INDIAN EARTHWORMS. I. THE GENUS *PHERETIMA*.

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CONTENTS.

INTRODUCTION.

Since 1872 more than a score of species have been erected for Indian forms or listed or reported from India. After examination of most of the material (Bourne's specimens apparently have not been preserved and a few other specimens of less importance have not been available for examination), it is now possible by the exclusion of mistaken records, elimination of forms probably belonging to other genera and the reduction of several names to synonyms to bring the number of species to 12, to which one hitherto unrecognized species must be added. All these 13 species now can be defined adequately, though the extent of variation of certain important characteristics of three of the species still remains to be determined. Barring accidental importation by man or

otherwise it is probable that no further species of *Pheretima* will be added to the Indian fauna, at least so far as the area south of the Himalayas and west of Assam and Chittagong is concerned (but see p. 186).

In this paper India is regarded as comprising political India, except that Nepal is included and Burma, the Andaman and Nicobar Islands are excluded. The inclusion of Ceylon would necessitate no additions to the list of species. Moving the eastern boundary of India into Burma nearly to the Irrawaddy in the north and nearly to the Shan Plateau in the south would require the addition of only one species, *P. peguana*.

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DISTRIBUTION.

Michaelsen in his 1909 and 1910 lists characterized almost all of the Indian species of *Pheretima* as peregrine or of doubtful status, with suggestions that the dubious names are synonyms of peregrine species. A single species is regarded as " probably endemic " (*anomala*, 1909, p. 119) but in the list in the same paper the term endemic is preceded by an interrogation mark and followed by " aus botanisch Garten !"

The term " peregrine " was introduced by Michaelsen in 1903 to characterize species widely spread through their own inherent powers of migration or as a result of accidental transference by man. " Ich bezeichnete deshalb Arten mit einer derartig. weiten Verbreitung überland, einerlei ob Verschleppung durch den Menschen oder Ausbreitung auf natürlichen Wege vorliegt, als ' Weitwanderer ' und vereinigte sie unter der Bezeichnung ' peregrine Formen' mit den sicher Verschleppten". (1903, p. 17). " Das hauptsächlichste Merkmal für Verschleppungsfälle bei Regenwürmern ist eine sehr weite, und zumal auch eine sprungweise Verbreitung übersee, sowie auch das sporadische Auftreten weit entfernt von dem Gebiet, das als das Hauptquartier der betreffenden Gattung anzusehen ist ". (p. 16). Endemic is explained as follows : " Eine Art, die lediglich in einem eng begrenzten Gebiet vorkommt, ist als endemisch in demselben anzusehen ". (p. 17). Michaelsen recognized that the very numerous gaps in our knowledge of the distribution of earthworms necessitated some further indication of endemicity and accordingly adds " Eine Anzahl nahe verwandte Arten, die lediglich in einem eng begrenzten Gebiet vorgefunden wurden, sind als endemisch in demselben anzusehen ". (p. 17).

Stephenson (1923) refrained from using the terms peregrine and endemic in his lists but indicated by difference in type those species which are considered to be of zoogeographical value or with no such value. No clue is given as to how " zoogeographical value " was determined though peregrine forms are said to be of no importance. " Semi-peregrine forms " however are italicized. Only five species of *Pheretima* are regarded as having zoogeographical value. Of these, *burliarensis* is probably not a *Pheretima*, at all, *travancorensis* and *trivandrana* are merely synonyms of *houlleti*, a widely spread form of " no zoogeographical value ", while *alexandri* is the same as Stephenson's *lignicola*, a species also considered to be of no zoogeographical importance. This leaves only *anomala* which is known now to be distributed widely throughout Burma and also present in Siam. Presumably all of the Indian species of *Pheretima* would be considered by Michaelsen as peregrine, or at least as " etwas peregrine ", or by Stephenson as of no zoogeographical value.

It is true that a number of the Indian [1] species of *Pheretima* have been carried far and wide and have been able to establish themselves in a number of localities far removed from their original habitat. Beddard in 1900 characterizes the distribution of *P. heterochaeta*, now known as *diffringens*, as " everywhere, including Europe " Gates, in a paper on " The genus *Pheretima* in North America ", now in the press, recognizes 13 American[1] species of which 8 are also Indian. It is likewise true that several species of *Pheretima* are more or less widely distributed throughout India. But the common occurrence of certain species in those (relatively few) localities from which collections have been made and the wide accidental transference have been so over-emphasized that important and almost obvious aspects of distribution have been overlooked. Such statements as " being a well-known peregrine form, the occurrence is of no importance from a zoogeographical point of view " (Stephenson, 1915, p. 37) and " It is scarcely necessary any longer to particularize concerning the distribution of this almost ubiquitous worm, at any rate in those provinces where it has already been found " (Stephenson, 1917, p. 385) are especially unfortunate as they may have been responsible for a failure to record the presence of certain species in important localities.

Beddard's characterization of the distribution of *heterochaeta* is obviously to be taken as an epigram rather than literally. There are many regions to which the species might have been carried and within which it might have become established but from which *P. diffringens* is quite unknown. Expressions such as " one of the commonest worms in India " (Stephenson, 1923, p. 302), " almost ubiquitous ", " Throughout India " (1923, p. 304) and " universally found " (1923, p. 311) have certainly led to misconceptions. To mention but one of these, Bahl (1936, p. 8) says that " *Pheretima posthuma* is found *nearly all over* India, Burma and Ceylon " (italics mine). This statement is incorrect or at least conveys an altogether erroneous impression for the species is quite unknown from large sections of Burma, including some sections which have been fairly thoroughly investigated, and in the districts in which it has been found, is restricted (largely, though not entirely) to a fairly limited habitat. Furthermore, no record can be found of the occurrence of the species in Ceylon. The statement is also too optimistic so far as India is concerned as a glance at the distribution on p. 182 will show.

Before proceeding to a discussion of the individual distribution of Indian species of *Pheretima* it is again necessary to emphasize certain aspects of our knowledge of Indian earthworms. Systematic collection and study of earthworms has been carried out hitherto only in the Punjab and in Travancore (Aiyer, 1929). Accordingly it is still true " that India is so large and diversified that all that has been done is really not much more than the taking of a few samples here and there " (Stephenson, 1915, p. 17). Therefore, in spite of the memoirs on Indian earthworms that have been published since 1909, any discussion of distribution must still be characterized by considerable caution, as " we

[1] The term Indian or American as used in this paragraph implies only that the species is known from India or America.

are still far from a complete acquaintance with the distribution of Indian earthworms, and . .any conclusions based on the absence of any forms from this or that region are liable to be upset at any time" (Stephenson, 1915, p. 37).

During the past 13 years considerable work has been done on the earthworms of Burma. This work, though still far from complete, has been extensive enough to warrant certain conclusions though based on absence of forms from especial areas. Such conclusions, if found to be applicable in India, are less likely to be upset even though our knowledge of Indian distribution be fragmentary. The consideration of each of the Indian species is prefaced therefore by a statement of the Burmese distribution and, when possible, by some indication as to the Siamese, Indo-Chinese, Chinese or Malayan distribution. However, it should be noted that very little is known of the earthworms of Siam and not a great deal more of the worms of the Malay Peninsula or French Indo-China.

I.

P. alexandri. This species is widely distributed in central and eastern Burma, having been found in 27 of the 40 districts or political divisions (the Northern and Southern Shan States and Karenni each counted as a district). The worm is equally common on the plains and in the hills, and on the Shan Plateau has been found up to an elevation of 4,000+feet. There is no reason to suspect that the species is lacking in those few districts of central and eastern Burma where collections have not yet been made or where it has not yet been found. At present the species appears to be absent from the Arakan Division and the Chin Hills district of western Burma, but it has been collected at Chiengrai, Chiengmai, Mu'ang Pong (Ban Muang) on the Me Yom, in Upper Siam, Bangkok, Kosichang (on the Gulf of Siam) in Lower Siam, and is also known from Yunnan (Lawng Neu in Mong Lem State) and the Andaman Islands.

A line drawn on a map from Mergui through Siam just east of Bangkok to Chiengmai and then through Mong Lem State into Myitkyina district and from there south to the Chindwin and along the eastern side of the Arakan Yomas to the Bay of Bengal will enclose an area that is compact and which lacks just those physical barriers such as the snow-covered mountain ranges, deserts, or salt seas which are usually regarded as effective in restricting the migration of earthworms. Although compact, the area is not homogeneous with respect to climatic, physiographic and edaphic factors but this seems to be of no particular importance in view of the ability of the species to maintain itself in a variety of habitats in both plains and hills. Since accidental transference is not necessary to explain the distribution of the species within the region just outlined, it is possible to regard this area as the natural range of the species and to conclude that the species originated at some point therein. Though this region is compact Michaelsen might not regard it as an "eng begrenzten Gebiet" But how far from its point of origin can a species migrate within a compact region and still be considered endemic?

The presence of *alexandri* in Bombay as well as on the Andaman Islands, for the present at least, must be regarded as due to accidental transportation.

When a species is found in an isolated locality far from its natural range, such a discontinuous distribution can be explained by assuming that the species has been carried by some external agent to the isolated locality or else that the species has become extinct in the intervening area. Extinction can be disregarded so far as the genus *Pheretima* and south-eastern Asia are concerned.

Earthworms are known to have been carried unintentionally by man, for quite considerable distances. Similar accidental transportation by birds, cattle or other non-human agencies have been postulated but not demonstrated. (I have been told of the finding of cocoons of *Pontodrilus bermudensis* on feet of birds but can find no record of this.) It is possible, if not probable, that most instances of accidental carriage mentioned in this paper are to be attributed to man, but whether this be true or not, the agent or agents involved in the transport to 'foreign' regions are not of importance in the present discussion.

If *alexandri* is really absent from western Burma the Calcutta record also will have to be regarded as due to accidental carriage.

The other Indian locality, Dibrugarh in Assam, is less than 200 miles from the nearest Burmese locality. The earthworm fauna of the intervening region, unlike that between Burma and Calcutta, is unknown. There is however no reason to assume that *alexandri* has been unable to push through the intervening region or that it is lacking therein. Dibrugarh is the northernmost record and it should be noted that *alexandri* has never been found in the Himalayas especially at those higher elevations at which *diffringens* has been obtained.

P. anomala. This species is widely spread throughout the province of Burma and has been found in 29 of the 40 political districts. It is known from the Arakan division and the Chin Hills district in which *alexandri* has not yet been found and is common both in the plains and on the Shan Plateau where it has been found up to an elevation of 4,000+feet. There is no reason to suspect that the species is lacking in the 9 central and 2 peripheral districts which have not yet been investigated or in which it has not yet been secured. The species has been collected in Siam (Chiengrai) and in the Chinese province of Yunnan (Mong Mong State) but is unknown from the Malay Peninsula and the Andaman Islands.

A line drawn on the map to mark off the *anomala* range passes from a point southeast of Mergui north to Chiengrai, through Mong Mong (Yunnan) and Pang Long (Burma) States into Myitkyina district and then in a southerly direction west of the Chindwin river and the Arakan Yomas to Akyab. The area thus demarcated is compact and approximately of the same size as the *alexandri* area. Within this area *anomala* seems to adapt itself equally well to the varied habitats offered by the hills, the Plateau, the monsoon tropics and the semi-arid central zone. (This distribution is especially impressive in view of the constantly occurring high percentage of abnormal forms.)

The three Indian localities of *anomala* are at some distance from the natural range of the species as indicated above, the two easternmost localities about 300 miles (Calcutta) or 400 miles (Darjiling district) from the western boundary of the area in Burma. The other Indian locality (Dehra Dun) is about 700 miles west from Darjiling district. In the intervening region between Burma and the Indian localities the

physical features (such as snow-covered mountains, etc.) that prevent earthworm migration are lacking. In view of the ability of the species to maintain itself in a variety of habitats and to perpetuate itself in spite of the large percentage of abnormal and sexually non-functional individuals, there is no reason to conclude that the species has been unable to penetrate into Bengal to Calcutta and to Darjiling district by its own activity, providing only that sufficient time for such migration has been available. On this latter topic no information whatever is available. At present the three Indian records appear to be the result of accidental transference and especially the Dehra Dun record. It should be noted however that the western border of the *anomala* area is close to the political boundary of India and probably will have to be moved in the future into India.

Dehra Dun and Pashok (Darjiling district) are the northernmost records. Unfortunately the elevations at which the worms were secured are unknown. Although known from lower elevations in the southern Himalayas, *P. anomala*, like *alexandri*, has not been found at those higher elevations at which *diffringens* has been obtained.

P. campanulata. This species is widely spread throughout the province of Burma and has been found in 24 of the political districts. It has been obtained, like *anomala*, from the Arakan division and the Chin Hills district where *alexandri* is unknown, and is common both in the plains and hills and on the Plateau where it has been found up to an elevation of 4,000+feet. The species is known from the Chinese province of Yunnan (Ang Lawng Mt., and Mong Ma, Mong Lem State) and has been found at Mu'ang Pong (Ban Maung) on the Upper Me Yom in Siam (unpublished Ms.), in the Malay Peninsula (Kuala Lumpur) as well as on the Andaman Islands.

P. campanulata is closely related to two other Burmese species. One of these, *P. meridiana*, has been found as yet only in eastern and northern Burma (except for one record from the Bahamas, obviously the result of accidental transportation), but the other, *P. houlleti*, is even more widely distributed than *campanulata*.

The *campanulata* range is slightly larger than that of *anomala* due to the fact that the line begins at Victoria Point at the southernmost extremity of Burma and passes north through Siam further east than in the case of *anomala*. If " eng " and " Anzahl " are not too strictly interpreted— *campanulata* appears to possess both of Michaelsen's qualifications for endemicity. The species seems to be equally adapted to the varied habitats of the plains and hills except for that of the semi-arid zone of Central Burma in which it has not yet been found.

The only Indian localities (both in Darjiling district) are about as far from the northern border of the *campanulata* area as Kuala Lumpur is from the southern border. The Indian and Malay Peninsula as well as the Andaman Islands records, at present, appear to be the result of accidental transference. As in the case of *anomala* the western border of the *campanulata* area is close to the political boundary of India and probably will have to be moved over into India. The elevations at which the Darjiling district worms were secured unfortunately are unknown.

P. houlleti. This species is widely spread throughout the province of Burma, having been collected in 33 of the 40 districts. It is found on the plains and hills, and on the plateau up to an elevation of 5,000+ feet and most probably is present in the 7 districts which have not yet been investigated. It is known from several localities in Siam (Bawti, Not Theinko, Bangkok in the south; Chiengmai and Muang Pong in the north), the Malay Peninsula (Kuala Lumpur, Aring in Kelantan, Singapore) and the Andaman Islands. Michaelsen (1900, p. 273) includes Cochin China in the list of localities but I have been unable to trace this record. The species is not known from China (previous records are the result of erroneous suppression of valid species) except for one record from Yunnan just across the Burmese border (Mong Lem State).

In India the species is widely spread and here also has been found in hills and plains and about equally in both. In the hills the species has been found up to an elevation of 4,500 feet but seems to be quite rare or lacking in most parts of the Himalayas, especially at those, higher elevations from which *diffringens* has been obtained. Rawalpindi is the northernmost locality, Dehra Dun and Bhim Tal the next.

Beyond the mainland of Asia the species has been reported from Sumatra (twice), Java (twice), the Philippine Islands (twice), Fiji Islands, Ceylon, Madagascar, Gross Comoro and French Guiana. None of these records can be accepted until verified because of a long confusion of *houlleti* with at least three other species. In view of the ability of the species to maintain itself successfully in a wide range of habitats varying from the equatorial rain forest to the monsoon plains and semi-desert lowland regions as well as the hills, its wide distribution throughout India and southeastern Asia, it is very curious that the species has not been transported as widely as *diffringens.*

P. houlleti is close to two other Burmese species, *P. campanulata* (Burmese-Siamese), and *P. meridiana* (eastern and northern Burma). The species is considered to have originated somewhere in the Burmese-Siamese region but just how much of its Indian distribution, if any, is to be attributed to accidental transportation is not clear. The Ceylon and Andaman Islands records are regarded as due to accidental carriage.

P. planata. This species is rather widely spread in Burma, having been found in 22 of the 40 districts. Within the semi-arid region of Central Burma it has been found but once (Pyinmana) and is known from only three localities on the Shan Plateau (Namkham, Lashio, Karen Hills of Toungoo district) where it has been found at elevations of 2,000+ to 3,000+feet. Although widely spread it is not common, usually being found only after careful search and then not in numbers. It is not known from Siam and China but has been found once in the Malay Peninsula (Kuala Lumpur) and apparently is rather common on the Andaman Islands. *P. planata* is close to a trans-Salween species, *P. immerita*, known only from Kengtung, Mang Lun and Pang Long States, an area quite definitely to be characterized as " eng begrenzten "

The only Indian record is Katlicherra (South Cachar in Assam) which is perhaps 150 miles from the nearest Burmese locality (Upper Chindwin district). Very little is known of the earthworm fauna of the

intervening region but there is no reason to suppose that *planata* is lacking therein. A line drawn from the northern portion of Mergui district north through Burma to Lashio, Namkham, and Myitkyina and then through Cachar to Akyab marks off the range of the species as now known and encloses an area somewhat smaller than that of *anomala* (but west of the *immerita* area). *P. planata* appears, at present to be primarily a Burmese species that has been accidentally transported to the Malay Peninsula and the Andaman Islands. However, it is possible if not probable that the species will be found to be fairly widely spread in Assam and Siam and perhaps also throughout the Malay Peninsula.

P. posthuma. This species is rather widely spread through the province of Burma, having been collected in 29 of the 40 districts, but is restricted to the plains and low country. Even here it is found most commonly and in greatest numbers in the sandy soil along the banks of rivers and streams. Two records from the Shan Plateau are erroneous. If found in the higher hills and on the Plateau, the localities probably will be along banks of streams. The species is known from the Andaman Islands and has been recorded once from the Malay Peninsula (no specific locality) by Beddard but the record has never been confirmed and Stephenson was unable to find Beddard's specimens in the British Museum. The species has been collected at several localities in Upper Siam (Chiengmai 1,000 ft., Ban Sa-iep and Mu'ang Pong) as well as in lower Siam (Bangkok) but is unknown from China.

According to Stephenson (1923, p. 311) *P. posthuma* is " universally found in North India " but though it has been collected from a number of localities it has never been reported from the higher mountain elevations at which *diffringens* has been found. The northernmost localities are in the Punjab. Furthermore, the species has been found hitherto only once south of a line from Baroda to Calcutta and then at Bombay. Of the Indian localities, almost all are in the plains or lowlands. Five times only has the species been reported from places with an elevation greater than a thousand feet (Hoshiarpur, 1,000+feet, ; Kalka, 2,000-3,000 ft. ; Ajmere and Udaipur, 1,500-2,000 ; Dehra Dun, 2,000-3,000 ; and even here the elevations at which the worms were secured may be unknown). Eighteen of the Indian localities are shown even on our small maps as being on the banks of rivers.

Morphologically as well as physiologically (adaptation to the sandy river-bank habitat) *P. posthuma* is rather peculiar and unlike all other Burmese species of *Pheretima*. For this reason a Burmese origin for the species at first seems to be rather doubtful. However, the more important of the morphological peculiarities have to do with the commissural blood vessels of segments x and xi and these characteristics also distinguish the species from all other Pheretimas, at least so far as is known at present. The Burmese distribution though extensive is much less so than that of *Pontoscolex corethrurus* which is certainly an introduced species but not so restricted as to habitat. For the present *P. posthuma* may be regarded, though doubtfully, as of Burmese or Burmese-Siamese origin and with a south-eastern Asiatic mainland distribution that does not require the assumption of accidental transference at least by man,

II.

P. diffringens. In Burma this species has been found on the Shan Plateau (Namkhai, Namkham, Lashio, Maymyo, Mogok, Taungyi, Htamsang, Kalaw, Manchio and Thandaung) and outside the plateau only once, at Bhamo. It has been found at elevations of 2,000+to 4,000+feet and only once below 2,000 feet, and then at Bhamo (under 500 feet but north of the tropic of Cancer). The species is known from several provinces of China (Yunnan, Szechuan, Kiangsu, Kiangsi, Chekiang, Anhwei and Fukien) and is close to Chinese, Korean and Japanese species which are not at present clearly distinguished and which may have to be suppressed. Unknown from Siam, French Indo-China, the Malay Peninsula or the Andaman Islands.

In spite of the fact that Stephenson gives the distribution of the species as " Throughout India " (1923, p. 304), *diffringens* has been found hitherto only in a region north of a slightly curved line drawn from Lahore south-east to Rangamati, and in South India where it is known only from the Bababudan, Nilgiri and Palni Hills. *P. diffringens* has been found in the eastern and western Himalayas and Assam at elevations of 3,000-7,000 feet, in the North-west Frontier Province at elevations of 1,000-2,000 feet, and in South India at elevations of 4,500-7,500+feet.[1] At lower elevations the species is known only from the Punjab (600+feet), Siliguri, Teesta Bridge (500-700 ft.) and Rangamati in Bengal, Kobo and Sadiya in Assam. The Kangra district localities (Punjab) are at the edge of hills north-east of Lahore, Siliguri and Teesta Bridge are close to the Himalayas as are Kobo and Sadiya while Rangamati is close to the hills of the Chittagong Hill Tracts. Rangamati is the only plains record south of the tropic of Cancer (the Rangamati worms may of course have been obtained at some nameless locality in hills near Rangamati), all of the other plains and lower hills records quite to the north of that tropic.

P. diffringens is widely spread as a result of accidental transportation, probably much more widely spread than any other species of *Pheretima.* Much of this accidental carriage is certainly due to man,—note the records from botanical gardens and hot houses in Europe, America and elsewhere. It is extremely unlikely that this species has been carried by man, in India for example, only to temperate zone localities or only to those high hills in the tropics with a cool climate. We must assume therefore, that in tropical lowland localities to which the species has been transported, it has been unable to maintain itself though able to adapt itself to a variety of habitats in the temperate zone and higher hills of the tropics. These considerations together with the wide Chinese distribution seem to indicate that the worm is a temperate zone form and that it has originated somewhere in the Chinese region. Penetration into Burma and at least into the eastern portion

[1] The elevations at which *P. diffringens* has been secured in South India are as follows:—Kodaikanal, 7,000, 6,850, 6,900, 6,850-7,000 ft.; Kotagiri, 5,700; Fern Hill, 7,500; Bababudan Hills (Kadur district in Mysore), 4,500; Naduvatam, 6,000; Coonoor, *ca.* 5,000; Benhope, exact elevation not known but nearest railway station, Hillgrove, is *ca.* 3,000 ft. The writer is indebted to Dr. S. L. Hora for much of this information.

of north India accordingly is to be regarded as due to natural migration of the species, while accidental transportation must be invoked to explain its presence in South India. Whether the presence of *diffringens* in north India way into the North-West Frontier Province can be regarded as brought about without accidental transportation is not yet clear.

P. hawayana. In Burma this species has been found on the Shan Plateau and only on the northern portion (Namkham, Kawngmu, Kutkai, Lashio and Mogok, all north of 22° latitude). It has been found only at elevations of 2,000 to 3,000+feet. The species is known from several provinces of China (Yunnan, Szechuan, Fukien and Chekiang) and may have been described from Japan under another name. Stephenson has recorded the species from the Malay Peninsula (Kuala Lumpur and Singapore), records which cannot be accepted until verified because of a failure to distinguish between *hawayana* and *morrisi.*

In spite of the fact that Stephenson calls this species " one of the commonest worms in India " (1923, p. 302), it is known at present only from a few localities ; Lahore (Punjab), Ramnee (Western Himalayas), Kurseong (Eastern Himalayas) and Shillong (Assam). All of these localities are north of 25° latitude and the westernmost are north of 30° All Indian records are from elevations of 3,000 to 5,000+feet. The Ceylon records are also from the hills.

With a distribution like that of *diffringens* and an apparently similar temperature restriction (barrier) it is probable that *hawayana* likewise originated in China. Presumably it has penetrated into Burma and at least the eastern portion of north India by its own activity.

P. morrisi. This species is more widely spread in Burma than *hawayana,* having been found not only on the Shan Plateau (Namkham, Kutkai, Hsenwi, Lashio, Mogok, Maymyo, Taungyi, Htamsang, Pang Long, Mang Lun, Mong Yai and Kengtung States) but also in Myingyan (Mt. Popa only), Bhamo and Myitkyina districts. It has been found only at elevations of 2,000 to 4,000 feet, except at Myitkyina and Bhamo (under 500 feet but north of the tropic of Cancer). The species is known from four provinces of China (Szechuan, Fukien, Chekiang and Yunnan). It has been collected once in Siam (Chiengmai, 1,000 feet) but is unknown from the Malay Peninsula and French Indo-China. (A record of *P. hawayana* from the Malay Peninsula by Stephenson may actually be for *morrisi* which is known from Penang.)

In India *morrisi* has been found chiefly at elevations of 2,000 to 6,500 feet. It has been obtained at only three localities south of the Lahore-Rangamati line ; Brindaban, Udaipur (2,460 feet) in Rajputana, and Bombay. Only three records are from lowlands ; Lahore (600+feet), Brindaban (500-feet), and Bombay.

With a distribution like that of *diffringens* and *hawayana* and an apparently similar temperature barrier, it is possible that *morrisi* likewise originated in China and like the other two species has penetrated into northern Burma and at least the eastern portion of north India by its own activity. Its presence on Mt. Popa in Burma and those localities in India south of the Lahore-Rangamati line is regarded as due to accidental transportation.

P. robusta. In Burma this species has been found only in the northern portion of the Shan Plateau (Namkham, Kutkai, Lashio, Hsipaw and Pang Long States) where it has been found at elevations of 2,000+to 4,000+ft. The species is probably widely distributed in China and has been recorded from the provinces of Yunnan, Szechuan, Fukien, Kiangsu, Kiangsi, Chekiang and Hupei.

Outside the Asiatic mainland the species has been reported from Madagascar, Mauritius, the West Indies and the Philippines. None of these records have ever been confirmed and some of them must be regarded as very dubious.

The only Indian record is that of *P. himalayana* from Darjiling at an elevation of 7,000 feet.

At present it is necessary to regard *P. robusta* as having originated somewhere in China and also as a temperate zone form, that has been able to penetrate into Burma and India as a result of its own activity.

III.

P. elongata. This species is rather widely distributed in Burma having been collected in 20 of the political districts. It has been found both in the plains (monsoon and semi-arid) and hills and in the latter to a height of 3,000 feet but has been obtained from only four localities north of the tropic of Cancer; Mawlaik, Indaw Lake, Bhamo and Myitkyina. Although fairly widely spread it is not common and when found is usually not obtained in any considerable numbers unless the soil is "black" It has been collected in Siam (Bangkok and Chiengmai) and the Andaman Islands but is unknown from the Malay Peninsula, French Indo-China and China.

In India the species is almost confined to the tropical portion as it has been found only once north of the tropic of Cancer, and then at Karachi.

P. elongata has been transported widely throughout the tropics and presumably by man. Only in Burma and at Karachi has the species been found outside of the tropics and then not far to the north. It is unlikely that a species so widely spread by external agencies has been carried only into tropical regions. Restriction to the tropics with the correlated inability to maintain itself in cooler regions to which it must have been carried seems to require a tropical origin for the species. Morphologically *elongata* can be included in Michaelsen's subgenus *Polypheretima* from the southern portion of the Malay Peninsula, Borneo, Celebes and New Guinea and in fact is so close to one of the Borneo species, *P. stelleri*, that the two cannot be adequately distinguished, at least at present. Should the original home of *elongata* be in Borneo, the Burmese and Indian records are to be considered the result of artificial transference. Even though the home of the species should prove to be in the Malay Peninsula the (present) Indian distribution will still have to be explained as the result of accidental transportation.

P. bicincta and *P. taprobanae.* Neither of these species has been found in Burma and at present there is little of importance to be said with regard to the distribution of these worms. *P. bicincta* has been recorded only twice from the "*Pheretima* domain"; once from the Philippines and once from Java. Its presence in India is obviously the

result of accidental transportation. *P. taprobanae* is quite unknown from the "*Pheretima* domain", and also must have been carried into India accidentally. All localities at which these two species have been found are within the tropics. Like *elongata*, *bicincta* and *taprobanae* appear to have had a tropical origin and to be able to maintain themselves only in that portion of the world.

To summarize.—Of the thirteen Indian species of *Pheretima*, three quite obviously are present in India as the result of accidental transportation. The original homes of these species are unknown but one is to be sought for in Borneo and the probability is that all three are tropical if not primarily equatorial. Four species are regarded as originally Chinese, *e.g.*, *diffringens*, *hawayana*, *morrisi* and *robusta*. Of the remaining species, *alexandri*, *anomala*, *campanulata* and *planata* (possibly also *houlleti* and *posthuma*) are regarded as primarily Burmese or Burmese-Siamese. Each species in the last two groups (Chinese and Burmese) is in India, or will eventually be shown to be, as a result of its own activity rather than as the result of accidental carriage. Immigration of Chinese species from the north-east (and north ?) and of Burmese species from the east explains the heavy concentration of *Pheretima* localities in that portion of India north of a line from Baroda to Calcutta. Some species however have been carried accidentally to isolated localities which may be at considerable distances from regions to which the species have penetrated naturally.

South-eastern Asia—India-Burma-Siam-French-Indo-China—lacks the physical features such as deserts, snow-covered mountain ranges and salt seas that are usually regarded as effective barriers to earthworm migrations. This region does have a wide variety of climatic, edaphic and physiographic habitats. One species, *P. posthuma*, is restricted largely to one peculiar habitat, the sandy soil of river banks. Another species, *P. campanulata*, at present, seems to be unable to exist in the semi-arid region of central Burma. Other species however are able to adjust themselves to and maintain themselves in a wide variety of the habitats available. Within the region the only effective barrier to migration seems therefore to be that of temperature. But temperature cannot be invoked to explain the boundaries of natural areas of certain species, or why a particular species is lacking in a contiguous region of suitable habitats. Of those factors which are of most importance in explanation of this problem, factors such as speed of travel and time available for migration since origin of the species, we have no knowledge whatever.

On a previous page a prophecy has been hazarded that few further species of *Pheretima* will be found in India, barring of course importations of an accidental nature. If found, further species will be collected in the Himalayas to the north and in Assam and Chittagong on the east. Of the Chinese species perhaps the most likely to be found is *P. californica* which may be anticipated in the hills and mountains to the north. Of the Burmese species the most likely immigrants to be found in Assam are *austrina*, *choprai*, *exigua*, *birmanica*, *peguana* and some of the *doliaria* group. In Bengal (Chittagong) the most likely immigrant is *P. peguana*. Burmese species are not to be expected in the Himalayas,

at least at the higher elevations at which *diffringens* and other Chinese species are obtained.

Habits.

In an attempt to "determine the significance" of the enteronephric excretory organs of earthworms, Bahl (1934) has discussed the "Habits of *Pheretima* as compared with those of *Eutyphoeus*" Nowhere in the text of the paper is there any indication of the number or names of the species studied, though two names, *P. posthuma* and *E. waltoni*, are mentioned in labels of figures. Failure to observe an elementary precaution in scientific work has resulted in statements such as "the castings of *Pheretima always* consist of solid rounded pellets" (italics mine). Actually, *P. posthuma* is the only species of the genus that is known to produce pellet-like castings. The castings of all other species of *Pheretima*, so far as is known, are of the tower-like type that Bahl imputes only to *Eutyphoeus*. Furthermore, *P. posthuma* is the only species of the genus that is restricted to the river-bank habitat.

Systematics.

Genus: **Pheretima** Kinberg.

1867. *Amyntas* (Type, *A. aeruginosus, non* Wollaston 1865), + *Nitocris* (Type *N. gracilis, non* H. & A. Adams 1854.) + *Pheretima* (With two species, *P. montana* and *P. californica.*) + *Rhodopis* (Type, *R. javanica, non* Reichenbach 1854.) + *Perichaeta*, Kinberg, *Öfv. Ak. Forh.* XXIII, pp. 101, 102.
1883. *Megascolex* (maximum part) + *Perichaeta* (minimum part) Beddard, *Ann. Mag. Nat. Hist.* (5), XII, p. 214.
1884. *Perichaeta* (part), Beddard, *Ann. Mag. Nat. Hist.* (5), XIII, p. 401.
1888. *Perichaeta* (maximum part) + *Megascolex* (minimum part), Rosa, *Ann. Mus. Genova*, XXVI, p. 155.
1889. *Megascolex* (part), Vaillant, *Hist. Nat. Annel.* III, (1), p.
1890. *Perichaeta* subgenus *Perichaeta*, Beddard, *Proc. Zool. Soc. London*, 1890, p. 56.
1895. *Perichaeta* (part, excluding *Lampito* and probably also *P. viridis* Schmarda 1861) + *Megascolex* (part, including *M. margaritaceus, M. iris* and *M. pictus*), Beddard, *Monog.* pp. 388 and 370.
1899. *Amyntas*, Michaelsen, *Mitt. Mus. Hamburg*, XVI, p. 3.
1900. *Pheretima* (part, excluding *P. burliarensis* and *P. lawsoni*), Michaelsen, *Das Tierreich*, X, p. 234.
1900. *Amyntas*, Beddard, *Proc. Zool. Soc. London*, 1900, p. 613.
1907. *Pheretima*, Michaelsen, in Michaelsen and Hartmeyer, *Fauna Sudwestaustraliens*, I, p. 164. (*P. montana* designated type species.)
1922. *Promegascolex*, Cognetti, *Boll. Mus. Zool. Torino*, XXXVII, (744), p. 3. (Type, *P. mekongianus.*)
1923. *Pheretima* (part), Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 288, (excluding *P. burliarensis.*)
1928. *Pheretima*, Michaelsen, *Ark. Zool.*, XX, A, (3), p. 4.
1930. *Megascolex* (part, including only *M. mekongianus*) + *Pheretima*, Stephenson. *The Oligochaeta*, pp. 837 and 838.
1934. *Pheretima*, Michaelsen, *Quart. J. Mic. Sci.* LXXVII, p. 12. (*P. californica* designated as type species in place of *P. montana.*)

Diagnosis. Setae perichaetine. One gizzard in viii[1]. Excretory organs exonephric and enteronephric micronephridia. Testes and male funnels in testis sacs. Prostates racemose.

[1] Although the gizzard is in viii, in all species in which septum 8/9 is present, one or more of septa 8/9-10/11 may be lacking or rudimentary so that the gizzard has the appearance of extending posteriorly.

A large proportion of the species of *Pheretima* are characterized as follows. The setae begin on ii on which segment there is a complete setal circle. The clitellum is annular, extending from 13/14 to 16/17; with development of the clitellar glandularity the setae of the clitellar segments drop out and are not replaced, the intersegmental furrows between xiv and xv, and xv and xvi disappear and the dorsal pores on 14/15 and 15/16 are occluded. Ventral reproductive apertures; the spermathecal and male pores symmetrically paired, a single female pore. Septa 8/9-9/10 lacking, rudimentary or not normal. The intestine begins in xv or xvi close to 15/16. The last pair of hearts is in xiii, all hearts of ix-xiii opening into the ventral blood vessel. Seminal vesicles are paired in xi and xii, the vesicles of xi excluded from the testis sac or sacs. Spermathecal diverticulum passing into the duct just at, close to or within the parietes. Only constant specific deviation from any of these characteristics requires especial mention in the diagnoses.

Within a species there may be variation with regard to certain characteristics. Thus the single female pore may be replaced by paired female pores. One or more of the anteriormost dorsal pores may fail to develop. An occasional specimen may have an unusually large or an unusually small number of setae on one or more segments. Normally paired testis sacs may be replaced by unpaired testis sacs and *vice versâ*. A genital marking may be lacking or extra genital markings may be present. One or more of the spermathecae, ovaries, prostates, etc., may be lacking or one or more extra spermathecae, prostates, ovaries, etc., may be present. When the specific norm or pattern is known it is scarcely necessary to include such variations in a diagnosis of the species. Unfortunately, in several forms, as *P. taprobanae* and *bicincta*, only a very few specimens have been studied and hence little is known as to the variation of important structures or characteristics. Even in some of the older species, as *P. elongata* (E. Perrier) 1872, the specific norm is as yet scarcely obvious in all its details. In certain species, abnormal individuals may be much more common than normal individuals. Some of these species are known, even today, only from the aberrant specimens, though none of these species are Indian. Even though abnormal individuals are more common than normal worms, a diagnosis must of course describe only the normal forms. A correct definition based on normal individuals has only recently been possible for one Indian species, *P. anomala* (*vide* p. 193).

Descriptive and diagnostic terms and conventions. Intersegmental furrow is used in a definitely restricted sense so as to refer only to the slight line constituting the boundary externally between two successive segments. By this limitation of meaning a much more definite characterization of the location of the spermathecal pores is possible. The intersegmental furrow as now defined must be distinguished from the deep circular groove often present between adjacent metameres on strongly contracted specimens. The intersegmental furrow lies at the bottom of such a groove. Actually the intersegmental furrow, as now defined, is not a furrow at all but a new term is perhaps unnecessary.

Important information with regard to setal numbers is shown by a setal formula such as the following: vi/13-17, xvii/20-27, xviii/10-15, xix/20-27, 56-64/xx. The first portion of this formula shows that on segment vi there are 13-17 setae ventrally between two longitudinal lines passing across the spermathecal apertures parallel to the midventral line. These setae are called spermathecal setae. Ventral setae on xviii between the male pores are called male setae. The formula indicates that the number varies from 10 to 15. Similarly there are 20-27 male setae on xvii and xix but in this case the figures show the number of setae between longitudinal lines passing across the male pores parallel to the midventral line when the pores are superficial or across the centres of the apertures of the invaginations if the male pores are invaginate. If the spermathecal pores are large or invaginate the spermathecal pore lines also pass across the centres of the apertures. The portions of a formula with segmental numbers (in Roman numerals) as denominators indicate the total number of setae on the segments mentioned, thus 56-64/xx shows that the number of setae in the circle on xx varies from 56 to 64. It is sometimes necessary to refer to a definite seta or intersetal interval and in such references italicized small letters are used, thus *a* refers to the first seta on either side of the midventral line, *b* to the second, *c* to third, etc. Dorsally the first seta on either side of the middorsal line is called *z*, the second *y*, the third *x*, etc. A male pore may be located as in line with seta *b* while a dorsal spermathecal pore may be in line with *y*. The setal nomenclature is most useful however in connection with indication of location of genital markings. Thus a genital marking may be said to be in *ab* which does not necessarily mean that the marking is actually between *a* and *b* but in the space between two lines passing across setae *a* and *b* parallel to the midventral line, the exact location of the marking indicated by qualifying terms such as pre- or postsetal or intersegmental.

Superficial and invaginate, in connection with the genital markings scarcely require explanation. An invagination containing a genital pore may be restricted to the body wall or conspicuously protuberant into the coelomic cavity, in the latter case, if associated with the male genital terminalia, a pouch formed by the invagination is called a copulatory chamber.

Spermathecal apertures may be minute as in *diffringens* or large as in *indica*, minute pores may be superficial or invaginate, a large pore, apparently always, superficial. A large primary spermathecal aperture (superficial) must not be confused with the secondary spermathecal aperture of an invagination containing the primary spermathecal pore.

Genital markings are special areas that develop in the epidermis of certain segments of an anterior portion of the body towards sexual maturity. Like the male and spermathecal pores the markings may be either superficial or invaginate. If invaginate the markings are usually within copulatory chambers of male or spermathecal pore invaginations but may be located, as in *P. anomala*, in special invaginations that are eversible. The markings are usually associated with definite, glandular masses which may be sessile on or within the body-

wall, or stalked and either buried in the muscular layers or protuberant into the coelomic cavity.

Length, diameter, and number of segments are usually mentioned in specific descriptions and diagnoses. There has however been considerable carelessness in connection with these characteristics. It should be obvious that segmental enumerations and measurements of juvenile, immature, autotomized, regenerating or regenerated specimens have no particular value so far as specific characterization is concerned. Measurements for the sake of uniformity should be made on preserved, contracted specimens. (The best method of killing worms for taxonomic study is to merely drop the specimen into commercial methylated spirit. Worms may be hardened in 10 per cent. formalin and then preserved in formalin or alcohol.) The diameter may be measured at the region of greatest thickness, usually in or near the clitellar region.

Simple, as applied to intestinal caeca, is used to characterize an anteriorly directed, more or less finger-shaped evagination of the gut that has but one main axis. The term is used even though there may be several short, secondary outgrowths from the dorsal or ventral margins of the caecum.

A seminal vesicle is an outgrowth from a septum, first appearing, at least in many species, as an ovoidal vesicle or ampulla attached by a ventral stalk to the posterior face of a septum, either 10/11 or 11/12. With further development the stalk broadens out into a softish, ventral lamina with which the smaller dorsal ampulla may become fused so as to be no longer recognizable, or the dorsal ampulla may be definitely constricted off from the ventral lamina and of a distinct texture and shade. Seminal vesicles may be free or (in segment xi only) included within the testis sac or sacs. " Included " in association with testis sacs in the specific diagnoses has reference only to the anterior pair of seminal vesicles. Exclusion of these vesicles, as a negative characteristic, is not mentioned in the diagnoses.

Testis sacs are thin-walled, membraneous sacs enclosing the testes and male funnels. The testis sacs may be paired or unpaired. If paired each sac contains only one testis and one male funnel. If unpaired, each sac contains the two testes and two male funnels of a segment. Paired sacs may be ventral and suboesophageal or vertical, *i.e.*, extending dorsally at the sides of the gut. The seminal vesicles of xi may be included within paired, vertical sacs but are never included within paired or unpaired suboesophageal sacs. Unpaired sacs may be ventral and suboesophageal or U-shaped, horseshoe-shaped, annular or cylindrical. When the sacs are U-shaped or horseshoe-shaped the limbs of the sac extend dorsally or ventrally at the sides of the gut. An annular sac surrounds the gut completely and is formed by the dorsal or ventral union of the limbs of a U-shaped or horseshoe-shaped sac. A cylindrical sac is formed by a sheet of tissue in form of a cylinder passing anteroposteriorly between two successive septa in such a way as to enclose practically all of the organs of a segment. If the testis sac of xi is cylindrical the seminal vesicles of that segment are always

included therein. If the sac is U-shaped the vesicles may or may not be included.

Miscellaneous notes.—Identification internally of certain anterior segments has occasionally, from Bourne to Bahl, proved troublesome, as a result of the loss of certain septa and the dislocation or delicacy of some of those present. The female pores in *Pheretima* are always (except on very rare, abnormal specimens) on xiv and the ovaries are always one segment in front, in xiii. Having determined that the specimen is normal by reason of the location of the female pores on xiv, the ovaries can then be located in the opened specimen and from the ovarian segment which is readily identified the anterior segmentation can be worked out, checking lost septa against segmental commissures of the circulatory system (hearts) or in case of loss of hearts against segmental nerves or the setal circles which are visible on the coelomic face of the parietes. Spermathecae can be used as indicators only after it has been determined whether the ducts pass into the parietes anteriorly or posteriorly. Failure to observe this simple precaution has resulted in mistaken enumeration of the first post-gizzard septum in *P. posthuma.*

The worm should be dissected through a mid-dorsal incision. This mode of dissection most often enables determination of important characteristics without damage to structures that may require to be kept intact for future reference.

Key to Indian species of *Pheretima.*

For the sake of greater convenience this key has been based so far as is possible on external characteristics.

1.	*a.* Multithecal	*P. elongata.*
	b. Not multithecal	2.
2.	*a.* Bithecal	*P. taprobanae.*
	b. Quadrithecal to decithecal	3.
3.	*a.* Quadrithecal	4.
	b. Sexthecal to decithecal	6.
4.	*a.* Male pores superficial	5.
	b. Male pores invaginate, in copulatory chambers	*P. planata.*
5.	*a.* Spermathecal pores on 5/6-6/7	*P. morrisi.*
	b. Spermathecal pores on 7/8-8/9	*P. robusta.*
6.	*a.* Sexthecal	7.
	b. Octothecal to decithecal	10.
7.	*a.* Spermathecal pores on 5/6-7/8	8.
	b. Spermathecal pores on 6/7-8/9	9.
8.	*a.* Male pores on xx, genital markings invaginate	*P. anomala.*
	b. Male pores on xviii, genital markings superficial.	*P. hawayana.*
9.	*a.* First dorsal pore on or anterior to 10/11, one stalked gland to each spermathecal invagination	*P. houlleti.*
	b. First dorsal pore on or posterior to 11/12, two stalked glands to each spermathecal invagination	*P. campanulata.*
10.	*a.* Octothecal	11.
	b. Decithecal	*P. bicincta.*

11.	*a.* Spermathecal pores segmental, male pores invaginate, genital markings in the setal circles	*P. posthuma.*
	b. Spermathecal pores intersegmental, male pores superficial, genital markings not in the setal circles	12.
12.	*a.* Preclitellar genital markings present, seminal vesicles excluded	*P. diffringens.*
	b. Preclitellar genital markings lacking, seminal vesicles included	*P. alexandri.*

ABNORMAL FORMS.

Abnormal forms, in particular localities or in certain species, may be as common as or even much more common than normal forms. One unacquainted with the normal forms and having only abnormal individuals may have considerable difficulty in identification. A key is therefore given to assist in placing the more commonly found abnormal forms..

1.	*a.* Athecal	2.
	b. Thecal	9.
2.	*a.* Male pores present	3.
	b. Male pores lacking	7.
3.	*a.* Male pores superficial	*P. alexandri.*
	b. Male pores invaginate	4.
4.	*a.* Male pores in parietal invaginations	5.
	b. Male pores in copulatory chambers	6.
5.	*a.* Male pores on xviii, genital markings superficial.	*P. elongata.*
	b. Male pores on xx, genital markings invaginate	*P. anomala.*
6.	*a.* First dorsal pore on 11/12 or posteriorly	*P. campanulata.*
	b. First dorsal pore on 10/11 or anteriorly	*P. houlleti.*
7.	*a.* First dorsal pore on 12/13, seminal vesicles included	*P. alexandri.*
	b. First dorsal pore on 11/12 or anteriorly, seminal vesicles excluded	8.
8.	*a.* First dorsal pore on 11/12	*P. campanulata.*
	b. First dorsal pore on 10/11 or anteriorly	*P. houlleti.*
9.	*a.* Spermathecal pores superficial, occasionally in groups of 2-4	*P. elongata.*
	b. Spermathecal pores invaginate, never grouped	10.
10.	*a.* Male pores lacking	*P. anomala.*
	b. Male pores present	11.
11.	*a.* Male pores on xix-xxi	*P. anomala.*
	b. Male pores on xviii	4.

Pheretima alexandri (Beddard.).

1900. *Amyntas alexandri*, Beddard, *Proc. Zool. Soc. London*, 1900, p. 998. (Type locality, Calcutta. Type in the British Museum.)
1903. *Pheretima Alexandri*, Michaelsen, *Geogr. Verbr. Berlin*, p. 94.
1909. *Pheretima alexandri*, Michaelsen, *Mem. Ind. Mus.* I, p. 109.
1910. *Pheretima Alexandri*, Michaelsen, *Abh. Nat. Ver. Hamburg*, XIX (5), p. 11.
1914. *Pheretima lignicola*, Stephenson, *Rec. Ind. Mus.* VIII, p. 399. (Type locality, Dibrugarh, Assam. Type in the Indian Museum.)
1915. *Pheretima lignicola*, Stephenson, *Mem. Ind. Mus.* VI, p. 99.
1920. *Pheretima lignicola*, Stephenson, *Mem. Ind. Mus.* VII, p. 223.
1922. *Pheretima suctoria*, Stephenson, *Rec. Ind. Mus.* XXIV, p. 434.
1923. *Pheretima alexandri* + *P. lignicola* + *P. suctoria* (part. excluding Andaman Island forms), Stephenson, *Oligochaeta*, in *F. B. I. Series*, pp. 291, 305 and 311.

1924. *Pheretima lignicola* + *P. suctoria* var. *mullani*, *Rec. Ind. Mus.* XXVI, p. 340.
1925. *Pheretima suctoria* var. *mullani*, Stephenson, *Proc. Zool. Soc. London*, 1925, p. 893.
1931. *Pheretima alexandri*, Stephenson, *Rec. Ind. Mus.* XXXIII, p. 182. (Redescription of the type.) Also Gates, *Rec. Ind. Mus.* XXXIII, p. 363.

Diagnosis.—Octothecal, spermathecal pores minute and superficial, four pairs, on 5/6-8/9. Male pores minute and superficial. Just anterior and posterior to each male pore a small, greyish, translucent area, usually rather crescent-shaped and with the concave side of the area facing the male pore, the translucent areas and the male pore slightly depressed and surrounded by a narrow, slightly protuberant, U-shaped ridge, the limbs of the U directed midventrally. Setae: vi/6-12, vii/8-14, viii/10-16, xvii/13-21, xviii/10-18, xix/14-21, 13-20/ii, 18-24/iii, 40-50/viii, 50-60/xii, 61-71/xx. First dorsal pore on 12/13. Length 105-200 mm. Diameter 4-8 mm. Segments 90-133.

Intestinal caeca simple. Testis sacs paired, ventral in x, vertical in xi; seminal vesicles included. Spermathecal duct bulbous, muscular, lumen in ental portion of the duct large and communicating with the narrowed lumen in the ectal portion through a minute pore on the bluntly rounded tip of a rather conical papilla; diverticulum with slender but muscular stalk and a looped, elongately tubular seminal chamber.

Distribution.—Bombay, Calcutta and Dibrugarh in Assam. Outside of India; Burma, China (Yunnan), Siam and the Andaman Islands.

Pheretima anomala Michaelsen.

1907. *Pheretima anomala*, Michaelsen, *Mitt. Mus. Hamburg*, XXIV, p. 167. (Type locality, Calcutta. Types in the Indian and Hamburg Museums).
1909. *Pheretima anomala*, Michaelsen, *Mem. Ind. Mus.* I, pp. 110 and 189.
1910. *Pheretima anomala*, Michaelsen, *Abh. Nat. Ver. Hamburg*, XIX (5), p. 11.
1923. *Pheretima anomala*, Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 294.
1933. *Pheretima anomala*, Gates, *Rec. Ind. Mus.* XXXV, p. 496.

Material examined.—From the Indian Museum.—1 macerated, clitellate specimen labelled, " On the hill sides near Pashok Bungalow. Dr. S. L. Hora.", 33 aclitellate and 19 ciitellate specimens labelled, " Forest Rest House, Lachhiwala, Dehra Dun District. 29. ix-3. x. 35. Dr. S. L. Hora.", and 1 clitellate specimen labelled, " Dehra Dun. 12. x. 35. Dr. S. L. Hora.". All of the Dehra Dun specimens are softened.

The Dehra Dun specimen and all except two of the Lachhiwala specimens are athecal (= *forma typica* of Stephenson, 1929). Each of the two exceptional specimens, one clitellate and one aclitellate, has a single spermathecal pore, on 5/6, on the right side. The spermathecae are normal but there is no spermatozoal iridescence in the seminal chambers.

Diagnosis.—Sexthecal, spermathecal pores minute and invaginate, each pore at the centre of a vertically placed, elliptical marking on the anterior wall of an invagination with a transversely slit-like aperture; three pairs, on 5/6-7/8. Male pores minute and invaginate, each pore at the centre of a transversely elliptical tubercle on the roof of a slight parietal invagination in the setal circle of xx. Genital markings internal, each marking on the roof of a slight parietal invagination

with a transversely slit-like aperture ; three pairs, in the setal circles of xvii-xix. Setae present ventrally on xvi : vi/17-22, vii/17-23, xix/16-18, xx/15-21, 60-68/iii, 90-96/viii, 87-95/xii, 81-90/xiii, 6-26/xvi, 61-70/xx. First dorsal pore on 12/13. Length 80-180 mm. Diameter 4-5½ mm. Segments 119-30.

Intestinal caeca simple. Testis sacs unpaired and ventral. Spermathecal diverticulum with short stalk, looped middle portion in which the lumen is gradually widened and a slenderly club-shaped seminal chamber. Genital marking glands mushroom-shaped, the duct muscular, shortly spindle-shaped and coelomic.

Very few or none of the specimens in a series of *P. anomala* from any particular locality are actually characterized as above. Most of the specimens are quite markedly different. The variations diverge in two different directions with a large proportion of the variant forms attaining the extreme of divergence in one direction or the other. One extreme (= *forma typica* of Stephenson, 1929) is distinguished from the forms defined above as follows : genital markings on xxi-xxiv, testes and male funnels in (iv) v-ix (xii), no seminal vesicles, no normal testis sacs, no spermathecae, genital marking glands in xxi-xxiv. Intermediates between this extreme and the form defined above have one or more seminal vesicles, more or less normal testis sacs, one or more spermathecae and lack one or more of the genital markings and their glands posterior to xx as well as some of the supernumerary testes and male funnels. The variation in this direction tends towards a reduction or elimination of certain secondary female organs, the spermathecae, and increase in the number of certain male organs, the gonads, deferent duct funnels and copulatory glands. Without spermathecae a worm cannot receive spermatozoa in a copulatory act and such an individual is regarded by Stephenson as a secondarily evolved, dioecious male. There is, however, no evidence (*vide* Gates 1932 and 1933) to show that spermatozoa are ever produced in completely pseudo-masculinized individuals for the testes are always flat discs in an undischarged, juvenile condition. Furthermore, seminal vesicles, the organs in which the spermatozoa mature, are lacking. Although the pseudo-masculinized individuals do not produce mature spermatozoa, they do have, and apparently always, normal ovaries and a functional oviducal apparatus as well as a clitellum for the secretion of a cocoon. Since spermatozoa are not produced the worms cannot function as males even though the male deferent apparatus is present and normal. Although the clitellum is normally developed and ovaries and the oviducal apparatus appear to be functional the worms apparently do not function as females since they cannot receive spermatozoa from another worm during a copulatory act. In these circumstances the pseudo-masculinized individuals can only be regarded as abnormal. Gates (1933, pp. 508-510) has suggested that the pseudo-masculinization is caused by protozoan parasites present in juvenile individuals prior to initiation of development of the secondary reproductive organs. The definition above is accordingly of normal individuals with a full hermaphroditic complement of reproductive structures.

The other extreme of divergence from normality (= *forma insolita* of Stephenson, 1929) is represented by worms characterized as follows :—

male pores, prostates, prostatic ducts, genital markings and their glands lacking. Intermediate forms between this extreme and the normal worms have one or more prostates and one or more genital markings and mushroom-shaped glands. The deviation from normal in this direction consists of a reduction or elimination of the male copulatory organs. Without male pores a worm cannot transfer spermatozoa in a copulatory act and such an individual is regarded by Stephenson as a secondarily evolved, dioecious female. These pseudo-feminized individuals always have normal seminal vesicles, normal testis sacs with discharged testes and matured spermatozoa and are merely prevented from functioning as males by a failure of the male genital terminalia to develop. A similar condition is occasionally found as an abnormality in other Indian species of *Pheretima* (*P. alexandri* and *P. campanulata*) and there is at present no reason for regarding the absence of the male genital terminalia in *P. anomala* as other than an abnormality in spite of the frequency of its occurrence. Gates (1933, pp. 508-510) has suggested that the pseudo-feminization is caused by protozoan parasites present in juvenile individuals prior to the initiation of development of the secondary reproductive organs, the parasites different from those which cause the pseudo-masculinization. Pseudo-feminized individuals can, theoretically, receive spermatozoa in a copulatory act and deposit cocoons containing fertile eggs.

Only completely or almost completely pseudo-masculinized individuals of *P. anomala* have been found hitherto in India.

Distribution.—Pashok (Darjiling district), Eastern Himalayas ; Dehra Dun and Lachhiwala (Dehra Dun district), Western Himalayas ; Calcutta in Bengal. Outside of India : Burma, Siam (Chiengrai), and China (Mong Mong in Yunnan).

Pheretima bicincta (Perrier).

1875. *Perichaeta bicincta*, E. Perrier, *C. R. Ac. Sci. Paris*, LXXXI, p. 1044. (Types in the Paris Museum. Type locality unknown but supposed to be on Luzon or Mindonoro, Philippine Islands.)
1909. *Pheretima violacea*, Michaelsen, *Mem. Ind. Mus.* I, pp. 110 and 188.
1910. *Pheretima bicincta*, Michaelsen, *Abh. Nat. Ver. Hamburg*, XIX (5), pp. 11 and 84.
1916. *Pheretima bicincta*, Stephenson, *Rec. Ind. Mus.* XII, p. 335.
1923. *Pheretima bicincta*, Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 294.
1929. *Pheretima bicincta*, Aiyer, *Rec. Ind. Mus.* XXXI, p. 15.

Material examined.—From the Indian Museum : 3 clitellate specimens labelled, "*Pheretima bicincta* = *Pheretima violacea* (Bedd.). Hyderabad, Deccan. Col. D. C. Phillot. ZEV 2829/7.".

External characteristics.—Pigmentation is no longer reconizable.

The setae begin on ii, on which segment there is a complete circle, and are small, closely and regularly spaced. The setal formulae are shown below :—

v	vi	vii	viii	xvii	xviii	xix	iii	viii	xii	xx
10	7*	10	9	9	7	10	33	43	44	
7*	9	10	11	10	8	11	35	45	46	..
6*	7	9	10	8	6	9	31	42	43	42†

* Gaps in setal line in which setal pits or traces of setal pits are visible.
† Including setal pits as setae.

The clitellum is yellowish or reddish brown, annular, extending from 13/14 to just in front of the setae of xvi, not protuberant (level or constricted); intersegmental furrows and dorsal pores lacking, setae present.

There is a pair of female pores (3).

The male pores are minute and superficial, each pore at the tip of a very tiny, rather conical or almost thread-like protuberance from the centre of a small, indistinctly delimited, shortly elliptical, transversely placed, male pore area that scarcely reaches to a presetal or postsetal secondary furrow.

Genital markings are not visible on these specimens, even after removal of the cuticle, nor with brilliant illumination and under the highest magnification of the binocular. Although the markings are not visible, glands are present internally and after noting these glands the sites of the genital markings were re-examined. On the postsetal portion of xviii, in a region just median to the male pore line, on each side, a number of minute pores are just barely visible, but the areas on which these pores are situated do not appear to be different from the surrounding epidermis.

Internal anatomy.—Septum 9/10 is present and muscular (2); 8/9 lacking (2).

The intestine begins in xv (2). The intestinal wall of one specimen is softened and in this worm the caeca were not seen. In the other specimen the caeca are short, anteriorly directed, confined to xxii, two slight incisions of the dorsal margin, 2-3 slight incisions of the ventral margin.

The last pair of hearts is in xii (2). There is a pair of hearts belonging to ix (2). The hearts of x and xi are included within the testis sacs.

The testis sacs are unpaired and horseshoe-shaped, the midventral termini of the sacs separated by a slight space in which is the ventral blood vessel. The dorsal blood vessel, in at least the posterior portions of x and xi, is included within the testis sac. The sac may be constricted in such a way as to form an anteriorly directed mid-dorsal lobe. The ventral ends of the anterior testis sac may be continued anteriorly on the ventral parietes parallel to the nerve cord for a short distance. The anterior vesicles are small and are included within the posterior testis sac. The vesicles of xii are rather small, acinous, vertically placed bodies that reach up into contact with the dorsal blood vessel. The prostates are in xvii-xix. The duct is short, with muscular sheen, bent into a U-shaped loop, the ectal limb much thicker than the ental limb, but narrowed as it passes into the parietes.

The spermathecae are small, the ampulla only slightly wider than the duct, shortly ovoidal, ellipsoidal or heart-shaped, and distinguished from the duct by a translucent appearance. The duct, including the portion within the parietes, is a trifle longer than the ampulla. The diverticulum which passes into the anterior face of the duct at the parietes is shorter than the combined lengths of duct and ampulla and comprises an ellipsoidal seminal chamber that is translucent or transparent and a stalk of about the same length as the chamber.

The genital marking glands are acinous masses, sessile on the parietes, the masses circular or nearly so in outline.

Diagnosis.—Decithecal, spermathecal pores minute and superficial, 5 pairs, on 4/5-8/9. Male pores minute and superficial, each on a transversely placed marking which may be included within a genital marking. Genital markings paired, on xviii. Setal circles present on all clitellar segments; v/9-10, vi/7-11, vii/9-11, viii/9-12, xvii/8-11, xviii/4-8, xix/9-11, 31-35/iii, 42-45/viii, 43-46/xii, 42/xx. First dorsal pore on 12/13. Clitellum terminates anterior to the setae of xvi. Length 50-80 mm. Diameter 2-3 mm. Segments 78.

Septum 9/10 present and muscular. Intestinal caeca simple but with margins incised, in xxii. Last hearts in xii. Testis sacs unpaired and horseshoe-shaped; anterior seminal vesicles included. Spermathecal diverticulum shorter than combined lengths of duct and ampulla, passing into the anterior face of the duct at the parietes, comprising an ovoidal to ellipsoidal seminal chamber and a stalk that may be as long as or longer than the chamber. Genital marking glands sessile on the parietes.

Distribution.—Trivandrum, Travancore; Hyderabad, Deccan. Outside of India known from the Philippines, Java, Penang, Trinidad, Grenada and St. Thomas. The species has been recorded only twice from the *Pheretima* domain; once from Java—3 specimens from Malan, and once from the Philippines, 371 (?) specimens from some locality on Luzon or Mindonoro. The original home of the species is to be looked for either in the Philippines or in the region between those islands and Java.

Pheretima campanulata (Rosa).

1890. *Perichaeta campanulata*, Rosa, *Ann. Mus. Genova*, XXX, p. 115. (Type locality, Palon, Burma. Types in the Genoa Museum.)

1923. *Pheretima houlleti* (part), Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 304. (Excluding synonymy and distribution of forms with only one stalked gland to the spermathecal pore invagination and also forms with no copulatory chambers.)

1931. *Pheretima campanulata* var. *penetralis*, Gates, *Rec. Ind. Mus.* XXXIII, p. 435.

Material examined.—From the Indian Museum: 1 clitellate specimen labelled, "On the hillside near Pashok bungalow. S. L. Hora".

Diagnosis.—Sexthecal, spermathecal pores minute and invaginate, each pore on a tiny conical protrusion into an invagination with transversely slit-like lumen and aperture; three pairs, on 6/7-8/9. Male pores minute and invaginate, each pore on a penial body with a trilobed tip within a spheroidal copulatory chamber, a genital marking on each of the two lateral lobes of the penial body. Genital markings tiny, circular, greyish, translucent areas, sharply demarcated by slight circumferential furrows, on the margins of segments near 6/7-8/9 or on the intersegmental furrows, median to the secondary spermathecal apertures, and in addition internally; one marking on the anterior wall and one on the posterior wall of each spermathecal invagination, a group of 3-5 markings within each copulatory chamber in addition to markings at the base and at the tip of the penial body. Setal circles present on all clitellar segments, clitellar setae with bifid tips, 1-2 penial

setae within the wall of each copulatory chamber: vii/11-15, viii/14-19, xvii/18-22, xviii/9-17, xix/17-21, 20-25/iii, 33-43/viii, 44-52/xii, 50-61/xx. First dorsal pore on 11/12. Length 107-200 mm. Diameter 4-7 mm. Segments 107-136.

Intestinal caeca simple. Testis sacs unpaired and ventral. Lumen in ental part of the spermathecal duct large and communicating with the narrowed lumen of the ectal portion of the duct through a tiny, slit-like pore on the bluntly rounded, dorsal face of a conical papilla; diverticulum comprising a short, slender stalk and an elongate seminal chamber, the latter slightly widened entally and looped, often in an approximation to zigzag. One or more stalked glands on the posterior face of each copulatory chamber, three or more on the anterior face; one stalked gland to the anterior face and one to the posterior face of each spermathecal invagination. Genital marking glands stalked and coelomic.

Distribution.—Kalimpong and Pashok, Darjiling district, Eastern Himalayas. Outside of India; Burma, China (Yunnan), Siam, Malay Peninsula (Kuala Lumpur), Andaman Islands.

Pheretima diffringens (Baird).

1869. *Megascolex diffringens*, Baird, *Proc. Zool. Soc. London*, 1869, p. 40. (Type locality, Plas Machynlleth, Montgomeryshire, North Wales. Types in the British Museum.)
1887. *Perichaeta mirabilis*, Bourne, *Proc. Zool. Soc. London*, 1886, p. 668, (Type locality, Naduvatam, Nilgiris, S. I. No types.)
1900. *Pheretima mirabilis*, Michaelsen, *Das Tierreich*, X, p. 284.
1900. *Amyntas heterochaetus* (part), Beddard, *Proc. Zool. Soc. London*, 1900, p. 622.
1909. *Pheretima heterochaeta*, Michaelsen, *Mem. Ind. Mus.* I, pp. 110 and 189.
1910. *Pheretima heterochaeta*, Michaelsen, *Abh. Nat. Ver. Hamburg*, XIX, (5), pp. 11 and 83.
1914. *Pheretima heterochaeta*, Stephenson, *Rec. Ind. Mus.* VIII, p. 399 and X, p. 343.
1915. *Pheretima heterochaeta*, Stephenson, *Mem. Ind. Mus.* VI, p. 99.
1916. *Pheretima heterochaeta*, Prashad, *J. Bombay Nat. Hist. Soc.* XXIV, p. 503.
1916. *Pheretima heterochaeta*, Stephenson, *Rec. Ind. Mus.* XII, p. 334.
1917. *Pheretima heterochaeta*, Stephenson, *Rec. Ind. Mus.* XIII, p. 385.
1917. *Pheretima heterochaeta*, Stephenson, *Quart. J. Mic. Sci.* LXII, p. 265. (Pharyngeal gland cells.)
1918. *Pheretima heterochaeta*, Thapar, *Rec. Ind. Mus.* XV, pp. 71 and 73. (Lymph glands.)
1919. *Pheretima heterochaeta*, Bahl, *Quart. J. Mic. Sci.* LXIV, p. 104 (Nephridia), and p. 111 (Septa).
1920. *Pheretima heterochaeta*, Stephenson, *Mem. Ind. Mus.* VII, p. 222.
1921. *Pheretima heterochaeta*, Stephenson, *Rec. Ind. Mus.* XXII, p. 760.
1922. *Pheretima heterochaeta*, Stephenson, *Rec. Ind. Mus.* XXIV, p. 433.
1923. *Pheretima heterochaeta* (part, excluding synonymy and distribution of forms with copulatory chambers), Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 302.
1924. *Pheretima heterochaeta*, Stephenson, *Rec. Ind. Mus.* XXVI, p. 339.
1924. *Pheretima heterochaeta*, Stephenson, *Proc. Roy. Soc. London*, B. XCVII, pp. 179, 188, 198, and 201. (Blood glands.)
1925. *Pheretima heterochaeta*, Stephenson, *Rec. Ind. Mus.* XXVII, p. 59.
1925. *Pheretima heterochaeta*, Stephenson, *Proc. Zool. Soc. London*, 1925, p. 893.
1931. *Pheretima heterochaeta*, Gates, *Rec. Ind. Mus.* XXXIII, pp. 387 and 437.
1934. *Pheretima mirabilis*, Gates, *Rec. Ind. Mus.* XXXVI, p. 260.

Material examined.—From the Indian Museum.—92 clitellate specimens labelled, " Dumpep, Khasi Hills, Assam. Dr. S. L. Hora ", 49 clitellate specimens labelled, " Teesta Bridge[1] Teesta Valley. Dr. S. L. Hora ", 1 aclitellate and 7 clitellate specimens labelled, " Kalimpong, E. Himalayas. Dr. S. L. Hora ", 1 clitellate, macerated specimen labelled, Dharamshala Cantonment, Kangra Dt., Punjab. Dr. S. L. Hora ", 9 clitellate specimens labelled, " Dhobijhora, Kurseong, Darjeeling. Md. Sharif ", 2 clitellate specimens labelled, " Kotla, Kangra Dt., Punjab. Dr. S. L. Hora ", 13 aclitellate, macerated specimens labelled, " Kangra, Punjab. Dr. S. L. Hora ", 4 clitellate specimens labelled, " Palampur, Kangra Dt., Punjab. Dr. S. L. Hora ", 1 clitellate specimen labelled, " Kodaikanal, Palni Hills, S. India. Dr. S. L. Hora ", 41 clitellate specimens labelled, " Benhope, Nilgiris. Dr. S. L. Hora ", 5 clitellate specimens labelled, " Fern Hill, Nilgiris. Dr. S. L. Hora ". From the Madras Museum.—27 clitellate specimens labelled, " From a pit containing decomposing cow dung and vegetable matter, Coonoor, Nilgiris. Major K. R. K. Iyenger, I. M. S.", 1 aclitellate and 21 clitellate specimens labelled, " From garden soil, Coonoor, Nilgiris. Major K. R. K. Iyenger, I. M. S.". From the Fisheries Reserve Officer.—3 clitellate specimens labelled, " Fern Hill. 6-8. x ·35.". From Prof. K. N. Sharma.—13 aclitellate and 55 clitellate specimens labelled, " Near Katmandu, Nepal."

External characteristics.—The setal numbers of five Nepal specimens are shown below:—

iii	vi	viii	xii	xx
26	33	40	43	51
25	32	37	45	49
24	32	35	41	43
27	28	36	42	49
28	32	35	41	50

The clitellum, on nearly all of the mature Nepal specimens, extends slightly anterior to 13/14 and slightly posterior to 16/17, intersegmental furrows 13/14 and 16/17 not visible but the sites of the occluded dorsal pores of those two furrows visible.

The first dorsal pore is on 11/12 (all Nepal specimens) except that two worms have a definitely pore-like marking on 10/11.

On the Nepal worms there are no postsetal or postclitellar genital markings. The presetal genital markings are paired, on some or all of vii-ix. Each marking is approximately in *cd*.

Of the Madras specimens, 19 have paired presetal genital markings on vii-ix, while 14 have similar markings on vii-viii only. Other worms lack some or all of these markings. The markings are usually slightly nearer to the setae than to the intersegmental furrow and are either in *c*, *cd*, or *d*. A number of the Madras specimens have paired, postsetal genital markings on vi-viii, immediately in front of the spermathecal pores.

Nearly all of the Dumpep specimens have three pairs of postsetal genital markings, one marking immediately in front of each spermathecal pore on 6/7-8/9. One specimen has in addition postsetal markings on v. Nearly all of these worms have two pairs of presetal markings on vii-viii while one specimen also has presetal markings on ix.

[1] Teesta Bridge, according to Dr. S. L. Hora, is about 33 miles from Siliguri Ry. station and at an elevation of 500-700 feet.

Internal anatomy.—There is a pair of hearts belonging to ix in 5 specimens, a single heart belonging to ix, on the right side in 16 specimens, on the left side in 19 specimens. There are no hearts belonging to x in 26 specimens ; a single heart belonging to x, on the left side in 6 specimens, on the right side in 7 specimens. One worm has a pair of hearts belonging to x (Nepal specimens).

The seminal chamber of the spermathecal diverticulum is about twice as long as thick, the chamber about three times as thick as the stalk and one-half to one-third as long as the stalk.

Abnormality.—Two of the Teesta Valley specimens are abnormal. One worm varies from normal as follows :—The right male pore is on xx, on the left side an additional male pore on xvii. The clitellum extends on the right side to 17/18. The other worm varies from normal as follows.—Spermathecal pores on 7/8-12/13. Female pores on xvii, xviii and xix. Male pores on the left side on xxiii and xxiv, on the right side on xxiv. The clitellum extends from a posterior portion of xvii on to xxii. Presetal genital markings on the left side of viii and the right side of ix ; postsetal markings on the right side of viii and the right and left sides of ix. (There are no spiral, metameric abnormalities.) The gizzard is in xi-xiii, septa 10/11-12/13 lacking. The intestine begins in xvi, the right intestinal caecum extending through xl-xxxviii, the left through xxxix-xxxvii. Testis sacs in xiii and xiv. Seminal vesicles in xiv and xv. No prostates. Paired ovaries and oviducal funnels in xvi, xvii and xviii. The single heart of xii on the right side, of xiii on the left side, the last hearts in xvi.

Diagnosis.—Octothecal, spermathecal pores minute and superficial, four pairs, on 5/6-8/9. Male pores minute and superficial, each pore at the centre of a transvesely placed, disc-shaped porophore. Genital markings small, circular to shortly elliptical tubercles, paired ; presetal on vi-ix, in *cd* or (and) about in *bc*, postsetal on v-viii and just in front of the spermathecal pores. Setae : vi/6-11, vii/8-14, viii/10-16, xvii/13-18, xviii/9-16, xix/12-17, 21-28/iii, 26-36/vi, 35-42/viii, 39-45/xii, 42-52/xx. First dorsal pore on 11/12. Length 45-170 mm. Diameter 3-6 mm. Segments 90-113.

Intestinal caeca simple. Hearts of x lacking. Testis sacs unpaired and ventral. Spermathecal diverticulum with long stalk and shorter, thicker, ovoidal, simple seminal chamber. Genital marking glands stalked and coelomic.

Distribution.—Peshawar, Mardan, Northwestern Frontier ; Lahore, Dharamsala Cantonment, Kotla, Kangra, Palampur, Punjab ; Simla, Naini Tal, Western Himalayas ; Nepal, Darjiling, Kurseong, Kalimpong, Teesta Bridge, Singla, Ghum, Sureil, Pashok, Darjiling district, Gangtok (Sikkim), Kobo (Abor country), Eastern Himalayas ; Cherrapunji, Sadiya, Myntaung Valley, Shillong, Imphal (Manipur), Dumpep, Assam ; Siliguri, Rangamati (Chittagong Hill Tracts), Bengal ; Kodaikanal, Tiger Shola (Palni Hills), Naduvatam, Benhope, Kotagiri, Fern Hill, Coonoor (Nilgiri Hills), Bababudan Hills (Mysore), South India.

Outside of India : Ceylon, Burma (Shan Plateau and Bhamo district only), China (Provinces of Yunnan, Szechuan, Chekiang, Kiangsi, Kiangsu, Anhwei, Fukien, as well as Hongkong), Java, Sumatra, New

Caledonia, Australia, Hawaiian Islands, Transvaal, Natal, Madagascar, Anjouan, Cape Verde, St. Helena, Sardinia, Azores, Poland,* Scotland,* Wales,* Italy, Portugal, France, United States, Mexico, Costa Rica, San Domingo, Colombia, Peru.

Pheretima elongata (Perrier).

1872. *Perichaeta elongata*, E. Perrier, *N. Arch. Mus. Paris*, VIII, p. 124. (Type locality, Peru ! Type in the Paris Museum.)
1909. *Pheretima biserialis*, Michaelsen, *Mem. Ind. Mus.* I, pp. 110 and 187.
1910. *Pheretima elongata*, Michaelsen, *Abh. Nat. Ver. Hamburg*, XIX (5), pp. 11 and 84.
1920. *Pheretima elongata*, Stephenson, *Mem. Ind. Mus.* VII, p. 222.
1922. *Pheretima elongata*, Michaelsen, *Mitt. Mus. Hamburg*, XXXVIII, p. 68.
1922. *Pheretima elongata*, Stephenson, *Rec. Ind. Mus.* XXIV, p. 433.
1923. *Pheretima elongata*, Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 298.
1924. *Pheretima elongata*, Stephenson, *Rec. Ind. Mus.* XXVI, p. 433.
1926. *Pheretima elongata*, Stephenson, *Rec. Ind. Mus.* XXVIII, p. 256.

Diagnosis.—Multithecal, spermathecal pores minute and superficial, in paired groups of 2-4, on or near to 5/6-6/7. Male pores minute and invaginate, each pore on a disc-shaped porophore on the median wall of a parietal invagination with a crescentic aperture. Genital markings transversely elliptical, presetal, widely paired, on xix-xxiv. Setae: xvii/12-17, xviii/10-15, xix/12-15, 50-66/iii, 67-104/viii, 54-80/xii, 55-75/xx. First dorsal pore on 12/13. Length 85-300 mm. Diameter $3\frac{1}{2}$-6 mm. Segments 169-241.

Testis sacs unpaired and annular; seminal vesicles as well as hearts of x and xi included. Spermathecal diverticulum with stalk longer than the ovoidal to ellipsoidal seminal chamber. Genital marking glands sessile on the parietes.

Remarks.—*P. elongata* is usually athecal. Absence of spermathecae, as in *P. anomala*, is regarded as an abnormality. Thecal specimens do not have a symmetrically paired arrangement of the spermathecae, the latter either asymmetrical or in groups. A grouped arrangement of the spermathecae characterizes a subgenus of *Pheretima* recently erected by Michaelsen (1934, p. 15). The subgenus *Polypheretima* is further distinguished only by the absence of intestinal caeca. *P. elongata* which is acaecal and when thecal often with a multithecal arrangement of the spermathecae, may possibly have originated in Michaelsen's *Polypheretima* region, an area including the southern portion of the Malay Peninsula, Borneo, Celebes and New Guinea. Actually *P. elongata* is close to *P. stelleri* (Michaelsen), 1891. This species cannot at present be adequately characterized and is possibly a conglomerate of two or more species.

Distribution.—Poona, Bombay, Manmad and Karachi in Bombay Presidency; Palia, Indore and Ujjain in Central India; Namkhana (Sunderbans) and Calcutta in Bengal; Hyderabad, Deccan; Mockoli, Bhaganamola, Manakoti (Curg), Shimoga (Mysore), Singanallur (Coimbatur district) in South India. Outside of India: Ceylon, Burma, Andaman Islands, Siam, Sumatra, Java, Celebes, Philippines, New Caledonia, Sumba, Salibaboe, Kei, Flores and Hawaiian Islands, Madagascar, Porto Rico, Hayti, Cuba, Panama, Peru, Venezuela, British and Dutch Guiana.

* Only in greenhouses.

Pheretima hawayana (Rosa).

1891. *Perichaeta hawayana*, Rosa, *Ann. Hofmus. Wien*, VI, p. 396. (Type locality, Hawaii. Type in the Vienna Museum.)
1909. *Pheretima hawayana f. typica*, Michaelsen, *Mem. Ind. Mus.* I, pp. 110 and 187.
1910. *Pheretima hawayana f. typica*, Michaelsen, *Abh. Nat. Ver. Hamburg*, XIX (5), pp. 11 and 83.
1914. *Pheretima hawayana* (part), Stephenson, *Rec. Ind. Mus.* X, p. 343. (Excluding quadrithecal forms.) Although none of these specimens have been preserved in the Indian Museum, individuals with enlarged setae on iv-viii or v-vii must be referred to *hawayana*.
1916. *Pheretima hawayana typica* (part) + *P. h. barbadensis* (part), Prashad, *J. Bombay Nat. Hist. Soc.* XXIV, pp. 499 and 501. (Excluding quadrithecal forms.)
1916. *Pheretima hawayana f. typica*, Stephenson, *Rec. Ind. Mus.* XII, p. 334.
1923. *Pheretima hawayana* (part), Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 300. (Excluding synonymy and distribution of quadrithecal forms.)
1925. *Pheretima hawayana*, Stephenson, *Rec. Ind. Mus.* XXVII, p. 59.
1934. *Pheretima hawayana*, Gates, *Rec. Ind. Mus.* XXXVI, p. 259.

Material examined.—From the Indian Museum: 5 clitellate specimens labelled, "*Pheretima hawayana* (Rosa). Under stones in thicket of trees, Kurseong, E. Himalayas. Sta. 13. 5,000 feet. 9. iii. 24. Dr. B. N. Chopra. W 1221/1.", 1 clitellate anterior fragment and 1 aclitellate specimen labelled, "*Pheretima hawayana forma typica.* Kurseong, E. Himalayas. 4,500 feet. 26. iii. 10. Dr. F. H. Gravely. ZEV 6540/7.", 1 clitellate specimen labelled, "*Pheretima hawayana forma typica.* Kurseong, E. Himalayas. E. Bergtheil, Esq. ZEV 2826/7.", 3 clitellate specimens labelled, "*Pheretima hawayana forma typica.* Kurseong, E. Himalayas. 5,000 feet, 13-16. vii. 07. Mus. Coll. (R. Hodgart). ZEV 4154/7.", 1 clitellate specimen labelled, "*Pheretima hawayana forma typica.* Ramnee, Garwhal Dist. U. P. 20-10-07. Mus. Coll. (R. Hodgart). ZEV 4188/7.", 3 clitellate specimens labelled, "*Pheretima hawayana forma typica.* Tengyueh, Yunnan. J. Coggin Brown. ZEV 4892/7.", and 1 clitellate specimen labelled, "*Pheretima hawayana forma typica.* Pattipola (Hill Country) Ceylon. Dr. N. Annandale. ZEV 5085/7.". The Yunnan tube contains, in addition to the *P. hawayana*, 1 macerated and 1 well preserved specimen of *P. californica* Kinberg 1867.

One of Dr. Chopra's specimens from Kurseong has twelve postsetal genital markings on xviii, in two groups of six each. One of Hodgart's specimens from Kurseong has eight postsetal genital markings on xviii.

Diagnosis.—Sexthecal, spermathecal pores minute and superficial, three pairs, on 5/6-7/8. Male pores minute and superficial, each pore at the centre of a small, transversely elliptical, disc-shaped porophore. Genital markings small, paired tubercles; postsetal on vii-viii and slightly median to the spermathecal pore lines; on xviii, in or just behind the setal circle and just median to the male pore lines. Setae present ventrally on xvi: vi/4-8, vii/10-15, xvii/15-20, xviii/10-15, xix/16-20, 17-21/iii, 36-40/viii, 44-49/xii, 48-56/xx. First dorsal pore on 10/11. Length 60-112. Diameter 3-4 mm. Segments 71-91.

Intestinal caeca simple, with a few short lobes on the ventral margin. Testis sacs unpaired and ventral. Spermathecal diverticulum with stalk longer than the seminal chamber and with irregular lumen, seminal chamber slenderly club-shaped. Genital marking glands stalked and coelomic.

Distribution.—Kurseong in the Eastern Himalayas, Shillong in Assam, Ramnee in the United Provinces, Lahore in the Punjab. Stephenson (1923, p. 302) includes Rangamati in the distribution of the species but no record of this can be found. Outside of India: Ceylon

(Pattipola), Burma (Namkham, Kawngmu, Kutkai, Lashio and Mogok, all on the Shan Plateau), China (Provinces of Chekiang, Szechuan, Yunnan, Fukien, also Hongkong), Borneo, Samoa, Hawaiian and Fiji Islands, Bermuda, Barbados, United States (southern), Brazil, Uruguay and Chile.

Pheretima houlleti (Perrier).

1872. *Perichaeta houlleti*, E. Perrier, *N. Arch. Mus. Paris*, VIII, p. 99. (Type locality, Calcutta. Types in the Paris Museum.)
1889. *Megascolex Houlleti*, Vaillant, *Hist. Nat. Annel.* III, (1), p. 75.
1895. *Perichaeta houlleti* (part), Beddard, *Monog.*, p. 424. (Excluding *P. campanulata.*)
1898. *Perichaeta crescentica*, Fedarb, *Proc. Zool. Soc. London*, 1898, p. 447. (Type locality, Dehra Dun. Types probably in the British Museum. *Vide* note below.)
1898. *Perichaeta travancorensis*, Fedarb, *J. Bombay Nat. Hist. Soc.* XI, p. 435. (Type locality, Travancore. Types in the British Museum. The types were obtained by the Museum on the purchase of Beddard's collection. It is probable that specimens labelled *crescentica* and obtained in the same way and from the type locality of this species are actually the types.)
1900. *Pheretima crescentica* + *P. houlleti* (part, excluding at least *campanulata, guillelmi* and possibly also *udekemi*) + *P. travancorensis*, Michaelsen, *Das Tierreich*, X, pp. 262, 273 and 310.
1900. *Amyntas houlleti* (part, excluding at least *campanulata* and *guillelmi*) + *A. travancorensis*, Beddard, *Proc. Zool. Soc. London*, 1900, pp. 613 and 614.
1903. *Pheretima Houlleti* (part, excluding distribution of *campanulata* and Bahama forms) + *P. travancorensis*, Michaelsen, *Geogr. Verbr.* pp. 97 and 100.
1909. *Pheretima houlleti* (part, excluding the distribution of *campanulata*) + *P. travancorensis* + *P. houlleti*, Michaelsen, *Mem. Ind. Mus.* I, pp. 110 and 187.
1910. *Pheretima houlleti* (part, excluding the distribution of *campanulata, guillelmi* and *meridiana*) + *P. travancorensis* + *P. houlleti*, Michaelsen, *Abh. Nat. Ver. Hamburg*, XIX (5), pp. 11, 13 and 83.
1911. *Pheretima travancorensis*, Cognetti, *Ann. Mag. Nat. Hist.* (8), VII, p. 494.
1916. *Pheretima houlleti*, Stephenson, *Rec. Ind. Mus.* XII, p. 334.
1916. *Pheretima trivandrana*, Stephenson, *Rec. Ind. Mus.* XII, p. 335. (Type locality, Trivandrum, Travancore. Type in the Indian Museum).
1917. *Pheretima houlleti*, Stephenson, *Rec. Ind. Mus.* XIII, p. 385.
1922. *Pheretima houlleti*, Michaelsen, *Mitt. Mus. Hamburg*, XXXVIII, p. 68.
1922. *Pheretima houlleti*, Stephenson, *Rec. Ind. Mus.* XXIV, p. 434.
1923. *Pheretima houlleti* (part, excluding *campanulata* and the distribution of *guillelmi* and *meridiana*) + *P. travancorensis* + *P. trivandrana*, Stephenson, *Oligochaeta*, in *F. B. I. Series*, pp. 304, 313 and 314.
1924. *Pheretima houlleti*, Stephenson, *Rec. Ind. Mus.* XXVI, p. 340.
1929. *Pheretima travancorensis* + *P. trivandrana*, Aiyer, *Rec. Ind. Mus.* XXXI, p. 15.
1934. *Pheretima houlleti*, Gates, *Rec. Ind. Mus.* XXXVI, p. 259.

Material examined.—From the Indian Museum: 12 clitellate specimens labelled, "*Pheretima houlleti* (E. Perr.) Bhim Tal, Kumaon; 4,500 ft. alt., N. A., 19-28. ix. 06. ZEV 2825/7.", 4 clitellate specimens of which two are dissected, labelled, "*Pheretima houlleti* (E. Perr.). Raniganj, Burdwan dist., Bengal. L. L. Fermor. ZEV 2824/7.", 1 dissected, clitellate specimen labelled, "*Pheretima houlleti* (E. Perr.). Mangalore, Malabar. G. Matthai. ZEV 4143/7.", 2 dissected, clitellate specimens labelled, "*Pheretima houlleti* (E. Perr.). Trichur (Cochin State) Malabar, Madras Pres. July 1909. G. Matthai. ZEV 3504/7.", 1 aclitellate, dissected specimen labelled, "*Pheretima houlleti* (E. Perrier). Trivandrum, Travancore. Trivandrum Museum. "Type". ZEV 7233/7.", 1 clitellate, dissected specimen labelled, "*Pheretima houlleti.* Rawal Pindi, Punjab. Dec. 1915. Ragunath Sahai. Lt. Col. J. Stephenson, I.M.S. W 41/1.", 1 dissected, clitellate specimen labelled, "*Pheretima houlleti* (E. Perr.) Bombay. J. P. Mullan. W 1165/1.", 1 clitellate, macerated, dissected

specimen labelled, "*Pheretima houlleti* (E. Perr.). Compound of the Forest Research Institute, Dehra Dun. 20. viii. 21. W 686/1.", 2 clitellate, dissected specimens labelled, "*Pheretima houlleti* (E. Perr.). Khasi Hills, Sta. 5, Under stones and in muddy pools around Dak bungalow at Cherrapunji, Assam. 28. x. 1921. S. L. Hora. W 685/1.", 1 clitellate, dissected specimen labelled, "*Pheretima houlleti* (E. Perr.). Matheran. x. 21. J. P. Mullan. W 1164/1.", and 2 clitellate, dissected specimens labelled, "*Pheretima houlleti* (E. Perr.). Gorge below Chota tank, Buldana, Berar. 2190 ft. Sta. 7, 17, ii. 23. H. S. Rao. W 1128/1.". From the British Museum: 1 aclitellate and 3 clitellate dissected specimens labelled, "*Pheretima travancorensis* (type) 1904. 10. 5. 167/8. coll. Beddard.".

Remarks.—The types of *P. travancorensis* are quite obviously referable to *houlleti.*

With the exceptions noted below, all of the Indian Museum material can be referred, without question, to *houlleti.* One lot of specimens from Bombay (Stephenson) and others from Malabar (Chevagun bei Calicut), Trivandrum, Coorg and Mysore (Michaelsen) have not been available for examination. There is, however, no evidence to indicate that any of these specimens might be anything but *houlleti.*

The Mangalore specimen is peculiar in that some of the spermathecal pore invaginations have the posterior stalked gland characteristic of *campanulata* and *meridiana.* The left spermathecal invagination of vii has two anterior stalked glands. The penial body is slenderly conical, genital markings apparently lacking thereon or nearby, the shape much more like that of *houlleti* than that of either *campanulata* or *meridiana.* The first dorsal pore is definitely on 8/9. The size is well within the *houlleti* limits. In spite of the presence of the posterior stalked glands the other characteristics just mentioned necessitate identification as *houlleti.* The presence of posterior stalked glands on the spermathecal invagination is accordingly regarded as an abnormality, associated with an abnormal doubling of the anterior glands. The doubling of the anterior glands has been observed previously but the presence of posterior glands on the spermathecal pore invagination has not hitherto been noted in *P. houlleti.*

One specimen labelled, "*Pheretima houlleti* (E. Perr.) Bansda, Surat. October 1922. J. P. Mullan. W 1166/1.", is macerated and lacks at least a portion of the anterior end. Identification in the present condition is not feasible, but paired, rather thread-like segmental structures are almost certainly meganephridia. It is highly improbable that Stephenson mistook a meganephric worm for *P. houlleti,* which is purely micronephric. Presumably labels or specimens have been accidentally changed. Hence the Surat record has not been questioned.

Diagnosis.—Sexthecal, spermathecal pores minute and invaginate, each pore on the roof or lateral wall near the roof of an invagination with transversely slit-like lumen and aperture; three pairs, on 6/7-8/9. Male pores minute and invaginate, each pore on a slenderly conical to shortly columnar penis on the roof of a spheroidal copulatory chamber. Genital markings tiny, circular, greyish translucent areas sharply demarcated by slight circumferential furrows, internal only; one marking on the anterior wall of each spermathecal pore invagination, one marking on the median wall of each copulatory chamber, one to three markings on or near the base of each penis. Seta *a* and some of the ventral setae of the preclitellar segments enlarged, modified and ornamented;

setae present on all clitellar segments and with bifid or trifid tips: vii/11-17, viii/16-25, xvii/12-16, xviii/5-12, xix/12-15, 24-31/iii, 37-51/viii, 46-54/xii, 51-61/xx. First dorsal pore on 7/8-10/11. Length 55-110 mm. Diameter 3-4½ mm. Segments 90-116.

Intestinal caeca simple. Testis sacs unpaired and ventral. Lumen in ental part of the spermathecal duct wide and communicating with the narrowed lumen of the ectal portion of the duct through a tiny, slit-like aperture at the centre of a low, disc-shaped papilla of circular outline; diverticulum with short, straight stalk and wider, elongate seminal chamber, the latter looped in part or in whole, often in an approximation to zigzag. One or more stalked glands to the anterior face of each copulatory chamber, one stalked gland on the posterior face; one stalked gland to the anterior face of each spermathecal invagination.

Distribution.—Rawalpindi, Punjab; Dehra Dun, Bhim Tal, Allahabad, United Provinces; Calcutta, Raniganj (Burdwan district), Bengal; Cherrapunji, Assam; Bombay, Matheran, Bansda (Surat), Bombay Presidency; Buldana (Berar), Central Provinces; Mangalore, Trivandrum (Travancore), Trichur (Cochin), Chevagun (near Calicut), Merkara (Coorg), Shimoga, Bangalore (Mysore), Salem, South India. Outside of India: Ceylon (Panadhure), Burma (widely spread), Andaman Islands, Siam, Malay Peninsula. *P. houlleti* has been recorded from other places but in view of the confusion of at least three species with *houlleti* the records require confirmation. There is no valid record of the occurrence of the species in China, outside of the province of Yunnan.

Pheretima morrisi (Beddard).

1892. *Perichaeta morrisi*, Beddard, *Proc. Zool. Soc. London*, 1892, p. 166. (Type locality, Penang. Types in the British Museum.) According to Beddard the types are from Penang, but the label in the tube of types states that the worms are from Hongkong.)

1898. *Perichaeta cupulifera*, Fedarb, *Proc. Zool. Soc. London*, 1898, p. 445. (Type locality, Dehra Dun. Types, if still in existence, in the British Museum.)

1900. *Pheretima barbadensis* (part, excluding sexthecal forms) + *P. morrisi*, Michaelsen, *Das Tierreich*, X, pp. 254 and 287.

1900. *Amyntas hawayanus* (part), Beddard, *Proc. Zool. Soc. London*, 1900, p. 645. (Excluding sexthecal forms.)

1903. *Pheretima hawayana* (part), Michaelsen, *Geogr. Verbr.*, p. 96. (Excluding sexthecal forms.)

1909. *Pheretima hawayana barbadensis*, Michaelsen, *Mem. Ind. Mus.* I, pp. 110 and 187.

1910. *Pheretima hawayana barbadensis*, Michaelsen, *Abh. Nat. Ver. Hamburg*, XIX (5), p. 11.

1914. *Pheretima hawayana* (part), Stephenson, *Rec. Ind. Mus.* X, p. 343. (Excluding sexthecal forms with enlarged setae on iv-viii or v-vii.)

1916. *Pheretima hawayana typica* (part) + *P. h. barbadensis* (part), Prashad, *J. Bombay Nat. Hist. Soc.* XXIV, pp. 499 and 501. (Excluding sexthecal forms.)

1917. *Pheretima hawayana*, Stephenson, *Rec. Ind. Mus.* XIII, p. 386.

1920. *Pheretima hawayana*, Stephenson, *Mem. Ind. Mus.* VII, p. 222. (All of Stephenson's specimens of *hawayana* from Bombay that have been preserved in the Indian Museum are referable to *morrisi*.)

1921. *Pheretima hawayana*, Stephenson, *Rec. Ind. Mus.* XXII, p. 760.

1922. *Pheretima hawayana*, Stephenson, *Rec. Ind. Mus.* XXIV, p. 433.

1923. *Pheretima hawayana* (part), Stepehnson, *Oligochaeta*, in *F. B. I. Series*, p. 300. (Excluding sexthecal forms.)

1924. *Pheretima hawayana*, Stephenson, *Rec. Ind. Mus.* XXVI, p. 339. (*Vide* note under Stephenson, 1920.)

1926. *Pheretima hawayana*, Stephenson, *Rec. Ind. Mus.* XXVIII, p. 256. (*Vide* note under Stephenson, 1920.)

Material examined.—From the Indian Museum: 10 clitellate or partially clitellate specimens labelled, "*Pheretima hawayana* (Rosa). Lahore, Punjab. Lt.-Col. J. Stephenson. W 49/1.", 1 aclitellate specimen labelled, "*Pheretima hawayana* (Rosa). Nepal Valley, E. Himalayas. 4,500-6,500 feet. Lt.-Col. J. Manners-Smith. W 74/1.", 7 clitellate specimens labelled, "*Pheretima hawayana* (Rosa). Brindaban, Muttra Dist. U. P. 15. vii. 17. Dr. B. Prashad. W 233/1.", 5 clitellate specimens labelled, "*Pheretima hawayana* (Rosa). Udaipur, Rajputana. March 1918. Lt.-Col. J. Stephenson. W 234/1.", 4 clitellate macerated specimens labelled, "*Pheretima hawayana* (Rosa). Compound of Forest Res. Inst. Dehra Dun. 20. viii. 21. W 682/1.", 4 clitellate specimens labelled, *Pheretima hawayana* (Rosa). Imphal Residency Garden, Manipur. 2. iii. 20. Manipur Survey. W 566/1.", 1 aclitellate and 1 clitellate specimens labelled, "*Pheretima hawayana* (Rosa). Bombay. Prof. J. P. Mullan. W 1163/1.", 13 clitellate, macerated specimens labelled, "*Pheretima hawayana* subsp. *barbadensis*. Lahore, Punjab. Major J. Stephenson. ZEV 2827/7.", and 1 aclitellate and 6 clitellate specimens labelled, "Kalimpong, E. Himalayas. June 1934. S. L. Hora.".

One of Stephenson's specimens from Lahore has a transverse, presetal row of 8 markings on xviii, a transverse row of 7 presetal markings on xix, in addition to the usual pair of markings just median to each male porophore. Other specimens from Lahore have several presetal genital markings on each of segments xviii and xix in addition to the markings close to the male porophores. Four of the Kalimpong specimens have a presetal row of markings on xvii, of 5 markings (3 specimens) or of 6 markings (1 specimen). One of these specimens has in addition 5 presetal markings on xix. One of Mullan's specimens from Bombay has an extra male pore on xvii on the left side and just median thereto a pair of markings, one presetal and one postsetal. Associated with the extra male porophore is a well-developed prostate and prostatic duct. On one of the Manipur Survey specimens the median presetal marking on vii is replaced by a pair of markings in contact at the midventral line.

Diagnosis.—Quadrithecal, spermathecal pores minute and superficial, two pairs, on 5/6-6/7. Male pores minute and superficial, each pore on a tiny, transversely elliptical, disc-shaped porophore. Genital markings small, transversely elliptical to circular tubercles; two just median to each male porophore with one presetal and one postsetal; presetal and median on v-viii; presetal and just median to the spermathecal pore lines on vii-viii; presetal and median to the male pore lines on xviii-xix, postsetal and median to the male pore lines on xvii-xviii. Setae present ventrally on xvi: vi/16-28, xvii/16-23, xviii/10-17, xix/16-23, 23-29/iii, 46-51/viii, 48-56/xii, 4-22/xvi, 46-59/xx. First dorsal pore on 10/11. Length 40-150 mm. Diameter $2\frac{1}{2}$-6 mm. Segments 87-95.

Intestinal caeca simple, with a few short lobes on the ventral margins. Testis sacs paired and ventral. Spermathecal diverticulum with short stalk-lumen narrow and irregular, a middle portion with high and thick transverse ridges, seminal chamber slenderly club-shaped. Genital marking glands stalked and coelomic.

Distribution.—Lahore, Punjab; Dehra Dun, Bindraban near Muttra, United Provinces; Nepal Valley, and Kalimpong, Eastern Himalayas; Imphal, Manipur; Udaipur, Rajputana; Bombay. Outside of India: Burma (widely distributed on the Shan Plateau and also known from

Myitkyina and Bhamo district and from Mt. Popa in Myingyan district), China (provinces of Yunnan, Szechuan, Fukien and Chekiang, also Hongkong), Siam (Chiengmai), Penang, Sumatra, Hawaiian Islands, Cape Verde, St. Helena, Barbados, United States (southern), Brazil and Chile.

Pheretima planata Gates.

1926. *Pheretima planata*, Gates, *Ann. Mag. Nat. Hist.* (9), XVII, p. 411. (Type locality, Rangoon.)
1926. *Pheretima planata*, Stephenson, *Rec. Ind. Mus.* XXVIII, p. 256.

Diagnosis.—Quadrithecal, spermathecal pores minute and superficial, two pairs, on the anterior margins of vii and viii close to 6/7 and 7/8. Male pores minute and invaginate, each pore on the roof of a copulatory chamber with a transversely slit-like aperture. Genital markings tiny, circular, translucent areas; external markings on the posterior margins of vii and viii and the anterior margin of viii, 1-4 markings just median to each spermathecal pore; internal markings 8-12, on the roof and walls of the copulatory chamber. Setae; vii/35-42, xvii/17-22, xviii/9-14, xix/16-20, 60-67/iii, 75-87/viii, 63-78/xii, 56-65/xx. First dorsal pore on 11/12. Length 64-170 mm. Diameter 4-7 mm. Segments 115-142.

Intestinal caeca simple. Testis sacs paired; of x, ventral; of xi, vertical; seminal vesicles included. Spermathecal diverticulum longer than combined lengths of duct and ampulla, comprising a short stalk, a thicker middle portion with thick wall within which are numerous small, spheroidal to ovoidal chambers opening into the central lumen, and a terminal, elongately ellipsoidal seminal chamber. Genital marking glands stalked and coelomic.

Distribution.—Katlicherra in South Cachar, Assam. Outside of India found in Burma, Andaman Islands and the Malay Peninsula (Kuala Lumpur).

Pheretima posthuma (Vaillant).

1868. *Perichaeta posthuma*, L. Vaillant, *Ann. Sci. Nat.* (5), X, p. 228. (Type locality, Java! Types in the Paris Museum.)
1883. *Megascolex affinis*, Beddard, *Ann. Mag. Nat. Hist.* (5), XII, p. 214.
1889. *Megascolex posthuma*, Vaillant, *Hist. Nat. Annel.* III, (1) p. 72.
1895. *Perichaeta posthuma*, Beddard, *Monog.* p. 424.
1900. *Pheretima posthuma*, Michaelsen, *Das Tierreich*, X, p. 295.
1900. *Amyntas posthumus*, Beddard, *Proc. Zool. Soc. London*, 1900, p. 641.
1901. *Amyntas posthumus*, Beddard, *Proc. Zool. Soc. London*, 1901, p. 196.
1902. *Pheretima posthuma*, Beddard and Fedarb, *Proc. Zool. Soc. London*, 1902, p. 164. (Coelomic pouches.)
1903. *Pheretima posthuma*, Michaelsen, *Geogr. Verbr.* p. 98.
1909. *Pheretima posthuma*, Michaelsen, *Mem. Ind. Mus.* I, pp. 110 and 189.
1910. *Pheretima posthuma*, Michaelsen, *Abh. Nat. Ver. Hamburg*, XIX (5), p. 12.
1911. *Pheretima posthuma*, Lloyd, *Introduction to Biology for Students in India*, p. 68.
1911. *Pheretima posthuma*, Lloyd and Powell, *J. Bombay Nat. Hist. Soc.* XXI, pp. 289 and 291.
1913. *Pheretima posthuma*, Stephenson, *Trans. Roy. Soc. Edinburgh*, XLIX, p. 764. (Circulatory System.)
1914. *Pheretima posthuma*, Stephenson, *Rec. Ind. Mus.* X, pp. 323 and 342.
1915. *Pheretima posthuma*, Stephenson, *Mem. Ind. Mus.* VI, pp. 37 and 99.
1916. *Pheretima posthuma*, Prashad, *J. Bombay Nat. Hist. Soc.* XXIV, p. 502.

1916. *Pheretima posthuma*, Prashad, "*The Anatomy of an Indian Earthworm, Pheretima posthuma.*", Lahore, p. 1.
1916. *Pheretima posthuma*, Stephenson, *Rec. Ind. Mus.* XII, p. 334.
1917. *Pheretima posthuma*, Stephenson, *Quart. J. Mic. Sci.* LXII, p. 261. (Pharyngeal gland cells.)
1917. *Pheretima posthuma*, Stephenson, *Rec. Ind. Mus.* XIII, p. 385.
1918. *Pheretima posthuma*, Thapar, *Rec. Ind. Mus.* XV, pp. 71 and 74. (Lymph glands and coelomic organs.)
1919. *Pheretima posthuma*, Bahl, *Quart. J. Mic. Sci.* LXIV, pp. 76 and 109. (Nephridia and septa.)
1920. *Pheretima posthuma*, Stephenson, *Mem. Ind. Mus.*, VII, p. 222.
1921. *Pheretima posthuma*, Bahl, *Quart. J. Mic. Sci.* LXV, pp. 349 and 354. (Circulatory system.)
1922. *Pheretima posthuma*, Stephenson, *Rec. Ind. Mus.* XXIV, p. 434.
1922. *Pheretima posthuma*, Bahl, *Quart. J. Mic. Sci.* LXVI, p. 56. (Cocoons.)
1923. *Pheretima posthuma*, Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 309.
1924. *Pheretima posthuma*, Stephenson, *Rec. Ind. Mus.* XXVI, p. 340.
1924. *Pheretima posthuma*, Stephenson, *Proc. Roy. Soc. London*, B, XCVII, p. 180. (Blood glands.)
1926. *Pheretima posthuma*, Stephenson, *Rec. Ind. Mus.* XXVIII, p. 258.
1926. *Pheretima posthuma*, Bahl, *Indian Zool. Mem.* I, p. 1.
1930. *Pheretima posthuma*, Nath, *Quart. J. Mic. Sci.* LXXV, p. 477. (Golgi Apparatus.)
1933. *Pheretima posthuma*, Nath, *Quart. J. Mic. Sci.* LXXVI, p. 138. (Golgi bodies.)
1934. *Pheretima posthuma*, Bahl, *Quart. J. Mic. Sci.* LXXVI, p. 567. (Castings.)
1936. *Pheretima posthuma*, Bahl, *Indian Zool. Mem.* I, 2nd ed., p. 1.

Material examined.—From the Indian Museum: 3 aclitellate (and probably also 2 juvenile) specimens labelled "On ground near the cistern of extension Filter Bed No. 7. Pulta Waterworks. Pulta Waterworks Survey.", 4 partially clitellate or aclitellate specimens labelled, "On the banks of New Filter Bed No. 3, Pulta Waterworks. Pulta Waterworks Survey.", 1 clitellate and macerated specimen labelled, "On sand in New Filter Bed No. 3. Pulta Waterworks. Pulta Waterworks Survey.", 1 juvenile and 45 clitellate specimens labelled, "Forest Rest House. Lachhiwala, Dehra Dun District. 29. ix-3. x. 35. Dr. S. L. Hora.".

Diagnosis.—Octothecal, spermathecal pores minute and superficial, four pairs, on the posterior margins of v-viii, each pore at the centre of a transversely elliptical, greyish, translucent area. Male pores minute and invaginate, each pore on a tiny tubercle on the median wall near the roof of a slight parietal invagination with a longitudinally directed, crescentic aperture. Genital markings small, transversely elliptical tubercles, two pairs, in the setal circles of xvii and xix. Setae present ventrally on the clitellar segments: vi/37-43, vii/38-44, viii/36-43, xvii/15-20, xviii/17-21, xix/16-20, 90-104/iii, 106-129/viii, 63-75/xii, 64-86/xx. First dorsal pore on 12/13. Length 60-140 mm. Diameter 4-8 mm.

Septum 8/9 present and muscular. Intestinal caeca simple, small. Hearts of x and xi replaced by commissural loops connecting the supra-oesophageal and suboesophageal vessels. Testis sacs unpaired: of x ventral, of xi U-shaped; seminal vesicles included. Lumen in ental part of the spermathecal duct large and communicating with the narrowed lumen of the ectal portion through a pore in a vertical groove on the median face of a dorsally directed, shortly conical papilla. Diverticular stalk shorter than the ovoidal to ellipsoidal seminal chamber. Genital marking glands sessile on the parietes.

Distribution.—Lyallpur, Mian Mir, Lahore, Ludhiana, Hoshiarpur, Jullundur, Phagwara, Ferozepore, Kalka, Punjab; Ajmere and Udaipur,

Rajputana; Dehra Dun, Saharanpur, Allahabad, Agra, Lucknow, Bindraban, United Provinces; Kierpur, Pusa, Bihar; Calcutta, Dattapakur, Khulna, Bongaon, Bhagalpur, Purneah, Dhalla, Netracona (Mymensing district), Raniganj (Burdwan district), Rajshahi, Saraghat, Comillah and Rangamati (Chittagong district), Bengal; Bombay and Baroda, Bombay Presidency; Gwalior, Central India. Outside of India: Burma (widely distributed, but absent from the western hills and the Shan Plateau), Andaman Islands, Siam, French Indo-China, the Malay Peninsula, Java, Sumatra, Philippines, Celebes, Christmas Island, Groot Bastaard, Ternate, New Hebrides, Santa Cruz Is., Amboine, Nias, Flores, Sebesi, Sumba, Nice (? France). (Recorded once from the Bahamas but never confirmed. According to Bahl, 1936, p. 8, found in Ceylon but no record of this can be found.)

Pheretima robusta (Perrier).

1872. *Perichaeta robusta*, E. Perrier, *N. Arch. Mus. Paris*, VIII, p. 112. (No type designation. Types from Mauritius and Manila, in the Paris Museum.)
1925. *Pheretima himalayana*, Stephenson, *Proc. Zool. Soc. London*, 1925, p. 893. (Type locality, Darjiling, India. Type in the British Museum.)
1934. *Pheretima robusta*, Gates, *Rec. Ind. Mus.* XXXVI, p. 264.

Diagnosis.—Quadrithecal, spermathecal pores minute and superficial, two pairs, on 7/8-8/9. Male pores minute and superficial, each on a small, transversely elliptical tubercle surrounded by several concentric furrows. Genital markings small, circular to elliptical tubercles, about 1 intersetal interval wide: on xviii presetal and postsetal, slightly median to the male pore lines (slightly lateral to the midventral line); presetal and postsetal on vii-viii, slightly median to the spermathecal pore lines; on the spermathecal porophores, just behind the spermathecal pores. Setae: viii/19-31, xvii/24-31, xviii/18-24, xix/23-31, 34-40/iii, 50-53/viii, 54-59/xii, 63-70/xx. First dorsal pore on 11/12. Length, 120-140 mm. Diameter, 5-8 mm. Segments, 106.

Intestinal caeca simple but with short lobes on the ventral margins. Testis sacs unpaired and ventral. Spermathecal diverticulum with spheroidal to ellipsoidal seminal chamber usually shorter than the slender stalk. Genital marking glands stalked and coelomic.

Distribution.—Darjiling in the Eastern Himalayas. Outside of India: Burma (northern portion of the Shan Plateau only, at Namkham, Kutkai and Lashio), China (Provinces of Fukien, Szechuan, Chekiang, Kiangsu, Kiangsi and Hupei, also Hongkong), Philippines (?), Mauritius (?), Madagascar (?), West Indies (?).

Pheretima taprobanae (Beddard).

1892. *Perichaeta taprobanae*, Beddard, *Proc. Zool. Soc. London*, 1892, p. 163. (Type locality, Ceylon. Types in the Oxford University Museum and the British Museum ?).
1929. *Pheretima taprobanae*, Aiyer, *Rec. Ind. Mus.* XXXI, pp. 15 and 72.

Indian specimens have not been available for study. Material in the British Museum has been examined and the account will be published elsewhere.

Diagnosis.—Bithecal, spermathecal pores minute and superficial, one pair, on the anterior margin of viii. Male pores minute and superficial, each on an indistinctly demarcated, circular, postsetal porophore. Genital markings small, circular, presetal, paired, on vi-xi and xviii-xxii. Setal circles present on all clitellar segments: viii/34-41, xvii/20-25, xviii/14-19, xix/19-25, 70/v, 77/x. First dorsal pore on 12/13. Length 80-145 mm. Diameter 4-7 mm. Segments 95-122.

Septum 8/9 present but membranous. Hearts of x and xiii lacking. Testis sacs unpaired and annular; seminal vesicles included. Spermathecal diverticulum with spheroidal to ovoidal seminal chamber and slender muscular stalk that passes into the anterior face of the duct at the parietes. Genital markings slight epidermal thickenings without internal glands.

Distribution.—Trivandrum, Travancore. Outside of India has been found in Ceylon, Madagascar and Brazil but is quite unknown from (or at least unrecognized within) the *Pheretima* domain.

APPENDIX TO THE GENUS *PHERETIMA*.

The reference listed below cannot be placed in any of the synonymies.

1917. *Pheretima hawayana*, Stephenson, *Quart. J. Mic. Sci.* LXII, pp. 260 and 267. (Pharyngeal glands.)
1918. *Pheretima hawayana*, Thapar, *Rec. Ind. Mus.* XV, pp. 69 and 71. (Blood glands.)
1919. *Pheretima hawayana*, + *P. barbadensis*, Bahl, *Quart. J. Mic. Sci.* LXIV, pp. 103 and 104. (Nephridia.)
1919. *Pheretima hawayana*, Stephenson and Ram, *Trans. Roy. Soc. Edinburgh*, LII, pp. 436, 438 and 439. (Prostates.)
1919. *Pheretima hawayana*, Stephenson and Prashad, *Trans. Roy. Soc. Edinburgh*, LII, pp. 457 and 460. (Calciferous glands.)
1924. *Pheretima hawayana*, Stephenson, *Proc. Roy. Soc. London*, B. XCVII, pp. 179 and 192. (Blood glands.)

Stephenson did not distinguish between *hawayana* and *morrisi*, now recognized as specifically distinct, and often gave no clues that would enable recognition of his forms. The material involved apparently has not been preserved. For the present at least, the proper disposition of *P. hawayana* and *P. barbadensis* of the authors and dates just cited is impossible.

1889. *Perichaeta houlleti*, Bourne, *J. Asiatic Soc. Bengal*, LVIII, p. 111.

Figure 5, pl. 3, shows a " spermatheca seen turned forwards " Presumably then it is the posterior face of the spermatheca that is drawn. Since a stalked gland is shown passing to the posterior face the worm hitherto could have been referred to *campanulata*. With the finding, as an occasional abnormality (*vide* p. 204) of posterior glands passing to the spermathecal pore invaginations, identification is no longer possible unless information with regard to other characteristics is available. Since Bourne's specimens have not been preserved and in the absence of the necessary information the reference, at least for the present, cannot be properly placed,

1886. *Perichaeta burliarensis*, Bourne, *Proc. Zool. Soc. London*, 1886, p. 667. (Type locality, Burliar, Nilgiris, S. I.)
1895. *Perichaeta burliarensis*, Beddard, *Monog.* p. 403.
1900. *Pheretima burliarensis*, Michaelsen, *Das Tierreich*, X, p. 258.
1909. *Pheretima burliarensis*, Michaelsen, *Mem. Ind. Mus.* I, p. 110.
1910. *Pheretima burliarensis*, Michaelsen, *Abh. Nat. Ver. Hamburg*, XIX, (5), p. 11.
1923. *Pheretima burliarensis*, Stephenson, *Oligochaeta*, in *F. B. I. Series*, p. 297.

This species, if a *Pheretima*, is quite unrecognizable. The only evidence for recognition as a *Pheretima* is the presence of the gizzard in x, and the presence of intestinal caeca in xxvi. Equally good evidence against recognition is the inclusion of segment xvii in the clitellum and the presence of two pairs of groups of enlarged setae on vii and viii. The supposed location of the gizzard in x cannot be considered as important evidence. In the same paper Bourne incorrectly placed the gizzard of his *P. stuarti* also in x. The location of the gizzard of *P. lawsoni* and *P. hulikalensis* is probably also incorrect.

Perichaeta lawsoni and *P. hulikalensis* Bourne 1886 are quite unrecognizable and the latter, according to Stephenson (1923, p. 290), "may be a *Megascolex*." *P. lawsoni* has the gizzard in x and intestinal caeca in xxvi. Bourne failed to mention the gizzard of *hulikalensis* and evidently had some doubt as to the caeca, "I believe intestinal diverticula are present in the usual position." Both species have a clitellum that includes segment xvii. Little is known of the earthworms of the Nilgiris (one species of *Megascolex* was briefly characterized by Bourne but has not been seen since). When the fauna of this region has been worked out it may be possible to refer Bourne's three species of *Perichaeta* more or less definitely to some species of *Megascolex*.

REFERENCES.

Aiyer, K. S. P. An account of the Oligochaeta of Travancore. *Rec. Ind. Mus.* XXXI, 1929.

Bahl, K. N. On the significance of the enteronephric nephridial system found in Indian earthworms. I. Evidence from their habits and castings. *Quart. J. Mic. Sci.* LXXVI, 1934.

Bahl, K. N. *Pheretima.* In "*Indian Zoological Memoirs*", 2nd ed. (Lucknow, 1936).

Gates, G. E. The earthworms of Burma. III. *Rec. Ind. Mus.* XXXIV, 1932.

Gates, G. E. The earthworms of Burma. IV. *Rec. Ind. Mus.* XXXV, 1933.

Michaelsen, W. Oligochaeta. *Das Tierreich*, X, 1900.

Michaelsen, W. *Die Geographische Verbreitung der Oligochaeten.* (Berlin, 1903).

Michaelsen, W. The Oligochaeta of India, Nepal, Ceylon, Burma and the Andaman Islands. *Mem. Ind. Mus.* I, 1909.

Michaelsen, W. Die Oligochatenfauna der vorderindisch-ceylonischen Region. *Abh. Nat. Ver. Hamburg*, XIX, (5), 1910.

Stephenson, J. On some Indian Oligochaeta, mainly from southern India and Ceylon. *Mem. Ind. Mus.* VI, 1915.

Stephenson, J. On a collection of Oligochaeta from various parts of India and Farther India. *Rec. Ind. Mus.* XIII, 1917.

Stephenson, J. *Oligochaeta.* In, *Fauna of British India Series* (London, 1923).

Stephenson, J. The Oligochaeta of the Indawgyi Lake (Upper Burma). *Rec. Ind. Mus.* XXXI, 1929.

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