EARTHWORMS (ACANTHODRILIDAE AND EUDRILIDAE : OLIGOCHAETA) FROM GAMBIA

by R. W. SIMS

CONTENTS

SYNOPSIS

Earthworms are reported from the coastal and central areas of Gambia. Seven species of Acanthodrilidae and two of Eudrilidae are recognized; two species of the former have previously been recorded from the savannas of western Africa while one species of the latter has a wider distribution from the Congo to Senegal; the remaining species are regarded as being endemic. One new genus and five new species of Acanthodrilidae (Octochaetinae) and one new species of Eudrilidae (Pareudrilinae) are described. With the exception of one species of *Benhamia*, all of the other species are new records for Gambia. A brief Appendix contains a new record for Senegal.

INTRODUCTION

Although the savannas of the northern tropical region of western Africa form a discrete area of special faunal interest, the terrestrial oligochaetes are poorly known. There are few records of earthworms from the territories north of Sierra Leone and our total knowledge of Gambian Oligochaeta rests on the first descriptions of three new species of *Benhamia* (Beddard, 1900 : 653 and 1901 : 210). The lack of information on the terrestrial Oligochaeta of the savannes of western Africa although important in itself, prevents an understanding of the structure of the oligochaete fauna of the western Aethiopean region generally. Knowledge of the earthworms of this northern area permits the recognition of a lowland savanna component in faunae in other areas especially where vegetational zones are complicated by altitude.

The climate of the region may be largely the cause of our poor knowledge of the earthworms. The weather is dry for most of the year, the soil is parched and earthworms are difficult to find; then there are heavy rains during the height of the northern summer when travelling becomes difficult and collecting is not attempted. There are localities where these generalizations do not strictly apply and one is the

strip of land along both sides of the River Gambia. Here the soil is less arid in the dry season, or at least during the earlier part, than in most places in the region. One result is that collecting is possible here at a time when earthworms are seldom found elsewhere. To increase our knowledge of the terrestrial Oligochaeta of the savanna of western Africa, I visited the area in 1964 and took advantage of the more favourable conditions along the River Gambia to collect at several localities in Gambia. An account of the visit and of the material obtained is presented in this report together with details of a small collection of earthworms from Senegal.

ACKNOWLEDGEMENTS

I must record my gratitude to the Trustees of the Godman Fund for their generosity in contributing towards the expenses incurred in visiting Gambia. To Mr. Hector Davidson, Director of Agriculture, and to other members of the Department of Agriculture, Gambia, go my grateful thanks for the willing assistance they gave to me without which the field programme could not have been completed. My thanks are also due to Professor A. Chabaud, Museum National d'Historie Naturelle, Paris, and Dr. P. L. G. Benoit, Koninklijk Museum Voor Midden Africa, Tervuren, for their courtesy in permitting me access to the collections in their charge. Finally, I must acknowledge the assistance given to me by Mr. E. G. Easton during the preliminary laboratory studies on the material reported here and by Mr. P. Green who is responsible for the excellent photographs reproduced below.

COLLECTING LOCALITIES

The material listed in this report was collected at the end of the rainy season in September and October when the more favourable conditions begin. Field work was carried out from two centres in Gambia, the first near to the coast around Yundum and the second in central Gambia near to Sapu. Samples were collected in a number of habitats in the localities listed in Table 1.

TABLE 1

Abuko	10 miles south of Bathurst
Bakau	7 miles west of Bathurst
Brikama	20 miles south of Bathurst
Brikama Ba	10 miles west of Georgetown
Nyambai	16 miles south of Bathurst
Sapu	12 miles west of Georgetown
Williagara	13 miles west of Georgetown
Yundum	14 miles south of Bathurst

The numbers of earthworms present in each sample varied considerably and in many places no specimens were obtained, for example, collecting was frequently attempted in the bush, i.e. forested savanna, but earthworms were never found there. It is possible, however, that where negative results were obtained they may be largely attributed to the collecting methods employed (see below). The paucity of earthworms led to a wide search for favourable sampling plots but few were found. The few that were satisfactory, were confined to soil under mulch near cultivation,

at the sides of fields where weeds and the unwanted tops of ground crops had been discarded, or, near to water. In these situations earthworms were often present in large numbers.

ECOLOGY: CLIMATE AND SOIL

The two main collecting areas are similar in consisting of lightly wooded grassland with scattered villages surrounded by cultivated land. In the coastal region, however, the climate is slightly more humid and the temperature a little lower than inland. The soils of the two areas also differ slightly although in both localities they are essentially sandy loams.

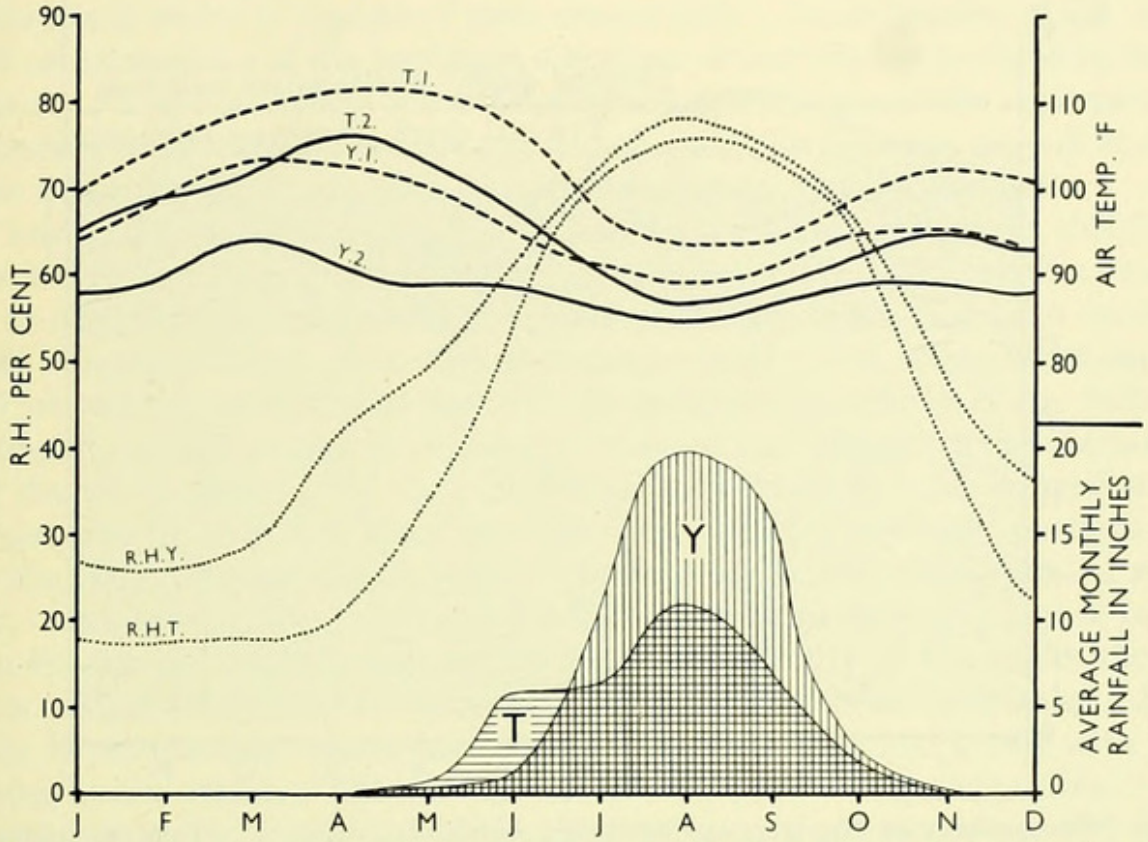

FIG. 1. Climate of the basin of the R. Gambia. TEMPERATURE (Fahrenheit), *Broken line:* average highest temperature each month, *T*.1.–Tambacounda; *Y*.1.–Yundum. *Continuous line:* average daily temperature, *T*.2.–Tambacounda; *Y*.2.–Yundum.
HUMIDITY, *Dotted line:* relative humidity, *R.H.T.*–Tambacounda, daily average R.H. at 11.00 hrs.; *R.H.Y.*–Yundum, daily average R.H. at 14.00 hrs.
RAINFALL (Inches) Average monthly precipitation. *Horizontal lines: T.*–Tambacounda (average total annual rainfall 39·5 inches); *vertical lines: Y.*–Yundum (average annual rainfall 51·0 inches).

The only meteorological station in Gambia is situated at Yundum in the coastal region but meteorological information of inland areas can be obtained from data collected at Tambacounda in Senegal, near to the eastern extremity of Gambia. The meteorological data available (Meteorological Office, London, 1958) were obtained by standard apparatus so the temperature and humidities at ground level, or indeed the soil itself, which influence earthworm ecology and behaviour, are unknown. Nevertheless, the data recorded (Text-fig. 1) provide a useful guide to the general

conditions experienced and it can be readily seen that Tambacounda is hotter and drier than Yundum. Clearly the rainfall pattern largely governs the climate of the region with the rate of precipitation being a more important factor than the duration of the rainy season in affecting the humidities and temperatures of the two areas.

The air temperatures at Yundum and Tambacounda are of especial interest because they straddle the temperature ranges which contain critical thresholds in earthworm physiology. El-Duweini & Ghabbour (1965*a*) investigated the effect of temperature on the behaviour of Egyptian material of the tropical earthworm

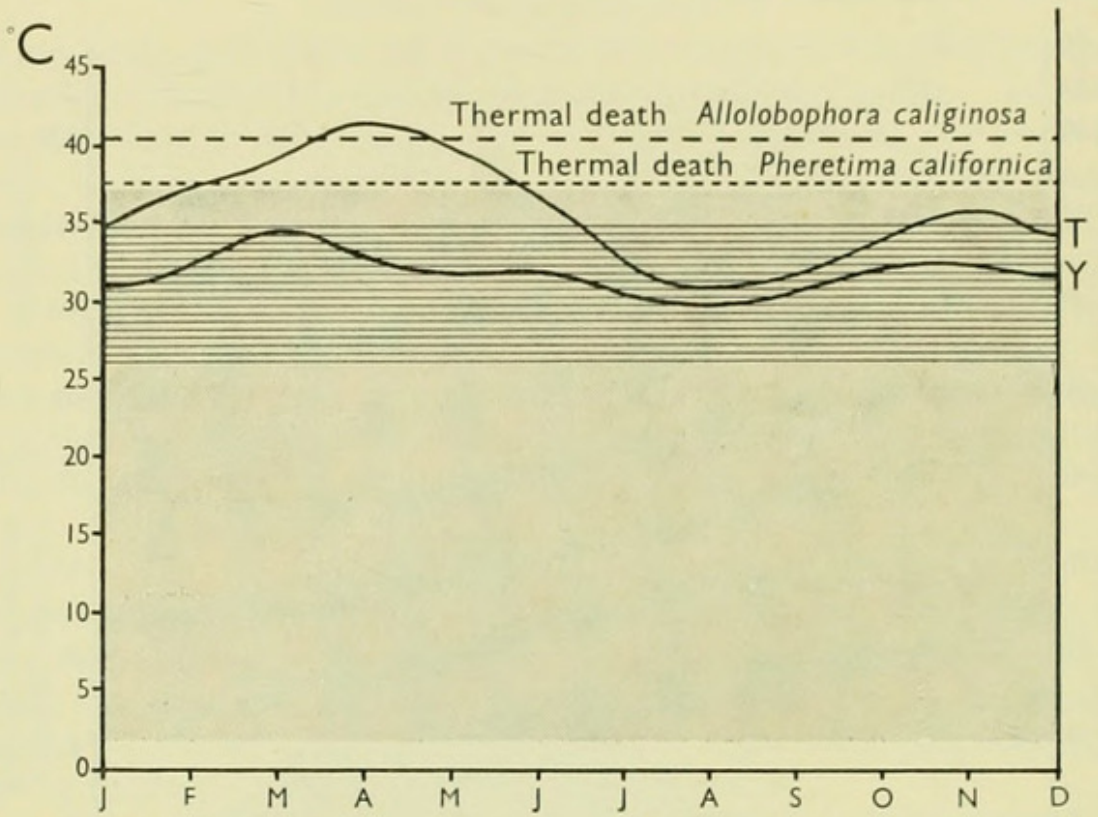

FIG. 2. Comparison of the average daily air temperatures at *T.* (Tambacounda) and *Y.* (Yundum) with earthworm thermal thresholds showing lethal temperatures (dry heat) and thermal preferences, (based on data from El-Duweini & Ghabbour). *Stipple:* thermal preference range of *Allolobophora caliginosa*. *Shading* (horizontal lines): thermal preference range of *Pheretima californica*.

Pheretima californica and of the northern temperate species *Allolobophora caliginosa*, their results are summarized in Text-fig. 2 in relation to the air temperature data derived from Text-fig. 1. It can be seen that the average daily temperatures recorded at Yundum are similar to the temperature preferences of *Pheretima californica* and near to the upper limit of that of *Allolobophora caliginosa* whereas the average daily temperatures at Tambacounda (also the monthly maxima at Yundum) not only exceed the temperature preferences of both of these worms but also the onset of thermal death.

The physiology of Gambian earthworms has not yet been invsetigated but it is reasonable to assume that it will not prove to be dissimilar from that of the Egyptian

worms. Although there is no information available about soil temperatures in Gambia, it is almost certain that the temperatures of the soil near to the surface will often be in excess of the shade temperatures of the air. Hence, the temperatures of the surface layers of the soil in western Gambia will be unsuitable for earthworms and species normally dwelling just below the surface will be unable to survive there.

Evelyn & Thornton (1964) sampled soils at Yundum and at Yoroberikunda which is in central Gambia between Sapu and Georgetown. They concluded that the upland soils of Gambia are very sandy with a low humus content and low fertility status. At Yundum the soil is loose and sandy and is representative of the soils of the coastal region but the soil at Yoroberikunda is more compact being a leached ferruginous soil which is typical of most inland soils. An indication of the similarities and characteristics of the two main soil types of Gambia, is provided by the data in Table 2. From the aspects of earthworm ecology and distribution, it is particularly interesting to note that there is a marked resemblance between the soil at a depth of 14–30 inches at Yundum and in the top 8 inches at Yoroberikunda.

The aridity of soil is an important factor governing earthworm distribution. El-Duweini & Ghabbour (1965*b*) showed that in soils with a low water content the degree of aridity is more important than the pH value in limiting both species and numbers of earthworms. Although the water content of a soil is dependent on a number of factors, comparisons are possible between the aridity of the soils in the two collecting areas in Gambia despite the fact that no comparative data are available of the water contents of the soils throughout the year. An indication of the differences can be obtained since the soil types and the drainage patterns are so similar that any differences in the water content may be directly correlated with the climate. The lower rainfall and the ensuing lower humidities and higher temperatures in the interior provide the clue to the greater aridity of the soil in the inland localities. Here the hazard of desiccation is greater and exists only a short distance from the River Gambia, where cocoons and the newly emerged young with limited burrowing ability which dwell near the surface are particularly vulnerable.

Attention is drawn to these dissimilarities between the temperature and the soils of the coastal and central areas because not all species of earthworms are uniformly distributed throughout the country (see below). It is probable that either the temperatures or the characteristics of the soil, or both of these factors acting in conjunction and affecting the aridity of the areas, are responsible for the restriction in the ranges of some of the species so far recorded. They could well operate in the same way that the combined effects of soil type, water content and soil temperatures influence the distribution of the European Lumbricidae (Atlavinyté, 1965).

COLLECTING TECHNIQUES AND PRESERVATION

Earthworms were collected by methods seldom employed in a tropical region. They were driven from the ground by the direct application of a dilute solution of formalin following the recommendations of Raw (1959) who found that 25 ml. of concentrated formalin added to 1 Imperial gallon (approximately 1·5 litres) of water and applied to a 4 foot quadrat (about 1·5 square metres) of soil led to the collection

TABLE 2

Soil profiles and analyses (Evelyn & Thornton, 1964)

Site	Depth in inches	Type and structure	Mechanical Analysis: Course sand %	Fine sand %	Silt %	Clay %	Chemical Analysis: pH	C %	N %	C/N ratio	Total P p.p.m.	Ca/K ratio
Yundum	0–6	Light brown loose sandy loam of single-grain to weak subangular blocky structure.	46·0	50·7	0·0	3·3	6·0	0·41	0·035	11·7	38	7·3
	6–14	Reddish-yellow structureless sandy loam.	43·8	44·2	4·7	7·3	5·9	0·29	0·044	6·6	52	3·8
	14–30	Reddish-yellow compact sandy loam of massive to weak subangular blocky structure, and slightly hard consistence.	39·8	44·5	1·4	14·3	5·7	0·25	0·037	6·8	71	2·7
	30–62	Reddish-yellow compact sandy loam, as in the 14–30 in. horizon	35·4	41·3	3·6	19·7	..	0·21	0·035	6·0	83	13·2
Yoroberi-kunda	0–8	Light brown compact sandy loam of massive to weak subangular blocky structure and slightly hard consistence	43·8	46·5	1·6	8·1	5·7	0·21	0·033	6·4	52	9·8
	8–25	Reddish-yellow very compact sandy loam of very weak polyhedral structure and hard consistence.	38·2	45·0	5·6	11·2	5·5	0·12	0·033	3·6	68	10·2
	25–35	Reddish-yellow clay of massive structure and hard consistence.	1·5	17·5	12·4	68·6	5·6	0·12	0·031	3·9	107	15·0

of a large percentage of the earthworms present in the plot. The formalin extraction method proved suitable for collecting in many localities in Gambia; on two occasions samples were obtained by digging near to plots subsequently sampled by the formalin method but the results from hand-sorting proved inferior. The disadvantage of using the formalin method in a region where water is scarce is the need to carry large water containers when collecting some distance from wells and rivers.

When the earthworms were expelled from the ground they were narcotized by being placed in a 1% solution of Propylene Phenoxetol. Usually 5–10 minutes immersion was sufficient for complete relaxation and narcosis, depending on the size of the specimen. The worms were then transferred to a 4% solution of formalin for killing and fixing. After 24 hours they were removed from the fixative and preserved in a 1% solution of Propylene Phenoxetol.

The 1% solution of " Phenoxetol " was prepared following the procedure recommended by Owen & Steedman (1956). A " stock " solution, i.e. a 20% solution in alcohol, was prepared in advance and the " Phenoxetol " was taken into the field in this dilution, thereafter, the 1% solution of " Phenoxetol " was prepared when required. It was found when travelling that the chief advantages of " Phenoxetol " over alcohol are that loss by evaporation is negligible and that " Phenoxetol " is not subject to the same rigorous fire or customs and excise regulations.

The specimens reported below were later transferred to a 1% solution of preserving " Phenoxetol " (β-phenoxyethylalcohol) and they are currently in a better condition than specimens which have been preserved in 80% alcohol for the same period. The septa, for example, have remained supple and other delicate structures are not brittle which so often happens to tissues in other preservatives. Moreover, the animals are still in a relaxed state and can be manipulated. The body pigments at first retained their colours but after the first year, although stored in the dark, the colours faded and the specimens became the usual grey-straw colour of alcohol preserved specimens. (" Phenoxetol " is manufactured by NIPA Laboratories Ltd, Treforest Trading Estate, Pontypridd, Glamorgan, Great Britain.)

RESULTS

Nearly 2,500 earthworms were collected in Gambia but only 698 were subsequently studied taxonomically and added to the collections of the British Museum (Natural History), London, S.W.7. Details of the latter provide the basis of this report. The remainder of the specimens were found to be immature and unsuitable for taxonomic study. One result of the collection containing a high proportion of indeterminate, juvenile specimens has been that it has not proved possible to analyse the earthworm populations in the localities investigated.

A summary of the identified specimens and the localities from where they were obtained is given in Table 3. It is evident that half of the species collected have restricted distributions, *Hyperiodrilus africanus* was collected only in the coastal areas while *Omodeona proboscoides* is apparently confined to Abuko where it occurs in large numbers in the banks of the reservoir. Similarly, *Benhamia mandinka*, *B. fula*, *B. reducta* and *Chuniodrilus fragilis* were collected only in central Gambia.

TABLE 3

Numbers of identified earthworms (adults and sub-adults) from Gambia

	Coastal region					*Central Gambia*		
	Abuko	*Bakau*	*Brikama*	*Nyambai*	*Yundum*	*Brikama Ba*	*Sapu*	*Willigara*
Benhamia budgetti species-group*	—	—	—	2	2	23	9	87
Benhamia mandika sp. nov.	—	—	—	—	—	22	—	3
Benhamia fula sp. nov.	—	—	—	—	—	35	10	8
Benhamia reducta sp. nov.	—	—	—	—	—	—	3	—
Dichogaster ehrhardti (Michaelsen)	4	1	1	—	—	3	2	15
Dichogaster titillata sp. nov.	—	—	1	—	—	52	1	187
Omodeona proboscoides gen. et sp. nov.	30	—	—	—	—	—	—	—
Chuniodrilus fragilis sp. nov.	—	—	—	—	—	1	6	—
Hyperiodrilus africanus Beddard	42	27	14	18	78	—	—	—
TOTAL	76	28	16	20	80	136	31	300

* This species complex comprises: *Benhamia budgetti* Beddard, *B. gambiana* Beddard and *B. michaelseni* Beddard, known only from McCarthy Island which is situated in the River Gambia near to Sapu.

Although *Hyperiodrilus africanus* seems to be confined to coastal areas in Gambia and nearby Senegal where it is the common earthworm of Dakar (see Appendix), in the Congo it has also been recorded from inland localities (Omodeo, 1958 : 100). The reason for the differences in the local distributions between the two areas, may lie in the dissimilarities between the climate of the regions. The temperatures recorded in Leopoldville are closer to those at Yundum, Dakar and Lagos (the type locality) than at Tambacounda where the climate is hotter and drier. These factors could be of the greatest importance in governing the distribution of *Hyperiodrilus africanus* which dwells in the surface layers of the soil where air temperature and humidity play a major part in determining the physical environment of the worms living there. From the literature, the genus *Benhamia* would also appear to consist of coastal species (Omodeo, 1958 : 104) but the three new species described below from Gambia were recorded only from inland localities. The explanation, in this case, may be that collecting in other territories was confined in the past to the coastal regions so that collections made inland in the future will reveal the presence of several more species, some of them new, as in Gambia.

DISCUSSION

Only a small number of genera and species of earthworms were collected in Gambia and in comparison with areas further south where greater numbers have been recorded, it is evident that the terrestrial oligochaete fauna of Gambia is reduced. Few of these Gambian species have been reported from outside the territory and most appear to be endemic, many being confined to inland localities near to the River Gambia. Here they are separated by compartively arid country from those areas further to the south with the richer earthworm faunae. Under these conditions of isolation and reduced interspecific competition, speciation is favoured and the extent of the differentiation detected in the Gambian species indicates that this process has been taking place. The new genus and species *Omodeona proboscoides* shows an unusual degree of specialization among western African Octochaetinae, particularly in the reduction in the number of caliciferous glands, while *Dichogaster titillata* sp. nov. has highly developed prostatic glands. In both of these species, the amount of modification would appear to be in accord with the specializations which tend to occur in reduced, isolated populations.

The species of *Benhamia* recorded here are of especial interest not only because of evidence of their plasticity but also since among them are two species groups whose members differ morphologically only slightly from others in the same complex. The first group consists of the three taxa described by Beddard, *B. budgetti*, *B. gambiana* and *B. michaelseni* and the second comprises the two new species *B. mandinka* and *B. fula*. The restricted distributions of the members of these two groups, together with the absence of related forms of most from elsewhere, permit us to regard many of them as emergent species. The taxonomic status of the three taxa in the *budgetti-gambiana-michaelseni* group is uncertain (see p. 16) but clearly the present confused situation is indicative that speciation and change are currently taking place. Evidence that the *budgetti* element in the complex may be the stem form is largely distributional and is provided by the presence in Liberia of *B.*

robertsiana (Michaelsen) which shares sufficient characters with *budgetti* for the two taxa to be regarded as possibly synonymous (see p. 17), whereas no earthworms have so far been described from outside of Gambia with *gambiana* or *michaelseni* attributes. This being so, *budgetti* (inc. *robertsiana*) which it is morphologically stable throughout its wide range, can be regarded as undergoing a minor radiation in the basin of the River Gambia.

Only three species of earthworms with wide distributions have so far been collected in Gambia, there are the two species previously discussed, *Hyperiodrilus africanus* and *Benhamia budgetti*, and a third, *Dichogaster ehrhardti* which was originally described from Portuguese Guinea. As already mentioned, *H. africanus* is widely distributed from the interior of the Congo northwestwards along the western African coastal regions at least as far north as Dakar. Throughout its range it lives in a variety of soil and floral types which experience fairly equable temperatures. As *H. africanus* is the only species of earthworm from Gambia with such a wide distribution, it can be regarded as forming a separate element in the oligochaete fauna of the country. The other two widely distributed species, *B. budgetti* and *D. ehrhardti*, form a second element. Both are species of the grasslands of western Africa but their distributions are wider than those of the remaining species collected. This last group of species forms a third element in the earthworm fauna of Gambia, it comprises those species which have been recorded only from in the basin of the River Gambia where they are apparently endemic.

CLASSIFICATION

It is necessary to comment on the classification of the non-Eudrilid earthworms recorded below. The generic criteria which are adopted were proposed by Omodeo (1955) and later employed by him in his report on the Oligochaeta from Mount Nimba (1958). One result of following this author has been the necessity to describe a new genus, *Omodeona* (see below). However, the suprageneric categories proposed by Omodeo are not accepted and instead the higher classification follows the system proposed by Gates (1959). The decision to accept Omodeo's generic criteria yet follow Gate's classification, rests on the results of a re-appraisal of 29 Megascolecoid genera (Megascolecidae *sensu* Stephenson, 1930) by using taxonometric techniques (Sims, 1966). It was found, for example, that the genera *Benhamia* and *Millsonia* were sufficiently dissimilar from *Dichogaster* that all three should be regarded as distinct, which is in agreement with Omodeo. Whereas the genera in the families as defined by Gates, occurred together in a vector diagram while those included in Omodeo's higher catagories were apart (as were many of those in the classification proposed by Lee (1959) arising from studies on New Zealand earthworms).

One interesting aspect of the results of the computer investigation was that in the vector diagram the genera of the Megascolecidae *sensu* Gates (1959), were somewhat isolated from all of the other genera assessed. In reporting this comparative isolation no conclusions were reached about the status of each group of genera, that is, the hierarchical categories to which the groups could be assigned. However, in view of the isolation of the Megascolecidae *s.s.* and the undoubted similarity of both of the other groups of genera investigated, I am now of the opinion

that the latter cannot be divided into separate families as Gates proposed. Accordingly, their status is now modified although Gates's criteria of classification are accepted.

KEY CHARACTERS TO THE CLASSIFICATION OF THE MEGASCOLECOID EARTHWORMS (MODIFIED AFTER GATES, 1959)

Family **MEGASCOLECIDAE**	Prostatic glands racemose in structure, usually in segment *xviii*.
Family **ACANTHODRILIDAE**	Prostatic glands tubular in structure, situated in either or both segments *xvii* and *xix*.
Subfamily **OCNERODRILINAE**	Calciferous glands in segment *ix*, or, *ix* and *x*.
Subfamily **ACANTHODRILINAE**	Calciferous glands, arrangement non-Ocnerodriline. Execretory system holonephridial.
Subfamily **OCTOCHAETINAE**	Calciferous glands, arrangement non-Ocnerodriline. Excretory system meronephridial.

All of the non-Eudrilidae so far collected in Gambia have tubular prostatic glands, paired caliciferous glands situated between segments *xiv* and *xvii* and meronephridial excretory systems; they are, therefore, assigned to the family Acanthodrilidae, subfamily Octochaetinae. (The non-Eudrilids in a collection of earthworms from Ghana were similarly classified (Sims, 1965) although no explanation was provided in that report of the criteria for recognizing the higher groups).

TAXONOMY

Family **ACANTHODRILIDAE**

Subfamily **OCTOCHAETINAE**

Benhamia budgetti species-group

(Plates I & II)

Benhamia budgetti Beddard, 1900, *Proc. zool. Soc. Lond.*, **1900** : 653.—McCarthy Island, central Gambia.

Benhamia gambiana Beddard, 1901, *Proc. zool. Soc. Lond.*, **1901** (2) : 210.—McCarthy Island, central Gambia.

Benhamia michaelseni Beddard, 1901, *Proc. zool. Soc. Lond.*, **1901** (2) : 213.—McCarthy Island, central Gambia.

? Dichogaster robertsiana Michaelsen, 1922, *Cap. zool.*, **1** : 18.—Robertsport, Liberia.

Forest floor, Nyambai Forest Reserve, 23 Sept. 1964; 1 clitellate, 1 aclitellate specimens.

Under groundnut mulch, nursery plots, Forestry Department, Yundum, 28 Sept. 1964; 2 clitellate specimens.

Semi-flooded forest, edge of Jahkali Swamp, Sapu, 3 Oct. 1964; 3 clitellate, 6 aclitellate specimens.

Sides of paths through groundnut fields, Brikama Ba, 5–7 Oct. 1964; 8 clitellate, 15 aclitellate specimens.

Sides of paths through groundnut fields, Williga ra, 7 Oct. 1964; 21 clitellate, 66 aclitellate specimens.

DESCRIPTION. *External characters.* Non-regenerating worms measure between 192 and 286 mm. in length and 4–5 mm. in diameter anteriorly and 3 mm. posteriorly. The number of segments varies between 166 and 218. In life the worms are a cream-flesh colour ventrally, a more brownish-flesh dorsally in the pre-clitellar region and a very dark green dorsally in the intestinal region; the clitellum is almost black with a greenish hue. Preserved specimens are medium brown above in the intestinal region, the clitellum is dark brown, while the remainder of the body is a pale straw colour. (In regenerating individuals, the regenerating portion is paler than elsewhere). The cuticle has a slight rose-green iridescence which gives a copper-like lustre, there are additional violet reflections around each dorsal pore. The first dorsal pore is usually situated in furrow 13/14, occasionally in furrow 14/15 or even in 19/20 or 20/21 when the dorsal pores are occluded in the clitellar region. The prostomium is prolobous and somewhat inclined to the pro-epilobic condition. There is some feeble triannulation in the pre-clitellar region where the setal rings are sometimes slightly raised. The clitellum is saddle-shaped, dorsally it extends from segment $\frac{1}{2}xiii$ to xx ($7\frac{1}{2}$ segments) and ventrally from segment xiv to $\frac{1}{2}xx$ ($6\frac{1}{2}$ segments). The ventral border is in setal line b except in the segments containing the genital field where it is edged by the seminal grooves.

The setae are closely paired on the ventral surface. The setal formula at segment ix is $aa : ab : bc : cd = 2{\cdot}5 : 1 : 2{\cdot}5 : 1$ and $dd = \frac{2}{3}$ circumference, at segment xxv it is $3{\cdot}5 : 1 : 3 : 1$ and $dd = \frac{3}{4}$ circumference.

The male pores are paired on segment $xviii$ midway between the setal lines b and c where they discharge into slightly convex, paired seminal grooves which join the prostatic pores of their respective sides. The prostatic pores are paired in segments $xvii$ and xix and lie midway between setal lines a and b. Paired penial setae are present on segments $xvii$ and xix in setal line a. The penial setae of most specimens are 2·8 mm. long and taper from 80 μ in diameter proximally 40 μ in diameter distally (Text-fig. 3a (1)). These penial seta have a simple outline, the only ornamentation being the presence of small pits in the region of the distal end. (Unless examined under very high-power, the pits may be mistaken for small spines). Penial setae of a few specimens are smaller with a digitiform tip to a slightly swollen distal end (Text-fig. 3a (2)).

Paired female pores are present on $\frac{1}{3}xiv$ within setal lines aa, each pore is situated approximately $\frac{1}{2}ab$ medially to setal line a.

The spermathecal pores are paired in furrows 7/8 and 8/9 and lie in setal line b.

The genital field is sunken only in the more fully mature individuals. It consists of six, low transverse ridges bounded laterally by the seminal grooves, the anterior ridge is developed from the posterior region of segment $xvii$ while the posterior ridge is formed from the anterior region of segment xix. Genital papillae are indistinct; single, median ventral papillae are present in varying combinations in furrows 13/14, 14/15, 21/22 and 22/23, sometimes these hinder papillae are situated slightly anteriorly to the furrow near to the posterior borders of segments xxi and $xxii$. Occasionally a broad, median ventral papilla, or two closely paired papillae, may be present

on segment *xx*. Paired papillae are present in furrows 16/17 (sometimes), 17/18 and 18/19 where they are situated in setal line *a*, there is also a pair on segment *xviii* in setal line *b*.

Internal characters. The first septum is 4/5 and all of the anterior septa to 12/13 are thickened, 13/14 being only slightly less so. The first four septa, 4/5–7/8, are strongly conical, septa 8/9 to 12/13 are moderately conical while septum 13/14 is only slightly so.

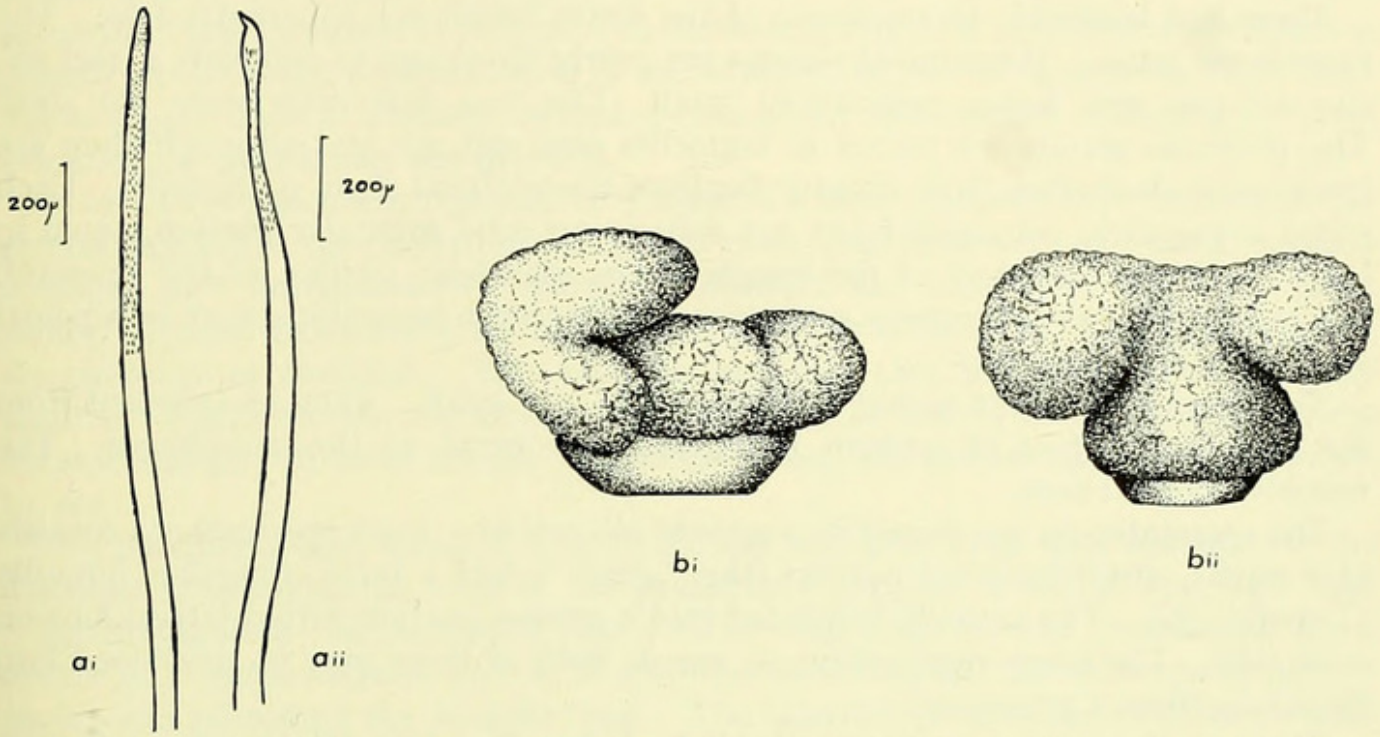

FIG. 3. *Benhamia budgetti* species-group. (a) Distal ends of penial setae: (1) *michaelseni*-type; (2) *budgetti*-type. (b) Spermathecae (medio-dorsal view): (1) *michaelseni*-type; (2) *budgetti*-type.

The pharynx extends posteriorly to septum 4/5. There are two gizzards, the anterior gizzard in segment *v* is slightly smaller than the posterior gizzard in segment *vi*. Each gizzard superficially resembles a mammalian heart, anteriorly there is a double, thin-walled " auricular " region and posteriorly a double, highly muscular " ventricular " region. In contracted individuals, the thin-walled anterior half lies partly dorsal to the muscular, posterior half which is inclined antero-dorsally. Numerous tendinous strands pass posterolaterally from the gizzards to the body wall throughout the oesophageal region. The oesophagus extends to segment *xvii* and the intestine begins in segment *xviii*. The anterior region of the intestine is swollen and its bulk displaces septum 17/18 anteriorly so that superficially the contents of segment *xvii* appear to have been suppressed. The swollen region is thickened inter-segmentally to septa 25/26–28/29. The two hindermost intersegmental thickenings tend to coalesce to form the posterior limit of a crop-like region. The typhlosole arises as a low ridge in segment *xviii* but it increases in height until by segment *xxiv* it is equal to about half the internal diameter of the intestine.

Calciferous glands are paired in segments *xiv*, *xv* and *xvi*. The anterior pair is slightly smaller and paler than the others, the posterior pair being the darkest in colour.

The dorsal blood vessel is well-developed between the posterior gizzard and segment *xxx*. A pair of commissural vessels are present in each segment from *vi* to *xii*. The anterior pair is small but each successive pair is larger than the preceding pair until segment *x*. In segments *x*, *xi* and *xii* they are functional as contractile, lateral hearts.

There is a holandric arrangement of the testes which are apparently free. The funnels are large. The seminal vesicles are poorly developed in segments *xi* and *xii*, the anterior pair being particularly small The vasa deferentia were not seen. The prostatic glands are paired in segments *vxii* and *xix* and although they are moderately sized, their bulk slightly displaces the adjacent septa posteriorly. Each gland is regularly convoluted but not coiled; an ectal muscular portion, equal in length to about one half of the length of the glandular portion of the prostate, passes into the ventral parietes postero-ventrally to the muscular sheath of a penial setal bundle.

The ovaries which are paired in segment *xiii*, are small. They are pendent from the posterior surface of septum 12/13 almost ventrad to the oesophagus. The funnels were not seen.

The spermathecae are paired in segments *viii* and *ix*. Each spermatheca consists of a squat, muscular ectal portion (the " duct ") and a large, irregular, ampulla (Text-fig. 3b). The ampulla is divided into a central portion with a lateral lobe on each side. The lobes may be low, or one or both of them may be developed into flexed digitiform processes.

The excretory system is meronephridial A few nephridia can be seen in the anterior region of the body where they are thinly scattered around the posterior region of each segment near to where the septa join the parietal wall. In segments *x* to *xvi* they are more numerous and throughout the intestinal segments they are large and completely cover at least the posterior half of the parietal wall in each segment.

Remarks. The specimens listed above are only tentively identified due to an uncertainty which became apparent as work progressed, about the validity of the characters which Beddard employed to separate *budgetti*, *gambiana* and *michaelseni*. The three taxa were named on a series from McCarthy Island which Beddard at at first described as *budgetti*, but split in the following year when he separated the other two species. They cannot, however, be recognised from the original descriptions of their internal characters but apparently only on their external morphology. Unfortunately even these differences prove to be of little value when examining worms in series. The specimens reported here increase the problem of identification as their external characters are present in various combinations and do not always coincide with the patterns which are diagnostic of any of the three taxa, in addition these characters are mainly imperfectly developed. Generally, however, most of the specimens tend towards the condition described for *michaelseni*, twelve tend towards *budgetti* and only two have some resemblance to *gambiana*. Even so, the differences are slender and incomplete.

Difficulty of identification is increased by the fact that out of the three type series, only one complete, but dissected, specimen and a few fragments of a second have survived and do not help fix the identity of the taxon which they represent. The specimens are labelled as the types of *Benhamia budgetti* but in the pattern and the number of the genital papillae, the complete specimen approaches the description of *gambiana*, while a penial seta examined matches the illustration of a penial seta of *michaelseni*; the specimen, however, does agree with the description of *budgetti* in size and in the number of segments. In view of the discrepancies between the surviving type specimen of *budgetti* and the description and especially the variation present in the series reported here, it seems advisable not to merge the three taxa but to regard them as a closely related species group until further collecting provides evidence for elucidating the problem.

In all of the specimens reported here there is a basic *gambiana*-like pattern of the genital papillae in the genital field although most specimens have additional papillae arranged in a *michaelseni*-like manner. Beddard did not record the presence of genital papillae within the genital fields of *budgetti* or *michaelseni* but only mentioned the presence of swellings. This omission suggests that his types were not fully mature. Unfortunately the same would appear to be true of the present specimens because the genital fields are poorly developed and the genital papillae are difficult to see.

The possibility that Beddard's material was not fully adult may account for the discrepancy between the form of the penial seta removed from the type and that originally figured. Replacement penial setae commonly become successively more ornate as a worm matures and so it could be with *budgetti*, the *michaelseni*-type of penial seta preceding the *budgetti*-type. The alternative condition with more than one kind of penial seta present at the same time, is unlikely as this condition has not so far been recorded in *Benhamia*; only one kind of seta, the *michaelseni*-type, was found in all of the new specimens examined.

The problem of establishing the characters by which *budgetti* can be distinguished prevents the easy recognition of other taxa which may be synonymous. Nevertheless, the general characters of *budgetti* agree sufficiently with the description of *Dichogaster robertsiana* Michaelsen from Liberia that it seems reasonable to suggest that these two taxa may be synonymous. The illustrations of the penial setae in particular, are almost identical There are a few discrepancies and the most readily evident is the absence of genital papillae from *robertsiana* but the difficulty experienced in seeing the papillae of *budgetti* indicates that too much importance cannot be attached to their reported absence in the former.

Omodeo (1958 : 41) recorded four specimens from the Ivory Coast which he identified as *Benhamia robertsiana* var. These specimens differ on description from the worms listed above mainly in the presence of an annular clitellum, the number of genital papillae and the shape of both the spermathecae and the penial setae. These differences indicate that the Ivory Coast specimens may possibly represent a different, probably un-named, species. However, as the identity of *robertsiana* Michaelsen is not entirely certain. I do not propose to separate this Ivory Coast material. Clearly the solution to this problem must await the collection of further

specimens from the Ivory Coast, Liberia and Gambia, particularly the last from where more fully mature, topotypical material is required.

Benhamia mandinka sp. nov.

(Plate III)

Sides of paths through fields of maize and groundnut, Brikama Ba, 5–7 Oct. 1964; Syntypes: 6 clitellate, 16 aclitellate specimens. B.M.(N.H.) Reg. No. 1966.30.129/150. [Schizosyntype (slide) 1966.30.151].

OTHER MATERIAL: Sides of paths through groundnut fields, Williga ra, 7 Oct. 1964; 3 aclitellate specimens.

DIAGNOSIS. *External characters.* Length 102–122 mm., diameter 2–3 mm. Segments 148–160. Colour: in life, anterior region pink, clitellum yellow pink, unpigmented posteriorly. First dorsal pore 18/19. Prolobous. Setae ventral, closely paired. Clitellum saddle-shaped. Genital setae absent from region of spermathecal pores, penial setae present. Male and prostatic pores combined *xvii*, paired midway between *b* and *c*. Female pores closely paired *xiv* within *aa*. Spermathecal pores paired in furrow 8/9 near to *a* within *aa*. Genital papillae as single, transverse ridges *ix-xvi* and *xviii*, *xix* mainly extending to *cc*, paired genital papillae *xvii* bearing penial setae.

Internal characters. Septa 4/5–8/9 conical, 5/6–12/13 thickened. Gizzards *v*, *vi*. Calciferous glands paired *xiv*, *xv*, *xvi*. Intestine begins *xvii*, anterior region slightly dilated *xix–ixl* terminated by thickened rings 39/40 and 40/41. Typhlosole *xx–xl* width equal to internal diameter of intestine, more posteriorly width equal to ¼ diameter of intestine. Lateral hearts *x–xii*. Holandric, testes paired in testes sacs *x*, *xi*; seminal vesicles small, granular *xi*, *xii*. Prostatic glands paired *xvii*, extending into *xviii*, *xix*. Ovaries paired *xiii*. Spermathecae paired *ix*; ampullae thin-walled, duct thick -walledand spherical with two long digitiform, ental diverticula. Meronephridial.

DESCRIPTION. *External characters.* The length of the worms in the series varies between 102 and 122 mm., and the diameter between 2 and 3 mm. (3–4 mm. in the clitellar region). There are 148–160 segments in the clitellate specimens. The anal region, comprising the last 15 or so segments, is slightly swollen in most specimens. In life the colour of the intestinal region is brownish flesh, the anterior region a bright pink and the clitellum is yellow pink; in presperved specimens the intestinal region is a pale greyish flesh, the anterior region whitish flesh and the clitellum is purple brown. The cuticle has a slight green-pink iridescence. The prostomium is broad and prolobous. The first dorsal pore occurs in furrow 18/19. The ventral surfaces of the anterior segments are moderately trianulate; segments in the intestinal region are faintly pentannulate. The ventral surface between setal lines *cc* of the third annulus of segments *ix* to *xix* is raised and forms a genital ridge (see below). The body is often swollen in the anterior intestinal region, circa *xx* to *xxxiv*.

Setae are situated ventrally and are closely paired. The setal formula (*aa* : *ab* : *bc* : *cd*) at segment *ix* is 5 : 1 : 3 : 1 and *dd* = ¾ circumference; at segment *xxv* it is 4 : 1 : 4 : 1 and *dd* = ⅔ circumference while at segment *c* the formula is 4 : 1 : 3 : 1, *dd* = ¾ circumference. The setae *cd* are absent from the clitellar region.

Setae in the region of the spermathecal pores are unspecialized. Paired penial setal bundles are present on segment *xvii* with each bundle usually comprising two slender setae about 1·3 mm. in length (Text-fig. 4a). Each seta tapers distally, about 0·2 mm. from the distal end it becomes slightly swollen and serrated, it is tipped with a small tooth-like process. The laterally directed surface of the swollen distal portion of each seta is ornamented with a large number of very small, distally directed ridges.

The clitellum is saddle-shaped and extends ventrally to setal line *c* on segments ½*xiii* to *xviii* (5½ segments).

The male terminalia have a microscolecine reduction with combined paired male and prostatic pores on segment *xvii*. The pores are situated near to furrow 17/18

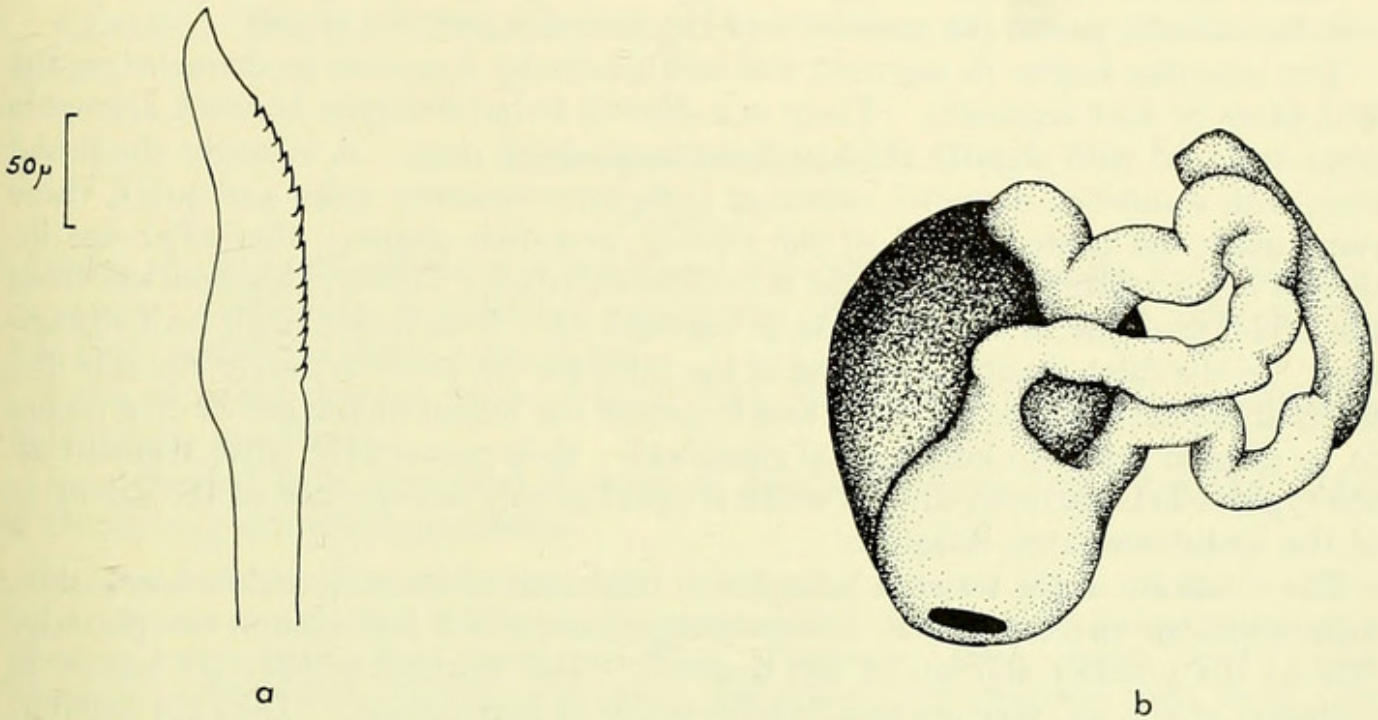

FIG. 4. *Benhamia mandinka* sp. nov. (a) Distal end of penial seta. (b) Spermatheca (ventral view).

midway between setal lines *b* and *c* where they are partly obscured anteromedially by paired genital papillae which bear the penial setae.

The female pores are paired on segment *xiv* and are seen on the ventral surface as two, short longitudinal slits situated on the anterior part of the second annulus only a short distance (½*ab*) within the setal lines *aa*.

The spermathecal pores are large, they are paired and lie in furrow 8/9 slightly within the setal lines *aa*. Each pore is situated within a lateral slit extending across setal lines *ab*. In fully adult specimens, the body wall in the region of the slits is raised and the two slits join medially so that superficially there appears to be a single, median ventral pore. The raised, swollen region is formed by the median-ventral portion of the body wall being raised in both the posterior half of segment *viii* and the anterior half of segment *ix*.

Genital papillae are present as single, median-ventral transverse ridges on segments *ix* to *xvi* and on *xviii* and *xix* (Plate III); the paired papillae in segment

xvii each bear the penial setae. The majority of the papillae, or ridges, are confined between setal lines *cc* but those in segments *xvi* and *xviii* extend further laterally.

Internal characters. The first septum is 4/5, septa 5/6 to 8/9 are moderately thickened while septa 9/10 to 12/13 are only slightly thickened. Septa 4/5 to 8/9 are strongly conical.

The pharynx is long and slender. Two gizzards are present, one in each of segments *v* and *vi*. The anterior gizzard is highly muscular and campanulate in shape with the broader end leading from the pharynx and the narrower end passing into the posterior gizzard. The hinder gizzard is more oval in shape and only the posterior half is strongly muscularized.

Paired calciferous glands are present on the oesophagus in segments *xiv*, *xv*, and *xvi*, the anterior pair is the smallest and the posterior pair the largest.

The intestine begins in segment *xvii* and gradually increases in diameter in the first three or four segments. There is a dilated anterior region between segments (*xix*) *xx* to *ixl* with slightly thickened intersegmental rings. A strongly thickened ring, with a reduced diameter occurs at both intersegments 39/40 and 40/41, these rings mark the posterior end of the dilated, crop-like, region; thereafter the intestine has a smaller diameter and is undifferentiated. The typhlosole arises from the mid-dorsal line of the intestine in segment *xx*. It is large, single and ribbon-like. In the dilated anterior region of the intestine its width is nearly equal to the internal diameter of the intestine and it causes the lumen of the gut of this region to be divided into two longitudinal chambers. More posteriorly, after segment *xl*, the typhlosole is narrower and its width is equal to only one-quarter of the diameter of the undifferentiated intestine.

The condition of the testes is holandric. Each pair of testes is enclosed by a thin, membraneous, median-ventral, suboesophageal sac which lies against the posterior face of the anterior septum of the segment. The seminal vesicles are paired in segments *xi* and *xii*, they are small and granular in appearance. The vasa deferentia which are slender and semi-transparent, are paired on each side. They pass posteriorly to segment *xvii* where each pair forms a loop on the parietal wall. There the vasa deferentia pass laterally then medially over the antero-dorsal surface of the ectal portion of the prostatic duct of their side and with it enter into the parietes.

Only one pair of prostatic glands is present, they are tubular in structure and enter the parietes in segment *xvii*. The glandular, ental portions of the glands are coiled, usually in segments *xvii* to *xix* or even as far posteriorly as segment *xxi*. The muscular, ectal duct of each gland is confined to segment *xvii* where it enters the parietes near to septum 16/17. A penial setal follicle is associated with the ectal end of each prostatic duct. The follicles are small and lie transversely on the ventral parietes, they pass into the body wall immediately anteriorly to the adjacent prostatic duct.

The ovaries are paired in segment *xiii* where they are freely pendent from the posterior surface of septum 12/13 laterally to the oesophagus. The funnels are paired and small on the posterior septum of the ovarian segment. The paired oviducts in segment *xiv* pass medio-ventrally from septum 13/14 and converge towards the median ventral parietes.

One pair of spermathecae is present in segment *ix*. Each spermatheca has a short, spherical, thick-walled duct and a somewhat larger but thinner-walled ampulla. Two long, digitiform, transulcent diverticula arise from the latero-ventral surface of the ental end of the spermathecal duct. The diverticula are loosely coiled but when they are unravelled they are found to be about three times longer than the length of the duct although their diameter is only about one-fifth (Text-fig. 4b).

The excretory system is meronephridial. The nephridia are comparatively large but are thinly distributed. They are absent from the parietal wall in the pre-clitellar region, two to four are present in segments *xiv* to *xviii* thereafter, throughout the intestinal region, six to eight are present on the parietes of each segment.

REMARKS. See the " Remarks " on p. 22 following the description of the next species.

Benhamia fula sp. nov.

(Plate IV)

Sides of paths through fields of maize and groundnut, Brikama Ba, 5–7 Oct. 1964; Syntypes: 8 clitellate, 27 aclitellate specimens. B.M.(N.H.) Reg. No. 1966.30.155/189 [Schizosyntype (slide) 1966.30.190].

Sides of paths through fields of groundnut, Willigara, 7 Oct. 1964; 2 clitellate, 6 aclitellate specimens.

Semi-flooded light woodland at edge of Jahkali Swamp, Sapu, 3–5 Oct. 1964; 6 clitellate, 4 aclitellate specimens.

DIAGNOSIS. *External characters*. Length 98–133 mm., diameter 2 mm. (3 mm. at clitellum). Segments 158–183. Unpigmented posteriorly, in life anterior region bright pink, clitellum yellow pink. First dorsal pore 18/19. Prolobous. Setae ventral, closely paired. Clitellum saddle-shaped. Genital setae absent from region of spermathecal pores, penial setae present. Male and prostatic pores combined *xvii*, paired midway between *b* and *c*. Female pores closely paired *xiv* within *aa*. Spermathecal pores paired in furrow 8/9 within *aa* but near to *a*. Genital papillae as single transverse ridges *xii–xvi* and *xviii–xx* mainly between *cc*, paired genital papillae *xvii* bearing penial setae.

Internal characters. Septa 4/5–8/9 conical, 5/6–12/13 thickened. Gizzards *v*, *vi*. Calciferous glands paired *xiv*, *xv*, *xvi*. Intestine begins *xvii*; anterior region, *xix–xxxiv*, slightly dilated extending to thickened rings 34/35 and 35/36. Typhlosole *xx–xxxv* width equal to internal diameter of intestine, more posteriorly width equal to ¼ diameter of intestine. Lateral hearts *x–xii*. Holandric, testes paired in testes sacs in *x*, *xi*; seminal vesicles small, granular *xi*, *xii*. Prostatic glands paired *xvii*, extending posteriorly through four or more segments (*xvii–xx*). Overies paired *xiv*. Spermathecae paired *ix*; ampullae thin-walled, duct thick-walled and spherical with two long, digitiform, entral diverticula. Meronephridial.

DESCRIPTION. A full description of this species is not provided as it is similar to *mandinka* from which it may be distinguished by the following attributes (the corresponding characters of *mandinka* are given for comparison in parenthesis): *External characters*. Length 98–133 mm. (102–122 mm.). Segments 158–183 (148–160).

Genital papillae present as single, median ventral, transverse ridges on segments *xii–xvi* and *xviii–xx* (*ix–xvi* and *xviii*, *xix*).

Internal characters. The anterior region of the intestine is slightly dilated, this specialized region is terminated by thickened intersegmental rings at intersegments 34/35 and 35/36 (39/40 and 40/41).

REMARKS. Only two species of *Benhamia* (sensu Omodeo) have previously been described with a single pair of prostatic pores discharging on segment *xvii*. The first, *hupferi* (Michaelsen, 1891), which is a larger worm than either *mandinka* or *fula*, has the male and spermathecal pores situated in different positions relative to the setae and has specialized setae in the region of the spermathecal pores. The second, *stockhauseni* (Michaelsen, 1913), is also a larger worm but, among other differences, it has an annular clitellum and no genital ridges on the ventral surface, however, the prostatic glands are similar to those of *mandinka* (Omodeo, 1958 : 43). Generally the Gambian worms differ externally from these other species by the pattern of the genital ridges and internally by the characteristic spermathecae with their long diverticula* and the broad typhlosole in the expanded anterior region of the intestine. In turn, they can be distinguished from each other by the characters given above.

The two earthworms, *mandinka* and *fula*, are regarded as representing separate species because although individuals of both come from the same samples none with intermediate features or a combination of the characters of both, has been found. There is, however, the possibility that the two taxa may represent a single dimorphic species but I believe that it is better to regard the two taxa as distinct species.

It is possible that the worms of both species are protandrous as there is a seemingly precocious development of the male organs. Most individuals collected are aclitellate and have small ovaries and spermathecae yet the genital ridges, or papillae, and prostatic glands are fully developed and the seminal vesicles full of developing sperm.

Benhamia reducta sp. nov.

(Plate V)

Semi-flooded forestland, edge of Jahkali Swamp, Sapu, 5 Oct. 1964. Syntypes: 3 clitellate specimens. B.M.(N.H.) Reg. No. 1966.30.209/211 [Schizosyntype (slide) 1966.30.212].

DIAGNOSIS. *External characters.* Length 42–60 mm., diameter 1–1·5 mm. Segments 116–137. Clitellum bright orange in life, pale orange in preserved specimen; body unpigmented., Epilobous. First dorsal pore 20/21. Clitellum annular, *xiii–xix* (7 segments). Setae ventral closely paired. Male and prostatic pores combined, single, median ventral *xvii*. Penial setae present. Female pores small *xiv*, closely paired within *aa*. Spermathecal pore single, median ventral 8/9. Genital papillae absent.

Internal characters. Septa 5/6–10/11 conical, thin; 12/13 and 13/14 join laterally. Gizzards *vii, viii*. Calciferous glands paired *xiv. xv, xvi*. Intestine begins *xviii*, typhlosole arises *xix*. Paired lateral hearts *xi, xii*. Metandric. Prostatic glands tubular, paired *xvii* (ental portions in *xviii*). Ovaries paired *xiii*. Spermatheca single *ix*; duct squat with paired lateral ental diverticula; ampulla large, simple. Meronephridial.

* It is interesting to note that in *braunsi* (Michaelsen, 1895 : 27) from Sierra Leone, the spermathecae resemble those of *mandinka* and *fula*. However, *braunsi* differs from these two new species in having among other characters, a balantine reduction of the male terminalia.

DESCRIPTION. *External characters.* The lengths of the syntypes vary between 42 and 60 mm., the anterior diameters between 1–1·5 mm. and the posterior diameters 0·75–1 mm. In one specimen there are 116 segments (last 6 segments regenerating) in another 125 (last 10 segments regenerating) and in the third, 137 segments. The cuticle has a slight yellow-green iridescence. The clitellum is bright orange in life but pale orange in preserved specimens, otherwise the body is unpigmented. The prostomium is broad and epilobous; the peristomium is slightly cleft dorsally. The first dorsal pore occurs in the first post-clitellar, furrow i.e. 20/21. The clitellum is annular, *xiii–xix* (7 segments) and the body wall of segment *xiii* not so intensively pigmented as the remainder of the clitellum. At both ends of the clitellum the body wall is constricted and the external segmentation is difficult to determine especially anteriorly where much of segment *xiii* has been suppressed.

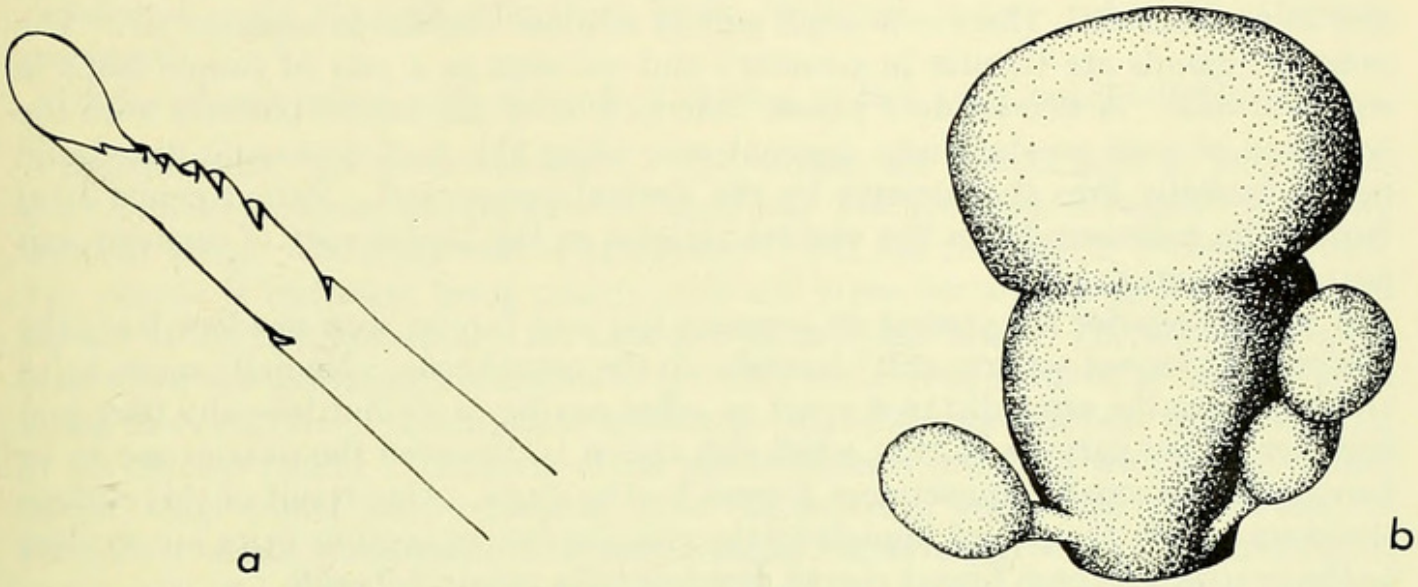

FIG. 5. *Benhamia reducta* sp. nov. (a) Distal end of penial seta. (b) Spermatheca (dorsal view).

The setae are very small, ventrally situated and closely paired; they are absent from the clitellar region. The setal formula is *aa* : *ab* : *bc* : *cd*, 6 : 1 : 4 : 1; *dd* = $\frac{2}{3}$ circumference.

There is a microscolecine reduction of the male terminalia and the male and prostatic ducts discharge on *xvii* through a common, single, median ventral pore situated on a papilla. Paired penial setae are present; they are mostly smooth but serrated distally with a spatulate tip (Text-fig. 5a). One penial seta measured 540 μ in length and 15 μ in diameter. Genital papillae are absent.

The female pores are very small and inconspicuous; they are paired in setal lines *aa* on segment *xiv*. In one individual there is a slight depression in the region of the female pores with two crescentic grooves extending a short distance postero-laterally to within setal line *cd*.

The spermathecal pore is single, median ventral in furrow 8/9.

Internal characters. The first septum is 4/5. Septa 5/6–8/9 are strongly conical and septa 9/10 and 10/11 are slightly less so. The anterior septa are thickened.

A small pharynx extends posteriorly to segment *iv*. The oesophagus is undifferentiated in segments *v* and *vi* but in segment *vii* it is developed into the anterior gizzard which is separated from the posterior gizzard in the hinder half of segment *viii* by a short portion of soft-walled oesophagus in the anterior half of the segment. The gizzards are comparatively large and their bulk has led to a posterior displacement of the coelomic contents so that the posterior gizzard in *viii* lies within the parietes of segment *ix*. Three pairs of calciferous glands are present on the oesophagus, one pair occurring in each of segments *xiv*, *xv* and *xvi*. The intestine begins in segment *xviii* and the typhlosole arises in segment *xix*. The typhlosole is lamellate for the first 3 to 5 segments but for most of its length it is a simple ribbon with a width approximately equal to half of the diameter of the intestinal lumen.

Paired lateral hearts are present only in segments *xi* and *xii*.

There is a metandric reduction of the testes; the testes and funnels are paired and free in segment *ix*. There is a small pair of seminal vesicles in segment *xii*. The prostatic glands are tubular in structure and are seen as a pair of simple loops in segment *xviii*. A slender duct passes anteriorly over the lateral parietes from the ectal end of each prostate into segment *xvii* where the duct is sharply flexed and passes medially into the parietes by the ventral nerve cord. Paired penial setal bundles lie transversely on the ventral parietes in the hinder part of segment *xvii* near to septum 17/18.

A pair of ovaries are present in segment *xiii* and can be seen pendent from the posterior surface of septum 12/13 laterally to the oesophagus. Medially septa 12/13 and 13/14 are the same distance apart as other nearby septa but laterally they join together at the parietes so that when this region is dissected the ovaries are to be found within a small compartment formed by the septa. One result of this curious structure is that the paired funnels on the anterior face of septum 13/14 are so close to the ovaries that each funnel almost envelopes the ovary of its side.

A single, median ventral spermatheca is situated in segment *ix* either to the right or to the left side of the ventral nerve cord. It is a simple structure with a short wide duct and large ampulla. A pair of small lateral diverticula are present near to the ectal end of the duct, each terminates in one or two spherical chambers (Text-fig. 5b).

The excretory system is meronephridial and four pairs of nephridia are present in each segment throughout the intestinal region.

Remarks. This is a fragile little worm which may be mistaken in the field for an Ocnerodriline species, especially as it appears to have a limnetic habitat. However, it clearly possesses all of the attributes characteristic of the genus *Benhamia* as emended by Omodeo (1958). It is readily distinguishable from all other Benhamias by the presence of a single, median ventral, combined prostatic and male pore on segment *xvii* and a single, median ventral spermathecal pore in furrow 8/9. Internally it has features which resemble those of *Dichogaster titillata* (see below), in particular, the gizzards occur in segments *vii* and *viii* also the blood vessel leading from the prostatic gland can be clearly seen passing forward to segment *xiii* where it enters the dorsal vessel.

Dichogaster ehrhardti (Michaelson, 1898)

(Plate VI)

Balanta Ehrhardti Michaelsen, 1898, J. Hamburg wiss. Anst., **15** : 1.—Bissau, Portuguese Guinea.

Side of rice field, Brikama, 25 Sept. 1964; 21 clitellate specimens.

Grass banks, Abuko Reservoir, 29 Sept. 1964; 4 aclitellate specimens.

Semi-flooded light forest, edge of Jakhali Swamp, Sapu, 5 Oct. 1964; 2 aclitellate specimens.

Sides of path through groundnut field, Brikama Ba, 7 Oct. 1964; 1 clitellate, 2 aclitellate specimens.

Sides of paths through groundnut fields, Willigara, 7 Oct. 1964; 15 aclitellate specimens.

Under Rheum palms, edge of rice field, Bakau, 10 Oct. 1964; 1 aclitellate specimen.

DESCRIPTION. *External characters.* The worms are 79–112 mm. in length and 2–2·5 mm. in diameter having 126–166 segments (one specimen is regenerating from segment *xciv*). The body wall is unpigmented but the clitellum is a vinous brown. The cuticle is iridescent being mainly pink and green but a deep blue on the dorsal surface of the clitellum and on the anterior region of the body. The first dorsal pore occurs in a few individuals in furrow 11/12 otherwise it is to be found in furrow 12/13; in the more mature of the clitellate specimens the dorsal pores appear to be occluded in the clitellar region. The form of the prostomium is epilobous with a single, mid-dorsal, longitudinal furrow running from the posterior end of the prostomium to furrow 1/2 which is represented by only a slight transverse groove in the mid-dorsal region with the result that the peristomium appears to merge into segment *ii* (Text-fig. 6a). The peristomium is withdrawn in contracted individuals and segment *ii* may be mistaken for the first segment.

The setal formula appears to be fairly constant throughout the entire length of each worm and may be expressed as $aa : ab : bc : cd = 4 : 1{\cdot}25 : 3{\cdot}5 : 1$ and $dd = \frac{2}{3}$ circumference. The ventral setal pairs are missing from segment *xix*.

The clitellum is saddle-shaped between segments *xiv–xix* (occupying 6 segments) ventrally and $\frac{1}{2}$*xii–xx* ($7\frac{1}{2}$ segments) dorsally. It extends towards the ventral surface as far as setal lines *ab* where there is only a diffuse region on each side to mark its borders.

There is a balantine reduction of the male terminalia. The male pores cannot be seen but they presumably discharge, together with the prostatic pores, into a short, lateral furrow passing between each penial setae and setal line *b* on segment *xix*.

Paired penial setae are present on segment *xix*, midway between setal lines *a* and *b*. Usually there are 4 to 5 penial setae at different stages of development in each bundle. The largest vary in size between 1–2 mm. in length, they are hooked with a hooded, almost gouge-like, distal end and with a series of shallow, distally directed, irregular serrations on the inner surface of the distal one-fifth of the shaft.

The serrations do not extend to the hooked end-portion of the setae (Text-fig. 6b).

There is a single female pore on segment *xiv* situated midway between setae *aa*.

The spermathecal pores are paired in furrow 7/8 and lie between setal lines *ab*.

Numerous genital papillae are present on segments *vi–viii* and *xvii–xxii*. Closely paired anterior genital papillae occur in furrow 6/7 within setal lines *aa*, while on segment *viii* there are two pairs situated in setal lines *bb*, the first is in furrow 7/8 laterally to the spermathecal pores and the second in furrow 8/9; there is a single, median ventral papilla near to the posterior border of segment *vii*. Paired posterior genital papillae occur on segments *xvii–xxii* in setal lines *bb* (in some specimens one

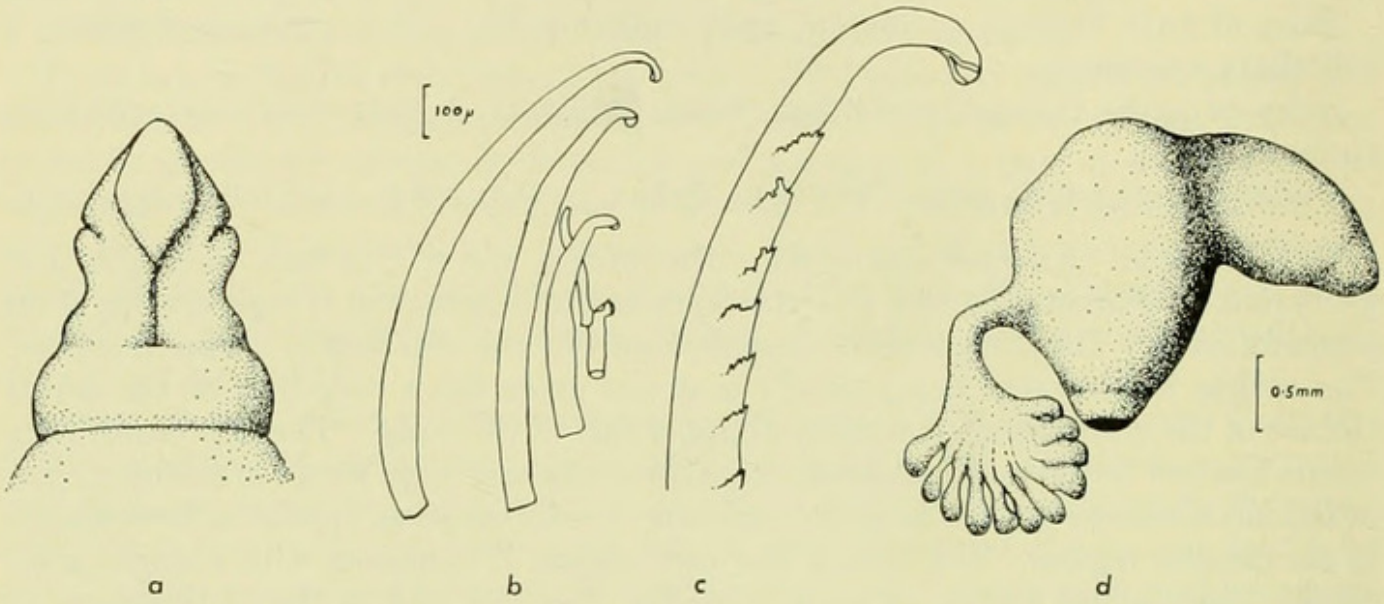

FIG. 6. *Dichogaster ehrhardti* (Mich.). (a) Anterior region showing the prostomium and the relationship between the peristomium and segment *ii*. (b) Penial setal bundle. (c) Distal end of a well-developed penial seta (very high-power). (d) Right spermatheca (dorsal view).

member of a pair may be missnig); there is a single, median ventral papilla in the posterior half of both segments *xviii* and *xix*.

Internal characters. The first septum is 4/5 and septa 4/5–9/10 are conical and and thickened, septa 10/11–12/13 are moderately thickened and 13/14–17/18 only slightly thickened.

The pharynx is long but extends posteriorly only to segment *iv*. The oesophagus leads from segment *v* into the anterior half of *vi* then begins to dilate as it passes into the anterior gizzard in segment *vii*, there is a posterior gizzard in segment *viii*; both gizzards are alike. The oesophagus continues posteriorly to $\frac{1}{2}xix$ where the intestine begins. Three pairs of calciferous glands are present in segments *xv*, *xvi* and *xvii*, the anterior pair is the smallest and the posterior pair the largest. The anterior region of the intestine is dilated in segments *xix–xxiv* to produce a series of six crop-like pouches each separated from the next by an intersegmental thickening. The internal surface of the intestine is convoluted in this region and is apparently strongly

glandular. The typhlosole arises in segment *xx* and gradually increases in size until it reaches its fullest development in segment *xxiv* where its height is nearly equal to the internal diameter of the intestine thus dividing the instestine longitudinally into two chambers. The free, distal edge of the typhlosole is thickened and there is a series of thickened vertical ridges on each side, with five ridges extending to halfway up the typhlosole in each segment. There is also a pair of longitudinal ridges along the dorsal surface of the intestine lying one to each side of the typhlosole, the ridges arise in segment *xxiv* where the typhlosole first reaches its full size.

Paired lateral hearts are present in segments *x*, *xi* and *xii*.

There is a holandric condition of the anterior male organs with free testes and funnels in segments *x* and *xi*. The testes are situated on the ventral parietes on each side of the ventral nerve cord by the anterior septum of segment *x* and *xi*; the funnels are seen as large, paired rosettes on the anterior surface of the posterior septum of each testis segment and, like the testes, they are situated near to the ventral parietes by the ventral nerve cord. The seminal vesicles are paired in segments *xi* and *xii* and are glanular in appearance.

One pair of tubular prostatic glands is present. Each gland is loosely coiled in segment *xxii* and perhaps in segment *xxiii*, it passes forward into segment *xxi* becoming more muscular to form the ectal duct which continues through segment *xx* and enters into the parietes in segment *xix*. The penial setal bundles are paired in segment *xix*, each enters the parietes medially to the muscular ectal region of the prostatic duct of its side.

The ovaries are very closely paired in segment *xiii* and appear almost to be single. They are pendent from the posterior surface of septum 12/13 between the ventral surface of the oesophagus and the ventral parietes. There is no funnel on the anterior surface of septum 13/14, instead a large, single, simple, slit-like aperture ventrad to the oesophagus leads into the oviduct. The oviduct is single and median in segment *xiv*, it passes down the posterior surface of septum 13/14 to the ventral parietes where it is slightly flexed posteriorly before entering the ventral parietes.

One pair of spermathecae is present in segment *viii*. The duct of each spermatheca passes medially from the ventral parietes by septum 7/8, it is stout and has a greater diameter than the ampulla which is flexed posteriorly. A diverticulum arises from the anterior surface of the ectal end of the duct, it is short and slender and develops distally into a number of diffuse seminal chambers (Text-fig. 6d).

The excretory system is meronephridial. Twelve meronephridia are present in all segments except *x*, *xi*, *xii* where apparently there is none. In the oesophageal region they are small but in the intestinal region they are larger and form a continuous covering to the parietes.

Remarks. The distinctive pattern of the genital papillae and the balantine reduction of the male terminalia are easily recognisable characters by which *ehrhardti* can be separated from all other species of *Dichogaster*. Internally, the form of the spermathecae and the penial setae serve as useful confirmatory features.

The worms listed above represent only the second record for this species in addition to being a new record for Gambia.

Dichogaster titillata sp. nov.

(Plate VII)

Sides of paths through groundnut fields, Williga ra, 7–9. Oct. 1964. Syntypes: 128 clitellate, 59 aclitellate specimens. B.M.(N.H.) Reg. No. 1966.30.240/426 [Schizosyntype (slide) 1966.30.427].

OTHER MATERIAL: Pasture and sides of paths through groundnut fields, Brikama Ba, 5–7 Oct. 1964; 44 clitellate, 8 aclitellate specimens.

Side of rice field, Brikama, 28 Sept. 1964; 1 clitellate specimen.

Semi-flooded light forest, edge of Jahkali Swamp, Sapu, 4 Oct. 1964; 1 clitellate specimen.

DIAGNOSIS. *External characters.* Length 90–158 mm., diameter 2·5–3 mm. (clitellar diameter 3–5 mm.). Segments 129–168. Colour above green-brown in life, grey-brown preserved; below unpigmented. First dorsal pore 12/13. Epilobous. Setae small, ventral, closely paired. Clitellum *xiii–xxi* (9 segments), saddle-shaped. Male pores paired *xviii* in setal line *a*. Prostatic pores paired *xvii, xix*. Penial setae present *xviii, xix*, 11 mm. long. Female pore single, midventral *xiv*. Spermathecal pores paired 7/8, 8/9 in setal line *b*. Genital papillae present, single or very closely paired (14/15) 15/16, 19/20 (sometimes widely paired), 20/21; also one often adjacent to each spermathecal pore.

Internal characters. First septum 4/5, 4/5–8/9 conical, 9/10–12/13 less so; 8/9–16/17 thickened. Septa 17/18–29/30 conical but with apex of cone directed anteriorly. Gizzards *vii, viii*, partly fused. Calciferous glands paired *xv–xvii*. Intestine begins *xviii*, anterior region pouched; typhlosole arises *xix*. Lateral hearts paired *x–xii*. Holandric, testes paired in anteriorly directed septal pouches. Seminal vesicles paired *xi, xii*. Prostates tubular, paired *xvii, xix*, extending posteriorly (with penial setal sheaths) to *xxxv–ixl*; convoluted. Ovaries very closely paired *xiii*. Spermathecae paired *viii, ix*; duct stout with long, coiled diverticulum, ampullae simple. Meronephridial.

DESCRIPTION. *External characters.* Worms in the type series are 90–158 mm. in length and 2·5–3 mm. in diameter in the intestinal region and 3–5 mm. in diameter in the clitellar region. There are 129–168 segments present in undamaged individuals. The worms are mainly triannulate but occasionally the groove separating the first from the second annulus is not clearly seen in the anterior segments and these segments may appear to be biannulate; more frequently there is a tendency for individuals to become pentannulate in the post-clitellar region and even anteriorly to this region where locally this process may be imperfectly developed to produce a tetrannulate condition. The prostomium is epilobous and the first dorsal pore occurs in furrow 12/13.

The colour of the dorsal surface is in life green-brown and in preserved specimens grey brown, the ventral surface is unpigmented. The cuticle has a green-red iridescence.

The setae are small and are closely paired on the ventral surface. The setal formula at segment *xx* is *aa* : *ab* : *bc* : *cd* = 3·5 : 1 : 3 : 1 and *dd* = $\frac{3}{4}$ circumference.

The clitellum is saddle-shaped extending over segments *xiii–xxi* (9 segments) with the ventral borders passing down to setal lines *bb*.

The male pores are paired on segment *xviii*, they are inconspicuous and situated in setal lines *aa*. Small glandular folds join each pore with the slightly more laterally

situated seminal grooves. The prostatic pores are paired on segments *xvii* and *xix*; the pair on segment *xvii* discharge on the posterior surfaces of the papillae from which the anterior pair of penial setae protrude and the pair on segment *xix* discharge on the anterior surfaces of the papillae bearing the posterior pair of penial setae. The prostatic pores of each side are joined by an inconspicuous, convex, seminal groove which in segment *xviii* almost touches the ventral border of the clitellum.

The penial setae are paired on segments *xvii* and *xix* and arise from paired papillae each in setal line *a*. The setae measure up to 11 mm. in length and are very slender and flexible. There is little ornamentation apart from a tooth-like tip and a slight moniliform appearance of the distal half (Text-fig. 7a).

The genital field is small covering the ventral surface only on segments *xvii* and *xix* where it is smooth and uniformly concave.

The female pore is single on segment *xiv* being situated mid-ventrally in the setal ring.

Two pairs of spermathecal pores are present in furrows 7/8 and 8/9 in setal lines *bb*. They are conspicuous and each may have an adjacent papilla situated slightly latero-posteriorly which superficially gives the appearance of the pore being double.

Genital papillae are present. In the region of the genital field most are single but they may be very closely paired instead. Paired papillae occur occasionally in furrow 14/15 but always in furrows 15/16, 19/20 and 20/21; sometimes the papillae in furrow 19/20 may be widely paired when they may be as far apart as setal lines *aa*.

Internal characters. The first septum is 4/5 and all of the anterior septa to 8/9 are strongly conical while septa 9/10–12/13 are only moderately conical. Septa 17/18–24/25 are also conical but with the " apex " pointing anteriorly, septa 25/26 29/30 become progressively flatter. Septa 10/11–12/13 are thickened and septa 8/9 and 13/14–16/17 are slightly thickened.

A large pharynx extends posteriorly into segment *iv*. In segment *v* the oesophagus is undifferentiated although it begins to dilate posteriorly and continues enlarging in segment *vi* until it is the same diameter as the oesophageal gizzards in segments *vii* and *viii*. Throughout segments *v* and *vi* the oesophageal wall becomes progressively thicker. The gizzards are fused with only a slight intersegmental constriction at septum 7/8. The calciferous glands are lamellate and paired in segments *xv*, *xvi* and *xvii*. The intestine begins in segment *xviii* and is dilated until segment *xxiii*, or *xxiv*, to form a crop-like region. Here the intestine is divided internally by a series of intersegmental thickened rings to form a series of pouches. The typhlosole arises in segment *xix* as a low slender ridge, it gradually forms into a thick, lamellate structure which by segments *xxiv–xxvi* is fully developed, extending nearly half-way across the lumen of the intestine.

The dorsal blood vessel is seen anteriorly as a slender vessel passing posteriorly from the pharynx and over the gizzards. It increases in diameter in segments *x*, *xi* and *xii* where it is apparently contractile. Paired lateral hearts are present in segments *x*, *xi* and *xii* where they join the dorsal and ventral vessels. A supra-oesophageal vessel can be traced between the posterior region of the dorsal surface

of the first gizzard in segment *vii* and the calciferous glands. Paired circumoesophageal vessels are present in segments *vii–xii* joining the supra-oesophageal vessel with a pair of longitudinal latero-ventral oesophageal vessels. The latero-ventral oesophageal vessels arise in segment *xii* and pass anteriorly to the ventral surface of the pharynx, they are dilated in segments *vii* and *viii* where they receive blood from the spermathecae. In segment *xiii* paired vessels pass ventrally from the supraoesophageal vessel then each flexes posteriorly and passes to the prostatic gland of its side.

The testes arrangement is holandric with both the testes and the funnels paired in segments *x* and *xi*. The testes are situated in paired pouches formed by anteriorly

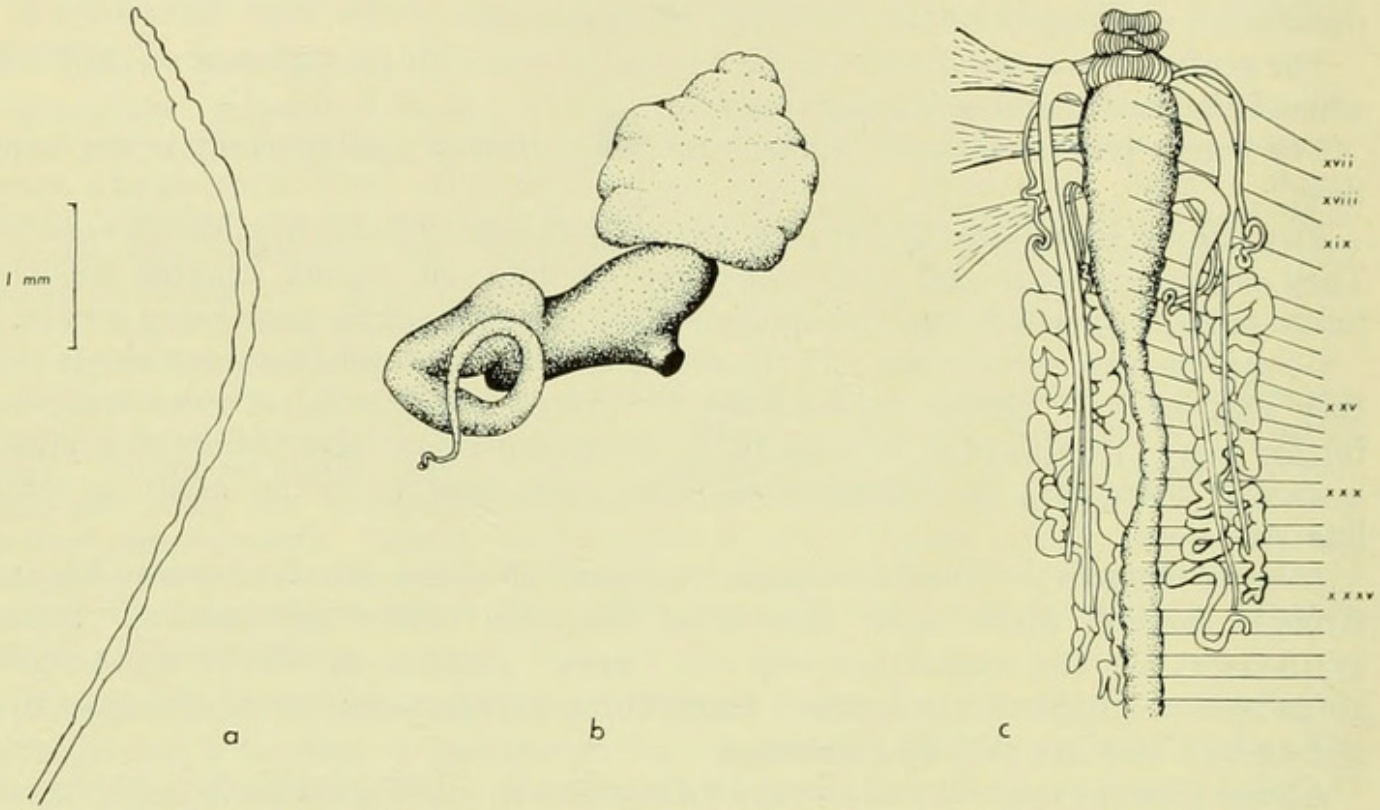

Fig. 7. *Dichogaster titillata* sp. nov. (a) Distal end of penial seta. (b) Spermatheca (antero-ventral view). (c) Dorsal dissection showing the prostatic glands and the muscular sheaths of the penial setae. The septa of the left-half of the body are omitted and the muscles of the right-halves of segments *xvii*, *xviii* and *xix* are not shown.

directed extensions of the anterior septa of the testes segments. Depending on the length of the pouch, the testes may be seen lying on the parietes one or two segments in front of the testes segments, the posterior pouches are usually smaller than the anterior pair. The testes are contained in testes sacs which are continuous with the funnels and the seminal vesicles. The seminal vesicles are paired in segments *xi* and *xii* and are deeply incised with a granular texture. The anterior pair is large, the posterior pair small.

Two pairs of tubular prostatic glands are present as elongate, convoluted masses in the anterior intestinal region, with a muscular duct entering the parietes in segments *xvii* and *xix*. (Text-fig. 7c). Each prostatic duct is slender and slightly convoluted, as it leads posteriorly through about three segments into the tubular prostatic gland.

Each gland is loosely coiled and lies alongside the intestine, extending posteriorly to segments *xxxv-ixl*. There are two pairs of penial setae whose muscular sheaths enter the parietes medially to the ectal ends of the muscular prostatic ducts. The penial setal sheaths are exceptionally long and flexed posteriorly, the anterior pair extend from segment *xvii* to *xxxii* and the posterior pair from segment *xix* to *xxxiv*.

The ovaries are very closely paired in segment *xiii*; they may be seen as a single, median ovary pendent from the posterior surface of septum 12/13 ventrally to the oseophagus. The funnel is single being a simple, vertical, slit-like aperture in the anterior face of septum 13/14 below the oesophagus close to the ventral parietes. The oviduct is thin-walled, it passes down the posterior surface of septum 13/14 then is flexed a short distance posteriorly over the ventral parietes before entering the body wall.

The spermathecae are large and are paired in segments *viii* and *ix*. Due to the posterior displacement of the foregut they are situated ventrally to the pre-gizzard portion of the oesophagus. The duct of each spermatheca is about half of the diameter of the ampulla which is very large; a long, coiled, unilocular diverticulum arises from the duct (Text-fig. 7b). In well-developed, mature individuals, torsion has resulted in each spermatheca appearing as a long, tapering coil joined to an ampulla by a stout duct from which a smaller, shorter duct leads into the parietes.

The excretory system is meronephridial. Anteriorly there are a few diffuse nephridia situated on the septa near to the parietal wall but posteriorly from segment *xv* the nephridia are slightly more numerous. They lie on the parietes in the line of the setal ring and more posteriorly they form four longitudinal rows along the body on each side of the intestine. The nephridia are small throughout the region containing the prostatic glands and do not reach their full size until segment *xxxvi*.

Remarks. Although this species may be recognized externally by the presence of papillae both adjacent to the spermathecal pores and in the region of the genital field, it can be more readily identified by internal features. The shape of the spermathecae, the great length of the prostatic glands and the muscular sheaths surrounding the penial setae are unusual specializations. The function of the penial setae is obscure. These setae are very long, extremely slender and bend easily so that they would seem unlikely to be able to pierce another individual during copulation. When uncoiled, the spermathecal diverticula are also found to be long and it may be that their size is correlated with the great length of the penial setae. If each seta enters into the lumen of a partner's spermatheca during copulation, it is necessary for the seta to be flexible for it to follow round the coils of the diverticulum.

D. titillata resembles *D. ehrhardti* in that the oesophageal gizzards are situated in segment *vii* and *viii* but differs, among other characters, in that the oesophagus is slightly thickened and dilated in segment *vi* but the same diameter as the gizzard in the following segment. The modification of the oesophagus in segment *vi* could almost be regarded as a rudimentary gizzard, if so then *titillata* would have to be placed, by definition, in the genus *Eutrigaster* Cognetti which differs from *Dichogaster* only in the presence of a third oesophageal gizzard. However, the degree of muscularization provides insufficient evidence for arriving at this conclusion. The oesophageal muscularization may represent the penultimate stage either in the

posterior migration of the gizzards from *vi* and *vii* to *vii* and *viii* or, more likely, the loss of the anterior gizzard from a condition in which gizzards were present in the three segments *vi*, *vii* and *viii*. Whatever the explanation, it would seem that generic criteria of this nature may need re-assessment.

The paired blood vessel passing between the supra-oesophageal blood vessel in segment *xiii* and the prostatic glands is of especial interest although it is not unique to this species, for example it can be traced in *Benhamia reducta*, but it is more easily seen in *D. titillata*. The prostatic blood supply is of interest because although the glands lie in segments *xvii* and *xix* the paired vessel passes from a more anterior segment. There may well be a functional necessity for the prostatic blood vessels to arise from the supra-oesophageal blood vessels which terminate posteriorly at the calciferous glands. On the other hand, it could indicate the original, ancestral, position of one of the pairs of the prostatic glands. During the evolution of this group of earthworms, the prostatic glands (and the ectal ends of the vasa deferentia) may have moved posteriorly while the blood vessels still rise in the primitive position. If this were so then the male pores would have been originally situated on segment *xiv*, an unknown condition in present-day worms. A more probable explanation could be that the blood supply to the anterior prostatic glands from the supraoesophageal vessel was lost and that both pairs of prostates came to be supplied by the vessel which originally passed only to the posterior prostatic glands. This condition would result in the prostatic glands being originally situated in segments *xi* and *xiii* and the male pores in segment *xii*. This arrangement of the male terminalia is similar to the condition present in the less highly specialized worms, both freshwater and terrestrial, in the families Syngenodrilidae and Alluroididae which have many features not found in the Octochaetinae (Gates, 1945; Brinkhurst, 1964). This single factor, the origin of the prostatic blood vessels, cannot be taken to indicate phylogenetic affinity but it can serve to indicate the grade of structure of an ancestor which may have been similar to that now found among species of more primitive families. It may be significant that currently the Syngenodrilidae and, with the exception of one species, the Alluroididae are solely African in distribution.

Omodeona gen. nov.*

DIAGNOSIS. Octochaetinae (Acanthodrilidae) with a lumbricine arrangement of the setae. Two gizzards present, an anterior gizzard in segment *v* and a posterior gizzard in segment *vi*. Two pairs of calciferous glands present as stalked, lamellate, oesophageal diverticula; the first pair in segment *xv* and the second pair in segment *xvi*. Intestine simple throughout, typhlosole ⅄-shaped. Anterior male organs holandric; prostatic glands tubular in structure. Penial setae present. Excretory system meronephridial.

TYPE SPECIES. *Omodeona proboscoides* sp. nov.

REMARKS. *Omodeona* is distinguished from other genera sharing a large number of common attributes by the situation and the number of the calciferous glands. Species of the genera *Pickfordia* Omodeo, *Neogasier* Cernosvitov (sensu Omodeo) and

* Named in honour of Dr. Pietro Omodeo.

Wegeneriella Michaelsen resemble *Omodeona* in having two pairs of calciferous glands but they differ in that the glands are situated more anteriorly, the first pair occurring in segment *xiv* and the second pair in segment *xv*. On the other hand, *Omodeona* is readily separable from the genera *Benhamia* Beddard (sensu Omodeo) and *Dichogaster* Beddard (sensu Omodeo) because of the presence of three pairs of calciferous glands in segments *xiv–xvi* and *xv–xvii* respectively in species of these genera. Yet, it is possible to regard *proboscoides* as an aberrant member of either of these genera which has lost one pair of calciferous glands, the anterior pair in the case of *Benhamia* or the posterior pair in the case of *Dichogaster*. Generally, *proboscoides* has greater affinity with species of *Benhamia* than with species of other genera (*see* Remarks, p. 36) nevertheless it is necessary to erect a new genus to accommodate it in view of the validity of the separation of *Benhamia* and related genera (Sims, 1966) on the positions and number of their calciferous glands (Omodeo, 1955).

Omodeona proboscoides sp. nov.

(Plate VIII)

Beside Pumping House, grass banks of the reservoir, Abuko, 24–28 Sept. 1964.

Syntypes: 22 clitellate, 8 aclitellate specimens. B.M.(N.H.) Reg. No. 1966. 30. 483/512 [Schizosyntypes (slides) 1966.30.513/514].

Gut contents. Small particles of vegetable matter (fibres and seeds) with a quantity of very fine soil.

Diagnosis. *External characters.* Length 59–83 mm., diameter 1·5–2·5 mm. (clitellum diameter 2·5–3·5 mm.). Segments 132–173. Unpigmented. First dorsal pore 20/21. Epilobous; proboscis present, when fully everted equal in length to first three segments. Setae small, ventral, closely paired. Clitellum *xiii–xx* (8 segments), annular. Male and prostatic pores combined, paired *xvii* in setal line *b*. Penial setae present. Female pores closely paired *xiv* within setal lines *aa*. Spermathecal pores paired in furrow 7/8 in setal line *b*. Genital papillae absent.

Internal characters. First septum 4/5–8/9 conical, 9/10 less so; 5/6–11/12 thickened. Gizzards *v, vi*. Calciferous glands paired *xv, xvi*. Intestine begins *xviii*; typhlosole arises *xx*. Lateral hearts paired *x–xii*. Testes holandric in testes sacs. Seminal vesicles paired *ix, xii*. Prostates tubular paired *xvii*. Ovaries paired *xiii*. Spermathecae paired *viii*, duct short and stout with two short, convoluted, ental diverticula each terminated by three digitiform processes; ampulla simple. Meronephridial.

Description. *External characters.* The worms are 59–83 mm. in length, 1·5–2·5 mm. in diameter in the intestinal region and 2·5–3·5 mm. in diameter at the clitellum. There are 132–173 segments present in undamaged individuals. The prostomium is very broad and epilobic but there are longitudinal striations on the peristomium which superficially give the appearance of being tanylobic. An obvious feature of this species is the presence of a small, eversible, digitiform proboscis which is strongly reminiscent of the proboscis of some species of *Alma*. It arises from the postero-ventral surface of the prostomium and when fully everted is equal in length to the first three body segments. Secondary annulation is weak and may be seen only on the ventral surface of the posterior end of the intestinal region

where the middle, i.e. setal, annulus of each segment may be slightly raised. The clitellum is annular and extends from segments *xiii to xx* (eight segments), sometimes segments *xiii* and *xx* may be reduced when the clitellum may seem to extend over only segments *xiv* to *xix*. The first dorsal pore occurs in the first postclitellar furrow, i.e. in furrow 20/21.

The body wall is unpigmented and the preclitellar region is a bright pink colour in life but a whitish grey in preserved specimens; in the intestinal region the gut contents can be seen through the body wall which is a reddish brown in life but otherwise a greyish brown. The clitellum is a bright orange when the animal is alive but fades to a greyish brown when the specimens are preserved. The cuticle is not strongly iridescent and it has only weak pink and pale green reflections to which blue is added in the clitellar region.

The setae are small, closely paired and situated ventrally. The setal formula is the same throughout the body, $aa : ab : bc : cd = 3 : 1 : 4 : 1$ and $dd = \frac{3}{4}$ circumference.

The male and prostatic pores are paired and apparently combined on the surface of segment *xvii*. They discharge from a pair of mammalate papillae in setal lines *bb*. The papillae are situated in an oval, glandular area sunken into the clitellum. Each papilla carries a penial seta. The penial setae are slender, being 1·9 mm. long but only 15 μ in diameter. They are smooth and rounded for most of their length but towards the distal end they become crenulated then flattened immediately before a hook-line tip (Text-fig. 8a).

The female pores are inconspicuous and closely paired on segment *xiv*; they are situated in the setal ring about $\frac{3}{4}ab$ within setal lines *aa*.

The spermathecal pores are paired in furrow 7/8 and situated in setal line *b*. Each pore opens into a deep transverse slit extending from setal line *a* to within *bc*.

Genital papillae are absent but between setal lines *bb* on segment *xv*, the ventral surfaces of the more mature individuals have an unpigmented, oval area.

Internal characters. The first septum is 4/5, all of the anterior septa to septum 8/9 are strongly conical and septum 9/10 is slightly less so; septa 5/6 to 11/12 are thickened. A large pharynx extends posteriorly to septum 4/5. Two gizzards are present, they are large and of equal size being situated in segments *v* and *vi* where they are joined by a short portion of dilated but otherwise undifferentiated oesophagus in the anterior region of segment *vi*. Two pairs of calciferous glands are present, occurring in segments *xv* and *xvi* as stalked, lamellate diverticula arising from the dorso-lateral surface of the oesophagus. The intestine begins in segment *xviii*, it is undifferentiated throughout. A typhlosole arises in segment *xx*; it is ⅄ shaped in cross section and its height is little more than half of the internal diameter of the intestine.

The dorsal blood vessel is slender except in the region of the calciferous glands where it is somewhat dilated. Paired lateral hearts are present in segments *x*, *xi* and *xii*, the posterior pair is slightly smaller than the other two pairs. A peri-oesophageal blood sinus is present in segments *xiv*, *xv* and *xvi* serving the calciferous glands in segments *xv* and *xvi*, anteriorly it is supplied by a slender supra-oesophageal blood vessel which is difficult to trace because of its small size.

There is a holandric condition of the testes which are paired and situated within testes sacs in segments *x* and *xi*, the sacs being continuous with the funnels. The arrangement of the seminal vesicles is unusual among the Octohaetinae in that the vesicles are paired in segments *ix* and *xii*. The seminal vesicles in segment *ix* are developed from the anterior surface of septum 9/10 but the seminal vesicles in segment *xii* are developed in the more usual manner from the posterior surface of septum 11/12. The prostatic glands are paired in segment *xvii*. They are tubular in structure, small and do not extend into the adjacent segments. Entally each

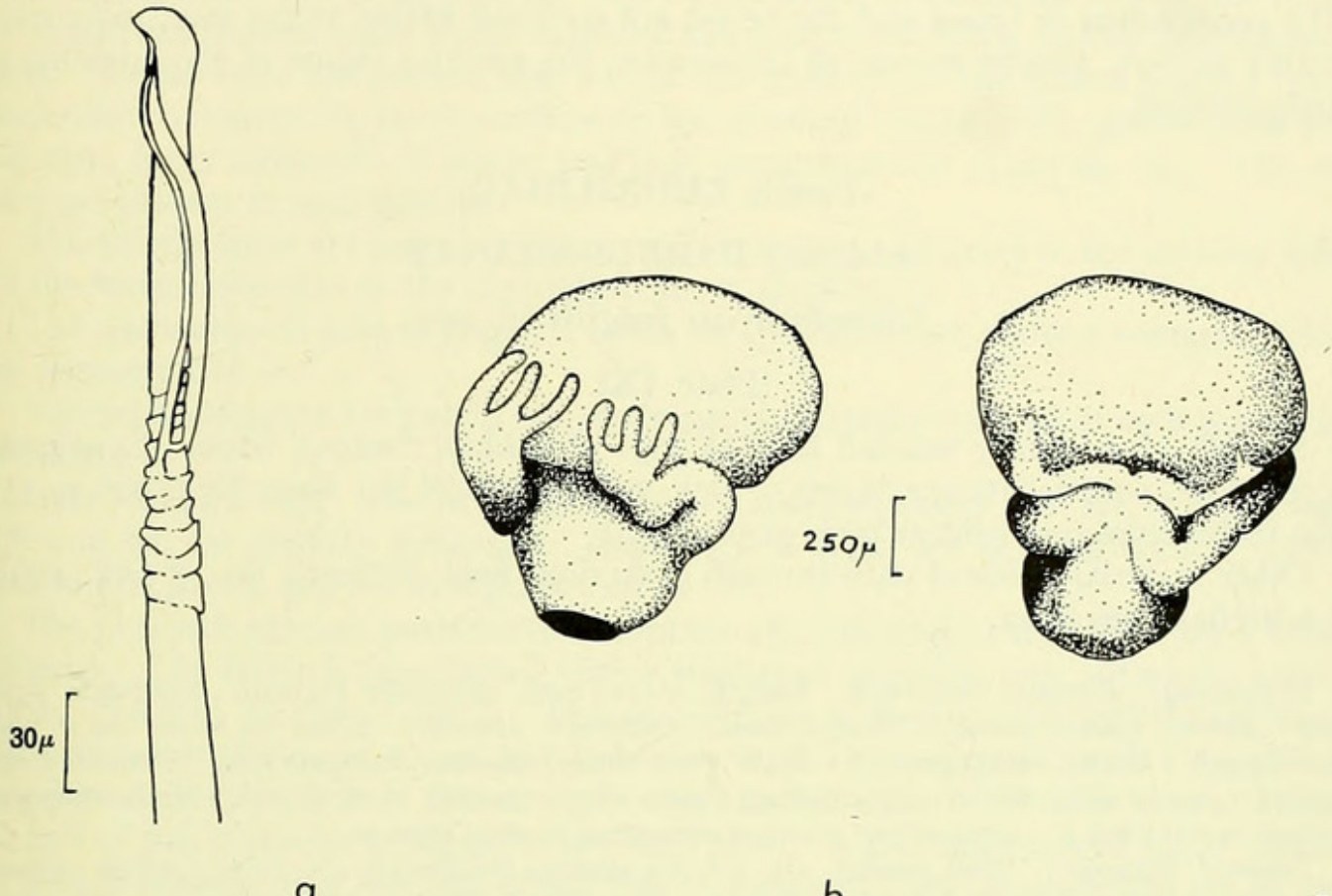

FIG. 8. *Omodeona proboscoides* gen. et sp. nov. (a) Distal end of penial seta. (b) Spermatheca (ventral view). (c) Spermatheca (dorsal view).

gland is slightly convoluted with three or four flexures, ectally a straight portion leads into a slender, muscular duct, about one quarter of the total length of the gland which passes into the ventral parietes anteriorly to the muscular sheaths of the penial setae.

The ovaries are paired in segment *xiii* where they are situated pendent from the posterior face of septum 12/13 laterally to the oesophagus. The funnels are paired on the anterior face of septum 13/14 near to the ventral parietes.

The spermathecae are paired in segment *viii*. Each has a wide, stout duct with ampullae of almost the same length and only a slightly greater diameter. Two diverticula arise from the ental end of the dorsal surface of the duct, they are slightly convoluted and pass around each side of the ampulla, terminally each is tripartite (Text-figs. 8b, c).

The excretory system is meronephridial. There are few nephridia in the preclitellar region of the body but up to twenty-five in each segment in the intestinal region, here they form a continuous band around the parietes completely filling the central third of each segment.

Remarks. Externally *proboscoides* may be readily recognized by the presence of a proboscis similar to that of some species of *Alma* also by the microscolecine reduced male terminalia discharging in a small genital field surrounded by a smooth annular clitellum. Its affinity with other species is mainly with those of the genus *Benhamia*. The prostomium is broad and the testes are enclosed within testes sacs, moreover, unlike western African species of *Dichogaster*, the anterior region of the intestine is unspecialized.

Family **EUDRILIDAE**

Subfamily **PAREUDRILINAE**

Chuniodrilus fragilis sp. nov.

(Plate IX)

Semi-flooded, lightly wooded land at edge of Jahkali Swamp, Sapu. Syntypes: 5 clitellate, 1 aclitellate specimens, 3 Oct. 1964; B.M.(N.H.) Reg. No. 1966.30.555 560 [Schizosyntypes (slides) 1966.30.561/563].

Other material: Side of path through groundnut field, Brikama Ba., 5 Oct. 1964. 1 aclitellate specimen.

Diagnosis. *External characters.* Length 86–125 mm., diameter 1·5 mm. Segments 137–217. Dorsal pores absent. Proepilobous. Clitellum annular. Setae $ab = cd$, $aa = 5ab$, $bc = 2{\cdot}5ab$. Penial setae present. Male pore single, median ventral *xvii*. Female pores paired 14/15 in setal line *d*. Spermathecal pore single, median ventral *xiii*. Nephridiopores paired in setal line *d*. Genital pad *xviii–xx* extending to setal lines *aa*.

Internal characters. First septum 4/5, 5/6–8/9 slightly thickened, 4/5–12/13 conical. Oesophageal gizzard *v*, intestinal gizzards absent. Oseophagus dilated and modified *xiv–xvi*, calciferous glands and oesophageal fat-bodies absent. Paired, commissural blood vessels *v–xii*. Holandric, testes free. Seminal vesicles paired *xi*, *xii*. Euprostates extending posteriorly to *xxi–xxiii*. Female and spermathecal systems separate. Ovaries paired *xiii* associated with a complex ovarian apparatus within an interconnecting coelomic sac. Spermathecal atrium single, median ventral *xiii* leading into a small receptaculum. Meganephridial.

Description. *External characters.* The body length varies between 86 and 125 mm., averaging 106 mm., the diameter is 1·5 mm. There are 137–217 segments present, the average number being 162. The body wall is unpigmented, in life the preclitellar region is pink in colour and the clitellum slightly paler while the intestinal region is a pinkish brown due to the gut contents being seen through the transparent body wall; in preserved specimens the preclitellar and clitellar regions are white and the intestinal region yellowish brown in colour. The cuticle is only slightly iridescent with pale green and bronze-pink reflections. Dorsal pores are absent. The prostomium has a proepilobic condition. Apart from some slight signs of triannulation in the preclitellar region, there is no secondary annulation.

The clitellum is annular and extends from segment *xiii* to *xviii* (six segments) dorsally but only from segment *xiv* to *xvii* (four segments) ventrally. The clitellar segments are approximately twice the length of the intestinal segments.

The setae are lumbricine in arrangement, the setal formula at segment *xxx* is *aa* : *ab* : *bc* : *cd* = 5 : 1 : 2·5 : 1, the dorsal distance between *dd* being $\frac{3}{5}$ of the circumference. In the clitellar region, setae *cd* may be absent while setae *ab* are slightly larger than elsewhere.

The male pore is single on segment *xvii* and is accommodated on a small, median ventral papilla. The orifices of the euprostatic ducts are situated within the male pore and can be seen below a pair of lateral lips as a pair of short, slender longitudinal slits. Penial setae are present also within the male pore; the paired sheaths open immediately anteriorly to the orifices of the prostatic ducts. The penial setae are 1·5 mm. long, sigmoidal in shape and lack ornamentation (Text-fig. 9a). One or two are present in each bundle.

The female pores are paired in furrow 14/15, they are situated in the anterior wall of the furrow opposite to the nephridiopores in setal line *d*.

The spermathecal pore is single, it opens on a small raised, median ventral papilla on segment *xiii*.

The nephridiopores are paired and discharge in the posterior wall of each furrow in setal line *d*.

Internal characters. The first septum is 4/5, most septa are thin and delicate but 5/6 and 8/9 are slightly thickened. Septa 4/5 to 12/13 are strongly conical, 13/14 less so and partly applied to septum 12/13.

The pharynx extends posteriorly to septum 4/5, followed in segment *v* by a large gizzard. The latter is cup-shaped with a thickened muscular ring anteriorly which forms the rim to the "cup". The oesophagus is slender and undifferentiated throughout segments *vi* to *xii* but it begins to dilate in segment *xiii*, throughout segments *xiv* and *xvi* it is the same diameter as the intestine but decreases in size to half of this diameter in segments *xvii* and *xviii*. A peri-oesophageal blood plexus is well-developed over the dilated portion of the oesophagus in segments *xiv* to *xvi* while calciferous glands and fat-bodies are absent from its entire length. The intestine begins in segment *xix* with a diameter equal to the oesophagus in the preceding segment, but immediately increases to its full size in segment *xx*. A typhlosole does not appear to be present.

The dorsal blood vessel passes forward to the dorsal surface of the pharynx, it is dilated in segments *xii* to *xix* as it passes through the region where the oesophagus is modified. A pair of commissural blood vessels is present in each segment from *vi* to *xii*, all are apparently contractile. Each successive pair is slightly stouter than the preceding pair, the vessels in segment *vi* being slender while those in segment *xii* are comparatively large. They convey the blood from the dorsal vessel to the ventral vessel which extends posteriorly from a pair of branches supplying the pharynx. A supra-oesophageal blood vessel lies on the oesophagus beneath the dorsal vessel with which it is interconnected by the commissural vessels. It can be traced posteriorly from the hinder end of the gizzard to segment *xii* where it passes ventrally to the right of the oesophagus and the main trunks to become the subneural vessel. A

small sub-oesophageal blood vessel extends posteriorly from the gizzard. It gradually decreases in diameter as it passes along the oesophagus and by segments *xi* or *xii* the sub-oesophageal blood vessel becomes too small to trace further with a dissecting microscope. Due to its small size I was unable to observe whether there were any branches or interconnections with other vessels.

The testes are holandric being paired in segments *x* and *xi*. They are not enclosed within sacs but may be attached to posterior face of the anterior septum or embedded in a sperm mass. The funnels are small. The seminal vesicles are paired in segments *xi* and *xii*, the posterior pair may be as much as twice the length of the anterior pair. The vasa deferentia were not seen. Paired euprostatic glands are

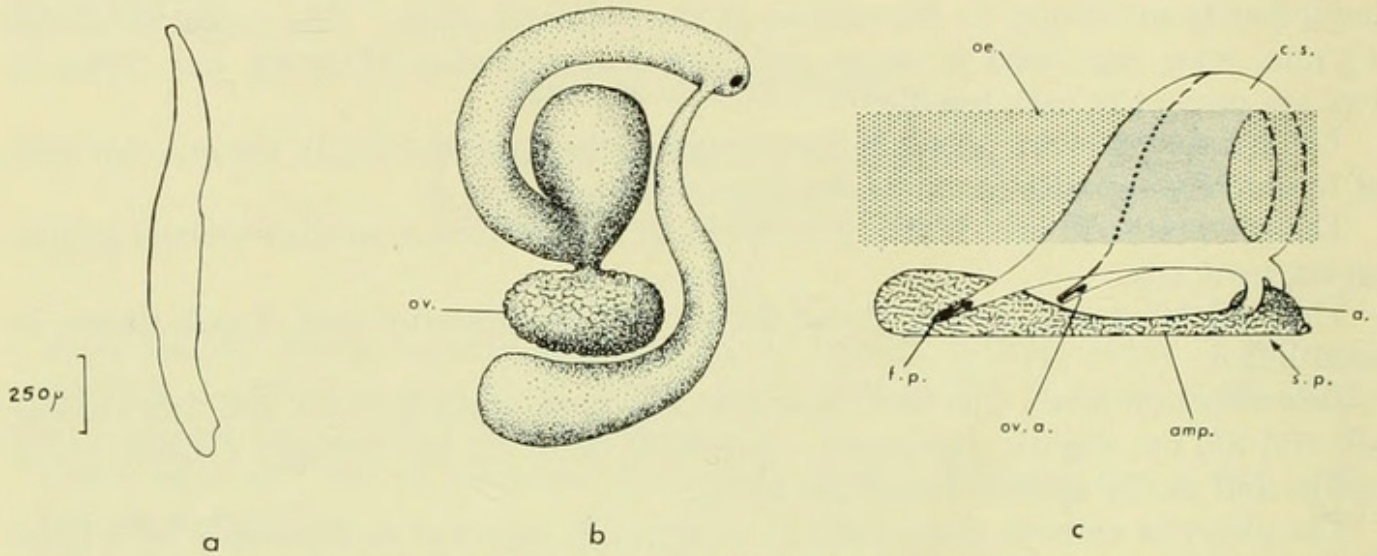

FIG. 9. *Chuniodrilus fragilis* sp. nov. (a) Penial seta. (b) Ovarian apparatus; *ov.*, ovary. (c) Schematic diagram of the coelomic sac in the posterior region of the oesophagus showing its relationship with the female and spermathecal systems; *a.*, atrium; *amp.*, ampulla; *c.s.*, coelomic sac; *f.p.*, (right) female pore; *oe.*, oesophagus; *ov.a.*, (left) ovarian apparatus; *s.p.*, spermathecal pore.

present in segment *xvii*, they are comparatively small and extend posteriorly to segments *xxi* to *xxiii*. A short duct leads from the ectal end of each euprostate and passes into the parietes by the ventral nerve cord. The penial setal sheaths are also paired in segment *xvii*. They lie transversely with their ectal ends entering the parietes immediately anteriorly to the euprostatic duct of the side.

The ovaries are paired in segment *xiii* where they are situated near to the lateral parietes in the posterior region of the segment. Septum 13/14 is slightly conical and the ovaries lie within the parietes of the hinder part of segment *xiv*. Each ovary is contained within a small sac, it discharges into an ovisac at the ental end of a short oviduct which passes postero-laterally and opens into furrow 14/15; a digitiform diverticulum arises near the ectal end of the oviduct and extends forwards and partly curls around the ovary (Text-fig. 9b). The female organs lie within a continuous coelomic sac formed by a delicate membrane. The sac passes anteriorly from the region of the ovaries to the dorsal surface of the spermathecal atrium and dorsally around the oesophagus (Text-fig. 9c).

The spermathecal system is single and is situated median ventrally in segments *xiii* to *xv* ventral to the ventral nerve cord. It consists of two parts, anteriorly there is a dome-like atrium which is confined to segment *xiii* which lead posteriorly into a slender, membraneous sac-like ampulla or receptaculum in segments *xiv* and *xv*.

The excretory system is meganephridial. The nephridia in the clitellar region are somewhat larger than others elsewhere.

Morphological notes. Attention is drawn above to the dilation of the oesophagus in segments *xiii–xviii* where the oesophagel wall is also modified in having a granular appearance and reflects light as if small crystals were present. Under high-power a large number of granules can be seen lying mainly immediately within the cell boundaries in the cytoplasm of the cells. All of the granules are of similar size, irregular in shape and translucent. The results of immersing a portion of the oesophageal wall in a dilute solution of hydrocholoric acid are inconclusive, a small number of the granules apparently dissolve but most seemed to remain unaltered. The same region of the oesophagus is further specialized in that the internal surface is thrown up into a large number of low, slender, longitudinal folds which substantially increase the surface area.

Other structures in the segments containing the posterior region of the oesophagus are also modified. The dorsal blood vessel has a greater diameter than elsewhere and the nephridia, like those in the clitellar region of Eudriline species (Sims, 1964 : 600), are larger. These two latter modifications indicate an increased metabolism in these segments although the segments may each contain only a portion of the oesophagus and a pair of nephridia. Functionally there is no readily evident reason for the specializations, particularly as the body wall in the clitellar region apparently plays a small part in locomotion. However, the physiology of the epidermis of this region is unknown during periods of clitellar activity and these modifications may well have arisen in response to breeding requirements.

The combinations of specializations could, nevertheless, be significant when they are considered in relation to the absence of calciferous glands and fat-bodies from elsewhere along the oesophagus. Laverack (1963) summarized the function and physiological requirements of the calciferous glands in the Lumbricidae and, in the case of this Pareudriline species, the enriched blood supply, enlarged nephridial vesicles, modified oesophagus with longitudinal ridges and cytoplasmic includions in the cells, provide evidence for suggesting that the posterior oesophageal region in this species may carry out the functions of the calciferous glands of other earthworms. Wasawo & Omodeo (1963) reported the presence of some of these specializations in the hinder oesophagus of *C. vuattouxi* and reached the same conclusion about the function of the specialized oesophageal wall in this region.

The absence of oesophageal glands and oesophageal fat-bodies, however, could be correlated with the ecology of this species. Among earthworms there is a tendency for calciferous glands to be reduced in size or absent in aquatic species (Stephenson, 1930 : 106) and to be larger in species living in soils with a high pH (Laverack, 1963 : 34). In the case of this new worm, the type series was collected in a swampy area adjacent to the River Gambia where the soil PH may be slightly

depressed by the decay of vegetable matter although salts would tend to be leached out by the water. (The specimen from Brikama Ba is damaged and aclitellate so it can be only provisionally assigned to this species. The conditions at Brikama Ba are dissimilar to those in the swampy, type locality).

REMARKS. Although *fragilis* lacks intestinal gizzards, it clearly belongs to the genus *Chuniodrilus* Michaelsen (*sensu* Wasawo & Omodeo, 1963 : 217). The female and spermathecal systems are functionally separate and comparatively simple, the hinder oesophageal wall is specialized and calciferous glands and oesophageal fat-bodies are absent. It resembles *Chuniodrilus compositus* in having the spermathecal pore on segment *xiii* instead of in the more usual position of furrow 12/13. It differs, however, in that the female pores and nephridiopores are situated in setal line *d* compared with setal lines *a* and *b* respectively in *compositus* and the large, smooth area extending over the ventral region of segments *xviii* and *xx* of *fragilis* is replaced in *compositus* by a number of small papilliform genital pads near by the male pore.

The comparatively simple morphology of the species of this genus could well represent the grade of struction of an ancestral Eudrilid from which existing forms were derived. If the function of the modified portion of the hinder oesophageal wall is concerned with acid-base balance then further modification in this region leading to the localization and development of calciferous glands would produce a Eudriline condition. Similarly, two, divergent lines of evolution of the female and sperm-athecal systems of the *Chuniodrilus*-grade could result in the appearance of either an *Eudrilus*-like or *Hyperiodrilus*-like condition. The paired female system of *C. fragilis* consists of an ovary and a small ovisac from which a short oviduct passes to the exterior, in addition there is a short digitiform diverticulum near to the ectal end of each oviduct. The female systems are contained within an interconnecting coelomic sac which encircles the oesophagus. The loss of the coelomic sac, the spermathecal atrium and the receptaculum would produce a condition similar to that present in species of *Eudrilus*. In this genus, the spermathecal atrium and pore have disappeared and the ectal, oviducal diverticulum of each paired ovarian apparatus has taken over the function of the spermatheca. On the other hand, the further development of the coelomic sac and the loss of the spermathecal recepaculum so that the spermathecal atrium discharged directly into the coelomic sac, would produce a complex female-spermathecal system similar to that present in species of *Hyperiodrilus* and *Legonea* which also includes a small oviducal diverticulum of unknown function (Sims, 1964).

Subfamily **EUDRILINAE**

Hyperiodrilus africanus Beddard, 1891

Hyperiodrilus africanus Beddard, 1891, *Quart. J. micr. Sci., n. set.*, **32**.236.—Lagos.

Bungalow garden, Agricultural Experimental Station, Yundum, 25 Sept. 1964; 4 clitellate, 6 aclitellate specimens.

Nursery plots, Forestry Department, Agricultural Experimental Station, Yundum, 28 Sept. 1964; 26 clitellate, 42 aclitellate specimens.

Plantation, Nyambai Forest Reserve, 23 Sept. 1964; 11 clitellate, 7 aclitellate specimens.

Grass banks, edge of reservoir, Abuko, 27 Sept. 1964; 13 clitellate, 8 aciitellate specimens.

Sandy soil forming bank to stream flowing from reservoir, Abuko, 27 Sept. 1964; 3 clitellate, 1 aclitellate specimen.

Edge of rice field, Abuko, 27 Sept. 1964; 4 clitellate, 13 aclitellate specimens.

Under Rheum palms, edge of rice field, near Bakau, 10 Oct. 1964; 12 clitellate, 15 aclitellate specimens.

Edge of rice fields, Brikama, 25 Oct. 1964; 9 clitellat: specimens.

REMARKS. New record for Gambia.

APPENDIX

Monsieur R. Roy, Département de Zoologie Invertébrés Terrestres, Institut Fondamental d'Afrique Noire, Université de Dakar, kindly sent me a small collection of earthworms from Senegal which are listed below. I am most grateful for the opportunity of examining the specimens particularly as I have been unable to find any reference to a previous collection of earthworms from that country.

Family **ACANTHODRILIDAE**

Subfamily **OCTOCHAETINAE**

Benhamia sp.

Mission I.F.A.N., Parc National du Niokolo-Koba. Aug.–Sept. 1955; 4 aclitellate specimens.

REMARKS. All of the specimens are juveniles, their prostatic glands and penial setae are hardly discernible. Due to their extreme youth specific identification is not possible. There is a wide range of variation present among the specimens from which I conclude that the series consists of more than one species.

Family **EUDRILIDAE**

Subfamily **EUDRILINAE**

Hyperiodrilus africanus Beddard, 1891

Hyperiodrilus africanus Beddard, 1891, *Quart. J. micr. Sci.*, n.ser. **32** : 236.—Lagos.

Villa garden, Dakar, Apl. 1966; 8 clitellate, 3 aclitellate specimens.

REMARKS. This series provides the first record of this species in Senegal and further extends the northern limit of the known range of *H. africanus*. The species is distributed throughout the coastal regions of western Africa from Senegal southwards to the Congo where it has also been recorded from inland localities.

Family **LUMBRICIDAE**

Bimastos sp.

Villa garden, Dakar, Apl. 1966; 1 clitellate specimen.

NOTES. The setae are closely paired and the paired male pores on segment *xv* are surrounded by a swollen area which overlaps onto the adjacent segments, *xiv* and *xvi*; additional internal characters observed permit the specimen to be placed in the genus *Bimastos* (Omodeo, 1956 : 178). The condition of the prostomium is epilobic. Tuberculae pubertates are absent but certain specific identification is impossible due to damage to the anterior region of the clitellum. It seems, however, that the clitellum extends over segments *xxiv* to *xxviii* ventrally and segments *xxiii* to *xxix* dorsally. Although the evidence is slender, it is possible that the specimen represents the species *parvus* (Eisen).

REMARKS. The genus *Bimastos* has a fairly restricted range in Europe and does not extend to Africa (Omodeo, 1956). As this single specimen was collected in a town garden, it seems likely that the genus has been introduced into the Dakar region.

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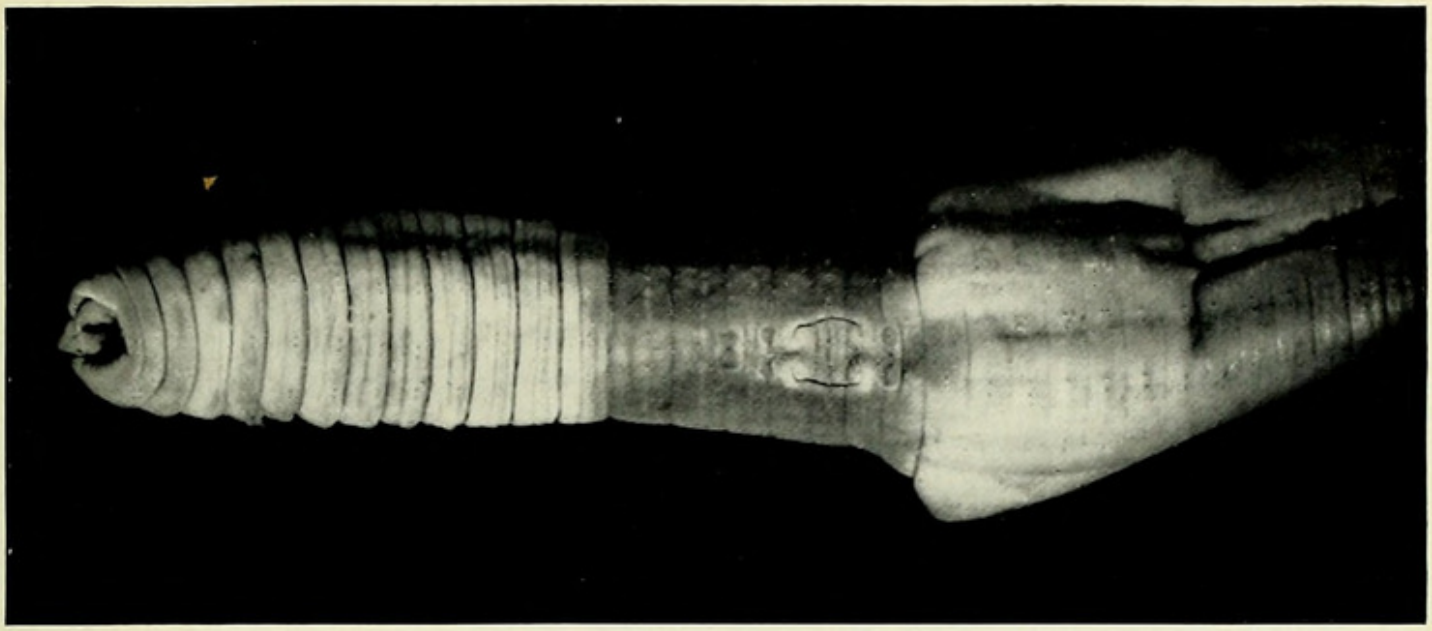
PLATES 1–3

1. *Benhamia budgetti* Beddard. Anterior region (ventral view) of the surviving whole syntype.

2. *Benhamia budgetti* species-group. Anterior region (ventral view) of a specimen with some *michaelseni*-like attributes.

3. *Benhamia mandinka* sp. nov. Anterior region (ventral view).



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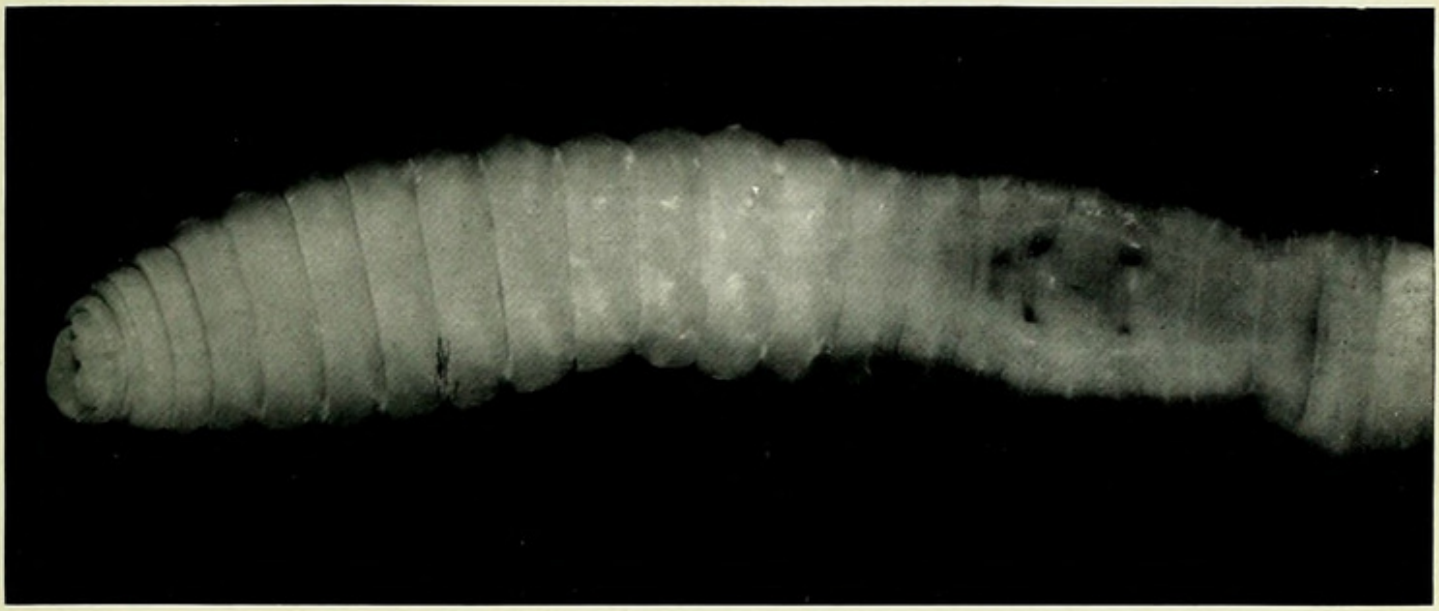

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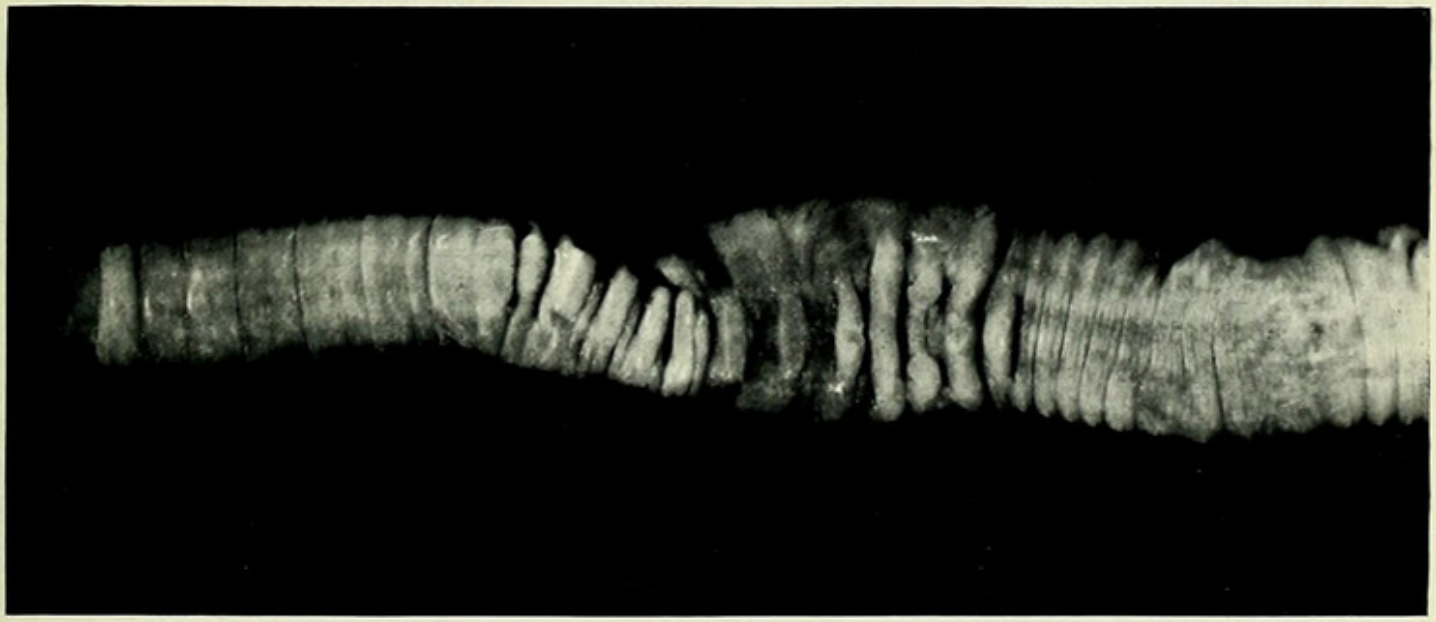

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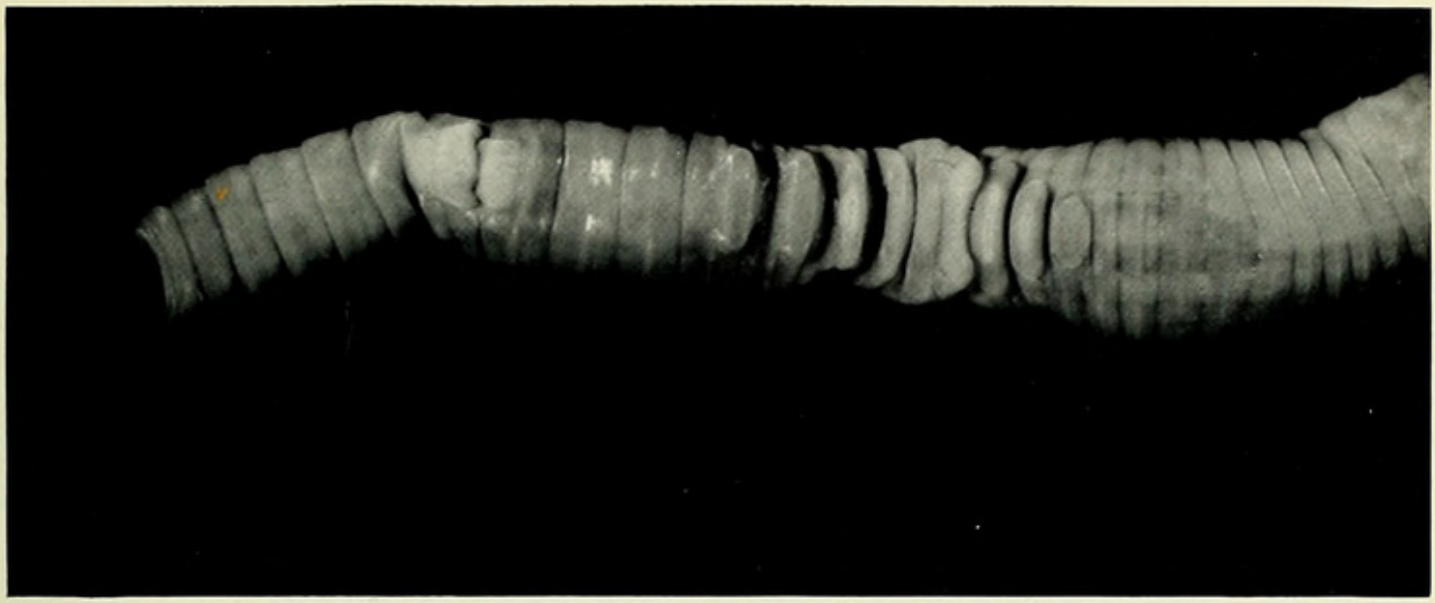
PLATES 4–6

4. *Benhamia fula* sp. nov. Anterior region (ventral view).

5. *Benhamia reducta* sp. nov. Anterior region (ventral view).

6. *Dichogaster ehrhardti* (Mich.). Anterior region (ventral view).



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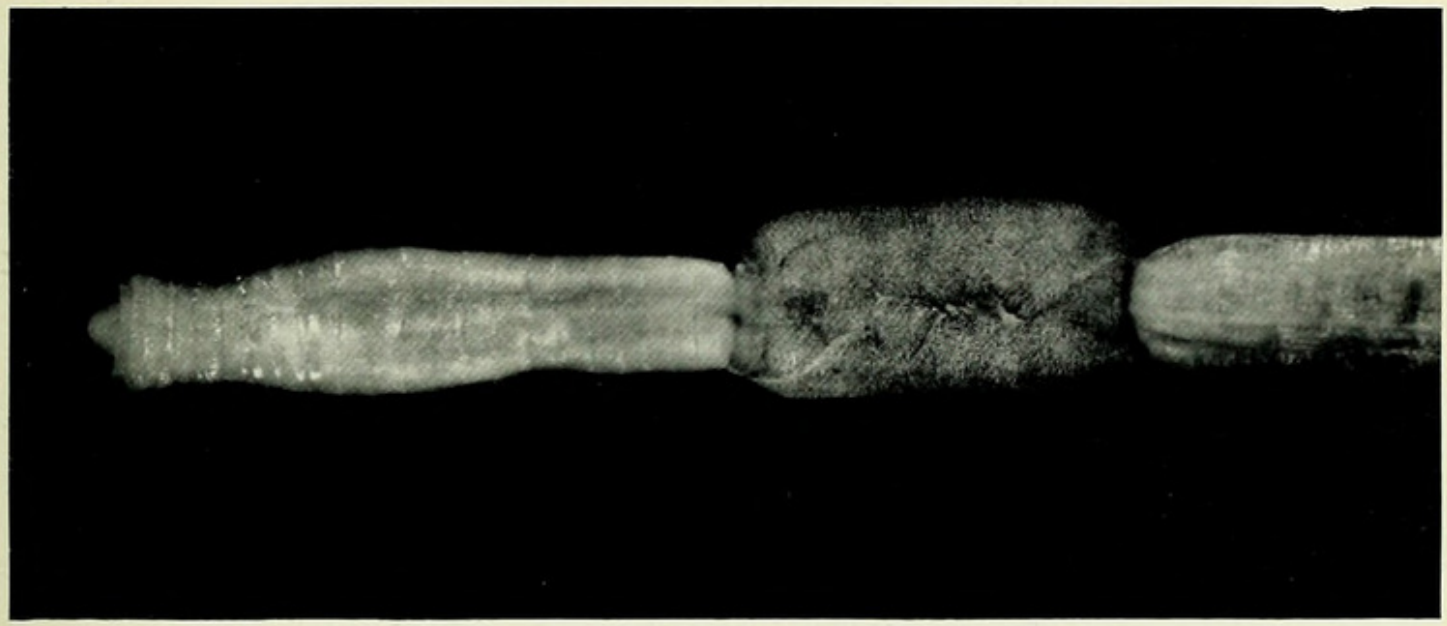

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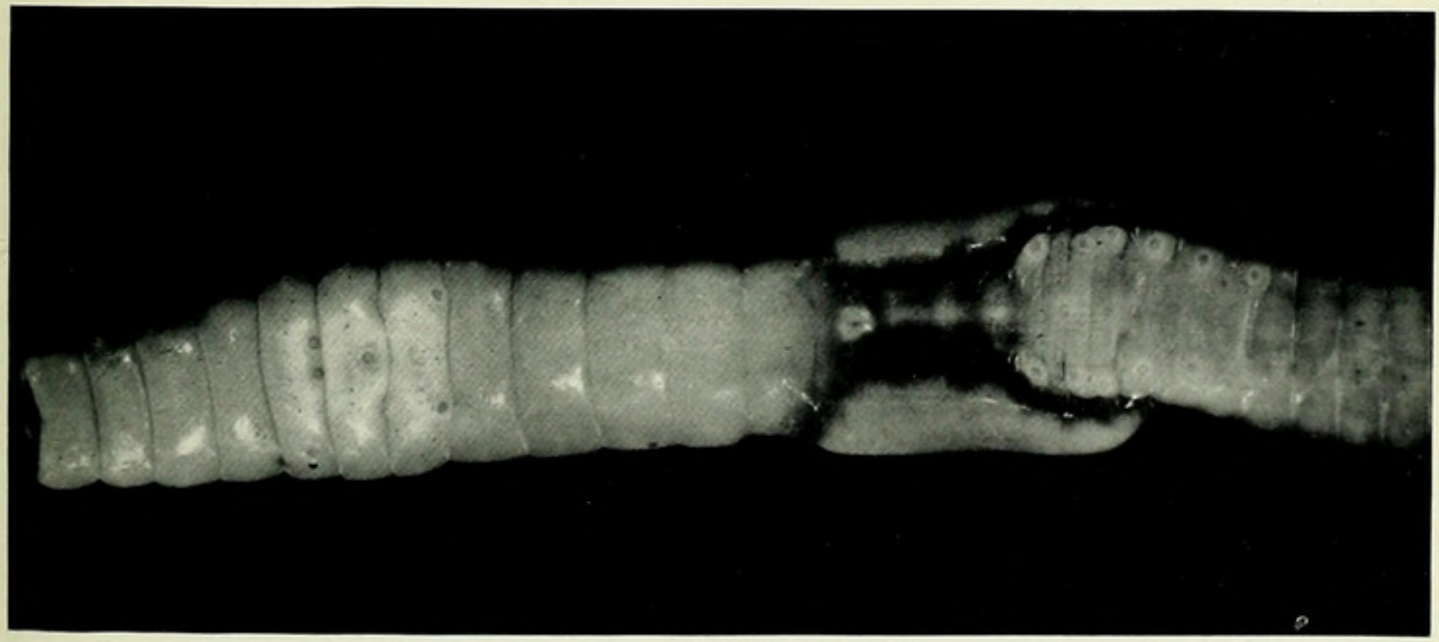

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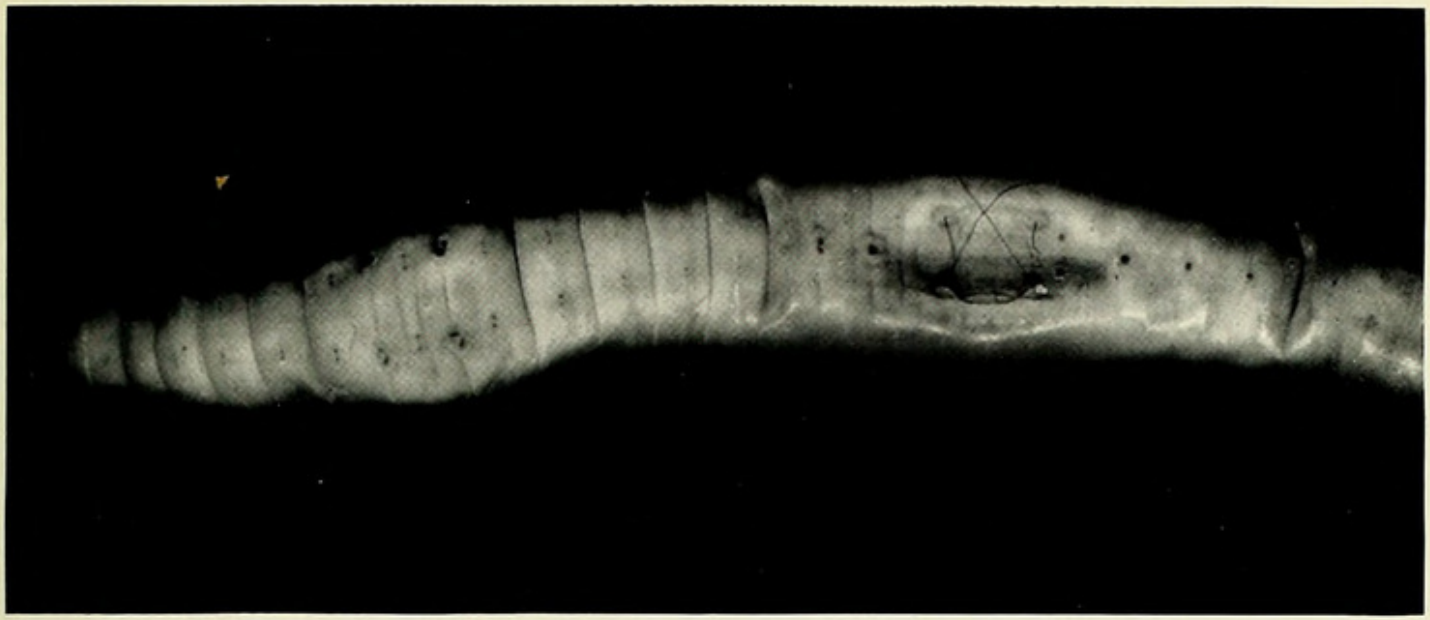
PLATES 7–9

7. *Dichogaster titillata* sp. nov. Anterior region (ventral view).

8. *Omodeona proboscoides* gen. et sp. nov. Anterior region (ventral view).

9. *Chuniodrilus fragilis* sp. nov. Anterior region (ventral view).



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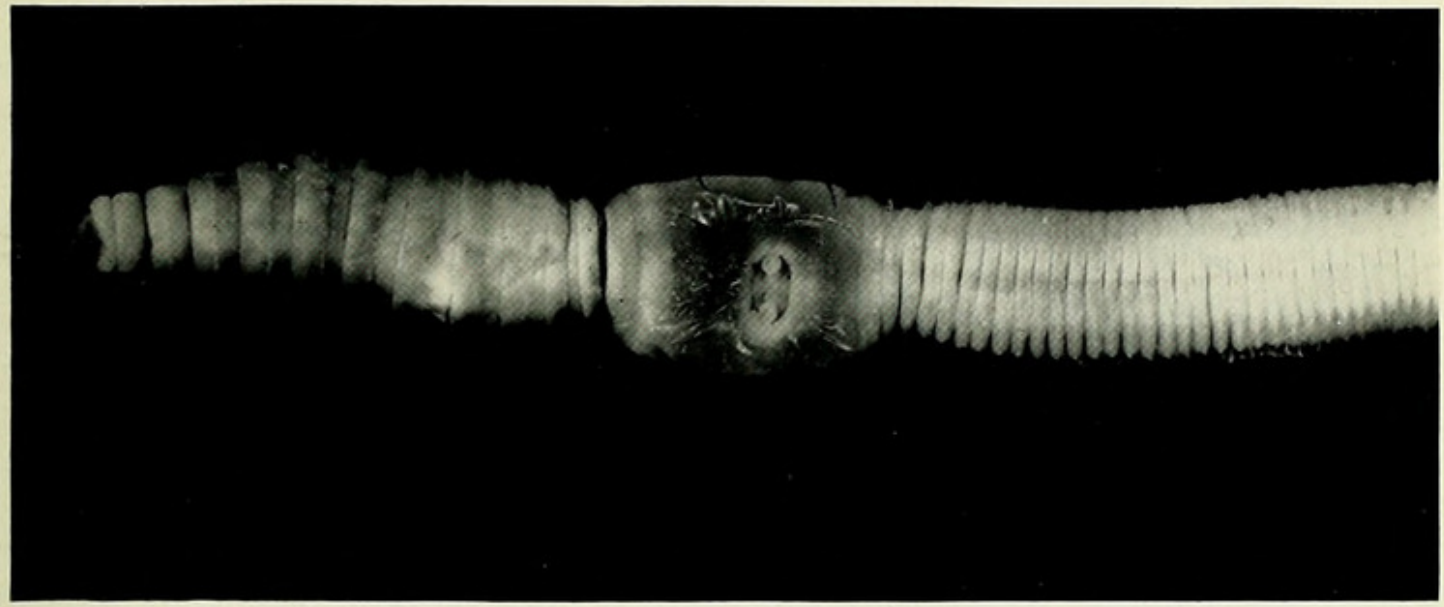

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