Soil and Health Library

Friend Earthworm

Practical Application of a Lifetime Study of Habits of the Most Important Animal in the World

by George Sheffield Oliver, B. Y. P.

Oliver's Earthworm Farm School
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Business Is Business

"Business is Business," the Little Man said,
"A battle where everything goes,
Where the only gospel is 'get ahead,'
And never spare friends or foes.
'Slay or be slain', is the slogan cold.
You must struggle and slash and tear,
For Business is Business, a fight for gold,
Where all that you do is fair!"

"Business is Business," the Big Man said,
"A battle to make of earth
A place to yield us more wine and bread,
More pleasure and joy and mirth.
There are still more bandits and buccaneers
Who are jungle-bred beasts of trade,
But their number dwindles with passing years
And dead is the code they made!"

"Business is Business," the Big Man said,
But it's something that's more, far more;
For it makes sweet gardens of deserts dead,
And cities it built now roar
Where once the deer and the gray wolf ran
From the pioneer's swift advance.
Business is Magic that toils for man.
Business is True Romance.

And those who make it a ruthless fight
Have only themselves to blame
If they feel no whit of the keen delight
In playing the Bigger Game,
The game that calls on the heart and head,
The best of man's strength and nerve.
"Business is Business," the Big Man said,
And that Business is to serve!

-- *Berton Braley*

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Practical Application of a Lifetime Study of Habits of the Most Important Animal in the World

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Part I

Introduction

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"There must be something wrong somewhere."

WHEN a human being is periodically indisposed; when there is want in a land of plenty, where there is nationwide unemployment with factories idle and work to be done; when old age must depend upon charity or a social security that does not secure; when fruit trees are chopped into firewood because they die many years before their natural span of life has been completed; when poultrymen find their chickens dying a premature death by wheelbarrow loads -- " there must be something wrong somewhere."

Why should modern man labor under these distressing and unnatural conditions? Are they the fault of a blind and disinterested nature? Or are they, after all, of man's own making?

It is the purpose of this book and the lessons it contains -- all books and teachings without purposes are empty things -- to encourage the reader to find the something that is wrong and, where possible, alleviate it.

At this point the writer wishes it definitely understood that he is not coming forward with a new theory, or fad, or panacea for all our individual and collective ills and disorders. What appears in the following chanters, was especially prepared for farmers, orchardists, nurserymen, poultrymen, gardeners, trout-farmers and all persons interested in any manner in such matters, is founded on scientifically established data, approved by eminent authorities, and designed by, and functioning through, natural law -- the only law from which there is no recourse, no appeal, no hung juries.

Not only are Nature's laws foolproof, but they are as irrefutable and enduring as the laws of mathematics -- and two and two will make four as long as numerals are used as media with which to count. And nature's laws need no policemen, for they are guardians within themselves.

Probably the chief cause of most of humanity's mental and physical disturbances is too much food of the wrong sort, and too little of the beneficial sort. Properly balanced food means a well balanced and healthy body, and such a body contributes an equitable mental condition to its owner, or, if you prefer the expression, an equitable spiritual well being.

"When there is want in a land of plenty."

Here indeed is a paradox. And this writer firmly believes that if it were humanly possible to stay the hands of politicians from signing politically expedient documents and statutes; gag them to silence their similarly expedient utterances and purge their thoughts of forthcoming elections, a fair distribution of the nation's wealth could become a reality. Here, again, we may safely disregard man's laws and turn to natural laws, for an answer. In Nature there is no waste. Everything, animal and plant, when its life is terminated, returns to its original elements, either in the soil or in the waters. Here, through chemical reactions, it is broken up and again becomes a beneficial part of these elements. But man's laws not only permit waste, but actually seem to thrive upon it.

This is particularly true in political, governmental and social spheres. Modern civilization, of which our American loose-leaf form of Democracy is a major part, seems incapable of producing unselfish statesmen. As examined by the thinkers and philosophers of the world today, general conditions point unmistakably to a decrease of intellectual and moral fiber in those who are elected, or take by force, the responsibility of public affairs. America's financial, industrial and commercial systems need revamping by humanitarians, not politicians. The fact that these systems are all-powerful, as well as gigantic, should not give them a license to act as dictators.

In truth, America has less to fear from a political dictatorship than from a financial, industrial or commercial dictatorship. Certainly no reasonable or reasoning person will deny that our financial system, so cleverly interlocked with the international system, needs a thoroughgoing house cleaning. Were this done, and done according to the principles set forth in the Constitution of the United States, industry and commerce would be forced to change their tactics and operate in a less plutocratic, dictatorial and monopolistic manner.

And again we may safely turn to Nature. She does not permit monopoly. Nowhere in either the animal or plant kingdoms will one

find monopolistic tendencies. Monopoly, political, industrial or economic, while it is undoubtedly beneficial to a few, is destructive to the mass. In the final analysis, monopoly is self-destructive, and any system that has within it the germ of self-destruction brings widespread disorder to other systems directly or indirectly related to it. Essentially, monopoly is a form of greed and the similarity is decidedly, if amusingly expressed, by calling the reader's attention to a pig pen at feeding time. Invariably, the fattest porker will push and shove and shoulder its way to the feed trough. Greedily it comes very close to monopolizing all the available food. Thus it grows faster and fatter than the others in the same pen -- and reaches the slaughterhouse first! Here we observe how greed and monopoly ultimately does lead to destruction.

"When old age must depend upon charity or a social security that does not secure."

Do natural laws ordain that the aged, animal or plant should suffer in their senile or infirm years? Definitely, no. Having lived naturally, all animals and plants complete their cycle of life in an even tenor, barring, of course, accidents, which are as much a part of Nature as the ebbing and flowing of the tides. Through progress, enlightenment and education -- the latter being far less perfect than our paid scholastics would have us believe -- we have graduated from many primitive customs which ordered that the aged members of some races, being senile, and therefore unproductive, should be destroyed.

Yet the system we boastful Americans employ in caring for our aged is relatively not far removed from the barbarous system of aged destruction. Today we do not kill our aged outright. We condescend to permit them to slowly starve or freeze to death, making them the while more susceptible to the ills to which old age is heir. Many Americans make of the aged, with their pension dreams and aspirations, a political football to be booted hither and yon about the political gridiron. In considering the problem of our aged, politicians obviously refuse to consider Nature. Probably few of them realize that mutual aid is a natural law; that very early in the nineteenth century, philosophers dimly developed the theory that in every branch of Nature mutual aid is as permanently fixed as the laws of conception and demise. It was Professor Kessler who, in 1880, while Dean of the St. Petersburg (now Leningrad) University, declared reciprocity to be a natural law. Prince Peter Alexevitch Kropotkin, Russian geographer, having absorbed Professor Kessler's declaration that mutual aid in Nature was irrefutable, wrote and published (1902) his great work, "*Mutual Aid as a Law of Nature and a Factor of Evolution*."

What both of these men know, or should know, is that the soil is deficient in one or more vitally necessary ways or elements. The orchardist who begins "guessing" about what is wrong with his soil is playing an ultimately losing game, for the law of averages is against

him. Such a man, desiring to learn the true nature of his soil, the element or elements it lacks or with which it may be over supplied, should have samples of his soil analyzed by capable chemists. Most soils are deficient in elements necesary for plant life not because the elements are not present, but because they are unavailable to the plant roots.

It is into this picture that the burrowing earthworm makes its potent appearance. All the elements that are in the soil, but which are hidden and unavailable to the plant roots, are broken down by the earthworm and made available. Man has yet to invent, devise or manufacture any machine, and solid or liquid fertilizer as efficient as the earthworm. In this invertebrate animal Nature has a perpetual soil builder, a four-in-one creature that acts upon the soil as chemist, triturator, cultivator and distributor -- as we shall see as we continue to peruse this volume.

"When poultrymen find their chickens dying a premature death by wheel barrow loads..."

For over a quarter of a century Southern California has been a mecca for thousands of individuals and families trekking here to enter the poultry business. Scattered, estimated and authentic figures give us the information that, in a period of fifteen years, well over 50,000 such business ventures failed. Among those who have managed to remain in business are many who suffer a poultry mortality that is astounding. One set of figures shows that some sixty per cent of pullets die before they reach maturity. Others show that fifty-five per cent of laying hens have to be replaced every second year, when they should live and be productive for from four to six years. Still other data point out that it costs many poultrymen twenty cents a dozen to produce eggs, when thinking members of their business are producing the finest eggs for less than ten cents a dozen. Poultry raisers and breeders of fowls for meat seemingly have great difficulty in producing birds with a necessary amount of feathers on them.

Why do such conditions exist in the poultry business? When we come to the portion of this work that deals with poultry we shall learn that the cause of all these conditions is in the poultryman himself. It is not the nature of domesticated fowls, nor is it Nature's design, to suffer such a high mortality rate, produce sterile eggs, or half bald chickens. For over forty years this writer has known and demonstrated the fact that, if there is little or no deficiency in the diet poultrymen feed their flocks, there will be a minimum of premature deaths, unfertile eggs, and featherless birds. It is no idle remark, no promise of magical prowess, no guesswork to declare that all of these adverse conditions may easily be remedied by the proper application of the earthworm, as we shall eventually see in a chapter devoted to this subject.

The statement taken for our premise -- "there must be something wrong somewhere " -- may be accurately changed to "there is something wrong somewhere."

It is the aim of this book to point out what and where that wrong is and how it can be overcome. Around and upon one word -- earthworm -- is built the highway to better and more productive trees, plants, vegetables, poultry, game birds and fish.

Such an animal as the earthworm, whose importance is universally accepted and admitted by scientists, deserves a more pretentious volume than this humble effort of mine, but I find solace and satisfaction in having prepared a book for the lay reader in which I have eliminated, as much as possible, the use of confusing technical and long, jaw breaking zoological terms.

In preparing this work I have included data about the earthworm that has long been recognized and admitted by men and women of science, and, in addition, I have embodied many facts which I myself have discovered through nearly half a century of experimentation.

This work was planned to be of especial interest to farmers, orchardists, nurserymen, gardeners, poultrymen and all others interested in agriculture, horticulture and their kindred professions. However, it will, I hope, be welcomed as an instructive review of the life and habits of the annelids discussed herein.

In offering this work to the public I do so in the sincere hope that it will add, to an already long list, many new and appreciative admirers of our friend, the earthworm.

-- GEORGE SHEFFIELD OLIVER

Part I

Lesson 1

History of the Earthworm

The animal kingdom -- Earthworm low in animal life -- Description of various types of worms -- Charles Darwin's opinion -- What is "Dry land?" -- External description of the earthworm -- Internal description -- Its sexual life -- The eggs of earthworms -- Their progeny

THE animal kingdom of the planet earth is divided into two subkingdoms, invertebrate and vertebrate animals. That is to say, animals with backbones and animals without backbones. The invertebrate group is distinguished by nine phyla or divisions. In this group there are over 500,000 known kinds of animals, ranging from the lowest form of animal life, the protozoa, or minute, single-celled creatures, to arthropoda, which includes crabs, insects and spiders. In the vertebrate group there are well over 30,000 known kinds, including fishes, amphibians, reptiles, birds and mammals.

When it is stated that in this vast array of creatures the lowly, segmented earthworm is probably the most important to mankind, the uninitiated might aptly declare that such a statement sounds neither logical nor reasonable. Yet few creatures equal the burrowing earthworm as an essential to better health and greater growth to plant and vegetable life, and, therefore, indirectly is of the utmost importance to man.

The burrowing earthworm is Nature's own plough, her chemist, her cultivator, her fertilizer, her distributor of plant food. In every way, the earthworm surpasses anything man has yet invented to plough, to cultivate or to fertilize the soil.

While it is unquestionably true that plants and vegetables grow and reproduce their kind without the aid of the earthworm, most naturalists claim that all fertile areas have, at one time or another, passed through the bodies of earthworms.

It is likewise unquestionably true that the finest plants and vegetables will become healthier and more productive through the activities of this lowly animal, which the ordinary person considers useful only to break the early bird's fast or to impale on a fish hook.

The lowly earthworm has been playing a very important role in the drama of plant life from time so distant that scientists can merely guess

as to the age of this invertebrate animal. But, regardless of the age of this lowly organized group, scientific men are agreed that mankind may rightly acknowledge the earthworm as one of his best friends.

In this chapter, or lesson, the reader will be presented with a brief genealogical background of the earthworm and the manner in which it has indirectly aided mankind by directly aiding plant life. This background should help the reader to understand facts regarding the earthworm which should be known to all persons interested in gardening, farming, orcharding and poultry raising.

If must first be realized that there are worms and "worms." All are invertebrate animals. But, except those known to science as the *phylum annelida*, we shall dismiss all others as beyond the scope of this work.

The division of invertebrate animals, of which the earthworm is a member, is composed of five families or classes. These, in turn, are divided into two orders. The *phylum annelida*, that is to say, the entire division of earthworms, contains upward of eleven hundred species.

Of this extensive array we shall concern ourselves only with earthworms, for there are marine worms, swamp worms and beach worms, many of which, to most casual observers, appear to be "just worms."

While all *annelida* are, more or less, closely related, each specie has distinct features. Some have habits quite foreign to other species. Some prosper only in certain, specific environments and die if transplanted elsewhere. Some have definitely formed heads, with whiskers, teeth and eyes. Others have no heads, as we understand the word, are toothless and eyeless. Some worms are hermaphroditical, others bisexual. Some live exclusively in water, others in soggy soil, others in decayed animal matter (manure), others in decayed vegetable matter (humus).

Low as earthworms are in the scale of life, they show unmistakable of intelligence. Charles Darwin's experimentations with them conclusively proved that instinct alone could not guide them so consistently.

Some earthworms come to the surface of the soil and crawl hither and yon (traveling many miles from the section of their nativity during their lives) especially in rainy weather, when their burrows or tunnels are flooded. All throw their bodily excrements, technically known as castings, behind them. Some species throw their castings above the surface of the soil, forming small hillocks or mounds.

Countless thousands of years before the rocky face or surface of the earth disintegrated to form what we call soil, an extensive list of animals and plants lived in the waters. Marine worms were

undoubtedly present in those obscure ages.

In time, as the waters receded, various animals and plants -- to meet the requirements of their changing environment -- evolved certain anatomical organs to meet the new conditions.

Joining in this natural and evolutionary parade of water born animals and plants, some marine worms acquired physical characteristics which permitted them to live, first in very marshy ground, later in "dry land."

The phrase, "dry land," should here be qualified, for, in the strictest sense, there are exceptionally few spots on the face of the earth that are dry. No creature can live on, or in, dry land. It is a common remark, "we breathe air," but what we are actually doing -- what all living things are doing -- is breathing nitrogen dissolved in water.

We should keep this fact regarding the vital need of water constantly before us as we study the worm and its relation to plant life, for both must have moisture to live.

Now that we have cursorily traced the earthworm from its parent environment to the so-called dry land, we are ready to dismiss all worms from our minds except those known to science as *Oligochaeta*.

This group is composed chiefly of terrestrial worms, and it is of these that this book concerns itself.

The earthworms, like all other families, is sub-divided into various groups, but for our purpose all we need know are the common names for this class. These are orchard worm, rain worm, angle worm, dew worm, brandling, compost worm, night crawler, fish worm, night lions and similarly descriptive names familiar to certain areas of the United States.

Let us now combine all these common names and visualize the earthworm as we last observed one.

In size, it may have been from two inches to perhaps a foot in in length, though twelve inches is long for an earthworm on the North American Continent except in very damp forest lands.

In offering an external description of our friend, the earthworm, we find all species so much alike that few can distinguish one specie from another without careful examination.

All are "headless," eyeless and toothless. There are no external antennae or feelers. From tip to tail the body is composed of ringlike

segments. A short distance from the "head" is seen a band, lighter in color than the balance of the body, which is usually a deep red.

That, briefly, describes the earthworm as visible to the naked eye. The earthworm's internal system is highly complicated. Yet, paradoxically enough, it is magnificently simple. The reader may grasp this marvel of Nature by picturing a flexible metal tube the size of a lead pencil, in which is built a plant capable of refining gasoline from crude oil. In a comparative sense, the earthworm's system does to soil what the modern refinery does to crude oil.

The earthworm has a multiple system of hearts, minute tubes circling that part of the alimentary canal between the pharynx and the crop. Through a complicated system, these hearts supply blood to all parts of the body.

Minus lungs, the earthworm "breathes" through its moist epidermis or outer skin. The blood corpusles are colorless and float to the surface of each segment where they absorb oxygen.

Under an ordinary magnifying glass, the pores of the various segments are visible, and if one were to gently squeeze an earthworm, minute drops of yellowish serum would be seen coming out from it.

This serum is composed chiefly of oil of high medicinal value, and experiments for its extraction (which will be discussed in a later chapter) are now in progress. It is hoped that this oil may be extracted in quantities sufficient to encourage production.

Except for a number of hearts, all the vital organs of the earthworm are under the previously mentioned band, which zoologists call the *clitellum*. This band is the chief characteristic of the earthworm, distinguishing it from all other worms except a few leeches and a few other marine worms.

Here, under this band, in compact uniformity, are seminal vesicles and receptacles, testis, ovaries, oviduct and egg sac. Directly back of these is the crop, where the food is held until the gizzard, just beyond the crop, is ready to accept it. Next follows the intestine, a distinctly oval shaped tube, and then the rest of the alimentary canal to the vent or anus.

Our earthworm is bisexual, that is, it contains both male and female organs of procreation, and must perform a reciprocal act of copulation to fertilize and be fertilized.

The sexual act of the earthworm, usually occurring in the cool hours of the early dawn and twilight, makes an interesting and curious study of nature's method of propagating the specie.

Neither animal has external sexual organs, though the pores, through which the seminal fluids appear, are visible under a small magnifying glass. The sexual act is not preceded by any display of amorous cooing or lovemaking. The worms, driven solely by instinct when the procreative glands demand relief, seek a position that brings their bands together and remain thus, quite motionless, for as long as fifteen minutes. If exposed to a bright light during the sexual act, the embrace is broken, for worms, though sightless, are very susceptible to light.

During the act of coitus, each worm exchanges male sperm, impregnating, or, at least, theoretically impregnating, their female ovas. Also during the act, there is an increased flow of the fluid which keeps the entire length of the worm's body moist. This fluid forms the capsule in which the eggs are deposited, and is, therefore, heavier and thickens rapidly.

When the hymeneal act is completed and the earthworms separate, this fluid forms an outer band. The new band or shield begins to move forward, eventually dropping from the earthworm's "head."

During the forward movement of the gelatine-like band, the impregnated eggs are held firmly within it. As it drops off the earthworm it closes into a yellowish-green pellet or capsule, slightly larger than a grain of rice. This capsule resembles, to a remarkable degree, a very small currant.

Earthworm capsules examined under a powerful microscope show a lack of uniformity in the number of cells. There will be, however, from three to fifteen fertile eggs in a capsule.

Earthworm eggs hatch in about twenty-one days. The newborn appear as short bits of whitish thread about one-quarter of an inch in length. In from twelve to forty-eight hours they become darker but are visible to the untrained eye only after a painstaking search for them.

Once hatched, it is a case of each worm for itself. Close observation, however, seems to lead students of these lowly organized creatures to believe their mortality rate exceptionally low.

Worms begin to mate from 60 to 100 days after birth, depending upon the richness or poorness of the soil in which they live or in which they are cultured.

Mating follows at periods of from six to eight days, Thus, if we are to follow the average fertility of each capsule laid, that is, three worms, one mature worm will beget over 150 worms each year of its life. Each mating, therefore, should produce twice that number, or over 300 worms a year.

Certain species of earthworms, particularly those that come to the

surface and crawl about during wet or rainy weather, seemingly are chiefly active during the nocturnal hours. Other species -- which we will discuss later -- are, apparently, active throughout most of the day and night. This specie seldom, if ever, comes to the surface, depending on the porosity of the soil.

Except in highly porous soils, the earthworm must eat its way through. Having no teeth, everything before it, if not too large to swallow, is sucked into the mouth. It is by necessity, therefore a ravenous eater.

Every morsel of soil and decayed vegetable and animal matter taken in by the earthworm passes through its digestive system. This is equipped with a gizzard-like organ. Here the food value in the swallowed matter is extracted for use by the worm. The rest is carried by muscular action down through, and out of, the alimentary canal. This waste matter is called castings.

Part I

Lesson 2

The Habits of the Earthworm

Terrestrial earthworms differ from other annelida -- Are found in nearly all parts of the earth -- Man helped to scatter them -- How the compost worm lives -- How the orchard worm lives -- Habits of both compost and orchard worms -- Diet of earthworms -- How one man made a mistake in feeding earthworms -- Nature's scheme -- Man can improve upon Nature

AS we have already seen, the burrowing earthworm of our time is an animal that evolved from similar animals which once lived exclusively in the waters of the earth. While the terrestrial earthworms differ greatly from their marine relations of today, there are, however, many features and characteristics in both that are relatively alike. It is on these likenesses that science bases its contention that the earthworm evolved from its marine prototype.

Earthworms abound in practically every geological section of this planet. The exceptions to this rule are the extreme northern and southern latitudes where extended cold periods preclude the existence of this branch of invertebrate animals. But in torrid and temperate zones some 1000 species of earthworms live, prosper and procreate.

The dense, humid jungles of equatorial climes gives us the largest specimens of the earthworm. These are undoubtedly the direct antecedents of all terrestrial worms that have spread from one end of the earth to the other.

Assuming that the first progenitors of our present-day earthworm began in equatorial sections, we may inquire how they became so widespread over the great portion of the face of the earth lying between the two frigid zones.

This is satisfactorily explained by the realization that many species of earthworms peregrinate, that is, they travel and migrate extensively. Some species are known to scale and cross high mountain ranges, though such migration probably required many hundreds of years.

Man, too, has undoubtedly, though unknowingly, aided in transporting earthworms from one hemisphere to another. This has been accomplished through the movement of trees and plants in whose roots worms, or their eggs, have been hidden.

It is quite possible that the early species of terrestrial worms were habitues of soil rich in organic matter or humus. It is also quite possible that these earthworms lived exclusively on the diet supplied them through humus and that the common brandling, or compost worm, is an evolutionary product of them.

In the early works regarding the life and habits of the earthworm we find no references to the compost worm. In fact, all references to earthworms lead us to believe that the early students of this branch of zoology, though they examined and studied the digestive organs of their subjects, failed to discover or to realize, or, at any rate, failed to describe, the ease with which the earthworm becomes a slave to its environment.

The compost worm demonstrates this slaveship admirably. As its name implies, it is found exclusively in manure compost piles, or in soil heavily laden with decayed animal matter. Tests have proved that in such fertilized soil the compost worm will become extinct if fresh manure is not repeatedly added.

To understand the peculiar dietary demand of the earthworm is vitally important for all persons interested in any way in the habits and life of the earthworm. Without this knowledge, any attempt to domesticate the earthworm for fertilizing purposes will be fruitless.

Due to the inability of the compost-raised earthworm to absorb nourishment from soil minus decayed animal matter, any transplantation of it to ordinary soil will prove fatal. Likewise, an attempt to transplant an orchard worm to a compost pile will result in its death.

Strangely enough, however, if the eggs of the compost worm are gathered and placed in a rich soil minus decayed animal matter, a large percentage of them will hatch and prosper. While the first offspring may not be high in quality, either in size or health, they will eventually become accustomed to their environment, and each following generation will show a decided improvement. It is therefore advisable to conclude, and work from this premise, that the brandling or compost worm is a distinct specie of earthworm.

Outwardly, the brandling or compost worm, is almost one-third smaller than the common orchard or rainworm. But being of the same family, its head band and rings or segments are identical, except that they are more emphasized.

In habits, the compost worm seldom burrows deeply beneath the surface. This is probably due to the fact that when soil is fertilized with decayed animal matter, the fertilization seldom is buried deeper than eight to twelve inches. And, inasmuch as it is from this organic

substance the brandling gets its food supply, it remains within that depth.

Another characteristic of the compost worm is the fact that it does not throw its castings above the surface. Because it is a much fatter worm than the orchard worm, it can release its excretions behind it without fear of packing the tunnel through which it has eaten its way.

These conclusions have been reached after more than a decade of close scrutiny of the habits of the earthworm. The reader may prove these facts to his own satisfaction, and there is considerable evidence available to further substantiate these conclusions.

Inasmuch as the earthworm will devour anything it can swallow, it must, like every other animal, including man, receive certain dietary necessities from what it eats. If the soil in which the earthworm lives is deficient in life-giving necessities, the worm suffers. Deficiency in food values, either for animal or plant life, ultimately ruins that which is so deprived.

All earthworms eat raw and cooked meat, seldom if ever anything putrid. They like fats, nuts, milk -- in short, anything and everything that enriches the soil.

The digestive fluid of the earthworm is of the same chemical nature as the pancreatic secretion in higher animals, which accounts for the worm's ability to digest meats and fats as well as starches and sugars.

To illustrate the manner in which the dietary habits of the earthworm are governed by their environment, the following actual story is worthy of consideration here.

A California orchardist developed a culture bed of 50,000 breeding prolific earthworms, of whose history and development a later chapter is concerned.

He had been instructed how to properly feed his earthworms, but discovered that he could procure beef suet at an invitingly low price.

Believing that he could revolutionize his system of feeding, he began to place small pieces of suet in his culture trays. Slowly he increased the amount until eventually suet became the worms' complete menu.

This method of feeding reduced the labor, what little there was, in tending to them, but the day of reckoning was not far distant.

When he was ready to harvest his crop of egg capsules, he discovered that the breeders had failed to breed. What few eggs there were contained no live germs.

Charging his well intentioned experiment to experience, the orchardist decided to impregnate some of his trees with the obviously sterile worms. Having adapted their digestive organs to an all-animal fat diet by slow degrees, these worms could not adjust themselves to an organic diet in time to prevent starving to death -- which they did in a short time.

Similar experiences are on record, and the lessons learned from them have led us to the logical conclusion that the soil should be impregnated, not with young or mature worms, but with their eggs.

By this method, tests have proved that when the worms are hatched in the environment in which they are intended to work, they will adapt themselves to its food.

From this brief description of the dietary habits of the earthworm we come face to face with natural laws reminding us that Nature, constantly working blindly, ungoverned by all but one rule -- the continuation of her various species -- is not interested in improving individuals of any of her species.

This fact has long since been accepted by man.

One should not be considered egotistical for claiming that he can improve upon Nature. Every stock farm and nursery disproves the once accepted statement, "You can't improve upon Nature." Our finest horses, cattle, dogs and other domesticated animals and fowls, as well as many trees, plants and vegetables, are the result of man's persistent and intelligent efforts to improve what Nature has given him.

Furthermore, these man-bred animals, trees and plants, if not carefully cared for by man and properly mated by him, eventually become atavistic: that is to say, they revert to their ancestral type -- a type far inferior to the product evolved by man's intelligence.

Therefore, if we are to accept the earthworm as an important part of nature -- as our friend, a natural friend that should be cultivated, developed and domesticated -- it behooves us to do our part to help and encourage the earthworm to do its part.

The possibilities of thought training are infinite, its consequence eternal, and yet few take the pains to direct their thinking into channels that will do them good, but instead leave it all to chance.
-- Marden.

Part I

Lesson 3

Habits of the Newly Developed Earthworm

Why Nature's earthworm will not function -- How the newly developed, prolific hybrid earthworm was developed -- New earthworm does not form mounds on lawns or golf course -- Leaves its casting under the surface near the root zones -- Characteristics of the new worm -- Retaining all favorable characteristics of both compost and orchard worm -- Has no unfortunate characteristics

SCIENCE has admittedly known and appreciated the work of the earthworm for well over half a century. Many farmers, orchardists and gardeners have realized that in soil in which earthworms lived, plant and vegetable life prospered.

There are scattered instances where farmers who fertilized land with decayed animal matter hauled from the neighborhood of the stables attempted to transplant the compost-bred earthworms. These attempts have been recorded, but, to this writer's knowledge no sincere effort was ever made to discover why such earthworms perished when moved.

Consistent experiments and research work brought to light the fact that earthworms are as much in need of the food on which they were raised as the fish is in need of water. It was found that compos-bred earthworms demanded decayed animal matter; those raised in soil containing decayed vegetable matter demanded humus.

The author's first efforts to develop a satisfactory cross-bred earthworm were made in 1927. Selected specimens of earthworms found in various sections of the United States were studied, bred and interbred.

Observation, most of them coming under practical conditions and circumstances when the author was engaged in landscape artistry, showed that the brandling possessed many favorable qualities which if transferred to, and retained by, this cross breed would be very advantageous.

Chief among these favorable qualities was the fact that the brandling never deposited its excretions above the surface of the soil.

This quality has two very important advantages.

First, no mounds are formed on the surface of the soil. Such little hillocks, while they are far from detrimental, cause lawns and golf courses to become uneven, sometimes unsightly, and, in the case of a golf course, ill-suited for the enthusiast of mountain billiards.

Second, by leaving all its castings under the surface of the soil near the root zones, the roots of plants and vegetables have easier access to the chemical and mineral elements pulverized by the earthworm's digestive tract.

Early experiments with the brandling, recorded in copious notes, showed that it appeared completely contented in a tray, box or can; that, as long as it was well supplied with food, heavy-laden with any and all sorts of decayed animal matter, it was a prolific breeder.

Another characteristic of the brandling was its habit of living close to the surface of the soil, seldom going below six inches. Such a burrowing earthworm will cultivate the soil only around the upper roots of the plants and vegetables, and while this may produce satisfactory results for some plant life, the author's desire was to develop an earthworm that would penetrate deeper into the soil.

Search for a promising earthworm to mate with the brandling produced no satisfactory results until a variety of orchard worm was found while matured trees were being transplanted.

This worm was large, and apparently spent much of its time deep in the ground, often down to ten and twelve feet.

A number of these worms were procured, carefully fed and studied. Observations showed that they burrowed as deep in the experimental trays, boxes and cans as they could get.

Being satisfied that this type of orchard worm would make an ideal medium for experimentation in the hope of producing a fertile cross between it and the brandling, healthy specimens of both were selected.

These were placed in a special soil mixture, approximately one-third soil, one-third vegetable humus and one-third decayed animal matter. Such a composition of inorganic matter -- that is to say, matter devoid of organized physical matter -- contains all (and theoretically more) of the vital elements necessary for plant life. These elements, however, are not always available to the roots of plants, as was explained in the introduction to this work.

Henry Drummond (1851-1897), an English philosopher and writer, pointed out that "... The inorganic or the mineral world is absolutely cut off from the plant or animal world... No change of substance, no modification of environment, no form of energy, no chemistry, no

electricity, no evolution of any kind can ever endow a single atom of the mineral world with the attribute of life. Only by the dipping down into this dead world of some living form (Drummond obviously referred to the roots of plants, and we may safely add earthworms) can those dead atoms be gifted with the properties of vitality. Without this contact with life they remain fixed in the inorganic sphere forever."

Some form of life, either plant roots or earthworms, must bridge the gap between inorganic and organic (or living) matter before the inorganic matter becomes available to plant life.

In the course of time, the worms having copulated, the egg capsules were extricated from the soil and placed in a separate container. When these hatched and grew to near-maturity, the weaker and less promising were culled out.

During the first six months, about a thousand cross-breeds which had been selected as breeders were mating and producing fertile eggs.

While this experiment, as it appears here in cold type, seems to have been the personification of simplicity, it should be realized that a full five years were consumed in these experiments. However, the results obtained in orchards, nurseries, gardens and poultry houres have proved that that quintet of years was worth every discouraging set-back. These set-backs were too numerous to be listed here. Suffice it to say that there were times when Nature appeared to be stubbornly antagonizing all plans, figures and calculation.

I call this cross between the orchard and compost worm "Soilution". Its chief features are:

1. A prolific breeder.
2. A free animal, no longer a slave to one environment.
3. Its castings never form objectionable mounds above the surface of the soil.
4. It is not an extensive traveler or migrator.
5. It makes exceptionally good fish bait, for it is lively and lives for many hours when impaled on a fish hook.

Part I

Lesson 4

Potential Markets for Earthworms

Know your business -- Unsound to enter any business without knowledge of it -- Fishermen are possible customers for earthworm breeders -- Types of worm best suited for fishermen -- The orchardist needs the services of the earthworm farmer -- Orchardist is best customer for earthworm culture bed -- Farmers are potential earthworm buyers -- Poultrymen can save money with earthworm culture beds -- One poultryman's opinion -- The home gardener is always interested in beautifying his garden -- Earthworms as garden beautifiers

IN discussing the potential markets for "Soilution" earthworms it behooves us to deal with facts and not become lost or confused in a maze of over-enthusiastic statements, over-zealous predictions; neither should we imagine that overnight wealth awaits all and sundry who would enter this new development of a natural resource that has been active on this planet long before man himself arrived.

That there is a wide and varied market for active, prolific earthworms is a fact too obvious to question. But these markets cannot be attained by a mere snap of the fingers. Financial security may also be assured, but certainly not by any magic power concealed in or about the culturing of worms for commercial use.

It is economically unsound for any individual to enter any type of business without at least a working knowledge of, or experience in, the business he or she selects. This economic rule, though undoubtedly it has its exceptions, is founded on sound logic and clear reasoning, and is the basic reason why beginning earthworm farmers should start on a small scale.

It should be borne in mind that the amateur earthworm farmer must thoroughly sell himself on the virtue of the earthworm. To accomplish this, he must study and understand the life and habits of his product. This may be accomplished by growing his own plants and vegetables as demonstrations with and without "Soilution" earthworm culture.

Once he has thoroughly sold himself, none can destroy the knowledge he has acquired nor the facts he has learned through personal experience, study and observation.

The tyro "Soilution" farmer must realize that it takes time for plants, shrubs and vegetables to show the benefits derived from the persistent and efficient work of the earthworm around the root zones.

Many forms of plant and vegetable life show a marked improvement in from thirty to sixty days after earthworms have been placed in the soil around their roots; in some instances, however, an entire growing season is required to prove the full merit of this type of culture.

And so, in justice to all persons contemplating entering this interesting and profitable line of endeavor, it is sincerely hoped that readers of this book will not invest large sums of money in worm farms under the assumption that they will be financial lords overnight. To use a common expression, "it just isn't in the cards."

Assuming that the foregoing facts have been accepted, let us now turn our attention to the potential markets for selectively bred earthworms.

When the subject of earthworm farming is ushered into a conversation and discussed as a business, the ordinary person will usually recall the difficulty he experienced in finding worms in his garden the last time he planned a fishing trip.

Too many potential "Soilution" farmers imagine that every fisherman for miles around might be a good customer of one who could supply him with fat and active earthworms for bait. They fail to realize that many other potential earthworm farmers have reasoned in the same channel, with the result that competition has become both keen and cut-throat during the annual fishing season, resulting in a highly undesirable commercial and unsound economic condition.

A few years ago the prevailing price of earthworm fish bait was one dollar for a six ounce can containing from forty to sixty mature worms. The depression, plus absurd competition, brought the price tumbling down.

Competition was so keen in Denver, Colorado, that an earthworm price war resulted in six ounce cans being retailed for five cents.

The price of a can of earthworm bait in 1937 in California ranged from thirty to fifty cents for a can containing not less than fifty mature worms.

However, there is a pleasant and encouraging side to this type of unrestrained competition. Inefficient earthworm farmers are forced from the field, and men employing ethical business principles remain.

These are the men who thoroughly understand the remark of Phil D. Armour, of meat packing fame, who often said, "Any fool can

compete, but it takes intelligence to organize and produce a better article."

When the smoke of the Denver price cutting war had cleared away, a lone worm farmer remained in the field. He had refused to reduce his prices, principally because he contended he had a better earthworm for the followers of the piscatorial sport.

Being a fisherman himself, the Denver man knew he could catch more fish with a small, active worm than he could with lifeless sections of large worms. This man's belief has been frequently substantiated by tests carried on by both amateur and expert fishermen, in soft and hard water, in lakes, rivers and gurgling streams.

The "Soilution" earthworm, properly fed and properly placed on the hook, will live and remain active for many hours. In various practical tests, "Soilution" has competed with other types of earthworms, as well as with amputated pieces of earthworms.

It is apparent, therefore, that the entrance to this particular market for "Soilution" earthworms should be carefully planned and thoroughly examined before making a decision. This suggestion is especially sound if the prospective bait-worm farmer contemplates gambling on the necessary investment required.

The progressive poultryman and game bird producer are promising prospects for "Soilution" culture beds, for both, particularly the poultryman, are rapidly learning the value of properly fed earthworms as an aid to better poultry and better eggs.

An example of the interest shown in worm culture beds by modernly progressive poultrymen is emphasized by the following paragraphs extracted from a personal letter to the author late in 1937.

"Six years ago I knew very little about the poultry and fruit business. Today I own a flock of 1,500 splendid birds and have been exhibiting at many of the poultry shows throughout the West during the past three years, and I believe I have garnered my share of blue ribbons. Incidentally, my fruit tops the market and I give the lowly burrowing earthworm credit for much of my success.

"In educating the public in the value of selectively bred earthworms under control, you are doing a commendable and highly educational work -- a work that should prove beneficial and profitable to all progressive people who depend on the soil for their living."

This poultryman had a "Soilution" culture bed for five years. His records show, and they are substantiated by similar tests made by other poultrymen, that a laying hen will consume from five to seven

"Soilution" earthworms daily. This amount is seemingly the limit of both her capacity and her appetite for them.

Similar tests on ducks produced startlingly different records. One small flock of carefully watched growing ducks consumed a gallon of earthworms daily and repeatedly quacked for more.

At this point the reader may ask why, if earthworms aid in producing better hens and, therefore, better eggs, poultrymen have not turned in greater numbers to the operation of earthworm culture beds. This question, which is a reasonable one, deserves more than passing attention here.

There are two very sound answers.

First, many individuals have entered the poultry business with the false assumption that all that was necessary to do was to feed anything the feed store operator sold or recommended. In the past decade, starting in the crazy twenties, hundreds of thousands of Easterners and Middle Westerners were induced to trek to California and enter the poultry business. From 1920 to the year of the crash, a countless number of otherwise steady minded persons proved susceptible to the poultry raising bug in the southern portion of the Golden State. A vast majority of these individuals knew no more about poultry raising and breeding than an Amazonian native knows about a full dress suit.

The most, many of these would-be poultry raisers contributed to the industry was a number of discouragingly black pages in their own personal book of experience. Many of them found that their dream of fortune became a nightmare of misfortune.

In a lesser degree, these conditions prevail in various sections of the United States and emphasize what has been said in the third paragraph of this chapter.

The second reason why so many poultrymen are laboring long hours and using feeding methods that should be classed as belonging to the horse and buggy age, is the admitted fact that many poultrymen, in many sections of the United States, are indebted to or are actually in hock, to the feed man. These men dare not change their system of feeding their flocks for fear of reprisals, ethical enough, it must be gnanted, from the feed man.

This is a discouraging situation, undoubtedly due to our nationally strained economic system. What hope there is for these men, what exit there is from their present position, are subjects more in keeping with a book on political philosophy or economic reform than for this volume.

Suffice it to say that the free-from-debt-to-the-feed-store poultry man is at liberty to purchase his poultry necessities, at liberty to operate his

business, without being forced to abide by semi-dictatorial orders from outsiders. Undoubtedly this man has left behind him the former methods of more or less haphazard feeding and has gone forward.

Through the assistance of the earthworm, the progressive poultry man can produce eggs for less than ten cents a dozen -- a surprisingly low figure. In addition, he can increase the productive longevity of his birds and reduce the mortality rate of his pullets -- a rate that has exceeded fifty per cent in the state of California, according to reputable reports.

Inasmuch as a single laying hen will consume about 2,000 breeding worms annually, the poultryman must operate a fairly large sized culture bed.

Therefore, the progressive poultryman may be considered by earthworm farmers as a very good potential customer.

The truck farmer, the suburbanite with a small vegetable garden, the nurseryman, the home gardener and the orchardist -- all of these are potential buyers of properly bred, properly raised and properly fed earthworms.

Of this group, the one most in need of the earthworm as a natural cultivator and fertilizer is the orchardist, then the truck farmer, the small vegetable gardener, the nurseryman and the home gardener, in the order named.

To state that an orchardist can reduce his overhead practically fifty per cent by impregnating his soil with earthworms, may bring the cynical charge that such a saving is absurd. Yet the following facts, carefully examined, checked and re-checked, should cause the most cynical to realize that the immortal Charles Darwin did not exaggerate when he said that the earthworm is one of the world's most important animals.

Late in 1937, the following article appeared in the *Valley News*, Montrose, California:

"Near Redlands, California, is an orange grove that people come miles to observe. It demonstrates a unique natural method of orchard culture.

"This 40 year old grove stands out among its neighbors in a way that even a layman can see. The foliage is thicker, a richer green, even at the top where others of its age show thin foliage and bare twigs. The trees are well filled with fruit and records show that they produce crops just as outstanding as their appearance. But the truly remarkable thing about this grove is the fact that these results are obtained with less labor, less water, and less fertilizer than is used by any of the neighbors.

"The present owner took possession 17 years ago. Since that date, no plow, harrow or cultivator of any kind has been allowed in the grove. Weeds have been eliminated by hand labor. At first this caused extra expense; but since no weed is allowed to go to seed, a few hours labor once a month is now all that is needed.

"The absence of mechanical cultivation is the first puzzle which this grove presents to horticulturists, for the necessity of soil conditioning has long been recognized. Actually this need has not been ignored here, but the owner depends, not on machinery, but on the world's finest and most efficient plow, the lowly earthworm. He has created conditions which are favorable to earthworms and in response they have multiplied until they are more numerous than in other groves. Their network of burrows has aerated the soil far more effectively and much deeper than mere surface cultivation could hope to do. At the same time, the feeder rootlets, which in an orange tree are very near the surface, are left undamaged, and therefore ready to absorb a maximum of food.

"Even more puzzling to the orthodox grower is the fact that this grove thrives on less than 50 per cent of the water required by others. The answer once more is explained by the burrowing habits of the earthworms. They prefer the cooler soil under the trees and dig most of their burrows there, with very few out in the sunny spots. During irrigation; a large proportion of the water enters the soil through these burrows, with the result that most of it goes under the trees where the roots can use it, while much less than usual is wasted out beyond the root zone.

"But the fact about the grove which seems hardest of all to comprehend is its fine health in spite of what seems to be a very inadequate fertilization plan: a little synthetic nitrate occasionally, nothing else in 17 years. Once again the earthworms furnish the answer, this time by their digestive processes. Earthworms depend for food on dead organic matter, leaves, old roots, etc. Through digestion these substances are changed in character so that they are highly soluble and when ejected are immediately available as plant food. A close examination of litter under the trees reveals thousands of leaves which have been completely consumed except for a delicate skeleton composed of their veins. The worms have put this material back into the soil, for reuse by the trees. Without them, it would be a very long time before the same material would become available for plant food.

"The earthworm's gizzard triturates large quantities of soil which the earthworm takes into its body for two purposes -- one to make his burrow by eating his way in; the other to obtain from his food all the essential elements necessary to produce fertile eggs.

"New surfaces are thus exposed to the dissolving action of the irrigating water, and plant food elements are released which would

otherwise remain locked up inside the grains of soil. Couple this with the fact that earthworms work to a depth of 6 or 8 feet, constantly bringing new dirt from these levels to the surface, and it can easily be understood how trees can thrive for a long period without the addition of new feed elements to the soil.

"Earthworms are nature's own means of soil building and conditioning. No orchard or garden can do its best without them. There are many kinds, some much more effective than others, and the study of their use and culture will repay anyone who grows fruit and flowers."

The foregoing concerns fine, cultivated fruit trees, and the reader might consider them so developed that they respond easily and quickly to such experiments. While it is admitted that the antecedents of these trees have been more or less pampered by orchardists for many generations; that man, in his desire to force them to bear more and more fruit, has grafted and pruned and fertilized and sprayed; the fact remains that they have not responded to earthworm culture more easily or rapidly than the woody perennial trees growing wild on mountains and in forests.

Seedling pine trees have been impregnated with "Soilution" for the Forestry Service in the Sierra Madre Forest Reserve. Each treated tree is clearly marked and identified. The pines treated have grown in two years to a height usually requiring five years to reach.

On March 23, 1937, a wet, heavy snow blanketed the region Many four year old pines, whose soil was not treated with earthworms, were almost carried to the ground by the weight of the snow upon their branches.

On the same day, four small Conifer pines, which had not been impregnated with "Soilution", were bent double, while those which had been supplied with the elements Nature intended them to have, stood perfectly straight. These necessary elements were made available to the roots of the pines through the pulverizing action of the earthworms.

An ambitious earthworm farmer may very easily demonstrate the ability of the earthworm as a cultivator, triturator, chemist and distributor. He may do this on his own premises and interest all visitors desirous of improving the quality and quantity of their gardens, orchards, farms or truck patches.

Once the earthworm farmer has aroused the interest of these individuals, he may place demonstrations on their property where they may see for themselves how the earthworm improves plants.

Controlling Production

There is a method of controlling egg production of "Soilution" Earthworms which makes it possible to have a crop every month in the year, but this information is given only to people who wish to go into the business commercially.

The Earthworm

Little brown earthworm under the sod,
A trusted worker in Nature's plan,
Fulfilling his destiny, obeying his God,
Living his life as a friend of man.

East, where the Nile flows down from the hills
Covering the sun-baked thirsty soil,
An important place in the scheme he fills,
Bringing new life by his humble toil.

West, where the pioneer follows the plow,
Turning the sod to the sun and rain,
This little brown brother is doing his bit
To nourish the roots of the growing grain.

North, where the snow lies still and white
And the blustering wind blows cold and chill,
When the spring thaw comes you will find him at work
And October's Harvest can go to the mill.

South, where cattle roam Argentine's plains,
And grass grows tall 'neath the summer sun,
This busy fellow is doing his best
To make "two blades grow in the place of one".

-- *K.J. MCCREEDY, Los Angeles*

Part II

Introduction

EVERY living thing, be it a tender blade of grass or a giant oak, an infinitesimal germ or a human being, has one point in common with every other living thing -- it must eat.

And, though eating is as commonplace to human beings as breathing, most of us dig our own premature graves with our teeth -- if our teeth haven't given out before the grave is ready to receive the remains of a badly mismanaged and mistreated body.

In the light of present-day science and the ease with which knowledge may be acquired, one is forced to stand agape at the general apathy the public maintains in matters pertaining to food.

We need not go beyond our own circles of friends and acquaintances to have this fact brought to our attention. Who among us doesn't know of an overweight woman who greedily devours every dish before her, especially those containing sweets and starches? Or a thin, sickly woman who pecks and nibbles at what is placed before her?

Overeating and undereating bring premature destruction to countless thousands of individuals annually. The overeater deserves little if any sympathy, but the undereater is, indeed, a subject with whom we might well sympathize. Usually, this type of individual is putty in the hands of all and sundry food faddists, new idea dietetists and their ilk.

Someone long ago passed out the misinformation that the human body is a machine and ever since that unfortunate moment faddists and charlatans have hooked their financially profitable ideas to this erroneous statement, and, to use the parlance of the day, have "gone to town with it."

Fundamentally, the human body is no more like a machine than modern printing resembles the crudest of prehistoric methods of record keeping.

The human body, as Alexis Carrel clearly explains in his remarkable work, "*Man, the Unknown*," originates in a single cell and grows into a series of cells which ultimately become the manifold unity of a living, breathing individual.

A machine is brought into being by an entirely opposite method. First, instead of one small unit -- the single cell that is man's beginning -- there are hundreds of small parts which, when properly assembled and

fitted into their designated positions, make one complete unit, ready to function as its designer planned.

Feeding living organisms, be they plant or animal, poultry or man, should not be looked upon in the same light as one considers fueling one's automobile. In the latter case, gasoline, lubricating oil and water are required in all but a few air-cooled motors. The gasoline is the actual "food", with oil and water playing their roles of lubricating and cooling the mechanism so that the gasoline will generate power, or, if you prefer the analogy, life.

Living things demand more than one, two or three essentials to continue to live. The living organism is a highly complicated unit, with each component part requiring definite types of foods or fuel.

It is the hope of this volume -- though primarily designed to assist poultry raisers and breeders in developing a sounder and more economical system of producing better eggs at a lower cost, thus, consequently, producing better, healthier poultry -- to explain food values which may be applied by human beings to their advantage.

Though the writer does not accept the Freudian theory that each individual's life is controlled by his or her sex glands, he does accept the scientific and biological fact that in the sex glands of all living things are gathered by Nature the chief chemical and mineral elements necessary to bear or beget their kind.

And so, from this premise, I approach a subject hitherto eschewed.

-- GEORGE SHEFFIELD OLIVER

Part II

Lesson 1

What Is Food?

Various names for food -- Alexis Carrel, Nobel Prize winner, quoted -- Devitalized foods -- White flour -- Refined sugar -- Pasteurized milk -- We need a better Pure Foods and Drug Act -- How children suffer from improper foods -- Potency of procreative glands in animals and plants -- How religion has bred ignorance on this subject -- What are vital food energies? -- Errors poultrymen make in feeding their flocks

FOR the purpose of blazing a straight trail to the goal of Part II -- better eggs and poultry at revolutionary low cost -- it behooves us to consider food as nourishment for plant and animal life, including man. In a general sense, everything animals eat, and plants absorb through their roots, is food. In a more strict sense, food is any solid matter taken into the systems of plants or animals which serves to build up physical structure.

A food may be extremely pleasing to the optic, olfactory and gustatory senses, yet have no more food value than a tooth pick. Much of this deception was generated in, and promulgated by, commercial and industrial interests who were selfishly seeking definite financial gain rather than preparing and marketing food stuffs with high nutritional content. While these commercial and industrial movements were heralded as being for the common good -- though nothing was said about the greater profits accruing for the sponsors! -- the benefits derived by the public are, at best, debatable.

We need not go beyond three staple foods -- bread, sugar and milk -- to bring this fact prominently to notice.

"Our life is influenced in a large measure by commercial advertising," Alexis Carrel tells us in "*Man, the Unknown*." "Such publicity is undertaken only in the interest of the advertisers and not of the consumers. For example, the public has been made to believe that white bread is better than brown. Then, flour has been bolted more and more thoroughly and thus deprived of its most useful components. Such treatment permits its preservation for longer periods and facilitates the making of bread. The millers and the bakers earn more money. The consumers eat an inferior product, believing it to be a superior one. And in the countries where bread is the principal food, the population degenerates. Enormous amounts of money are spent for publicity. As a result, large quantities of alimentary and

pharmaceutical products, at the least useless, and often harmful, are thought to be necessary for civilized man. In this manner the greediness of individuals, sufficiently shrewd to create a popular demand for the goods that they have for sale, plays a leading part in the modern world."

Dr. Carrel's analysis of the promotion of white bread may be applied, and not inaccurately, to the popularity of refined sugar and pasteurized milk.

In the case of sugar, many of the most important elements have been refined out of the raw material, giving us a devitalized product. We know that refined sugar "looks better" on the table than raw sugar; that it is easier to shovel from the sugar bowl to the coffee cup and that it keeps indefinitely in our cupboard. These things we know, but advertising and publicity has led us to imagine refined sugar superior to raw sugar.

Pasteurized milk is the third staple which modern advertising has inveigled us into believing is superior to raw milk, regardless of the fact that pasteurization completely destroys many of the vitally important elements in milk necessary to good health.

Summed up, white flour, refined sugar and pasteurized milk are counterfeit foods passed off on a gullible and apathetic public.

A large percentage of our present day ills may rightly be traced to deficiencies in our food. Many of these deficiencies are traceable to the high-speed and high-production systems employed in modern plants concerned with the business of making, packing and canning food stuffs.

This is civilization. Perhaps the Oriental Sage was not far from the truth when he defined civilization as a deterrent to progress.

Every civilization has within itself a suicide germ. This germ is fed by collective and individual greed. It destroyed the Greek, the Chinese and the Roman civilizations, and, as we have seen in the introduction to this volume, it is gaining potency in America through the medium of monopolies. All about us on this whirling sphere national civilizations are cracking and crumbling. American civilization is cracking -- every reasoning person is cognizant of this. Will it crumble? That is a question only time will decide.

No race, no nation whose members are both physically and mentally deficient or deteriorating can stem the encroachment of racial or national destruction. And no race or nation can expect its members to increase their physical and mental development if it persists in permitting misinformation about food deficiencies to continue.

"But we have a Pure Food and Drug Act on our statute books in Washington," you say. Yes, there is such an Act, but it is as useless as a gunless submarine on the Mojave desert. If this act were rewritten, sincerely rewritten for the benefit of you and me and our children and their children's children, every sack of flour, every bag of refined sugar and every bottle of pasteurized milk would have in large letters, a statement reading something like this upon it:

"THIS IS A DEVITALIZED PRODUCT
IT HAS VERY LITTLE FOOD VALUE."

But the mere mention of a truly sincere pure food and drug act sends shivers up and down the spines of the financially powerful milling, refining and kindred industries, whose leaders commit the sin of omission by refraining from telling their customers the true facts about devitalized foods.

Dr. Carrel merely brushed the surface when he wrote that "In the countries where bread is the principle food, the population degenerates."

The unnatural conditions that follow in the wake of a continued diet of devitalized foods are destined to take their toll in weaker physiques, duller mentalities and in human lives.

The current generation of children is probably suffering more from food deficiencies than the preceding generation. This is partly due to the fact that a large majority of American parents have been forced, through economic conditions, to buy cheap food, or food of which they receive quantity rather than quality.

Another important factor, mayhap the chief factor, is radio advertising. The popularity of radio has made of this medium an ideal outlet for the fancy and romantic, albeit questionable, phrases of advertising copy writers.

"Eat Whitey's Wheat Wafers and become a football star."
"Breakfast on Betty's Baked Barley Blocks and win a husband."
"Drink more Pasteurized milk and lick your weights in wildcats."
"Give the kiddies Carter's Coddled Candy Cakes and watch how quickly they grow," and so on, ad infinitum.

Radio advertising is the height of psychological suggestion. Few, indeed, are the radio fans capable of entering a drug or grocery store without leaving with a bag, package or bottle of a product their favorite radio performer says is "tops."

In the relatively pathological scramble for more business, manufacturers of food stuffs are permitted by an apparently disinterested government to flood the nation with devitalized foods for

man and beast not a few of which are as valueless for nourishment as a rubber band.

This lack of necessary food elements in a growing child's diet results in the child actually gorging itself in an unconscious effort to obtain sufficient and proper nourishment. The stomach of such a child begins to distend, it is forced to distend in order to accommodate the unnatural and unreasonable amount of food is receives. In time, the child is never satisfied unless it has packed its unnaturally dilated alimentary canal until it feels, and actually is, full.

Though it is not generally known, the average American eats nearly five times more bulk than he needs. If this absurd condition continues, physiology text books in the years to come will refer to Americans as a mongrel breed of human beings noted for their Gargantuan stomachs. Certainly, this is not a complimentary prediction. Yet even today there are many stomachs distended to ten times their necessary size.

The consistent eating of dead or devitalized foods is quite probably responsible for the increasing, number of sterile men and women in America under thirty years of age.

The procreative glands, being composed of the richest elements that have been transformed by the various organs of the body, can not be supplied with those elements if they are not in the food consumed.

Continued dieting by motion picture actresses in an attempt to remain slender to meet the exaggeration of size produced by the cinematic camera have not only injured their general health, but probably their procreative glands as well. When the body can not receive sufficient elements from the food intake, it automatically turns to the procreative glands to supply the deficiency. This reservoir is eventually drained, resulting in a sterility that, more often than not, becomes chronic.

However, this reference does not mean that all normally-sized or obese women (or men) are fertile. Undue fat on the human frame does not denote health; usually it signifies the opposite. Fat-producing foods contain very insignificant amounts of the elements demanded by the procreative glands.

Except in instances where a physical abnormality is responsible, eating too much of the improper mixture of food may be rightly blamed for the supercargo of avoirdupois that is being hauled around by obese men and women.

However, human beings are not the only animals that gorge themselves. Many plants and domesticated animals glut, not because it is their nature to do so, but because their diet is deficient in one or more elements necessary for a healthful condition.

All of this may appear to be a roundabout approach to our subject -- poultry. Nevertheless, we shall presently observe that what has been said about food for human beings, aptly applies to food for all forms of life.

Let us now consider the difference between organic or live food and devitalized or dead (inorganic) food.

It is at this point that the classical bull is taken by the horns and a subject discussed that has been shunned by writers on food and food values -- the unequaled nutritional value of the procreative germ as food.

Our subject must be approached gently, for religious thinking in the past warns us that sex, in any form, is more or less taboo.

But no matter what one's religious theories may be, the fact should be accepted that life begins with sex. All living things owe their humble origin to sex, regardless of the method Nature employs in planting the fertile, procreative germ.

In this germ, infinitesimal as it is, Nature has combined all -- not one, or a few, or an incomplete group -- but all the vital necessities which, when blended with its direct opposite, produces a human being, an ant, an elephant, an orchid.

The vital qualities that are in the germ-plasm are what our bodies need. We receive one type of them when we eat wheat that has not been devitalized. Such a food is a "live" or "organic" food. When we eat bolted wheat, most, if not all, of these vital qualities are missing. Bolting has destroyed them. Such food is "dead," or "devitalized." Its nutritional value is practically nil.

Fruits, berries, nuts and all grains, if not devitalized by dehydration or cooking, are the quintessence of the richest elements from the mother plant, tree or bush.

However, these germ cells are not rich -- some are even sterile -- if the plants, like human beings, do not receive their necessary elements from their food, the soil.

The average person has no qualms about eating the germ cells of fruits, berries, nuts, grains and vegetables. Nor does he object to eating eggs, which, if fertile, contain procreative germs.

The genitals of domesticated male animals -- those whose flesh we approve as edible -- are both palatable and nourishing. Most persons balk at the mere thought of such a dish -- a delicacy when properly prepared. They will eat a fertile egg without a quibble, but make a wry face if the above dish -- colloquially known as 'lamb, sheep, pork fry,"

or "Rocky Mountain oyster" -- is suggested.

Carnivorous animals in their wild state will gorge themselves, not on the flesh of their kill, but upon the vital organs. Instinct instructs them that they will procure the most nourishing elements from these organs for their bodies.

Rodents in a wild state are not interested in eating the lifeless leaves of plants. They live almost exclusively on grains, kernels, berries and seeds.

Are we to assume from these natural facts that wild beasts and rodents have "more sense" than we? Certainly, from the light of present-day eating, we would not be far wrong were we to admit their superiority in the matter of eating what is nourishing and what is not nourishing food.

Poultrymen are committing a grievous error in feeding their flocks tons of devitalized foods annually. Within their grasp is enough vital food to bring them greater profits, more productive hens and more fertile eggs.

How this germ-food for poultry and game birds is acquired is the subject of the next chapter.

Part II

Lesson 2

The Germ Life and Better Poultry

"Acquired richness" explained -- The parable of two chickens -- Live food versus dead food -- Bacteria, good and bad -- Nature destroys so that she can build -- Dr. William Shakespeare Baer, American physician, "discovers" curative powers of fly maggots -- Medical profession fought him -- Why we abhor the word maggots -- How germs evolve -- The bluebottle fly

IN this chapter, the second forward step toward better poultry through natural foods, we shall move along lines similar to those discussed in the preceding chapter.

This method of approach may appear unnecessary, but the writer's experience in these matters prompts him to dally a little so that the reader may have time to construct a foundation from which to visualize the method expounded here of producing healthier and more prolific poultry.

As we have already seen, the procreative cells of all animals and plants are extraordinarily rich in vital elements. Many other parts of edible animals and plants may be (many are) rich in food elements, but this richness is not necessarily native to the animal or plant. It is an acquired richness and comes from the food the animal or plant subsists upon during its life.

It might be well here to describe briefly what is meant by "acquired richness."

Let us visualize two chickens. One is penned up in an ordinary yard. The soil is dry and dusty. The food fed this chicken is one of a number of commercialized poultry feeds, most of which are, as we have seen in the last chapter, devitalized. The other chicken is turned loose near the dairy. All day it scratches and pecks in the decomposed animal matter piled nearby. The owner of such a hen need not spend money for commercial feed.

The first chicken is suffering from food deficiency, whether its owner realizes it or not. The second chicken is enjoying a full life, replete with a balanced, natural ration of food from which its entire physical system draws potent nourishment.

How do we account for this? Simply by realizing the fact that the chicken pecking in the manure pile has been eating *live food*, the other, *dead food*.

That one of these foods is dead, the other alive, is easily demonstrated by taking a shovelful of each and planting it. The shovelful from the manure pile will, in due time, send up sprouts of grain, depending upon that eaten by the animal that dropped it, for not all live grain germs are destroyed by the animal's digestive system -- not even in the dual systems of ruminants.

On the other hand, the shovelful of dry soil, being void of any form of plant germ life, returns nothing for the effort expended in planting it.

The foregoing example brings us again to organic (living) and inorganic (lifeless) matter. Both the dry, dusty soil in the chicken yard and the pile of manure back of the dairy barn are scientifically classified as inorganic matter.

However, there is considerable life in manure. It contains millions and millions of bacteria, which, as every one knows, are infinitesimal organisms. Bacteria are also known as microbes and germs.

At this point the reader should accept the fact that there are beneficial as well as dangerous bacteria. Some of these, according to the germ theorists of the medical fraternity, are disease germs and will, if left alone, produce illness and death.

Probably man's greatest handicap in this (so-called) enlightened age is not so much the general ignorance that is prevalent regarding Nature and her methods as it is the misinformation and misapplication of known facts, which some "authorities" distort to their personal and collective financial gain.

That certain bacteria are destructive to animal and plant tissues is a fact -- a natural fact -- but Nature, in her own definitely evolutionary and omniscient way, has developed other bacteria to defeat the dangerous inroads of destructive bacteria. This is one form of the law of preservation. Were Nature to develop one bacterium, one small insignificantly-sized germ, without also developing an enemy to keep it under control, entire species of animals and plants would pass from this planet.

Once destruction appears in living matter, if Nature can not combat it, she appears to hasten its ruin. The result is ultimate death. And even here she does not stem her onward march to destruction. Decomposition is rapid in most instances of dead, once organic matter, for Nature is anxious to prepare that matter for consumption by other living bodies. This cycle is aptly condensed by the late Ambrose Bierce, the immortal San Franciscan, who probably deserves a

posthumous peerage in the realm of American satirists, when he described "Edible" in his *Cynic's Dictionary* as "good to eat, and wholesome to digest, as a worm to a toad, a toad to a snake, a snake to a pig, a pig to a man, and a man to a worm."

(It is worth a parenthetical note here to say that only the lifeless remains of once living matter decays and decomposes rapidly. Inorganic matter, like rocks, for example, do decay and ultimately decompose, but the process is slow and drawn-out, lasting thousands of years. The reason for this is explained when we realize that Nature can put such inorganic matter to little use as food for her various species).

Bacteria, good and bad, have their place and their function in the laws governing all living things.

These minute creatures are everywhere; in the air we breathe, the water we drink and the soil we plough. Without them, you and I would not be here. We -- all living animals -- feed, to a greater or lesser degree, on plants. Plants in their turn, feed upon water, carbon dioxide and the nitrogens and other salts.

We know where plants receive their needed water and carbon dioxide, and we should know that they receive their necessary nitrogenous salts from but one source -- bacteria -- and that bacteria, in their turn, receive their necessary nourishment from a few minerals.

In short, bacteria are the beginning of animation, of life. Beyond bacteria is inanimate matter, lifeless rocks and colloidal substances.

So we see that the chicken pecking in the manure pile has a veritable storehouse of living food, countless trillions of minute bacteria, rich in the necessary food values its feathered body demands.

In rich soil, too, soil moistened adequately with water, countless other trillions of bacteria exist. The eminent naturalist, David Starr Jordan, has pointed out that he has found over four million (4,000,000) bacteria in one gram of such soil.

Let us now return to the procreative germ, the germ of life produced in healthy, mature animals and plants. This germ is the rudimentary element, the primary source of everything that lives, the earliest stage of an organism, the cause, origin, principle and prime mover of all life.

Though science has discovered many interesting and astonishing things about germs -- both procreative and bacterial -- there still remains much to be learned about these minute organisms, many of which are so infinitesimal that they are barely visible under a strong, microscopic lens.

Until the World War period, the maggots or larvae of flies were considered as filthy and disease-bearing as any creature known to man.

It was the late William Shakespeare Baer, an American M.D. working with the French forces, who first came upon the bacteria-destroying ability of fly maggots.

Two *poilus* were brought to the hospital where Dr. Baer was stationed. They had lain for a week behind bushes, minus food and water. Each had a thigh horribly smashed, and the shattered bones protruded through the skins, and the wounds extended into each abdomen. According to all medical science of the day, both men should have been dead. Yet they were alive, conscious and hungry.

When Dr. Baer examined these men, he found their wounds a teeming mass of fly maggots. When he cleaned them away, the flesh and bones were bright and clear and healthy. There was not the slightest trace of a disease-bearing germ anywhere in the wounds. The fly maggots had destroyed them.

With the passing of years, Dr. Baer experimented with fly maggots. He worked on the theory that they were more efficient workmen than the finest surgeon with all his modern sanitary methods, sterilized instruments, operations and amputations.

Naturally, such a theory did not set well with certain members of his profession, but Dr. Baer cared little about them. He thought of the two French soldiers, of how they lived when they should have been dead, and of the hundreds of children suffering from *osteomyelitis*, a pernicious rotting of bone marrow and bone structure.

In the Children's Hospital in Baltimore, of which he was the head, Dr. Baer bred fly maggots and placed them in the openings he made in the afflicted flesh. Against what appeared to be concerted objections by the medical fraternity, he carried on his work. He fought strenuously against those whose aversion to anything new or revolutionary is common knowledge.

And Dr. Baer cured those children -- or, rather, the maggots of flies cured them!

Though the story of Dr. Baer's work and struggle deserves considerable space, there is, unfortunately, no room for it here. Suffice it therefore, to conclude that fly maggots are used extensively today by the medical fraternity as destroyers of many disease germs, all of which proves the point desired, i. e., that many destructive germs can be destroyed by other germs if we but give these friendly germs a chance to work for us.

For centuries the medical profession has been teaching the general public to scowl at the mention of the word "maggot." Accordingly, the average person has generated both an aversion and a hate for the word. One may actually question if its use in polite society is permissible. To the average mind, "maggot" is synonymous with filth, offal, danger and disease.

And now the medical profession finds itself in the ludicrous position of expounding something it has hitherto warned against.

Appreciating the general dislike for the word "maggot," it will appear from now on in this work under its other name, larva.

Thousands of germs never pass the germ stage. That is to say, certain germs live and die as germs. Others go through varied forms of evolution. All germs begin life as single cells. Those that are destined by Nature to evolve into a higher plane, join another germ.

Nature employs a variety of systems to perform the task of impregnation. In higher animals, including man, the single male and female germs blend and produce the embryo. Here, the evolution of the single cell germ is made in one remarkable step.

In certain insects, the fleshfly, for example, the change from the procreative germ to the living, ultimate fly is performed by a circuitous route.

The fleshfly, of which the bluebottle is probably the best known, lays her eggs, many hundreds of them, in decayed or decaying animal flesh. In from two to three days these eggs hatch into small, white worms or larvae. In time, a sort of shell or cocoon forms around the worm. It enters a dormant period, during which the former worm is being slowly transformed into a fly. Upon the completion of the transformation, a full-grown bluebottle appears.

It is the intermediate stage that spans the egg to the fly with which we are especially concerned, and in a later chapter it will be referred to again at some length.

Thought, immaterial though it may be, is the matrix that shapes the issues of life. The mind has been active in all fields during this fruitful century, but it is to science we must look for the thoughts that have shaped all thinking.
-- Selected.

Part II

Lesson 3

Economical Poultry Housing

Poultry business in California -- Brief background of poultry colonies -- Promises made by promoters -- Poultry housing costs -- Buildings designed by "experts" -- Cost exorbitant -- Modern hennery simple to build -- Cuts housing cost down from one-tenth to one-thirtieth of general cost -- Better chance for profits when poultry housing investment is low

IN California, particularly Southern California (and in other sections of the United States to a lesser degree), there are acres and acres of empty and dilapidated poultry houses. These slowly disintegrating buildings are the ghosts of the dreams of thousands of individuals who "got the bug" to enter the poultry business and make a fortune "selling eggs." Crumbling, grim reminders of individual tragedies, they stand today as potent examples of what usually results from get-rich-quick schemes.

And, in addition to these ghosts of misapplied dreams, California is dotted with the decaying remains of poultry colonies, those highly-touted, co-operative organizations with the magnetic slogan "One for All and All for One." Usually this plagiarism from Dumas' "*The Three Musketeers*" proved beneficial to but one, and that one was the promoter. Gullible prospects invested in these colonies for a few dollars down, the balance to be paid from the profits made from the poultry.

Great, indeed, have been the glowing promises made to potential poultry farmers, especially in Southern California. The ghost towns of the gold regions of the state are insignificant in number when compared with the ghost poultry farms in Los Angeles County alone.

It appears safe to state that a vast percentage of those failures was due to an unnecessarily high cost of housing the poultry as well as the high cost of feeding.

This chapter deals with the problem of housing the poultry economically. In the following chapter the problem of feeding poultry economically will be discussed.

According to so-called scientific methods, housing poultry runs from one to three dollars per bird. These henneries are frequently designed by "authorities," but when these "experts" are investigated, one usually

discovers that they are men who have never raised a chick, and while these houses appear attractively practical, they lack much that a poultryman needs if he expects to make a profit on his investment.

The cost of these poultry buildings range from one thousand to three thousand dollars and are intended to house up to a few thousand birds. Considering the maximum returns from eggs and meat birds, such an investment is definitely out of proportion.

All of this probably sounds fantastic to the average active poultryman; yet, if he is honest with himself, he will agree that simple mathematics prove the fallacy of such an investment for poultry housing.

I am personally acquainted with many active poultrymen. They are hardworking, conscientious men, laboring an average of twelve full hours every day of the year, including Sundays and holidays.

Some of these men have sound, healthy flocks. Their business should show a net profit of from one to two dollars per bird per year. Many of them keep no books and can not come within fifty per cent of accurately estimating what it costs them to produce one dozen eggs.

I have discussed poultry housing costs with the most successful of these men and none of them have taken issue with me when I said that any poultryman whose housing costs run to one dollar a bird -- which is probably an average cost -- must face the undeniable fact that, from eggs alone, a hen will spend her entire life paving for her housing.

It is my contention, and I hope to satisfactorily set forth enough facts in this volume to substantiate this belief, that any poultryman whose housing cost runs above fifty cents per bird is destined to ultimate failure unless he is financially able to forget the interest due him on his original investment.

But, you will say, you have been told that in a couple of years you will have paid off the original investment in the building or buildings out of the profits of the business.

Let us figure this profit.

Out of the revenue brought in by the hens, after deducting for the mortality, feed, wages, water and whatnot, one must consider the original cost of the flock, taxes, insurance and interest on the money invested in the ground space used, and whatever is left may then be applied on the original housing cost.

One can readily understand how long it would take a hen to pay her housing bill of from one to three dollars, assuming that the net profit of the hen (that is, the amount over and above the expense of her general upkeep) should be from one to two dollars per year. It is easily

understood that the struggle to meet this indebtedness is usually extended over a period of several years -- if the poultryman lasts that long.

Let us concern ourselves now with the writer's idea of a wholly practical and extremely economical hennery.

Let us assume that we have approximately 400 square feet of land available for use for a hen house. On this we shall construct a hennery for the housing of 100 fowls.

In shape, our hen house may be square, rectangular, round, hexagon or any shape suitable for the space to be used.

The construction of the hennery is simple. It may be built where it is to be placed, or in sections in the workshop. The material used is reasonably priced -- and new material need not be used if other suitable material is at hand. This consists of lath -- or batting if stronger construction is required -- one by two inch boards and wider boards for the bases. Half inch pipe sufficient to supply water, some wire netting and a small amount of hardware complete the building requirements.

Including labor costs, whether of your own or those of a handy man, the total cost of such a hennery should be in the neighborhood of fifteen dollars -- or fifteen cents per hen! [With prices differing in various sections of the United States for chickens, and with certain breeds running higher than others, the writer at no time attempts to include an estimate of the cost of the flock.]

This fifteen cents per bird is a surprising figure, as any active poultryman will agree. It is from one-tenth to one-thirtieth of accepted poultry-housing figures -- and it should take the hen from one-tenth to one-thirtieth as long to pay for it!

Some years ago the writer constructed a hennery to prove to skeptics that his theory regarding hen houses and poultry feeding was practical. No effort was made, nor was it intended, to make this hen house anything but an experimental and demonstrational enclosure. Nonetheless, it definitely and conclusively proved its worth and admirably demonstrated the fact that better poultry can be successfully raised in compact confinement.

The reader should not jump at the conclusion that this type of hen house requires the elimination of a "scratching shed" or "run yard" beyond the confines of the hennery proper. If space is available, it may be used, especially if the poultryman insists his hens need more room for exercise.

What is inside this small, compact, yet wholly practical hennery? Having a clearance from ground to latticed roof of but two feet, there

can not be much room for anything, you may contend.

But there is all the room needed when the hens are scientifically fed.

I can best describe the "furnishings" of this hennery by taking the reader into the next chapter, for here the interior of the hen house is tied in tightly with the feeding of the poultry what I am pleased to call "Intensive Range."

Part II

Lesson 4

The Interior of the Economical Hennery

Popular poultry feeding systems will not work with Intensive Range -- Why poultry is destructive to gardens -- Poultrymen should take advantage of this knowledge -- Fowls should not be forced to glut to receive non-deficient foods -- Two methods of feeding Intensive Range -- Building the economical hennery -- Where earthworms come into the picture -- How to make an earthworm pit -- Henhouses for large poultry flocks

IN the preceding chapter the writer maintained that it is possible to construct a hennery to accommodate 100 hens for the small sum of fifteen dollars. A more definite explanation of its construction was omitted because there are a few highly important features necessary to meet the requirements of my system of feeding which must be explained before actual construction of the henhouse can be described.

Any hennery constructed after the general style described in the foregoing chapter, no matter how masterfully built, is not worth the space it covers if the poultryman does not follow the system of economical poultry feeding explained in this work.

To attempt to feed hens under any of the popular systems in such a henhouse would spell ruin for the poultryman.

The writer's sole aim here is to point out to the reader the road to economical poultry raising by feeding Intensive Range, and proper housing facilities for this system of feeding are necessary.

We must not lose sight of the fact that devitalized foods, for man, beast or plant, cannot furnish proper nourishment. Such food is responsible for the unnatural overloading of the digestive organs. This point is emphasized here because we are about to describe the natural food for poultry, one that has been distressingly pushed aside -- live food!

The poultryman does not have to be told that poultry is destructive to gardens, and the reason for this is that the fowls prefer sprouted seeds, insects, larvae and earthworms to all other varieties of food.

Admitting this fact, and it would be foolhardy to deny it, why do poultrymen continue to feed their flocks dead or devitalized food?

This is a question over which I have pondered these forty odd years. Why? Why? Why?

The term "Intensive Range" which, in due time, will be thoroughly described, was so selected by the writer because the food provided therein contains, in a small compactness, all the food elements that game birds and poultry can find on the range.

Intensive Range provides fowls with the necessary 18 per cent of albuminoids, 7 of fats and 75 of carbohydrates, which are approximately the percentages Nature intended. Fowls fed on Intensive Range will not have to gorge themselves in an attempt to obtain these essential food elements.

But before I yield to the temptation to wander too far afield, let us return to the construction of the interior of our hennery.

There are two methods of feeding hens Intensive Range, each economically productive. One of these is by means of "trays." The other, by utilizing the soil of the floor of the henhouse.

The first system is best to use for smaller flocks of poultry and where the ground space is limited.

The second method is more suitable for large flocks, ranging upward of a few hundred.

We shall begin with the first or "tray" method.

If the poultryman with a small flock of birds constructs the type of hennery discussed in the preceding lesson he should follow these general instructions:

Regardless of the shape (which is left to personal initiative) it should be lathed on the sides and top with a space between the laths sufficient for the hens to protrude their heads.

Adequate roosts should be built half way between the floor and the latticed roof directly over a pit three feet deep which has previously been excavated, then filled with about one-half manure and one-half peat moss (wood shaving or sawdust, if moss is not available). It is into this pit that we put our friends, the earthworms.

In the writer's experimental hennery 50,000 earthworms were originally placed in the pit. The reader should not be surprised at this seemingly Gargantuan amount. Earthworms are prolific breeders, and when properly raised will multiply at an astonishing rate.

It has been demonstrated that this large number of active earthworms are necessary for the above-described pit. A lesser number can not perform the expected work efficiently.

Once the pit is prepared, it should be covered with ordinary chicken wire, raised sufficiently to defeat any attempt of the chickens getting into it. Wire should also be placed upright around the edges of the pit to prevent the chickens from getting into the area from the sides.

The principle of the earthworm pit, in this, the "tray" method of feeding, is twofold.

First, the worms dispose of the hens' droppings, thus eliminating the unpleasant odor that is common to all ordinarily-operated poultry yards, and eliminates the disagreeable task of cleaning the henhouse.

Second, as the worms multiply, they burrow beyond the limits of the wired pit and thoroughly impregnate the ground. Once in this outer area, the scratching hens will unearth and eat them.

Repeated studies and observations lead us to believe that hens will not eat more than from seven to nine earthworms a day, provided they are fed vitalized food such as that contained in Intensive Range.

The original filling of the earthworm pit is all that is needed. A hen's average droppings approximate 75 pounds annually. This amount of fertilizer (from 100 hens) assures the replenishment of the pit permanently.

The water supply should be planned so that the overflow from the hens' drinking fountain will find its way into the pit which, at all times, should be kept moist to a degree bordering sogginess.

Nests should be conveniently placed, both for the hens and the individual who collects the eggs.

The poultryman should also prepare an earthworm master pit, or culture bed, beyond the confines of his new hennery, for the sole purpose of furnishing castings for the "trays," for earthworm castings make the finest rich soil. It is in this soil that Intensive Range is prepared.

Intensive Range for fair-sized flocks is best prepared in wooden boxes. For small flocks, one hundred or less birds, I have found discarded wash basins, many of which may be purchased at secondhand stores for a few pennies, ideally suited for this work. However, almost any type of container may be used with more or less satisfactory results.

Intensive Range "trays" are filled with earthworm castings, peat moss (or substitute) and grain. (See Lesson 5.) The "trays" are then set aside and left until the grain sprouts. The contents is then dumped out and placed outside the pen, but within reach of the fowls through the slats.

For the second method of feeding Intensive Range -- which is more suitable for large flocks -- we must build a somewhat different hennery.

The same general principles are followed as in the first hennery for the first method of feeding with provision added for sprouting the grain in the scratching area of the pens.

Each hennery, therefore, must be divided into two compartments or pens, to be occupied alternately.

My personal opinion in regard to large flocks of poultry is that henhouses, similar to those already described, be constructed with accommodations for from 15 to 25 birds.

My preference for these buildings is about 8 feet long, 8 feet wide and 2 feet high.

Earthworm pits are provided as in the first method, to take care of the hen's droppings and propagate the worms, some of which escape into the outer scratching area. The hens occupy one side of this enclosure while the grain, which has been sown in the other side, is sprouting in the scratching area, now rich in earthworm castings from the worms that have made their escape from the pits.

The grain sprouts in from seven to ten days, at which time the hens are moved back into this pen and the same procedure is carried out in the other compartment.

Assuming that I have covered the construction of these particular types of henhouses as well as this volume permits, the reader is now ready to learn more about Intensive Range, of which the following chapter concerns itself.

Part II

Lesson 5

Intensive Range

Intensive Range -- Its development through the years -- More about devitalized foods -- What Intensive Range will do for poultrymen -- How to prepare it -- Making the trays -- Do not overfeed poultry -- Fat hens are poor layers -- Intensive Range is a balanced diet, replete with all of Nature's elements necessary for healthy birds -- How to sprout grain

I APPROACH this chapter as I imagine a dramatist would when he brings his leading character to the climax, for this chapter is, indeed, a climax, not only of this volume, but of many years of experimentation. I have labored through many an anxious month awaiting the outcome of one or more experiments, and, if they failed, which many of them did, I figuratively hitched up my belt and started the nerve-racking tasks all over again.

Now, in retrospect of the twenty years of experimental work with Intensive Range, it seems as if it were only yesteryear when I first attempted preparing a natural food for poultry in compact containers. Through those years I have changed plans and experimented and changed them again, until today I wholeheartedly believe I have succeeded in developing a natural food for poultry that will stand the severest of investigations.

I would probably be charged with sophistry were I to expound Intensive Range as a perfect poultry food, but I fear no such charge when I indite that Intensive Range has more of the qualities that constitute perfection than any other poultry food.

It should be noted that I do not refer to Intensive Range as a "formula." In cycles of more or less annual occurrence, farm and agricultural journals give space to articles that invariably presage a millennium (that never arrives) for poultrymen through a new poultry feed formula.

To the active poultrymen, these formulae are old, old stories. As yet, no genuine revolutionary commercial poultry feed has been brought to my attention, though steps in the right direction were taken when dehydrated seaweed (kelp) was added to poultry feed.

I say "steps in the right direction," because seaweed contains thirty-five of the forty-eight known elements found in the sea. As a food adjunct, for man, beast or fowl, I can not muster enough praise for this marine plant.

Spasmodically exploited and usually short lived formulae merely add confusion to an already distressingly confused business, a confusion traceable, I believe, to the various claims made by many commercial poultry feed manufacturers and dealers, wholesale and retail.

A large majority of these commercial feeds, many of them devitalized, are far removed from what are naturally the best regimen for poultry; and these feeds are, in my opinion, driving the domesticated fowl farther and farther from their true nature.

In spite of the large part domesticated poultry plays in man's dietary of the present day, these fowls and their eggs are actually late additions in his cuisine.

[All of the represented types of poultry -- Sebright Bantams. Black-Breasted Red Games, Dark Garnish or Indian Games, Japanese Bantams, Silver-Spangled Hamburgs, Pit-Games, La Fleche, White Leghorns. Black Langshans, Buff Cochins, Partridge-Cochins, Light Brahmas, Mottled Javas, Barred Plymouth Rocks, Silver-Gray Dorkings, Houdans, White-Faced Black Spanish, Black Monircas and White-Crested Black Polish --have come down to us, through various degrees of breeding and crossbreeding, by a circuitous route from India. To citizens of Burma probably goes the credit for being the first to domesticate fowls, perhaps about 2000 B.C. Later (about 1500 B.C.) domesticated fowls appeared in China. From there they were introduced to Europe, thence to the Western Hemisphere. No mention of fowls or poultry is made in the Old Testament, though eggs (probably of birds of the air) are referred to four times, in Jeremiah, VII:11, (about 600 B.C.); Isaiah X:14. (about 710 B.C.); Deut XX:11-6 (about 1450 B.C.) and Job BI:6 (about 1520 B.C.). The New Testament refers twice to hens and thrice to cocks. It is also interesting to note that the early Britons would not eat domesticated fowls, tabooing them as they did the hare and the goose.]

Until about half a century ago, most domesticated birds in the United States were raised on feed that contained much of the necessary food elements their feathered bodies required. Then, with the coming of Big Business, and, later, exploitation of poultry as a get-rich-quick enterprise, poultry began to be fed more and more on commercial feed.

For the most part, poultrymen of the last two or three decades seemingly have forgotten how their fathers and grandfathers raised chickens. The modern poultryman appears completely satisfied with the knowledge he receives from advertisements that blandly promise –

too often in ambiguous phrases! -- unbelievably wonderful results from the advertisers' feeds.

I have talked to many poultrymen who consider themselves modern. Many of these men look upon the manure pile as an abomination. In my heart I actually pity believers in this form of modernism, just as I pity the individual who knows the earth is flat. Both individuals are in a mental mire from which no man can extricate them. Their only escape is through the proper use of their own reasoning faculties.

In offering Intensive Range to the poultry world, I do so convinced that it will be received by two general types of persons.

On the one hand will be the poultryman who will realize the value of live food for his flock and will welcome the information I have to give; on the other hand will be the Sir Oracles who propound as infallible the virtues of their own methods of feeding poultry regardless of the facts that the mortality rate of their flocks is high, the cost of producing eggs is not below that considered an average minimum and their feed bills run unreasonably high.

For the latter type of person I paraphrase Emerson: "Condemnation before investigation is a barrier that will hold any mind in ignorance."

Conscientious preparation and feeding of Intensive Range will produce benefits all poultrymen seek, but few find. Each of these benefits, which I emphasize by numerical classification, is a cardinal point sought after by all poultrymen.

Intensive Range will --

1. Reduce the feed bill about 50 per cent.
2. Reduce the cost of egg production about 50 per cent.
3. Reduce poultry mortality rate appreciably.
4. Reduce anatomical disorders in poultry.
5. Reduce poultryman's labor appreciably.
6. Increase the average longevity of fowls about 50 per cent.
7. Produce more fertile eggs.
8. Produce better meat birds.
9. Eliminate "bare backs," or nearly featherless birds.
10. Eliminate henhouse odors and cleaning.
11. Eliminate the feeding of meat.
12. Supply the fowls with pepsin. (See Lesson 6).

These benefits are accomplished because Intensive Range is based on natural laws regarding food energy. Fundamentally, these laws evolve from the basic principle that all animal life is dependent, directly or indirectly, on vegetable life.

Ages before being domesticated, fowls lived on insects, insect larvae and the live seed germs of plants. Were fowls permitted to return to their native state, they would soon seek out this kind of regimen, and, in time, would probably redevelop their wing spread and power to take once again to the air, as their distant antecedents did in the ages agone.

Why, then, should we not feed these fowls what is by nature their proper food?

If the reader agrees with me that chickens should be thus fed, he will readily see how and why Intensive Range provides a natural food supply for them.

For small, fair sized flocks of poultry, Intensive Range is prepared, as previously noted, in trays.

The equipment and material needed consists of --
A. Earthworm castings -- from the master pit.
B. Earthworms -- not more than twelve.
C. Peat moss -- or substitute.
D. Grain -- barley, wheat or oats.
E. Fish Gills -- or other fish, meat or fowl offal.
(See Lesson 6.)

In the earthworm castings, the soil, having passed through the digestive apparatus of the earthworm, has been thoroughly triturated. This treatment of the soil breaks down most, if not all, of the chemical and mineral elements and properties, making them more easily available to the roots of the grain, thus adding to the quality of the roots and sprouts.

The container in which Intensive Range is prepared should be filled with mixture of --

- One third castings;
- One third peat moss (or substitute);
- One third grain.

The "Trays" are then set aside and kept moist until the grain sprouts, which takes from seven to ten days, depending on the temperature.

In cold weather, the "trays" may be artificially warmed, thus assuring the grain germs enough heat to germinate and grow. Care should be taken not to overheat the Intensive Range.

When the grain has sprouted, the contents should be placed outside the hennery, but within reach of the fowls.

The writer considers one basin of Intensive Range sufficient to feed twenty-five hens for two days. Once the poultry raiser has prepared a

few basins of Intensive Range, he will find that a basin can be prepared in less than three minutes.

In addition to Intensive Range, poultry should be fed (at night) dry grain (preferably wheat), about one pint to twenty hens. One must regulate the amount of grain according to the fatness of the fowls. Do not allow them to get too fat. Fat hens are poor layers.

Grit should also be supplied, preferably shells which supply a goodly portion of lime.

Persons with small flocks will, in a short time, keep sufficient "trays" under preparation, so that when one "tray" is consumed another will be ready to take its place, thus keeping the chickens constantly supplied with live food.

All ages of poultry will benefit from Intensive Range, from very young -- for whom this method is exceptionally beneficial -- to very old.

For larger poultry farms, Intensive Range is prepared inside the enclosure of the hennery by utilizing the scratching area.

While the birds (divided according to your personal idea, from ten to twenty-five chickens to a unit) are cooped in one side or compartment (see preceding lesson), the grain is sprouted in the other.

Here we follow the same general principle as when preparing Intensive Range in "trays." The scratching area, being impregnated with earthworms and their castings from the pits under the roosts, is permanently ready to be planted in grain. The amount planted here is governed entirely by the area the poultryman wishes to cover.

Grain planted in hennery soil will, in warm weather, take root and sprout within ten days. In colder weather it may be found necessary to cover the hennery with canvas, something that should be done in all severely inclement weather.

We shall now move another step forward, into Lesson 6, where we shall observe the part the bluebottle fly plays in Intensive Range when properly put to work by poultrymen who seek sound profits; there, too, we shall observe some further facts regarding food for poultry, intelligent management of the poultry farm, and a few points that should be indelibly impressed on the minds of all persons desirous of receiving profitable returns from their investment in henneries, stock and feed.

Learn to keep the door shut, keep out of your mind and out of your world, every element that seeks admittance with no definite helpful end in view.
-- George Matthew Adams

Part II

Lesson 6

Putting the Bluebottle Fly to Work

The truth about flies being enemies of man -- J. Henri Fabre quoted -- Subject of fly larvae should not be considered obnoxious -- Potency of the house fly -- Pepsin -- Fly larvae high in this necessary element -- Preparing trays to trap the larvae -- How to encourage the "blow" where it will be beneficial for poultry -- This system is sanitary, and, when properly operated, will very likely rid the poultryman's house of annoying "blowflies"

COUNTLESS ages before homo sapiens evolved from some yet undetermined anthropoid, various small, two-winged insects flitted about heaps of decaying animal and vegetable matter. Among these were insects which we have come to call flies.

To the ordinary person of so-called civilized areas of the earth, the fly is a pest to be ensnared on sticky paper, trapped, swatted or cursed according to individual inclination.

Thoughtless persons might imagine that if flies were banished from the earth, this swirling sphere would take a long stride toward becoming a paradisical place on which to live. However, if such an extermination were humanly possible, which it is not, instead of the earth becoming a paradise, it would quite likely become much more of a hell than it is now claimed to be by pessimists.

Since modern medicine became so interested in public health and sanitation, we have been taught, from earliest school days, that the fly is an abomination, a bearer of disease, epidemics and death.

With no desire to "stick out my neck," I shall not deny the element of truth found in those statements, but I do object to any system that offers through our educational channels a half-truth. And to claim that the fly is only a bearer of sickness and disease is a half-truth.

Science is quite cognizant of the good work the fly performs in life; a good work it was performing long before man acquired the ability to use or misuse drugs and surgical instruments.

"The larva of the fly," says J. Henri Fabre, "is a power in this world. To give back to life, with all speed, the remains of that which has lived, it macerates and condenses corpses, distilling them into an

essence wherewith the earth, the plant's foster-mother, may be nourished and enriched... " There are hosts of these larva "to purge the earth of death's impurities and cause deceased animal matter to be once more numbered among the treasures of life," Fabre declares in his remarkable book, "The Life of the Fly."

[Jean Henri Fabre (Faw-br) was born in France, December 21, 1823, and died October 11, 1915. He was a schoolmaster, Professor of Philosophy and a scientist of immortal note. His literary works include, "*The Life of the Fly* " -- which every reader of this volume should read -- " *Insect Life*," "*The Life of the Spider*," "*The Mason Bees*," "*Bramble Bees and Others*," "*The Hunting Wasps*," "*The Life of the Caterpillar*," "*The Life of the Grasshopper*," "*The Sacred Beetle and Others*," "*The Mason Wasps*," "*The Glow-Worm and Other Beetles*," "*More Hunting Wasps*, "*The Life of the Weevil*," "*More Beetles*" and "*The Life of the Scorpion*." Fabre's works show a minute and sympathetic observation of the habits and lives of insects. Charles Darwin was a sincere admirer of Fabre and bestowed upon him the title of the "incomparable observer." Fabre wrote in a friendly, intimate and absorbing style.]

As the reader may have observed, a few references have been made to the fly in previous chapters. I purposely did not go into detail regarding this insect and the part poultrymen may easily make it play (and pay) in producing better poultry. I saved what I have to say about the fly and its eggs and larvae for this chapter. Here I shall devote sufficient time and space to the subject without confusing it with other matters.

For the past two decades I have found it practically impossible to discuss this matter without having the subject changed by listeners; as if speaking about flies and their eggs was a forbidden subject.

This disinterested reception of what I know to be beneficial facts (substantiated by reputable men of science) is, to say the least, discouraging. Many times I have resolved to cease attempting to point out the value of the fly to poultrymen, for it seemed to me to be a waste of valuable time trying to interest apathetic individuals in putting the fly, particularly the bluebottle, to work.

I have realized for many years that this subject is eschewed because of the wholly black reputation given the fly. It is to be admitted that flies can, and do, carry bacteria on their feet and the hairs of their legs and bodies. That these bacteria have, and do, infect humans is also admitted. But accusing the fly as the arch criminal in this matter is merely excusing the ignorance, carelessness and apathy of the general public.

The healthy human body, the body nourished by non-deficient foods, is quite capable of throwing off the bacteria brought to it by the fly or any other medium. It is the weakened body, the poorly and improperly-fed

body, that is susceptible to illness. Such bodies are fertile breeding grounds for disease bacteria.

However, in the fact of this general attitude toward the fly, her eggs and larvae, I am determined to approach the subject without further detours. No matter how much the reader may object to this subject, he can not interrupt what I have to indite. Of course, he may set aside this volume or skip this chapter. He can very easily close his eyes and mind to the facts I have gathered here. After all, it is up to the reader whether or not he wants to increase his knowledge and raise better poultry by putting the bluebottle fly to work.

Flies, like all other living things, are divided by naturalists into species. These cover a wide variety, extending from the small, gnatlike fly to insects very closely related to beetles.

Our concern is especially with the common housefly, of which there are a number of species. Common names for these are blowflies, horseflies, fleshflies, screwflies, gray fleshflies, greenbottles and bluebottles.

All of these are classified by science as *Luciliae*. Loosely defined, this means flies that glitter. These are all familiar to us, even if we can not distinguish one from another.

Reclassed for our purpose, I divide these flies into three groups:
A. Greenbottle.
B. Gray fleshflies.
C. Bluebottles.

The first two species are not given to haunting our kitchens, though both of them do pay occasional visits to the culinary department when attracted by strong cooking odors.

It is the bluebottle that despoils our poorly protected viands. She is the "blowfly" whom all housewives abhor, mayhap curse femininely under their breaths.

However, both the greenbottles and the gray fleshflies also "blow." That is to say, they select a suitable piece of decaying animal or vegetable matter and, in some dark recess, "blow" the contents of their ovaries into it.

During this egg-laying period, which varies between species, each fly lays from 100 to 600 eggs, or, as in the case of the fleshfly, hundreds of live larvae or grubs.

One mathematically-minded writer has shown that the progeny of one housefly -- from May 1 to September 30 -- will number three trillion, nine hundred and eighty-five billion, nine hundred and sixty one

million, seven hundred and fifty-five thousand, one hundred (3,985,961,755,100).

In the case of a bluebottle -- henceforth we shall dismiss the gray fleshfly and the greenbottle -- the eggs hatch in about two days, if the weather is warm.

From these eggs appear small worms, 0.029 of an inch in length. In a wriggling mass, the worms instantly begin to seek nourishment.

"They do not eat, in the strict sense of the word," says Fabre, "they do not tear their food nor chew it by means of implements of mastication. Their mouth-parts do not lend themselves to this sort of work."

Through their oral openings, the larvae (frequently and not inaccurately called grubs) excrete saliva that instantly liquifies the matter it contacts, turning it into a broth. This they drink.

Digestion is, after all, a form of liquification. In the instance of the bluebottle larva, it digests its food before swallowing it.

This curious form of exterior digestion is of vital interest to all poultrymen.

Pepsin, which fowls have no way of preparing within themselves, is the chief necessity of adequate digestion. Fowls, especially those raised as meat birds, should therefore be fed foods containing pepsin.

Commercial pepsin is scraped from the membranes of the stomach of the pig and the sheep. Yet, as Fabre points out, commercial chemists "would obtain a product of the highest quality" from the larvae of the bluebottle, for these grubs produce a "pepsin of singularly active kind."

From the moment the larva breaks from its egg, it begins to eat its way through the approximate ten days before it enters the dormant cocoon period.

As the larva approaches the cocoon period, it departs from the home it has had since birth. Under favorable circumstances it leaves its surroundings and buries itself in loose soil to a depth of a few inches. There it remains until it breaks free of its cylindrical home, the cocoon, and, after adjusting itself physically to its new life, flutters its wings and goes about its life as a full-grown bluebottle.

It is the embryonic stage -- that of the larva between the egg and the cocoon -- in which we are especially interested.

Not only is this grub a delicacy for fowls, both domesticated and game, but it is extremely high in pepsin, as I have already stated.

However, the poultryman who wishes to put the bluebottle fly to work for him should not imagine that he is pioneering.

Many years ago, caretakers of large European estates fattened fowls, domesticated and game, by a method of feeding fly larvae to the birds.

The system employed by the caretakers, which may be employed today by poultrymen, was to hang a piece of meat above a tray of meal. The meat was hung high enough to permit the air draft to carry off the odor. The flies "blew" this meat, the eggs hatched, the larvae grew and, in due time, fell into the tray of meal. Here the birds snatched them eagerly.

In putting the bluebottle fly to work, poultrymen with small flocks may attract the flies to their Intensive Range "trays" by placing fish gills, other fish offal, or decaying offal of any kind upon the top of the "trays."

These trays may be so placed as to avoid annoying either the neighbors or members of one's family by the odor. Be assured that the flies will find such "trays" and will "blow" them.

Properly-managed attractions for flies may actually rid the poultryman's home of "blowflies." If objectionable decaying matter is easily obtainable in the "trays," the flies will desert the kitchen.

My preference in preparing magnets to attract the bluebottle so that the birds will receive the utmost from this type of food supply is to --

1. (For small flocks) -- Prepare the "trays" as above.
2. (For large flocks) -- Follow the system used by European caretakers of poultry.

The latter is best done by suspending the decaying matter near the ceiling of the hennery. This should be done so that there will be an air draft that will carry off the odor. Odors from decaying matter are gaseous, and, being lighter than air, will rise and dissipate in the open air.

Little if any labor is required to keep this larvae-breeding matter perpetually functioning. When the decaying matter is hung, the flies will locate it and Nature will take her course. When the larvae have matured to a degree where they are ready to enter the dormant stage, that period during which the larvae is transformed from worms to full-grown flies, they will drop into the tray set directly beneath the decaying matter.

The genuinely sincere believer in this system may carry on the feeding of larvae throughout the year by constructing a fly-house. Here, by keeping the house adequately heated in cold weather, properly sealed,

though admitting sunlight, bluebottles may be successfully raised.

From a sanitary viewpoint, this system should meet with general approval for it segregates and controls the fly larvae. One of the objections invariably brought forth by persons to whom I have mentioned this system of feeding live food to poultry is that it will breed flies.

No statement can be further from the truth. Instead of breeding flies, it actually reduces their number.

It does encourage the breeding of larvae, but fly larvae are not flies.

In conclusion I wish to emphasize one paramount point -- money can be made in poultry *if* the poultryman will, first, *feed live food to his birds*, and second, *reduce his cost of feeding them*.

I do not claim that my system of Intensive Range is the acme of poultry feeding systems, but I do claim that a poultryman can develop it to a point where he may rightly claim it perfect.

The power to think, consecutively and deeply and clearly, is an avowed and deadly enemy to mistakes and blunders, superstitions, unscientific theories, irrational beliefs, unbridled enthusiasm and fanaticism.
-- Haddock

Part III

Introduction

INDIVIDUALS who engage in the business of breeding, raising and selling earthworms are, in a general sense, pioneering. But in no sense are they experimenting. The experimental labor has been done for them. All the prospective earthworm farmer need do is follow the advice and suggestions of those who have paved the way for him in this new and interesting business.

Once again I repeat -- do not enter the earthworm farming industry in the hope of becoming a plutocrat over night; and do not become interested in this business in the manner of a five-year-old girl playing house.

The business of breeding, raising and selling earthworms is a reputable, sound and profitable business, and one that must be operated along regular business principles with business acumen if success is to be attained.

A successful business man, be he seller of locomotives or children's tricycles, is the individual who knows the business in which he has made a success. The high-geared competitive system of the present era demands more from business men than any other era in the history of industry and commerce. And the man who can not keep pace with modern competition will soon be bringing up the rear like the tail of Mrs. Casey's cow.

As we shall see in this volume, a prospective, ambitious earthworm farmer need not make more than a comparatively-small investment in preparing his working equipment. But he, or she, must study the business of earthworm farming, both from its production and its selling angles.

Probably the most effective manner for the writer to emphasize these two points -- inexpensive equipment and a studious interest in earthworms -- is to briefly review the manner in which the immortal Charles Darwin worked during his experiments.

Darwin, who may be rightly called the discoverer of the indispensibility of the earthworm as an aid to soi1 productivity, believed far more in acquiring knowledge than he did in the quality of his equipment.

Darwin's instruments were of the simplest known. In his day (1809-1882) the compound microcope was still a weak and undeveloped

instrument. He used a microscope probably not as good, nor as accurate, as any of those that may be purchased today for a few dollars. The great naturalist considered tool and instrument makers of his time and place infallible, yet his micrometers varied greatly from one another and for lineal measurements he used an ordinary three-foot rule, "which," he says, "was the common property of the household, and was constantly borrowed, because it was the only one which was certain to be in its place -- unless, indeed, the last borrower had forgotten to put it back." For measuring tall plants, shrubs and young trees, Darwin used a seven-foot pole which was graduated by the village carpenter. No mention is made of what the carpenter used as a standard! The results of Darwin's work, unequaled in his particular scientific field, obviously proves that the adage, "A good workman is judged by his tools," like all other rules, has its exceptions.

Be that as it may, no matter how mediocre Darwin's equipment was, his method of keeping records of his experiments was in complete contrast to his carelessness anent his tools and instruments.

His measuring rule may have been a fraction of an inch inaccurate, his microscopic lens weak, his micrometers loose and uncertain, but the notes he made, the time he spent mentally preparing his material which was to be given to posterity through the media of papers, pamphlets and books, required labor with tools that had to be accurate -- and those tools were words,

But let us turn to Darwin himself:

"I will add," he says, "that with my large books I spend a good deal of time over the general arrangement of the matter. I first make the rudest outline in two or three pages, and then a larger one of several pages, a few words or one word standing for a whole discussion or series of facts. Each one of these headings is again enlarged and often transferred before I begin to write in extenso. As in several of my large books facts observed by others have been very extensively used, and as I have always had several quite distinct subjects in hand at the same time, I may mention that I keep from thirty to forty large portfolios, in cabinets with labeled shelves, into which I can at once put a detached reference or memorandum. I have bought many books, and at their ends I make an index of all the facts that concern my work: or, if the book is not my own, write out an abstract, and of such abstracts I have a large drawer full. Before beginning on any subject I look to all the short indexes and make a general and classified index, and by taking the one or more proper portfolios I have all the information collected during my life ready for use."

Wise, indeed, is the individual who will systematize his knowledge as did Darwin, and from the above quotation the prospective earthworm farmer should receive lasting help.

These two characteristics of Darwin were purposely brought in here to impress upon the reader that equipment -- which will be fully discussed in this volume -- need be neither expensive nor ostentatious.

What counts is studious attention to the earthworms and their habits. This makes for success.

All the needed-to-be known points which the earthworm farmer should understand are made clear within these pages. Neither I, personally, nor any other individual can make a success of an earthworm farmer. The quality to be successful lies within the individual engaged in earthworm production.

And so, with these friendly pointers. I bring you now the fundamentals of earthworm farming, leaving this introduction with just one more repeated, important sentence -- the average man or woman can become a financial success through breeding, raising and selling earthworms if he or she will wholeheartedly apply known and proved facts to the business.

Part III

Lesson 1

Natural and Man-Made Enemies of the Earthworm

Every living thing has natural enemies -- U. S. Department of Agriculture quoted regarding enemies of earthworms -- The Argentine and Pharoah ants -- Greatest enemies -- How to defeat them -- Earthworm farmer has little to worry about, except for these ants -- Be careful of Cyanide in any form -- Anything that kills earthworms should be shunned by all farmers, nurserymen and gardeners

LIKE all living things, the earthworm has a long list of enemies. It is distressingly unequipped to "fight back," is minus all trace of either defensive or offensive apparatus, and would, if left alone, be a paragon of pacifism and isolation. Its complete cycle of existence is devoted wholly to seeking nourishment for itself and propagating its kind. Beyond those two interests it is not concerned.

While we are not especially interested in the natural enemies of the earthworm as they apply to the earthworms under the watchful eye of the earthworm farmer, it is nonetheless advisable that we consider this aspect briefly.

The writer feels this is best done by turning to the United States Department of Agriculture's Bulletin, Number 1569, from which the following is lifted:

"In addition to the fisherman with his ever-ready garden fork and tin can, the earthworm has numerous natural enemies that are constantly alert. Song and game birds, as well as domestic poultry, patrol the meadows and woodlands during the day, while the ubiquitous toad with his huge appetite and sticky, darting tongue, stalks earthworms during the early hours of spring and summer nights. Some of the sma1ler species of harm1ess snakes feed largely on earthworms at times. The Bureau of Biological Survey has identified earthworms in the stomach of no fewer than 45 species of birds. The crow seems to get more egg capsules of the worms, and the jacksnipe, woodcock, starling and robin seem to get more adult worms. Earthworms are an important item of food to the four species named.

"This warfare, however, is not confined to the mere surface of the soil. The earthworms are by no means safe even in the fastnesses of their underground burrows. Here they are pursued relentlessly by the voracious shrews and moles, which subsist largely upon these

creatures. Centipedes and 'thousand leggers' follow the worms even to the depths of their longest tunnels.

"In addition to these formidable foes, some kinds of earthworms have still another enemy in the form of a two-legged fly, which superficially resembles closely the common house fly (*Musca domestica*). In point of fact this insect, which is known as the cluster fly -- *Pollenia rudis* -- and often enters houses in large numbers in the fall, is commonly mistaken for the house fly. By the use of a low-powered magnifying glass, however, the cluster fly is easily distinguishable from the house fly as it has a downy coat of yellow hairs upon its back and sides. This down is entirely absent in the house fly.

"For a long time the manner of life of the cluster fly was unknown, but this problem was solved in 1908, by David Keilin, of the Quick Laboratory, at Cambridge, England. He found that the larvae or maggot of this fly was parasitic upon certain species of earthworms. The fly's eggs are deposited on or in the soil and hatch in from five to seven days. The minute maggots then seek the worms and bore into their bodies, where they continue to feed until eventually the worms are destroyed. Subsequent investigations carried on by American entomologists confirmed in a general way these facts as applied to the life history of the insect in this country, but it was found that in summer the eggs hatch in about three days. It was found, also, that there may be several generations of the fly in a year and that it is possible for the insect, under certain conditions, to undergo its complete cycle of development in from twenty-seven to thirty-nine days. The cluster fly itself falls a victim in great numbers to a fungous disease which attacks it during the warm, humid weather of mid-summer. At this time even the newly-emerged flies may be observed, stilled in life-like poses, attached to the leaves of plants, where they have been killed by the action of this fungous enemy."

Not mentioned in the foregoing, though probably the earthworm's greatest enemy in farms, nurseries, truck patches and gardens is the ant or emmet.

In the development of the domesticated earthworm for commercial use it was definitely proved that, of all the handicaps to overcome in the highly-selected breeding of this type of worm, the various species of ants offered the groatest difficulty. To defeat the destructive ability of both the grease-eating and the sugar-eating ants called forth every effort on the part of the experimentalists. Numerous insecticides were used, some with no results, others with fair results. Only one commercial insecticide out of nearly one hundred was found that proved itself a definite destroyer of the two most pernicious species of ants on the West Coast -- the Argentine, or sugar-eating ant, and the Pharoah, or grease-eating ant.

As we have seen in Lesson 2 of Part I, the earthworm's digestive system is highly sensitive and a prey to environment. While its system absorbs the needed food energies from the large quantities of soil it swallows, the earthworm shows a preponderance of favor for fats and a general interest in sugars. In fact, these foods may rightly be called the staples of the earthworm's diet.

Inasmuch as all ants are lovers of fatty or greasy foods, it is readily understandable how an ant colony may eat or otherwise dispose of the fats in the soil in which earthworms are dwelling. A colony of ants, being energetic and tireless workers, will, in a comparatively short time, devoid the soil of fats, thus taking from it one of the chief food necessities of the earthworm.

The Argentine ant, existing in large numbers in and about the southern portion of the West Coast, is the only sugar-eating ant of the seven species catalogued in that section. In northern Mexico and many sections of the United States southwest, the Argentine ant is known as the "honey ant." It lives exclusively on sweets and is one of the hardest insects to destroy through the media of insecticides.

In developing, breeding and culturing earthworms for commercial use, the ant should be considered their most dangerous and destructive enemy. With culture beds always under control by the earthworm farmer, he has little to worry about from the general run of earthworm enemies -- except the ant.

Though largely carnivorous, frequently fatally attacking animals much larger than themselves, ants do not prey directly on the bodies of the earthworms, principally because the annelid spends most of its time beneath the surface of the soil. But because the ant does not attack the earthworm directly does not reduce its ability to destroy it indirectly.

Experiments were carried on for many months by California earthworm farmers regarding the potency of ants as denuders of the soil of sugars and fats. These experiments were performed in carefully-secluded and prepared earthworm culture beds. The work of the Argentine and Pharoah ants was painstakingly watched, checked and recorded. In all instances, the energetic ants denuded the soil of sugars and fats to such an extent that the earthworms began to show a decided decline in activity. As the worms began to weaken and die, the experimentalists gathered the remaining worms and placed them in culture beds free from ants.

The results of this change were immediately noticeable. Able to secure the needed starches and desired sugars, the earthworms showed instant signs of gaining a new lease on life. In a few days all trace of the lethargy, generated by the deficiency in sugars and fats in their food, disappeared.

It was while these experiments were in progress that efforts were made to procure an insecticide that would satisfactorily discourage or completely destroy these enemies of the earthworm.

It was found that insecticides definitely destructive to certain species of ants did not kill other species, and, inasmuch as all ants are enemies of the earthworms, it was essential that a suitable and potent insecticide should either be found or developed.

In time, a West Coast insecticide was found that did satisfy the experimentors. Of the seven known species of ants on the West Coast, none were able to withstand the new concoction.

The user of insecticides, and other poisonous solutions or powders to destroy such pests as shrew, moles and centipedes (all enemies of the earthworm), should employ judgment in placing the poison.

Most poisons used by farmers and orchardists to rid their premises of pests contain cyanide in one form or another. The earthworm breeder who promiscuously spreads any of these should realize that such lethal preparations, sufficiently potent to kill insects and animals, will also kill his worms, were they to come into contact with them.

Moles and other small burrowing animals that are enemies of the earthworm, may be safely destroyed by sprinkling poisoned grain at the entrance of the burrows. In this way, it is usually beyond the reach of the earthworms. In areas where moles abide, earthworms are known to penetrate deeper into the soil. By keeping as far away from the moles as it can, the earthworm is clearly expresing a natural law -- self-preservation.

Under no conditions should the breeder of earthworms attempt to destroy enemies of earthworms without realizing that what will kill the goose will also kill the gander -- a poison that will kill a mole will likewise kill an earthworm.

And so, I close this lesson with an emphatic warning -- be careful when you begin to rid your earthworm culture bed of enemies.

If you are not careful, you may destroy both the enemy and the friend.

Part III

Lesson 2

The Trout Farmer's Problem

Raising fish in captivity age-old art -- Approved today by national, state and private institutions -- Original feed for fish in captivity -- Change to by-products of meat and fish packing concerns -- How pet food threatens this industry -- Remarks regarding pet food by well-known bio-chemical analyst -- Advice to cat and dog owners -- Possibilities of the earthworm as food for fish in captivity

FOLLOWING the course of human, industrial and commercial progress there is always a wake of disturbing conditions, causing personal unrest, uncertainty and financial loss. In time, these disturbances mold or blend in readjustments necessary to meet the change is ultimately assured. Sometimes the new mode is introduced quickly; in other instances many years pass before an equilibrium is reached.

One example should suffice to clarify this point.

With the advent of the automobile, the horse, mule, harness accessory, carriage and wagon industries suffered greatly. Many of these businesses suspended operation; others blended amicably with the new conditions brought about by the "horseless carriage."

Today, one of the oldest arts in the history of man faces the grim outlook of being caught in one of these wakes of the good ship progress. In fact, there are those who believe that the art will find itself held high and fast on a sand bar thrown up in the current of progress.

The writer refers to the art of pisciculture -- feeding and fattening breeding, rearing and preservation of fish by artificial means.

Much older, indeed, is this art than the ordinary person imagines. It dates back into the central period of ancient Egypt. Later, across the Mediterranean Sea, the Greeks practiced it, and half way around the globe from Greece, the Chinese reached a high degree in its development.

During the past century, pisciculture has shown remarkable strides, especially in America. Its greatest forward step was taken when science discovered that the ova of the fish could be taken from the female, impregnated with male milt, and hatched in tanks. This took

away much of the element of chance (customary under natural spawning conditions) that the milt would fertilize the maximum number of eggs.

For the past quarter of a century, the art of artificially-raising fresh water fish -- though the artificial culture of oysters, clams, mussels, lobsters and other crustacea is also profitably practiced -- has come into general favor.

Our national government, under the American Fish Commission, has deeply interested itself in this art. It is practiced in the United States, Canada and many European countries on a surprisingly large scale. Many of our states, too, have piscicultural departments, and, of course, there are thousands of "fish farmers" scattered throughout the nation.

With national and state governments taking a thoroughgoing interest in this art, it has shown great improvement and has become an important department of our commercial life. Millions and millions of fish are "planted" annually by our governments and privately-owned piscicultural institutions.

And now, believe it or not, this productive industry is facing a possibly insuperable barrier.

Curiously enough, cats and dogs are innocently responsible for the clouds of possible doom that are gathering above the art of pisciculture; cats and dogs and their owners, who seem to fall easy victims to anything and everything that saves them a few minutes work.

During the past decade, the fastest growing industry in the nation has been that of packing and canning pet food. So enormous has become the sale of these prepared pet foods that their manufacturers are buying practically all of the by-products of meat packing houses and fish canning concerns. In addition to this, they are more or less responsible for the slaughter of wild horses on the ranges of our northwestern plains.

In discussing this problem in 1938, the Rainbow Angling Club and Hatchery, the largest west of the Mississippi, declared that national, state and privately owned fish hatcheries will have to have considerable ingenuity spent upon them if their managers and owners can not do something about feeding their fish if the trend toward greater sale of pet foods continues.

On the surface, all of this may sound like material for Robert Ripley. Yet when the matter is analyzed, it is not as fantastic as it at first appears.

Let us consider the food proposition as faced by the Rainbow Angling Club and Hatchery and see how cats and dogs, indirectly, were causing them no little amount of worry.

The Rainbow Hatchery deals exclusively in rainbow trout. The hatchery and propagation plant is located about fifteen miles from the source of Mill Creek at springs high in the San Bernardino mountains in Southern California. Mill Creek supplies 18,000 gallons of mountain water every minute to the hatchery, in which there are one and one-half million trout.

To this piscatorial metropolis, 7,500 pounds of ground meat and fish meal, a similar amount of cereals, are necessary every week. This is about 780,000 pounds annually, or approximately 400 tons, half of which (about 200 tons) is ground meat.

There are few, if any, streams in the world capable of caring for 1,500,000 trout; certainly none that could supply this number with adequate food the year around.

Fish in their natural state feed on either other small fish, insects or insect larvae. In captivity, under artificial conditions, such natural food is not available in an amount even vaguely bordering on sufficiency, and the only substitute known with enough food energy are the by-products from meat and fish packers.

For many years experiments have been carried on in the hope of finding a suitable substitute for fish food other than these by-products, but to date no success can be reported. Ground meat -- made from these same meat by-products used in pet foods -- contains vitamins and proteins necessary for a balanced diet for fish.

The feeding of cereals to fish in captivity is done merely to "fill" the fish. Cereals have no food value as far as fish are concerned. Being cold blooded vertebrates, they have no need for sugars or starches.

Fish food must be of the proper quality and the proper quantity if the hatchery man would successfully raise fish. The water, always running, should be between 40 and 60 degrees Fahrenheit.

The "range," that is, the number of fish to a given area, must be such as to avoid crowding. Crowding is dangerous, retarding growth and spreading disease.

Young fish are fed frequently, often as many as ten times a day. As they grow, this frequency is tapered off until, at maturity, they are fed but once a day.

"When I first became engaged in the pisciculture art, the staple food for fish was liver," they told me. "But the public was told that liver was

beneficial for them. They were advised to eat it -- and the price of liver rose to such a figure that we could no longer afford to feed it to fish.

"It was then we turned to the general run of by-products of the meat packing houses. Here we found we had an ever-present and seemingly unending supply of food ideally suited for fish in captivity. Then came the pet foods. Companies making them began to buy more and more of the meat packers' by-products. In a few years, the demand began to run nip and tuck with the supply and the meat packers boosted the price of their by-products -- by-products that a few short years before were a drug on the market.

"Our difficulties are now becoming acute. Not only is it becoming more and more difficult to buy these by-products, but the price has risen to a point that is dangerously close to a figure too high for our consideration. At the present time I can see no signs that the price of this commodity will come down -- which is fine for the meat packers (and I hope, for the farmer!) but it is certainly not a pleasant picture for fish hatchery owners to visualize.

"Here on the West Coast, there is one pet food manufacturer who has five boats plying Pacific harbors buying all the by-products from the fish canneries available."

It might not be amiss to insert here a reference foreign to the subject of fish hatcheries, yet of sufficient import to readers of this part who have a pet cat or dog to warrant its inclusion.

Many of these pet foods bear the phrase "government tested" on their labels. Discussing this phrase, J. W. Patton, experimental biologist of East Lansing, Michigan, says:

"... This phrase means one thing on a dog food canned in an establishment in which Federal inspection is maintained, and canned under the same conditions that exist for canning meat; but quite another on scrap and offal from inspected animals ... 'Made from U. S. Inspected Meat,' 'U. S. Inspected and Passed' -- passed for what? Edible or inedible? Food or fertilizer?"

Such phrases may be on a can that, "may contain 50 per cent lung and 50 per cent weasands handled like coal..." "Made from U. S. Inspected Meat" is openly used by unscrupulous manufacturers of the most unworthy feeds on the market; not only to cover up their inferiority, but to imply superiority -- and the dog and cat suffer.

Such food manufacturers, Mr. Patton claims, "may purchase scrap or even fertilizer from inspected establishments and use it without restriction." Such firms, we are informed, mix the foregoing with "meat from a desiccating works and still advertise that they are using U. S. inspected meat. Bones and trimmings from the meat market,

although they may go to a rendering plant and are shipped to a pet food manufacturer, are still 'U. S. Inspected and Passed.' True enough, they were formerly inspected and passed, and at the time were clean and wholesome... There is no authority in the meat inspection law to control them" (the pet food manufacturers).

And this is the business that threatens the very existence of fish hatchery operators!

"What are we going to feed our fish when the pet food industry monopolizes the meat and fish by-products which are necessary food for fish in captivity?" is a question thousands of fish hatchery operators in the United States are asking today.

Elsewhere in this work the reader has been presented with the advantages derived from feeding earthworms, through Intensive Range, to poultry and game birds.

It is the writer's personal conviction that properly-fed and properly-controlled earthworms, in properly-prepared beds, may produce the necessary food elements required by growing fish.

Earthworms may become a new and lasting substitute food for fish in captivity.

The attention of the reader interested in this feeding phase is called to the lesson, "Putting the Bluebottle Fly to Work," elsewhere in this series.

Similar contrivances to those used to supply hens with live larvae may also be employed by fish farmers to their advantage, and also by frog farmers, as we shall see in the next lesson.

Seemingly, the only objection raised to this form of live food feeding is the resultant odor of the matter used to attract the bluebottle.

Nonetheless, both the fish and frog farmers should be able to select a place for the bluebottle to "blow" that will not be an offense to the olfactory nerves of humans in the vicinity.

A complete description of preparing the tray to hold the matter attractive to the bluebottle, and the most feasible place to suspend the tray, will be found in the following lesson.

However, the reader, if interested in pisciculture, must realize the enormous quantities of earthworms that will be required to care for the appetites of large hatcheries.

This, though, is not a handicap, for the writer knows that earthworms can be produced in sufficient quantities to meet the demand of hatchery owners.

Readers of this part wishing further information on this subject will be advised of the progress of the current experiments carried on by the writer. I hope, in the space of a few months, to be able to produce a small booklet covering these experiments and this I shall make available at a price that will cover the actual cost of the booklet.

I would suggest in closing that persons interested in this subject drop the writer a card. The names of such persons will be carefully filed and the writers advised when the experiments are concluded, the results tabulated and the booklet ready for distribution.

And now let us glance at some of the problems of the frog farmer.

Part III

Lesson 3

Feeding Problems of the Frog Farmer

"Money in frogs" -- List of frogs that may be raised commercially -- Natural food for frogs -- A. G. Peek, Southern California frog man, quoted -- What frog food should be used -- What its qualifications should be -- Frog farmer should raise earthworms from egg capsules -- Feeding basket -- Master bed -- Discussion of electroculture for use by frog farmers

LET me lay my cards face up on the table before I start dealing advice and suggestions in this lesson. I do not wish to be understood as either encouraging or discouraging an investment of time or money in the business of frog farming for commercial gain.

I am quite cognizant of the fact that frog farming is, on the one hand, a legitimate business, scientifically taught, and, on the other hand, a racket sponsored by empirical promoters.

Be that as it may, I shall not become dictatorial in the matter. It should be within the mental province of the individual contemplating entering the frog farming business to be able to judge whether he is dealing with a reputable firm or one whose ethics will not stand a close investigation.

This, however, I shall say -- " Money in Frogs" (and similarly-attractive advertising catch lines) is ambiguous, regardless of the fact that such statements are acceptable as good English. The fact is, there is no money in frogs, nor earthworms, nor cats, nor horses, nor vegetables -- without that form of human energy which we call "work."

It may seem trite to declare that financial gains are produced by the individual raising these commodities. The commodities are the vehicles on which human energy rides to financial profit. This point is well worth emphasizing, for many persons are led by advertisements to believe that all they have to do to make money is to stock a farm with this or that and money will begin to pile up in voluminous proportions.

I have previously stated in this work -- in discussing the raising of earthworms for commercial use -- that it is foolhardy to enter any business with the hallucination of wealth over night. Such hopes are the fabric from which fairy tales are spun -- and fairy tales are further removed from facts than is fiction.

Nonetheless, a goodly annual income can be developed through the business of frog farming. For those already engaged in this business,

and for those contemplating entering it, this lesson is especially prepared.

The frog farmer's problems of feeding differ from those of the fish farmer. The latter, as we have already seen, is facing what might be called, and not inaccurately, a food shortage for his piscatorial school. The frog farmer's problems also concern food, though they are not as acute as those of the fish farmer.

However, if, as some dealers in frogs claim, the frog farmer believes he can go to the nearest abattoir and buy meat scraps for a mere nothing, he had better prepare himself for a shock. The previous lesson explains that matter and shows where the by-products of meat packing houses go.

Breeding, raising and fattening frogs -- of which there are four kinds suitable for commercial raising in the United States, i. e., French, Chinese, Louisiana and American -- in captivity is definitely artificial. Such frogs, if they are to increase and grow to marketable size, must be fed by the farmer, for, like fish in captivity, frogs can not produce sufficient food in enclosed ponds without human assistance.

Frogs, in their natural state, live on insects, insect larvae, various types of worms and crawfish (crayfish). During the tadpole stage, they are, for the most part, vegetarians.

But I have not set out to discuss the dietary habits or needs of frogs in captivity, except insofar as earthworms and the larvae of the bluebottle fly are employed. Your local library should have a number of books on this subject, or your Chamber of Commerce, or Board of Trade should be well enough informed about this matter to suggest a frog-canning concern to which you could address your inquiry regarding frog feeding. Most, if not all, of these concerns will be pleased to send you suggestions.

My primary interest in this series is our friend, the earthworm, and, in this lesson, the part it plays as a food supplement for frogs in captivity.

A. C. Peek, an official of the Rio Hondo Trout and Frog Farm, El Monte, California, in discussing frog food with the writer, declared that "Earthworms are a beneficial delicacy for frogs. They eat them ravenously, both in and out of captivity, and they should be an integral part of the frogs' diet."

Frog food, contends this authority, should have these qualifications:

1. It must be abundant.
2. It must not be injurious to land or marine vegetation, insects, or other natural food for frogs.
3. It must be low in original cost and upkeep.

4. It must be of such dimensions that all frogs can eat it.
5. It must be capable of withstanding changes in temperature, ranging from summer heat to winter cold.
6. It must be available for frogs where and when they want it.

Earthworms meet each of these six requirements thusly: (1) they are prolific breeders; (2) they will not injure plant, animal or insect life; (3) their cost and upkeep is low; (4) they are never too large for even the youngest, smallest frog; (5) they will withstand various temperatures, when properly housed; and (6) they are made available as frog food with very little labor on the part of the farmer.

Because of the slaveship of earthworms to the environment in which they have been raised, I do not look with glowing favor upon suggestions made by some teachers of frog culture who advise frog farmers to dig their own earthworms and transplant them to a previously-prepared culture bed. This system is not always successful. At best, it is a slow process, for the earthworms that withstand the change of environment will be slow breeders, much too slow for the needs of the frog farmer.

My theory, substantiated by many tests over a period of years, is that the culture of earthworms, regardless of what their future use may be, should begin with the egg capsules. In this way, the newly-hatched earthworms will immediately partake of the nourishment available. They will mature naturally, in about ninety days, and when properly housed, controlled and fed, will reproduce regularly every week throughout the year.

I have two suggestions to make regarding the earthworm culture bed for frog farmers.

First: For large frog farms, a culture bed not to exceed twenty-five (25) feet long, ten (10) feet wide and four (4) feet deep should be excavated. The location should be shady, and, if possible, damp.

Fill this bed (about six to eight inches below the top) with a mixture of peat moss (or sawdust or wood shavings), rich, black soil, manure from grain-fed horses or cattle, chicken droppings, and about a bushel of leaf mould. No care should be taken in filling the bed, except, of course, to have the ingredients well mixed.

Into this bed I would place 50,000 earthworm egg capsules and allow nature to take her course.

In two months, if the minimum amount of earthworms and egg capsules are placed in the bed, the frog farmer may begin to harvest his crop of annelids for frog food.

Care should be taken during the daily, biweekly, or weekly harvesting

of the earthworms that too many breeding earthworms are not fed to the frogs. Such carelessness would soon deplete the earthworm culture bed of its most valued asset -- prolific breeders. (Elsewhere in this work the culling of young, immature and sluggish, earthworms from the healthy breeders is explained).

In the course of six months to a year, less care need be taken in selecting the earthworms to be fed the frogs, for by that time the earthworm bed should be a veritable mass of annelids.

The frog farmer should select a secluded spot in which to feed earthworms to the frogs, for they are sensitive creatures and seldom eat in public. Another frog eccentricity is the fact that it will not eat anything unless it (the food) moves.

One of the best methods for feeding earthworms to frogs is to prepare a metal tray or trays, not more than three inches deep. These should be set into the ground so that the edges are level with the surface of the soil. The sides of the trays should be slanted inward from, the bottom, to prevent the earthworms from crawling out.
When the earthworms are transferred to the trays (with a small amount of soil from the culture bed) the contents of the trays should be thoroughly soaked with water. This is done to force the earthworms to the surface, thus assuring the frogs easy access to them.

Frogs will devour all the earthworms the frog farmer sees fit to give them. It is up to him, therefore, to determine the amount of earthworms he should feed his frogs. In time, he can adjust his earthworm supply to meet his demands.

The second method of feeding earthworms to frogs will, I believe, eventually displace all other methods now in use.

In this method, the earthworm culture bed is placed within the confines of the frog pond enclosure, near the bank of the water.

In preparing this bed, and before the culture is placed in it, it should be wired for electricity as approved by the new science of electroculture. Between the bed and the electric switch should be placed a transformer, a common electrical device that transforms the electrical current up or down as required.

(Before I explain the use of electricity in this manner, it should be understood that the construction of this electrically-equipped culture bed is probably beyond the ability of the ordinary person whose knowledge of electrically-operated appliances is, at best, elemental. It behooves the person contemplating the installation of this system, therefore, to contact his electric maintenance bureau or write his State Agricultural College for information concerning electroculture).

When this system is properly installed, the culture bed prepared as above noted, the earthworms and egg capsules planted and a sufficient quantity of earthworms matured, the electric contrivance is ready to be brought into use.

The first move is to turn the dial of the transformer down to its lowest point, which permits the minimum of "juice" to pass through the wires in the culture bed. This done, the electric current is turned on. If the amount of current is sufficient, earthworms will appear instantly upon the surface of the culture bed, sent there by the electricity. If the earthworms do not appear, the dial of the transformer should be moved to the next higher notch. If again no earthworms appear, the upward movement of the dial should be continued, one notch at a time, until they do appear. Once the frog farmer using this system learns the necessary amount of electric energy required to expose the earthworms, he can set the dial at this point for future use.

Experiments with this system have shown it to have two beneficial advantages for frog farmers. First, the larger, mature earthworms, i. e., the breeders, do not come to the surface until a comparatively large volume of electricity is turned into the wires in the culture bed. This assures the breeders comparative safety from capture by the frogs. The second benefit is that the frogs may feed to their hearts' content upon the earthworms that do come to the surface.

In the near future I hope to produce a pamphlet dealing exclusively with the application of electricity to earthworm culture beds. While this is still in an embryonic state, I believe it has many possibilities, and I am working on a few experiments at this writing.

Let us now turn our attention briefly to the bluebottle fly, its larvae, and the manner in which these are procured by the frogs.

Lesson VI in Part Two of this series, "Putting the Bluebottle to Work," explains the method by which the larvae are developed for a supplement diet for hens.

For the frog farmer, the same general principle prevails. There is in use at the present time a screen-like basket which certain frog culturists recommend for the purpose of placing thereon decayed fish or animal by-products as an invitation to the bluebottle fly to "blow."

I can recommend no better device than these baskets. They should be suspended over the earthworm feeding trays, high enough to permit the air to carry away the odor, yet not so high as to discourage the bluebottle flies from "blowing" the decayed matter on them.

It seems to me that this dual system of feeding earthworms and fly larvae to frogs in captivity -- both foods being the natural food for frogs -- should be highly productive of healthier, bigger and better

frogs -- a goal which all frog farmers hope to some day reach.

Relation and connection are not somewhere and time, but everywhere and always.
-- Emerson

Part III

Lesson 4

Housing the Earthworm Stock

Building an earthworm farm -- The window sill earthworm farmer -- Small stock all that is necessary -- Earthworm farming in gallon cans -- Economical way to start -- Farming in vegetable lugs -- One of the finest methods -- Proved by many years of experimentations -- Farming in master beds or banks -- What the U. S. Department of Agriculture says about this type of earthworm breeding

IN this lesson we approach the vortex of earthworm farming around which everything tending toward success revolves -- the containers in which the earthworm stock is housed.

These containers are to the earthworm farmer what chicken coops are to the poultryman, though the labor required to keep them serviceable is far below that necessary for efficient poultry raising.

For continuity's sake, let us follow, step by step, an earthworm farmer's progress from an humble beginning with the smallest type of container toward his ultimate goal -- the housing facilities for one or more millions of earthworms.

Our first step in this figurative journey will be with

The Window Sill Earthworm Farmer

Countless thousands of people take delight in decorating the window sills of their homes, apartments or rooms with flowers; and a surprisingly large number raise a limited amount of vegetables in window sill boxes.

Regarding this subject, Dr. Martha B. Carey, of Los Angeles, writes:

"Earthworms have interested me for several years, but I have had to confine my own practical experience with them to window boxes in an apartment house. I have four boxes -- 30 inches long, 8-1/2 inches wide and 7 inches deep -- in which I grow many varieties of flowers and enough carrots, onions, lettuce and parsley to supply my own table..."

A convenient and efficient method for the windowsill earthworm farmer desiring to develop a stock of earthworms from say a

tablespoonful (about fifty) egg capsules may be satisfactorily begun in a flower pot.

An ordinary flower pot, not less than six inches in height, should he filled within an inch of the top with rich soil. (A small amount of manure and peat moss, if available, would also be beneficial).

Place the earthworm capsules in this mixture and set the pot in a saucer of water. Less than a teaspoonful of corn meal should be sprinkled over the soil and a few grains of barley added. Both of these are food for the earthworms, though barley has the added advantage of sweetening the soil.

Soil in containers in which earthworms are bred and raised becomes so rich in earthworm castings that the soil must be sweetened. If it were that the earthworm farmer discarded the castings, the procedure of sweetening would not be necessary. But earthworm castings, being of high nutritional value to plant and vegetable life, are constantly kept and used and reused. This system of using earthworm castings may be best explained by comparing them to a sponge. One may fill a sponge with water, squeeze it out and keep this up almost indefinitely.

(Parenthetically, the writer here wishes to refer the reader to the following lesson regarding food and feeding methods, where complete instructions for all types of containers will be found. In this lesson, I deal primarily with the types of containers used and the methods employed to prepare them for soil, food and earthworms.)

Under ordinary conditions, the fifty earthworm eggs will have hatched and begun breeding in about three months.

Care should be taken to keep the saucer well filled with water. The pot should never be watered from the top.

In from three to four months, when the windowsill earthworm farmer is ready for the first harvest of earthworms, another flower pot should be filled with soil and food, as described in the following lesson.

The new pot is then placed in a saucer of water. The first pot is removed from its saucer and placed on top of the new container. Through the standard hole in the bottom of the pot, the growing and breeding earthworms will pass from the upper to the lower pot, leaving their eggs behind them.

Earthworms breed so rapidly that from this period onward the window sill farmer will be surprised at the speed with which the earthworm stock increases.

Either earthworms or their eggs (or both) may be transplanted from the breeding pots to flower boxes or other pots containing plants as soon as the farmer desires to do so.

As the earthworm stock increases and more and more flower pots are needed to hold them -- care should be taken in observing that they are not too crowded (100 mature earthworms being the maximum) -- the window sill farmer graduates to

Earthworm Farming in Gallon Cans

These containers are made ready to receive the culture and stock by punching three holes, equidistant, about two inches above the base. Holes are punched in them for the purpose of permitting surplus water to drain off. Were the water to gather in the bottom of the can, it would sour, the resulting chemical action being injurious to the continued good health of the earthworms housed within it.

When the gallon cans are properly filled with culture, earthworms and their capsules -- not to exceed one hundred of the former and three hundred of the latter -- are placed in them.

Like all containers for breeding and raising earthworms, gallon cans should not become overcrowded. Under no conditions is crowding of earthworms advisable.

Space required for storing this type of container need not be a problem. Twelve such cans may be easily placed on a shelf on the back porch, in the cellar or in the garage.

At no time should more than 600 -- 500 is preferred -- growing and breeding earthworms be housed in a one-gallon can.

The gallon can earthworm farmer will find that his stock increases much faster than it did when he was engaged in breeding and raising them in flower pots. For now his stock is approximately tripled, and the increase in breeders will be from three to four times what they were during the flower pot stage.

In a few months, the number of gallon cans required to house his constantly increasing family of earthworms will be such that he will be ready to set these aside and turn to larger containers. He is now fast approaching the stage when he may rightly consider his stock of earthworms enough to encourage him to give considerable thought to markets and marketing. He is now ready to begin

Earthworm Farming in Vegetable Lugs

Vegetable lugs are both popular and practical for the earthworm farmer. They are easy to handle, weighing less than fifty pounds when properly prepared to receive the earthworm stock. (See following lesson).

Vegetable lugs are purchasable at any market for from three to five cents each. Their approximate inside measurements are 17 inches long, 14 wide and 6 deep.

A similarly satisfactory container, weighing not over thirty pounds when properly filled, is the common butter box. Its approximate inside measurement is 10 inches long, 9 wide and 6 deep. This container is the choice of women earthworm farmers because of its compactness and the ease with which it can be handled.

Both the vegetable lugs and butter boxes are prepared thusly:

In the bottom of each, six quarter-inch holes should be punched or bored. These should be more or less equidistant, about four inches apart, three on each side of the bottom.

These holes play a dual role. Firstly, as drainage for surplus water, and, secondly, to permit the egress of the earthworms from upper to lower boxes. (See following lesson).

High in the center of one end bore a hole large enough to receive the nozzle of an ordinary garden hose. This hole is to facilitate watering the stock when the lugs are stacked.

Butter boxes should not contain more than 800 growing and breeding earthworms. Vegetable lugs may safely house 1000 such earthworms without fear of crowding.

When the vegetable lugs become numerous, say 24 to 36, the earthworm farmer needs considerably larger quarters. He now enters

Earthworm Farming in Master Beds

Master beds (or pits, piles or banks, as they are frequently called) are the ultimate goal of every earthworm farmer. With these -- for he may have need for a number of them -- he will be in a position within twelve months to supply the demands of his clients.

Let us consider a master bed as suggested by the United States Department of Agriculture in its Farmer's Bulletin, No. 1569, from

which we learn that "Where it is desired to store or rear earthworms for sale, a larger container placed out of doors is desirable.

"For this purpose a tight box, preferably constructed of tongue-and-groove material, is suitable. It should be at least 18 inches deep and of a size proportionate to the number of worms it is proposed to handle. A box 18 by 36 by 60 inches will serve very well for several hundred large worms. If the exterior of the box is well tarred it will last much longer in the soil than if untreated. Creosote is not recommended for this purpose because of its possible effect on the worms. In any case the inside of the box should not be treated with either of these substances, but, if so desired, it may be waterproofed by painting with hot paraffin wax.

"The box should be supplied with a well-fitting lid, which should project sufficiently over its edges to prevent flooding during heavy rains. It should be set into the soil with the upper 2 or 3 inches projecting above the surface, in a fairly well-drained place, and should be shaded to prevent the temperature of the interior from rising too high in midsummer. A temperature of 75 deg F. or higher is quickly fatal to earthworms under most conditions. The box should be nearly filled with good soil which is damp but not wet. The richer the soil is in humus the better, as the worms require less artificial feeding in rich soil than in poor. A loamy soil is preferable, but very sandy soil is not suitable.

"After the box has been stocked with worms, the surface of the soil may be covered with a layer of cut sod if desired, but a very excellent covering consists of well-decayed leaves, which form a considerable part of the natural food of earthworms. In dry weather it will be necessary to moisten the soil in the box occasionally, but in doing so care should be taken to avoid flooding it, as too much water is injurious to the worms. Freezing kills earthworms, and in severe climates, where the soil commonly freezes to a depth of a foot or more during the winter, it may be necessary to protect the soil in the box from frost. Winter protection may be secured by giving the box a generous covering of half-decayed manure or compost.

"Although under the conditions just described earthworms can live for a long time without artificial aid, it will be found desirable to feed them a little fat occasionally, in the form of chopped beef suet, or a little sugar in some cheap form. One dealer in earthworms claims to have been very successful in feeding worms ordinary molasses spread on the surface of gunny sacking or burlap, which is simply laid upon the soil with the sticky side down and moistened occasionally. The worms undoubtedly will reproduce more rapidly and be more thrifty if they are well fed. When the worms obtain insufficient food they shrink rapidly in size and lose vigor."

One may say, and not inaccurately, that the foregoing compost bed will be the earthworm farmer's most expensive item. There are others which should be found satisfactory.

One of these is turning old bath tubs, porcelain or metal-lined, into compost containers. This is best done by sinking the tub, or tubs, within a few inches of their rims. A screen should be placed over the drain hole to permit water to pass out, but to defeat attempts of the earthworms from escaping.

Other pits, beds or banks may be made according to one's own ideas.

At Highland Park, California, two erstwhile wells have been filled with compost and earthworms are now being bred and raised in these.

These pits are colloquially referred to as "banks," principally because from them the farm draws its needed supply of both earthworms and their capsules.

These "banks" are divided into quarters, with lattice work partitions. Each quarter is developed independently of the others, with the results that as one quarter is being drawn upon, the three others are developing. With the depletion of one quarter, fresh compost, food and earthworms and their capsules are placed in it and the farm begins to draw the next quarter, and so on, ad infinitum.

Our figurative journey has taken us through all the popular and approved housing facilities for earthworms bred and raised for private and commercial purposes. When the simple rules and suggestions presented in the foregoing are followed, the earthworm farmer will realize that he can spend more money for equipment, but he can not extract more or better service from it.

And now, with the knowledge of how to prepare containers for earthworm breeding and raising, we turn our attention to the type of soil and food used in them to keep our friend the earthworm healthy and productive.

Those who have finished by making all others think with them have usually been those who began by daring to think for themselves.
-- Colton

Part III

Lesson 5

General Care and Feeding of Earthworms

Sound business advice -- What successful business men must know -- How Charles Darwin worked with his equipment -- How he worked with his records -- Earthworm farmer need not have expensive equipment -- But he should know earthworms -- How to acquire this knowledge -- One last tip for beginning earthworm farmers

IN the preceding lesson we saw how various containers to house earthworms were constructed or procured. We have now reached a point where we shall consider the matter of feeding and caring for the earthworms so that they will live, prosper and multiply according to the natural laws governing them as a specie.

The earthworm farmer should constantly keep uppermost in his mind the realization that he must attend to his stock just as he would have to attend to a flock of chickens, a drove of milch cows or a kennel of dogs, or any other specie of fowl or animal he was raising for private use or commercial disposition. But I hurry to relieve his mind at this juncture. The time and labor required to attend earthworms, whether they are in the hundreds or the hundred thousands, is far less than he would have to expend on any other animal he was breeding and raising in captivity. As we progress through this lesson we shall see how insignificant is the time and labor involved in tending earthworm stock.

In approaching the subject of earthworm food and feeding, let us visualize an earthworm farmer who is just entering the field.

Prior to, or within a few days after the arrival of his original stock of earthworms, the fledgling farmer should prepare a compost pit, or, if more convenient, a pile. This compost is definitely essential and should be kept complete at all times, for it is, one might accurately say, the soil reservoir from which the earthworm farmer draws almost weekly.

Let us assume that the compost will total three bushels. It should be prepared thusly:

Either in the pit or in a pile mix one-third manure, one-third soil and one-third peat moss (or substitute). To this may be added much of the kitchen waste, except acids, citrus rinds or scouring powders. Tin cans

may also be added, for, as they rust and disintegrate, they are absorbed by the compost.

To mix the above the following instructions should be followed:

The manure should be either (1) Karakul sheep; (2) horse manure, preferably from grain fed animals; (3) chicken droppings; (4) cattle; (5) rabbits. After many experiments we have found that Karakul sheep manure is the best of all. We all know that every plant, every weed, and every form of vegetation contains elements, differing in different species, which through the unchangeable law of the universe they in time contribute to the upbuilding process of Nature. Karakul sheep do not seem to be discriminating in the matter of their feed. They eat almost everything that grows and in so doing they acquire all the elements of the various forms of vegetation and, therefore their manure also contains all these life giving elements. A good grade of soil should be used, preferably a sandy loam. This should be thoroughly screened before it is mixed with the manure and peat moss.

Peat moss has exceptionally fine properties for an earthworm compost pit and for use in various types of earthworm containers, as well as for soil in general. Its chief advantage is that it is highly absorptive, absorbing from ten to fifteen times its own dry weight in water. It is an organic material, brown in color and of spongy consistency. There are a number of grades of peat moss, the best coming to us from the boglands of Germany. However, any peat mosses minus an alkali content may be satisfactorily used. Many domestic peat mosses are high in alkalines and should be shunned by the earthworm farmer.

The use of peat moss is advisable, principally because it will reduce frequent watering of the earthworm stock. It has little, if any, food value; blends easily with soil and is unequivocally superior to any substitute yet known for use in earthworm culturing.

However, if peat moss is unavailable, wood shavings or sawdust may be used. These may be from all woods except redwood. Redwood shavings and sawdust will kill earthworms!

Peat moss should be well dampened before it is mixed with the compost or used for any purpose by the farmer. This assures easier mixing and diminishes the chances of a sudden gust of wind scattering it. Peat moss is purchasable in bales, the most economical size for the earthworm farmer being one hundred pounds.

Screening is very important. The oftener the compost is screened the better it will be as earthworm food. And not only does the screening mix the various elements, but it has a tendency to break them down -- a condition always advantageous to the root zones of plants.

Let us assume that the beginning earthworm farmer's stock came to him in 216 sixteen-ounce spice cans. These are technically known as earthworm spawn bricks. Each can or brick contains approximately one hundred egg capsules and growing earthworms, making a grand (approximate) total of 21,OOO egg capsules and growing earthworms.

At his earliest convenience the earthworm farmer should transfer the contents of the spice cans (the spawn bricks) to vegetable lugs. (See preceding lesson.)

This transfer includes the following operations:

In the bottom of the vegetable lug (prepared as described in the preceding lesson) should be placed one-quarter of a gunnysack (burlap). It should be laid flat so as to cover most, if not all of the bottom of the container. Upon this should be placed some fresh compost from the pit or pile -- to a depth of about two inches. Then empty the contents of eighteen of the spawn bricks into it. Cover this with more compost, scatter a small amount (about a tablespoonful) of corn meal or walnut meal over it. A handful of walnut shells may be added. Now, another quarter of a gunnysack -- or half or whole if you are so inclined -- should cover the contents of the lug. Dampen this thoroughly, using about two quarts of water. Sprinkle about an ounce of barley seed over the burlap and the lug is now ready to be set aside.

It is advisable to place the lug on a flat, heavy board, metal plate or flat piece of heavy tin. Otherwise the earthworms will crawl through the holes or openings in the bottom of the container, burrow into the ground and disappear.

The earthworm farmer should always remember that his earthworms must constantly be kept under control.

Corn meal, walnut meal and walnut shells are placed in the lug as food. Barley, likewise, is a food, but it serves the additional purpose of keeping the compost sweet.

When the 216 spawn bricks have been emptied into twelve lugs -- eighteen to a lug (prepared as described above) -- numbers, from one to twelve, should be conspicuously painted or attached to each lug. The dozen lugs should then be stacked in numerical order in three rows, four deep, with each bottom lug on a flat, level surface.

Except to assure himself that his earthworm stock is adequately watered, the earthworm farmer does not disturb his lugs again until the lapse of a short three weeks. At this time, the position of the lugs are reversed. It is to preclude confusion in this change of position of the lugs that it is advisable to number them.

Earthworms always have a tendency to work from upper to lower cases. Reversing the order, therefore, assures the earthworm farmer a satisfactory distribution of his stock through the various containers and offsets a chance of crowding in one or more lugs.

As each lug is taken from its original position, the green, sprouted barley should be torn off -- and, if convenient, thrown into the compost pit -- the gunnysack again dampened with water, a small amount of fresh food added and another ounce of barley sprinkled on top. This lug is then placed so that it becomes the bottom container of its stack. Each lug is similarly treated until all twelve lugs have been reversed.

This reversing of the lugs should be done every week or two. Unlike most other animals raised in captivity, the earthworm does not require perfectly-timed and regular attention.

The earthworm farmer will be ready for his harvest in from ninety to one hundred days after the arrival of his original stock. At this time, all the original egg capsules will have hatched and from forty to sixty per cent will have laid one or more eggs.

This increase in the earthworm farmer's stock should be sufficient to allow him to market approximately 8000 egg capsules, growing and, in a small percentage, breeding earthworms. However, he should not appear too anxious to dispose of his first harvest. It is much sounder business to retain that crop and "put it back in the business."

This is accomplished thusly:

Twelve new lugs, twelve previously prepared quarters of gunny sacks and handy containers for food -- corn meal, walnut meal and walnut shells -- should be conveniently placed on a bench of congenial height. On the bench should be a flat board -- or the bench top itself will be enough if it is free from holes or cracks -- or a metal plate or heavy sheet of tin.

The earthworm farmer begins this work from the top lug of the first row. The sprouted barley is removed and discarded. The burlap bag -- which is used to retain moisture and keep out bright light -- should be placed to one side. Never attempt to pull any earthworms out of the bag. By doing so you will probably pull them apart, injuring them seriously if not fatally. Left untouched, they will crawl out of their own volition, at which time they may be rescued and returned to the compost.

The contents of the lug is then dumped in the center of the bench. With the hands, build it into a pyramidal pile and leave it exposed for from fifteen to twenty minutes.

During this period the earthworms will burrow toward the bottom of the pile, permitting the earthworm farmer to begin his harvest without unnecessarily annoying the breeders.

The egg capsules, with a liberal amount of soil (and additional soil from the compost pit) are now gathered and placed in one of the prepared lugs. When the pile has been divided, that is, about one-half of the soil with as many egg capsules as could be found is placed in one lug and the balance of the soil containing the breeders placed in the other, both are fed and watered as hitherto explained.

In transferring the growing and breeding earthworms into the second box, the farmer will quickly learn to recognize culls. These become readily distinguishable following a few practices in caring for the earthworms. Culls are either pale or of unusually large proportions. Our healthy earthworm, the type described in Part One of this work, is a rich reddish animal, seldom longer than four inches. Both types of culls should be destroyed. The large earthworms are, apparently, atavistic and are not to be desired on a well managed and well operated earthworm farm.

In harvesting the egg capsules for commercial disposition, the earthworm farmer should have small spice tins containing a small amount of food and compost. Into these the capsules may be dropped, the number noted and prepared for shipping.

Summary

Important Rules for Beginning Earthworm Farmers

1. Number lugs prominently.
2. Gunny (burlap) sacks, cut in quarters, should be free from alkali or any caustic.
3. Place quarter of sack in bottom of each lug.
4. Place not more than two inches of compost in bottom of lug, on top of quartered sack.
5. Empty spawn bricks into the lug, eighteen to a lug.
6. Feed about one tablespoonful of corn meal, walnut meal. (Cottonseed oil may be used).
7. Place on top of this another one-quarter of gunnysack. (Feeding may also be done by placing the gunnysack on top lug first, sprinkling the food over it).
8. Sprinkle about one ounce of seed barley over top of gunnysack.
9. Contents of lugs should be kept moist at all times, the quantity of water used may be judged by amount of evaporation.
10. To facilitate harvesting egg capsules and earthworms, contents of lugs should be allowed to dry out.

Care and Harvesting

1. For best results, lugs should be reversed every fortnight.
2. When reversing lugs, remove barley growth, re-feed and re-barley with fresh seed.
3. Lugs should be reversed every two weeks thereafter.
4. When reversing is completed, water thoroughly, using about two quarts of water for each lug.
5. It is not advisable to fill lugs higher than three-fourths of their depth. This is suggested to reduce the weight. A full lug will weigh in the neighborhood of fifty pounds. Lowering the contents will reduce this weight to as low as thirty pounds.
6. In transferring breeding stock from one lug to another, the top sack of the first lug may be used as the bottom carpet for the new lug. Bottom sacks remain serviceable for about three weeks.

A potential commercial field which was not discussed in the body of this work is that of the extraction of oil from earthworms for medicinal use.

I have repeatedly experimented with earthworm oil and have found it has exceptionally fine penetrating proclivities.

I purposely refrained from mentioning this subject in the lesson devoted to markets for earthworms, principally because the experiments I have so far carried on (in co-operation with a number of

chemists) have not progressed sufficiently to warrant a lengthy discourse on the subject.

That earthworm oil has medicinal value is, however, an accepted fact, but to date myself and associates have not found a satisfactory method to employ to extract the oil in sufficient quantities to raise it to meet even a small commercial demand. I have used very primitive methods to extract the oil, which must be done by heat -- to which earthworms are very susceptible. The method used was slow, tedious and annoying, though I have managed, by painstaking efforts, to garner well over a gallon over months of experimenting.

At the present writing experiments are being prepared which will employ electric heat.

On the whole, I feel confident that, in time, a suitable and wholly satisfactory method of extracting earthworm oil in sufficient quantities to warrant its consideration in commerce will be available. When that time comes, which I hope will not be in the too distant future, I shall make it a point to advise all interested readers of this book. Should the reader desire further information on this subject of earthworm oil, I suggest he contact Dr. 0. M. Crause, 4575 Melrose Avenue, Hollywood, California, in care of The Associated Laboratories.

Another subject purposely left out of the preceding parts is that of kelp ore. This ore is, geologists say, the result of a cataclysmic earth disturbance that threw countless tons of kelp (seaweed) out of the sea. In time, this kelp became buried under many tons of earth, ossified and remained undiscovered for many eons.

Seaweed -- kelp is a Saxon word meaning charred seaweed -- is one of the oldest plants known. It antedates by millions of years the first forms of plant life on land -- the mosses. It is potent in minerals, contains 14 of the 16 elements in the human body, and is especially well impregnated with iodine, iron and phosphorus.

Kelp is recognized today by progressive physicians as a food supplement of high nutritional value for man, beast and fowl.

Of the 82 known elements, 35 are found in the sea, and of these 35, kelp contains 27.

I have been experimenting with kelp ore for over a decade and use it, in solution, myself and recommend it to my friends.

Using kelp ore in conjunction with earthworm culture is advisable, but, due to its many recommendable qualities, due to the fact that much of its potency can be taken off in solution for human consumption and the residue used for earthworms, I must regretfully refrain from going into its use by earthworm farmers at this time.

Considerable detail is necessary to clearly explain the use of kelp ore, the benefits derived and why. To cover this, I am preparing a small Paper on the subject. Persons writing the author may receive this information.

The greatest events of an age are its best thoughts. It is the nature of the thought to find its way into action.
-- Bovee

Conclusion

THE purpose of these final words regarding our friend, the earthworm, is to draw together a number of loose ends that were inadvertently left out of the main body of this work. In addition, the writer wishes to explain briefly the physiology of plants, particularly that dealing with the roots of plants, for it is in the root zone that the earthworm plays its major role.

In Lesson One, Part One, we saw how all life began on this planet in the waters. Only superficially was it mentioned that the origin of plants was also in the water.

First of all, let us differentiate between animals and plants. Off hand, the average person would say that animals are sensitive and mobile; that plants are not sensitive and are rooted or stationary.

Such a definition is satisfactory, though it is not correct. Among the zoophytes (Greek; zoo - animal: phyte - plant) there are immobile animals and sensitive plants. These latter respond to vibrations of the air around them and to the touch of a foreign body. In addition, there are marine animals that remain stationary from birth to death, and marine plants that travel extensively.

So we see that neither movement nor sensitiveness are essential distinctions when we are pinned down to it and asked to explain the difference between animals and plants. However, men of science have an infallible method of classifying them, and that is by the manner in which they acquire nourishment. Animals "eat"; plants "absorb" food.

Generally speaking, plants have two sets of "mouths" -- their roots and leaves, or, in the absence of leaves, stalks or stems.

We are especially interested in the physiology of roots because of our friend, the earthworm. It behooves us, therefore, to spend a little time on roots so that we shall all have a clearer picture, a sound foundation, from which to visualize the work of the earthworm in the root zone.

There are more varieties of roots than there are plants, and there are many thousand species of plants. There are roots that store water for the plant (many desert species); roots that store food (potatoes, onions, etc.); roots that support plants and plants that support roots, like the banyan tree. There are roots that are parasites, some of which never need contact with the earth. There are others, like the wild fig tree -- which is a relative of the banyan -- that comes to life high on the trunk of the eucalyptus. As the fig tree grows, it sends shoots of new roots

earthward. Here they burrow into the soil, eventually supporting the tree itself.

The earth's first plant life was in the form of moss. It was in this age that roots originated! Gradually, through hundreds of thousands of years, evolution developed other and sturdier-rooted mosses. Then, during the Devion Period -- a geological era in the Paleozoic Age -- ferns, clubmosses, horsetails and trees so large that they would make California redwoods look like celery stalks in comparison, grew and prospered for countless centuries.

From the very beginning of plant life on land, roots have performed a dual role -- as support for the plant and as a feeding apparatus for the plant.

The fundamental purpose of roots is to gather water and certain salts from the soil, which, through the chemistry of the plant's system, becomes nourishment.

The outstanding peculiarity of roots is not observed without close investigation. This peculiarity is to be found in the myriad of hairlike, fibrous fingers through which the nourishment for the plant is sucked up. The brush or "tap roots" common to many plants are almost exclusively engaged in anchoring the plant in the soil.

The small, hairlike, inconspicuous roots (which may be observed by washing the root area carefully) are the real "mouths" of the plant. However, nourishment is not actually sucked up by these hairlike roots. The expression is used merely in a figurative sense. The action is entirely chemical.

Water is attracted by the plant roots by the sugary content of the minute cells of which the roots are composed.

Plants take nitrogen, oxygen and hydrogen from the soil. Carbon, another highly essential element needed by plants, is received through the leaves and (or) stalks.

The leaves or stalks compose the second set of the plant's "mouths." These are filled with a substance of very peculiar properties. This substance was named chlorophyl by the Greeks and means "green leaf."

Chlorophyl is an ingredient in the cells of loaves, stems and stalks. It is the chemical that breaks up the carbonic acid gas in the air which the leaves "breathe." From this breaking up process carbon is extracted, mixed with hydrogen. The oxygen is set free, for enough oxygen is taken in by the roots to satisfy the plant's needs.

Chlorophyl is the substance that makes plants green. It is developed by the plant as needed, but it cannot be developed without sunlight, or a satisfactory, albeit inferior, substitute. Take light from plants and chlorophyl disappears. Example: when soil is piled around the stalks of celery just above the ground, the portion covered becomes white. Lack of light has forced the chlorophyl up the stalks.

Sunlight and chlorophyl are as important to plants above the soil as roots are under it. And it is because of their importance that plant life, from the tenderest orchid to the sturdiest oak tree, spread their leaves and branches about so haphazardly. Each is endeavoring to absorb as much sunlight as it possibly can.

Not only do the leaves of plants "breathe" moisture through their pores; they must also prevent the plant from losing too much water through them -- but I fear I am getting too far away from our real interest, roots. Persons interested in this subject would do well to consult their local librarian for suitable books on this especial subject.

We have already seen how the earthworm, by its constant eating, pulverizing what it eats and excreting it as castings, unconsciously, but with extreme efficiency, prepares the soil so that its mineral and chemical qualities are more easily absorbed by the tender roots of plants.

This pulverization, this trituration into a fine powder of every minute morsel the earthworm swallows, ultimately results in, (1), a healthier plant; (2) a plant richer in chlorophyl; (3) more fertile, healthier seeds; (4) rapid, even growth, and (5) if edible for man or beast, a plant richer in food elements.

These advantages are the natural outgrowth of the burrowing earthworm, substantiated by men of science, and therefore not mere words to befuddle or annoy the reader.

Writing in *Soil Science*, October, 1935, two members [W L. Powers & W. B. Bollen] of the Oregon Agricultural Experimental Station, said, in part, "... Earthworm castings were found in the fir forest under the litter in the crumbmull on top of the mineral soil. The castings were collected from the surface on cut over land where there was a little litter... The work of the earthworms appears to have little effect on reaction. There is evidence of a build-up in base exchange capacity, *and the nitrogen and organic matter are much higher in the casting than in the parent soil*." (The italics are mine.)

In an accompanying table the percentage of organic matter and nitrogen were as follows.

	Maple and grass litter	Soil	Casting
Organic matter	73.14	6.52	34.66
Total nitrogen		0.228	0.672

(Clarence Burnham, research fellow in soils, assisted in the determinations.)

The fact that these investigators found that nitrogen was much higher in the earthworm castings than in the native soil, is a point all persons interested in plant culture will find extremely enlightening.

Nitrogen is the first fertilizing principle to become depleted. But with earthworms functioning in the soil, nitrogen content is increased and will continue to remain as long as there are enough earthworms burrowing in soil containing traces of it. And not only will the earthworms triturate it and make it available for the plant roots, but it will quite probably be brought to the root zone by passing through the alimentary canal of many earthworms.

Let us shift our line of thought for a few minutes.

The new word incorporated in this work for the first time -- Soilution -- may be misconstrued by casual readers as pertaining to the so-called new water culture method. This method, in addition to being currently known under various and attractive trade names, is also called, chemical culture, hydroponics, tank farming, tray agriculture and what-not.

Hydroponics has been sweeping the nation lately under the guise of being "new." It is not new -- by seventy-five years.

"First of all," writes D. R. Hoagland of the University of California in the February, 1938, issue of *The Pacific Rural Press*, "it should be recalled that plants have been grown in solutions containing the essential nutrient salts (plants, of course, will not grow in pure water, so the term water culture is not accurate), by hundreds of investigators during the past three quarters of a century. Their purpose in growing plants in this way has been to study the laws of plant growth, under controlled conditions. During the same period, another method of artificial culture has also been extensively employed by investigators, that of growing plants in silica sand irrigated with nutrient salt solutions."

Writer Hoagland is not at all optimistic about this "new" form of plant raising. What few favorable comments he does make he offsets with "however, without expert knowledge of the water culture technique, commercial success is unlikely."

And again, "Contrary to some statements, plants are not protected against diseases (except soil diseases) or insect pests by growth in water culture. Also, it has not been proved that food produced by water culture has in general nutritional value superior to that of feed produced by soil, with respect to mineral content of the food."

Writer Hoagland also tells us that "most amateurs are not in a position to make mixtures of nutrient salts for themselves, and various firms and individuals offer for sale small packages of salts ready to dissolve. Some of the prices are from twenty to fifty times the original cost of salts."

I believe the following letter is worthy of the reader's attention, therefore I include it here.

"... The subject (of earthworms), instead of being of minor importance, is one of the greatest of modern times. Words are inadequate to express the real importance of this lowly creature to the life and pleasure of man. The more one studies the matter, the more vast become the possibilities. In June of this year I will move to a small place I have at Barwick, Georgia. There I hope to experiment further, as there are eighty pecan trees, ten years old, on the place that I want to treat with castings and earthworms to see what can be accomplished in a backward grove.

"This morning I measured petunia plants with branches twelve and one-half inches long, leaves three and one-quarter by two and one-quarter inches. The plants are growing in a box that has been full of earthworms since last spring, working in manured soil.

"These plants were from a bed that had been enriched both last year and this year with various fertilizers, in which companion plants of the same age and specie have branches only three and one-half inches long and leaves only one and one-half by one and one-quarter inches.

"I have been showing these to some ladies who have flowers, as I feared they would not believe me if I told them without (showing them) the living proof. In fact, it almost looks impossible, but I know the particulars. I wish I were capable of taking a good photograph of these plants while they show such a vast difference in size and thrift.

"Perhaps we can work out a plan which I can put into operation when I move to Barwick. It should be very interesting, for there are a lot of rich estates in and around Thomasville, eighteen miles from my future home, such as those of the late Hon. Robert Bingham, one-time ambassador to England; Mrs. Howard Payne Whitney, Ruth Hanna McCormick and others, who might become interested in the use of earthworms for their landscape projects.

"At Albany, Georgia, not far from Barwick, there are many more such estates and great game preserves, consisting of as many as 20,000 to 30,000 acres, owned by wealthy people from the north...

"I have made a living with hens, and feel that with the information in Part II of *Our Friend the Earthworm*, I can make more than I have in the past. As to housing costs, that is a low item in this section -- less than twenty-five cents per hen under usual conditions -- but your feeding plan is a lot cheaper and more in the way Nature intended...

"I see no way of improving your books, unless it would be that you impress your readers with the fact that your writing is very condensed, and for them to read the book over and over; or rewrite them in more extended form, for the subject is broad and far deeper than casual notice makes it appear -- as broad as every square foot of tillable soil on the surface of the earth.

"I am fifty years of age, far too old to try all the experiments I would like with them before my allotted time shall end."

Thus writes R. A. Caldwell from Faceville, Georgia.

Thought means life, since those who do not think do not live in any high or real sense. Thinking makes the man.
-- A. B. Alcott