

LUMBRICILLUS REYNOLDSONI N.SP., AN
ENCHYTRAEID FROM THE BEACHES
OF NORTH WALES

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(Plate XIV and Text-figs. 1-4)

Dr T. B. Reynoldson of the Department of Zoology, University College of North Wales, Bangor, found some large enchytraeids on the shores of the Menai Straits. He suspected that it was an undescribed, or at least a rare and interesting species, and kindly sent six specimens to me for further study. I find that the specimens are indeed to be ascribed to a new species, which is here named *Lumbricillus reynoldsoni*, in recognition of the finder's prominent work on the ecology of *Lumbricillus lineatus* Mull. and *Enchytraeus albidus* Henle.

Dr Reynoldson gives the following description of the habitat. 'The worm was found in considerable numbers among decaying seaweed and the underlying gravel at the extreme high tide level along with *Enchytraeus albidus* Henle in the Bangor area of the Menai Straits at the locality known as Gorad-y-Gyt. It occurs all the year round here, and cocoons have been collected during March and April. So far these worms have not been taken from other shores in North Wales although search has been made during general collecting trips.'

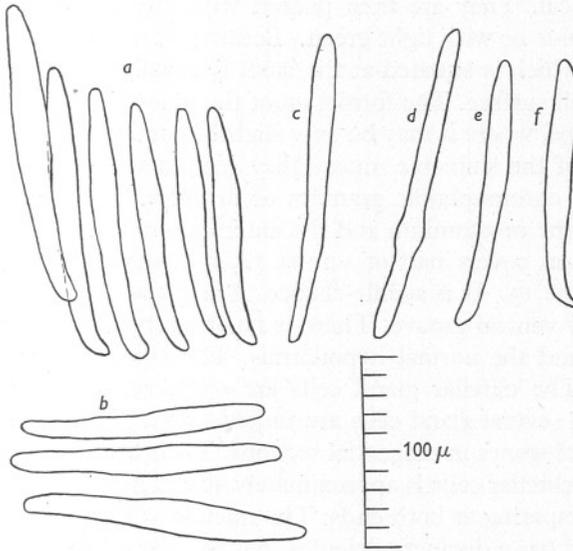
The specimens were excellently preserved. Dr Reynoldson had narcotized them with chloroform vapour and fixed them in Bouin's solution. Three specimens were examined in sections stained with Masson's and Mallory's stain respectively, one specimen was heated in lactic acid.

The length of the mature worm is 40 mm., the width 1.2 mm. The number of somites is about 65. The worm is opaque and light pink from the coloured blood. The segmental grooves are obsolete, while the clitellum is not prominent. The worm tapers at the hinder extremity. The prostomium is small and rounded. The head-pore is situated between pro- and peristomium. The mouth-grooves are shallow on the prostomium, deeper on the peristomium.

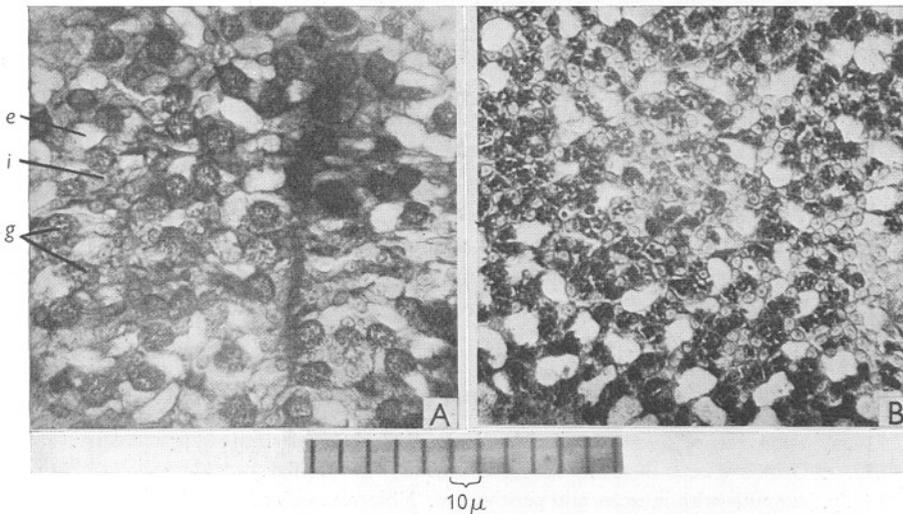
The setae (Text-fig. 1) are almost straight, particularly in the anteclytellar somites. The recently formed setae in the last somites are slightly smaller than the older ones. In the first 25-30 somites there are 5-6-7 lateral and 6-8-9 ventral setae, then the number decreases to 3-4 lateral and 3-4 ventral setae.

The cuticle is very thin for such a large species, only 1-1.2 μ thick.

In the hypodermis there are no regular rows of enlarged gland cells. Instead, the whole hypodermis is scattered with small gland cells (Text-fig. 2A and Plate XIV, fig. 6). In their most active stage these cells are swollen and



Text-fig. 1. Setae (a) from somite 25, (b) from somite 60, (c-f) from various somites.



Text-fig. 2. A. Tangential section through hypodermis of anteclitellar somites; *e*, emptied gland cell; *i*, group of interstitial cells; *g*, active gland cells. The dark stripe is part of a muscle band. Masson stain. Red filter. B. Tangential section through clitellar hypodermis. Stain, filter and magnification as in A. The active gland cells are narrow, columnar. The mucous droplets much larger than in common gland cells.

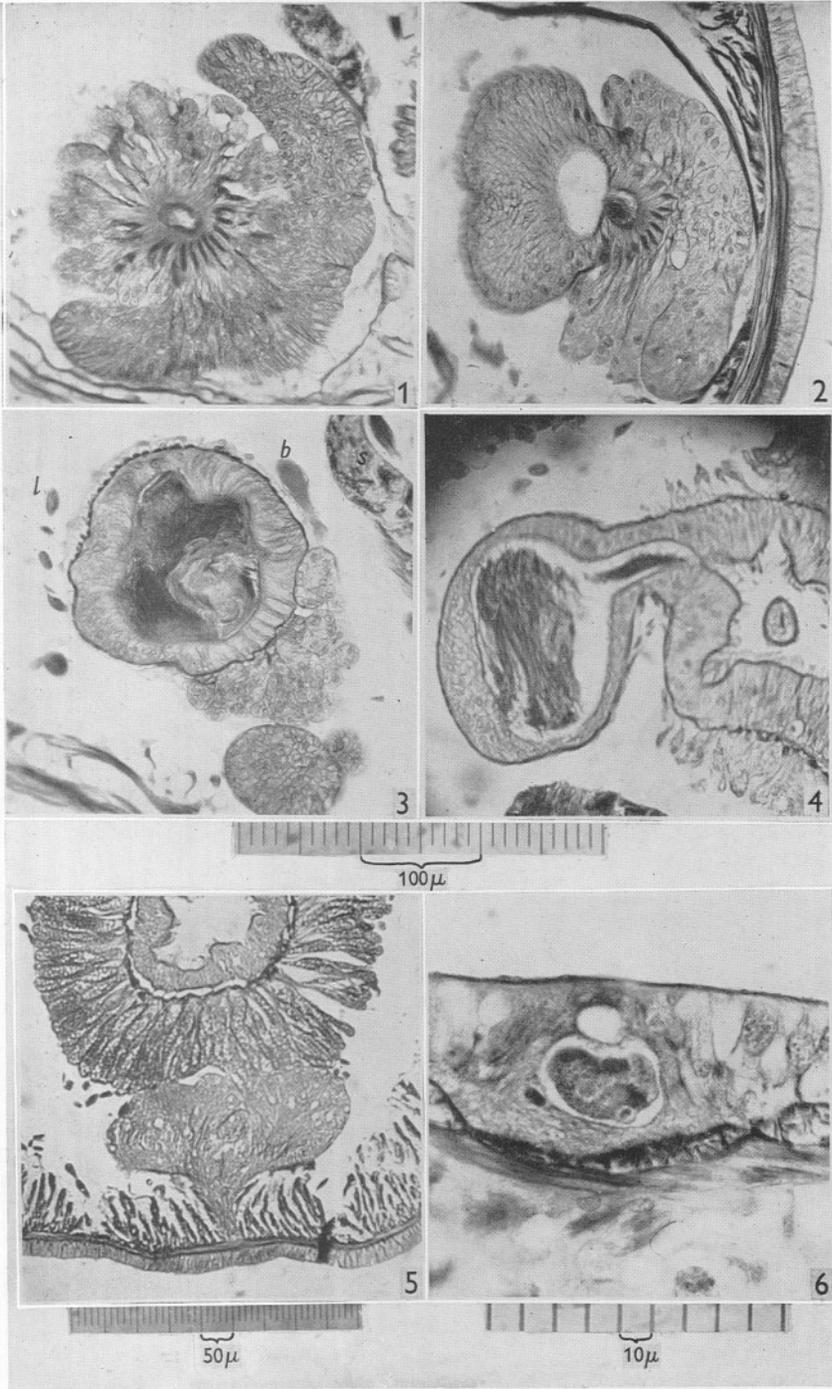
almost spherical. They are then packed with mucous droplets which stain with aniline blue or with light green. Because of the pressure within the cell the nucleus, which is situated at the base, is usually seen protruding beyond the general cell surface. The formation of the mucus begins in cells of regular columnar shape, where it may be only slightly stainable. When the gland cells are emptied of the stainable mucus they remain swollen and are filled with small, diffuse chromophobic granules or droplets. The gland cells are most numerous in the prostomium and the anterior somites.

The clitellum covers half of somite 11, the whole of 12, and almost the whole of somite 13. It is saddle-shaped. The gland-free surface is, however, only a narrow ventral groove. There is no sharp border between the clitellar hypodermis and the normal hypodermis. The latter changes gradually into the former. The clitellar gland cells are scattered quite irregularly (Text-fig. 2B), often several gland cells are united into a group. These cells appear as irregular polygons in tangential sections. Their diameter is 5-9 μ only. The height of the clitellar cells is approximately 50 μ . Thus the gland cells are high and narrow, tapering at both ends. The nucleus is always at the narrow base of the cell and has a distinct nucleolus, but the rest of the chromatic matter is less distinct than in the interstitial cells. Instead, the nucleoplasm stains with iron trioxyhaematin. The mucous droplets are large, with a diameter of 1 μ . They stain very brightly with light green, less so with aniline blue. The droplets are sharply defined, since the rest of the plasma remains unstained. The emptied cells lose their connexion with the basement membrane and become subspherical. They are situated just under the cuticle. These cells are not really quite empty, since they contain some unstainable, slightly granular matter. Their nuclei have no nucleolus and are little stained. In the narrow interstitial cells the nuclei may be situated at any level, but are usually concentrated near the basement membrane.

The muscle layers are thick. The circular muscles are well-defined bands which protrude into the hypodermis, giving the latter a wavy inner surface. The longitudinal muscles are of an extreme lumbricilline type, long and pointed. In transverse sections the longitudinal muscle bands are almost feathery and show a superficial similarity to those of *Lumbricus*.

EXPLANATION OF PLATE XIV

- Fig. 1. Ectal duct of spermatheca with gland cells and muscles. Masson; red filter.
 Fig. 2. Orifice of ectal duct into ampulla. Mallory; green filter.
 Fig. 3. Ampulla with muscles and peritoneum. *b* blood vessel, *l* lymphocytes, *s* septal gland. Masson; red filter.
 Fig. 4. Ampulla, ental duct and oesophagus. In the oesophagus a section through *Anoplophrya* sp. Mallory; green filter.
 Fig. 5. Copulatory gland from somite 14. Mallory; green filter.
 Fig. 6. Hypodermis with sporozoite in enlarged cell. Masson; red filter.



The peritoneum is highly developed. In many places it consists of several layers of loosely connected, slightly stainable cells and is rather reminiscent of some kind of parenchyma.

The lymphocytes are typical for the genus *Lumbricillus*. The numerous granulocytes are spindle-shaped or ellipsoidal with more or less pointed ends. One end often tapers into a delicate protoplasmic thread, which sometimes is attached to the peritoneum. The cells are filled with minute granules, which stain dark blue-violet in Mallory's, green in Masson's stain. In the spherical nuclei no nucleoli were observed. Aggregations of 5-10 rather small amoebocytes with inclusions of varying size are rather numerous.

There are no peptonephridia or other appendages or widenings of the intestine. The mouth-ridge is large and sharp, the bulbous pharynx is comparatively low. The intestinal epithelium shows several differentiations, but these are too insignificant to have any taxonomic value.

Septal glands occur in segments 4/5 to 6/7; that in 5/6 is the largest. Only the first two pairs fuse in the dorsal line. On the ducts from the glands in 5/6 and 6/7 there are proliferations of glandular tissue, but no real secondary glands.

Chloragogen cells begin in somite 4, but are again missing where the septal glands are at their largest. The chloragogen layer is dense, consisting of long, club-shaped sac-cells, which are only attached to the basement membrane by a narrow stalk (Pl. XIV, fig. 5). Naturally their length varies and reaches 200μ . The maximum width (at the tip) is 20μ . The long stalks contain but few chloragogen granules: most of these are concentrated in the sac-like body of the cell. The granules are small, not exceeding 1μ . They are arranged in a network around and between vacuoles of varying size, up to 12μ in diameter. Probably these vacuoles were filled with fat in the living specimens. The chloragogen granules retain their own yellow-brown colour and stain additionally with iron tri-oxyhaematin, the surrounding plasma stains slightly with light green. With Mallory's stain the chloragogen material in the body of the cells becomes bright red from acid fuchsin, whereas the small chloragogen granules in the cell stalks are yellow—probably their own natural colour. In the twelfth somite the chloragogen cells are missing; the intestine is covered only with a loose peritoneum of the same kind as on the body walls. Transitional stages between chloragogen cells and peritoneal cells occur.

The brain is 250μ long, 115μ high, and 185μ broad. Its anterior end is convex, the posterior end concave. The first ventral ganglion is large and protrudes in front of the brain connectives.

The first nephridium is situated in segment 6/7. The anteseptalium is small, consisting of the funnel only. The postseptalium is continuous with the terminal ectal duct.

The dorsal blood vessel originates in 14/15. It is enlarged in 14 and 13 and contains here nuclei belonging to a syncytium which is little stainable.

The testes are large, and much lobed. The sperm funnel is slightly bent. It is 750μ long and 280μ wide. The duct is central, 30μ wide. The collar is large but not so wide as the body of the funnel, 200μ only. It is not reflected. The distal end of the sperm funnel is square. The sperm duct is narrow. It is loosely and irregularly coiled and does not extend farther caudad than the penial bulb.

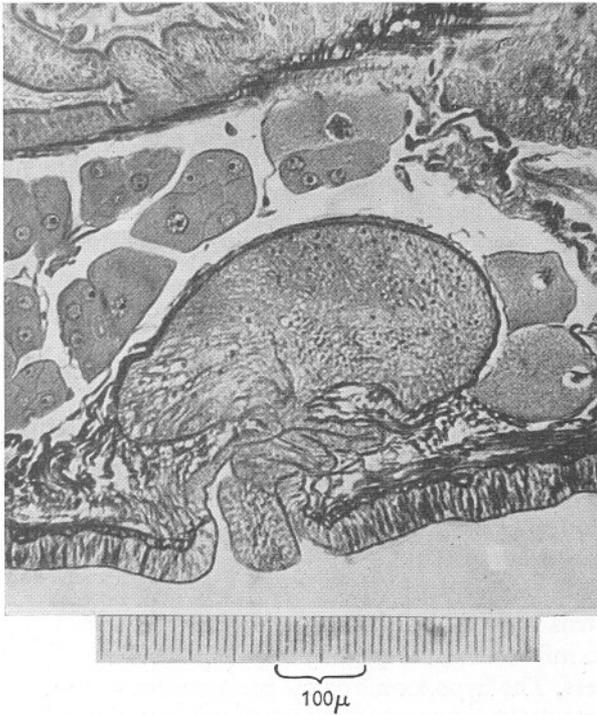
The penial bulb (Text-fig. 3) is strictly lumbricilline, large and covered with a thick muscular coating. It contains a large number of glandular cells in several layers. The penial invagination is very deep and much puckered. The oocytes are confined to somite 12.

The spermatheca (Text-fig. 4; Pl. XIV, figs. 1-4) consists of ectal duct, ampulla, and ental duct. The ectal duct is 140μ long and slightly bent. The lumen is approximately 18μ wide and is bounded by a cuticle which is thicker than the cuticle of the body surface. The walls of the duct consist of long and narrow gland cells. The length of the gland cells may be more than 150μ . In the proximal part, around the duct, there are naturally no intercellular spaces between these gland cells. But distally the cells are united into lobes of some 10-15 cells, the lobes being free from each other. The longest cells are club-shaped, with a narrow proximal neck. Not all gland cells reach the lumen of the duct, some are restricted to the distal parts of the lobes. However, these cells also have narrow extensions, forming ductules, to the cuticle of the duct. These ductules are exceedingly narrow and are visible only as darkly stained, wavy striations (like the ductules in the penial bulb). All nuclei are situated in the distal parts of the cells. The cells stain very lightly while the secreted granules are very small and scarce.

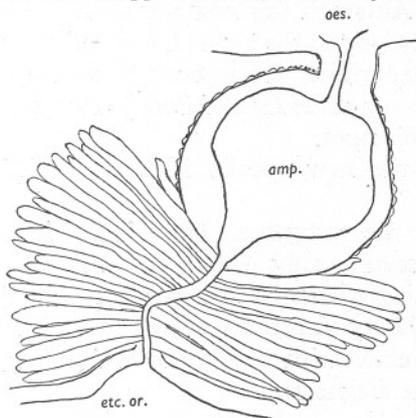
The subspherical ampulla is sharply defined from both the ectal and the ental duct. The length of the ampulla is approximately 290μ , the width 240μ . The walls are 30μ thick in the proximal, 12μ in the distal parts of the ampulla. Thus the lumen is pear-shaped. The cells are non-glandular, columnar in the proximal, cubic in the distal parts. Near the entrance of the ectal duct the inner surface is covered by a thick cuticle, but in the distal parts the inner surface of the ampulla is quite uncovered.

The ental duct is short, only 55μ long and there is a quite wide communication between ampulla and oesophagus. The lumen of the duct is 26μ wide, the total width is $50-55\mu$. The walls of the ental duct are similar to those in the distal part of the ampulla. In the innermost part of the ental duct the epithelium is ciliated as in the oesophagus.

The spermatheca has a rather interesting and complicated muscle-coating. At the ectal orifice muscles from the circular muscle layer are bent inwards. These muscles follow the ectal duct longitudinally. The muscle bands are broad in the radial direction, flat in the tangential. Thus, in perpendicular sections, the muscles appear as beams radiating from the lumen. The muscles are situated neither on the surface of the gland, nor in the innermost parts near



Text-fig. 3. Sagittal section showing penial bulb with deep invagination and oocytes. Intestine in the upper left corner. Mallory stain. Green filter.



Text-fig. 4. Outline of spermatheca. Schematic drawing with camera lucida.

the cuticle, but between the glandular lobes at the middle of their length. Often the thin parts of the muscles follow the walls of the gland cells closely. Therefore it may be hard to distinguish them from cellular surface-fibrillae. The muscles are continuous with the strong muscles which cover the ampulla. Here these muscles have again the same appearance as the sub-hypodermal circular muscles; they are, however, naturally weaker. On the ental duct the muscles become still weaker, similar to, and continuous with the muscles on the oesophagus. The peritoneal covering is very thin and probably incomplete on the glands of the ectal duct, but quite thick on the ampulla (Pl. XIV, fig. 3).

The elaborate muscle-coating of the spermatheca is a result of the structure of the ectal duct. Naturally, a duct with only glandular instead of epithelial walls must be supported by fibres when it is as large as in *L. reynoldsoni*. Since the fibres of connective tissue do not occur in enchytraeids the spermatheca is strengthened by muscles. I do not think that the muscles function in the emptying of the gland, but probably they do function when sperm is being ejected.

Large copulatory glands exist in somites 14 and 15 (Pl. XIV, fig. 5). The anterior and posterior ends are entirely free, but the median part surrounds the whole ventral nerve cord.

The specimens subjected to me were heavily parasitized. The intestine contained both infusorians, *Anoplophrya* sp. (Pl. XIV, fig. 4), and sporozoans in great numbers. The hypodermis of the prostomium and the first 35 somites held many, irregularly scattered, intracellular sporozoites (Pl. XIV, fig. 6).

Systematic position. Although this new species has almost straight setae it should without doubt belong to the genus *Lumbricillus*.¹ Its main character is the absence of peptonephridia. On account of the lobed testes the species should be placed in the subgenus *Lumbricillus* (= *Pachydriilus*). This subgenus inhabits mainly shore biotopes.

The full name of the new species is thus *Lumbricillus* (*Lumbricillus*) *reynoldsoni*.

The taxonomy of the subgenus *Lumbricillus* is rather complicated. *L. reynoldsoni* is, however, easily distinguished from all earlier described species. It is outstandingly large and the combination of characters of setae, spermatheca and copulatory glands do not occur elsewhere. This species has many characters in common with *L. pagenstecheri* (Ratz.), but the differences are easily seen from the diagnosis.

¹ On the authority of Dr Černosvitov I have earlier (Swedish Enchytraeida I and II, *Lunds Univ. Arsskrift* N.F. XLII, 13 and XLIII, 8) used the generic name *Pachydriilus*. On the suggestion of Dr Reynoldson I have looked through the older literature but could not find out why Černosvitov used the more recent name *Pachydriilus* Claparède 1889 instead of *Lumbricillus* Orsted 1861. Probably Černosvitov in his turn has followed his eminent compatriot Vejdvovsky.

Diagnosis. Length 40 mm. Somites about 65. Blood pink. Clitellum saddle-shaped, not prominent, with small, irregularly scattered gland cells. Setae almost straight, L 5-7, V 6-9. Posterior end of brain concave. Nephridia with anteseptalium consisting of funnel only, with terminal ectal duct. Origin of dorsal blood vessel in 14/15. Penial bulb lumbricilline, with deeply puckered invagination. Spermatheca with subspherical ampulla sharply defined from both ectal and ental ducts. Ectal duct consists of large gland cells. Copulatory glands in 14 and 15 surround ventral nerve cord.

The type specimen (longitudinally sectioned) is in the author's collection at the Zoological Institution of Lund.