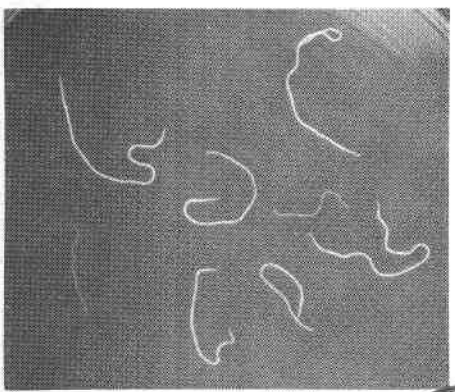
STATION TECHNICAL BULLETIN 28 MARCH 1953

Incidence and Effect of Lungworm in Oregon Swine

J. F. SULLIVAN
J. N. SHAW



Agricultural Experiment Station
Oregon State College
Corvallis

ACKNOWLEDGMENTS: This information is based on data from the master's thesis of James F. Sullivan, Department of Veterinary Medicine, Oregon State College, June 1952.

Grateful acknowledgment is made to Dorothy McKey Fender, Entomologist, McMinnville, Oregon, for her suggestions in working with and help in identifying the earthworms; to Dr. O. H. Muth, Veterinarian, Department of Veterinary Medicine for photographic work; and to T. K. Johnson, Swine Herdsman, Animal Husbandry Department, for his help in procuring experimental animals and materials.

Incidence and Effect of Lungworm in Oregon Swine

J. F. Sullivan and J. N. Shaw
Department of Veterinary Medicine

"Thumps" or difficult respiration has been seen in many young pigs along with the post-mortem discovery of lungworms in the diseased animals. This has made swine growers conscious of the existence of lungworms and interested in information about this parasite. Because reliable data has been lacking, it was impossible to answer questions concerning the prevalence of this parasite in swine.

This study was conducted with two main objectives in mind: to obtain a statistical picture of the incidence of lungworms in Oregon swine, and to determine the effect of varying loads of the parasites on the time and feed required to produce marketable carcasses.

Survey of Incidence of Swine Lungworm Infestation in Willamette Valley, Oregon

Extent of the survey

To obtain data on the incidence of lungworm infestation in Oregon swine a survey was conducted during the calendar year 1951. Swine were examined in two main slaughterhouses supplying the Albany-Corvallis, Oregon, area. Because of the location of these slaughterhouses, it is safe to assume that at least 90 per cent of the 518 animals examined in the incidence survey were raised in the Willamette Valley, Oregon, with a majority coming from Linn and Benton counties.

Method of the survey

The lungs and windpipe were removed intact from the carcass. Scissors were used to open the windpipe and smaller air passageways in the lungs. An animal was considered free from infestation if no adult lungworms were revealed by this dissection. Several specimens of lungworms were taken from the lungs of positive cases. These were brought to the laboratory where a number were preserved in 10 per cent formalin and submitted to Dr. L. A. Spindler of the Zoological Division of the U. S. Department of Agriculture for verification of identification. The remainder were used to increase the number of lungworm larvae present in the earthworms later employed in the inoculation of experimental animals.

Results of Survey on Incidence of Swine Lungworm Infestation

A total of 518 pigs were examined post-mortem for the presence of lungworms. Of these, 269 (51.9 per cent) were positive and 249 were negative. Table 1 shows the incidence of infestation as revealed by this survey.

Table 1. THE INCIDENCE OF LUNGWORM INFESTATION IN OREGON SWINE

Date examined	Source	Number examined	Number positive	Number negative	Amount of infestation
					Per cent
2-2-51	Custom kill[1]	23	15	8	65.2
2-9-51	"	12	8	4	66.6
2-13-51	"	8	6	2	75.0
2-16-51	"	20	13	7	65.0
4-20-51	"	22	11	11	50.0
4-23-51	O. S. C.	20	13	7	65.0
7-27-51	Custom kill	46	27	19	58.8
8-3-51	"	68	40	28	58.0
8-11-51	"	100	55	45	55.0
8-24-51	4-H	14	7	7	50.0
8-31-51	4-H	25	16	9	64.0
9-7-51	Custom kill	66	31	35	46.9
9-14-51	"	21	1	20	4.7
9-21-51	"	28	16	12	57.1
9-26-51	"	45	10	35	22.2
Totals	.....	518	269	249	51.9

[1]The term "custom kill" refers to swine brought to the slaughterhouse to be killed, dressed, and returned to the farmer for his own consumption.

Among the animals examined were 20 slaughter weight animals (190 to 240 pounds) from the College swine herd. A lungworm incidence of 65 per cent was observed in this group. Thirty-nine pigs raised by children in 4-H clubs also were examined and an incidence of 58.87 per cent was revealed. These animals assume particular significance inasmuch as it may be assumed that management of these animals adheres closely to recommended standards.

Samples were collected over a period of 8 months. A decrease in the incidence of infestation was noted in the late months; it is presumed that this decline was due in part to the long periods of drought in which pasture soils were hard and rooting discouraged.

Effect of Lungworm Infestation on Swine Production

The second phase of the study after the survey was completed was that of determining if lungworm infestation had a material bearing on swine production. To accomplish this required a comparison of a noninfested with an infested group after feeding them to marketable weights under identical conditions.

To do this required the development of suitable techniques for raising the experimental animals. The methods used for increasing the number of lungworm larvae in the intermediate host and determining the degree of infestation in both the intermediate and definitive host are described.

Selection and management of experimental animals

All animals used in these trials were raised under conditions designed to prevent natural infestation with parasites. Three purebred Berkshire sows, all bred to the same boar, were transported (not driven) from the swine barn to the veterinary barn. These sows were placed in separate concrete-floored box stalls a week prior to the expected farrowing date. A deep straw litter was used for bedding. All sows farrowed within a 3-day period, each giving birth to nine live young. All piglets were weighed, earmarked, and their navels treated with tincture of iodine. In the absence of a brooder, heat lamps were suspended in the center of each stall 3 feet from the floor. Guard rails of 2" x 8" timbers were placed around the circumference of the stall 10 inches from the floor to prevent the sows from lying on and crushing the young. A ration, designed for pregnant and nursing sows, was fed throughout the gestation and lactation periods.

At 3½ weeks of age all animals were bled from the anterior vena cava and the hemoglobin levels were determined by the Spencer method. As was expected of pigs raised on concrete, the hemoglobin level was low. Six pigs were found to be definitely anemic. Treatment was initiated, using 2 ounces of ferrous sulfate and ½ ounce of copper sulfate suspended in 500 ml. of blackstrap molasses. This mixture was painted on sections of rubber innertube nailed to the guard rails. This method was found to be effective and preferable to the older system of painting the sow's udder.

At 1 month of age, all male piglets were castrated and three trial groups of eight pigs each were segregated. At this time an animal was sacrificed and examined post-mortem for evidence of lungworm infestation; none was found.

All pigs were weaned at 6 weeks. Following weaning the experimental animals were maintained upon a ration designed for

weanling pigs. In addition to dry feed, a daily milk supplement was given. Whole milk was fed during the 6-week post-farrowing period. For the remainder of the trial, 3 pounds of reconstituted skim milk was fed to each group. All piglets were protected from hog cholera by vaccination.

Infectious material.

The earthworms were obtained from the soil in the vicinity of holding sheds of one of the local slaughterhouses. A total of about 2,500 earthworms were procured. Several specimens were identified by Dorothy McKey Fender, entomologist at Linfield College, as *Eisenia foetida.* (See Figure 1.) Schwartz and Porter (1)[1] state that this species appears to be the most suitable intermediate host of the swine lungworm. The earthworms were placed in a wooden container filled with a mixture of soil, manure, and sawdust. The soil surface of the box was covered at all times with several layers of moist paper towels to prevent dehydration.

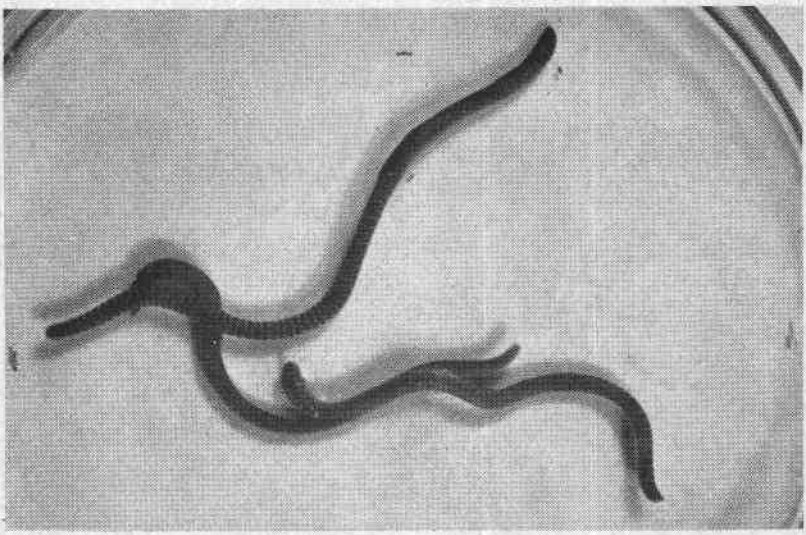


Figure 1. *Eisenia foetida*, the common manure worm.

Technique used to determine the infestivity of the earthworm

Several specimens of the earthworms used in this experiment were examined, using a modified Schwartz-Porter technique (1) to determine if they harbored swine lungworm larvae.

[1]Numbers in parentheses refer to Literature Cited, page 11.

Early examinations were exploratory in nature and served only to show that all earthworms contained larvae. Quantitative counts were made only after the infestivity of the intermediate host was increased by the addition of large numbers of lungworm eggs to the soil containing the experimental earthworms.

Quantitative counts of 27 earthworms totaled 4,743 larvae—an average of 175.5 larvae per worm. This average compares favorably with that of 26 earthworms examined by Schwartz and Porter (1) where an average of 161 larvae per worm was found.

Method of infestation of swine with lungworms

Initial doses of earthworms were given to the members of the heavily and moderately infested groups when the pigs were 1 month old. Subsequent doses were given each week until a total of eight doses had been administered. Whole earthworms or their anterior half were placed in small gelatine capsules, lubricated with mineral oil, and administered orally with the aid of a pig mouth speculum. Each of the members of the moderately infested group received three earthworms a week until a total of 24 earthworms were administered. The eight pigs comprising the heavily infested group were subdivided into four groups of two pigs each. These subgroups received a total of 40, 80, 200, and 400 earthworms respectively. Confirmation of infestation was obtained by positive fecal examinations.

Results

Weekly records of weight gains and daily records of feed consumption were kept in an effort to determine what effect, if any, lungworm infestation had on the growth and feed utilization of the affected pigs. Table 2 records the average weekly weight gains of the individual pigs within the groups. The ratio of feed used to produce a pound of pork varied between a high of 3.55 to 1 and a low of 3.40 to 1. The most efficient utilization of feed was seen in the experimental control group. The feed conversion ratios of pigs in both the moderately and heavily infested groups were almost identical, being 3.55 to 1 and 3.54 to 1, respectively. No significance is attached to this slight deviation inasmuch as all ratios fall well within normal limits.

Following the attempted experimental infestation, all animals were observed for symptoms associated with lungworm infestation. The earliest and most common symptom seen was a cough, accom-

Table 2. WEIGHT GAINS AT WEEKLY INTERVALS

Age	Average weight per pig, by groups		
	Control	Moderate	Heavy
	Pounds	*Pounds*	*Pounds*
4 weeks	18.9	18.8	18.9
5 weeks	21.5	21.9	22.2
6 weeks	24.1	24.2	24.4
7 weeks	27.6	28.0	28.6
8 weeks	30.0	31.0	32.3
9 weeks	30.5	33.3	33.5
10 weeks	37.6	39.1	42.1
11 weeks	44.2	45.6	44.8
12 weeks	51.3	51.61	48.8
13 weeks	59.6	60.2	58.9
14 weeks	69.7	70.3	66.8
15 weeks	77.3	78.3	75.0
16 weeks	88.1	88.0	85.6
17 weeks	89.2	84.3	89.9
18 weeks	105.3	103.9	104.5
19 weeks	117.8	119.5	120.1
20 weeks	128.1	132.2	133.95
21 weeks	139.3	146.1	145.6

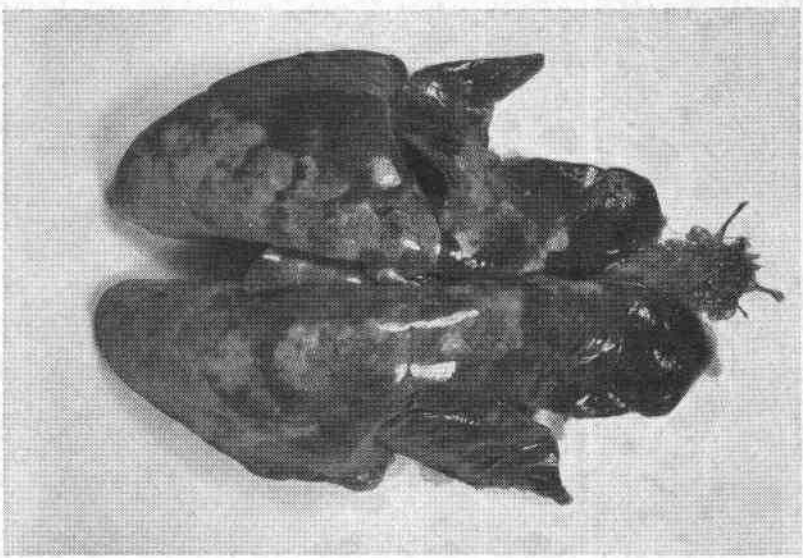


Figure 2. Lungs from a hog with verminous pneumonia. Note lungworms at the extreme right.

panied in severe cases by difficult respiration. Two of the heavily infested pigs died as a direct result of infestation. Confirmation of infestation was made by finding lungworm eggs in the feces of the exposed pigs. Eggs were first seen 28 days following the administration of the initial dose of infested earthworms.

The maximum number of eggs was shed during the fifth week following exposure. Periodic fecal examination showed a tendency for egg passage to decrease after the fifth week.

Post-mortem examination was made of the two pigs that died as a result of the heavy lungworm infestation. In both cases death was ascribed to a verminous pneumonia (see Figure 2). The first pig died at 13 weeks of age after receiving a total of 400 infectious earthworms. Its weight at this time was 48.5 pounds. The lungs showed a verminous pneumonia with an extreme lungworm infestation. The parasites were too numerous to count.

The second pig was the smallest in its litter, weighing 2.85 pounds when farrowed. This heavily infested pig received a total of 200 earthworms. It was found dead in its pen at 13½ weeks of age. At this time it weighed 30.25 pounds. Lungworms were extremely numerous and were estimated to total about 7,000.

Discussion

The death of two members of the heavily infested group, to which extremely large numbers of parasitized earthworms (200 to 400) were administered, indicates that lethal infestations occur.

The remainder of the heavily infested pigs, together with the moderately infested animals, showed a sublethal syndrome characterized by coughing and occasional difficult respiration.

Two of the control animals showed a light lungworm infestation on post-mortem examination. Since infested earthworms were not administered to any member of the control group, the mode of infestation cannot be positively determined. During the first 2 weeks of these trials, however, the suckling pigs were kept with their sows, irrespective of whether they received infested material or not. It is thought that one of the infested piglets regurgitated one or more earthworms, which were then ingested by the two affected members of the control group. The cement floors and curbs in the stalls housing the experimental animals minimize the possibility of nonexperimental earthworms gaining access to the pens.

Weekly weight averages of the members of the three experimental groups are shown in statistical form (Table 2). Comparison of these figures failed to reveal a significant deviation in any group

that may be attributed to lungworm infestation. It is apparent that the growth rate of all groups was depressed between the twelfth and thirteenth week and again between the twentieth and twenty-first week. This inhibitory effect was believed due primarily to the increased area required by the growing pigs. This condition corrected itself when the groups were further subdivided and fewer pigs allotted to each box stall.

There was no visible difference in the carcasses of the three groups.

The most efficient utilization of feed was made by the experimental control group (3.40 to 1). Feed conversion ratios of the moderately and heavily infested experimental groups were almost identical, between 3.55 to 1 and 3.54 to 1 respectively. No significance is attached to this variation.

From these observations it may be concluded that moderate lungworm infestation in swine is not essentially detrimental to the definitive host. Similar conclusions have been drawn regarding the pathogenicity of lungworm infestation in the other species of domestic animals. In his work with sheep, Shaw (3) was able to produce experimental lungworm infestation in all but two of the 27 lambs where infestation was attempted. In this group of infested animals no untoward symptom could be observed with the exception of a moderate cough. Taylor, in a discussion of lungworm infestation of cattle (4), summarizes his observations in the following quotation: "According to the modern teachings of parasitology, the nematode worms concerned in these diseases are not to be regarded as essentially pathogenic but as able to live in their hosts without giving rise to any systemic disturbances so long as they are present in reasonable number. What these reasonable numbers might be varies considerably with the species of worm concerned, but in several instances it is a matter of thousands and in some of tens of thousands."

Lungworm eggs were first observed in the feces of experimentally infested pigs 28 days following exposure, maximum numbers being passed during the fifth week. A continuous decline in the number of eggs produced was observed from this time on. Schwartz (2) reports that lungworms that gain access to young swine may be eliminated from the lungs or otherwise disposed of. If the parasite continues to live in the definitive host, a reduction in the number of eggs produced occurs. These findings suggest that swine lungworms are self-limiting and that continued reinfestation is essential for prolonged parasitism.

Conclusions

1. Swine lungworms were found in the lungs of 265 (51.9 per cent) of the 518 market weight pigs examined in slaughterhouses supplying the Corvallis-Albany, Oregon, area.
2. Techniques were developed to increase the infestivity of earthworms and to produce artificial infestation of susceptible pigs.
3. The study showed that heavy infestations may be lethal.
4. The time necessary to produce marketable hogs was not lengthened by sublethal swine lungworm infestation.
5. No significant difference was observed when a comparison of the carcasses of the infested and noninfested pigs was made.

Literature Cited

1. Schwartz, Benjamin A. and Dale A. Porter. The localization of swine lungworm larvae in the earthworm, *Helodrilus foetidus*. Livro Jubilar Prof. Travassos. Rio de Janeiro, Brazil III. pp. 429-440. 1938.
2. Schwartz, Benjamin A. Controlling lungworms in swine. Washington, U. S. Department of Agriculture, 1936. 5 p. (U. S. Department of Agriculture Leaflet 118.)
3. Shaw, James N. Lungworms (*Dictyocaulus filaria* Rudolphi) in sheep and goats. Corvallis, Oregon State College, 1934. 12 p. (Oregon Agricultural Experiment Station. Station Bulletin 327.)
4. Taylor, E. L. Further notes on husk. The *Veterinary Record*. 63:703-706. 1951.