Acanthodrilus*, unless *Allolobophora* be counted, there are no genera in common ; and while *Lumbricus* and *Allolobophora* are the prevailing forms of the north, we have such genera as *Anteus*, *Eudrilus*, and *Geoscolex* in the south. The West Indies clearly go with South America, though they have their own peculiarities. It would be very interesting to have some information about Central America.

The Nearctic region cannot, so far as Earthworms are concerned, be separated from the Palæarctic ; although there are genera found in one region which do not occur in the other. The importance of this might easily be overrated. Four Palæarctic genera do not occur in the Nearctic region, and three Nearctic genera are absent from the Palæarctic region ; but it cannot be denied that the prevailing character-

istic of the earthworm fauna of both these regions is the abundance and prevalence of *Lumbricus* and *Allolobophora*, amounting to an identity of species. These facts therefore support the reasonableness of instituting an Arctogæa or Holarctic region, as it is termed by Heilprinn. The community of the earthworm fauna of the northern parts of the old and new worlds is of course explicable on the assumption of a recent land connection. The distribution of certain other animals (*e.g.*, the glutton, beaver, and elk) is in harmony with such a view, and there is no difficulty on the geological side of assuming such a connection by way of Behring Strait where the sea is shallow, and the distance from shore to shore small.

Dr Günther noticed that Japan differs more particularly than any other tract of country from the rest of the Palæarctic region, and resembles the Oriental.

We have already seen that in Japan (and possibly adjacent parts of China) alone is the genus *Perichæta* probably indigenous. Here, then, is a decided confirmation of Dr Günther's position.

Huxley proposed to separate New Zealand as a distinct region, while Heilprinn distinguishes a Polynesian region *not* including New Zealand. Is there anything to be said for either of these modifications of Mr Sclater's regions? We know too little of the earthworm fauna of Polynesia to make any deductions worth putting on paper; but New Zealand is better known.[1] It does *not* show a close resemblance to Australia. The prevailing genus in New Zealand is *Acanthodrilus*, which is there represented by five species. This genus is certainly not common in Australia; in fact only one species, *A. australis*, has been as yet met with. And we have the careful investigations of Fletcher[2] for reference, which must comprise a fair sample of the earthworm fauna of South-Western Australia—the nearest part to New Zealand. On the other hand, our knowledge of the earthworm fauna of New Zealand is confined to that of the

[1] The Oligochætous Fauna of New Zealand—P. Z. S. (1889), p. 377.

[2] Notes on Australian Earthworms—a series of papers in Proc. Lin. Soc. N.S.W. (1886-89).

Southern Island. The North Island may prove to be more "Australian" in its character, when it comes to be known. If it were not for the fact that in New Caledonia *Acanthodrilus* is a characteristic form, the earthworm fauna of New Zealand would, perhaps, rather support Professor Huxley's view of its independence as a separate region.

This is the place to point out the very striking resemblance that exists between many parts of the Antarctic hemisphere in respect of their terrestrial Oligochæta.

Patagonia and the Falkland Islands have between them four species of earthworms which are *all* referable to the genus *Acanthodrilus*. Although other species may be met with, this genus is hardly likely to prove anything but most characteristic. From South Georgia only one species of earthworm has been described (*Acanthodrilus georgianus*), which also occurs in the Falklands. Kerguelen and Marion Islands have not, perhaps, been very thoroughly explored, but it is remarkable that the only form which has been discovered should be identical in the two islands, and should be a species of *Acanthodrilus*. In South Africa the genus *Acanthodrilus* occurs; but although several species have been described from the African continent, the genus cannot at present be exactly regarded as characteristic.

It is possible that this similarity between such widely removed parts of the earth's surface as those enumerated above may be caused by their nearness to the Antarctic continent, from which they were all originally stocked. This is more credible than the assumption by some of a former direct land connection between New Zealand and South America. It might, perhaps, be believed that the distribution of the genus *Acanthodrilus* had a relation to temperature, were it not for the fact that species have been found in Africa near to, but north of, the Equator. The distribution of this genus is in some respects parallelled by that of the marine Isopodan genus *Serolis*, and of the Penguins and Sheathbills among birds, and of the Coleoptera among insects.[1] It must surely have originated in the Antarctic continent, and have gradually spread northwards. The species are

[1] Heilprinn, *loc. cit.*, p. 281.

decidedly more numerous the closer we get to the Antarctic continent. In America, for example, there are four species found in S. Georgia, the Falklands, and Patagonia, two in Chili, and one in North America. I have mentioned a few instances here; but Mr Blanford has lately argued with considerable force in favour of an ancient land connection between these countries by the extension of the Antarctic continent. Quoting many instances of closely-allied forms of life, and especially laying stress upon the facts that America and New Zealand are not separated by a depth greater than 2000 fathoms from the southern land mass, he also points out that there are not any soundings due south of Cape of Good Hope; hence it is possible that the ocean here may be no deeper.

On the other side, we have seven species in New Zealand as against *one* in Australia.

The African continent does not, it is true, furnish much evidence for this position as far as decrease of species as we pass northwards is concerned; but, on the other hand, the absence(?) of the genus from North Africa, and at any rate its certain absence from Europe, shows that either the Desert of Sahara or the Mediterranean has formed a bar sufficient to prevent the immigration of this genus *from the south northwards.*

There is an unmistakable agreement also between the Old and New World tropics. The following generic types are common to the two:—*Perichæta*, *Urochæta*, and *Rhinodrilus*. On the other hand, the genera *Diachæta*, *Onychochæta*, *Urobenus*, *Trigaster*, *Geoscolex*, and *Anteus* are peculiar to the New World; while *Typhæus*, *Perionyx*, and *Moniligaster* are peculiar to the Old.

There is not a marked agreement in species. *Urochæta corethrura*, *Perichæta indica*, *P. affinis*, and *P. Houlleti* are the only forms which are common to the Neotropical and Oriental regions.

This resemblance is probably largely due to climatal causes. *Perichæta*, although an almost world-wide genus, is decidedly more abundant as we approach the hotter regions.

It is an old form, and has, therefore, had time to spread widely, like the tapir and *Peripatus*.

But although the resemblance may have something to do with climatal causes, the evidence at our disposal by no means supports any theory of climatal distribution and division of the world into faunal zones.

The Australian region, at any rate as regards the Australian continent, has a somewhat peculiar earthworm fauna. Apart from *Perichæta* and *Megascolex*, which occur here as in almost all parts of the world, there is the peculiar genus *Anisochæta*, which connects *Perichæta* with *Cryptodrilus*.[1] This latter genus is, with the exception of two species, confined to Australia. It and *Megascolides*, *Digaster*, and *Didymogaster*,[2] which are absolutely confined to Australia, are the most characteristic genera of that continent. *Urochæta* is represented in Queensland by a distinct species.[3] *Acanthodrilus* is represented by one species, as is also *Microscolex* (Rosa considers that Fletcher's *Eudrilus dubius* is probably really to be referred to that genus). The bulk of the Australian earthworms therefore belong to Rosa's family *Eudrilidæ* (which, as it appears to me, is a very natural family, if only *Eudrilus* itself be excluded!). Out of the remaining eight genera of this family, three—viz., *Neodrilus*, *Rhodo-drilus*, and *Dichogaster*—are confined to the Australian region, though not inhabiting Australia itself. Of the remaining five, *Pontodrilus* and *Photodrilus* are Palæarctic, while *Typhæus* is Oriental, in fact, Indian, and *Eudriloides* and *Callidrilus* are Ethiopian.

The Australian area, especially the Australian continent, forms, therefore, a very well-marked distributional region, which has something—though little—in common with the Oriental region.

Oceanic islands are naturally—from their origin—not

[1] I regard Michaelsen's *Cryptodrilus purpureus* (=*unicus*, Fl.) as representing a new genus. I discuss the reasons for this in a forthcoming paper.

[2] Fletcher's *Perissogaster* does not appear to me to be a valid genus.

[3] I hope to show elsewhere that some examples of *Urochæta*, which I described from Queensland some years ago (Observations on the Structural Characters of certain new or little known Earthworms—Proc. Roy. Soc. Edin., vol. xiv., 1887, p. 160 *et seq.*), are distinct from *U. corethrura*.

inhabited by purely terrestrial animals which are not gifted with means of crossing the ocean. There are, however, exceptions to this rule, which are not a little puzzling—such as, for example, the occurrence of *Rana Guppeyi* in the Solomon Islands. Earthworms form another exception. Apart from the islands of the Pacific, which are for the most part separated from each other by such narrow tracts of ocean that an accidental transfer of species is credible, we have earthworms occurring in Madeira, Tenerife, St Helena, Fernan Noronha, Marion Island, Kerguelen, and South Georgia. Tenerife is included in the Palæarctic region, and the justice of this conclusion is borne out by a consideration of its earthworms. Through the kindness of Mr E. B. Poulton, F.R.S., and Mr F. W. Headley, I have become possessed of a number of earthworms from that island belonging to the genera *Microscolex*, *Allurus*, and *Allolobophora*. This resemblance, however, may perhaps be only the result of a more active commercial intercourse with Europe than with any other part of the world. St Helena is inhabited by several species of earthworms belonging to the genus *Perichæta*. But the most interesting occurrence of earthworms on any oceanic islands is their occurrence in Kerguelen and Marion Islands. On each of these islands one species occurs, which appears to be the same. As Lankester's *Acanthodrilus kerguelenensis* was adequately described, while Grube's *Lumbricus kerguelarum* was—to avoid all semblance of exaggeration—*in*adequately described, I retain the former name, though the species are probably identical.

There is obviously not sufficient intercourse between Kerguelen and other parts of the world to account for the artificial introduction of this *Acanthodrilus;* and, as it differs specifically from any form hitherto described, it has probably occupied the islands for a considerable period. Kerguelen itself is an island of considerable age, as is evinced by the fact that it possesses sedimentary rocks (formed, however, exclusively out of the *débris* of its volcanic substructure).[1] I point out elsewhere that Kerguelen forms part of an Antarctic

[1] Since the above was written, Mr Blanford's "Presidential Address" to the Geological Society has appeared. I have quoted on p. 286 some other

faunal area, including New Zealand and Patagonia; this is shown in many groups, both terrestrial and marine. Probably Kerguelen and these other countries were stocked from an Antarctic continent which was in a comparatively recent geological period inhabited by terrestrial animals.

TABLE INDICATING NUMBER OF GENERA IN DIFFERENT REGIONS.

	Genera.	Peculiar Genera.	Percentage.
Palæarctic, . . .	8	4	50·0
Ethiopian, . . .	10	7	70·0
Oriental, . . .	9	5	50·5
Nearctic, . . .	5	3	60·0
Neotropical, . . .	11	6	50·4
Australian, . . .	11	7	63·6

We cannot, of course, at present pay much regard to the numbers given for the Ethiopian region, it has been too little explored; but of some of the other regions, particularly the Palæarctic and Australian, we have a fair knowledge. It is noticeable that, as in Vertebrata,[1] the Ethiopian, Neotropical, and Australian regions have the largest number of peculiar forms, and the Nearctic the smallest. The genera allowed are those given in the faunal lists on pp. 269-278, with the exception of the doubtful ones marked in those lists with a query.

Chief Facts contained in the above.

(1.) The close resemblance between the Nearctic and Palæarctic regions necessitating their fusion into a Holarctic region.

(2.) The separation of Japan from the Palæarctic, and its relegation to the Oriental region.

(3.) The great richness of South America and Australia in peculiar types.

suggestions from this important contribution to the subject under discussion. He remarks, with reference to Kerguelen, that it is far from clear that its volcanic formations do not belong to the continental type.

[1] Wallace, Geographical Distribution of Animals, vol. i., p. 81.

(4.) The wide distribution of *Acanthodrilus* in the land masses of the Southern hemisphere, which agree in the great abundance of species of this genus and comparative rarity of other forms.

(5.) The marked difference between New Zealand and Australia.

Explanation of Maps.

Pl. XIII. The distribution of the Acanthodrilidæ is shown in red.

Pl. XIV. The dots indicate the areas occupied by the Eudrilidæ.[1] The cross lines indicate the areas occupied by the Perichetida. The dark red patches show when *both* families occur.

XXVI. *Notes upon the Marine Accumulations in Largo Bay, Fife, and at Portrush, County Antrim, North Ireland.*

By Alfred Bell, Esq., London. (Communicated by James Bennie, Esq.)

(Read 15th January 1890.)

Largo Bay, Fife.

Shortly before leaving London for Australia, Mr Robert Etheridge, jun., a former president of this Society, suggested to the writer that if ever opportunity served, a further examination of the fauna in the raised beds near the Cockle-mill Burn in Largo Bay would be desirable, as the list of species recorded by him in his paper upon these deposits, read before the Royal Physical Society, Edinburgh, vol. vi., p. 105 (1881), only embraced the larger forms. At a later period, thanks to the kindness of Mr J. Bennie, who had worked with Mr Etheridge, the smaller matter and floatings came into my hands, and from these and a second parcel from the same gentleman, and material obtained on a personal visit, the appended lists have been compiled.

The physical features of the deposit have been so carefully and thoroughly described by Mr Etheridge, that little can be added. On my visit the driving sands had partly obscured the face of the section, but not so far as to obliterate the traces of current bedding and lamination.

Agreeing with my friend that its origin is marine rather

[1] I have not referred in the text to the occurrence of two new genera of Eudrilidæ which I have just received from Lagos, W. Africa.