Onderstepoort J. vet. Res. 45, 49–54 (1978)

PARASITES OF DOMESTIC AND WILD ANIMALS IN SOUTH AFRICA. VIII. HELMINTHS IN PIGS KEPT UNDER SEMI-INTENSIVE CONDITIONS*

I. G. HORAK, Department of Parasitology, Faculty of Veterinary Science, University of Pretoria, Box 12580, Onderstepoort 0110

ABSTRACT

HORAK, I. G., 1978. Parasites of domestic and wild animals in South Africa. VIII. Helminths in pigs kept under semi-intensive conditions. *Onderstepoort Journal of Veterinary Research* 45, 49–54 (1978).

The seasonal incidence of nematode infestations in pigs raised under semi-intensive conditions was determined by the monthly slaughter of 2–4 tracer pigs exposed to infestation in an earthern-floored pen for periods of 1 or 2 months.

Although worm burdens were generally small, *Ascarops strongylina* appeared to be more prevalent from November to March than during the other months of the year.

Once *Ascaris suum* became established in the pen nearly all the pigs became infested. The number of worms never exceeded 88, however, and no seasonal incidence pattern could be determined.

Trichuris suis favoured the warmer months from November to March, the smallest numbers being recovered during September and October.

One pig only harboured *Trichostrongylus colubriformis* and 3 had *Oesophagostomum dentatum.*

Résumé

PARASITES DES ANIMAUX DOMESTIQUES ET SAUVAGES EN AFRIQUE DU SUD. VIII. HELMINTHES DU PORC MAINTENU DANS DES CONDITIONS SEMI-INTENSIVES

La frequence saisonnière de l'infestation par les nématodes de porcs élevés dans des conditions semi-intensives a été déterminée en sacrifiant chaque mois de 2 *à* 4 *animaux indicateurs qui avaient été exposés à l'infestation dans un enclos sur sol nu pour des périodes d'un ou deux mois.*

Quoique les charges helminthiques aient été généralement faibles, Ascarops strongylina *semble avoir été plus répandu de novembre à mars que pendant les autres mois de l'année.*

Une fois Ascaris suum *s'est etablie dans l'enclos, presque tous les porcs en ont été infestés. Le nombre de vers n'a cependant jamais dépassé* 88 *et l'on n'a pu déterminer aucun schéma d'incidence saisonnière.*

Trichuris suis *préfère les mois plus chauds, de novembre à mars, les nombres les moins élevés ayant été récoltés en septembre et octobre.*

Un porc seulement s'est trouvé abriter Trichostrongylus colubriformis *et* 3 *avaient des* Oesophagostomum dentatum.

INTRODUCTION

The prevalence of helminth infestations in pigs slaughtered at abattoirs has been determined by necropsy examinations in a number of countries: Jacobs, 1967 (Denmark); Sinha, 1968 (India); Jacobs & Dunn, 1969 (United Kingdom); Bennett & Copeman, 1970 (United States of America); Himonas & Triantaphyllou, 1972 (Greece); Horak, 1978 (Republic of South Africa). The pigs examined in all these surveys originated from various sources and consequently it would be difficult to determine the seasonal incidence of porcine helminths for a particular region within these countries.

The epizootiology in Europe of *Oesophagostomum* spp. and *Hyostrongylus rubidus* in pigs, based on faecal worm egg counts and cultures, has been described by Barnett (1966), Jacobs (1966), Connan (1967) and Jacobs & Dunn (1968). With the exception of the investigations by Andrews & Connelly (1945) and Andrews, Stewart, Richardson & McCormick (1970), who examined pigs raised on pasture in Georgia, U.S.A., no surveys involving the regular slaughter of pigs from a particular locality have been reported.

The use of worm-free tracer animals exposed to infestation for short periods in a specific environment and then slaughtered for helminth recovery is an accepted practice for the determination of the seasonal incidence of helminth parasitism in cattle and sheep (Michel, Lancaster & Hong, 1970; Muller, 1968; Anderson, 1972). This paper describes the use of worm-free tracer pigs for determining the seasonal fluctuations in parasite availability in a pen with an earth floor.

* This survey was conducted while the author was employed at the MSD Research Centre, Hennops River

Received 6 December 1977—Editor

MATERIALS AND METHODS

This survey was conducted on a pig and poultry farm in the Boekenhoutkloof area (25° 42′S; 28° 03′E; Alt. 1 341 m) which lies in the Magaliesberg range of mountains to the west of Pretoria. This is a summer rainfall region with dry winters.

Pig farming has been practised on this farm for many years. The piglets are born, raised and prepared for market in concrete-floored pens that are regularly cleaned. The boars are maintained in camps with earth floors and also the sows after their piglets have been weaned and until just before they farrow again. The only anthelmintic known to have been used on the farm was Hygromycin administered with the feed for a few months during 1966 and 1967.

Before the start of the survey numerous faecal examinations done on piglets, weaners, sows and boars gave negative results. Five stunted piglets, which had been reared in a pen with an earth floor, were found at necropsy to harbour *Trichuris suis.*

On 14 February 1968, 6 newly-weaned piglets and 2 pregnant sows were placed in an earthern-floored pen, 10 m × 20 m in area. The sows and 2 of the piglets were to serve as a source of infestation, but the 2 piglets died within 2 months and were not replaced. When the sows were about to farrow they were replaced by 2 other sows.

The sows were removed during August 1968 after the level of infestation within the pen had built up to a satisfactory level. In November the pen size was reduced to 10 m × 10 m.

The pigs were fed a proprietary feed, and water was supplied in a cement drinking trough that frequently overflowed and formed a muddy patch.

Two of the 6 piglets introduced originally were slaughtered after being in the pen for 1 month and 2 newly-weaned piglets were introduced at the same time. Thereafter, 2 newly-weaned piglets were introduced at monthly intervals and slaughtered after being 2 months in the pen, thus allowing a period of 1 month overlap between successive pairs. From August 1968 onwards, 4 piglets were introduced each month, 2 to be slaughtered after 1 month and the other 2 after 2 months. The last tracer pigs were slaughtered on 20 March 1969 and at the same time 2 previously unexposed piglets were slaughtered.

On the day prior to slaughter, the pigs were transported to the laboratory, starved overnight and slaughtered the following morning. After the presence of milkspot lesions in the livers had been noted, the lungs, livers and gastro-intestinal tracts were processed for helminth recovery, according to the methods described by Horak & Pienaar (1972), Horak, Snijders & Louw (1972) and Reinecke (1967).

Until November 1968 mucosal scrapings of the gastro-intestinal tract were digested with pepsin and hydrochloric acid, as described by Reinecke (1967). Thereafter mucosal scrapings of the small and large intestine only were digested, while the mucosa of the stomach was thoroughly scraped and the scrapings processed with the stomach ingesta in the waterbath. From November 1968 onwards, 1/10th–1/8th of the liver by mass was also subjected to pepsin/HCl digestion. Worm burdens were calculated from total counts and counts done on aliquots of the gastro-intestinal ingesta.

Temperature and rainfall data were obtained from 2 weather stations each situated approximately 5 km from the pig farm.

Results

The total worm burdens of the individual pigs and the presence of liver lesions are presented in Table 1. For convenience the pigs are numbered consecutively in the order in which they were exposed and the helminths are listed in the order in which they occur in the alimentary canal.

Ascarops strongylina: Small numbers of worms were recovered from individual pigs slaughtered from March to October 1968. Larger numbers of parasites were recovered from most pigs slaughtered from November until the completion of the survey in March 1969.

Trichostrongylus colubriformis: Two adult worms only were recovered, both from a single pig slaughtered during July 1968.

TABLE 1 Worm burdens of tracer pigs

Pig No.	Date		No. of helminths recovered										Liver lesions
	Exposed	Slaughtered	*A. strongylina*			*A. suum*			*O. dentatum*	*T. suis*		*Capillaria* sp.	
			3rd	4th	Adult	3rd	4th	Adult	Adult	Immature	Adult		
1	14 Feb 68....	15 Mar 68...	0	0	0	0	0	0	0	0	8	—	
2	14 Feb 68....	15 Mar 68...	0	0	0	0	0	0	0	0	0	—	
3	14 Feb 68....	17 Apr 68....	0	0	3	0	0	0	1	0	29	—	
4	14 Feb 68....	17 Apr 68....	0	0	3	0	0	0	0	0	34	—	
5	14 Mar 68...	17 May 68...	0	0	0	0	0	0	0	0	75	—	
6	14 Mar 68...	17 May 68...	0	0	0	0	0	0	18	0	84	—	
7	18 Apr 68....	18 Jun 68....	0	0	1	0	0	0	0	0	28	—	
8	18 Apr 68....	18 Jun 68....	0	0	1	0	0	0	0	0	17	—	
9	16 May 68...	17 Jul 68.....	0	4	1	0	0	0	0	5	51	—	
10*	16 May 68...	17 Jul 68.....	0	1	0	0	1	6	0	5	7	—	
11	20 Jun 68....	14 Aug 68...	0	0	0	0	2	0	0	2	64	—	+++
12	20 Jun 68....	14 Aug 68...	0	0	0	0	4	0	0	1	34	—	++
13	18 Jul 68.....	10 Sep 68....	0	2	0	0	3	6	0	7	19	—	+++
14	15 Aug 68...	10 Sep 68....	0	0	0	0	0	0	0	0	0	—	
15	15 Aug 68...	10 Sep 68....	0	0	0	0	0	0	0	0	0	—	
16	15 Aug 68...	15 Oct 68....	0	0	1	0	2	3	0	3	2	—	+
17	15 Aug 68...	15 Oct 68....	0	0	0	0	1	0	0	5	4	—	+
18	12 Sep 68....	15 Oct 68....	0	0	0	0	0	0	0	0	0	—	
19	12 Sep 68....	15 Oct 68....	0	0	0	0	0	0	0	1	0	—	
20	12 Sep 68....	13 Nov 68...	0	5	12	19	53	0	0	292	70	8	++++
21	12 Sep 68....	13 Nov 68...	0	0	0	1	4	0	0	158	115	8	++++
22	17 Oct 68....	13 Nov 68...	0	0	1	38	50	0	1	48	24	4	++++
23	17 Oct 68....	13 Nov 68...	0	46	77	27	53	3	0	18	83	4	++
24	17 Oct 68....	11 Dec 68....	3	7	91	2	1	0	0	33	380	0	+++
25	17 Oct 68....	11 Dec 68....	0	2	0	0	0	0	0	132	864	40	+++
26	14 Nov 68...	11 Dec 68....	0	0	0	0	7	1	0	52	144	10	+++
27	14 Nov 68...	11 Dec 68....	0	0	2	31	23	0	0	45	97	10	++++
28	14 Nov 68...	14 Jan 69....	0	2	5	0	1	0	0	1	439	0	+
29	14 Nov 68...	14 Jan 69....	0	12	12	0	0	12	0	0	708	0	++
30	12 Dec 68....	14 Jan 69....	0	8	5	2	1	13	0	6	6	0	+
31	12 Dec 68....	14 Jan 69....	0	1	0	0	1	0	0	18	39	0	+
32	12 Dec 68....	20 Feb 69....	1	16	67	0	1	18	0	170	322	40	+
33	12 Dec 68....	20 Feb 69....	12	49	34	0	1	0	0	99	169	10	+++
34	16 Jan 69....	20 Feb 69....	0	5	4	2	1	0	0	361	100	0	+++
35	16 Jan 69....	20 Mar 69...	2	11	4	7	0	0	0	20	171	0	++
36	16 Jan 69....	20 Mar 69...	0	4	25	1	0	0	0	4	104	0	+++
37	Weaner 69...	20 Mar 69...	0	0	0	0	0	0	0	0	0	0	
38	Weaner 69...	20 Mar 69...	0	0	0	0	0	0	0	0	0	0	

* 2 adult *T. colubriformis* recovered

\+ = Few liver lesions

++++ = Very many liver lesions

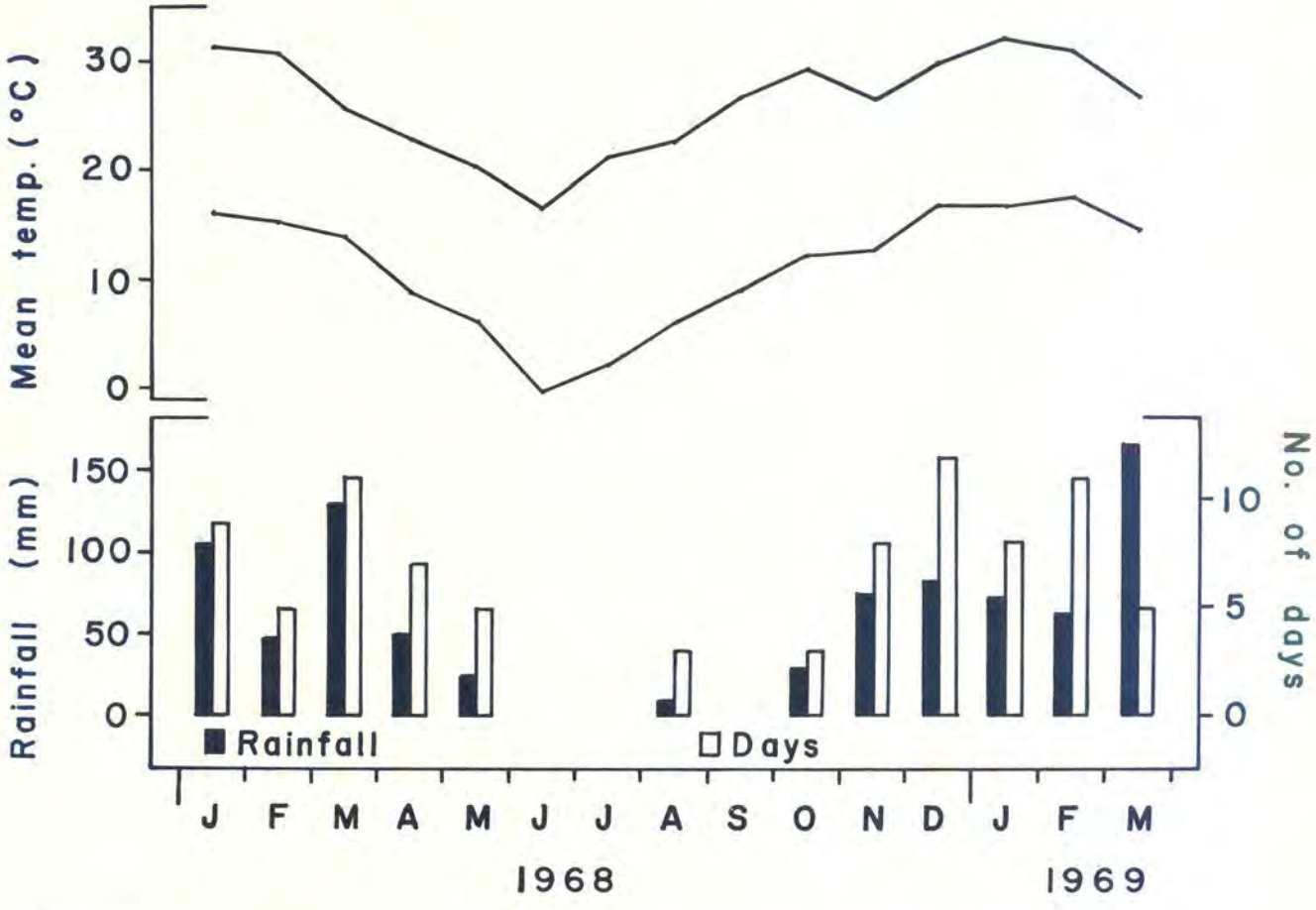

FIG. 1 Atmospheric temperature and rainfall at 2 weather stations within a 5 km radius of the pig farm

Ascaris suum: Infestation was absent in the 8 pigs slaughtered during March to June 1968. During July to October, 6 of the 11 pigs slaughtered were infested with 4th stage larvae or adult worms. Of the remaining 17 tracer pigs slaughtered, 16 were infested, 10 of these harbouring 3rd stage larvae in their intestines. The greatest number of adult worms recovered from a single pig was 18, and the largest total burden consisted of 88 3rd and 4th stage larvae. Once *A.suum* infestation had become established in the pen, liver lesions were encountered in nearly all the pigs.

Oesophagostomum dentatum: Three pigs were infested with adult worms of this species, but no immature worms were recovered.

Trichuris suis: The majority of pigs slaughtered from March to August 1968 harboured 5th stage or adult worms. The level and incidence of infestation was markedly reduced during September and October but rose sharply thereafter to continue at a high level until the completion of the survey. Many immature worms were recovered during this latter period.

Capillaria sp.: Worms of this genus were recovered only from those portions of livers subjected to pepsin/HCl digestion. As only immature worms were recovered, specific identification was not possible.

General: The 2 newly-weaned pigs that had been raised in a manner similar to the tracer pigs before exposure were free from helminth infestation.

The temperature and rainfall data obtained from 2 weather stations within a 5 km radius of Boekenhoutkloof are graphically reproduced in Fig. 1.

Rainfall was virtually confined to the summer months.

Discussion

The absence of infestation in the 2 newly-weaned pigs that had been subjected to the same form of management as the tracer pigs before exposure, indicates that the latter pigs were indeed worm-free at exposure and that infestation was acquired during their sojourn in the earthern-floored pen and not before.

Ascarops strongylina

The virtual absence of this parasite in the pigs slaughtered during the winter and early spring is probably due to the dormancy of its intermediate hosts, coprophagous beetles, during these seasons. Development of the larval stages within the intermediate hosts during the cooler months is probably also prolonged and thus the possibility of infestation is further reduced. During the summer months the beetles are more abundant and the development of the helminth larvae to the infective stage would probably be accelerated and result both in a greater incidence of infestation and higher worm burdens.

Trichostrongylus colubriformis and *Oesophagostomum dentatum*

Under the conditions prevailing in the experimental pen, the free-living stages of these parasites could either be ingested, exposed to the direct sunlight or buried under the soil by the rooting pigs before reaching the infective stage. This would account for the virtual absence of these genera in this experiment.

Ascaris suum

The first adult *A. suum* were recovered from a pig slaughtered during July 1968, and these worms and those in the sows were therefore responsible for contaminating the pen and ensuring the infestation of pigs introduced subsequently. Because the eggs of this species are resistant to adverse conditions, it is almost impossible to eliminate this infestation once it has become established in an earthern-floored pen. The worm burdens or liver lesions observed in nearly all the pigs exposed after July 1968 show that the rooting habits of the pig ensure that virtually every animal will become infested.

Although *A. suum* infestation is frequently encountered in pigs (Jenkins & Erasmus, 1963; Sinha, 1968; Bennett & Copeman, 1970; Himonas & Triantaphyllou, 1972; Horak, 1978), its establishment in the intestine of this host after artificial infestation is extremely variable (Kelley, Olsen & Hoerlein, 1958; Schwartz, 1959; Green & Oldham, 1964). This variableness is probably due to the elimination of larvae from the small intestine 10–15 days after infestation and is associated with the 3rd moult (Douvres, Tromba & Malakatis, 1969) and further elimination 21–30 days after infestation (Schwartz, 1959). This may also be true in natural infestations, particularly those acquired over a period and in which immunity may also play a role in eliminating infestation.

The presence and severity of liver lesions in the present survey suggest that larger intestinal worm burdens should have been recovered and that the elimination of worms from the intestinal tract was probably responsible for the small numbers of worms encountered. The recovery of 3rd stage larvae from the small intestine is in agreement with the life cycle as described by Douvres *et al.* (1969).

Trichuris suis

The rate of development of the larvae to infectivity within the egg is dependent upon temperature. At temperatures between 31° and 34° C, this stage is reached in 19–20 days, while at 20° C development takes 102 days (Beer, 1973). The delay in development due to cold is reflected in the low incidence of infestation in the pigs slaughtered during September and October 1968. Although September and October are not the coldest months, the eggs deposited in the coldest months prior to them would not have developed to infectivity and this would account for the low incidence of infestation. The rapid increase in infestation from November onwards is probably due to large numbers of larvae developing simultaneously to infectivity in the eggs excreted during the earlier months.

No attempt was made to determine the numbers of larvae in the various stages of larval development, as development from the 1st to the 5th stage occurs within the host and differentiation would be difficult (Beer, 1973). In contrast to his findings many larvae were recovered from the mucosa and ingesta of the small intestine.

Capillaria sp.

The worms recovered from the liver digests may have been acquired from poultry, as dead birds were occasionally fed to the pigs, or from rats which were present in the pens. *Capillaria* sp. have not previously been recovered from pigs and the fact that only immature worms were recovered indicates that these parasites were probably in an abnormal host.

General

The conditions in the experimental pen suited the free-living stages of certain helminths. Both *A. suum* and *T. suis* develop to infectivity within the egg and these eggs can survive for exceptionally long periods. Thus, once these eggs are present, burying, exposure or desiccation would not seriously affect their ability to infest pigs and it is logical that these parasites should predominate under these conditions.

Those helminths with free-living larval stages would be at a considerable disadvantage as the exposed nature of the pen, complete absence of vegetation and rooting habits of the pigs would subject these larvae to extremely adverse conditions. The low incidence of *O. dentatum* and *T. colubriformis* can largely be ascribed to these factors.

Helminths, such as *A. strongylina,* which utilize a coprophagous beetle as intermediate host for the larval stages, would by this means escape the adverse conditions in the pen. The pigs would then become infested by ingestion of these beetles which would be attracted to the accumulation of faeces in the pen.

ACKNOWLEDGEMENTS

The services of Dr H. Hellig of Imperial Cold Storage in providing facilities and piglets for the survey, are gratefully acknowledged; also those of Mrs S. M. Raymond and Miss I. Penderis who ably assisted with the processing of the necropsies for helminth recovery.

REFERENCES

ANDERSON, N., 1972. Trichostrongylid infections of sheep in a winter rainfall region. I. Epizootiological studies in the western district of Victoria, 1966–1967. *Australian Journal of Agricultural Research,* 23, 1113–1129.

ANDREWS, J. S. & CONNELLY, J. W., 1945. Worm parasites in swine raised under a moderate degree of sanitation. *Proceedings of the Helminthological Society of Washington,* 12, 6–12.

ANDREWS, J. S., STEWART, T. B., RICHARDSON, G. V. & McCORMICK, W. C., 1970. Internal parasites in pigs in southern Georgia: acquisition by suckling pigs raised on temporary and permanent pastures and grazed on permanent pasture after weaning. *Journal of Parasitology,* 56, 1210–1217.

BARNETT, S. F., 1966. A post-parturient rise of faecal nematode egg counts in sows. *Veterinary Record,* 79, 156–157.

BEER, R. J. S., 1973. Studies on the biology of the life-cycle of *Trichuris suis* Schrank, 1788. *Parasitology,* 67, 253–262.

BENNETT, D. G. & COPEMAN, D. B., 1970. Gastro-intestinal helminth infections in feeder pigs. *American Journal of Veterinary Research,* 31, 1093–1096.

CONNAN, R. M., 1967. Observations on the epidemiology of parasitic gastro-enteritis due to *Oesophagostomum* spp. and *Hyostrongylus rubidus* in the pig. *Veterinary Record,* 80, 424–429.

DOUVRES, F. W., TROMBA, F. G. & MALAKATIS, G. M., 1969. Morphogenesis and migration of *Ascaris suum* larvae developing to fourth stage in swine. *Journal of Parasitology,* 55, 689–712.

GREEN, D. A. & OLDHAM, J. N., 1964. Resistance in pigs to artificial infection with *Ascaris lumbricoides. Veterinary Record,* 76, 671–673.

HIMONAS, C. A. & TRIANTAPHYLLOU, J. S., 1972. (A research survey on the parasitic fauna of swine in Northern Greece) (In Greek). *Hellenic Veterinary Medicine,* 15, 139–146.

HORAK, I. G., 1978. Parasites of domestic and wild animals in South Africa. VII. Helminths in pigs slaughtered at the Pretoria Municipal Abattoir. *Onderstepoort Journal of Veterinary Research,* 45 (1), 43–48.

HORAK, I. G. & PIENAAR, INA, 1972. The efficacy of thiabendazole against immature and adult *Dictyocaulus filaria* in sheep. *Journal of the South African Veterinary Medical Association,* 43, 107–109.

HORAK, I. G., SNIJDERS, A. J. & LOUW, J. P., 1972. Trials with rafoxanide. 5. Efficacy studies against *Fasciola hepatica, Fasciola gigantica, Paramphistomum microbothrium* and various nematodes in sheep. *Journal of the South African Veterinary Medical Association,* 43, 397–403.

JACOBS, D. E., 1966. The peri-parturient egg-rise of the sow. *Veterinary Record,* 79, 272–273.

JACOBS, D. E., 1967. Helminthiasis of the adult pig in Denmark. I. A *post-mortem* study. *Nordisk Veterinaermedicin,* 19, 457–461.

JACOBS, D. E. & DUNN, A. M., 1968. The epidemiology of porcine oesophagostomiasis. *Nordisk Veterinaermedicin,* 20, 258–266.

JACOBS, D. E. & DUNN, A. M., 1969. Helminths of Scottish pigs: occurrence, age incidences and seasonal variations. *Journal of Helminthology,* 43, 327–340.

JENKINS, T. & ERASMUS, D. A., 1963. Studies on the incidence of helminth parasites in pigs from South Wales. *Journal of Helminthology,* 37, 299–306.

KELLEY, G. W., OLSEN, L. S. & HOERLEIN, A. B., 1958. The influence of diet on the development of *Ascaris suum* in the small intestines of pigs. *American Journal of Veterinary Research,* 19, 401–404.

MICHEL, J. F., LANCASTER, M. B. & HONG, C., 1970. Observations on the inhibition of development of *Cooperia oncophora* in calves. *British Veterinary Journal,* 126, XXXV–XXXVII.

MULLER, G. L., 1968. The epizootiology of helminth infestation in sheep in the south-western districts of the Cape. *Onderstepoort Journal of Veterinary Research,* 35, 159–194.

REINECKE, R. K., 1967. Improved methods for the recovery of parasitic nematodes at autopsy. *Onderstepoort Journal of Veterinary Research,* 34, 547–562.

SCHWARTZ, B., 1959. Experimental infection of pigs with *Ascaris suum. American Journal of Veterinary Research,* 20, 7–13.

SINHA, B. K., 1968. On the helminth parasites of domestic pigs (*Sus scrofa domestica*) in Bihar (India). *Indian Veterinary Journal,* 45, 119–123.