

CERTAIN DIFFERENCES BETWEEN TEXT-BOOK
EARTHWORMS AND REAL EARTHWORMS

FRANK SMITH, UNIVERSITY OF ILLINOIS

This paper deals with earthworms of two quite different kinds; those that are found out of doors, in which I have been interested for the past 30 years, and those that are found in text-books, in which I have become interested more recently. During the 30 years that I have been interested in the outdoor varieties I have spent considerable time in collecting species in various parts of the country and have examined a great many collections made by others. This has led to the discovery and description of several new species not previously known, and also has made clear that in almost any locality in the United States there are likely to be several species that may properly be called common. In most of the northern and eastern states, the most abundant forms in random collections brought into school rooms and laboratories would commonly include several species which are also very common in Europe, and they have been introduced wherever Europeans have settled and cultivated the soil for many years. Introduced of course unintentionally, they have thrived at the expense of indigenous forms and to some extent have replaced them in the long cultivated areas. In the Northern tier of states most of the common species belong to the family Lumbricidae, but include several different species of at least three different genera. In the latitude of Illinois and farther south, representatives of other families of earthworms are abundant, and in many cases include the largest of the specimens collected. Anatomically these are very different from Lumbricidae. It is no more reasonable to talk about "the common earthworm" than it would be to talk about the common species of bird or the common kind of fish. It is done in 29 of 47 text-books recently examined.

My interest in the text-book varieties of earthworms has been increased recently as a result of a historical study of the development of our knowledge of Lumbricidae in general. *Lumbricus terrestris*, which includes

the largest fairly common species of northern Europe, was the first species to be carefully and also carelessly described by European workers, and naturally was the species adopted by text-book writers of England. Earlier American text-book authors have followed in their footsteps, for the greater part, and this has been feasible since *L. terrestris*, or *L. herculeus* as it was formerly called, has become fairly abundant in our northern states and is supplied by dealers. In most cases this text-book *L. terrestris* is the one which was known a half century ago before the use of the serial section method of anatomical study. It is quite different in some respects from the outdoors *L. terrestris* as made known by more recent investigations, which very few of our text-book authors have consulted.

"The common earthworm" is a variety which is met with very frequently in more recent text-books, but not in collections. As described in a new text-book which appeared within the last year, this variety would seem to be a hybrid form from ancestors belonging to two different genera of outdoor species, which has also acquired some additional characters found in none of them.

In so far as time will permit I wish to deal with three different topics: viz, the calciferous glands, certain blood vessels in the anterior dozen somites, and the position of the nephridiopores, and will compare text-book statements with facts.

I have no disposition to criticize any teacher or writer who decides against the advisability of giving attention to the calciferous glands, but I do protest against the incorrect statements that are found in the text-books that make a pretense of giving information about them. We will first give attention to the calciferous gland of the extremely abundant species *Helodritus caliginosus trapezoides*.

An essential feature is the peculiar modification in the structure of the wall of the esophagus in the somites 10 to 14. In these somites, the muscle layer of the wall becomes separated from the inner epithelial layer, and the space between them is divided into a series of longitudinal chambers which are separated by flattened lamellae

that are radially arranged around the lumen of the esophagus. These chambers seem to end blindly at their posterior ends, which are in somite 14, or at the anterior margin of 15. In most species commonly studied in the laboratories, the esophageal wall in somite 10 is evaginated into two lateral pouches, one on each side, often called esophageal pouches, which retain the communication between their cavities and the lumen of the esophagus. The longitudinal chambers with their separating lamellae extend into these pouches between the muscle and epithelial layers for a distance which varies in the different species. Ultimately the cavities of the chambers open into the pouch cavities and a definite communication is established. In one species, and in only one of those commonly studied, *Lumbricus terrestris*, in each of the two somites next posterior to the pouches there are paired lateral swellings of the chambered wall which superficially resemble the pouches in somite 10 in size and form. This results in the presence of three pairs of lateral expansions of the esophageal tube which superficially resemble each other somewhat, and have led to the very common statements concerning three pairs of glands.

These paired inflations of the esophagus are in somites 10, 11, and 12. They are not separate glands, but are simply parts of one glandular structure, developed in the wall of the esophagus in somites 10 to 14. They certainly are not three pairs of pouches or diverticula opening into the esophagus as often stated. Marshall and Hurst's Zoology and a few other text-books that have adopted the statements contained in it are most nearly correct in their statements concerning the gland or glands, but make no mention of the continuation of the gland development in somites posterior to the 12th somite.

We will now consider some of the more common errors found in the text-book statements concerning this part of the worm. A new text-book which appeared in 1923 states that the esophagus begins in the "6th segment and continues posteriorly as a thin-walled, undifferentiated tube to the 14th segment where it connects with the crop

and gizzard. Three pairs of calciferous glands open into the esophagus near its posterior end." We have seen that the so called glands are merely parts of a highly differentiated wall, and furthermore that instead of the three pairs alike opening into the esophagus only one pair has such direct openings. In this book "The Common Earthworm" is described without any specific name, but the statement is made that the clitellum is on somites 28 to 35, from which it is evident that the author was writing about an earthworm altogether different from *Lumbricus terrestris*, in which the clitellum is on somites 32 to 37, and one in which there is but one pair of conspicuous enlargements of the esophagus instead of three pairs. The description of the reproductive organs also applies to *L. terrestris* rather than to a worm with the clitellum on somites 28 to 35.

The statements in such text-books concerning the calciferous glands in earthworms are more than a century behind the times, since they include less that is accurate and more that is inaccurate than is found in a paper by a European writer which appeared in 1820. I have recently examined 47 text-books in which earthworms are included in the list of animals studied. In 23 of them the calciferous glands are not discussed. Just 18 of the other 24 state, or imply, that the glands of the three pairs are alike. Only six mention differences of structure. Four give the correct location; five an incorrect location; and the other 15 are indefinite. Five of the 24 books describing the glands do not mention the number, and the other 19 all state that there are three pairs, even though the majority of them do not intimate that *L. terrestris* is the species of earthworm being discussed. The trouble is due to the fact that most authors do not base their statements on their own study of the animals nor on the published results of careful investigations, but chiefly on what they find in other text-books with an ancestry dating back into the previous century. A paper by Harrington in 1899 in the Journal of Morphology contained illustrations and information which supply a basis for correct statements concerning the anatomy of the glands in *L. terrestris*, but Hegner is the only author

that seems to have made use of it, and he has incorporated in his account one rather serious error. The general facts of position and form can be seen easily in a preparation made by splitting a well hardened specimen with a razor blade, in a frontal plane, about on a level with the upper rows of seta bundles. Serial sections are necessary for a detailed study of the anatomy.

Another topic in which I have been interested includes the text-book statements concerning the location of the nephridiopores. The nephridia are paired excretory organs of which one pair is found in each of all the somites, except a few at the anterior and posterior ends of the worm. Internally their ducts enter the body wall quite uniformly at the anterior margins of their respective somites, and slightly dorsad of the rows of ventral seta bundles. Approximately one half of the ducts pass directly through the body wall, and their external openings or nephridiopores are slightly dorsad of the rows of ventral seta bundles and hence on the surface of the ventral half of the worm. Since all the nephridial ducts enter the body wall at about the same level it seems natural to expect them to open externally at about the same level, but on the contrary approximately one half of the nephridial ducts follow a course in the body wall which leads dorsad for some distance and they emerge at the surface dorsad of the row of dorsal seta bundles at irregular distances. Marshall and Hurst described the location correctly more than 30 years ago and explained how the irregularity might be readily shown by stripping off pieces of the cuticula from slightly macerated specimens and placing them on slides, a very simple operation. Of 24 text-books making statements concerning the location of the nephridiopores, I find but three that have their statements correct. The others all assign a uniform location.

I will make brief reference to another feature of earth-worm anatomy which is the occasion of numerous text-book errors. It involves a part of the circulatory system. The dorsal vessel, posterior to the so-called hearts of which the posterior one is in the 11th somite, is a collecting vessel and receives blood from the body wall and

from the alimentary tract through branches of the vascular system in each of most of the somites. This blood flows anteriorly and is forced into the ventral vessel by the hearts. In the anterior dozen somites the dorsal vessel does not function as a collecting vessel. The ventral vessel is in general a distributing vessel and from it blood is distributed to the body wall and alimentary tract. In it the blood flows anteriorly in front of the hearts and posteriorly throughout the remainder of the body. It is a very common assumption by text-book authors that the dorsal vessel functions as a collecting vessel throughout its whole extent, which is not true. Two longitudinal vascular trunks lying one on each side of the alimentary canal, and joining the dorsal vessel at their posterior ends in the twelfth somite, act as the collecting vessels in the anterior somites in place of the dorsal vessel. Only seven of the text-books mentioned make any reference to these vessels, and only one of them makes reference to the posterior connections of these vessels with the dorsal vessel in somite 12. Very few of the authors seem to have known of a very useful paper on circulation in earthworms which appeared in *The American Naturalist* in 1902 and was prepared by Johnston and Johnson.