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Studies on bovine gastro-intestinal parasites. VII. Attempts to develop an active immunity to *Haemonchus contortus* by injection of a saline extract of adult worms. ROY L. MAYHEW, Louisiana State University.

In the following paragraphs is a description of 3 experiments carried out in an attempt to produce an active immunity to the large stomach worm, *Haemonchus contortus*, by the injection of a normal saline extract of adult parasites.

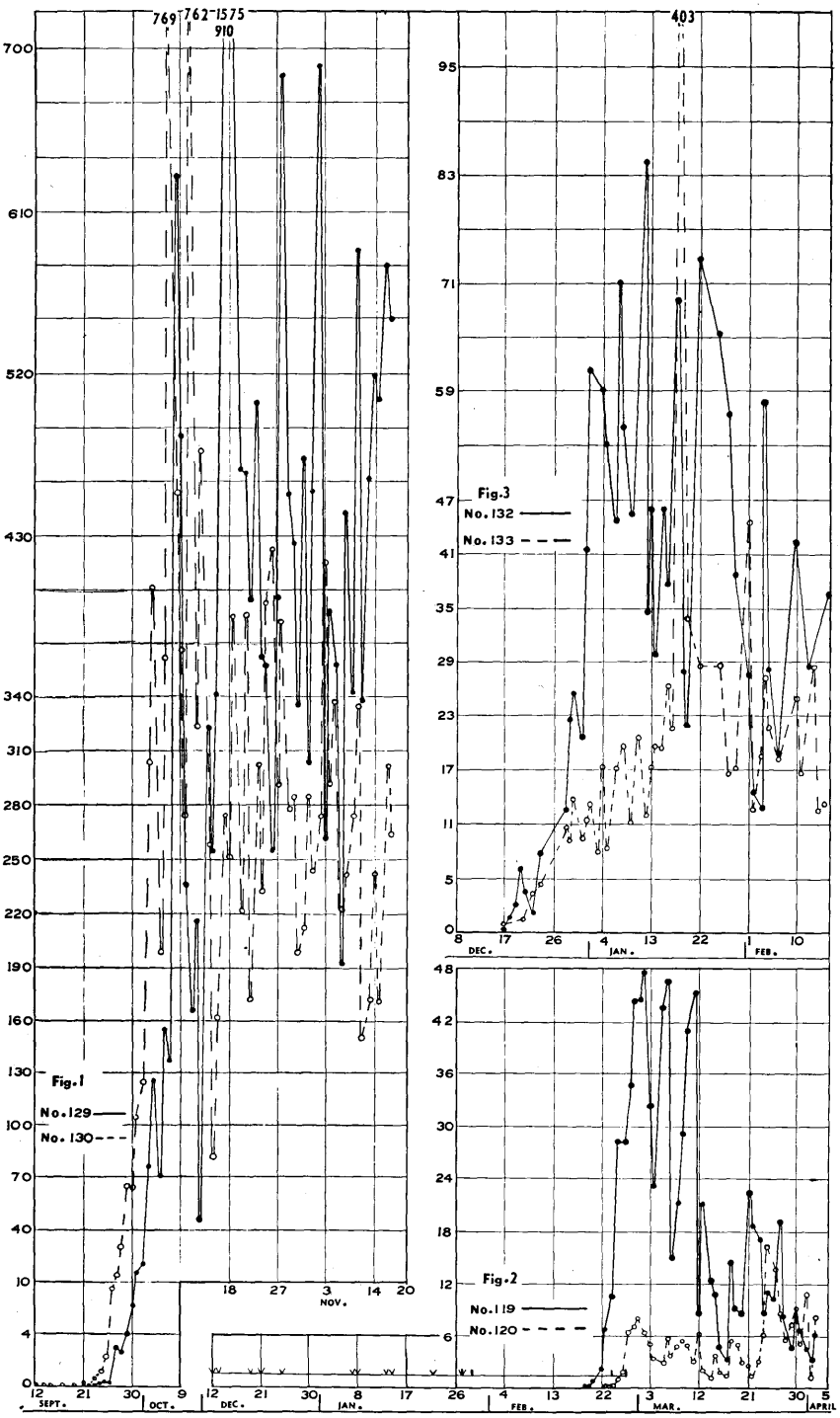
The methods used in the care of the calves are the same as those used in the experiments previously described in this series of papers (Mayhew, 1940, Jour. Parasit. 26: 345–357).

The method used in the preparation of the Haemonchus extract was as follows: Adult male and female worms were collected from the stomachs of calves killed at the Baton Rouge City Abattoir by the usual washing and sedimentation procedure. After being recovered from the debris, they were washed 2 or 3 times in normal saline and ground in fine sand in a mortar in normal saline made from C.P. salt. This was allowed to stand at room temperature for 2 to 3 hours, then transferred to a 50-cc centrifuge tube and centrifuged at 1200 r.p.m. for 2 minutes. The supernatant liquid was then filtered through a sterilized Seitz filter and the filtrate usually injected at once, but a few times placed in a refrigerator and the injections made the next morning. Time did not permit the counting of the worms every time, but it is estimated that 400 to 500 worms were used in the preparation of approximately 5 cc of the extract. Culture of the extract and the absence of any abscess formation at the point of injection demonstrated the lack of bacterial contamination. Plans for further experiments with these animals did not permit their being killed in order to recover the parasites. No clinical symptoms of parasitism were observed in any animal.

EXPERIMENTAL DATA

Calf No. 129.—This animal was a grade Jersey male born November 5, 1941. Two cc of extract were injected intramuscularly on the following dates: July 23, 28, August 2, 11, 22, 25, and September 1, 1942. Infective *Haemonchus contortus* larvae were given August 28, and September 1, 1942. Calf No. 130, a purebred Jersey male born November 8, 1941, served as the control and received an equal amount of the same suspensions of larvae at the same time as did No. 129. It will be noted that (Fig. 1) there is essentially no difference in the egg counts of the two animals except that those of the injected calf No. 129 on the whole might be considered to be a little higher than those of the control.

Calf No. 119.—This calf was a purebred Jersey male born August 22, 1940. The injections of extract were made December 12, 13, 19, 21, 25, 1940, and on January 7, 8, 13, 14, 22 and 27, 1941, as indicated in figure 2. Two cc were injected subcutaneously and intramuscularly on each of the first three dates and 4 cc on each of the other dates. On January 27 and 29 an equal volume of suspension of infective larvae was administered to No. 119 and to the control No. 120. It will be noted that (Fig. 2) the resulting infection was heavier in the injected animal than in the control when we compare the resulting egg counts.



FIGS. 1 TO 3.—Egg-count data.

Calf No. 132.—This animal was a grade Jersey male born June 10, 1942. Injections of 2 cc each were made on September 23, October 7, 12, 17, 21 and 4 cc on October 30, November 5, and 10, 1942. On November 14 an equal amount of suspension containing a very large number of infective *Haemonchus contortus* larvae was given No. 132 and No. 133, the latter serving as a control. No. 133 was also a grade Jersey male and was born on June 9, 1942. Judging the results of the experiment by the egg-count data (Fig. 3), the filtrate offered no protection against the infective larvae since the number of eggs eliminated may be considered higher on the whole in the injected calf.

SUMMARY

The results of 3 experiments are reported in which a normal saline extract of adult *Haemonchus contortus* was injected intramuscularly and subcutaneously into parasite-free calves previous to inoculation in an attempt to develop an active immunity to infective larvae of the parasite. The results indicate that no protection is offered by the extract prepared and administered in the manner described.

Limited tests of mixtures of tin oleate with ammonium compounds for the removal of experimental tapeworm infections of chickens. JAMES E. GUTHRIE[1] and PAUL D. HARWOOD,[2] U. S. Bureau of Animal Industry.

Earlier investigations indicated that mixtures of synthetic pelletierine hydrochloride with various tin salts possess a synergistic action for the removal of experimental infections of *Raillietina cesticillus* from chickens (Guthrie and Harwood, 1941, Amer. Jour. Vet. Res. 2(2): 108–116; Guthrie, Powick and Bandel, 1941, North Amer. Vet. 22(1): 22–24). Since synthetic pelletierine hydrochloride cannot be used for this purpose economically, some tests with cheaper ammonium compounds were made. The preliminary results obtained thus far are reported at this time because circumstances have prevented further work along these lines.

All birds used in the experiments reported in this paper were obtained as one-day-old chicks from the Animal Husbandry Division of the Bureau of Animal Industry, Beltsville Research Center, U. S. Department of Agriculture, Beltsville, Maryland. The conditions under which these birds were kept precluded extraneous helminth infections.

Meal beetles (*Tribolium spp.*) were fed on gravid segments of *R. cesticillus*. Five to six weeks later the beetles were dissected in a small amount of physiological saline and the fully developed cysticercoids were counted and administered into the crop of each bird by means of a glass pipette. All test birds were given 50 fully developed cysticercoids.

The dung beetle, *Onthophagus hecate*, was used as an intermediate host for *Hymenolepis carioca*. The birds were infected with fully developed cysticercoids in the same manner as those which were used in the experiments with *R. cesticillus*, with the exception that 100 cysticercoids were given to each bird.

Two to four weeks after infection, each bird was confined in a separate compartment of a laying battery having a wire floor through which the droppings passed into a small amount of water. After a fast of 18 to 24 hours the drugs were administered in hard gelatin capsules. Similarly infected control birds were studied in connection with each treated group. The droppings of each bird were collected separately over a period of 24 hours following treatment and examined in the usual manner for tapeworms. Two weeks after treatment each bird was necropsied and the intestinal tract carefully examined for any remaining tapeworms.

[1] Resigned December 2, 1940.

[2] Resigned February 25, 1941.

TABLE 1.—*Effect of mixtures of tin oleate with ammonium compounds on experimental infections of Raillietina cesticillus in chickens*[a]

Experiment No.	Date of infection	No. of birds in experiment	Date of treatment	Drugs employed	Dose	Mean wgt. at time of treatment	Mean gain in wgt. during 4 days following treatment	Tapeworms recovered at necropsy[b]	Efficacy of treatment
	1940		*1940*		*Grams*	*Grams*	*Grams*	*Mean No.*	*Per cent*
1	6/25	10	8/14	Tin oleate & triethanolamine[c]	2.5	1132.3	41.6	0.5	97.73
		10		Controls	.....	1086.3	112.3	22.1	.....
2	9/12	8	10/3	Tin oleate & triethanolamine[d]	2.0	1255.5	154.1	8.1	48.07
		7	10/3	Tin oleate & ammonium hydroxide[d]	2.0	1270.1	134.1	9.1	41.66
		8		Controls	.....	1257.0	406.7	15.6	.....

[a] All chickens were infected with 50 cysticercoids each.
[b] All birds were necropsied 14 days after treatment.
[c] 25 grams tin oleate and 15 cc of triethanolamine were mixed and heated slightly.
[d] Equal molecular quantities of each.

TABLE 2.—*Effect of mixtures of tin oleate with ammonium compounds on experimental infections of Hymenolepis carioca in chickens*[a]

Date of infection	No. of birds in experiment	Date of treatment	Drugs employed	Dose	Mean wgt. at time of treatment	Mean gain in wgt. during 4 days following treatment	Tapeworms recovered at necropsy[b]	Efficacy of treatment
1940		*1940*		*Grams*	*Grams*	*Grams*	*Mean No.*	*Per cent*
	9	10/17	Tin oleate & triethanolamine[c]	1.5	704.1	81.4	0.88	97.58
	9	10/17	Tin oleate & ammonium hydroxide[c]	1.5	741.6	94.5	3.6	90.03
10/1								
	10	10/17	Tin oleate	1.0	877.2	76.0	0.0	100.00
			Syn. pelletierine HCl	0.1				
	10		Controls	.....	769.9	140.6	33.1	.....

[a] Each bird was infected with 100 cysticercoids.
[b] Each bird was necropsied 14 days after treatment.
[c] Equal molecular quantities.

The results obtained from the treatment of chickens infected with 50 cysticercoids of *R. cesticillus* with mixtures of tin oleate and triethanolamine, and tin oleate and ammonium hydroxide are recorded in table 1. In experiment 1 the mixture of 25 grams of tin oleate and 15 cc of triethanolamine gave encouraging results. However, a mixture of equal molecular quantities of the same drugs was less effective, as may be seen from experiment 2. In both cases the mixtures were made up and used promptly, because upon exposure to air, it was noted that the product changed from a light cream color to a dark brown in a short time. The mixture of tin oleate and ammonium hydroxide was composed of equal molecular quantities of the two compounds. The results obtained from the administration of this mixture were not encouraging.

In table 2 are reported the results obtained abainst *Hymenolepis carioca* with mixtures of tin oleate with triethanolamine, ammonium hydroxide, and synthetic pelletierine hydrochloride. The mixture of tin oleate and triethanolamine consisted of equal molecular quantities of each compound, and as may be seen from the table it was effective for the removal of this tapeworm. The tin oleate and ammonium hydroxide mixture also was composed of equal molecular quantities of the two compounds and, while slightly less effective, the action of the treatment was satisfactory. The results obtained from the administration of a mixture composed of 1 gram of tin oleate and 0.1 gram of synthetic pelletierine hydrochloride agree well with the efficacy as reported for this same mixture elsewhere. (Guthrie and Harwood, *loc. cit.*).

From the data reported it is doubtful that a mixture of tin oleate and triethanolamine is of practical value as a poultry taeniacide since this mixture deteriorates quickly in the presence of air and the efficacy is inconsistent, particularly against *R. cesticillus*. The limited data on the use of ammonium hydroxide and tin oleate mixtures suggest that this product does not have a satisfactory efficacy for the removal of *R. cesticillus*. In the case of *H. carioca*, however, the efficacy was satisfactory. Further investigations of the simultaneous adminstration of a tin compound and various ammonium compounds seem desirable in view of the increased efficacy obtained when two such compounds, namely, triethanolamine and ammonium hydroxide, were mixed with tin oleate, which is weakly taeniacidal when used alone. That synthetic pelletierine hydrochloride increases the taeniacidal activity of various tin compounds has already been reported, and the data presented in this paper indicate that a mixture of tin oleate and this compound is effective for the removal of *H. carioca*. Unfortunately synthetic pelletierine hydrochloride has not proved economically feasible for use as a poultry taeniacide in the field.

SUMMARY

Mixtures of tin oleate with triethanolamine and with ammonium hyroxide were administered to chickens experimentally infected with *Raillietina cesticillus*. The latter mixture appears to be of limited efficacy but the former mixture, when freshly prepared, gave excellent results in one test. When mixtures of tin oleate with triethanolamine were prepared a few days in advance of use, they proved of limited efficacy, possibly because of deterioration due to chemical changes. The same mixtures and, in addition, a mixture composed of tin oleate and synthetic pelletierine hydrochloride, administered to chickens infected with *Hymenolepis carioca* were effective in limited tests.

Effect of skim milk on the growth and acquisition of parasites by pigs under conditions of constant exposure to infection. L. A. SPINDLER and HARRY E. ZIMMERMAN, JR., U. S. Bureau of Animal Industry.

INTRODUCTION

Spindler, Zimmerman, and Hill (1944, Proc. Helminth. Soc. Wash. **11**(1): 9–12) reported that pigs maintained on a diet of fluid skim milk, exclusive of all other feed, for 3 to 5 days expelled during that time 61 to 100 per cent of their whipworms, 90 to 100 per cent of their nodular worms, and as many as 94 per cent of their ascarids. In view of this fact an investigation was begun to ascertain whether by feeding skim milk it would be possible to keep at a low level infections of the parasites named, and at the same time produce satisfactory weight gains in pigs constantly exposed to infections. The investigation was carried out from April to October 1943, at the field station of the Zoological Division, Beltsville Research Center, Beltsville, Md.

EXPERIMENTAL PROCEDURE

Two tests were carried out. The numbers of animals involved, the conditions under which they were maintained, the method of feeding, and other pertinent information are briefly summarized below:

Experimental animals.—Littermate pigs of mixed breeds were used in each test. Test 1 involved 5 pigs, 13 weeks old; test 2 involved 9 pigs 11 weeks old. In each test the pigs were divided into 3 groups on the basis of weight and sex. In test 1, groups 1 and 2 consisted of 1 male and 1 female each and group 3 of a male. In test 2 each group was composed of 1 male and 2 females.

Method of feeding.—Each evening the group 1 pigs were fed as much fluid skim milk as they would consume before the next morning; grain and water were withheld when milk was being administered. Each morning the pigs were fed as much of a balanced grain ration as they would consume during the day.

At intervals of 3 weeks in test 1, and 2 weeks in test 2, the group 2 pigs were fed fluid skim milk exclusively for a period of 3 days; the milk was fed morning and evening, and during that time all grain feed and water were withheld. At all other times the animals were given twice daily as much of a balanced grain ration as they would consume.

The group 3 pigs were fed twice daily as much of the balanced grain ration as they would consume and were not fed milk at any time; these animals, therefore, served as controls. In the case of all groups the grain ration was fed on the ground, a different site being selected for each feeding; this procedure was followed to enhance the chances of parasite infections being acquired by the animals.

Experimental pens.—Each group was maintained in a separate pen measuring approximately 40 by 45 feet. The pens were constructed on an area that had been used during the last 10 years for hogs infected with various species of the parasites common in this region, namely, *Ascaris lumbricoides* var. *suis*, *Trichuris suis*, *Oesophagostomum dentatum*, *Metastrongylus elongatus*, *Choerostrongylus pudendotectus*, *Ascarops strongylina*, *Physocephalus sexalatus*, *Eimeria* spp., *Endameba* spp., and *Balantidium coli*. Examinations of the soil showed that eggs of *Ascaris* and *Trichuris*, larvae of *Oesophagostomum*, and oöcysts of *Eimeria* were present on the soil in large numbers. The pigs used in the investigation harbored natural infections of *Strongyloides*, *Endameba*, and *Balantidium* at the time they were placed on experiment and therefore served to contaminate the soil with these parasites.

The pens were bare of vegetation but each was partially shaded during the late afternoons. During the drier portion of the summer the soil of each pen was

sprinkled daily with water from a hose to minimize destruction of the infective stages by desiccation.

In order that the pigs in all groups would be exposed equally to contamination existing in the three pens, they were moved each week to the adjoining pen; rotation was always in a clockwise direction. By following this scheme each group made the circuit of the pens every three weeks. Whenever the pigs were transferred they were weighed and a rectal sample of feces taken from each for parasite examination. The course of the infections of helminths, *Eimeria,* and *Balantidium* was followed by the Stoll dilution egg count technique; the course of the infections of *Endameba* was followed by direct microscopical examination of fecal smears.

SUMMARY OF FINDINGS

Test 1 was begun April 26, and terminated June 22, 57 days later, because accidental injury to one of the pigs necessitated its destruction. As can be seen from table 1, groups 1 and 2 made average weight gains of 50.27 and 53 pounds,

TABLE 1.—*Weight data*

	Average at beginning of test	Average at necropsy	Average gain	Average daily gain
	pounds	*pounds*	*pounds*	*pounds*
Test 1				
Group 1 fed milk daily	51.00	101.27	50.27	0.88
Group 2 fed milk every three weeks	43.00	96.00	53.00	0.90
Group 3 (controls) fed grain only	69.50	109.50	40.00	0.70
Test 2				
Group 1 fed milk daily	29.50	145.00	115.50	1.17
Group 2 fed milk every two weeks	29.10	113.60	83.50	0.85
Group 3 (controls) fed grain only	31.90	63.60	31.70	0.32

respectively, whereas the control pig gained 40 pounds during the test. On postmortem examination the control pig was found to harbor infections of *Ascaris, Trichuris, Oesophagostomum, Ascarops* and/or *Physocephalus,* and *Metastrongylus* and/or *Choerostrongylus* as shown in table 2. In the case of the milk-fed pigs (groups 1 and 2) infections of these parasites were either absent or less than one-half those in the control (table 2).

Test 2 was begun July 6, and terminated October 12, 98 days later. During the test the group 1 pigs made an average weight gain of 115.50 pounds, or 1.18 pounds per day; the group 2 pigs made an average gain of 83.50 pounds, or 0.85 pound per day. In contrast to the gains made by the milk-fed pigs (groups 1 and 2) the controls (group 3) gained 31.70 pounds (average) which is 0.32 pound per day (Table 1).

At necropsy the control pigs (group 3) harbored infections of *Ascaris, Trichuris, Oesophagostomum* spp., *Ascarops* and/or *Physocephalus,* and *Metastrongylus* and/or *Choerostrongylus* as shown in table 2.

As can be seen from this table, all of the group 2 pigs and 2 of the group 1 pigs were free of intestinal helminths at necropsy; the other pig of group 1 harbored 25 *Trichuris.* As can be seen from the data, infections of *Metastrongylus, Choerostrongylus, Ascarops,* and *Physocephalus* were either absent or light in the pigs of these 2 groups.

As stated previously the course of the helminth infections and the infections of *Eimeria* and *Balantidium* was followed by counts at weekly intervals during

TABLE 2.—*Numbers of worms, other than Strongyloides, recovered at necropsy*

	Ascaris	*Trichuris*	*Oesophagostomum* spp.	*Ascarops* and/or *Physocephalus*	*Metastrongylus* and/or *Choerostrongylus*
	number	*number*	*number*	*number*	*number*
Test 1					
Group 1 fed milk daily	None	2, 20	0, 4 immature	None	10, 17
Group 2 fed milk every three weeks	None	None	4, 15	None	15, 6
Group 3 (controls) fed grain only	20	82	156	68	35
Test 2					
Group 1 fed milk daily	None	25 in one pig	None	None	0, 7, 3
Group 2 fed milk every two weeks	None	None	None	None	0, 7, 15
Group 3 (controls) fed grain only	38, 116, 88[a]	150, 90, 221	75, 225, 154	80, 120, 56	256, 342, 197

[a] A total of 178 ascarids of various sizes were found during the experiment on the lots occupied by this group.

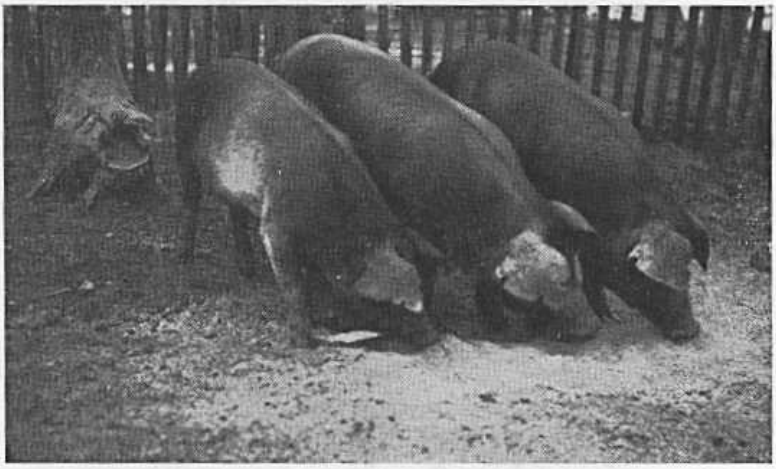


FIG. 1. Group 2 pigs fed milk for periods of three days at intervals of two weeks. These pigs made an average weight gain of 83.50 pounds during the test and were free of intestinal helminths at necropsy.

the test. The course of the infections in the pigs of test 1 was very similar to those in test 2. For that reason and because of the fact that test 2 was of longer duration the findings for that test will be briefly discussed as representative of conditions during the experiment.

At the beginning of the test (Test 2) all the pigs harbored light natural infections of *Strongyloides* and the eggs were found in relatively small numbers in the feces of all pigs throughout the test. At no time did the number of eggs per gram of feces exceed 5,800 and no consistent difference was noted between the infections in the milk-fed pigs and the controls. Conditions existing on the bare soil of the lots were apparently not favorable for survival of *Strongyloides* larvae as they were found only infrequently in soil samples taken from the experimental areas.

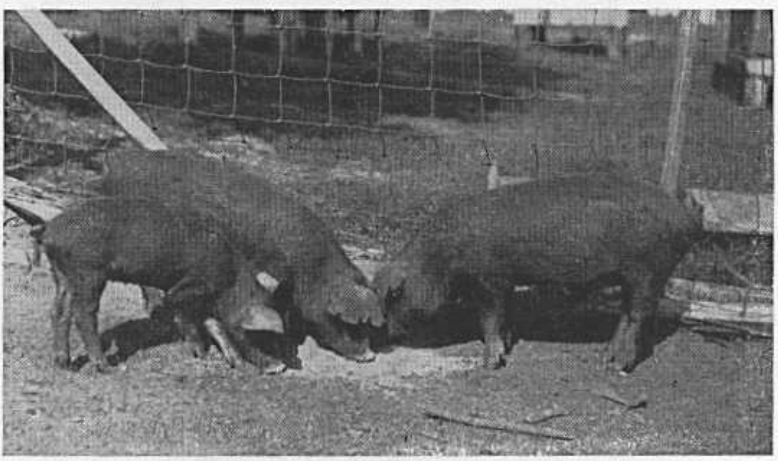


FIG. 2. Control pigs (Group 3) fed only grain. Note stunted, rough appearance. These pigs made an average weight gain of only 31.70 pounds during the test and were heavily infected with intestinal helminths.

Of the milk-fed pigs (Group 1 and 2) only the male pig of group 1 came to harbor sexually mature intestinal helminths other than *Strongyloides*. *Trichuris* eggs were found in the feces of this pig 8 weeks after the beginning of the experiment and the egg count reached a peak of 4,800 per gram just prior to necropsy. No worm eggs other than *Strongyloides* and an occasional egg of *Metastrongylus* or *Choerostrongylus* were found in the feces of the other pigs of group 1, or in the feces of the group 2 pigs; as can be seen from table 2 these pigs were free of intestinal helminths at necropsy.

In the case of the group 3 pigs (control) eggs of *Ascaris* appeared in the feces approximately 6 weeks after the beginning of the experiment; the maximum count observed was 105,800 eggs per gram. *Trichuris* eggs were first found in the feces of the 3 pigs 6 weeks after the animals were placed on contaminated ground; the maximum egg count observed was 3,800 per gram. *Oesophagostomum* eggs were found in the feces of all the controls 35 days after beginning of the test. At the height of egg production as many as 1,800 eggs per gram of feces were found.

Oöcysts of *Eimeria* spp. were found in the feces of all the pigs 7 days after the beginning of the test. On the basis of numbers of oöcysts per gram of feces, the group 1 pigs harbored the heaviest infection; the maximum oöcyst counts in that group ranged from 14,200 to 124,800 per gram. In the group 2 pigs the maximum counts varied from 8,000 to 80,800 per gram. Pigs that did not receive milk apparently harbored the lightest infections as the maximum oöcyst counts ranged from 20,300 to 66,200 per gram.

Low-grade infections of *Balantidium* and *Endameba* persisted in all pigs throughout the test, but were too light to be considered of any particular significance.

DISCUSSION AND CONCLUSIONS

Data presented in this paper show that it is possible to keep at a low level infections of intestinal helminths and at the same time produce satisfactory weight gains in growing pigs by frequent administration of fluid skim milk even though the animals are constantly exposed to infections (Figs. 1 and 2). In the tests herein reported the milk was fed in quantities sufficient to produce copious purging. The effectiveness of the milk in keeping the pigs free of intestinal helminths was apparently associated with the completeness of the purging, and with the amount of milk consumed. One of the milk-fed pigs in test 2 (Group 1) did not consume the milk readily; consequently, the degree of purging attained was rather unsatisfactory and the animal acquired an infection of *Trichuris* as previously noted.

The purging that accompanied the milk feeding did not appear to be harmful to the pigs, as they regularly gained weight and did not lose their appetites. In the case of the group 2 pigs, weight gains were most pronounced during weeks when milk was fed.

While a low-grade enteritis was observed in two of the group 1 and one of the group 2 pigs at necropsy, a similar condition was observed in one of the controls. For that reason the condition in the milk-fed pigs is considered to be of doubtful significance.

The stage of development at which the parasites were expelled from the milk-fed pigs was not determined. It was noted, however, that the milk-fed pigs as well as the controls exhibited symptoms of severe verminous pneumonia during the early stages of the test. Consequently, it is thought that *Ascaris* was probably eliminated after migration through the lungs before the worms could become established in the intestine. In the case of *Trichuris*, which does not migrate, elimination may have occurred soon after the worms became established. *Oesophagostomum* is known to spend a portion of its life cycle encysted in the wall

of the cecum and colon. It is thought that some of the third-stage larvae may have been expelled before they could penetrate the wall of the colon; others were eliminated after they emerged from the intestinal wall into the lumen. The former assumption is based on the fact that there were noticeably fewer nodules in the colons of the milk-fed pigs than in the controls.

It is not known whether the smaller numbers of *Metastrongylus* and *Choerostrongylus* recovered from the milk-fed pigs (Groups 1 and 2) were a result of the larval worms being swept out of the intestine before they could penetrate the lymph spaces prior to migration to the lungs, or whether they are a manifestation of greater resistance on the part of the milk-fed pigs which resulted in elimination of worms from the lungs. The relatively light infection of these parasites in all the pigs is probably a result of the fact that rings were placed in the noses of the pigs approximately 3 weeks after the beginning of the test.

It is of interest that, whereas infections of *Trichuris* in the control pigs (Group 3) were demonstrable 6 weeks after the beginning of the test, eggs of this parasite did not appear in the feces of the infected group 1 pig before 8 weeks. There is no way of determining whether this is a manifestation of resistance to infection due to better dietary conditions or an indication that the pig did not forage so widely over the lots and, therefore, did not pick up eggs so quickly as did the controls. The latter assumption may be correct because it was noted that after the pigs were fed milk they generally lay down in a contented fashion. The controls on the other hand, even after having eaten as much of the grain ration as they wanted, often wandered about the pen as if looking for food of a different type.

The fact that oöcysts of *Eimeria* spp. appeared in the feces of all pigs on the seventh day shows that infective oöcysts were swallowed by all the pigs within a few hours after they were placed on the contaminated ground. It is of interest that the pigs fed the greatest quantities of milk eliminated the most oöcysts. This is in agreement with observations of Becker and Wilcke (1938, Poultry Science, 17(5): 405–407) that certain milk products in the diet apparently provide conditions in the alimentary tract of the host which are favorable to completion of the intracellular development of the parasite.

It is recognized that the method herein described for keeping pigs free of intestinal helminths has certain definite limitations. Perhaps the most important of these is the amount of milk required. While the amount of milk that a 12-week-old pig can consume at one time is comparatively small, the amount increases rapidly as the pig grows older. During the latter portion of the investigation the 3 pigs of group 1 (Test 2) were consuming from 8 to 10 gallons of milk per day. Under conditions where milk is available, however, satisfactory weight gains and freedom from severe parasitism can be attained either by feeding sufficient milk to purge the pigs each day, or by feeding the milk for short periods at intervals of 2 weeks.

The occurrence of *Eurytrema allentoshi* (Foster, 1939) in the opossum in Texas.[1]

J. Fred Denton, University of Georgia School of Medicine, Augusta, Georgia.

Seven specimens of a trematode of the genus *Eurytrema* were removed from the gall bladder of an opossum, *Didelphis virginiana,* captured at Houston, Texas. After a comparison with *E. allentoshi* described by Foster (1939, Trans. Amer. Micros. Soc. 58: 185–198), our material has been assigned to that species. Since, as far as the writer has been able to determine, this is the first time this species has been collected from the opossum in North America, a brief description of the material is presented.

[1] Contribution from the Department of Biology, Rice Institute, Houston, Texas.

Our specimens are very young, only 6 of the 7 having recently attained sexual maturity as evidenced by the paucity of embryonated eggs in the uteri; the other specimen is immature. After fixation they measure 1.94–2.62 mm long by 0.65–0.88 mm wide between testes and ovary, smaller than the minimum measurements given by Foster (*loc. cit.*). The various organs are correspondingly smaller; oral sucker 0.178–0.210 mm in diameter, acetabulum 0.325–0.360 mm in diameter, ratio of oral sucker to acetabulum 1: 1.7–1: 1.8, pharynx 0.080–0.095 mm in length, testes 0.125–0.200 mm in diameter, ovary 0.120–0.168 mm in greatest diameter, cirrus sac 0.140–0.192 mm long by 0.050–0.063 mm wide, ova 30–36 μ long by 21–25 μ wide. The oral sucker is subterminal, preceded dorsally by a fairly prominent lip-like projection. The excretory system, not described by Foster, was observed in detail in some of our specimens. The excretory pore is terminal, excretory vesicle (Fig. 1) simple tubular, extending anteriorly for about ½ of body to receive a common collecting tubule from each side. Each of the rather voluminous common collecting tubules passes anteriorly lateral to the testes to divide into an anterior and posterior main collecting tubule at level of equator of acetabulum. The anterior and posterior main collecting tubules on each side of body both give rise to 3 pairs of capillaries which penetrate the body parenchyma. Each capillary tubule terminates in a single flame cell, thus establishing a $2 \times 6 \times 2$ type of flame cell pattern for this trematode. The vitellaria are composed of rather small round follicles, which in slightly contracted specimens extend medially in the region of Mehlis' gland. Although slightly smaller in size, our specimens agree very closely with the original description of *E. allentoshi* in respect to ratio of sucker sizes and position of acetabulum, length of the ceca, shape and position of genital organs, position of genital pore and extent of vitellaria.

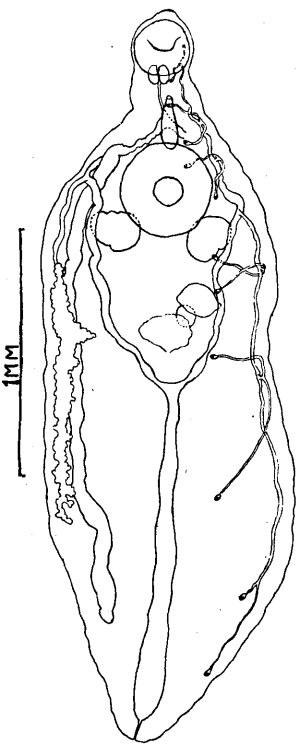


FIG. 1. Excretory system of *Eurytrema allentoshi*, ventral aspect.

A specimen, no. 36733, has been placed in the Helminthological Collection of the U. S. National Museum.

The species under consideration is transferred to the genus *Eurytrema* Looss, 1907, as most of the characters exhibited by our material are typical of that genus. An extensive study of the species assigned to either the genus *Eurytrema* or *Platynosomum* Looss, 1907, has convinced the writer that not a single specific character or combination of characters exists by which this group can be segregated into 2 genera. Thus the genus *Platynosomum* must be regarded as a synonym of *Eurytrema*. This is in accordance with the views of many recent writers who have studied species belonging to this group.

The anthelmintic action of "butylphen" in dogs. FRANK D. ENZIE, U. S. Bureau of Animal Industry.

In preliminary tests of alkylhydroxy benzenes for anthelmintic action, one, namely p-tertiary-butyl-phenol, gave promising results in dogs. This compound, for

which the name "butylphen" is proposed, was effective against ascarids and hookworms; and in therapeutic doses its administration was unattended by toxic reactions.

"Butylphen" is a soft, crystalline substance with a slightly pinkish tint, having a mild, characteristic odor and a slightly pungent taste. Its constitutional formula is $(CH_3)_3C–C_6H_4OH$ and its melting and boiling points are stated to be 97° to 99° C. and 236° to 238° C., respectively. Its water solubility is said to be approximately 1 part in 2000.

Lamson and his co-workers (1935, J. Pharmacol. and Exp. Therap. 53: 239–249) tested this substance *in vitro* against the common roundworm of swine and, to a limited extent, *in vivo* against ascarids in dogs. The drug was completely effective against 26 ascarids when given to 4 dogs at a dose rate of 0.1 gram per kilogram of body weight. These investigators, however, were interested primarily in an ascaricide which was non-irritating to the oral mucosa of man; and as this substance exhibited irritant properties, it was eliminated from further consideration. Since local irritant properties are of less consequence in the treatment of domestic animals, on account of the methods by which drugs are given to them, it was considered advisable to test more completely the anthelmintic properties of this substance.

The tests were conducted at the station of the Zoological Division, Beltsville Research Center, Agricultural Research Administration, Beltsville, Maryland. From 1 to 4 days before treatment, the dogs were confined in individual cages. The feces were screened daily in the usual manner in order to detect spontaneous elimination of parasites but no worms were recovered. The types of parasites in each animal were determined by fecal examination prior to treatment. The drug was given in hard gelatin capsules, usually after a fasting period of 18 to 24 hours. Three to four hours after treatment, the animals were returned to regular feed. The feces of each animal were collected individually every 24 hours and examined for parasites. After the elimination of parasites ceased, usually within 3 days, the dogs were submitted to necropsy and the entire gastrointestinal tract was carefully examined for parasites and lesions.

The results obtained are shown in table 1. In the aggregate, dose rates varying from 0.1 to 1.0 gram per pound of body weight removed 96 per cent (180) of 187 ascarids from 7 dogs, 97 per cent (449) of 462 hookworms from 12 dogs in 13 tests, and 57 per cent (216) of 382 whipworms from 11 dogs in 14 tests. The only untoward reaction was encountered in dogs that were not fasted before treatment and in animals that were given doses obviously above the therapeutic level. The reaction consisted of vomition unattended by nausea, depression, or subsequent inappetence. When the drug was given after a suitable fasting period at a dose rate of 0.2 gram per pound of body weight, it removed 100 per cent of 93 ascarids from 4 dogs, 99 per cent (378) of 380 hookworms from 7 dogs and 54 per cent (134) of 246 whipworms from 6 dogs.

In order to ascertain the necessity of a fasting period, dog 202 was given a therapeutic dose after a portion of the regular feed had been eaten. The dog vomited 2 hours later and again sometime during the subsequent 22-hour period. The treatment was completely effective against 3 ascarids, but it was wholly ineffective against hookworms and whipworms. In a test of tolerance, this dog was given the drug at a dose rate of 1.0 gram per pound of body weight after a fasting period of 24 hours. The only untoward reaction consisted of vomition between 3 and 4 hours after treatment. The dog was returned to regular feed 4 hours after treatment and, shortly after consuming the feed, the dog vomited again. The treatment was completely effective against 4 hookworms but not at all effective against whipworms. In another tolerance test, dog 207 was given the drug at a dose rate of 0.5 gram per pound after a fasting period of 24 hours. About 4 hours after treat-

TABLE 1.—*Data on anthelmintic tests with "butylphen" in dogs*

Animal No.	Weight	Dose	Worms recovered after treatment		Worms found at necropsy		Efficacy	Remarks
	pounds	*grams*					*per cent*	
163	11.0	1.1	Ascarids	73	Ascarids	7	91	
			Hookworms	16	Hookworms	7	69	
			Whipworms	0	Whipworms	3	0	
166	16.0	3.2	Ascarids	82	Ascarids	0	100	
			Hookworms	50	Hookworms	0	100	
			Whipworms	3	Whipworms	6	33	
174	27.0	5.4	Hookworms	188	Hookworms	2	99	Ascarid ova observed on salt flotation before treatment.
			Whipworms	91	Whipworms	3	97	
175	31.0	3.1	Hookworms	11	Hookworms	0	100	Treatment repeated in 8 hrs.
			Whipworms	51	Whipworms	4[a]	93	
		3.1	Whipworms	0	Whipworms	4	0	Treatment repeated in 8 hrs.
176	31.0	6.2	Hookworms	16	Hookworms	0	100	Gave magnesium sulfate 4 hrs. before treatment.
			Whipworms	0	Whipworms	14[a]	0	
		6.2	Whipworms	0	Whipworms	14	0	
201	39.0	7.8	Hookworms	14	Hookworms	0	100	
203	29.0	5.8	Ascarids	1	Ascarids	0	100	
			Hookworms	49	Hookworms	0	100	
			Whipworms	1	Whipworms	21	4	
206	24.0	4.8	None		None		–	Hookworm ova observed on salt flotation before treatment.
210	24.0	4.8	Hookworms	10	Hookworms	0	100	
			Whipworms	39	Whipworms	15	72	
211	16.5	3.3	Ascarids	8	Ascarids	0	100	
			Hookworms	21	Hookworms	0	100	
			Whipworms	0	Whipworms	34	0	
213	48.0	9.6	Ascarids	1	Ascarids	0	100	Gave magnesium sulfate 4 hrs. before and after treatment.
			Hookworms	46	Hookworms	0	100	
			Whipworms	0	Whipworms	33	0	
202	16.0	3.2	Ascarids	3	Ascarids	0	100	Without fasting period. Vomited twice.
			Hookworms	0	Hookworms	4[a]	0	
			Whipworms	0	Whipworms	3[a]	0	
		16.0	Hookworms	4	Hookworms	0	100	Toxicity test. Vomited twice.
			Whipworms	0	Whipworms	3	0	
207	14.0	7.0	Ascarids	12	Ascarids	0	100	Toxicity test. Vomition, mucus in feces on first day after treatment.
			Hookworms	24	Hookworms	0	100	
			Whipworms	31	Whipworms	9	78	

[a] Calculated.

ment, the animal ejected a very small amount of the drug. The treatment was completely effective against 12 ascarids and 24 hookworms. It also removed 78 per cent (31) of 40 whipworms. A small amount of mucus was observed in the feces the day after treatment.

Attempts were made to increase the efficacy of the drug for the removal of whipworms by altering the regimen of treatment. Dog 175 was given a therapeutic dose on each of 2 consecutive days; the dose, 0.2 gram per pound, was given in 2 equal parts with an interval of 8 hours. Dog 176 was given a similar but undivided dose on each of 2 consecutive days after a pre-treatment purge. Dog 213 was given a therapeutic dose supported by a pre- and post-treatment purge. In no instance was the efficacy against the whipworm improved.

Three dogs with severe, generalized mange were given the drug at a dose rate of 0.2 gram per pound of body weight after a fasting period of 18 hours. The treatment removed 74 ascarids and 9 hookworms from these animals. Since these dogs were on a mange experiment, they were not available for necropsy. One dog, however, died 2 days later, and 1 hookworm was found at necropsy. In view of the general condition of this dog before treatment, death was not attributed to the action of the drug.

In the critical tests, no gross lesions were observed at necropsy which could be attributed to the action of the drug; and in view of the absence of toxic reactions coincident with treatment, studies of the histopathology of representative tissue sections were temporarily postponed.

Limited tests with "butylphen" indicate that this substance may compare favorably with other anthelmintics for dogs. In order to achieve maximum efficiency, all feed should be withheld for approximately 18 hours before treatment and preferably for an additional 4 or 5 hours afterwards. A dose rate of 0.2 gram per pound of body weight gave very satisfactory results, but it is possible that a somewhat lower rate will prove equally effective. The use of a purgative either before or after treatment does not appear to increase significantly the efficacy or safety of the drug.

Parasite-host list of the genus *Eutrichomastix* (Protozoa: Flagellata).[1] BANNER BILL MORGAN, Department of Veterinary Science, University of Wisconsin.

The writer published a parasite-host list (Mimeograph, Compilation No. 1, Dept. Veterinary Science, July, 1942) and a host-parasite list (Trans. Wis. Acad. Sci. In Press) of the genus *Trichomonas*. This paper is a continuance of compilatory data on related genera. In a recent paper Morgan and Noland (1943, Jour. Amer. Vet. Med. Assoc. 102: 11–15) reported the finding of *Eutrichomastix* sp., in the sheaths of several bulls suspected of bovine trichomoniasis.

This list has been arranged by Orders and Families to facilitate a comprehensive view of host-parasite relationships. The genus is widely distributed in the animal kingdom with 20 species listed among 2 Phyla, 7 Classes, 22 Orders, representing over 40 Families.

PARASITE-HOST LIST OF EUTRICHOMASTIX

1. *Eutrichomastix axostylis* Kirby, 1931. (Ar)[2] ISOPTERA (Termitidae) *Nasutitermes kirbyi* (termite).
2. *E. batrachorum* (Dobell, 1909). (Am) URODELA (Salamandridae, Ambystomidae, Plethodontidae). *Triturus v. viridescens* (common newt), *Ambys-*

[1] Published with the approval of the Director of the Wisconsin Agricultural Experiment Station. Project No. 622–V; Trichomoniasis and other reproductive diseases of cattle.

[2] (Ar) = Arthropoda, (Am) = Amphibia, (Av) = Aves, (P) = Pisces, (R) = Reptilia, (M) = Mammalia.

toma opacum (marbled salamander), *Plethodon cinereus* (red-backed salamander), *P. glutinosus* (slimy salamander), *P. metcalfi* (salamander), *P. yonahlossee* (salamander), *Pseudotriton r. ruber* (salamander), *Eurycea wilderae* (salamander), *E. gutto lineata* (salamander), *Desmognathus f. fuscus* (dusty salamander), *D. o. carolinensis* (salamander), *D. phoca* (salamander, *D. quadramaculatus* (salamander). ANURA (Bufonidae, Ranidae), *Bufo m. melanosticus* (Asiatic toad), *Rana temporaria* (common toad), *R. fuscigula* (brown-throated frog), *R. tigerina* (Indian bull frog).

3. *E. caviae* (Grassi, 1881). Syn *E. aguti* Cunha and Muniz, 1926, *E. caviae var. rossica.* Yakimoff *et al.*, 1921. (M) RODENTIA (Caviidae; Dasyproctidae). *Cavia coboya* (guinea-pig), *C. apera* (pig-like cavy), *Dasyprocta aguti* (golden agouti).
4. *E. colubrorum* (Hammerschmidt, 1844). Syn. *E. coronellae* (Grassi, 1879); *E. lacertae* (Blochman, 1884); *E. viperae* (Leger, 1904); *E. serpentis* (Dobell, 1907); *E. mabuiae* (Dobell, 1910); *E. saurii* (Fonseca, 1917). (R) LACERTILIA (Scincidae, Gekkonidae, Xantusiidae, Agamidae, Lacertidae, Iguanidae, Anguidae, Chamaeleontidae, Amphisbaenidae). *Mabina carinata* (Ceylon skink), *Chalcides lineata* (green-eyed skink), *Tarentola mauritanica* (Moorish gecko), *Hemidactylus leschenaulti* (gecko), *Xantusia vigilis* (night lizard) *Agama stellio* (starred lizard), *Lacerta agilis* (sand lizard), *L. muralis* (wall lizard) *L. viridis* (green lizard) *L. ocellata* (eyed lizard) *Tropidosaurus algirus* (sand lizard), *Acanthodactylus pardolis* (fringed-fingered lizard), *Uta stansburiana* (brush lizard), *U. vandenburgianus* (brush lizard), *Sceloporus biserratus* (collared lizard), *S. vandenburgianus* (collared lizard), *S. magister* (collared lizard), *Anguis fragilis* (blind-worm lizard), *Chamaeleon vulgaris* (common chamaeleon), *C. quilensis* (chamaeleon), *Amphisbaena* sp. (burrowing lizard), *Anolis carolinensis* (American chamaeleon), OPHIDIA (Colubridae, Viperidae, Boadae, Crotalidae, Elapidae). *Homalosoma lutrix* (smooth-bellied snake), *Natrix natrix* (grass snake), *N. viperinus* (viperine snake), *Coronella austrica* (smooth snake), *C. girundica* (southern smooth snake), *Coluber scalaris* (ladder snake), *Coelopeltis insignitus* (coluberine snake), *Pituophis catenifer* (western bull snake), *Eutaenia sirtalis* (ribbon snake), *Dryophis mycterizans* (long-nosed tree snake), *Psammophis sibilans* (African beauty snake), *Boadon lineatum* (African line snake), *Crotaphopeltis hotambolia* (rufescent snake), *Storeria dekayi* (Dekay's snake), *Vipera aspis* (asp viper), *Boa constrictor* (boa constrictor), *Phython reticulatus* (reticulated python), *Crotalus oregonus* (Pacific rattlesnake), *Bungaris candidus* (blue krait snake).
5. *E. coprocola* Alexeieff, 1929. Horse manure, cow manure.
6. *E. cruzi* (Cunha and Muniz, 1925). (Av) GRUIFORMES (Aramidae) *Crotophaga ani* (ani).
7. *E. cuniculi* (Tanabe, 1926) (M) LAGOMORPHA (Leporidae) *Lepus cuniculi* (domestic rabbit).
8. *E. gallinarum* (Martin and Robertson, 1911). (Av) GALLIFORMES (Phasianidae) *Gallus g. domestica* (domestic chicken).
9. *E. globosus* (Cunha and Muniz, 1925). (Av) TROGONIFORMES (Trogonidae) PALAMEDEIFORMES *Trogon variegatus* (trogon), *Chauna cristata* (crested screamer or pelicano).
10. *E. gracilis* (Cunha and Muniz, 1925). (Av) CHARADRIIFORMES (Charadriidae) CAPRIMULGIFORMES (Caprimulgidae) PICIFORMES (Galbulidae) *Nyctibuis grandis* (nightjar), *Monasa nigrafons* (nunbird), *Podager nacunda* (nacunda nightjar), *Belanopterus cayenensis* (cayenne lapwing).

11. *E. Motellae* (Alexeieff, 1910) (P) ANACANTHINA (Gadidae) *Motella tricerrata* (three-bearded rockling).
12. *E. orthopterorum* (Parisi, 1910). (Ar) ORTHOPTERA (Blattidae) *Periplaneta orientalis* (cockroach).
13. *E. passali* (Tanabe, 1926). (Ar) COLEOPTERA (Passalidae) *Passalus* sp. (horned beetle).
14. *E. phyllophagae* Travis and Becker, 1931. (Ar) COLEOPTERA (Scarabaeidae) *Phyllophaga* sp. (white grub).
15. *E. rhinocrici* Fonseca, 1928. (Ar) DIPLOPODA (Julidae) *Rhinocricus* sp. (myriapod).
16. *E. ruminantium* (Braune, 1913). (M) ARTIODACTYLA (Bovidae) *Bos taurus* (domestic ox).
17. *E. salpae* (Alexeieff, 1910) (P) TELEOSTEI (Sparidae) *Box salpa* (sea bream).
18. *E. termitis* Bernstein, 1928. (Ar) ISOPTERA (Hodotermitidae) *Hodotermes murgabicus* (termite).
19. *E. trichopterae* (Mackinnon, 1910). Syn. *E. trichopterae var. tipulae* Geiman, 1932. (Ar) DIPTERA (Tipulidae) *Tipula* sp. (crane fly larva), *T. abdominalis* (crane fly). TRICHOPTERA (Limnophilidae, Sericostomatidae) *Limnophilus rhombicus* (caddice fly larva), *L. flavicornis* (caddice fly larva), *Stenophylax* sp. (caddice fly larva), *Sericostoma* sp. (caddice fly larva).
20. *E. vital-brasili* Vidigal, 1943. (R) LACERTILIA (Teiidae) *Ameiva ameiva* (new world lizard).

Notes on a protective action of borax and related compounds in cecal coccidiosis of poultry. A. B. HARDCASTLE and A. O. FOSTER, U. S. Bureau of Animal Industry.

Pearse (1942, p. 41) stated that "Bad cases of coccidiosis in fowls are often cured by mixing borax with the food." As far as is known to the writers, this is the only published statement on such use of this chemical. Experiments with borax and other boron compounds for the control of poultry coccidiosis were begun in this Bureau in 1939. It was found then (unpublished data) that mashes containing 1 per cent of sodium borate, sodium perborate, or boric acid, fed from the time of inoculation, were of definite value; 1 per cent borobenzoic acid or calcium borate were without effect, and copper borate was quite toxic. Boric acid (5 per cent) in the drinking water was also toxic, but cloacal injections of a 5 per cent solution showed some curative action. Work with this group of drugs was continued by the writers in 1943 in the hope that a more efficient means of administration, or some less toxic boron compound, might be found. Although the results reported herein are incomplete, a temporary cessation of the work makes their publication desirable.

EXPERIMENTAL RESULTS

Experiment 1.—In a preliminary experiment, 10 chicks, 8 weeks of age, were given a mash containing 2 per cent sodium borate (tech. grade) at the time of inoculation with 100,000 oöcysts of *Eimeria tenella.* Ten similar birds were infected but untreated. By the end of the 6th day all of the latter birds had died, after passing blood copiously. The treated birds passed no blood, but appeared slightly listless, apparently on account of the toxicity of the drug. On the 7th day they were put on regular mash and improved immediately. At necropsy on the 10th day no evidence of infection could be found.

Experiment 2.—In order to determine how long after inoculation medication with borax could be delayed and still effectively prevent coccidiosis, 5 groups of 25

birds each were given a mash containing 2 per cent borax, beginning in each group at successive 24-hour intervals after inoculation and ending, except as noted below, on the 8th day of infection. Six-week-old chickens were used and were inoculated with 100,000 sporulated oöcysts each.

In groups 1, 2, and 3, in which treatment was begun 24, 48, and 72 hours after inoculation, respectively, there were no deaths from coccidiosis (1 from an unknown cause in group 1). A few scattered blood-tinged droppings were seen in the pen of group 3. In groups 4 and 5, in which medication was delayed 96 and 120 hours, respectively, there were 8 and 10 deaths respectively; both of these groups discharged blood freely on the 5th, 6th, and 7th days. In 2 groups of controls, 9 and 14 of 25 birds each died; bloody discharges were likewise heavy in these groups.

The same gradation of infection evidenced by the bloody discharges was apparent at necropsy in the relative number of lesions present in the ceca. There were

TABLE 1.—*Intervals during the course of an infection with Eimeria tenella when administration of 2 per cent sodium borate in the mash will prevent symptoms of coccidiosis. Birds 2 to 3 weeks old when experiment was begun; each inoculated with 50,000 sporulated oöcysts. Data from experiment 3*

Group	No. birds	Interval after inoculation		No. died	Wt. change
		Treatment begun	Treatment ended		
		hours	*hours*		*grams*
1	25	0	24	23	+17.3
2	25	0	48	21	+13.9
3	25	0	72	55	+ 2.6
6	20	48	72	15	+22.6
7	20	48	96	3[a]	+27.6
8	20	48	120	3[b]	+26.5
11	20	72	96	0	+11.0
12	20	72	120	0	+ 2.2
13	20	72	144	0	−13.2
16	20	96	120	9	.....
17	20	96	144	17	.....
18	20	96	168	11	.....
4, 9, 14, & 19[c]	85	.....	.....	59	+26.8
5, 10, & 15[d]	65	.....	.....	0	+52.0

[a] One bird showed no infection.
[b] Two birds showed no infection.
[c] Untreated controls. The numbers of deaths in the individual groups were, respectively, 21, 15, 11, and 12.
[d] Uninoculated controls.

none in group 1, a trace in group 2, scattered lesions in group 3, and numerous lesions in groups 4 and 5 as well as in the control groups.

Group 4 was maintained on the borax mash for 6 days in all, and at the end of this time all birds were visibly sick from the drug. Twenty of these birds were weighed and divided into 2 sub-groups. Ten birds were continued on medicated mash and at the end of 3 days 2 had died. The survivors were extremely sick and had lost an average of 9 grams each in weight. The other 10 were placed on regular mash. At the end of 3 days 1 had died, but the survivors were healthy and had made an average gain of 74 grams each. It is noteworthy that birds exhibiting toxic symptoms maintained a good appetite, even when *in extremis*, so that weight was rapidly regained when administration of the drug was stopped.

Experiment 3.—This experiment was designed to determine how long, at various stages of the infection, medication with borax must be continued in order to afford

protection. The results (Table 1) show that borax was ineffective during the first 72 hours after inoculation. Medication from the 48th to the 96th or 120th hours, however, almost completely protected the birds.

In groups 11, 12, and 13, feeding the borax mash was delayed until 72 hours after inoculation. In this case protection was complete when medicated mash was available for as long as 24 hours after this time.

As shown by the data on groups 16, 17, and 18, postponement of treatment for 96 hours after inoculation practically eliminated its protective value.

The data suggest that the toxicity of borax for young birds is more marked than for older birds like those used in other experiments. From the weights in table 1, it appears that more than 3 days on a 2 per cent borax mash may cause serious retardation of growth in birds 2 to 3 weeks old, whereas 6 days or more on this mash was required to cause comparable effects in birds 6 to 10 weeks of age.

TABLE 2.—*Effect of various boron compounds on the course of infection with Eimeria tenella. The drugs were fed for seven days, beginning at the time of inoculation. Data from experiment 6*

Lot	No. birds	Age	No. oöcysts	Drug	No. died	Lesions
		weeks				
1	10	3	50,000	1% nickle borate	3 [a]	+
2	10	3	50,000	2% zinc borate	1 [b]	+
3	10	3	50,000	2% aluminum borate	1 [c]	+
4	10	3	50,000	None	8	+++++
5	5	4	100,000	2% potassium borate	0	++
6	5	4	100,000	2% borobenzoic acid	0	++++
7	5	4	100,000	2% sodium perborate	0	+++
8	5	4	100,000	2% zinc perborate	4	++++
9	5	4	100,000	2% manganese borate	0	+
10	5	4	100,000	1% magnesium borate	0	+++
11	5	4	100,000	2% magnesium borocitrate	0	++
12	5	4	100,000	2% calcium borate	0	+
13	5	4	100,000	2% boric acid	2[d]	0
14	5	4	100,000	None	2	+++++

[a] Two died of toxicity. Drug reduced to 0.25 per cent after 72 hours.
[b] Died of toxicity. Drug reduced to 1 per cent after 48 hours.
[c] Died of toxicity. Drug reduced to 1 per cent after 72 hours.
[d] Died of toxicity.

Experiment 4.—Sodium borate is readily soluble in water, and weak solutions are not distasteful to chicks. To determine whether this chemical is effective when administered in solution, groups of 10 birds each were given different percentages in their drinking water. Four-week-old birds were used and the solutions were kept continually before them for 1 week after inoculation with 50,000 oöcysts.

On a 0.3 per cent borax solution, no birds died or exhibited symptoms of coccidiosis. At the end of 7 days they had made an average weight gain of 6 grams each. On a 0.2 per cent solution, 1 bird died and the remainder made average gains of 13 grams each. On 0.1 per cent, 6 birds died and the survivors lost an average of 4 grams each. On 0.05 per cent, 3 birds died and the survivors made average gains of 15 grams each, although all showed marked symptoms of coccidiosis. Of 10 inoculated but untreated birds, 7 died and the remainder lost an average of 4 grams each. Ten uninoculated and untreated birds gained an average of 86 grams each.

Experiment 5.—Because urea, p-aminobenzoic acid, and sodium thiosulfate have been used to detoxify various drugs, combinations of these substances with borax

were tested in an effort to increase the efficacy of the latter or lower its toxicity. Six-week-old birds were used and were inoculated with 100,000 oöcysts. Medication was begun at inoculation and continued for 7 days thereafter.

Weight changes of the 10 birds in each group were as follows: on 1 per cent borax alone, an average loss of 22 grams each; on 1 per cent borax 1 per cent urea, an average gain of 24 grams each; on 1 per cent borax 0.1 per cent p-aminobenzoic acid, an average gain of 9 grams each; on 1 per cent borax 0.25 per cent sodium thiosulfate, an average loss of 14 grams each; inoculated but untreated controls, an average gain of 63 grams each; uninoculated untreated controls, an average gain of 84 grams each. No deaths occurred in the treated groups and only 2 in the inoculated but untreated group.

Experiment 6.—Several other boron compounds were tested in the hope of finding one less toxic than sodium borate (Table 2). Of these, the best results were obtained with manganese borate, magnesium borocitrate, magnesium borate, and borobenzoic acid, in the order named.

No deaths occurred among the test birds on calcium and potassium borates, although these drugs exhibited marked toxic action. All of these substances, however, caused weight losses.

DISCUSSION

The administration of a mash containing 2 per cent borax, begun at the time of inoculation and continued through the infection, effectively prevented coccidiosis in birds infected with *E. tenella.* In addition, the results of experiment 2 indicate that borax exerted a coccidiacidal action when the start of medication was delayed not later than 96 hours after inoculation. That the period of medication may be limited even more is shown by the data in table 1. The conclusion appears warranted that administration of borax for 72, 48, or even 24 hours is probably sufficient, provided the interval between 72 and 96 hours after inoculation is included; when borax is not fed during this period, protection is incomplete. From a consideration of the life cycle of *E. tenella,* as described by Tyzzer (1929), it would seem that the first generation merozoites, which are liberated at this time, may be the stage affected, although the data are insufficient to preclude the possibility of action by the drug upon other stages.

When used in solution in the drinking water the efficacy of borax was enhanced considerably, since a 0.3 per cent solution afforded as much protection as 2 per cent administered in the mash. Also the toxicity seemed to be diminished, since birds that received a protective amount of borax in the drinking water for 7 days made weight gains not significantly different from those that received a protective amount in the mash for only 3 days.

The use of urea with borax would appear to warrant further investigation. The culture of oöcysts used in this experiment (Experiment 5) was unfortunately too old to be effective, and the mortality in the controls does not justify any conclusions as to the efficacy of the combinations. The greater weight gains made by the borax-urea group, however, are significant of a decrease in toxicity.

The toxicity of borax is an obvious disadvantage but from the results of tests with other boron compounds it seems possible that one may be found having a negligible toxicity. On the other hand, in natural outbreaks of coccidiosis, sodium borate appears to offer some promise since it effectively aborts the disease in birds already exposed. Moreover, its disadvantages may be offset somewhat by its availability and inexpensiveness.

SUMMARY

Two per cent borax in the mash effectively protected birds infected with *E. tenella* when it was administered for as long as 24 hours and begun not later than

72 hours after inoculation, provided the period between 72 and 96 hours was included. A 0.3 per cent solution of borax used as drinking water during an infection was apparently as effective as 2 per cent in the mash, and less toxic. The use of urea and p-aminobenzoic acid to detoxify borax, and the testing of other boron compounds against cecal coccidiosis, are promising lines of investigation.

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Unsuccessful attempts to infect eleven species and subspecies of domestic Planorbidae with *Schistosoma mansoni*. ELOISE B. CRAM, MYRNA JONES, and WILLARD H. WRIGHT, National Institute of Health.

Until recently there apparently has been no concerted attempt to determine whether or not species of snails occur in the continental United States capable of acting as intermediate hosts for *Schistosoma mansoni*, the blood fluke of man. Faust (Faust and Hoffman, 1934, Puerto Rico Jour. Publ. Health and Trop. Med., 10: 26) reported without details that he had twice attempted to infect the local New Orleans planorbid, *Helisoma lentum* (Say), with miracidia of *S. mansoni*, obtained from Puerto Rican hosts. Hoffman (1938, *Ibid.*, 14: 24–25) tested the susceptibility of the common aquarium snail, *Planorbis corneus*. Attraction and attachment of miracidia were noted but penetration was not seen; no cercariae were passed 4 to 6 weeks after exposure and dissection of the liver showed no evidence of sporocysts.

In view of the timeliness of the subject, because of the possible introduction of cases of human schistosomiasis into the country, initial attempts have been made by us during the past year to infect various species of Planorbidae that occur in this country. Negative results are now available on one hundred specimens, belonging to eleven species and subspecies,[1] as follows: *Helisoma anceps, H. duryi intercalare, H. duryi normale, H. subcrenatum, H. subcrenatum disjectum, H. subcrenatum plexatum, H. tenue californiense, H. trivolvis, H. trivolvis turgidum, Planorbis corneus,* and *Tropicorbis donbilli.* With *H. anceps* and *H. subcrenatum plexatum* only wild snails, that is, those originally obtained from their natural habitat, were available; with all other species and subspecies laboratory-reared specimens were also available. In only one instance was a group exposure made (see *H. duryi intercalare,* below). In other tests, each snail was exposed individually in a small amount of water, usually to a known number of miracidia, and observations were made microscopically during the following 4 to 7 hours to ascertain the fact of penetration by some or all of the miracidia. The Puerto Rican strain of *S. mansoni* and, as controls, *Australorbis glabratus,* the known intermediate host, were used.[2] Of 165 specimens of *A. glabratus,* some were killed and dissected to obtain early developmental stages; the majority were held until after

[1] Identifications were made by Doctor J. P. E. Morrison through the courtesy of Doctor Paul Bartsch, Curator of Mollusks and Cenozoic Invertebrates, U. S. National Museum. Many persons cooperated generously in collecting and forwarding snails from various parts of the country; of the species included in this report, the original specimens were collected in Alabama by Doctor Septima Smith; in California by Doctors G. H. Ball, W. O. Gregg, E. L. Lazier, E. N. Wilcox and R. Stohler; in Florida by Messrs. Frank Lyman and Roy Komarek; in Illinois by Doctor H. J. Van Cleave; and in Texas by the Superintendent of the fish hatchery of the U. S. Department of the Interior at San Marcos.

[2] We are indebted to Doctor P. Morales Otero, Director, School of Tropical Medicine, San Juan, P. R., and to the late Doctor William A. Hoffman for an infected monkey and for eggs of *A. glabratus.*

the emergence of cercariae which, in all cases, occurred between the 20th and 25th day after exposure.

Miracidia were attracted to and apparently penetrated all the species of snails tested but the degree of attraction and the speed of penetration varied greatly. *Tropicorbis donbilli* exhibited the greatest attraction for the miracidia; usually there was immediate response to the presence of the snail, followed promptly by attachment and penetration. Judging from this behavior, *T. donbilli* appeared as a possible host for further development of the larval stages of the parasite. Moreover, in its morphological relationships *Tropicorbis* appeared theoretically to hold special interest in this connection. Pilsbry (1934, Proc. Acad. Nat. Sci. Phila. **86**: 55 and 56) pointed out the close relationship of this genus to certain African Planorbidae and the similarity of its soft anatomy to that of *Australorbis*, concluding, from a comparative study, that *Australorbis* "might, perhaps, be considered a subgenus of *Tropicorbis.*" For these reasons attention was centetered on *T. donbilli* and a total of 40 specimens was exposed individually. Conditions were varied in order to determine what effect, if any, these might have on infectibility. Juveniles of various ages as well as adults were used; in some cases there was a single exposure to miracidia, in other cases multiple exposures with varying time intervals. The numbers of miracidia used for any one exposure ranged from 2 to 100.

Some snails were killed, dissected, and examined for early stages of development of sporocysts or cercariae of *S. mansoni*, all results being consistently negative. peatedly for emerging cercariae. Observations made on snails dissected after a natural death were not considered reliable because disintegrative changes of the snail body start quickly after death and sporocysts of *S. mansoni* disintegrate quickly under such conditions. Only when the snail was killed and examined immediately was the negative necropsy evidence considered valid; in all other cases only the observations made during the life of the snail, as to non-emergence of cercariae, were accepted as evidence of failure to infect.

Particulars concerning the tests are given below. In no case was there evidence of sporocysts of cercariae of *S. mansoni*, all results being consistently negative.

Tropicorbis donbilli.—Four wild adults, exposed 1 to 3 times, observed for emerging cercariae for periods of 3 to 6 months.

Thirty-six laboratory-reared, of which 22 were juveniles and 14 were young adults. Nineteen of these snails, exposed from 1 to 10 times, were killed and examined for the presence of sporocysts or cercariae after periods ranging from 2 to 97 days following exposure. Fourteen of the remaining 17 snails, exposed 1 to 4 times, were observed over periods of 2 to 5 months. The remaining 3 snails were juveniles; one, the youngest snail used, died after 4 exposures to 4 to 10 miracidia each, death occurring 7 days after the first and 4 days after the last exposure; the other two died on the 6th or 7th day after exposure to, and penetration by, approximately 100 miracidia.

Helisoma anceps.—Four wild adults each individually exposed to 10 miracidia. Observations for 22 to 41 days; necropsy examinations on 3.

H. duryi intercalare.—Five adults reared in indoor tanks (lily pools) exposed collectively to many miracidia; observations for approximately 3 months. Thirteen laboratory-reared (7 juveniles, 6 adults): 3 exposed a single time to a small dose (5 to 12 miracidia); 10 exposed 2 to 4 times to 5 to 50 miracidia each, with a total maximum number of miracidia of 145 to one snail. Necropsy examination for sporocysts and cercariae on 3 snails, after time periods ranging from 10 days after the most recent exposure to 53 days after the earliest exposure. The remaining 7 snails examined periodically for emerging cercariae for periods ranging from 43 days to 8 months following exposure.

H. duryi normale.—Six laboratory-reared (2 juveniles, 4 adults) exposed individually from 2 to 4 times, to 3 to 50 miracida each time. Examined for emerging cercariae for periods ranging from 2 to 9 months following exposure.

H. subcrenatum.—Two wild snails, one exposure each, to 20 miracidia; on one, necropsy examination at 14 days, on the other, observations for emerging cercariae for 28 days.

Four juvenile laboratory-reared: Two exposed once only, to 15 to 20 miracidia, observed for cercariae for 3 months; 2 exposed 11 times to small numbers, totalling 80 miracidia, with necropsy examination made 3½ and 4 months after first exposure, and 9 and 19 days after last exposure, respectively.

H. subcrenatum disjectum.—Two wild snails exposed individually 9 times to a total of approximately 300 miracidia, the first 3 exposures fairly light, at monthly intervals, the last 6 heavy, during a 3-week period 3 months later; necropsy examination on one snail 30 days after last exposure, and continued observations for cercariae from other snail for 60 days. One laboratory-reared juvenile exposed 5 times during a period of 18 days, killed and examined 31 days after the first, 13, days after the last exposure.

H. subcrenatum plexatum.—Two wild snails, one exposed once, one twice; observed for emerging cercariae for 25 days and 78 days, respectively.

H. tenue californiense.—Three wild adults; 2 exposed once, necropsy examination made on one at 50 days, while the other was held for observation for 59 days; 1 exposed 3 times, with observations for emerging cercariae up to 95 days from first exposure. One laboratory-reared juvenile, exposed once, held for 3 months' observation.

H. trivolvis.— Six laboratory-reared juveniles, exposed 1 to 4 times; necropsy examination of one at 39 days, the others held for periods up to 8 months following first exposure. One laboratory-reared adult exposed once to 10 miracidia, necropsy examination after 4 months' observation.

H. trivolvis turgidum.—Four wild adults exposed 1 to 3 times, held for observation for periods ranging from 34 days to 6 months. Four laboratory-reared juveniles, each exposed once to 50 miracidia, held for 2 months' observation.

Planorbis corneus.—Two laboratory-reared adults, one exposed 2 times, held for 76 days observation; the other exposed 8 times, with necropsy examination 5 months after the first, 20 days after the last exposure.

The genus *Metastrongylus* Molin, 1861 (Nematoda: Metastrongylidae).[1] ELLSWORTH C. DOUGHERTY, Department of Zoology, University of California, Berkeley, California.

In two recent papers (Dougherty, 1943a, b) I have discussed the systematics of certain lungworms in the superfamily Metastrongyloidea Lane, 1917, of the suborder Strongylina—in the first, the metastrongyloids of porpoises and in the second, those of the genera *Filaroides* v. Beneden, 1858, and *Metathelazia* Skinker, 1931. The present paper is another on the same nematode group and deals with the type genus of the superfamily—namely with *Metastrongylus* Molin, 1861, which is composed of lungworm species occurring in pigs. This genus is, of course, also type of the family Metastrongylidae Leiper, 1909, which I consider to include, besides *Metastrongylus,* the genera *Protostrongylus* Kamenskiĭ, 1905, and *Filaroides* v. Beneden, 1858, with respectively related genera. Further consideration of metastrongylid classification I leave to a later work.

[1] I wish to express my appreciation to Drs. E. W. Price and Gerard Dikmans of the Zoological Division, U. S. Bureau of Animal Industry, Beltsville, Maryland, for kind and unfailing coöperation and advice.

A modern review of the systematics of the genus *Metastrongylus* is needed in English, as the only recent work up to the present paper is that of Shul'ts and Kaminskiĭ (1937), which appeared in a generally unavailable Russian publication.

I. THE HISTORY OF METASTRONGYLUS

In 1861 Molin published one of the great helminthological treatises of the nineteenth century. Among the many genera proposed by him, most of which are accepted today in their original sense, was *Metastrongylus*. It was less happily conceived than most, for Molin united a number of species in a genus based on the possession of a single ovary in the female, supposed to be common to all forms included in the genus. The species for which this character is true are at present placed in the family Heligmosomidae Cram, 1927, of the superfamily Trichostrongyloidea Cram, 1927; and the genus *Metastrongylus* is now restricted to species with two ovaries. Molin (1861) did not designate a type species, and for over forty years little attention was paid to his genus. Finally Stiles and Hassall (1905)[2] designated a pig lungworm species *Strongylus paradoxus* Mehlis in Creplin, 1831, as type of *Metastrongylus*. By this act the genus was limited to forms with two ovaries.

Vostokov (1905), in ignorance of Stiles and Hassall's procedure and in a paper appearing, in all probability, before they published their work, did the same thing by designating as type of *Metastrongylus* the species *Strongylus apri* Gmelin, 1790, from the domestic pig. He redefined this genus in the sense in which it is accepted today and described as new the species *Metastrongylus pudendotectus* from the same host. Two years later Railliet and Henry (1907) also accepted *Metastrongylus* and defined it as it is understood at the present time with type *Metastrongylus apri* (Gmelin, 1790). They were unaware of Vostokov's earlier work and described as new under the name of *Metastrongylus brevivaginatus* the same form that the latter had called *M. pudendotectus*. Later (Railliet and Henry, 1911) they adopted the name *Metastrongylus elongatus* in place of *M. apri* without explanation for this act.

In 1923 Gedoelst described a third species as *Metastrongylus salmi*. From *M. elongatus* and *M. salmi* he separated *M. brevivaginatus* Railliet and Henry, 1907, as type of a new genus *Choerostrongylus*. Skriabin (1924) the following year called attention to Vostokov's earlier species, *M. pudendotectus*, and substituted *Choerostrongylus pudendotectus* for *C. brevivaginatus*.

Since the work of Gedoelst there has been no general agreement on the validity of *Choerostrongylus* as an independent genus. Most American investigators have accepted it with *C. pudendotectus* as type, whereas European workers have tended to synonymize it with *Metastrongylus* or at most to regard it as a subgenus of *Metastrongylus* as first done by Yorke and Maplestone (1926). Similarly the type of *Metastrongylus* has been known both as *M. elongatus* and *M. apri*. Shul'ts and Kaminskiĭ (1937) have given convincing evidence for discarding *Choerostrongylus* as either a genus or a subgenus; they have accepted *M. elongatus* as type of *Metastrongylus* without commenting on reasons for their choice of this specific name.

II. THE SPECIES OF METASTRONGYLUS

I accept three species in *Metastrongylus*—*M. apri* (Gmelin, 1790) Vostokov, 1905 (genotype), *M. salmi* Gedoelst, 1923, and *M. pudendotectus* Vostokov, 1905. The recent paper by Shul'ts and Kaminskiĭ (1937) includes a brief historical con-

[2] Although Stiles and Hassall in their Index-Catalogue (1920, p. 577) indicated that Stiles (1902, p. 185) made this designation of genotype, such was actually not done until the work of Stiles and Hassall (1905, p. 119) on roundworm genera and their types.

sideration of these forms, reports of their occurrence in various parts of the Soviet Union, and diagnoses for each (in Russian). I do not feel it necessary to repeat their diagnoses here, but am instead including the following table which gives distinguishing characters. This is an adaptation of a similar chart by Shul'ts and Kaminskiĭ. However, these authors have not correctly distinguished the females of *M. apri* and *M. salmi;* in fact, I believe that they have confused one for the other. Their table has therefore been appropriately modified and added to.

The genus *Metastrongylus* is unique in the Metastrongyloidea in the peculiar manner in which bursal reduction in the male, a characteristic of the superfamily, has taken place. In most metastrongyloids the bursal rays are considerably reduced in size by comparison with those of strongyloids and trichostrongyloids, but except for the dorsal ray have not been altered from a digitiform shape. The species of certain extreme genera, however, such as those of the family Pseudaliidae Railliet, 1916, have rays fused and reduced in size, or as *Metathelazia* Skinker, 1931, reduced to papillae, or as *Metastrongylus* typical in number, but bizarrely misshapen. This last pattern of bursal reduction is found only in *Metastrongylus* and sets it off from other genera of the family Metastrongylidae Leiper, 1909. The family Pseudaliidae, comprising the metastrongyloid lungworms of porpoises, exhibits an analogous type of bursal ray disproportion, but in that group the rays have become fused to such a large degree that they are in part no longer individually recognizable, whereas reduction in *Metastrongylus* has not decreased the number of discernible rays. The nature of the reduced bursal rays in this genus is evident in figures A–C, of the male posterior ends of its three species.

Metastrongylus is also unique in the peculiar structure of the female posterior end. No other metastrongyloid genus possesses the peculiar prevulvar swelling which renders the tail somewhat digitiform of appearance and abruptly narrower than the immediately anterior part of the body. By provagina, a term first used by Vostokov (1905), is meant a transparent cuticular membrane enveloping the prevulvar swelling of *M. pudendotectus* (Fig. F). It is probably homologous with a somewhat similar structure in certain species of the genus *Protostrongylus* Kamenskiĭ, 1905, and closely allied genera. But in none of the latter does it take the subspherical, blister-like form seen in *M. pudendotectus.*

The species of *Metastrongylus* are white, thread-like worms, all of about the same length; the males range from about 1.5 to 2 cm, the females from 2 to 5 cm. *M. salmi* is the least common of the three. Grossly *M. pudendotectus* can be recognized by the larger, ventrally flexed bursa in the male and the presence of a provagina in the female. But *M. apri* and *M. salmi* are more difficult to distinguish, particularly the females. The males can be told apart quite readily on the basis of spicular length. The length of the vagina in the female is theoretically a good criterion, but unfortunately many specimens cannot be well enough cleared to enable this measurement to be taken easily. In well-fixed, unbroken specimens the nature of the prevulvar swelling is probably a good differentiating character. But broken and contracted female posterior ends of *M. apri* may so simulate the appearance of the female posterior end of *M. salmi* that the two species may be indistinguishable without vaginal measurements. I have studied two lots of several dozen pig lungworms, one collected in California[3] and one in Washington, D. C.[4] In neither did I find any *M. salmi* males. Only *M. apri* and *M. pudendotectus* seemed present. I have studied a male and two females of *M. salmi*[5]; the former and one of the latter are here illustrated in figures A and E. Among the lung-

[3] Collected for Dr. M. A. Stewart, Division of Entomology and Parasitology, University of California.

[4] Collected and sent to me by Dr. G. Dikmans.

[5] Lent me by Dr. E. W. Price.

worms collected in California all the females associated with males of *M. apri* corresponded exactly to certain of the figures (16 and 25b) given by Shul'ts and Kaminskiĭ (1937) for "*M. salmi.*" The better preserved specimens from the District of Columbia also agreed with these figures. On the other hand the two specimens of *M. salmi* seen by me closely resembled figures 7 and 25a given by Shul'ts and Kaminskiĭ for "*M. elongatus*"; however, certain broken and contracted specimens of *M. apri* in the lot from Washington also looked like the same figures. Dr. E. W. Price has expressed the opinion to me (*in litteris*) that Shul'ts and Kaminskiĭ's figures for both "*M. elongatus*" and "*M. salmi*" refer to *M. apri.* This may be true. However, I am inclined toward the belief that the Soviet workers have confused the females of the two species, at least in part. Certainly the characters of the prevulvar swelling given to distinguish "*M. elongatus*

		Metastrongylus apri (Gmelin, 1790) Vostokov, 1905. (Figs. A and D)	*Metastrongylus salmi* Gedoelst, 1923 (Figs. B and E)	*Metastrongylus pudendotectus* Vostokov, 1905 (Figs. C and F)
Males	Length of spicules	3.9 – 5.5 mm	2.1 – 2.4 mm	1.4 – 1.7 mm
	End of spicules	Hook-like	Hook-like	Anchor-like
	Gubernaculum	Absent	Present	Present
	Genital cone	Strongly developed	Moderately developed	Weakly developed
Females	Length of vagina	Over 2 mm	Between 1 and 2 mm	Less than 1 mm
	Provagina	Absent	Absent	Present
	Prevulvar swelling	Often set off sharply from body anteriorly, projecting posteriorly and ventrally	Only slightly or not at all set off from body anteriorly, projecting posteriorly	Set off sharply from body anteriorly, with provagina attached
	Position of vulva	At posterior end of prevulvar swelling, usually at juncture of swelling with with body	Midway between anterior and posterior ends of prevulvar swelling, pressed against ventral side of body	At posterior end of prevulvar swelling, surrounded by provagina

(= *apri*)" and "*M. salmi*" apply to the opposite species. Further work is desirable, however, on a large series of the females of both species to ascertain to what degree the appearance of the female posterior ends in the two species overlaps.

Metastrongylus is apparently characteristic of pigs and other related suine artiodactyls. So far no form has been found closely related to the species of the genus, but at the same time sufficiently different to justify erection of a separate genus. Perhaps new genera are to be sought in the many genera of wild pigs

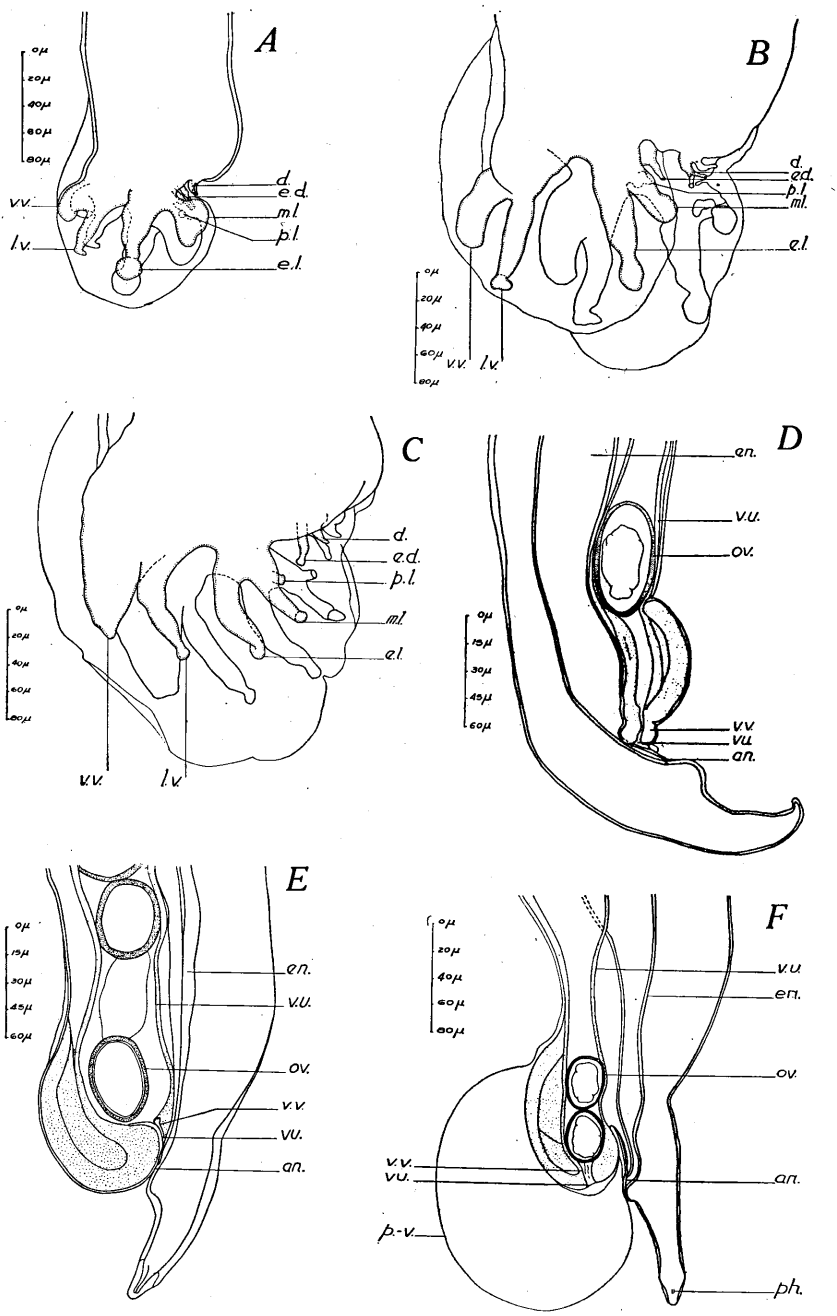

FIG. A—*Metastrongylus apri* (Gmelin, 1790) Vostokov, 1905; posterior end of male, lateral view. B—*M. salmi* Gedoelst, 1923; posterior end of male, lateral view. C—*M. pudendotectus* Vostokov, 1905; posterior end of male, lateral view. D—*M. apri;* posterior end of female, lateral view. E—*M. salmi;* posterior end of female, lateral view. F—*M. pudendotectus*; posterior end of female, lateral view. *an.*, anus; *d.*, dorsal ray; *e.d.*, externodorsal ray; *e.l.*, externolateral ray; *en.*, mesenteron; *l.v.*, lateroventral ray; *m.l.*, mediolateral ray; *ov.*, ovum; *ph.*, phasmid; *p.l.*, posterolateral ray; *p.v.*, provagina; *v.v.*, ventroventral ray or vagina vera; *vu.*, vulva; *v.u.*, vagina uterina.

(Suidae) and peccaris (Tayassuidae) for which no lungworms have been reported, or possibly in hippopotami (Hippopotamidae). However, both *M. apri* and *M. salmi* have been reported by Chavarría (1938) for the "jabalí," or peccary (*Pecari angulatus*). *M. apri* has been found on a few occasions in man (as *Strongylus longevaginatus* by Diesing, 1851), from the dog (as *Cloacina octodactyla* by von Linstow, 1906), and from other mammals. These are unnatural hosts as the worms apparently seldom reach maturity in them.

The three species are listed as follows with their synonyms and hosts and with brief nomenclatorial notes under *M. apri*. They are of cosmopolitan distribution.

Metastrongylus apri (Gmelin, 1790) Vostokov, 1905.

SYNONYMY.—*Ascaris filiformis cauda rotundata* Goeze, 1782 (partim); *Ascaris filiformis* Schrank 1778 (partim); *Ascaris apri* Gmelin 1790; *Fusaria apri* (Gmelin, 1790) Zeder, 1803; *Strongylus suis* Rudolphi, 1809; *Gordius pulmonalis apri* Ebel [1777], of Rudolphi, 1809; *Ascaris bronchiorum suis* Modeer [1791], of Rudolphi, 1809; *Strongylus paradoxus* Mehlis in Creplin, 1831; *Strongylus elongatus* Dujardin, 1844; *Strongylus longevaginatus* Diesing, 1851; *Metastrongylus paradoxus* (Mehlis in Creplin, 1831) Molin, 1861; *Metastrongylus longevaginatus* (Diesing, 1851) Molin, 1861; *Eustrongylus longevaginatus* (Diesing, 1851) Dunglison, 1874; *Strongylus paradoxis* Francis, 1894 (*err. pro S. paradoxus*); *Strongylus apri* (Gmelin, 1790) Blanchard, 1895; *Metastrongylus apri* (Gmelin) 1789, of Vostokov, 1905; *Cloacina octodactyla* v. Linstow, 1906; *Sclerostoma apri* (Gmelin, 1790) Braun and Lühe, 1910; *Metastrongylus elongatus* (Dujardin, 1844) Railliet and Henry, 1911.

HOSTS.—*Normal:* Domestic pig, *Sus scrofa scrofa* Linné (type host); wild pigs: *Sus scrofa atilla* Thomas, *Sus scrofa nigripes* Blanford, *Sus scrofa continentalis* Nehring, *Sus scrofa leucomystax* Temminck and Schlegel; peccary, *Pecari angulatus* ? subsp. (in Zoölogical Park, Chapultepec, D. F., Mexico—see Chavarría, 1938). *Abnormal*: man, dog, ox, sheep, goat, guinea pig.

NOMENCLATORIAL NOTES. The first observation on the occurrence of lungworms in pigs seems to have been made by Ebel (1777) who did not designate them by name. Gmelin (1790) was the first to employ a specific designation exclusively for pig lungworms; he used the name *Ascaris apri*. There is nothing in his description[6] to indicate whether he described one or all of the three species of *Metastrongylus*. However, there is likewise no such distinction in the descriptions accompanying the first use of any subsequent name for pig lungworms—namely for *Strongylus suis* of Rudolphi (1809, p. 246), *Strongylus paradoxus* of Mehlis (in Creplin, 1831, p. 84), and *Strongylus elongatus* of Dujardin (1844, p. 127)—up to the name *Strongylus longevaginatus* of Diesing (1851) which probably applies to *M. apri* alone. Thus, except possibly for the last name, the earliest designation, *Ascaris apri*, has a greater right to modern application than any of the others. The generally prevailing use of *Metastrongylus elongatus* for the genotype of *Metastrongylus* is not justifiable on the basis of priority. However, the use of the specific name *apri* becomes necessary, I feel, because Vostokov (1905), who was first to review the genus *Metastrongylus* and recognize that more than one species of lungworm occurred in the pig, specifically restricted the name *Metastrongylus apri* to a single recognizable species which he distinguished from *M. pudendotectus*. He apparently had no specimens of *M. salmi* at hand. As already mentioned the

[6] *Habitat in* apri pulmone, *vivipara, friabilis, utrinque attenuata, fili tenuissimi crassitie, pollicem circiter longa.*

use of the combination *M. elongatus* originated with Railliet and Henry (1911), who had already employed *M. apri* in 1907. The only alternative, I believe, would be to use Diesing's *S. longevaginatus*, which is itself, however, not utterly free from question as to its original application to a definite species.

Metastrongylus salmi Gedoelst, 1923.

SYNONYMY.—*Metastrongylus elongatus* of Salm, 1918.

HOSTS.—*Sus scrofa scrofa* Linné (type host); *Sus scrofa atilla* Thomas; *Pecari angulatus* ? subsp.

Metastrongylus pudendotectus Vostokov, 1905.

SYNONYMY.—*Metastrongylus brevivaginatus* Railliet and Henry, 1907; *Choerostrongylus brevivaginatus* (Railliet and Henry, 1907) Gedoelst, 1923; *Choerostrongylus pudendotectus* (Vostokov, 1905) Skrîabin, 1924.

HOSTS.—*Sus scrofa scrofa* Linné (type host); *Sus scrofa nigripes* Blanford.

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MINUTES

Two Hundred Thirty-seventh to Two Hundred Forty-fourth Meetings

The 237th meeting was held October 13, 1943, in the U. S. National Museum. A schedule of meetings for the current year was adopted. Papers were presented by Cram, Wehr, Spindler and Price.

The 238th meeting was held November 10, 1943, at the Beltsville Station of the Zoological Division. It was announced that Dr. Dikmans replaced Dr. Steiner as chairman of the committee to revise the constitution and by-laws, and that Mr. Lucker replaced Dr. Olivier on this committee. Dr. D. C. Butts was elected to membership. Papers were presented by Enzie, Boughton, Rees and Worth.

The 239th meeting was held December 8, 1943, in the U. S. National Museum. Cpt. G. E. Davis was elected to membership. Dr. Dikmans read the committee's draft of a new constitution and by-laws. Dr. Price was reelected to represent the Society in the Washington Academy of Sciences. Papers were presented by Davis, Martin and Hunter.

The 240th meeting was held January 19, 1944, at the National Institute of Health, Bethesda, Md. The resignation of Miss Jocelyn Tyler from membership was accepted. Dr. E. G. Reinhard, Dr. H. Elishewitz and Miss E. Newmayer were elected to membership. A paper and moving picture on onchocerciasis was presented by Dr. Wright.

The 241st meeting was held February 9, 1944, in the U. S. National Museum. Dr. Dikmans submitted the report of the committee for revision of the constitution and by-laws. After discussion and adoption of a series of amendments, all the articles of the constitution and by-laws, with exception of articles 1 and 2 of the constitution, were accepted. A committee, consisting of Drs. Steiner, Dikmans and Mr. Lucker, was appointed to consider the feasibility of changing the name of the society and to secure a vote of the members of the society on articles 1 and 2 of the constitution.

The 242nd meeting was held March 8, 1944, at Georgetown University. Cpt. C. Saunders was elected to membership. Papers were presented by Knott and Steiner.

The 243rd meeting was held April 12, 1944, in the U. S. National Museum. Dr. Dikmans reported that the majority of members voted in favor of retaining the old name of the society. The report of the committee was accepted. Articles 1 and 2 of the constitution were accepted. Papers were presented by Bartlett, Boughton and Becker.

The 244th meeting was held May 13, 1944, in form of the annual picnic meeting at the Horticultural Station of the Bureau of Plant Industry, Beltsville, Md. Mr. J. T. Lucker and Miss M. Farr were appointed to the Executive Committee.

THEODOR VON BRAND,
Recording Secretary

Report of the Brayton H. Ransom Memorial Trust Fund

December 31, 1943

There was a meeting of the trustees on May 15, 1943. An award of $25.00 for 1943 was voted for the Proceedings of the Helminthological Society of Washington.

The status of the Fund, since the December 31, 1942, statement, published in the Proceedings of the Helminthological Society, January, 1944, is as follows:

ON LOAN		$1400.00
BALANCE ON HAND, January 1, 1943		100.06
RECEIPTS:		
Interest on loan to Apr. 27		28.00
Interest on loan to Oct. 27		28.00
TOTAL RECEIPTS		156.06
DISBURSEMENTS:		
1943 rent, safe deposit box	$3.50	
tax	.70	4.20
Award to Helminthological Soc. Proc.		25.00
TOTAL DISBURSEMENTS:		29.20
BALANCE ON HAND, December 31, 1943		126.86
		$156.06

Note: There was no receipt of bank interest during 1943. By virtue of regulations in effect January 1, 1943, there must be a balance of One Hundred Dollars (or more) during the six months' interest periods, in order that the account draw interest. The above account was below the One Hundred Dollar mark during each interest period in 1943.

ELOISE B. CRAM,
Secretary-Treasurer

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