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v.12 (1902-1904): <http://www.biodiversitylibrary.org/item/87223>

Article/Chapter Title: Freelifving fresh water New Zealand nematodes

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Subject(s): Nematodes

Page(s): Page 363, Page 364, Page 365, Page 366, Page 367, Page 368, Page 369, Page 370, Page 371, Page 372, Page 373, Page 374

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Free-living fresh-water New Zealand Nematodes. By N. A. COBB, with note by K. LUCAS, B.A., Trinity College. (Communicated by Mr A. E. SHIPLEY.)

[Read 1 February 1904.]

The Nematodes whose descriptions follow are of some little interest in the following particulars.

In view of the few species at present known from New Zealand it is of interest to see that all the present ones belong to well known genera, and that as species they present no remarkable variations from the normal types of their respective groups. This leads us a step further towards the belief that many of the Nematode genera living free in the soil and in water will be found to have a very wide geographical distribution. This is precisely what was to be expected from what we know of the life histories in a number of these genera. The small size of the individuals, their fecundity, their adaptability to transportation by a great variety of agencies, and their resistance to desiccation, at least in certain stages of their existence, are all in favour of wide distribution.

The depths from which some of the present specimens were dredged throws an interesting light on the fauna of such depths. There have been comparatively few Nematodes taken in fresh water from such depths. That all the species thus taken should belong, in the present instance, to known genera and be closely related to known species indicates that even very considerable changes of environment effect small changes in the form of these worms.

That all the species here presented are for the most part of large size may be an idiosyncrasy of the collector, an effect of the apparatus used, or a mere coincidence, and hence little weight can be attached to the fact.

So far as I can see the species resemble most closely other austral species, though some of them are certainly closely like those of Europe. The *Mononchus rex* finds its closest known relative in Fiji, while the *Dorylaimi* are most closely related to Australian species.

The fact that the two species of *Dorylaimus* dredged from New Zealand lakes should belong one to the North Island and the other to the South Island may be indicative of variation from a common stock, especially as the species appear to be closely related. The localities from which the two species are derived are six to eight hundred miles apart on a north and south line, and hence the differences in climate are considerable.

There is no clue to the host of the species of *Mermis*. The discovery of a species of *Mermis* at such a depth living free in fresh water is rather interesting.

Otherwise than in these few small points these descriptions appear to add nothing of particular value to our knowledge of the Nematode group.

Formula used in the descriptions.

Fig. 1 illustrates the formula used in the text to express the necessary measurements. The formula derived from the

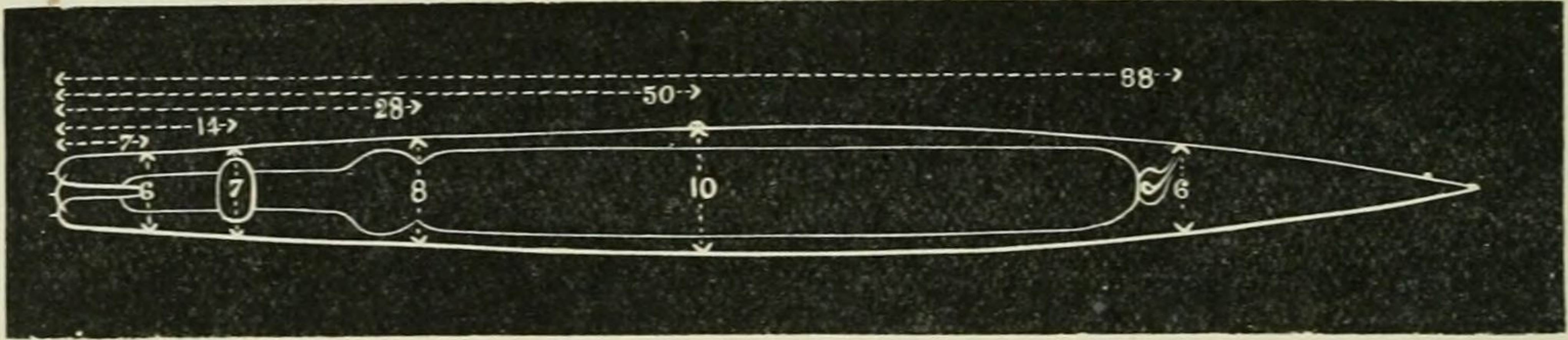


FIG. 1. Diagram in explanation of the descriptive formula used for Nematode worms. 6, 7, 8, 10, 6 are the transverse measurements, while 7, 14, 28, 50, 88 are the corresponding longitudinal measurements. The formula in this case is:—

$$\frac{7 \cdot 14 \cdot 28 \cdot 50 \cdot 88}{6 \cdot 7 \cdot 8 \cdot 10 \cdot 6}$$

The unit of measurement is the hundredth part of the length of the worm, whatever that may be. The measurements become, therefore, percentages of the length.

The measurements are taken with the animal viewed in profile; the first is taken at the base of the pharynx, the second at the nerve-ring, the third at the cardiac constriction (base of the "neck"), the fourth at the vulva in females and at the middle (M) in males, the fifth at the anus.

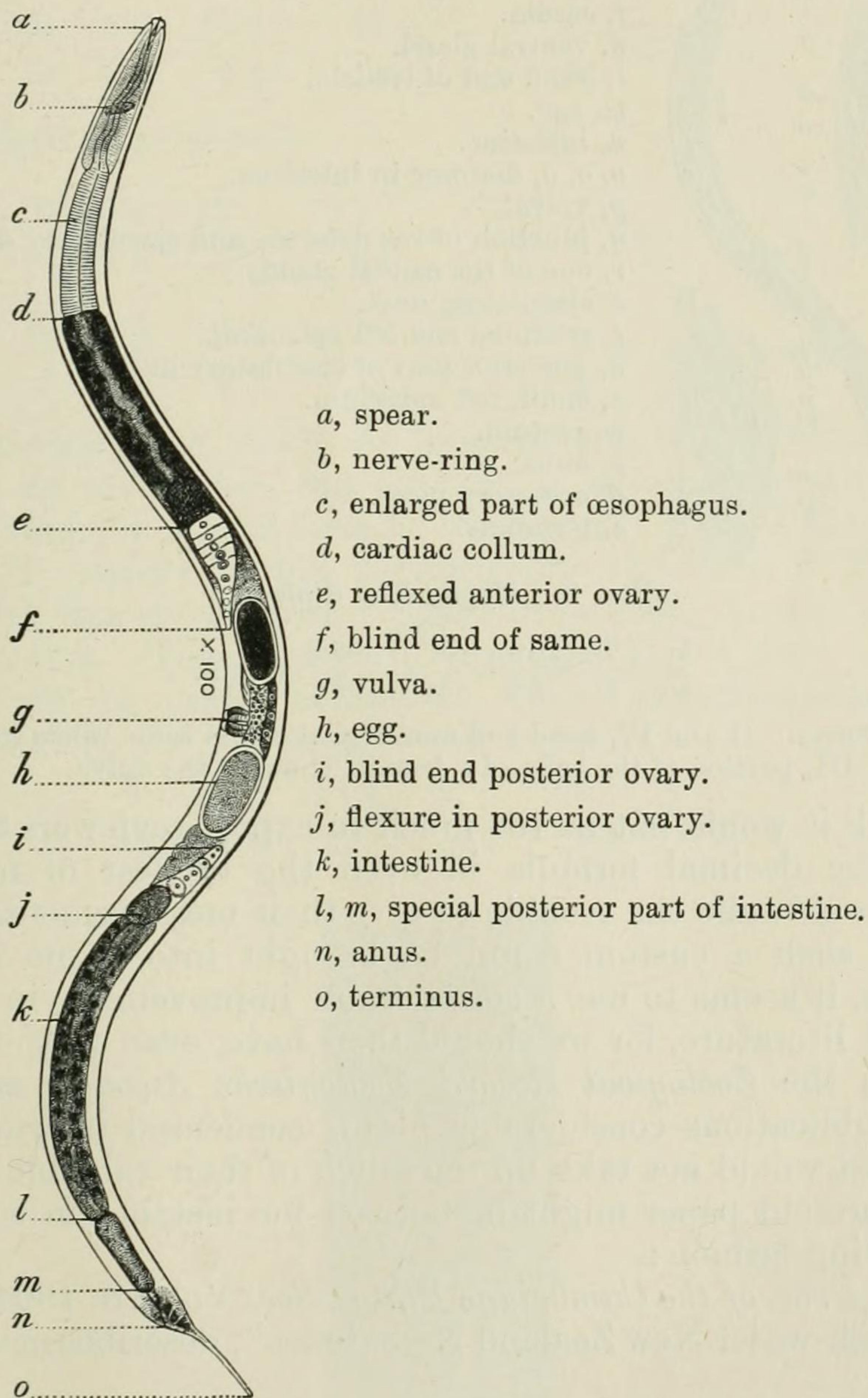
diagram is however capable of considerable amplification, for by simple modifications the fourth term above the line can be made to express both the size and form of the internal sexual organs. Thus, letting — (a dash) represent an outstretched, and ' (an apostrophe or quotation mark) a reflexed or contorted, ovary or testicle, we have in the case of a male:—

- M for a simple outstretched apparatus extending forward.
- = M for a double outstretched apparatus extending forward.
- M — for outstretched testicles extending in opposite directions.
- ' — M for two testicles extending forward, one of them reflexed.

"M for two testicles extending forward, both reflexed, or contorted. Similarly in the case of a female, in which for the sake of illustration we will place the vulva at 66 per cent. of the length from the head:—

- ' 66 ' for two reflexed ovaries extending in opposite directions.
- " 66 for two reflexed ovaries extending forward.
- 66 — for two ovaries outstretched in opposite directions.
- ' 66 for a single reflexed ovary extending forward.
- 66 for a single outstretched ovary extending forward.
- 66 — for a single outstretched ovary extending backward.
- 66 ' for a single reflexed ovary extending backward.

Furthermore by adding an exponent to the fourth term we may indicate roughly the size of the organs. Thus $-66-^{33}$ indicates a female having the vulva located 66 per cent. of the length from the head end, and whose uteri and ovaries are outstretched and occupy 33 per cent. of the length of the body. Again $-M-^{33}$ indicates a male with straight testicles extending in opposite directions, and whose internal sexual apparatus extends forward from the anus a distance equal to 33 per cent. of the length of the body.

FIG. 2. *Dorylaimus Bastiani*.

·4	6·	20·	·50·	·32	93·	
·9	2·6	3·7	3·9	1·5	1·3 mm.	

The annexed illustrations of some known species together with their formulae will serve to make the application of this decimal system perfectly clear. (Figs. 2 and 3.)

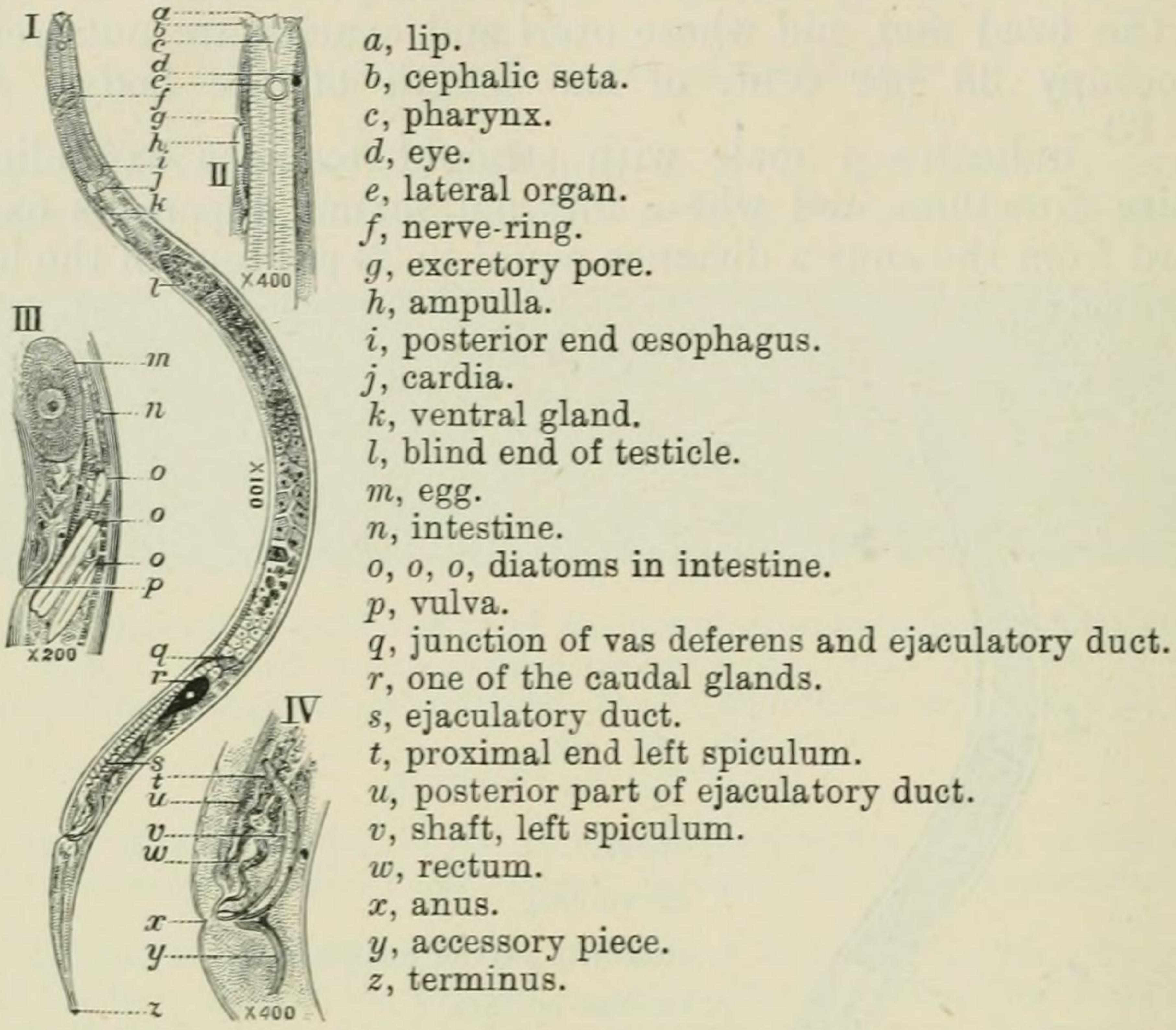


FIG. 3. *Monhystera diplops*.

1·	7·	15·	— M ⁵⁰	85·3	
1·8	3·	3·3	4·	3·	·8 mm.

I, male worm. II and IV, head and anal region of the same worm more highly magnified. III, portion of the body of a female, showing the vulva.

I think it would not be too much to expect reviewers to always include the decimal formula in even the briefest of notices if authors would take the trouble to give their measurements in that form. If such a custom could be brought into vogue it would constitute, it seems to me, a considerable improvement in helminthological literature, for we should then have, even in the briefest notices in the *Zoological Record*, *Zoologische Anzeiger* and other similar publications considerable highly condensed information in a form that would not take up too much of their valuable space.

The present paper might be noticed for instance in somewhat the following fashion:—

Cobb, *Proc. of the Cambridge Philos. Soc.*, Vol. XII. 1904, "Free-living Fresh-water New Zealand Nematodes"; describes new species as follows:—

Mermis Novae Zealandiae

·0	1·7	4·7	·48· ²⁶	?	
·1	·4	·6	·7	?	28· to 38· mm.

Mononchus rex

2·	6·	20·	·58· ²⁷	81·	6·5 to 7· mm.,
1·6	1·7	2·	2·2	1·4	

2·	5·5	20·	M ⁵⁰	85·5	6·5 to 7· mm.
1·5	1·9	2·1	2·3	1·5	

Dorylaimus Novae Zealandiae

·0	5·5	20·	·45·	95·	6·7 mm.,
·5	1·6	2·5	2·8	·8	

·0	5·3	21·8	— M — ²⁷	99·2	6·36 mm.
·4	1·4	2·1	2·3	·8	

Dorylaimus profundis

·0	5·9	22·	·50· ³⁴	98·2	7· mm.,
·5	1·8	2·3	2·8	1·	

·0	6·4	23·6	— M — ²⁴	99·	6· to 6·3 mm.
·5	2·1	2·7	3·	1·1	

The sketch from which the formula is to be derived may be as complete as one wishes, but all that is necessary is a very rudimentary skeleton of the form of the worm. Draw a line with the aid of the camera lucida representing the axis of the worm. Across this line at the proper places draw cross lines representing the diameters. The result will resemble Fig. 4 from which the formula can be easily computed. The measurements of the skeleton shown in Fig. 4 give the formula

2·	9·3	17·4	45·5	93·	·78 mm.
2·8	4·2	5·9	8·6	3·6	

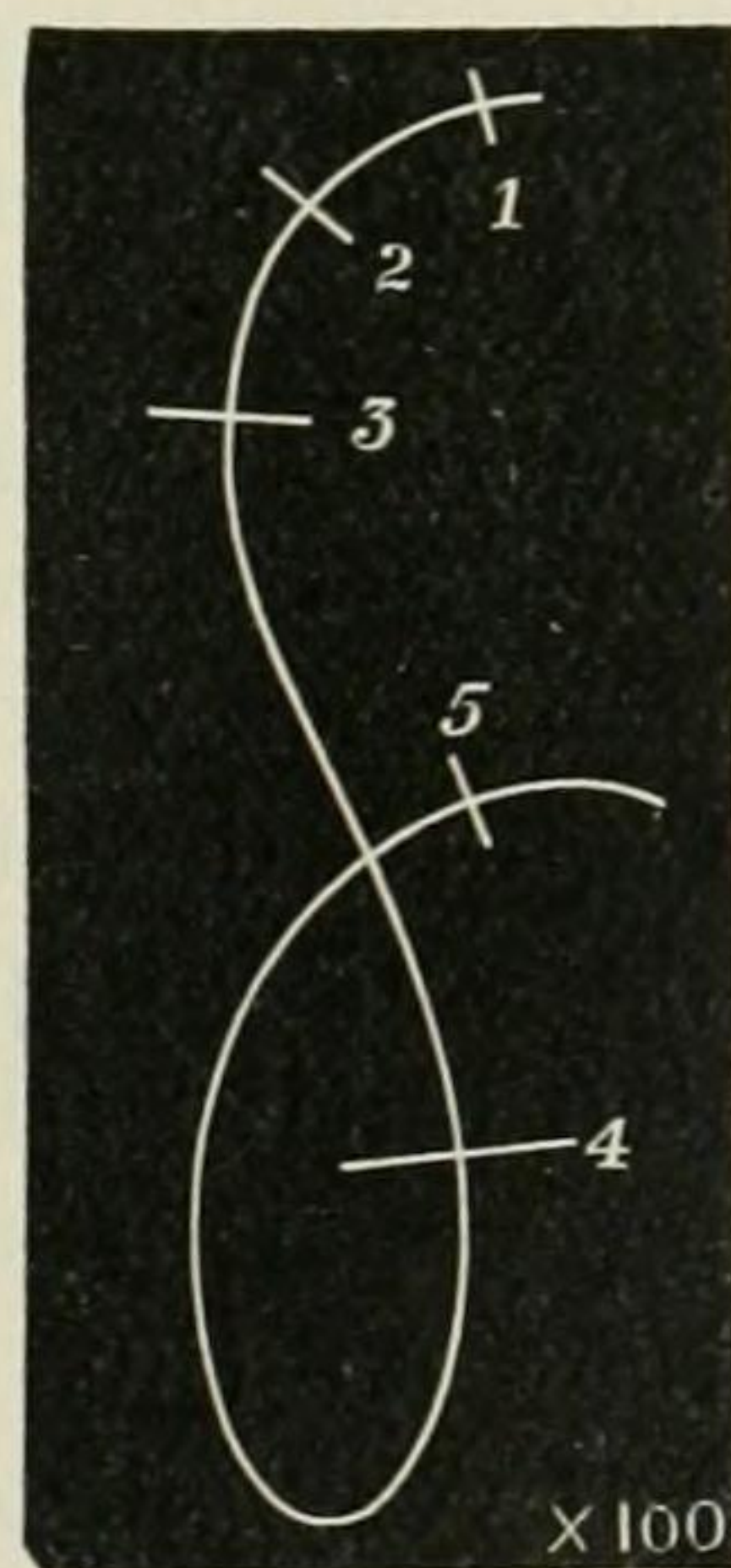


FIG. 4. Skeleton camera lucida drawing from which to compute the nematode formula.

If one possesses and uses a slide rule or other calculating machine the labour of producing the formula from such a skeleton is much reduced. I estimate that in most cases by the above method the formula may be derived from a specimen in about five minutes, provided there is a clear perception beforehand of what is to be done.

Where the worm is of large size, too large for measurement under the microscope, the camera lucida may be mounted on a lens holder without any lens, in which case the worm may be drawn natural size or even be reduced.

The rules etched upon glass so that the scale can be laid in contact with the paper, thus doing away with parallax, are very convenient for use in measuring the skeleton drawings.

Mermis Novae Zealandiae, n. sp.

$$\begin{array}{cccccc} \cdot 0 & 1\cdot 7 & 4\cdot 7 ? & \cdot 48\cdot^{26} & ? & \\ \hline \cdot 1 & \cdot 4 & \cdot 6 & \cdot 7 & ? & 28\cdot \text{ to } 38\cdot \text{ mm.} \end{array}$$

is the best formula derivable from the half dozen specimens examined, only one of which was beyond question adult. The thin, smooth, whitish, translucent skin is destitute of hairs and striae, and it would appear that the musculature is weak. The body is threadlike and uniform in diameter, and ends anteriorly in a neck which in its anterior half is slightly convex-conoid. The head end is truncate, apparently without papillae, and certainly without setae, lips, lateral organs and eyes. There is no proper pharynx, the pore-like mouth opening being continued in the oesophagus as a tube of the same diameter. The cylindrical oesophagus is two-fifths as wide as the neck and in all the specimens is somewhat indefinite, though the length given in the formula is believed to be at least approximately correct. The intestine was plainly visible in most parts of the body but was manifestly becoming obsolete. No anus was to be seen. The posterior extremity for a distance equal to two to three body widths was more transparent owing to the absence of intestine. No ventral gland was seen.

The nerve ring was not very satisfactorily located but the measurement given in the formula is probably fairly correct.

The tail is rather suddenly convex-conoid at the somewhat blunt terminus, and it is quite destitute of hairs or papillae. There are no caudal glands and no spinnerets. The body continues to have its usual width until within a short distance of the tail end, the tapering taking place in a distance no greater than two to three times as great as the width of the body. The inconspicuous vulva is located very slightly in front of the middle of the body. There are two uteri, extending in opposite directions. In the only gravid female seen they contained towards

one thousand somewhat spherical eggs, measuring 50 to 60 micromillimetres in their greatest diameter, each egg being therefore one-fifth as wide as the body.

No males were found in the collection.

Habitat, Lakes Taupo and Waikaremoana, New Zealand, at a depth of 370 to 840 feet.

Mononchus rex, n. sp.

2·	6·	20·	58· ²⁷	81·	6·5 to 7· mm.
1·6	1·7	2·	2·2	1·4	

is the formula of an adult female. The skin is without hairs and there are no striae to be seen with moderate powers. As usual the neck is cylindroid and ends in a head destitute of setae, though there are papillae. These latter are low, broad and inconspicuous. While the lips do not project, the region is elevated enough to give the front of the head a rounded appearance. The lips are bulky and powerful, being one-third as thick as the pharynx is wide. There are no eyes, and no lateral organs were seen.

The pharynx is armed with very powerful muscles that can be easily seen passing from the lips to the region near the anterior end of the oesophagus. The teeth are less well developed than in some other species of the genus. There is a dorsal tooth, small in comparison with the size of the pharynx, and reaching not more than one-third the way to the lips. There are also ventrally sub-median teeth located opposite the dorsal tooth, but they are smaller, and one of them is seen only with difficulty in the specimens before me.

The oesophagus is cylindroid and is surrounded rather squarely by the nerve ring, which, as is usual in this genus, is situated well forward.

The intestine is dark in colour and is about one-half as wide as the body, the cells showing a tessellated arrangement of their contents. The rectum is shorter than the body diameter. No ventral gland or *porus excretorius* was seen.

The lateral fields are one-fifth as wide as the body.

The conoid tail tapers more rapidly at first, being nearly cylindroid in the posterior two-thirds. The terminus is slightly expanded, the usual spinneret being accompanied by two ventrally sub-median papillae after the manner of the species *longicaudatus*, except that here the papillae are slightly larger in proportion. Three caudal glands are present.

Two uteri lead from the inconspicuous vulva, one forward and the other backward. Each uterus is capable of carrying a single egg at a time, or possibly two. The eggs are nearly a fourth of a

millimetre long, and are half as wide as long. The ovaries are reflexed.

2·	5·5	20·	M ⁵⁰	85·5	6·5 to 7· mm.
1·5	1·9	2·1	2·3	1·5	

The tail of the male is shaped like that of his mate. In front of the anus it is armed with a ventral row of seventeen prominent papillae, extending forward from the anus a distance equal to half the length of the tail. There is no bursa. The spicula were not plainly seen, but are believed to be of the form usual to the genus. They are about twice as long as the anal body diameter.

Habitat, Lakes Manapouri and Wakatipu, New Zealand, at depths of 200 to 1150 feet. The species is a near ally of the writer's *M. gymnolaimus*, of Fiji.

Dorylaimus Novae Zealandiae, n. sp.

·0	5·5	20·	'45·2'	95·	6·7 mm.
·5	1·6	2·5	2·8	·8	

is the formula of a somewhat immature female, the largest seen. The smooth yellowish skin is destitute of transverse markings so far as can be seen with moderately high powers. Longitudinal markings (internal), due to the muscles, are plainly to be seen. The skin, especially near the head, is innervated, but the nature of the connected external organs was not made out; there are however no setae anywhere on the body. Very likely the innervations indicate the presence of sensory papillae.

The conoid neck becomes a trifle convex-conoid at the head end, where it is simply truncate, the lip region being neither contracted nor expanded. There appear to be six very inconspicuous lips each bearing a single minute papilla. The width of the head may be gauged by the fact that the lip region is about twice as wide as the spear. It seems that lateral organs are present in the shape of U-shaped markings immediately behind the lips and opening backwards. The spear is of the usual form and slides in a ring located a short distance behind the lips.

The œsophagus is of the form typical for the genus, being however simply conoid in form, enlarging gradually from two-fifths as wide as the corresponding part of the neck in front, to three-fifths as wide as the corresponding part of the neck behind. The lining is rather conspicuous in the posterior part. The œsophagus is set off from the intestine by a shallow but distinct constriction.

The dark coloured intestine is one-half to three-fifths as wide as the body. The cardia is inconspicuous and the cardiac cavity is nearly obsolete.

The rectum and pre-rectum vary in the two sexes, being longer

in the male. In the female the rectum is one and one-half times to two times as long as the anal body-diameter, while the pre-rectum is nearly or quite three times as long as the rectum. In the male the pre-rectum is about three-fourths as long as the neck. Numerous glands are to be seen in the neighbourhood of the anus, especially in the male.

The lateral fields are about one-fifth as wide as the body.

The inconspicuous nerve-ring surrounds the œsophagus rather squarely.

The tail of the female is concave-conoid in the anterior half and setaceous in the posterior half, where it ends in an acute terminus, destitute of opening or spinneret. The tail of the male is obtusely conoid, and bears, near its extremity, at least two slightly lateral papillae. The posterior extremity of the male is invariably incurved. The anal region is not raised or made conspicuous by any special external markings or structures.

From the large depressed vulva the vagina leads half-way across the body where it branches into two symmetrical uteri extending in opposite directions so as to occupy the middle third of the body. Each ovary is reflexed and reaches about two-fifths the way back to the vulva. As only immature females were seen nothing is known about the eggs.

$$\begin{array}{rccccccc} \cdot 0 & 5\cdot 3 & 21\cdot 8 & - M - & ^{27} & 99\cdot 2 & \\ \hline \cdot 4 & 1\cdot 4 & 2\cdot 1 & & 2\cdot 3 & \cdot 8 & 6\cdot 36 \text{ mm.} \end{array}$$

is the formula of an adult male.

External tactile supplementary sexual organs are present on the males in the form of a row of ventral papillae arranged in close juxtaposition. Taking the adjacent body-diameter as a measuring unit, this row of papillae begins three measures from the anus and extends two measures forwards. Each papilla is innervated, and the total number is twenty-nine, the anterior one being somewhat the largest. These papillae are most plainly to be seen when the body is strongly incurved. There is no bursa. The immediate region of the anus was not supplied with any conspicuous papillae.

The two equal, plain, linear, arcuate, somewhat pointed spicula were of the form usual to the genus and measured two and one-half times as long as the anal body-diameter. Accessory pieces were present. Powerful oblique copulatory muscles occupied part of the space opposite the row of papillae. The two testicles were straight and extended in opposite directions from a point a little in front of the middle of the body, where they occupied a space over one-quarter as long as the body.

The species is a typical *Dorylaimus* of large size.

Habitat, Lake Taupo, New Zealand, at a depth of 350 feet.

Dorylaimus profundis, n. sp.

·0	5·9	22·	·50· ³⁴	98·2	7· mm.
·5	1·8	2·3	2·8	1·	

is the formula of a female that, though having the appearance of being full grown, had not yet produced eggs. The structure of the skin was entirely typical, and so closely resembled that of *Novae Zealandiae* that the same description would apply to both, and it may be here remarked that in spite of the marked differences pointed out later on, the two species resemble each other outwardly in a marked degree.

The conoid neck becomes convex-conoid at the head end, where there is a distinct lip region, which though presenting the same contour as that of *Novae Zealandiae* is of quite a different character. In speaking of *Dorylaimus latus* in Vol. VI. (1891) of the *Proceedings of the Linnaean Society of N. S. W.* I described the manner in which the lip region of that species can be protruded, and gave a figure of the protruded condition of the lips. It seems that the head of *D. profundis* has a similar structure. In the present case I have not seen the lips protruded, but the chitin at the head presents that infolding characteristic of the head of *latus* and some other species. This structure of the head together with differences in the structure of the posterior extremity enable one to distinguish readily between the two species *Novae Zealandiae* and *profundis*.

As usual there are six obscure lips each bearing a single almost invisible papilla.

There is nothing striking about the structure of the pharynx, the stout spear sliding in a ring located behind the infolded lips at a distance one and one-half times as great as the width of the head.

The œsophagus is simply conoid, being anteriorly one-third and posteriorly one-half as wide as the corresponding part of the neck. The lining is plainly to be seen in the posterior part. The œsophagus is set off from the intestine by a prominent constriction.

The dark coloured intestine is one-half as wide as the body and is composed of cells presenting a tessellated arrangement. In the female the pre-rectum is one-third to one-half as long as the neck, while in the male it is much longer, namely somewhat longer than the neck.

There seems to be no gland emptying ventrally as in many Nematode genera, but certain organs, apparently glandular, are to be seen in the neck region and these probably debouch laterally.

The lateral fields are one-third to one-fourth as wide as the body. The nerve-ring encircles the œsophagus rather squarely.

The tail of the female is concave-conoid to a rather blunt point, while that of the male is conical to a rounded terminus, where a few innervated papillae are to be seen. The anus is neither raised nor depressed, and though easily to be discovered is not rendered conspicuous by any accessory apparatus in its immediate vicinity.

The vulva is depressed, and from it the vagina extends half way across the body, where it divides into two uteri, one extending forward and the other extending backward. These, together with the reflexed ovaries, occupy the middle third of the body. No eggs or young were seen.

$$\begin{array}{ccccccc} \cdot 0 & 6\cdot 4 & 23\cdot 6 & - M - & 24 & 99\cdot & \\ \hline \cdot 5 & 2\cdot 1 & 2\cdot 7 & 3\cdot & & 1\cdot 1 & 6\cdot \text{ to } 6\cdot 33 \text{ mm.} \end{array}$$

A row of ventral tactile papillae, numbering thirty-five to forty-two, is found some distance in front of the anus on the male. Reckoning from the anus these occupy the second fourth of the pre-rectal region. These papillae are plainly to be seen only when the body is strongly incurved, and then only as doubly innervated, low and inconspicuous contiguous elevations.

The two equal arcuate spicula are two and one-half to three times as long as the anal body-diameter, and are of the nature characteristic of most of the species of the genus. Powerful oblique copulatory muscles exist in the pre-rectal region.

The species is a typical *Dorylaimus* of large size, readily distinguished from *Novae Zealandiae* by the structure of the head, the shortness of the female tail and the number of the male accessory papillae.

Habitat, Lakes Wakatipu, Waikaremoana, and Manapouri, New Zealand, at a depth of 200 to 1100 feet.

Register of the Species, Localities and Depths.

	Depth in feet.	
Lake Taupo,	350	<i>Dorylaimus Novae Zealandiae</i> .
" "	350	" "
" "	370	<i>Mermis Novae Zealandiae</i> .
Lake Waikaremoana,	840	" "
" "	300—600	<i>Dorylaimus profundis</i> .
Lake Manapouri,	200—600	<i>Dorylaimus profundis</i> and <i>Mononchus rex</i> .
" "	360	<i>Dorylaimus profundis</i> .
Lake Wakatipu	500—1100	" "
" "	200—300	<i>Dorylaimus profundis</i> and <i>Mononchus rex</i> .
" "	1150	<i>Dorylaimus profundis</i> and <i>Mononchus rex</i> .

NOTE. At the Author's request I add a note on the dates of collection of the Nematodes described above. They were collected during 1902, as follows:—

Lake Taupo, during May and June.

Lake Waikaremoana, August and September.

Lake Wakatipu, October and November.

Lake Manapouri, November and December.

Lakes Waikare, examined during April, and Rotoiti, during July, yielded no specimens. K. LUCAS.

The following text is generated from uncorrected OCR.

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M)' Cobb, On fresh-water Neiu Zealand Nematodes. 363

Free-living fresh-tuater Neiv Zealand Nematodes. By N. A. Cobb, with note by K. Lucas, B.A., Trinity College. (Communicated by Mr A. E. Shipley.)

[Read 1 February 1904.]

The Nematodes whose descriptions follow are of some little interest in the following particulars.

In view of the few species at present known from New Zealand it is of interest to see that all the present ones belong to well known genera, and that as species they present no remarkable variations from the normal types of their respective groups. This leads us a step further towards the belief that many of the Nematode genera living free in the soil and in water wall be found to have a very wide geographical distribution. This is precisely what was to be expected from what we know of the life histories in a number of these genera. The small size of the individuals, their fecundity, their adaptability to transportation by a great variety of agencies, and their resistance to desiccation, at least in certain stages of their existence, are all in favour of wide distribution.

The depths from which some of the present specimens were

dredged throws an interesting light on the fauna of such depths.

There have been comparatively few Nematodes taken in fresh water from such depths. That all the species thus taken should belong, in the present instance, to known genera and be closely related to known species indicates that even very considerable changes of environment effect small changes in the form of these worms.

That all the species here presented are for the most part of large size may be an idiosyncrasy of the collector, an effect of the apparatus used, or a mere coincidence, and hence little weight can be attached to the fact.

So far as I can see the species resemble most closely other austral species, though some of them are certainly closely like those of Europe. The *Mononchus rex* finds its closest known relative in Fiji, while the *Dorylaimi* are most closely related to Australian species.

The fact that the two species of *Dorylaimus* dredged from New Zealand lakes should belong one to the North Island and the other to the South Island may be indicative of variation from a common stock, especially as the species appear to be closely related. The localities from which the two species are derived are six to eight hundred miles apart on a north and south line, and hence the differences in climate are considerable.

There is no clue to the host of the species of *Mermis*. The

discovery of a species of Mermis at such a depth living free in fresh water is rather interesting.

24—2

[Begin Page: Page 364]

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Mr Cobb, On Free-living fresh-water

Otherwise than in these few small points these descriptions appear to add nothing of particular value to our knowledge of the Nematode group.

Formula used in the descriptions.

Fig. 1 illustrates the formula used in the text to express the necessary measurements. The formula derived from the

Fig. 1. Diagram in explanation of the descriptive formula used for Nematode worms. 6, 7, 8, 10, 6 are the transverse measurements, while 7, 14, 28, 50, 88 are the corresponding longitudinal measurements. The formula in this case is: —

7- 14- 28- 50- 88-

$6^1- 8^1- 10^1- 6^1$

The unit of measurement is the hundredth part of the length of the worm, whatever that may be. The measurements become, therefore, percentages of the

length.

The measurements are taken with the animal viewed in profile ; the first is taken at the base of the pharynx, the second at the nerve-ring, the third at the cardiac constriction (base of the "neck"), the fourth at the vulva in females and at the middle (M) in males, the fifth at the anus.

diagram is however capable of considerable amplification, for by simple modifications the fourth term above the line can be made to express both the size and form of the internal sexual organs. Thus, letting — (a dash) represent an outstretched, and ' (an apostrophe or quotation mark) a reflexed or contorted, ovary or testicle, we have in the case of a male : —

— M for a simple outstretched apparatus extending forward.

= M for a double outstretched apparatus extending forward.

— M — for outstretched testicles extending in opposite directions.

' — M for two testicles extending forward, one of them reflexed.

" M for two testicles extending forward, both reflexed, or

contorted. Similarly in the case of a female, in which for the sake of illustration we will place the vulva at 66 per cent, of the length from the head : —

' 66 ' for two reflexed ovaries extending in opposite directions.

" 66 for two reflexed ovaries extending forward.

— 66 — for two ovaries outstretched in opposite directions.

' 66 for a single reflexed ovary extending forward.

— 66 for a single outstretched ovary extending forward.

66 — for a single outstretched ovary extending backward.

66 ' for a single reflexed ovary extending backward.

[Begin Page: Page 365]

Neiu Zealand Nematodes.

365

Furthermore by adding an exponent to the fourth term we

33 .

may indicate roughly the size of the organs. Thus — 66 — indicates a female having the vulva located 66 per cent, of the length from the head end, and whose uteri and ovaries are outstretched and occupy 33 per cent, of the length of the body. Again

33 . .

— M — ' indicates a male with straight testicles extending in

opposite directions, and whose internal sexual apparatus extends forward from the anus a distance equal to 33 per cent, of the length

of the body.

, spear.

, nerve-ring.

, enlarged part of oesophagus.

, cardiac collum.

, reflexed anterior ovary.

blind end of same.

, vulva,

.egg.

blind end posterior ovary.

flexure in posterior ovary.

, intestine.

m, special posterior part of intestine.

, anus.

, terminus.

Fig. 2. Dorylaimus Bastiani.

20-

50

,32

93-

•9 2-6 3-7

3-y

1-5

1"3 mm.

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The annexed illustrations of some known species together with their formulae will serve to make the application of this decimal system perfectly clear. (Figs. 2 and 3.)

Ito §:;;;:=-SiL^ a, Up.

h, cephalic seta.

c, pharynx.

d, eye.

^ ^ ' ^ sfl e, lateral organ.

/, nerve-ring.

g, excretory pore.

^ i, posterior end oesophagus.

j, cardia.

k, ventral gland.

l, blind end of testicle,

m, egg.

n, intestine.

,,, 0, 0, 0, diatoms in intestine.

' ^ Ji. T " JM P' vulva.

. ^ W q, junction of vas deferens and ejaculatory duct,

r, one of the caudal glands.

• s, ejaculatory duct.

t, proximal end left spiculum.

u, posterior part of ejaculatory duct,

f, shaft, left spiculum.

w, rectum.

X, anus.

y, accessory piece.

\ z, terminus.

Fig. 3. Monhystera diplops.

1- 7- 15- -M[^] 8.5-3 ^

1-8 3- 3-3 4- 3[^] •"^^-

I, male worm. II and IV, head and anal region of the same worm more highly magnified. III, portion of the body of a female, showing the vulva.

I think it would not be too much to expect reviewers to always include the decimal formula in even the briefest of notices if authors would take the trouble to give their measurements in that form. If such a custom could be brought into vogue it would constitute, it seems to me, a considerable improvement in helminthological literature, for we should then have, even in the briefest notices in the Zoological Record, Zoologische Anzeiger and other similar publications considerable highly condensed information in a form that would not take up too much of their valuable space.

The present paper might be noticed for instance in somewhat the following fashion : —

Cobb, Proc. of the Cambridge Philos. Soc., Vol. xii. 1904, 'Free-

living Fresh- water New Zealand Nematodes"; describes new species

as follows : —

Mermis Novae Zealandiae

• 0 1-7 4-7 -48- '44 ? .^, _

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New Zealand Nematodes.

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lo 1-9 21 2-3

Dorylaimus Novae Zealandiae

• 0 5-5 20- '45-' 95-

1-5

6'5 to 7" mm.,

65 to 7* mm.

6'36 mm.

mm.

•5 21 27

11

6" to 6'3 mm.

The sketch from which the formula is to be derived may be as complete as one wishes, but all that is necessary is a very rudimentary skeleton of the form of the worm. Draw a line with the aid of the camera lucida representing the axis of the worm.

Across this line at the proper places draw cross lines representing the diameters. The result will resemble Fig. 4 from which the formula can be easily computed. The measurements of the skeleton shown in Fig. 4 give the formula

2- 9-3 17-4 45-5 93- ^,,

78 ram.

2-8 4-2 5-9 8-6 36

Fig. 4.

Skeleton camera lucida drawing from which to compute the nematode formula.

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If one possesses and uses a slide rule or other calculating machine the labour of producing the formula from such a skeleton is much reduced. I estimate that in most cases by the above method the formula may be derived from a specimen in about five minutes, provided there is a clear perception beforehand of what is to be done.

Where the worm is of large size, too large for measurement under the microscope, the camera lucida may be mounted on a lens holder without any lens, in which case the worm may be drawn natural size or even be reduced.

The rules etched upon glass so that the scale can be laid in contact with the paper, thus doing away with parallax, are very convenient for use in measuring the skeleton drawings.

Mermis Novae Zealandiae, n. sp.

• 0 1-7 4-7? '48^{^^}-.[^] _.

— s ^ 28 to 38' mm.

• 1 -4 -6 -7

is the best formula derivable from the half dozen specimens examined, only one of which was beyond question adult. The

thin, smooth, whitish, translucent skin is destitute of hairs and striae, and it would appear that the musculature is weak. The body is threadlike and uniform in diameter, and ends anteriorly in a neck which in its anterior half is slightly convex-conoid. The head end is truncate, apparently without papillae, and certainly without setae, lips, lateral organs and eyes. There is no proper pharynx, the pore-like mouth opening being continued in the oesophagus as a tube of the same diameter. The cylindrical oesophagus is two-fifths as wide as the neck and in all the specimens is somewhat indefinite, though the length given in the formula is believed to be at least approximately correct. The intestine was plainly visible in most parts of the body but was manifestly becoming obsolete. No anus was to be seen. The posterior extremity for a distance equal to two to three body widths was more transparent owing to the absence of intestine. No ventral gland was seen.

The nerve ring was not very satisfactorily located but the measurement given in the formula is probably fairly correct.

The tail is rather suddenly convex-conoid at the somewhat blunt terminus, and it is quite destitute of hairs or papillae. There are no caudal glands and no spinnerets. The body continues to have its usual width until within a short distance of the tail end, the tapering taking place in a distance no greater than two to three times as great as the width of the body. The inconspicuous vulva is located very slightly in front of the middle of the body. There are two uteri, extending in opposite directions. In the only gravid female seen they contained towards

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New Zealand Nematodes. 369

one thousand somewhat spherical eggs, measuring 50 to 60 micromillimetres in their greatest diameter, each egg being therefore one-fifth as wide as the body.

No males were found in the collection.

Habitat, Lakes Taupo and Waikaremoana, New Zealand, at a depth of 370 to 840 feet.

Mononchus rex, n. sp.

2- 6- 20- 58- 81-

1-6 1-7 2- 2-2 1-4

6.5 to 7 mm.

is the formula of an adult female. The skin is without hairs and there are no striae to be seen with moderate powers. As usual the neck is cylindroid and ends in a head destitute of setae, though there are papillae. These latter are low, broad and inconspicuous. While the lips do not project, the region is elevated enough to give the front of the head a rounded appearance. The lips are bulky and powerful, being one-third as thick as the

pharynx is wide. There are no eyes, and no lateral organs were seen.

The pharynx is armed with very powerful muscles that can be easily seen passing from the lips to the region near the anterior end of the oesophagus. The teeth are less well developed than in some other species of the genus. There is a dorsal tooth, small in comparison with the size of the pharynx, and reaching not more than one-third the way to the lips. There are also ventrally sub-median teeth located opposite the dorsal tooth, but they are smaller, and one of them is seen only with difficulty in the specimens before me.

The oesophagus is cylindroid and is surrounded rather squarely by the nerve ring, which, as is usual in this genus, is situated well forward.

The intestine is dark in colour and is about one-half as wide as the body, the cells showing a tessellated arrangement of their contents. The rectum is shorter than the body diameter. No ventral gland or poms excretorius was seen.

The lateral fields are one-fifth as wide as the body.

The conoid tail tapers more rapidly at first, being nearly cylindroid in the posterior two-thirds. The terminus is slightly expanded, the usual spinneret being accompanied by two ventrally sub-median papillae after the manner of the species *longicaudatus*,

except that here the papillae are slightly larger in proportion.

Three caudal glands are present.

Two uteri lead from the inconspicuous vulva, one forward and the other backward. Each uterus is capable of carrying a single egg at a time, or possibly two. The eggs are nearly a fourth of a

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millimetre long, and are half as wide as long. The ovaries are reflexed.

2- 5-5 20- M⁸⁵⁻⁵ ^, ^

- o' to 7* mm.

1-5 1-9 21 2-3 1-5

The tail of the male is shaped like that of his mate. In front of the anus it is armed with a ventral row of seventeen prominent papillae, extending forward from the anus a distance equal to half the length of the tail. There is no bursa. The spicula were not plainly seen, but are believed to be of the form usual to the genus. They are about twice as long as the anal body diameter.

Habitat, Lakes Manapouri and Wakatipu, New Zealand, at

depths of 200 to 1150 feet. The species is a near ally of the writer's *M. gymnotaimus*, of Fiji.

Dorylaimus Novae Zealandiae, n. sp.,

• 0.5-5.20 - '45-2' 95- ^

o 1d 2o 28 8

is the formula of a somewhat immature female, the largest seen.

The smooth yellowish skin is destitute of transverse markings so far as can be seen with moderately high powers. Longitudinal markings (internal), due to the muscles, are plainly to be seen.

The skin, especially near the head, is innervated, but the nature of the connected external organs was not made out ; there are however no setae anywhere on the body. Very likely the innervations indicate the presence of sensory papillae.

The conoid neck becomes a trifle convex-conoid at the head end, where it is simply truncate, the lip region being neither contracted nor expanded. There appear to be six very inconspicuous lips each bearing a single minute papilla. The width of the head may be gauged by the fact that the lip region is about twice as wide as the spear. It seems that lateral organs are present in the shape of U-shaped markings immediately behind the lips and opening backwards. The spear is of the usual form and slides in a ring located a short distance behind the lips.

The oesophagus is of the form typical for the genus, being however simply conoid in form, enlarging gradually from two-fifths

as wide as the corresponding part of the neck in front, to three-fifths as wide as the corresponding part of the neck behind.

The lining is rather conspicuous in the posterior part. The oesophagus is set off from the intestine by a shallow but distinct constriction.

The dark coloured intestine is one-half to three-fifths as wide as the body. The cardia is inconspicuous and the cardiac cavity is nearly obsolete.

The rectum and pre-rectum vary in the two sexes, being longer

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New Zealand Nematodes. 371

in the male. In the female the rectum is one and one-half times to two times as long as the anal body-diameter, while the pre-rectum is nearly or quite three times as long as the rectum. In the male the pre-rectum is about three-fourths as long as the neck. Numerous glands are to be seen in the neighbourhood of the anus, especially in the male.

The lateral fields are about one-fifth as wide as the body.

The inconspicuous nerve-ring surrounds the oesophagus rather squarely.

The tail of the female is concave-conoid in the anterior half and setaceous in the posterior half, where it ends in an acute terminus, destitute of opening or spinneret. The tail of the male is obtusely conoid, and bears, near its extremity, at least two slightly lateral papillae. The posterior extremity of the male is invariably incurved. The anal region is not raised or made conspicuous by any special external markings or structures.

From the large depressed vulva the vagina leads half-way across the body where it branches into two symmetrical uteri extending in opposite directions so as to occupy the middle third of the body. Each ovary is reflexed and reaches about two-fifths the way back to the vulva. As only immature females were seen nothing is known about the eggs.

27

0 5 3 21-8 -M- ' 99-2 ^ _ ^

•4 14 21 2^ ^ ^ ^ ^ ^ ^ ^

is the formula of an adult male.

External tactile supplementary sexual organs are present on

the males in the form of a row of ventral papillae arranged in close juxtaposition. Taking the adjacent body-diameter as a measuring unit, this row of papillae begins three measures from the anus and extends two measures forwards. Each papilla is innervated, and the total number is twenty -nine, the anterior one being somewhat the largest. These papillae are most plainly to be seen when the body is strongly incurved. There is no bursa. The immediate region of the anus was not supplied with any conspicuous papillae.

The two equal, plain, linear, arcuate, somewhat pointed spicula were of the form usual to the genus and measured two and one-half times as long as the anal body-diameter. Accessory pieces were present. Powerful oblique copulatory muscles occupied part of the space opposite the row of papillae. The two testicles were straight and extended in opposite directions from a point a little in front of the middle of the body, where they occupied a space over one-quarter as long as the body.

The species is a typical *Dorylaimus* of large size.

Habitat, Lake Taupo, New Zealand, at a depth of 350 feet.

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Dorylaimus profundis, n. sp.

)• "^^ 98-2

7 • mm.

•0 5-9 22- '50-"^^ 98-2

•5 1-8 2-3 2-«

is the formula of a female that, though having the appearance of being full grown, had not yet produced eggs. The structure of the skin was entirely typical, and so closely resembled that of *Novae Zealaridae* that the same description would apply to both, and it may be here remarked that in spite of the marked differences pointed out later on, the two species resemble each other outwardly in a marked degree.

The conoid neck becomes convex-conoid at the head end, where there is a distinct lip region, which though presenting the same contour as that of *Novae Zealandiae* is of quite a different character. In speaking of *Dorylaimus latus* in Vol. VI. (1891) of the Proceedings of the Linnaean Society of N. S. W. I described the manner in which the lip region of that species can be protruded, and gave a figure of the protruded condition of the lips. It seems that the head of *D. profundis* has a similar structure. In the present case I have not seen the lips protruded, but the chitin at the head presents that infolding characteristic of the head of *latus* and some other species. This structure of the head together with differences in the structure of the posterior extremity enable

one to distinguish readily between the two species *Novae Zealandiae* and *profundis*.

As usual there are six obscure lips each bearing a single almost invisible papilla.

There is nothing striking about the structure of the pharynx, the stout spear sliding in a ring located behind the infolded lips at a distance one and one-half times as great as the width of the head.

The oesophagus is simply conoid, being anteriorly one-third and posteriorly one-half as wide as the corresponding part of the neck. The lining is plainly to be seen in the posterior part.

The oesophagus is set off from the intestine by a prominent constriction.

The dark coloured intestine is one-half as wide as the body and is composed of cells presenting a tessellated arrangement.

In the female the pre-rectum is one-third to one-half as long as the neck, while in the male it is much longer, namely somewhat longer than the neck.

There seems to be no gland emptying ventrally as in many Nematode genera, but certain organs, apparently glandular, are to be seen in the neck region and these probably debouch laterally.

The lateral fields are one-third to one-fourth as wide as the

body. The nerve-ring encircles the oesophagus rather squarely.

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The tail of the female is concave-conoid to a rather blunt point, while that of the male is conical to a rounded terminus, where a few innervated papillae are to be seen. The anus is neither raised nor depressed, and though easily to be discovered is not rendered conspicuous by any accessory apparatus in its immediate vicinity.

The vulva is depressed, and from it the vagina extends half way across the body, where it divides into two uteri, one extending forward and the other extending backward. These, together with the reflexed ovaries, occupy the middle third of the body. No eggs or young were seen.

• 0 6-4 23-6 -M-^ 99- „ ^ „ ^ „

• 5 2-1 2-7 3- TT| ^' " ^^ ""^

A row of ventral tactile papillae, numbering thirty-five to forty-two, is found some distance in front of the anus on the male. Reckoning from the anus these occupy the second fourth of the pre-rectal region. These papillae are plainly to be seen only when the body is strongly incurved, and then only as doubly innervated,

low and inconspicuous contiguous elevations.

The two equal arcuate spicula are two and one-half to three times as long as the anal body-diameter, and are of the nature characteristic of most of the species of the genus. Powerful oblique copulatory muscles exist in the pre-rectal region.

The species is a typical *Dorylaimus* of large size, readily distinguished from *Novae Zealandiae* by the structure of the head, the shortness of the female tail and the number of the male accessory papillae.

Habitat, Lakes Wakatipu, Waikaremoana, and Manapouri, New Zealand, at a depth of 200 to 1100 feet.

Register of the Species, Localities and Depths.

Depth in feet.

Lake Taupo, 350 *Dorylaimus Novae Zealandiae*.

» j> 00u „ J, „

„ „ 370 *Mermis Novae Zealandiae*.

Lake Waikaremoana, 840 „ „ „

„ „ 300 — 600 *Dorylaimus profundis*.

Lake Manapouri, 200 — 600 *Dorylaimus profundis* and Mo-

nonchus rex.

„ „ 360 Dorylaimus profundis.

Lake Wakatipu 500—1100

„ „ 200 — 300 Dorylaimus profundis and Mo-

nonchus rex.

„ „ 1150 Dorylaimus profundis and Mo-

nonchus rex.

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Note. At the Author's request I add a note on the dates of collection of the Nematodes described above. They were collected during 1902, as follows : —

Lake Taupo, during May and June.

Lake Waikaremoana, August and September.

Lake Wakatipu, October and November.

Lake Manapouri, November and December.

Lakes Waikare, examined during April, and Rotoiti, during July, yielded no specimens. K. Lucas.