THE YORKSHIRE POST AND LEEDS

INTELLIGENCER, TUESDAY, OCTOBER 25,

AGRICULTURAL NOTES.

DARWIN ON THE EARTHWORM.

When a man has devoted half a century to the careful investigation of a subject, and at the end of that period gives the results of his labours to the world, it might naturally be expected that he would publish something well worth reading; but when that man happens to be Mr Darwin, it may safely be said that a book emanating under such circumstances from his pen would meet with a reception the confidence of which must disarm all criticism. For Mr Darwin is not like other men. Not once only, nor twice, nor yet thrice has he come forward as the exponent of some new theory, or the narrator of some strange and almost incredible facts. His published works now number nearly a score, and every one of them, from the celebrated "Origin of Species" to the one which now lies before us, marks a distinct extension in the realms of knowledge. No living man, perhaps no philosopher whom the world has ever seen, has encountered such furious opposition or met with such severe and bitter criticism as the illustrious exponent of the theory of evolution; but he has lived to see the opposition of old dwindle away to nothing, and to earn the respect and even command the reverence of the most uncompromising of his critics. And why is this? It is not only on account of his brilliant genius, of his extraordinary powers of observation nor is it solely due to his honest expression of conviction or of doubt. More than to either of these it is in consequence of his inflexible love for the truth, and nothing but the truth. This, as it seems to us, is the key to the unique position he has won for himself. Years ago it had come to be said, even amongst those who differed from him most widely, that the most powerful arguments against Darwin's views were to be found in his own works. While he adduced every fact which had led him to formulate this or that theory, he as honestly and dispassionately discussed every fact of which he was possessed that told against him; and thus his opponents, even at the very outset of the attack, found that all their artillery was in the enemy's camp. The brilliancy of his genius is only equalled by its versatility; no subject seems to have come amiss to him—coral reefs and volcanoes, zoophytes and barnacles, flesh eating plants, insects and orchids, man himself, and now in his latest work the humble earthworm.

As long ago as 1837 Mr Darwin read a paper before the Geological Society of London on the action of worms in the formation of vegetable mould, in which he pointed out that worms were prime agents in the formation of soils, and that the mould had passed many times through the intestines of worms, and would do so many times again. Like most of his opinions when first enunciated this view was warmly controverted, and for upwards of 40 years the subject has lain dormant, but not in the mind of Charles Darwin. He has had time to test his conclusions and to accumulate facts, and the result is that he adheres firmly to his opinions of 44 years ago.

After a brief introduction, the first two chapters of the book deal with the habits of worms, the third is on the amount of fine earth brought up by worms to the surface, while the fourth treats of the part which worms have played in the burial of ancient buildings, such as old Roman cities and villas. The next two chapters are concerned with the denudation of the land by the agency of earthworms, while the seventh and last chapter gives, in a space of eight pages, a summary of the work.

Earthworms require for their environment a soil which is not too sandy or gravelly, and which is sufficiently moist. They breathe through the skin, and can live for some months under water if it is not too cold. They are nocturnal in their habits, and emerge from their burrows at night, not infrequently leaving them and wandering about, in which case they do not appear capable of finding their way back again. They often lie through the day just within the mouths of their burrows, whence they are plucked out and destroyed in large numbers by birds, especially by blackbirds and thrushes. Though they possess no eyes, they nevertheless have the power of distinguishing between light and darkness, and beat a hasty retreat when brightly illu-

minated. Minute setæ or bristles extend in pairs along their bodies, and they can crawl either forwards or backwards. Besides being blind, they are completely deaf, as they display the most utter indifferance to all sounds, whether shrill or profound. But they at once respond to vibrations communicated to the medium surrounding them; thus, when a flower-pot containing earth and worms was held close to a piano and various notes were struck, the worms took no notice, but directly the flower-pot was placed on the piano, the vibration caused them to disappear in their burrows. They possess a feeble power of smell, and exhibit likes and dislikes in the matter of taste; thus they usually prefer green cabbage to red cabbage, and prefer onion leaves to both, and while they are extremely partial to celery and carrot leaves, they will have nothing to do with sage and thyme. They eat very largely of earth, from which they digest various animal and vegetable matters, and when their comrades die they illustrate their cannibalism by eating them.

The worm's body is made up of a series of rings or segments, the anterior of which is furnished with a mouth, and by means of this latter various objects are seized and drawn along. Leaves and leaf stalks are the chief objects to which worms direct their attention, and Mr Darwin considers they exhibit intelligence, inasmuch as they grasp leaves, &c., by the narrow end, thereby facilitating their passage into the burrows. To discover which is the narrower end they must evidently be guided by the sense of touch. Failing leaves and leaf stalks, small sticks are called into requisition, and if these are not at hand small pebbles have to do service. Whichever of these objects may be employed, they are used for plugging up or covering over the mouths of the burrows, apparently for the sake of warmth.

In making a burrow the worm forces its anterior segment into some little chink or crevice in the soil; it then causes the immediately succeeding part of the body to swell, thereby pushing away the earth on all sides; a continuation of these operations leads to the excavation of the burrow. But if the soil be very hard, the worm has to eat its way down, passing the soil by its mouth through the body and ejecting it at the tail end in the form of a casting. Having made its burrow, the worm often paves the bottom with little stones or seeds, and, more than this, it plasters over with its ejecta the entire wall of the burrow, so that it is like a little tunnel lined with cement. The castings ejected by a worm must be familiar to everybody who has walked across a grass sward on a moist autumn morning. In some countries these castings assume the form of little mounds or towers three or four inches high, and weighing several ounces. But whatever the height may be, the worm always keeps an open channel through it. Worms are very numerous in fine garden soils, and as many as sixty-four open burrows have been found in a space of 14½ square feet. Hensen calculates that there are 53,767 worms in an acre of such land, and Mr Darwin thinks we may fairly take half that number as representing their average abundance on, say, good corn land. The data are given for estimating that each worm passes through its body and ejects 20 ounces of earth on an average per annum, and this on agricultural land represents 15 tons an acre every year! But even assuming it to be only 10 tons, Mr Darwin says:—

The result for a country of the size of Great Britain, within a period not very long in a geological sense, such as a million years, cannot be insignificant, for the 10 tons of earth has to be multiplied first by the above number of years, and then by the number of acres fully stocked with worms; and in England, together with Scotland, the land which is cultivated and is well fitted for these animals has been estimated at above 32 million acres. The product is 320 million million tons of earth."

The worm thus is undoubtedly a farmer's friend; he is pre-eminently a cultivator—not so fast as a steam cultivator or a horse plough, but equally sure and certain in his results, and far more effectual in his *modus operandi*. In making a soil mellow and rich nothing indeed can equal the earthworm. On this point we give another quotation from the work itself:—

Worms prepare the ground in an excellent manner for the growth of fibrous rooted plants and for seedlings of all kinds. They periodically expose the mould to the air, and sift it so that no stones larger than the particles which they can swallow are left in it. They mingle the whole intimately together, like a gardener who prepares fine soil for his choicest plants. In this state it is well fitted to retain moisture and to absorb all soluble substances, as well as for the process of nitrification. The bones of dead animals, the harder parts of insects, the shells of land molluscs, leaves, twigs, &c., are before long all buried beneath the accumulated castings of worms, and are thus brought, in a more or less decayed state, within reach of the roots of plants. Worms likewise drag an infinite number of dead leaves and other parts of plants into their burrows, partly for the sake of plugging them up and partly as food. The leaves which are dragged into the burrows as food, after being torn into the finest shreds, partially digested, and saturated with the intestinal and urinary secretions, are commingled with much earth. This earth forms the dark coloured rich humus which almost everywhere covers the surface of the land with a fairly well-defined layer or mantle. Von Hensen placed two worms in a vessel 18 inches in diameter, which was filled with sand, on which fallen leaves were strewed, and these were soon dragged into their burrows to a depth of three inches. After about six weeks an almost uniform layer of sand, a centimeter (·4 inch) in thickness, was converted into humus by having passed through the alimentary canals of these two worms.

"Long before man existed," says Mr Darwin, "the land was regularly ploughed, and still continues to be thus ploughed by earthworms." The worm is the primeval ploughman. He works on steadily and slowly, in silence and in darkness; he asks no return for his labours, and too frequently gets trodden on and mangled as a mean, despicable thing, unfit to encumber this fair earth of ours. But landlord and tenant alike must bow to the lowly annelid; the soil is his, and they cannot take it from him. From time immemorial he has held it, and by every right, not excepting primogeniture, he will continue to hold it. During the whole of his dark, silent life he is doing a great work, fertilising the soil in which he lives, and enriching the earth when he dies.

A friend called on us while Mr Darwin's book on worms was lying on the table. He picked it up and turned over the leaves, casually at first, but speedily with interest. For more than an hour the only sound was that of the pen, and then with a deep breath our friend closed the book, picked up hi hat, and said, "I never saw a book of Darwin's yet that I couldn't read. I looked in on you for a few minutes, and here I've been reading for nearly two hours about earthworms, animals on whom I honestly believe I never expended a moment's thought before." There is, indeed, a charm in the work—there must be in any work that both a schoolboy and a philosopher would read with interest—and we shall not be surprised if, in the course of a month or so, Mr Darwin's latest literary effort is in great demand as a Christmas gift book.

THE YORKSHIRE POST AND LEEDS INTELLIGENCER, TUESDAY, OCTOBER 2

Bg. H. F. Moore
College of Agriculture, Sakatoon

AGRICULTURAL NOTES.

DARWIN ON THE EARTHWORM.

When a man has devoted half a century to the careful investigation of a subject, and at the end of that period gives the results of his labours to the world, it might naturally be expected that he would publish something well worth reading; but when that man happens to be Mr Darwin, it may safely be said that a book emanating under such circumstances from his pen would meet with a reception the confidence of which must disarm all criticism. For Mr Darwin is not like other men. Not once only, nor twice, nor yet thrice has he come forward as the exponent of some new theory, or the narrator of some strange and almost incredible facts. His published works now number nearly a score, and every one of them, from the celebrated "Origin of Species" to the one which now lies before us, marks a distinct extension in the realms of knowledge. No living man, perhaps no philosopher whom the world has ever seen, has encountered such furious opposition or met with such severe and bitter criticism as the illustrious exponent of the theory of evolution; but he has lived to see the opposition of old dwindle away to nothing, and to earn the respect and even command the reverence of the most uncompromising of his critics. And why is this? It is not only on account of his brilliant genius, of his extraordinary powers of observation nor is it solely due to his honest expression of conviction or of doubt. More than to either of these it is in consequence of his inflexible love for the truth, and nothing but the truth. This, as it seems to us, is the key to the unique position he has won for himself. Years ago it had come to be said, even amongst those who differed from him most widely, that the most powerful arguments against Darwin's views were to be found in his own works. While he adduced every fact which had led him to formulate this or that theory, he as honestly and dispassionately discussed every fact of which he was possessed that told against him; and thus his opponents, even at the very outset of the attack, found that all their artillery was in the enemy's camp. The brilliancy of his genius is only equalled by its versatility; no subject seems to have come amiss to him—coral reefs and volcanoes, zoophytes and barnacles, flesh eating plants, insects and orchids, man himself, and now in his latest work the humble earthworm.

As long ago as 1837 Mr Darwin read a paper before the Geological Society of London on the action of worms in the formation of vegetable mould, in which he pointed out that worms were prime agents in the formation of soils, and that the mould had passed many times through the intestines of worms, and would do so many times again. Like most of his opinions when first enunciated this view was warmly controverted, and for upwards of 40 years the subject has lain dormant, but not in the mind of Charles Darwin. He has had time to test his conclusions and to accumulate facts, and the result is that he adheres firmly to his opinions of 44 years ago.

After a brief introduction, the first two chapters of the book deal with the habits of worms, the third is on the amount of fine earth brought up by worms to the surface, while the fourth treats of the part which worms have played in the burial of ancient buildings, such as old Roman cities and villas. The next two chapters are concerned with the denudation of the land by the agency of earthworms, while the seventh and last chapter gives, in a space of eight pages, a summary of the work.

Earthworms require for their environment a soil which is not too sandy or gravelly, and which is sufficiently moist. They breathe through the skin, and can live for some months under water if it is not too cold. They are nocturnal in their habits, and emerge from their burrows at night, not infrequently leaving them and wandering about, in which case they do not appear capable of finding their way back again. They often lie through the day just within the mouths of their burrows, whence they are plucked out and destroyed in large numbers by birds, especially by blackbirds and thrushes. Though they possess no eyes, they nevertheless have the power of distinguishing between light and darkness, and beat a hasty retreat when brightly illu-

minated. Minute setæ or bristles extend in pairs along their bodies, and they can crawl either forwards or backwards. Besides being blind, they are completely deaf, as they display the most utter indifference to all sounds, whether shrill or profound. But they at once respond to vibrations communicated to the medium surrounding them; thus, when a flower-pot containing earth and worms was held close to a piano and various notes were struck, the worms took no notice, but directly the flower-pot was placed on the piano, the vibration caused them to disappear in their burrows. They possess a feeble power of smell, and exhibit likes and dislikes in the matter of taste; thus they usually prefer green cabbage to red cabbage, and prefer onion leaves to both, and while they are extremely partial to celery and carrot leaves, they will have nothing to do with sage and thyme. They eat very largely of earth, from which they digest various animal and vegetable matters, and when their comrades die they illustrate their cannibalism by eating them.

The worm's body is made up of a series of rings or segments, the anterior of which is furnished with a mouth; and by means of this latter various objects are seized and drawn along. Leaves and leaf stalks are the chief objects to which worms direct their attention, and Mr Darwin considers they exhibit intelligence, inasmuch as they grasp leaves, &c., by the narrow end, thereby facilitating their passage into the burrows. To discover which is the narrower end they must evidently be guided by the sense of touch. Failing leaves and leaf stalks, small sticks are called into requisition, and if these are not at hand small pebbles have to do service. Whichever of these objects may be employed, they are used for plugging up or covering over the mouths of the burrows, apparently for the sake of warmth.

In making a burrow the worm forces its anterior segment into some little chink or crevice in the soil; it then causes the immediately succeeding part of the body to swell, thereby pushing away the earth on all sides; a continuation of these operations leads to the excavation of the burrow. But if the soil be very hard, the worm has to eat its way down, passing the soil by its mouth through the body and ejecting it at the tail end in the form of a casting. Having made its burrow, the worm often paves the bottom with little stones or seeds, and, more than this, it plasters over with its ejecta the entire wall of the burrow, so that it is like a little tunnel lined with cement. The castings ejected by a worm must be familiar to everybody who has walked across a grass sward on a moist autumn morning. In some countries these castings assume the form of little mounds or towers three or four inches high, and weighing several ounces. But whatever the height may be, the worm always keeps an open channel through it. Worms are very numerous in fine garden soils, and as many as sixty-four open burrows have been found in a space of 14½ square feet. Hensen calculates that there are 53,767 worms in an acre of such land, and Mr Darwin thinks we may fairly take half that number as representing their average abundance on, say, good corn land. The data are given for estimating that each worm passes through its body and ejects 20 ounces of earth on an average per annum, and this on agricultural land represents 15 tons an acre every year! But even assuming it to be only 10 tons, Mr Darwin says:—

"The result for a country of the size of Great Britain, within a period not very long in a geological sense, such as a million years, cannot be insignificant, for the 10 tons of earth has to be multiplied first by the above number of years, and then by the number of acres fully stocked with worms; and in England, together with Scotland, the land which is cultivated and is well fitted for these animals has been estimated at above 32 million acres. The product is 320 million million tons of earth."

The worm thus is undoubtedly a farmer's friend; he is pre-eminently a cultivator—not so fast as a steam cultivator or a horse plough, but equally sure and certain in his results, and far more effectual in his *modus operandi*. In making a soil mellow and rich nothing indeed can equal the earthworm. On this point we give another quotation from the work itself:—

Worms prepare the ground in an excellent manner for the growth of fibrous rooted plants and for seedlings of all kinds. They periodically expose the mould to the air, and sift it so that no stones larger than the particles which they can swallow are left in it. They mingle the whole intimately together, like a gardener who prepares fine soil for his choicest plants. In this state it is well fitted to retain moisture and to absorb all soluble substances, as well as for the process of nitrification. The bones of dead animals, the harder parts of insects, the shells of land molluscs, leaves, twigs, &c., are before long all buried beneath the accumulated castings of worms, and are thus brought, in a more or less decayed state, within reach of the roots of plants. Worms likewise drag an infinite number of dead leaves and other parts of plants into their burrows, partly for the sake of plugging them up and partly as food. The leaves which are dragged into the burrows as food, after being torn into the finest shreds, partially digested, and saturated with the intestinal and urinary secretions, are commingled with much earth. This earth forms the dark coloured rich humus which almost everywhere covers the surface of the land with a fairly well-defined layer or mantle. Von Hensen placed two worms in a vessel 18 inches in diameter, which was filled with sand, on which fallen leaves were strewed, and these were soon dragged into their burrows to a depth of three inches. After about six weeks an almost uniform layer of sand, a centimeter (·4 inch) in thickness, was converted into humus by having passed through the alimentary canals of these two worms.

"Long before man existed," says Mr Darwin, "the land was regularly ploughed, and still continues to be thus ploughed by earthworms." The worm is the primeval ploughman. He works on steadily and slowly, in silence and in darkness; he asks no return for his labours, and too frequently gets trodden on and mangled as a mean, despicable thing, unfit to encumber this fair earth of ours. But landlord and tenant alike must bow to the lowly annelid; the soil is his, and they cannot take it from him. From time immemorial he has held it, and by every right, not excepting primogeniture, he will continue to hold it. During the whole of his dark, silent life he is doing a great work, fertilising the soil in which he lives, and enriching the earth when he dies.

A friend called on us while Mr Darwin's book on worms was lying on the table. He picked it up and turned over the leaves, casually at first, but speedily with interest. For more than an hour the only sound was that of the pen, and then with a deep breath our friend closed the book, picked up his hat, and said, "I never saw a book of Darwin's yet that I couldn't read. I looked in on you for a few minutes, and here I've been reading for nearly two hours about earthworms, animals on whom I honestly believe I never expended a moment's thought before." There is, indeed, a charm in the work—there must be in any work that both a schoolboy and a philosopher would read with interest—and we shall not be surprised if, in the course of a month or so, Mr Darwin's latest literary effort is in great demand as a Christmas gift book.