THE CANADIAN VETERINARY JOURNAL
LA REVUE VÉTÉRINAIRE CANADIENNE
Volume 10 November-novembre 1969 No. 11

STUDIES ON THE INCIDENCE OF LUNGWORM (*DICTYOCAULUS VIVIPARUS*, BLOCH, 1782) IN QUEBEC CATTLE

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Introduction

Bovine parasitic bronchitis or lungworm disease is caused by the nematode *Dictyocaulus viviparus* (Bloch, 1782). This parasite has a cosmopolitan distribution and has been reported from many countries, including Denmark (14), the Democratic German Republic (10), Egypt (36), Great Britain (3, 20), Ireland (1), India (9), Poland (38), Romania (22), Russia (7), Sweden (24), and the United States (30).

In countries such as the U.S.S.R. (7, 23), the United Kingdom (11, 16, 37) and Germany (10), this condition still represents the most formidable of the important parasitic diseases and widespread outbreaks occur yearly in some parts of these countries.

Lungworm disease has also been reported from many Provinces in Canada, including, Alberta (8, 21), Ontario (4), Quebec (5, 13) and Saskatchewan (2). While it appears that in this country, the disease does not represent the hazard to cattle that it does in other areas of the world, in all of these reports it is suggested that it may occur more frequently than presently realized but that improved methods of diagnosis are required for its demonstration. Although the disease has been studied extensively in other countries, information is lacking on its incidence and epidemiology in Canada. It was, therefore, considered useful to conduct a survey on the incidence of this parasite as part of a broader study on this problem in the Province of Quebec. The factors studied were (*a*) total incidence, (*b*) age incidence (*c*) seasonal fluctuations and (*d*) geographic distribution, by counties, of the parasite.

Materials and Methods

Arrangements were made with a large local abattoir, Eastern Abattoirs Limited, Montreal, to provide facilities for postmortem examination of the lungs from a proportion of the animals slaughtered there. The survey work was started in December 1966 and extended up to November 1968. During the period from December 1966 to November 1967 weekly visits were made, while from December 1967 until November 1968 monthly visits were made except for those occasions when the regularity of visits was interrupted due to some unavoidable circumstance. Only animals originating in the Province of Quebec were included in the survey. Efforts were made to examine equal numbers of adult and young animals on every visit.

The lungs were first examined for any visible lesions suggestive of lungworm infection. Next, the bronchial tree was laid open with scissors and a pointed knife and a careful search was made for macroscopically visible worms. Lungs in which worms were found were classified as positive and the remainder as negative.

It was observed that some of the lungs, while showing lesions similar to those of parasitic bronchitis, did not contain any visible worms. A portion of such suspect lungs was excised and brought to the laboratory for microscopic examination to detect the presence, if any, of immature stages of *D. viviparus*. The techniques used were those of Michel and MacKenzie (18) and Silverman *et al.* (31).

The animals examined were divided into two groups. Animals up to one year of age were classified as "young" and the remainder were classified as "adult" animals. Separate records of total examined, total infected and percentage of animals found infected with *D. viviparus* were maintained for each group.

An effort was made to find the place of origin of the positive adult animals on the basis of ear tag and/or back tag numbers. Since the young animals did not have such identification tags, their place of origin was traced with the help of the livestock dealers at the abattoir.

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Results

Total Incidence

During the period of two years from December 1966 to November 1968 9,766 pairs of bovine lungs were examined. Results showed that 2.76% of these lungs were infected with the parasite (Table I). There was remarkable similarity in the monthly distribution patterns of infection when the data from each of the two years were compared. A detailed breakdown of the monthly percentage incidence of *D. viviparus* infection (pooled for 1966, 1967 and 1968) in young and adult animals is presented in Figure 1.

Age Incidence

Four thousand, eight hundred seventy-six and 4,890 pairs of bovine lungs from young and adult animals respectively, were examined. The total numbers of young and adult animals found infected are shown in Table I, and percent incidence in Figure 1. These results clearly indicate that more young than adult animals were infected with *D. viviparus*. The percentage infection rate was 4.25 in young animals and 1.29 in adult animals. Statistical analysis (X^2) showed that this difference in incidence was highly significant ($P < 0.01$).

Seasonal Incidence

A marked seasonal variation was observed in the incidence of *D. viviparus* infection during the period from December 1966 to November 1968. The lowest incidence of infection was seen during the winter months (Table II, Figure 2). Only 0.19% of the lungs examined during this season were found infected. On the other hand, fall appeared to be the season of highest incidence and as many

TABLE I

Total Incidence of *D. viviparus* in Young and Adult Cattle examined during December 1966 to November 1968

Animals	Total Examined	Total Positive	% Positive
Young	4,876	207	4.25
Adult	4,890	63	1.29
Grand Total	9,766	270	2.76

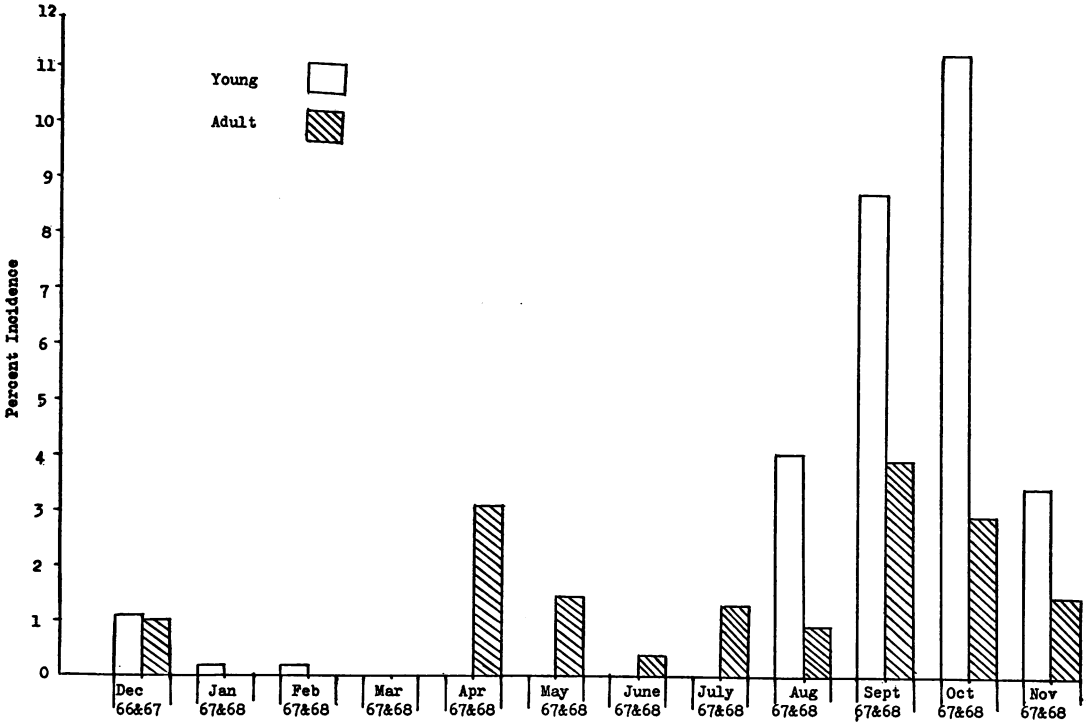

Figure 1. Monthly Percentage Incidence of *D. viviparus* (Pooled 1966, 1967 and 1968 data).

TABLE II

SEASONAL INCIDENCE OF *D. viviparus* IN CATTLE EXAMINED DURING DECEMBER 1966 TO NOVEMBER 1968

Season	Young			Adult			Total Cattle		
	Total Examined	Total Positive	% Positive	Total Examined	Total Positive	% Positive	Total Examined	Total Positive	% Positive
Winter (Dec 22–Mar 21)	1642	5	0.31	941	0	0	2583	5	0.19
Spring (Mar 22–June 21)	156	0	0	1180	15	1.27	1336	15	1.12
Summer (June 22–Sept 21)	1532	71	4.63	1295	9	0.69	2827	80	2.83
Fall (Sept 22–Dec 21)	1546	131	8.47	1474	39	2.65	3020	170	5.63

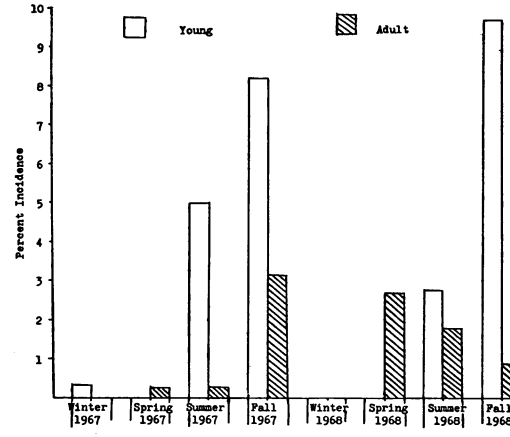

FIGURE 2. Seasonal Incidence of *D. viviparus*.

as 5.63% of the lungs examined at this time contained lungworm.

As was expected, the number of young animals available in the spring for examination was low. Fall was the season when most of the animals in this group were infected (Figure 1). The highest percentage of infection (25.0) was recorded at this time. Thereafter, the incidence of infection appeared to taper off and almost completely disappeared during the winter and spring, not reappearing until the early part of summer in this group of animals. In adult animals, the trend of infection with *D. viviparus* is different from that seen in young animals. Two peaks of infection were seen, one in the fall and another, a relatively smaller one, in the early part of the spring. During the winter not a single case of infection was recorded in this group of animals.

Statistical analysis (analysis of variance) of the data showed that these differences in seasonal incidence were significant ($P < 0.01$). Analysis of differences by season (method of least significant differences) proved that the incidence of *D. viviparus* in the fall was highly significantly ($P < 0.01$; Table III) different from that at other seasons.

Although there were wide variations in the percentage infection from one month to another, a comparison (Figure 1) of the average monthly incidence of the disease, for the two years, between young and adult animals, showed that the highest incidence (11.8%) in young animals was recorded in October, whereas, the highest incidence (3.86%) in adult animals was found in September.

Geographical Distribution

An attempt was made to trace the origin of the infected animals. *D. viviparus* infected

TABLE III

TEST FOR LEAST SIGNIFICANT DIFFERENCE IN SEASONAL INCIDENCE* OF *D. viviparus*

Season	Mean Transformed Incidence	Comparison	Difference Between 2 Seasons	Significance
Winter	1.10	Winter vs Spring	3.07	N.S.
Spring	4.17	Winter vs Summer	5.01	0.05
Summer	6.11	Winter vs Fall	10.57	0.01
Fall	11.67	Spring vs Summer	1.94	N.S.
		Spring vs Fall	7.50	0.01
		Summer vs Fall	5.56	0.01

*Original incidence data Table II transformed
(Arcs in $\sqrt{\text{percentage}}$ transformation)

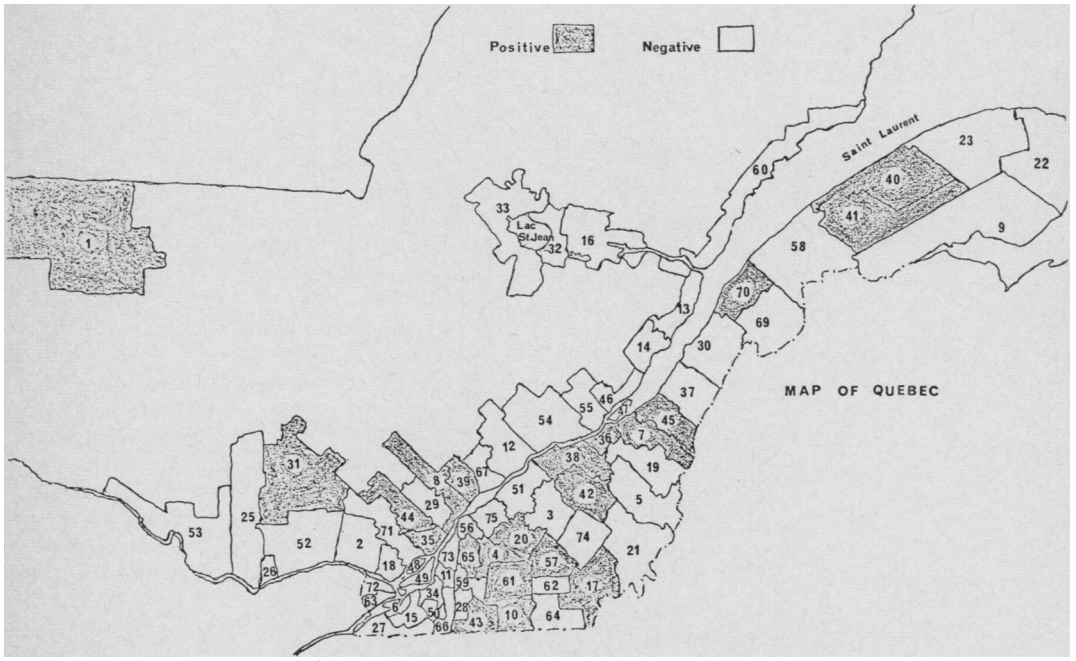

FIGURE 3. Map of Quebec Showing Incidence of *D. viviparus* by Counties.

List of Counties

KEY TO FIGURE 3.

1. Abitibi
2. Argenteuil
3. Arthabaska
4. Bagot
5. Beauce
6. Beauharnois
7. Bellechasse
8. Berthier
9. Bonaventure
10. Brome
11. Chambly
12. Champlain
13. Charlevoix-E
14. Charlevoix-W
15. Chateauguay
16. Chicoutimi
17. Compton
18. Deux-Montagnes
19. Dorchester
20. Drummond
21. Frontenac
22. Gaspe-E
23. Gaspe-W
24. Iles-de-la-Madeleine
25. Gatineau
26. Hull
27. Huntingdon
28. Iberville
29. Joliette
30. Kamouraska
31. Labelle
32. Lac St. Jean-E
33. Lac St. Jean-W
34. Laprairie
35. L'Assomption
36. Levis
37. L'Islet
38. Lotbiniere
39. Maskinonge
40. Matane
41. Matapedia
42. Megantic
43. Missisquoi
44. Montcalm
45. Montmagny
46. Montmorency n°1
47. Montmorency n°2
48. Ile-Jesus
49. Ile-de-Montreal
50. Napierville
51. Nicolet
52. Papineau
53. Pontiac
54. Portneuf
55. Quebec
56. Richelieu
57. Richmond
58. Rimouski
59. Rouville
60. Saguenay
61. Shefford
62. Sherbrooke
63. Soulanges
64. Stanstead
65. St-Hyacinthe
66. St-Jean
67. St-Maurice
68. Temiscamingue
69. Temiscouata
70. Riviere-du-Loup
71. Terrebonne
72. Vaudreuil
73. Vercheres
74. Wolfe
75. Yamaska

animals were found to have originated in 23 out of 75 counties. It will be seen from the map (Figure 3) that infection has been diagnosed in animals from such widespread locations as Abitibi (N.W.), Matane (E), Labelle (W) and Missisquoi (S).

Discussion

The present investigation showed that the incidence of *D. viviparus* infection is relatively high in Quebec cattle. It should be kept in mind that the methods used to detect the presence of worms are not completely accurate and it is quite likely that a number of positive cases with very few worms may have gone undetected.

In spite of these limitations, the number of positive cases which were detected in the present studies was surprisingly high. If one takes into consideration that the cattle population of the Province of Quebec is approximately 1,900,000 the number of positive cases according to these results would be more than 50,000. These results are based only on animals examined in the abattoir and as we did not investigate the problem on the farms of origin it is not possible to comment fully on the magnitude of the loss due to this disease.

There are a number of reasons why *D. viviparus* is more widespread and presents more of a problem in one country than in another or in one region over another. Factors such as climate, pastureland and management all play their part in influencing the disease picture. Popov *et al.* (25) are of the opinion that epidemics of lungworm disease are associated with damp and abundantly watered pastures. In Canada, a long winter stabling period, the severity of winter and method of housing animals may all be factors influencing the incidence of the disease.

Bovine parasitic bronchitis in Quebec appears to be definitely seasonal, as it is in most countries of the world. However, Smythe (32) reported that in places where winter is not cold enough to destroy infective larvae on the pasture and where the animal remains out on the pasture throughout the year, a mild type of lungworm disease can be encountered all the year round. The marked seasonal incidence of the disease can thus partly be explained on the basis that the occurrence of the disease depends on the availability of the infective larvae to the final host. Experiments conducted by Rose (27), Rose and Michel (29), Michel (16) and Rose (28), have amply proven that the population of the infective larvae of *D. viviparus* on pasture fluctuates due to seasonal changes in climate and husbandry. From observations on the bionomics of the free-living stages of *D. viviparus* by Soliman (33, 34), Michel and Rose (19), Rose (26), Rose and Michel (29) and Rose (28) it is obvious that conditions during autumn are very conducive for their development and survival. It is, therefore, to be expected that the incidence of this disease would be highest at this season. Another reason is probably related to the method of housing animals. Winter in this part of the country is severe and animals are brought inside the barn in the late fall and remain confined throughout the winter under conditions which preclude continuous reinfection. These animals are then turned out onto pasture in the late spring. Infection can only start after the animals are turned out and, presumably, it takes some time for the infection on pasture to reach peak levels. These two reasons, namely, climate and husbandry, thus contribute significantly to the seasonal incidence of lungworm disease.

Although approximately equal numbers of young and adult animals were examined, as many as three times more young animals were found infected than adults. In fairness, it should be noted that a number of the young animals slaughtered in the fall could be classed as unthrifty. In this respect therefore, we have a bias in favour of chronic diseases like lungworm in the population being examined. The results are, however, supported by those of Choquette (5) in Canada, and others from various parts of the world (1, 6, 14, 20, 24, 35) in that, where endemic, *D. viviparus* is more frequently a problem in younger than in older animals. There can be exceptions, however, since Jarrett *et al.* (12) and Campbell and Wetherill (4) at times, found the disease to be more frequent in adult animals. It appears that there is no true age resistance to *D. viviparus* infection (16). In the absence of age resistance, there could be two possible reasons for the difference in the incidence of lungworm disease between young and adult cattle. One, as suggested by Michel (15) and Michel and MacKenzie (17) is that the infection in older animals is terminated before it reaches patency as they develop resistance through exposure more quickly than young animals. The other is that, older animals have had the opportunity of acquiring immunity when they were young and are therefore resistant to subsequent infection.

With respect to geographical distribution, while a large number of cattle pass through Eastern Abattoirs, there are about 14 abattoirs in the Province of Quebec situated in different regions. It is, therefore, possible that many

animals from areas distant from Montreal, such as the Lac St. Jean area, would be shipped to the nearest abattoir. The animals examined in the Eastern Abattoirs might not therefore be truly representative for the entire Province of Quebec. In spite of this limitation, on the basis of the animals we were able to trace, the condition appeared widespread in the province. It would not be an exaggeration to presume that a detailed survey covering animals from all the parts of the province would reveal that infection is even more prevalent than was detected in the present survey.

Summary

Studies were undertaken on the incidence of *D. viviparus* in the cattle in the Province of Quebec. Postmortem examination of 9,766 pairs of lungs from young and adult animals, conducted over a period of two years, showed that 2.76% of these were infected with *D. viviparus*. There was a significantly higher incidence of infection in younger than in older animals, the average percentage infection rate being 4.25 in young animals and 1.29 in older animals.

The disease showed a marked seasonality and fall was the season of highest incidence. Among young animals at this time, the incidence rose to 25.0%, a high proportion of the young cattle population coming to slaughter.

On the basis of the origin of the infected animals, it was evident that lungworm infection is widespread in this part of Canada.

Résumé

Cette étude porte sur l'incidence de l'infestation du bétail par *D. viviparus*, au Québec. L'examen post-mortem de 9,766 paires de poumons d'animaux de tous âges, au cours d'une période de deux ans, a révélé que 2.76% étaient affectés. L'incidence de l'infestation était notablement plus élevée chez les jeunes animaux; les pourcentages étant respectivement 4.25 chez les jeunes et 1.29 chez les sujets plus âgés.

La fréquence de la maladie baissait passablement selon les saisons; l'affection étant beaucoup plus fréquente en automne. A cette époque de l'année, 25% des jeunes animaux sont infestés, ce qui représente une forte proportion du bétail abattu. L'origine des animaux infestés démontre que ce parasite est très répandu au Québec.

Acknowledgments

The authors are thankful to the Eastern Abattoirs Limited, Montreal, for providing facilities to conduct postmortem examination of lungs, particularly to Dr. J. A. L. Gonneville and the Canada Department of Agriculture Meat Inspection staff and to Dr. Henri Troalen, Canada Department of Agriculture, for their cooperation.

The technical assistance of Mrs. M. Mackie and Mr. W. Bogie is gratefully acknowledged.

Financial support for this project was provided by the Quebec Agricultural Research Council, which is highly appreciated.

References

1. Allan, D. A field study of a natural outbreak of parasitic bronchitis in calves. Brit. vet. J. 115: 19–26. 1959
2. Allen, J. R. Personal Communication. 1968.
3. Brown, T. H. and C. R. W. Spedding. A study of husk in calves. Brit. vet. J. 114: 296–307. 1958.
4. Campbell, D. J. and G. D. Wetherill. Parasitic bronchitis in adult cattle in Ontario: A case report. J. Am. vet. med. Ass. 131: 273–275. 1957.
5. Choquette, L. P. E. Verminous bronchitis in cattle. Can. J. comp. Med. 18: 347–356. 1954.
6. Cunningham, M. P., F. H. Jarrett, W. I. M. McIntyre and G. M. Urquhart. The carrier animal in bovine parasitic bronchitis: A knackery and farm survey. Vet. Rec. 68: 141–143. 1956.
7. Dmitriev, A. M. Epidemiology of dictyocaulosis in cattle in Omsk Oblast. Vet. Bull. 35: Abstr. No. 3465. 1965.
8. Graesser, F. E. Lungworm disease of cattle in Alberta. Can. J. comp. Med. 21: 355–358. 1957.
9. Gupta, R. P. Studies on bovine lung lesions. M.V.Sc. Thesis, University of Jabalpur. India. 1965.
10. Hiepe, T. Control of dictyocaulosis in cattle under conditions of intensive large-scale farming. Vet. Bull. 35: Abstr. No. 1831. 1965.
11. Hudson, J. R. Notes on husk. Vet. Rec. 63: 703–704. 1951.
12. Jarrett, W. F. H., W. I. M. McIntyre and G. M. Urquhart. Husk in cattle (A review of a year's work). Vet. Rec. 66: 665–676. 1954.
13. Lafortune, M. Jean-Guy. Bronchite vermineuse chez les bovides. Can. J. comp. Med. 18: 78–82. 1954.
14. Larsen, H. E. Verminous bronchitis in cattle. Vet. Bull. 31: Abstr. No. 472. 1961.
15. Michel, J. F. Studies on host resistance to Dictyocaulus infection. The phenomenon of inhibited development. J. comp. Path. 65: 149–158. 1955.
16. Michel, J. F. Recent progress in the epidemiology of parasitic bronchitis. J. R. agric. Soc. 120: 28–44. 1959.
17. Michel, J. F. and A. MacKenzie. An experimental study of certain aspects of the epidemiology of parasitic bronchitis in adult cattle. Emp. J. Exp. Agr. 24: 61–74. 1956.
18. Michel, J. F. and A. MacKenzie. Duration of the acquired resistance of calves to infec-

tion with *D. viviparus*. Res. vet. Sci. 6: 344–395. 1965.
19. MICHEL, J. F. and J. H. ROSE. Some observations on the free-living stages of the cattle lungworm in relation to their natural environment. J. comp. Path. 64: 195–205. 1954.
20. MICHEL, J. and A. SHAND. A field study of the epidemiology and clinical manifestations of parasitic bronchitis in adult cattle. Vet. Rec. 67: 249–266. 1955.
21. O'DONOGHUE, J. G. Clinical trials with cynacethydrazide for the treatment of lungworms in cattle and sheep. Can. J. comp. Med. 22: 237–239. 1958.
22. OLTEANU, G., V. FROMUNDA, V. NICOLA, E. SESTAC, I. LEONTE, V. CIMPEANU, V. GREVUT and E. URDEA. Contributions to the epizootic and prophylactic study of cattle dictyocaulosis. Helminth. Abstr. 32: Abstr. No. 926. 1961.
23. PENKOV. Experimental breeding of calves free from *Dictyocaulus viviparus*. Helminth. Abstr. 14: Abstr. No. 526b. 1945.
24. PETRELIUS, T. Lungmasksjuka hos notkreative i sverige. Helminth. Abstr. 20: Abstr. No. 934a. 1951.
25. POPOV, A., B. GEORGIEV and I. DENEV. Epizootiological and biological investigations into dictyocaulosis in calves. VetMed. Nauki, Sof. 2: 191–199. 1965.
26. ROSE, J. H. Observations on the bionomics of the free-living larvae of the lungworm *D. filaria*. J. comp. Path. Therap. 65: 370–381. 1955.
27. ROSE, J. H. The bionomics of the free-living larvae of *D. viviparus*. J. comp. Path. Therap. 66: 228–240. 1956.
28. ROSE, J. H. Experiments on the transmission of cattle lungworm infection. J. Comp. path. Therap. 70: 475–481. 1960.
29. ROSE, J. H. and J. F. MICHEL. Quantitative studies on the contamination of pasture herbage with husk worm larvae. J. comp. Path. Therap. 67: 57–68. 1957.
30. ROUNTREE, J. L., J. F. WITTIER and H. L. CHUTE. Acute lungworm infestation: A case report. Vet. Med. 49: 306–307. 1954.
31. SILVERMAN, P. H., D. POYNTER and K. R. PODGER. Studies on the larval antigens derived by cultivation of some parasitic nematodes in simple media. Protection tests in laboratory animals. J. Parasit. 48: 562–571. 1962
32. SMYTHE, R. H. The clinical aspects and treatment of "Hoose" (parasitic) and allied conditions in cattle. Vet. Rec. 49: 1221–1232. 1937.
33. SOLIMAN, K. N. Observations on the survival on pasture of preparasitic stages of *D. viviparus* in Southern England. I. Brit. vet. J. 108: 167–172. 1952a.
34. SOLIMAN, K. N. Observations on the survival on pasture of preparasitic stages of *D. viviparus* in Southern England. II. Brit. vet. J. 108: 204–213. 1952b.
35. SOLIMAN, K. N. The clinical manifestations of parasitic bronchitis in cattle with a note on epidemiology with special reference to adults. Vet. Rec. 64: 589–594. 1952c.
36. SOLIMAN, K. N. and H. ZAKI. A note on the outbreak of parasitic bronchitis in young buffaloes in Egypt. Vet. Bull. 34: Abstr. No. 2973. 1964.
37. TAYLOR, E. L. Husk in adult cattle. Agriculture 59: 109–112. 1952.
38. WERTEJUK, M. Lungworm in cattle in the Szezecin Province. Vet. Bull. 34: Abstr. No. 2970. 1964.

ABSTRACT

Shotts, E. B., Jr., Foster, J. W., Brugh, M., Jordan, H. E. and McQueen, J. L. (1968). An intestinal threadworm as a reservoir and intermediate host for swine influenza virus. A confirmation and amplification of Shope's syndrome.—J. exp. Med. 127, 359–369 (Sch. Vet. Med., Athens, Georgia 30601).

It was shown that *Strongyloides ratti* can act as a carrier of swine influenza virus and infect mice, despite the fact that the nematode has undergone a complete life cycle after exposure to virus in infected rats. Rats were inoculated with the virus intranasally and subsequently infected with S. *ratti*. The larvae and eggs appearing in the feces were cultured and the second generation filariform larvae were then inoculated s/c into mice. At 5–8 days after inoculation, swine influenza virus was isolated from 15% of the mouse lungs. The virus was not isolated from the feces of rats which served as a source of both unexposed and exposed nematodes but it was recovered from the nematodes. It is suggested that this laboratory model be used to study more closely the various aspects of the ecology of virus-helminth relationships in vertebrate hosts.

Reprinted from "The Veterinary Bulletin," Vol. 38, No. 9, September, 1968.