THE EFFECTS OF CERTAIN ANTHELMINTICS ON THE TISSUE PHASE LARVAE OF ASCARIDIA GALLI (SCHRANK, 1788)

by

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INTRODUCTION AND REVIEW OF LITERATURE

There is unquestionable evidence that the use of anthelmintics antedated the Greek civilization by many centuries. Among people whose ancestry has been traced beyond that of the Greeks, there has been found instances of anthelmintic application.

However historically the oldest anthelmintic now in use - male fern, a still popular drug - has been established in the writings of Theophratus, Deoscorides and Pliny as having been used by the Greeks (Hall 1920). Kamala was discovered with the people of India, and at the time of Columbus the American Indian was making use of chenopodium and spigelia.

Interesting enough, the earliest known and most widely used anthelmintic was that of plant derivatives which according to Hall (1928) followed quite naturally from the fact that plants made up the major source of food material. Winslow (1919) listed aspidium, turpentine, kousso, areca nut, kamala, pomegranate, pumpkin seed, santonin, spigelia, chenopodium and thymol as originations from plant life. Inorganic compounds included creolin, arsenic, copper sulphate, chlorophorm and carbon bisulphide. Of late however, there has been noted a trend to utilize other organic and inorganic compounds; but still with plant material in the preponderance.

Hall divided the development of anthelmintic medication into three epochs: centuries of uncritical impericism, less than half a century of critical impericism, and nearly half a century of critical experimental testing.

In the period of centuries of uncertain impericism, the basis for the use of anthelmintic was that upon administration, helminths were eliminated. It was not conceivable that this was no indication of total anthelmintic effectiveness; and in the development of the medicament, to the present time this seemingly oversight was not totally discarded with the other fallacious reasoning. So forceful was this elementary logic that commercial drugs have been manufactured and marketed to be used primarily for the elimination of adult parasites.

The recognition of the Old World hookworm Ancylostoma duodenale disease and its importance by Dubini in 1843 closed the first epoch of anthelmintic medication. But the second period did not begin until 1881 when Perroncito proposed the definite use of male fern as an anthelmintic against ancylostomiasis. This period involved the testing of the absolute and relative afficacy of the various anthelmintics used.

The period of critical experimental testing retained as its objective the standardization and development of new anthelmintics by the method of critical testing on experimental animals. While Grassi and Calandrucio in 1884 and 1885 and Perroncito in 1885 and 1886 participated in critical testing - they performed post mortems to prove that male fern killed liver flukes in treated sheep - concentrated and organized efforts were initiated and projected by the Zoological Division of the United States Bureau of Animal Industry in 1915 (Hall 1928,).

In 1918 Hall and Foster published the results of an extensive survey of the then known veterinary anthelmintics. They concluded

that while traditionally quite a few drugs were regarded as highly efficacious, they were actually without merit, and the authors were prepared to endorse only a few, namely; copper sulphate, oil of chenopodium, oleoresin of male fern, turpentine and nicotine. Later Hall introduced into the armamentarium of anthelmintics carbon tetrachloride and tetrachlorethylene - both chlorinated hydrocarbons and synthetic substances. With the development of this tendancy towards synthesization came newer and very often more effective drugs namely; normal butyl chloride, normal butylinene, chloride hexachloroethane, diphenylamine, phenothiazine, sodium fluoride and lead arsenate (Schwartz 1952).

While the tissue phase (when the parasite buried its head in the mucosal lining of the intestine) of the Ascaridia galli (syn. A. perspicillum and A. lineata) was found by Ackert (1923), the injrious effects resulting from this penetration were recognized by Guberlet (1924) who stated that heavily infected birds died from intestinal irritation and toxemia on the 10th to the 12th day following infection. Ackert and Herrick (1928) found that the most noxious period in the life cycle of this nematode was about 14 days after the host was successfully exposed to embryonated ova. This finding was later substantiated by Ackert (1931) when he found that irritation of the mucosal lining coincided with what he called the tissue phase of the parasite. The tissue phase occurred between the 10th and the 17th day after exposure to embryonated ova.

More recently, the importance of the various phases in the life cycle of a parasitic helminth was pointed out by Todd and

Hansen (1951) as having been encountered in the severe loss of weight and that this loss occurred at three periods namely; at exposure of the host to infective ova, during the tissue phase, and after maturity of the parasitic organism. Greatest and most conspicuous damage to the host was noted during the second period. The importance of the penetrating habit of the larval form other than that of A. galli was also noted by Mayhew (1949) when he observed severe adverse effects caused by the immature stages of Bonostomum phlebotomum in the calf.

The above studies suggested the possibility of one or more anthelmintics as being effective against parasitic larvae during the prepatent period. Thus the investigation reported here concerned itself with the effect of certain currently available commercial anthelmintics and aureomycin, a potential anthelmintic, on adult and tissue phase larvae of Ascaridia galli, as well as the effect of these anthelmintics on the host animals, Gallus domesticus.

Nicotine has been found in three anthelmintics, namely: Chicken Pharmacy Pills, Wormal and Nikophen, whereas, antimony potassium tartrate was the active ingredient in a fifth anthelmintic.

The use of nicotine as an anthelmintic against A. galli was initiated by Herms and Beach (1916) when they suggested finely chopped tobacco stems steeped in the drinking water of semi-fasting chickens. Dougherty and Beach (1919) mixed tobacco dust in the feed with partial success which was indicated by no further visible external signs of infection.

In a series of experiments Freeborn (1923) reported 98 to 100 per cent elimination of worms from adult birds fed on commercial tobacco dust containing 1½ to 2 per cent nicotine for over a period of one month, and that diluted water solution of nicotine sulphate administered orally in quantites sufficient to affect the parasites proved undesirably toxic to the hosts. This was experienced to be so by the writer when dilutions of Black Leaf 40 were used in the preliminary phases of the present study. Levine(1936) in a series of experiments found tobacco dust with 1.78 per cent nicotine content when fed in concentrations of 2, 4, 6, and 8 per cent in a dry mash prior to exposure to embryonated ova failed to prevent infection; that 6 and 8 per cent doses were toxic to the host and one dose of a 5 per cent nicotine compound (Black Leaf Worm Powder)--nicotine mixed in a special Fuller's earth--was 100 per cent effective against adult worms.

Roberts (1937) found 2 per cent tobacco dust with 0.86 per cent nicotine to have little effectiveness against A. galli. A 4 per cent dust with 0.81 per cent nicotine proved too distastefull to the birds.

Freeborn (1923) further instituted the idea of using a carrier agent for the nicotine sulphate solution when he used Lloyd's reagent in the "University Capsule." The dosage of 350 to 400 mgm of this mixture proved either too toxic for the host or impotent in its action on the parasite. The use of a carrier agent was studied further by Davis (1940) who combined 6 per cent or 70 to 80 mgm nicotine with an "organic colloid" material in an

amount sufficient to prove lethal to the worms and non-toxic to the host. Even though Levine (1936) previously had shown that 6 and 8 per cent doses of nicotine to be very toxic, Davis claimed that not only was the nicotine released solely in the alkaline portion of the small intestine, but also that it was released so slowly as not to be of any toxicity to the host.

Using 0.5 mgm of nicotine sulphate per pound weight of dry mash, Roberts found this mixture capable of giving an 825 per cent efficiency against A. galli if fed continuously over a period of seven to eight days. It was observed that worms voided were greater in number in older than in younger birds and that the less mature worms successfully resisted the treatment.

The use of antimony potassium tartrate, as an anthelmintic, has been of such recent interest that there has been no literature on the efficacy of this particular drug.

Phenothiazine was used by McCulloch and Nicholson (1940) in successfully removing the cecal worm of chicken Heterakis gallinae. When given orally, 0.05 to 0.5 gm of phenothiazine was 95 to 100 per cent efficient in killing and expelling the parasite. Quantites up to 25 gm proved non-toxic to the host.

While the importance of phenothiazine for the removal of the cecal worm was substantiated in the works of Allen, Olivier and Peterson (1942), Guthrie and Harwood (1942), and Olivier, Allen and Hardcastle (1943), the first attempt to determine the efficacy of the administration of phenothiazine in combination with nicotine as a single treatment for the removal of both A. galli and H. gallinae was made by Guthrie and Harwood (1942). A dose of

33 parts phenothiazine and 66 parts nicotine-bentionite (5 per cent nicotine) and 1 part sodium stearate resulted in a 96.2 per cent effectiveness against the ascarids. A further investigation of the efficacy of this compound on the individual species resulted in the findings that they were equally as effective as before (Harwood and Guthrie 1944).

Harwood and Stuntz (1945) used a mixture of 6 gm phenothiazine 12 gm nicotine-bentonite (5 per cent nicotine) and 4 pounds dry mash with 69.6 and 42.9 per cent efficacy against Ascaridia dissimilis in turkeys.

Jaquette and Wehr (1949) fed to naturally infected chickens the following mixture: to 44 pounds of dry mash were added 15 gm of a 40 per cent nicotine sulphate solution; 151 gm of phenothiazine powder, and 287 gm of bentonite (a clay like inert material). The percentage of each ingredient in the medicated mash was as follows: nicotine expressed as 40 per cent nicotine sulphate solution--0.74 per cent, phenothiazine 0.74 per cent and bentonite 1.41 per cent. When the treated food was kept before the birds for five consecutive days, 97 to 100 per cent of the ascarids were removed, and when fed for four consecutive days, 97.6 to 100 per cent of the parasites were expelled. Symptoms of toxicity of the anthelmintic were unobserved in the treated birds.

Gurthrie and Harwood (1941) were the first to initiate the use of tin compounds as possible anthelmintics. They found inorganic and organic tin compounds were of slight value for the removal of ascarids from experimentally infected chickens.

Mixtures of 0.3 to 1 gm of stannous tartrate and 0.07 to 0.2 gm of synthetic pelletierine hydrochloride had an efficacy of 86.8 per cent in 58 birds. No apparent toxicity were experienced.

Gurthrie and Harwood (1944) in limited tests of mixtures of tin oleate with ammonium compounds for the removal of experimental cestodes of the chicken found mixtures of triethanolamine more efficient than tin oleate with ammonia. In a series of experiments Kerr (1952) found that single doses of 75 mgm per kg of body weight was 85 per cent effective against the Raillietina cesticillus. When mixed in the feed, butynorate was found to have an efficiency of 85 per cent at 86 mgm per kg. Toxicity to the host was experienced when the dosage was raised above 1 gm per kg. Low level feeding of 0.16 per cent butynorate for seven days showed no toxic effects. Birds receiving 0.02 and 0.01 per cent outgained control groups in weight at the end of five weeks.

Craige and Kleckner (1946) found di-phentane-70 to have a bloating and deteriorating effect on cestodes. While obviously injured ascarids were recovered in the feces of the treated animals, in vitro studies with di-phentane-70 showed definite killing of the round worms. But in some cases "normal ascarids" were found in the intestine of treated dogs.

Oral doses of di-phentane-70 of 50 gm per kg were highly teniacidal though maximum efficiency was had with 200 gm per kg. Toxicity of the host was unobserved at a dose of 2 gm per kg.

While aureomycin has received very popular attention in its important role as a growth factor, Stokstead and Jukes, 1950, 1951, its anthelmintic potentialities have been of only recent

and sparse interest. Wells (1951) used 500 mg per kg of body weight of aureomycin in daily oral doses for fourteen days in experimentation with Aspiculuris (nematoda) infection in mice. She found the dose to be toxic in that 10 per cent of the host animals died. A dose of 150 mgm per kg of the antibiotic was only slightly effective. Todd (1951) found that 6.8 mgm of penicillin per pound of feed inhibited the development of A. galli in chickens. At 15 mgm per pound of feed the anthelmintic action was much more evident in a reduction to the numbers of worms. In comparing penicillin, streptoycin and neomycin, each fed at the rate of 15 mgm per pound, he found penicillin to be superior. A gain in weight of those chickens receiving penicillin was also quite evident.

It appears from a review of the literature that nicotine as an anthelmintic for the removal of A. galli has not been supplanted by any new anthelmintic. That nicotine was still the drug of choice against the large ascarid of chickens, was evident in the frequency with which it appeared in commercial products on the market at the present time.

MATERIALS AND METHODS

The experimental animals, with the exception of those in Experiment 1, which utilized White Leghorns, were all White Rock chickens purchased as day-old chicks from a commercial hatchery in Kansas. They were raised in electrically heated brooder batteries until three weeks old when they were transferred into

regular growing batteries. Standard commercial ration free of low-level aureomycin was fed the birds throughout the experiments. At two weeks of age the chicks were banded, weighed and divided into four groups of 10 chicks each. The groups were designated as Groups I, II, III and IV. Throughout the entire investigation Groups I and III received treatment with the anthelmintic while Groups II and IV were retained as untreated but infected controls.

All groups were exposed to 100± 10 embryonated ova of Ascaridia galli when the birds were 21 days old.

The egg cultures were prepared according to the method described by Riedel (1947). Gravid female Ascaridia galli nematodes were obtained from the small intestine, between the duodenal loop and the yolk sac diverticulum, of chickens which were being dressed for market at a local Manhattan packing plant. The anterior ends of the worms were excised, the internal organs squeezed out and the uteri isolated into petri dishes. Under a few milliliters of tap water, the fertile ova were pressed out of the uteri with the aid of a teasing needle and incubated at 28°C for 20 to 30 days at the end of which time the ova were in the coiled embryo stage.

Administration of the eggs was patterned after Riedel's method (1947). From the egg culture, embryonated ova were pipetted into a small cork stoppered shell vial into which was first placed about one half centimeter depth of very fine washed particles of sand. Water was added and the vial gently agitated to promote a homogeneous suspension which insured an even distri-

bution of ova throughout the liquid. Immediately following such an agitation, a pipette calibrated to deliver 100± 10 eggs with three drops of mixture, was inserted to the mid-point in the suspension and the liquid drawn up to the mark of calibration. One drop or one-third of the calibrated volume was placed on a microslide and the total number of embryonated eggs was determined with the aid of a microscope. Adjustments for increasing or decreasing the number of embryonated ova were made by respectively adding ova from the culture or diluting the concentration with water. Standardization was reached when the calibrated pipette delivered 100 ± 10 eggs in three drops of suspension.

Gentle agitation of the suspension preceded the administration of eggs to the chickens. The ova were administered by means of each bird. The chickensto be exposed were chosen from each group in consecutive order so that any extreme of variations in numbers of ova administered would more or less be evenly distributed among the experimental groups. The infected chickens were then placed in growing batteries until the 11th day after exposure at which time experiments with the various anthelmintics were initiated because the parasites were in the tissue phase of the life cycle (Ackert 1931).

Twenty-four hours after the administration of the anthelmintic and continuing at twenty-four hour intervals for 10 days, one member of Group I (anthelmintic) and one member of Group II (control) were killed. On the 11th day all the birds of Group III (anthelmintic) and Group IV (control) were killed.

The intestine from the duodenal loop to a little below the

yolk sac diverticulum - the region inhabited by the Ascaridia galli parasite (Ackert 1931) - was removed at the time of autopsy of Groups I and II. The intestine was then cut into two almost equal parts to facilitate flushing, and the contents of both pieces flushed into glass jars by the hydraulic pressure method described by Ackert and Nolf (1929). Two jars were used for each chicken. In one was placed the flushed contents and into the other was placed the intestine for digestion. The wing band number of each chicken was legibly written with glass marking pencil on their respective jars.

To allow for spontaneous relaxation on the part of the worms the jars with the flushed contents were allowed to stand for about 16 hours at room temperature. The contents were shaken and poured a few millilitres at a time into a petri dish, the bottom of which was marked with a diamond point in horizontal columns to facilitate examination under the binocular dissecting scope. The worms were collected with a teasing needle and placed into screw top vials containing ten per cent formalin. The vials were each labled with pertinent data concerning the wing band number of the chicken, date killed, and the number and origin - flusing or digestion - of all worms collected.

The mucosa larvae were collected by the digestion method as reported by Tugwell (1952). The individual intestines flushed of thin contents were broken into small pieces and placed in wide mouth quart jars with about 700 cc of 0.5 per cent solution of hydrochloric acid and 1.0 per cent pepsin. The jars were placed in a water bath and the contents agitated continually by

rotating glass rods mixers for 4 hours. After complete digestion of the intestines the contents were allowed to settle for about 20 minutes during which time the worms settled down to the bottom of the containers. The supernatent fluid was drawn off to about three centimeters from the bottom of the jars with a J-shaped tube and rubber hose attached to an aspirator which in turn was attached to a water faucet. The J-tube encouraged only surface currents to be set up thus eliminating appreciable loss of the larval worms.

The concentrated residue was then diluted with water and after a 20 minute period was again drawn off as previously described. This washing process was repeated about four times or until a clear workable residue of concentrated larvae was realized. This was then poured a few millilitres at a time into a marked petri dish and the larvae recovered with the aid of a needle under the wide-field binocular dissecting scope. The worms were counted and stored in 10 per cent formalin in screw capped vials.

The worms recovered from the flushings of the intestines were usually large enough to be measured by projecting the images of the worms upon a ground glass plate and accurately tracing with pencil the enlarged outlines of the worms on a sheet of thin foolscap. The magnification of the images was 6 times the actual size. The lengths of the pencilled reflections were measured by tracing over the markings with a calibrated Dietzgen map measurer. The results were reconverted to actual sizes by dividing by 6.

The smaller worms, especially those recovered from the intestinal wall, were measured with the aid of the camera lucida. The images were traced and the outlines measured with the Dietzgen instrument. The resulting measurements were corrected by dividing by the factor of magnification.

Because a chicken from each of Groups I and II was killed daily subsequent to treatment with the anthelmintic, it was not practical to maintain weight records on these groups; however daily weight records were kept for Groups III and IV beginning one day prior to administration of the anthelmintic to Groups I and III, and continuing until they were killed 11 days later.

The anthelmintics with the exception of Aureomycin were all administered according to the commercial directions.

In Experiments 1 and 2, nicotine expressed as an alkaloid was used as the anthelmintic. Commercially this product has been known as Chicken Pharmacy Pills and has been manufactured by the Chicken Pharmacy, Petaluma, California. Each tablet weighed 0.06 gm and contained as the active ingredient 6 per cent or 65 mgm of nicotine per tablet. Two tablets were administered to each bird of Groups I and III by mashing the tablets into small pieces and inserting each piece with a pair of blunted forceps well down into the oesophagus of the bird. Care was taken to reach beyond the glottis and water was used as a lubricant to encourage swallowing.

In Experiments 3 and 4, Dr. Mayfield Large Roundworm Tablets were used, a product of Dr. Mayfield Laboratories, Inc., Charles City, Iowa. The active principle in these tablets was antimonyl

potassium tartrate expressed as antimony trioxide with each tablet containing 6.7 gr. Two tablets were dissolved in every quart of drinking water and placed before the infected birds, to be treated, for two days. Then the troughs were thoroughly washed and fresh non-treated water was added and used continuously until the end of the experiment.

In Experiments 5 and 6 Wormal was used, a product of Dr. Salisbury's Laboratories, Charles City, Iowa. The active components of this drug were: di-n-butyl-dilaurate (butynotate) - 7 per cent, phenothiazine - 29 per cent, and nicotine (expressed as an alkaloid) - 3 per cent. A mixture of 14.93 gm of Wormal and 3 pounds of regular mash was fed to the chickens of Groups I and III. Addition of feed free from anthelmintic was not made until all of the treated mash was consumed.

Nikophen used in Experiments 7 and 8 was a product of Pitman-Moore Company, Division of Allied Laboratories, Inc., Indianapolis, Indiana. The active agents in Nikophen were: di-phenthane-70 or 2, 2 dihydroxy-5, 5-dichlorodiphenylomethane - 3.08 gr. or 3.08 per cent, phenothiazine - 6.63 gr. or 35.65 per cent, and nicotine - 0.63 gr. or 0.03 per cent. On the day of administration all chicks of the experiment were deprived of the evening meal. Each member of Groups I and III received one tablet by insertion of fragments of the tablet into the oral cavity. Feed was restored to all birds on the morning following application.

Aureomycin, an antibiotic, was used as the anthelmintic in Experiments 9 and 10. This drug was made available through the

courtesy of Lederle Laboratories Division, American Cyanamid Company, Pearl River, New York. In Experiment 9 each chick of Groups I and III received daily 18 mgm of aureomycin packed in single No. 2 gelatin capsules. The control birds received empty capsules. Treatment began 24 hours previous to exposure of the chickens to 100 ± 10 embryonated ova of A. galli and continued until all the chickens were killed on the 23rd day. In Experiment 10 each of the birds of Groups I and III received one dose of 32 mgm of aureomycin on the 11th day following exposure to the infective ova of the ascarid.

EXPERIMENTAL RESULTS

Experiment 1

The anthelmintic used in this experiment was Chicken Pharmacy Pills in which the active agent was 6 per cent nicotine expressed as an alkaloid.

The chickens were divided into four groups (I, II, III, and IV), of approximately equal weights. They were all exposed at 21 days of age to 100 ± 10 embryonated ova of Ascaridia galli, which were incubated at 28°C for about 30 days. Eleven days after exposure, members of Groups I and III were each given one tablet of the anthelmintic. Groups II and IV were reserved as untreated but infected controls.

The results of this experiment are recorded in Tables 1 and 2. From the day by day examination, Group I yielded a total of

Table 1. Results of daily examinations of chickens given Chicken Pharmacy Pills and untreated infected controls.

Group	Chickens: Band No	Days: Following Exposed to ova	Days: Killed	Worms recovered: Number: Flush	Number: Digest	Length: Flush	Length: Digest
I	5437	12	13	12	15	42.30	49.50
	5442	13	14	3	6	6.20	15.10
	5436	14	15	1	0	5.30	-
	5451	15	16	0	4	-	14.10
	5433	16	17	3	4	20.50	14.70
	5404	17	18	1	2	8.00	11.30
	5424	18	19	3	2	27.90	11.30
	5452	19	20	0	0	-	-
	5438	20	21	0	0	-	-
	5441	21	22	0	0	-	-
Total				23	33	110.20	115.30
Av.				2.3	3.3	4.8	3.4
			Control				
II	5423	12	13	9	12	41.00	42.20
	5460	13	14	0	12	-	44.28
	5413	14	15	0	0	-	-
	5417	15	16	0	0	-	-
	5421	16	17	4	0	12.50	-
	5439	17	18	5	2	63.20	8.80
	5444	18	19	1	0	6.60	-
	5440	19	20	7	1	47.70	5.40
	5455	20	21	0	0	-	-
	5457	21	22	0	0	-	-
Total				26	27	168.00	100.26
				2.6	2.7	7.2	3.7

Table 2. Data on the numbers and lengths of worms recovered from flushing 11 days subsequent to exposure of chickens to anthelmintic, as well as the weight gains of treated and control groups of chickens.

Chicken Pharmacy Pills					Control				
Chickens			Worms		Chickens			Worms	
Group	Band No	Wt. gain in gr.	Number	Length mm	Group	Band No	Wt. gain in gr.	Number	Length mm
III	5420	84	6	14.6	IV	5408	184	15	31.29
	5422	175	0	-		5427	207	1	1.91
	5425	146	0	-		5429	145	8	18.56
	5443	139	1	3.16		5445	199	3	6.10
	5446	153	9	25.51		5448	110	0	-
	5450	196	0	-		5449	229	7	14.39
	5454	193	20	54.36		5458	169	9	23.64
	5456	151	1	1.25		5459	196	3	8.30
	5462	207	3	10.49		5461	124	1	2.50
	5464	193	5	13.84		5463	196	0	-
Total		1637	45	123.27			1729	47	106.72
Av.		163.7	4.5	27.3			172.9	4.7	2.3

23 lumen larvae or an average of 2.3 per chick, while 33 or an average of 3.3 tissue phase larvae were recovered.

The average length of lumen worms recovered was 4.8 mm while that of the tissue phase larvae was 3.4 mm. The worms recovered from Group II average 2.6 for lumen worms and 2.7 for tissue phases larvae per bird. The lengths of these worms averaged 7.2 mm for the lumen worms and 3.7 mm for the tissue phase larvae.

From Group III, which was killed 22 days after exposure to embryonated ova of A. galli or 11 days after administration of the anthelmintic, 45 lumen larvae were recovered or an average of 4.5 worms per chick. Their average length was 27.3 mm. Group IV which was killed on the same day yielded 47 worms or an average of 4.7 per chick. Their average length was 2.3 mm.

The weight gains for the chickens in Groups III and IV over a period of 11 days, subsequent to exposure to ova and treatment with the anthelmintic, are recorded in Table 2. Group III gained a total of 1637 gm or an average of 163.7 gm, whereas, Group IV gained a total of 1729 gm or an averaged 172.9 gm.

Experiment 2

The results of Experiment 2, which again utilized Chicken Pharmacy Pills, are recorded in Tables 3 and 4.

From Group I, 21 or an average 2.1 lumen worms per chick were recovered. Their total length was 62.5 mm and averaged 3.0 mm per worm. The tissue phase larvae of Group I totaled 37 and averaged 3.7 per chick. The total length was 102.2 mm and the

Table 3. Results of daily examination of chickens given Chicken Pharmacy Pills and untreated infected controls.

Group	Chickens: Band No	Days: Following Exposed to ova	Days: Killed	Worms recovered: Number: Flush	Number: Digest	Length: Flush	Length: Digest
I	5412	12	13	10	8	28.3	21.4
	5071	13	14	2	8	5.3	21.7
	5169	14	15	1	3	4.6	6.2
	5127	15	16	0	0	-	-
	5091	16	17	2	2	5.3	7.0
	5001	17	18	0	10	-	31.4
	5132	18	19	4	4	14.1	9.2
	5061	19	20	2	2	4.3	5.3
	3791	20	21	0	0	-	-
	5024	21	22	0	0	-	-
Total				21	37	62.5	102.2
Av.				2.1	3.7	3.0	2.8
			Control				
II	3790	12	13	5	8	18.6	21.8
	5036	13	14	6	4	20.6	12.3
	5043	14	15	0	0	-	-
	5042	15	16	0	4	-	12.8
	5090	16	17	9	4	33.6	12.8
	5155	17	18	0	3	-	6.9
	5166	18	19	4	6	17.6	17.8
	5167	19	20	6	3	22.1	7.3
	5149	20	21	0	0	-	-
	3794	21	22	0	0	-	-
Total				30	32	112.5	91.6
Av.				3.0	3.2	3.7	2.8

Table 4. Data on the numbers and lengths of worms recovered from flushing 11 days subsequent to exposure of chickens to anthelmintic, as well as the weight gains of treated and control groups of chickens.

Chicken Pharmacy Pills					Control				
Chickens			Worms		Chickens			Worms	
Group	Band No	Wt. gain in gr.	Number	Length mm	Group	Band No.	Wt. gain in gr.	Number	Length mm
III	5002	100	3	6.6	IV	5003	204	4	10.4
	5005	170	0	-		5004	204	10	31.1
	5021	141	2	5.3		5007	143	3	12.5
	5023	134	1	2.5		5006	196	8	27.8
	5041	148	3	8.0		5055	206	0	-
	5044	191	4	19.1		5061	225	5	15.8
	5045	188	9	35.0		5062	166	2	6.1
	5050	146	0	-		5056	194	4	15.2
	5052	202	12	40.2		5059	220	4	14.6
	5054	188	1	4.5		5051	290	0	3.9
Total		1608	35	118.7			2048	40	130.4
Av.		160.8	3.5	3.4			204.8	4.0	3.7

average was 2.8 mm per worm.

Group II had a total of 30 lumen worms, and averaged 3.0 per chick. The total measurement was 112.5 mm, and the average per worm was 3.7 mm. The tissue phase larvae numbered 32 or an average of 3.2 per chick. Their total length was 91.6 mm and each worm averaged 2.8.

Worms recovered from Group III totaled 35 and averaged 3.5 per bird. The total lengths was 118.7 mm and each worm averaged 3.4 mm. The total weight gain of the chickens in this group was 1608, and the average was 160.8.

From Group IV, 40 or an average of 4.0 worms per chick was recovered. The lengths totaled 130.4 mm and each worm averaged 3.7 mm. The total weight gain of the individual of this group was 2048 gm or an average of 204.8gm.

The combined results of Experiments 1 and 2 indicated that Chicken Pharmacy Pills significantly retarded the growth of the lumen larvae which were recovered from treated birds of Group I, but did not significantly reduce the numbers of lumen larvae in comparison to the controls of Group II. The average length of the tissue phase larvae of Groups I and II differed very slightly. There were no significant differences between the numbers of tissue phase worms recovered in these two groups. The difference in average lengths of the worms recovered from Group III and IV approached significance at the 5 per cent level, whereas there were no significant differences in the numbers of the worms.

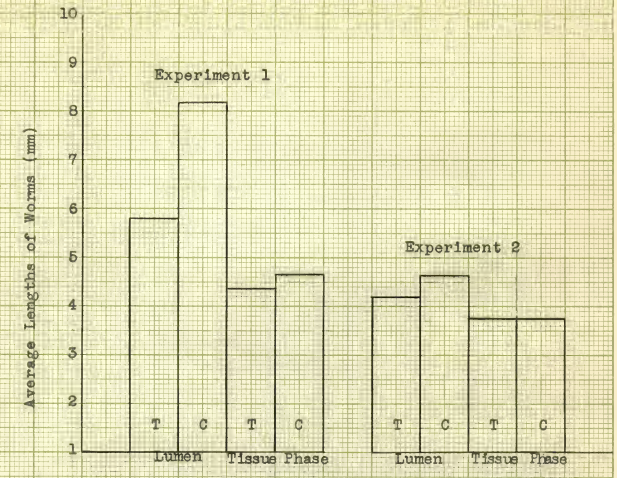

Fig. 1. Comparison of average lengths of worms recovered from chickens treated (T) with chicken Pharmacy Pills and their untreated controls (C).

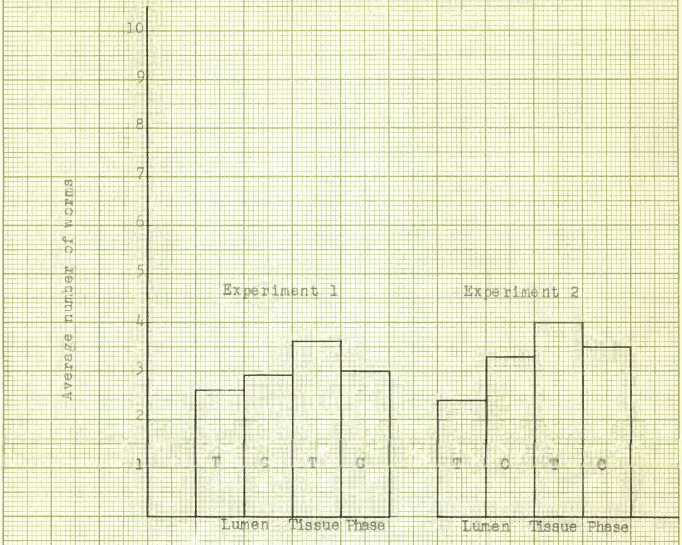

Fig. 2. Comparison of average numbers of worms recovered from chickens treated (T) with Chicken Pharmacy Pills and their untreated controls (C).

Experiment 3

Dr. Mayfield Large Roundworm Tablets were used for treatment in this experiment. The results have been recorded in Tables 5 and 6.

From group I, 77 or 7.7 lumen worms per chick were recovered. Their total length was 271.1 mm. and averaged 3.3 mm. per worm. The tissue phase larvae recovered from Group I totaled 54 and averaged 5.4. The total of the length was 176.8 mm. and the average was 3.3 mm. per worm.

Group II had a total of 46 lumen worms and averaged 4.6 per chicken. The total measurement was 145.3 mm., and the average per worm was 3.2 mm. The tissue phase larvae numbered 25 and averaged 2.5. The total lengths was 131.0 mm., and each worm averaged 5.2 mm.

Worms recovered from Group III totaled 63 and averaged 6.3 per chick. The total lengths was 780.9 mm. and each worm averaged 12.3 mm. The total weight gain of each chick of the group was 1962 and the average 196.2.

From Group IV, 47 or an average of 4.7 worms per chick were recovered. The lengths totaled 432.8 mm. and averaged 9.2 mm. per chick. Total weight gain was 2811 gm. and the average of each chick was 281.1 gm.

Table 5. Results of daily examination of chickens given Dr. Mayfield Large Roundworm Tablets and untreated infected controls.

Group	Chickens: Band No	Days: Following exposed to ova	Days: Killed	Worms recovered: Number: Flush	Number: Digest	Length: Flush	Length: Digest
I	5370	12	13	1	13	2.5	56.5
	5330	13	14	24	4	82.2	13.5
	5335	14	15	24	3	73.8	9.0
	5332	15	16	14	4	68.6	13.0
	5348	16	17	7	10	11.0	30.0
	5340	17	18	0	0	-	-
	5333	18	19	4	20	16.4	54.8
	5365	19	20	0	0	-	-
	5378	20	21	1	0	1.6	-
	5383	21	22	2	0	15.0	-
Total				77	54	271.1	176.8
Av.				7.7	5.4	3.3	3.3
			Control				
II	5384	12	13	8	3	17.5	7.0
	5339	13	14	8	1	24.0	3.9
	5359	14	15	6	11	26.4	53.0
	5334	15	16	5	13	23.2	13.0
	5353	16	17	11	3	27.0	4.0
	5351	17	18	1	0	4.5	-
	5357	18	19	2	1	8.5	2.5
	5343	19	20	5	2	14.2	7.0
	5347	20	21	0	1	-	5.0
	5358	21	22	0	0	-	-
Total				46	25	145.3	131.0
Av.				4.6	2.5	3.2	5.2

Table 6. Data on the numbers and lengths of worms recovered from flushing 11 days subsequent to exposure of chickens to anthelmintic, as well as the weight gains of treated and control groups of chickens.

Dr. Mayfield Large Roundworm Tablets					Control				
	Chickens		Worms			Chickens		Worms	
Group	Band No.	Wt. gain in gr.	Number	Length mm	Group	Band No	Wt. gain in gr.	Number	Length mm
III	5317	200	20	324.0	IV	5328	202	10	87.0
	5331	224	1	20.0		5336	253	7	18.9
	5338	242	1	10.0		5366	434	6	29.7
	5341	219	0	-		5367	150	3	43.3
	5349	194	9	146.4		5375	338	0	-
	5355	216	2	6.6		5376	242	0	-
	5356	239	5	22.5		5377	273	4	14.8
	5363	195	3	26.5		5379	295	15	217.5
	5369	206	0	-		5382	228	0	-
	5381	269	22	224.9		5386	298	2	21.6
Total		1962	63	780.9			2811	47	432.8
Av.		196.2	6.3	12.3			281.1	4.7	9.2

Experiment 4

The results of Experiment 4, in which Dr. Mayfield Large Roundworm Tablets was the anthelmintic, were noted in Tables 7 and 8.

Lumen larvae from Group I totaled 38 and averaged 3.8 per chick. The lengths totaled 445.4 mm., and the average per worm was 11.7 mm. Tissue phase larvae totaled 8 and averaged.8 in number. The lengths totaled 29.2 mm. and averaged 3.6 mm. per worm.

From Group III, 114 lumen worms were recovered. The average was 11.4 worms per bird. The lengths totaled 1558.6 mm. and each worm averaged 13.6 mm. Tissue phase larvae totaled 44 and averaged 4.4 per bird. The lengths totaled 148.0 mm. and averaged 3.3 mm. per worm.

Group III yielded 22 lumen worms and averaged 2.2 per chick. The total of the lengths was 214.1 mm. and the average was 9.7 mm. per worm. Total and average weight gains of each bird were 1545 and 154.5 gm. respectively.

From Group IV were recovered 83 or an average of 8.3 worms per chick. The total lengths was 969.2 mm., and each worm averaged 11.7 mm. The total weight gain of each chick was 2786 gm. and the average was 2786 gm.

The combined results of Experiments 3 and 4 revealed no significant differences in the average lengths of lumen larvae. There were no consistent trends in average lengths of the tissue phase larvae (Fig. 2). While there was a reverse trend in the

Table 7. Results of daily examination of chickens given Dr. Mayfield's Large Roundworm Tablets and untreated infected controls.

Group	Chickens: Band No	Days: Following exposed to ova	Days: Killed	Worms recovered: Number: Flush	Number: Digest	Length: Flush	Length: Digest
I	5808	12	13	3	0	13.3	-
	5812	13	14	1	0	10.0	-
	5780	14	15	31	0	386.4	-
	5781	15	16	0	0	-	-
	5790	16	17	1	4	16.6	13.2
	5811	17	18	1	2	5.8	8.0
	5791	18	19	0	2	-	8.0
	5793	19	20	0	0	-	-
	5798	20	21	0	0	-	-
	5806	21	22	1	0	13.3	-
Total				38	8	445.4	29.2
Av.				3.8	.8	11.7	3.6
			Control				
II	5818	12	13	4	4	13.2	11.0
	5779	13	14	17	1	54.9	4.0
	5782	14	15	32	10	505.6	35.5
	5796	15	16	2	14	29.1	44.0
	5784	16	17	11	0	124.5	-
	5894	17	18	16	4	292.0	14.5
	5803	18	19	8	2	79.6	7.5
	5792	19	20	6	9	126.6	31.5
	5815	20	21	16	0	316.5	-
	5717	21	22	2	0	16.6	-
Total				114	44	1558.6	148.0
Av.				11.4	4.4	13.6	3.3

Table 8. Data on the numbers and lengths of worms recovered from flushing 11 days subsequent to exposure of chickens to anthelmintic, as well as the weight gains of treated and control groups of chickens.

Dr. Mayfield Large Roundworm Tablets					Control				
	Chickens		Worms			Chickens		Worms	
Group	Band No	Wt. gain in gr.	Number	Length mm	Group	Band No	Wt. gain in gr.	Number	Length mm
III	5785	126	1	25.0	IV	5783	260	7	17.5
	5787	210	0	-		5795	214	4	103.5
	5800	168	1	2.5		5797	264	2	36.6
	5789	168	3	66.6		5801	270	41	205.0
	5788	217	0	-		5805	294	7	200.8
	5799	184	2	20.0		5809	232	1	15.0
	5802	194	0	-		5810	252	4	93.2
	5804	168	1	11.6		5813	218	10	154.8
	5807	98	1	6.6		5814	250	3	88.2
	5706	180	13	81.8		5816	278	4	54.8
Total		1545	22	214.1			2786	83	969.2
Av.		154.5	2.2	9.7			278.6	8.3	11.7

numbers of lumen larvae recovered from the treated versus control groups in these two experiments, the analysis of variance revealed that there were significantly fewer worms in the treated group. There was only a slight difference in the average lengths of larvae recovered from the tissue; however significantly fewer tissue phase larvae were recovered from the treated birds than from the untreated ones.

The relative lengths between the lumen worms recovered from Groups III and IV of Experiment 3 was in reverse to the relative lengths of the lumen worms of the same groups recovered from Experiment 4. However the analysis of the combined results of the two experiments showed that the control group had significantly longer worms, beyond the 1 per cent level. An analysis of the combined lengths of lumen worms of Groups III and IV from Experiments 3 and 4, did not indicate significance.

Experiment 5

In Tables 9 and 10 have been recorded the results of Experiment 5 in which Wormal was the treatment.

Worms recovered from the lumen of the birds of Group I totalled 51 and averaged 5.1. Total of the lengths was 70.5 mm, and the average per worm was 1.7 mm.

From Group II the lumen worms totalled 61 and averaged 6.1 per bird. Total of the lengths was 341.5 mm, and each worm averaged 59.9 mm. Tissue phase larvae totalled 34 and averaged 3.4 worms per chick. Total of the lengths was 108.0 mm, and the

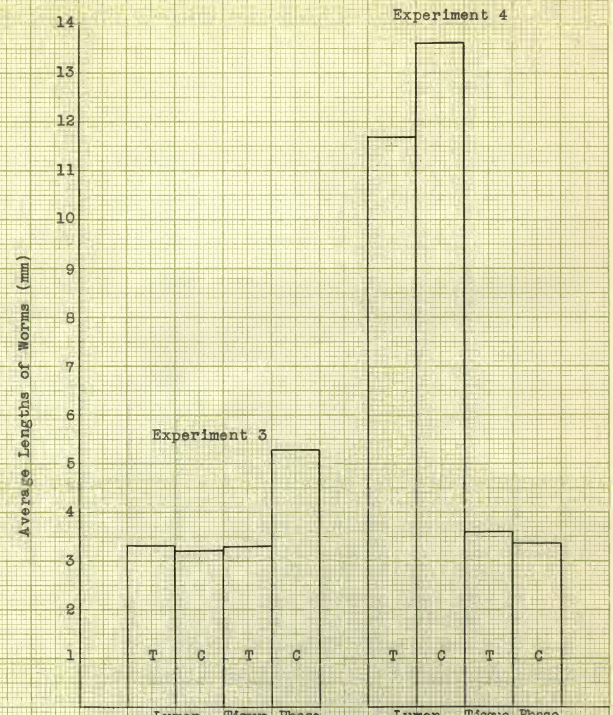

Fig. 3. Comparison of average lengths of worms recovered from chickens treated (T) with Dr. Mayfield's Large Roundworm Tablets and their untreated controls (C).

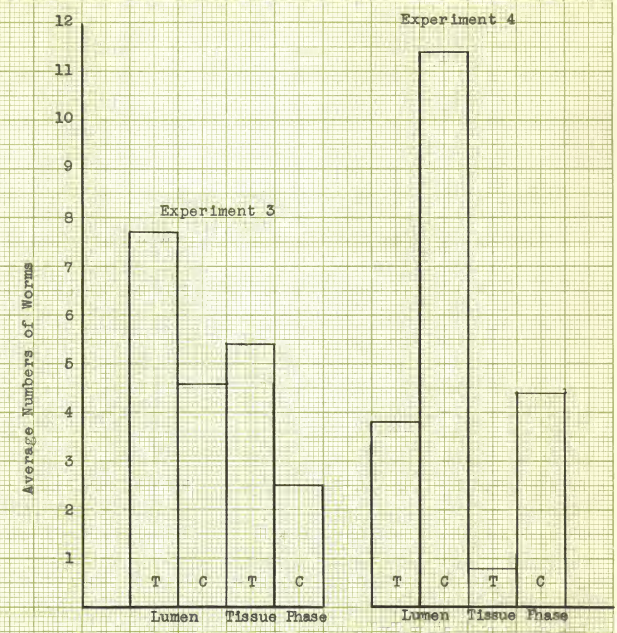

Fig. 4. Comparison of average numbers of worms recovered from chickens treated (T) with Dr. Mayfield's Large Roundworm Tablets and their untreated controls (C).

Table 9. Results of daily examination of chickens given Wormal and untreated infected controls.

Group	Chickens: Band No	Days: Following exposed to ova	Days: Killed	Worms recovered: Number Flush	Number: Digest	Length: Flush	Length: Digest
I	5511	12	13	10	21	50.5	23.0
	5532	13	14	2	9	4.9	9.5
	5521	14	15	12	0	48.0	-
	5540	15	16	16	1	13.0	3.0
	5541	16	17	3	0	12.5	-
	5545	17	18	0	0	-	-
	5527	18	19	2	10	10.0	30.0
	5544	19	20	2	1	12.0	4.5
	5526	20	21	4	0	15.7	-
	5539	21	22	0	0	-	-
Total				51	42	166.6	70.5
Av.				5.1	4.2	3.3	1.76
			Control				
II	5554	12	13	9	1	32.5	3.5
	5548	13	14	13	2	52.8	7.0
	5516	14	15	4	0	19.8	-
	5530	15	16	0	0	-	-
	5522	16	17	4	0	22.3	-
	5533	17	18	8	0	62.3	-
	5551	18	19	10	26	41.5	81.5
	5543	19	20	6	5	40.5	16.0
	5531	20	21	4	0	55.7	-
	5556	21	22	3	0	14.1	-
Total				61	34	341.5	108.0
Av.				6.1	3.4	5.9	3.2

Table 10. Data on the numbers and lengths of worms recovered from flushing 11 days subsequent to exposure of chickens to anthelmintic, as well as the weight gains of treated and control groups of chickens.

Wormal					Control				
Chickens			Worms		Chickens			Worms	
Group	Band No	Wt. gain in gr.	Number	Length mm	Group	Band No	Wt. gain in gr	Number	Length mm
III	5517	206	1	16.50	IV	5520	223	1	35.00
	5518	144	3	42.20		5523	156	3	46.00
	5519	208	3	21.80		5524	300	0	-
	5528	200	4	44.50		5527	200	1	16.00
	5535	214	6	36.80		5529	254	5	46.20
	5549	215	10	173.00		5534	178	0	-
	5537	156	5	63.80		5536	151	6	53.60
	5538	168	1	5.80		5542	112	5	84.00
	5546	188	3	56.60		5547	174	11	103.50
	5553	202	0	-		5552	273	3	36.00
Total		1901	36	467.00			2021	35	421.40
Av.		190.1	3.6	12.9			202.1	3.5	12.04

average was 3.17 mm per worm.

Worms recovered from Group III numbered 36 and averaged 3.6 per bird. Lengths totalled 467.0 mm and each worm averaged 12.9 mm. The total gain in weight of each bird was 1901 gm with an average of 190.1 gm.

From Group IV were recovered 35 worms which averaged 3.5 per chick. The total lengths was 421.4 mm and each worm averaged 12.0 mm. The total weight gain of each chick was 2021 gm and averaged 202.1 gm per bird.

Experiment 6

Tables 11 and 12 are recorded the results of Experiment 6. Wormal was again used as the anthelmintic.

Worms recovered from the lumen of the birds of Group I totalled 52 and averaged 5.2 worms per chick. The lengths totalled 238.3 mm and each worm averaged 4.5 mm. Tissue phase larvae totalled 106 and averaged 10.6 per chick. Lenghts totalled 295.9 mm and the average was 2.9 mm per worm.

From Group II the lumen worms totalled 82 and averaged 8.2 per bird. The lengths totalled 1235.1 mm and each worm averaged 15.0 mm. Tissue phase larvae totalled 69 and averaged 6.9 worms per chick. The total length wes 190.9 mm and the average was 2.7 mm per worm.

Worms recovered from Group III numbered 52 and averaged 5.2 per bird. Lengths totalled 842.7 mm and each worm averaged 16.2 mm. Total gain in weight of each bird was 1981 gm with an aver-

age of 198.1 gm.

From Group IV were recovered 76 worms which averaged 7.6 per chick. The total length was 1241.0 mm and each worm averaged 16.3 mm. The total weight gain of each bird was 2141 gm and the average was 214.1 per bird.

The average length of lumen larvae of Groups I and II showed a consistent difference in both Experiments 5 and 6, (Fig. 3). An analysis of the combined results revealed a difference in the mean lengths which was significant beyond the 1 per cent level. The numbers of lumen larvae of Group II were greater in both experiments than those of Group I, (Fig. 8), and an analysis of the combined results of Experiments 5 and 6 indicated a difference which approached the 5 per cent level of significance.

The lengths and numbers of the tissue phase larvae of Groups I and II did not vary noticeably in both experiments.

Combined results of the lengths of lumen worms of Groups III and IV from Experiments 5 and 6, indicated that the difference between the two groups approach significance at the 5 per cent level; however the difference in the numbers of these worms was not statistically significant, (Fig. 8).

Table 11. Results of daily examination of chickens given Wormal and untreated infected controls.

Group	Chickens: Band No	Days: Following Exposure to ova	Days: Killed	Worms recovered: Number Flush	Number Digest	Lengths: Flush	Lengths: Digest
I	5740	12	13	0	1	-	3.5
	5750	13	14	3	33	16.5	90.2
	5758	14	15	10	26	30.4	73.0
	5751	15	16	11	6	47.9	14.9
	5776	16	17	8	17	34.2	47.7
	5765	17	18	10	8	35.6	22.5
	5753	18	19	1	15	15.0	44.1
	5749	19	20	3	0	38.1	-
	5755	20	21	0	0	-	-
	5760	21	22	6	0	20.6	-
Total				52	106	238.3	295.9
Av.				5.2	10.6	4.5	2.9
			Control				
II	5762	12	13	10	3	31.7	8.0
	5766	13	14	1	23	3.0	62.6
	5746	14	15	5	16	16.0	44.8
	5669	15	16	10	0	86.0	-
	5754	16	17	10	20	51.0	53.5
	5747	17	18	11	1	204.4	3.5
	5761	18	19	21	6	358.4	18.5
	5756	19	20	1	0	10.0	-
	5745	20	21	0	0	-	-
	5742	21	22	13	0	474.6	-
Total				82	69	1235.1	190.9
Av.				8.2	6.9	15.0	2.7

Table 12. Data on the numbers and lengths of worms recovered from flushing 11 days subsequent to exposure to chickens to anthelmintic, as well as the weight gains of treated and control groups of chickens.

Wormal					Control				
Chickens			Worms		Chickens			Worms	
Group	Band No	Wt. gain in gr.	Number	Length mm	Group	Band No	Wt. gain in gr.	Number	Length mm
III	5738	216	0	-	IV	5733	263	2	23.0
	5739	154	0	-		5743	176	0	-
	5741	208	2	16.6		5748	310	8	176.0
	5763	230	4	13.4		5752	200	16	224.0
	5767	224	26	527.3		5757	274	21	386.5
	5768	225	15	218.9		5759	198	12	155.1
	5770	156	1	10.2		5764	151	3	28.0
	5773	168	0	-		5771	112	2	15.5
	5774	198	3	41.8		5775	184	5	118.2
	5777	202	1	14.5		5778	373	7	114.7
Total		1981	52	842.7			2141	76	1241.0
Av.		198.1	5.2	16.2			214.1	7.6	16.3

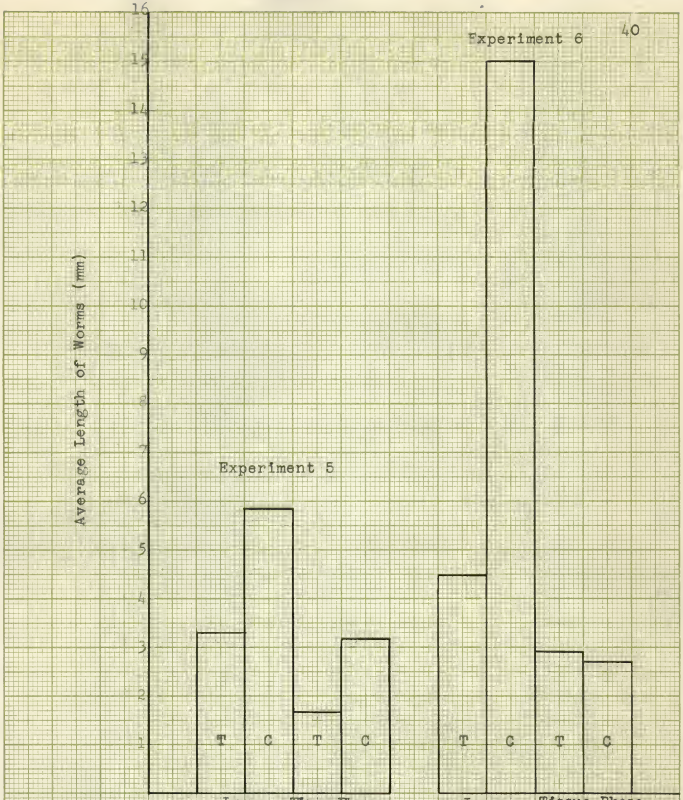

Fig. 5. Comparison of average lengths of worms recovered from chickens treated (T) with Wormal and their untreated controls (C).

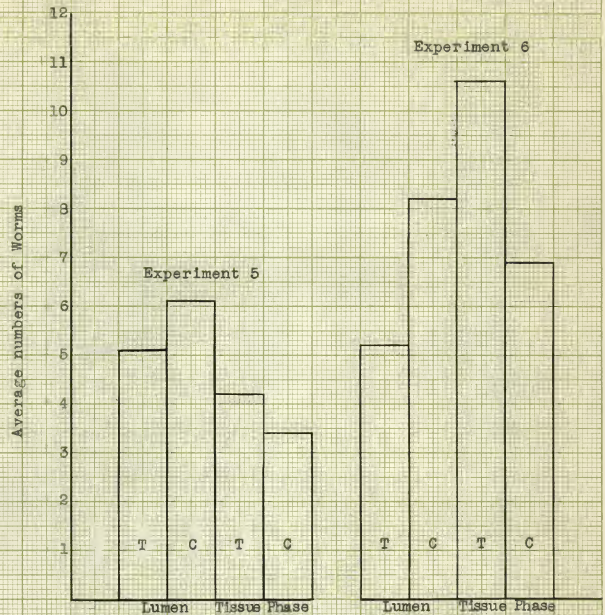

Fig. 6. Comparison of average numbers of worms recovered from chickens treated (T) with Wormal and their untreated controls (C).

Experiment 7

In tables 13 and 14 were recorded the results of experiment 7 when Nisophen was used as treatment. Worms recovered from the lumen of the birds of Group I totalled 34 and averaged 3.4. The total lengths was 243.3 mm with each worm averaging 7.2 mm. The tissue phase larvae totalled 74 and averaged 7.4 per chick. The total lengths was 236.1 mm and the average was 3.2 mm.

From Group II the lumen worms totalled 131 and averaged 13.1 per bird. The total of the lengths was 1133.4 mm and each worm averaged 8.7 mm. The tissue phase larvae totalled 33 and averaged 3.3 worms per chick. The total lengths was 90.2 mm and the average was 2.7 mm per worm.

The worms recovered from Group III numbered 47 and averaged 4.7 per chick. The lengths totalled 683.2 mm and each worm averaged 14.5 mm. The total gain in weight of each bird was 1903 gm with an average of 190.1 gm.

From Group IV were recovered 51 worms which averaged 5.1 per chick. The total lengths was 761.2 mm and each averaged 14.9 mm. The total weight gain of each bird was 1768 gm and averaged 176.8 gm per bird.

Table 13. Results of daily examination of chickens given Nikophen and untreated infected controls.

Group	Chickens: Band No	Days: Following Exposed to ova	Days: Killed	Worms recovered: Number Flush	Number Digest	Length: Flush	Length: Digest
I	6001	12	13	3	9	9.9	23.6
	5973	13	14	4	23	20.0	56.9
	5989	14	15	2	19	16.6	88.5
	5980	15	16	12	4	73.3	9.5
	5987	16	17	0	0	-	-
	5990	17	18	6	5	60.4	15.2
	5978	18	19	2	4	14.9	9.8
	5959	19	20	5	10	48.2	32.6
	5986	20	21	0	0	-	-
	5960	21	22	0	0	-	-
Total				34	74	243.3	236.1
Av.				3.4	7.4	7.2	3.2
			Control				
II	5988	12	13	6	4	14.6	7.9
	5945	13	14	13	2	52.8	6.0
	5963	14	15	9	5	38.7	13.9
	5977	15	16	21	2	151.8	6.0
	5993	16	17	47	0	534.8	-
	5943	17	18	28	5	262.0	15.2
	5958	18	19	3	10	27.6	28.5
	5968	19	20	3	5	39.1	12.7
	5955	20	21	0	0	-	-
	5961	21	22	0	0	-	-
Total				131	33	113.4	90.2
Av.				13.1	3.3	8.7	2.7

Table 14. Data on the numbers and lengths of worms recovered from flushing 11 days subsequent to exposure of chickens to anthelmintic as well as the weight gains of treated and control groups of chickens.

Nikophen					Control				
Chickens			Worms		Chickens			Worms	
Group	Band No	Wt. gain in gr.	Number	Length mm	Group	Band No	Wt. gain in gr.	Number	Length mm
III	5962	206	11	76.0	IV	5950	154	1	21.6
	5981	154	5	59.0		5979	190	0	-
	5982	133	18	337.1		5983	148	11	174.6
	5984	180	0	-		5985	94	13	187.7
	5992	187	8	122.1		5991	231	2	36.6
	5995	251	2	40.8		5996	183	4	30.0
	5997	146	1	16.6		6000	159	7	93.2
	5998	170	1	11.6		6003	198	0	-
	5999	140	0	-		6004	159	0	-
	6002	236	1	20.0		6005	252	13	217.5
Total		1803	47	683.2			1768	51	761.2
Av.		180.3	4.7	14.5			176.8	5.1	14.9

Experiment 8

Results from Experiment 8 in which Nikophen was used as treatment were recorded in tables 15 and 16.

Worms recovered from the lumen of the birds of Group I totalled 74 and averaged 7.4 per bird. The total length was 237.4 mm and the average was 3.2 mm per worm. The tissue phase larvae totalled 18 and averaged 1.8 worms per chick. The total length was 51.8 mm and the average for each worm was 2.9 mm.

From Group II the lumen worms totalled 66 and averaged 6.6 per bird. The total length was 329.0 mm and each worm averaged 5.0 mm. The tissue phase larvae totalled 34 and the average was 3.4 worms per chick. The total length was 92.7 mm and the average was 2.7 mm per worm.

The worms recovered from Group III numbered 66 and averaged 6.6 per bird. The length totalled 1002.4 mm and each worm averaged 15.2 mm. The total gain in weight of each bird was 1612 gm with an average of 161.2 gm.

From Group IV were recovered 46 worms which averaged 4.6 per chick. The total length of each bird was 761.3 mm and each worm averaged 16.6 gm per bird. The total gain in weight for each bird was 1698 gm and the average was 169.8 gm.

An analysis of the difference between the lengths of the lumen larvae of Groups I and II of Experiments 7 and 8 combined, approached significance at the 5 per cent level, (Fig. 4). The average number of these larvae were reversed in the two experiments, but when combined, proved to be nearly significant

Table 15. Results of daily examination of chickens given Nikophen and untreated infected controls.

Group	Chickens: Band No	Days: Following exposed to cys	Days: Killed	Worms recovered: Number Flush	Number Digest	Length Flush	Length Digest
I	5967	12	13	4	0	12.3	-
	6015	13	14	2	0	6.8	-
	6013	14	15	13	6	53.2	19.1
	6006	15	16	13	0	50.0	-
	5972	16	17	8	1	64.7	-
	6010	17	18	2	2	15.7	5.5
	5946	18	19	2	5	14.9	13.5
	5961	19	20	28	4	386.9	10.7
	5956	20	21	2	0	19.8	-
	5976	21	22	0	0	-	-
Total				74	18	237.4	51.8
Av.				7.4	1.8	3.2	2.9
			Control				
II	6061	12	13	8	23	24.8	55.6
	5952	13	14	23	2	80.7	6.5
	5966	14	15	4	0	13.0	-
	6008	15	16	11	0	88.2	-
	5954	16	17	2	0	7.4	-
	5960	17	18	3	4	18.5	13.8
	5947	18	19	11	3	79.8	9.8
	6011	19	20	4	2	16.6	7.0
	6009	20	21	0	0	-	-
	6077	21	22	0	0	-	-
Total				66	34	329.0	92.7
Av.				6.6	3.4	5.0	2.7

Table 16. Data on the numbers and lengths of worms recovered from flushing 11 days subsequent to exposure to chickens to anthelmintic, as well as the weight gains of treated and control groups of chickens.

Nikophen					Control				
Chickens			Worms		Chickens			Worms	
Group	Band No	Wt. gain in gr.	Number	Length mm	Group	Band No	Wt. gain in gr.	Number	Length mm
III	5948	208	1	16.6	IV	5944	176	2	34.9
	5949	134	2	42.6		5951	154	8	196.4
	5953	149	11	195.4		5957	158	8	98.0
	5964	140	3	50.7		5969	154	8	140.3
	5965	94	0	-		5970	158	5	94.8
	5971	242	7	105.2		5975	140	4	39.0
	5974	175	17	223.0		6012	212	0	-
	6017	138	7	74.5		6021	184	0	-
	6020	184	5	52.2		6023	134	5	63.1
	6024	148	13	242.2		6025	228	6	94.8
Total		1612	66	1002.4			1698	46	761.3
Av.		161.2	6.6	15.2			169.8	4.6	16.6

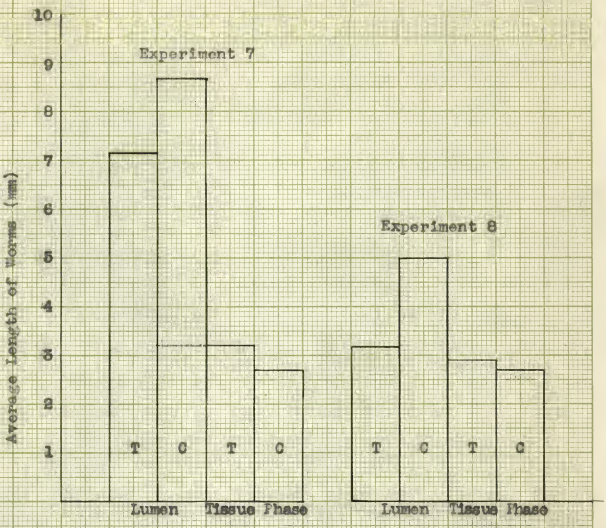

Fig. 7. Comparison of average lengths of worms recovered from chickens treated (T) with Nikophen and their untreated controls (C).

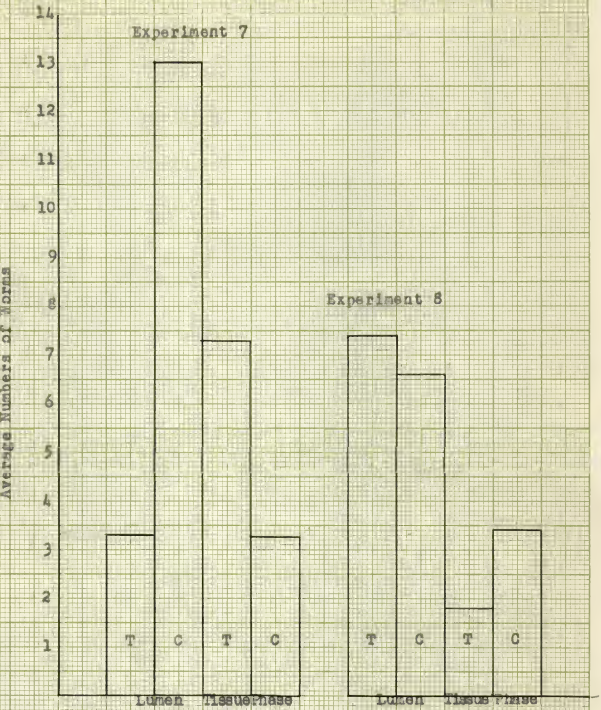

Fig. 8. Comparison of average numbers of worms recovered from chickens treated (T) with Nikophen and their untreated controls (C).

at the 5 per cent level, (Fig. 9).

The average lengths of the tissue phase larvae recovered from these groups, differed slightly, (Fig. 4); and, in spite of a reversal in the results of the numbers of worms of these two groups, when they were combined, the difference approached significance at the 5 per cent level.

The lumen worms of Groups III and IV, when combined from Experiments 7 and 8, did not show statistical significance in differences of lengths and numbers, (Figs. 4, 9).

Experiment 9

In Tables 17 and 18 are recorded the results of Experiment 9, when aureomycin was used as the anthelmintic.

Worms recovered from the lumen of the birds of Group I totalled 24 and averaged 2.4 per chick. The total lengths was 291.8 gm with each worm averaging 12.2 mm. The tissue phase larvae totalled 16 and averaged 1.6 per bird. The total lengths was 47.1 gm and averaged 2.9 mm for each worm.

From Group II the lumen worms totalled 46 and averaged 4.6 per bird. The total lengths was 217.0 mm and each worm averaged 4.7 mm. The tissue phase larvae totalled 13 and averaged 1.3 worm per chick. The total lengths was 36.0 mm and the average for each worm was 2.8 mm.

The worms recovered from Group III numbered 15 and averaged 1.5 per bird. The lengths totalled 362.2 mm and each worm averaged 24.1 mm. The total gain in weight of each bird was 2918 gm

and the average was 291.8 gm.

From Group IV were recovered 35 worms which averaged 3.5 per chick. The total lengths was 300.4 mm and each worm averaged 8.6 mm. The total weight gain for each bird was 2326 gm and averaged 202.1 gm per bird.

Statistical analysis of the difference in length of the lumen larvae of Groups I and II of Experiment 9 indicated a one per cent level, (Fig. 5). The difference in the numbers recovered for these groups was not significant, (Fig. 10); but was greater in the control group. The tissue phase larvae recovered from Groups I and II were almost of similar average lengths, (Fig. 5). The difference in numbers was not significant, (Fig. 10).

The lengths of the worms of Group III were significantly greater beyond the one per cent level than the control group, IV, (Table 18). The numbers did not differ significantly (Table 18).

Table 17. Results of daily examination of chickens given 18 mgm Aureomycin daily and untreated infected controls.

Group	Chickens: Band No	Days: Following Exposed to ova	Days: Killed	Worms recovered: Number: Flush	Number: Digest	Length: Flush	Length: Digest
I	5493	12	13	3	11	41.9	32.2
	5491	13	14	2	0	23.2	-
	5472	14	15	1	4	10.5	12.4
	5505	15	16	0	1	-	2.5
	5511	16	17	1	0	18.8	-
	5485	17	18	0	0	-	-
	5509	18	19	15	0	177.6	-
	5475	19	20	1	0	14.3	-
	5507	20	21	0	0	-	-
	5497	21	22	1	0	12.5	-
Total				24	16	291.8	47.1
Av.				2.4	1.6	12.2	2.9
			Control				
II	5489	12	13	6	2	15.0	5.8
	5490	13	14	6	10	25.4	27.4
	5486	14	15	19	0	85.5	-
	5477	15	16	7	1	28.1	2.8
	5390	16	17	4	0	15.5	-
	5471	17	18	2	0	19.1	-
	5403	18	19	0	0	-	-
	5404	19	20	0	0	-	-
	5483	20	21	1	0	11.8	-
	5513	21	22	1	0	16.6	-
Total				46	13	217.0	36.0
Av.				4.6	1.3	4.7	2.8

Table 18. Data on the numbers and lengths of worms recovered from flushing 11 days subsequent to exposure of chickens to anthelmintic, as well as the weight gains of treated and control groups of chickens.

Aueromycin					Control				
Chickens			Worms		Chickens			Worms	
Group	Band No	Wt. gain in gr.	Number	Length mm	Group	Band No	Wt. gain in gr.	Number	Length mm
III	5389	302	1	25.0	IV	5392	236	9	73.6
	5395	312	2	50.0		5393	323	4	34.4
	5397	281	1	20.0		5400	326	0	-
	5493	316	0	-		5467	301	2	45.0
	5481	313	0	-		5474	195	1	11.8
	5482	209	0	-		5478	253	0	-
	5492	267	5	126.6		5394	140	0	-
	5495	305	0	-		5484	151	0	-
	5498	305	5	134.8		5494	260	2	14.1
	5500	308	1	5.8		5499	241	17	121.5
Total		2918	15	362.2			2326	35	300.4
Av.		291.8	1.5	24.1			232.6	3.5	8.6

Experiment 10

Results of Experiment 10, in which Aureomycin was used as the anthelmintic, have been recorded in Tables 19 and 20.

From Group I, 66 or 6.6 lumen worms per chick were recovered. The measurement totalled 599.2 mm and averaged 11.5 mm per worm. The tissue phase larvae of Group I totalled 13 and averaged 1.3 per bird. The total of the lengths was 40.1 and each worm averaged 3.1.

Group II had a total of 57 lumen worms and averaged 5.7 per bird. The total measurement was 607.3 mm and each worm averaged 10.6 mm. The tissue phase larvae numbered 16 and each bird averaged 1.6. The total lengths was 45.0 mm and each worm averaged 2.8 mm.

Worms recovered from Group III totalled 32 and averaged 3.2 per chick. The total lengths was 499.0 mm and each worm averaged 15.5 mm. The total weight gain of each chick of the groups was 2624 gm and the average was 262.4 gm.

From Group IV, 115 or an average of 11.5 worms per chick were recovered. The lengths totalled 3265.8 mm and averaged 28.3 per worm. Total weight gain of each chick was 2427 gm and the average was 242.7 gm.

The difference in average lengths and numbers of lumen larvae recovered from Groups I and III of Experiment 10 was not significant, but in both cases the treated birds produced more and longer worms. The difference in length of the tissue phase larvae was not marked, (Fig. 10), and while the number difference

Table 19. Results of daily examination of chickens given a single dose of 30 mgm of Aureomycin on the 11th day after exposure to ova and of untreated controls.

Group	Chickens: Band No	Days: Following exposed to ova	Days: Killed	Worms recovered: Number: Flush	Number: Digest	Length: Flush	Length: Digest
I	6593	12	13	9	1	81.0	2.5
	6576	13	14	10	3	49.0	7.1
	6555	14	15	7	0	34.9	-
	6580	15	16	10	0	129.7	-
	6566	16	17	14	0	129.7	-
	6558	17	18	3	2	33.8	6.0
	6564	18	19	0	0	-	-
	6572	19	20	8	3	156.6	10.0
	6578	20	21	3	4	25.8	14.5
	6581	21	22	2	0	31.6	-
Total				66	13	599.2	40.1
Av.				6.6	1.3	11.5	3.1
			Control				
II	6565	12	13	6	4	21.3	9.4
	6551	13	14	9	5	46.5	14.1
	6560	14	15	17	0	188.5	-
	6587	15	16	4	0	49.0	-
	6552	16	17	0	0	-	-
	6559	17	18	4	2	53.8	6.5
	6570	18	19	9	3	132.3	9.5
	6588	19	20	6	2	92.6	5.5
	6589	20	21	0	0	-	-
	6590	21	22	2	0	23.3	-
Total				57	16	607.3	45.0
Av.				5.7	1.6	10.6	2.8

Table 20. Data on the numbers and lengths of worms recovered from flushing 11 days subsequent to exposure of chickens to anthelmintic, as well as the weight gains of treated and control groups of chickens.

Aureomycin					Control				
Chickens			Worms		Chickens			Worms	
Group	Band No	Wt. gain in gr.	Number	Length mm	Group	Band No	Wt. gain in gr.	Number	Length mm
III	6553	264	2	52.4	IV	6557	206	16	426.2
	6561	324	1	11.6		6563	302	1	8.3
	6562	287	0	-		6567	236	5	106.5
	6571	316	2	24.9		6569	216	0	-
	6573	134	8	94.0		6582	283	11	79.8
	6584	120	12	199.6		6583	335	14	239.6
	6591	183	3	56.6		6598	232	8	114.0
	6592	362	0	-		6586	247	50	2165.0
	6595	280	4	59.9		6556	197	0	-
	6598	354	0	-		6597	173	10	126.4
Total		2624	32	499 .0			2427	115	3265.8
Av.		262.4	3.2	15.5			242.7	11.5	28.3

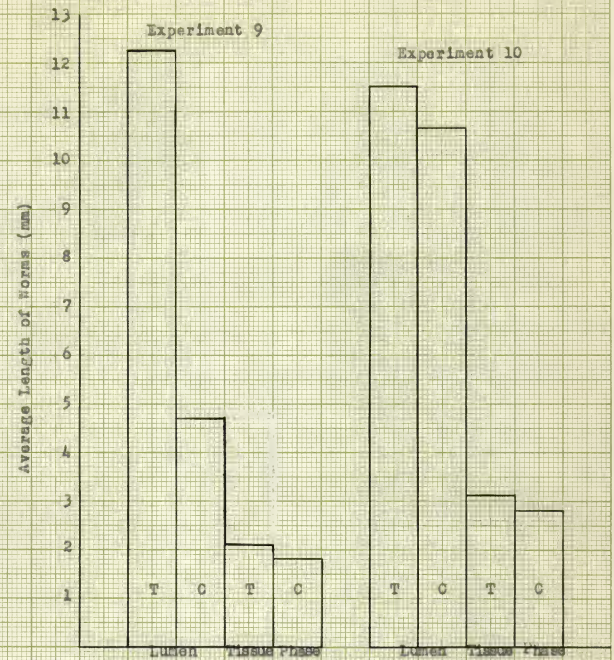

Fig. 9. Comparison of average lengths of worms recovered from chickens treated (T) with Aureomycin and their untreated controls (C). Chickens in Experiment 9 received 18 mgm daily for 10 days and in Experiment 10 only a single dose of 32 mgm was given.

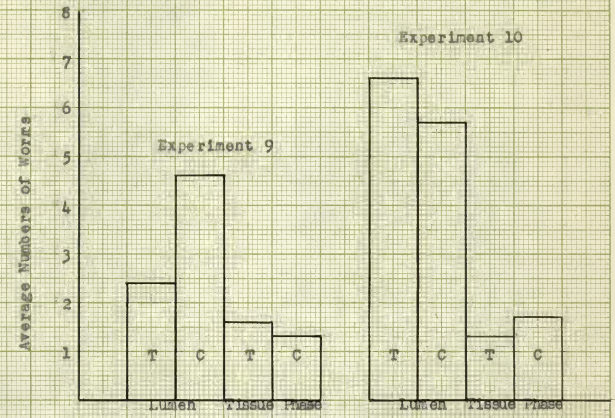

Fig. 10. Comparison of average numbers of worms recovered from chickens treated (T) with Aureomycin and their untreated controls (C). Chickens in Experiment 9 received 18 mgm daily for 10 days and in Experiment 10 only a single dose of 32 mgm was given.

was in favour of the controls, it was not great enough to be significant.

The average length of lumen worms recovered from Groups III and IV differed in that an analysis of variance indicated an approach to the 5 per cent level of significance in favour of the controls, Group IV. The number of lumen worms recovered from Group IV differed significantly and approached the 5 per cent level in the analysis, (Table 20).

The comparison of the growth curves as plotted from the daily average weight gains of the Groups III and IV, of all the experiments has been made in Figs. 11-20.

In both Experiments 1 and 2, Chicken Pharmacy Pill was found to be immediately toxic to the host as was seen in the loss of weight of the treated Groups after the first day of treatment, (Figs. 11, 12). Group III of Experiment I gained 585 gm less than Group IV. When the experiments were terminated the treated groups in both experiments had failed to regain the same rate of growth as the controls.

Visible signs of toxicity, as seen in the loss of weight, due to Dr. Mayfield Large Roundworm Tablets, was observed 2 to 3 days after treatment, (Figs. 13, 14). Group III of Experiment 3 gained 715 gm less than Group IV and in Experiment 4, Group IV was 1012 gm more in weight.

Toxicity of Wormal was apparently greater in Experiment 6 than it was in Experiment 5 as was seen by the weight differences of the treated and control groups, (Figs. 15, 16); but the final differences in weights between Groups III and IV of Experiment 5

was 72 gm and of Experiment 6 was 86 gm.

The initial drop in weight of both groups of chickens in Experiments 7 and 8 was due to the fasting of the chickens before treatment. Both treated groups showed a decline in weight between the 1st and 3rd day after treatment. The final differences of weight gained of Groups III and IV of Experiment 7 was 172 gm, and of the same groups of Experiment 8, was 86 gm.

Average weight gains of chickens of Groups III and IV of Experiment 9 showed that 18 mgm doses daily of aureomycin had a positive effect on the experimental animals. Final differences in weight gained of the two groups of Experiment 9 was 147 gm in favour of the treated group, (Fig. 19).

A dose of 32 mgm of aureomycin did not show any appreciable difference between the treated and untreated groups. However, the final weight gain of Group III was 143 gm more than Group IV.

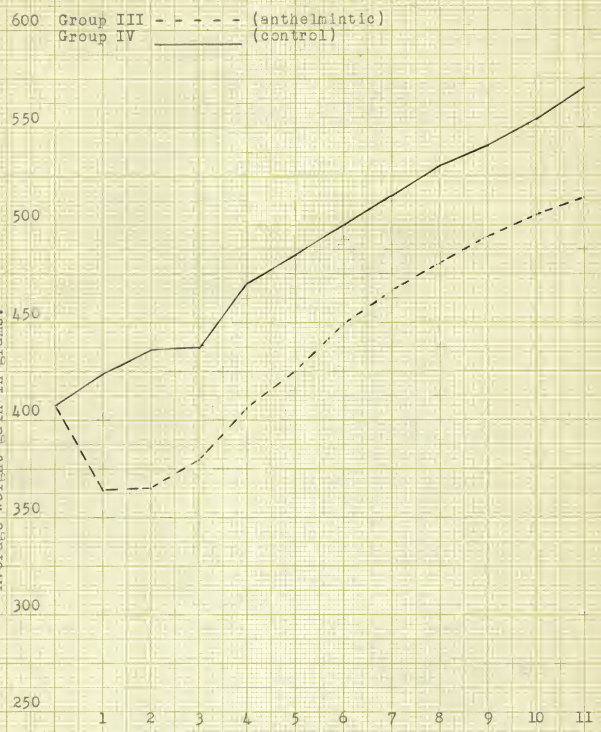

Fig. 11. Combined growth curves of Groups III and IV of Experiment 1.

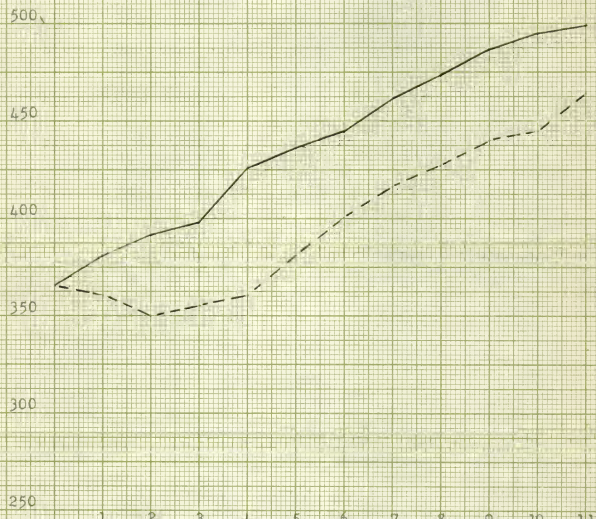

Fig. 12. Combined growth curves of Groups III and IV of Experiment 2.

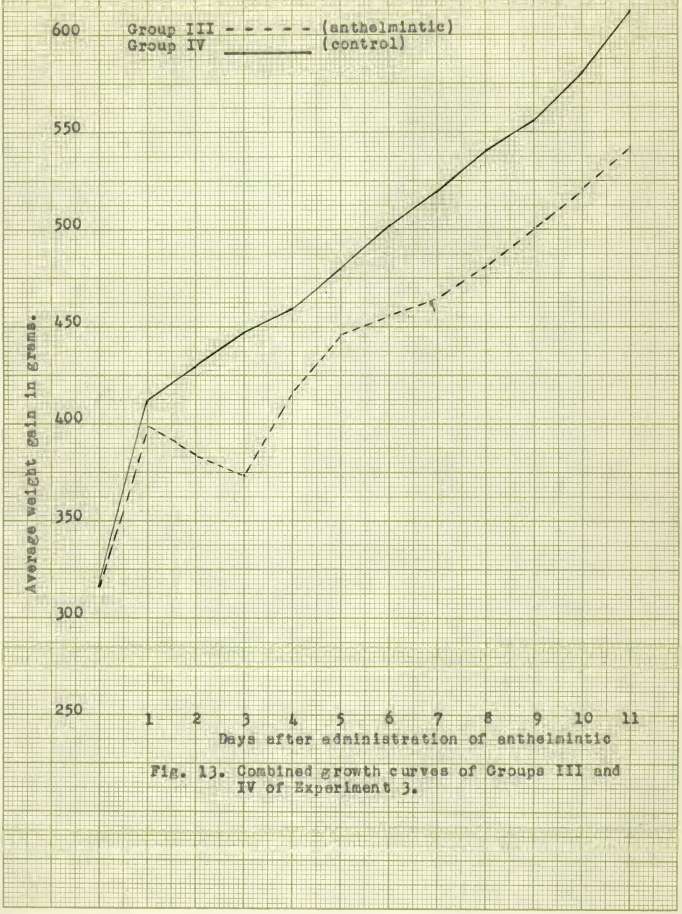

Fig. 13. Combined growth curves of Groups III and IV of Experiment 3.

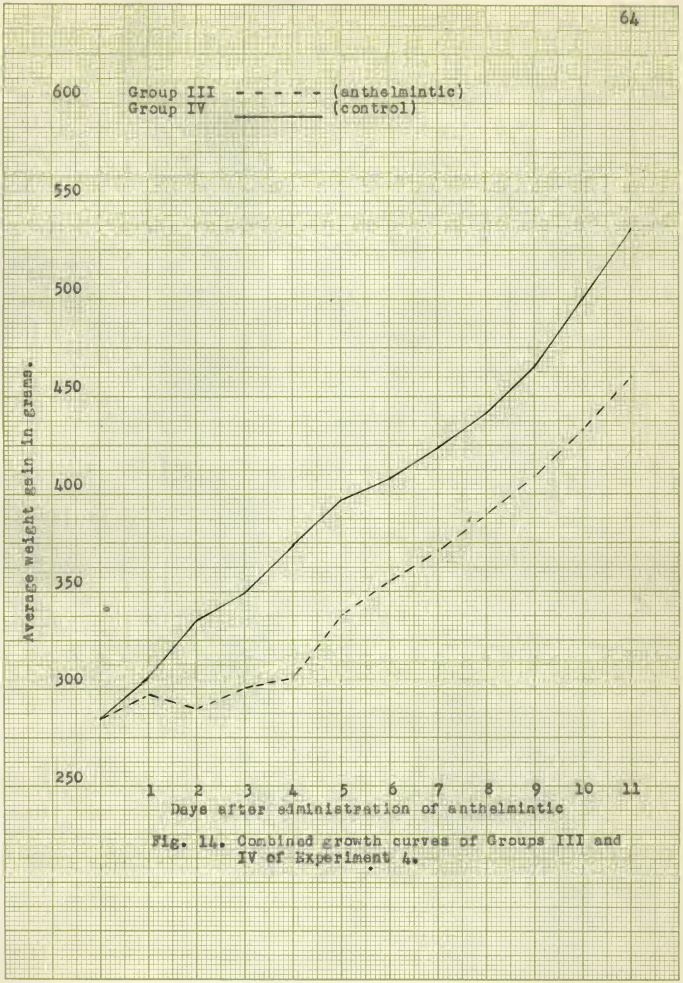

Fig. 14. Combined growth curves of Groups III and IV of Experiment 4.

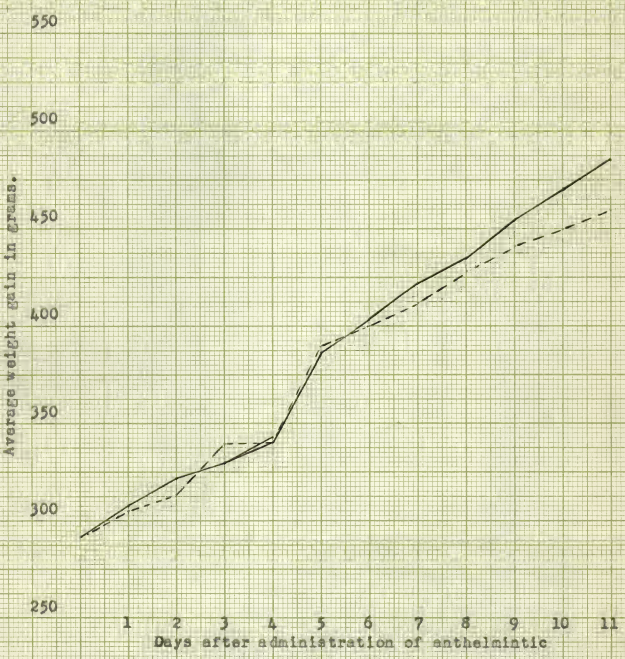

Fig. 15. Combined growth curves of Groups III and IV of Experiment 5.

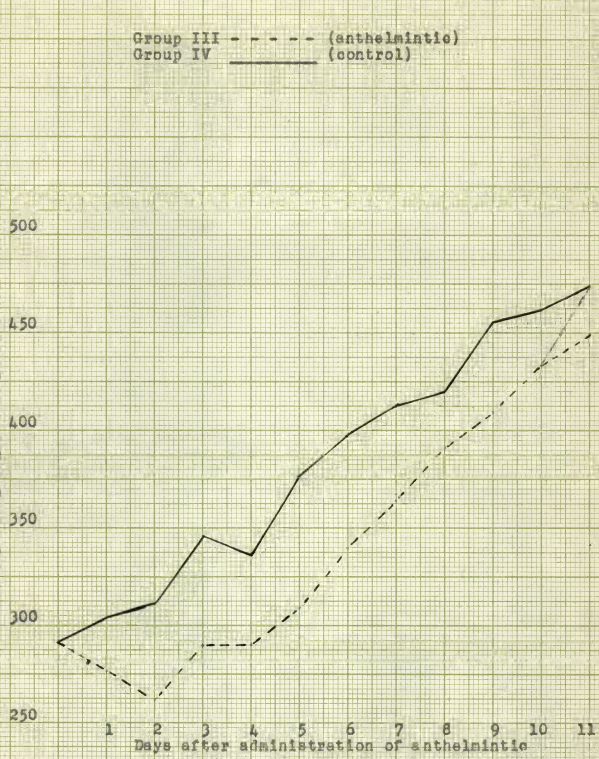

Fig. 15. Combined growth curves of Groups III and IV of Experiment 6.

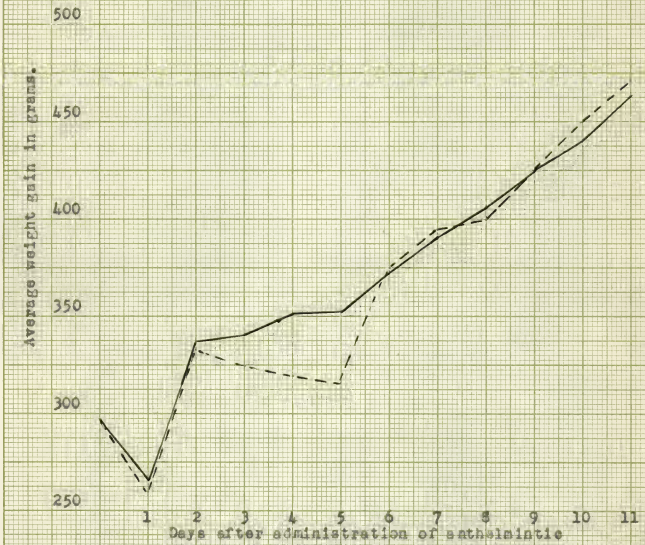

Fig. 17. Combined growth curves of Groups III and IV of Experiment 7.

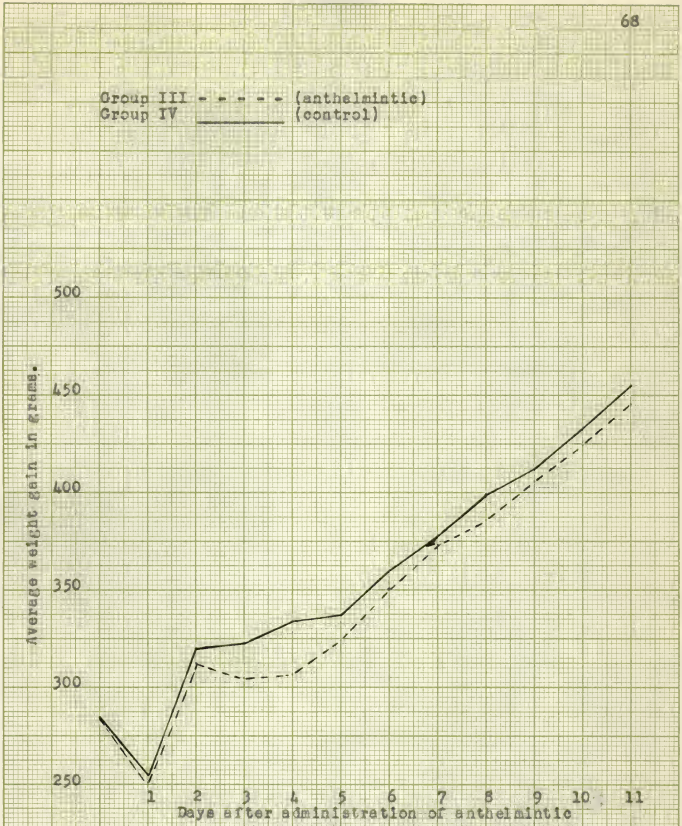

Fig. 18. Combined growth curves of Groups III and IV of Experiment 6.

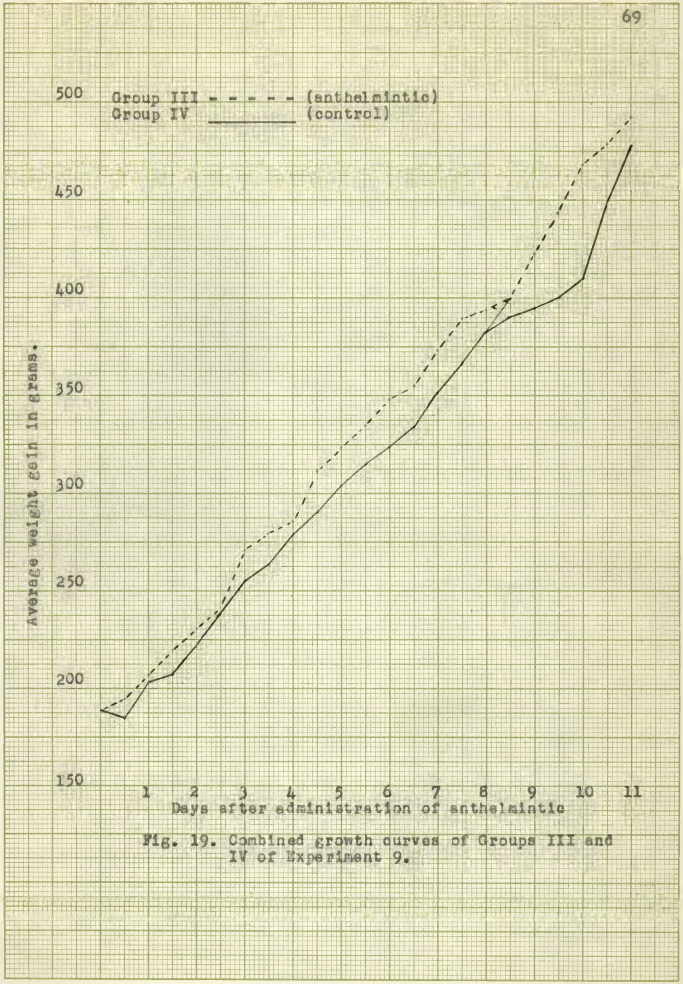

Fig. 19. Combined growth curves of Groups III and IV of Experiment 9.

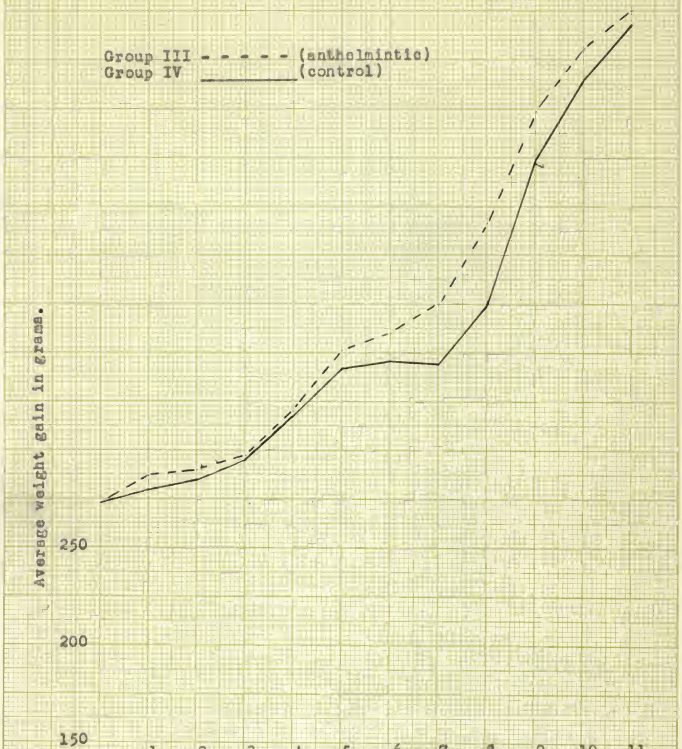

Fig. 20. Combined growth curves of Groups III and IV of Experiment 10.

DISCUSSION

The relative effectiveness of certain commercial anthelmintics has been demonstrated in terms of their ability to reduce the numbers of tissue phase and lumen larvae of A. galli, as well as their effects on the growth rate of the experimental chickens.

The amount of nicotine used in Chicken Pharmacy Pills was found to be effective in the removal of mature ascarids (Freeborn, 1932; Levine, 1936; and Davis, 1940). However these workers did not study the effects of nicotine on immature larvae nor on their growth rate. The results of the present study showed significance in the effectiveness of Chicken Pharmacy Pills in removing the lumen larvae of Group I. The drug did not appreciable affect the growth rate of numbers of the tissue phase larvae.

When the average daily weight gains of Groups III and IV - not to be confused with the total weight gain of each chicken for the entire period of weight observation, and which appeared in the Tables - when Experiments 1 and 2 were compared, - chickens of Group III showed a sharp decline in weight after the first day of treatment, (Figs. 11, 12). Levine (1936), found that 65 to 80 mgm, the amount present in Chicken Pharmacy Pills, produced mortalities among chickens. However, it was later demonstrated that the type of carrier used in Chicken Pharmacy Pills released the nicotine slowly enough in the alkaline small intestine so as to produce no fatal toxicity (Davis, 1940). This study indicated that the toxicity expressed itself in weight

loss of the chickens. Up to the termination of the experiment, the treated group did not attain the weight of the untreated infected controls (Figs. 11, 12).

Dr. Mayfield Large Roundworm Tablets did not appreciably affect the growth rate of the lumen larvae, (Fig. 2, Tables 5,7), but did reduce the numbers of lumen larvae in the treated birds. However it did affect the growth of the more adult forms as found in chickens of Group III, (Tables 6, 8). By significantly reducing the number of tissue phase larvae, this drug was the only one to affect the larval forms, however it did not affect the growth rates of the larvae, (Figs. 2, 7, Tables 5, 7).

Results of this experiment indicated the need of continued research with this drug. Daily weight gains of Groups III and IV indicated toxicity of the drug in the loss of weight of the treated group, which was sustained two days after treatment, (Figs. 13, 14). Recovery by the treated birds again proved slow. The intensity of toxicity of the anthelmintic on the host seemed to be proportional to its efficacy in removal of the parasites.

Butynorate has been used as an anthelmintic against cestodes and its compatibility with nicotine and phenothiazine indicated one compound which would remove tapeworms as well as intestinal and cecal roundworms. The literature cited did not indicate any study of the compound on A. galli.

The significant effectiveness in retarding the growth of the lumen larvae, (Fig. 3), indicated it had a similar action as that of nicotine (Fig. 1), but its efficacy in removing the worms was more intense.

Weight gains of Groups III and IV showed promise of being consistent for both treated and control groups, (Figs. 15, 16). Since the quantities of phenothiazine and nicotine were below the toxic levels as found by Freeborn (1936), and McCulloch and Nicholson (1940), it was assumed that butynorate was not toxic in its relative quantity - 7 per cent - in Wormal. If toxicity were to be expressed in the loss of weight, then Wormal was one of the lesser toxic commercial anthelmintics. Again the treated groups showed a tendancy to recover the loss of weight.

While Nikophen was approaching significance in its ability to reduce the length of the lumen larvae, it created reverses in the results of its effects on the number. Like all the preceding anthelmintics, it created an environment adverse enough to suppress normal growth but not enough to make it uninhabitable for the larvae.

The toxicity as measured by weight loss of the treated groups was not appreciable when compared with the controls, (Figs. 17, 18). Also it indicated that 630 mgm of nicotine when combined with diphentane-70 and phenothiazine failed to produce toxicity on the host.

A daily dose of 18 mgm of Aureomycin created what seemed to be a congenial environment which promoted the growth in length of the lumen larvae, (Fig. 5). A single dose of 32 mgm, Experiment 10, was not a growth promoting factor for the worms.

Daily weight gains indicated that tough 18 mgm of aureomycin was expected to be detrimental to the host, it was actually growth stimulating.

SUMMARY

Experiments involving 400 chickens and four commercially obtained anthelmintics and one antibiotic, have been carried out. Each experiment involved 40 birds which were divided into 4 groups, namely: I, II, III and IV. All 40 chickens received 100 10 embryonated ova of A. galli at 21 days of age. Eleven days after, to the chickens of Groups I and III, were administered the commercially directed dose of the anthelmintic used in the experiment. Groups II and IV were untreated but infected controls.

1. The combined results of Experiments 1 and 2 which utilized Chicken Pharmacy Pills as the anthelmintic, revealed that this anthelmintic did not remove significantly greater numbers of lumen or tissue phase larvae from the treated birds than from the control birds.

2. Chicken Pharmacy Pills were effective in retarding the growth of lumen larvae of the birds in Groups I and III.

3. The treated birds of Group III showed signs of toxicity produced by Chicken Pharmacy Pills one day after receiving treatment. This toxicity was expressed in a weight loss of 431 gm among the chickens of Group III when compared with no weight loss in Group IV. Recovery to the level of the growth rate of Group IV was never made.

4. Combined results of Experiments 3 and 4 in which the anthelmintic was Dr. Mayfield Large Roundworm Tablets, showed that while the anthelmintic did not significantly affect the

length of the lumen and tissue phase larvae of Group I as compared to Group II, it did reduce the number of worms to a degree approaching the 5 per cnet level in the former, and to the 5 per cent level of significance in the latter.

5. The anthelmintic retarded the length but not the number of lumen worms of Group III.

6. Treated birds of Group III in their loss of weight, showed signs of toxicity produced by Dr. Mayfield Large Roundworm Tablets on the 2nd day after treatment. They failed to regain the level of growth rate of the controls, Group IV.

7. Combined results of Experiments 5 and 6 in which Wormal was used as the anthelmintic, showed that while this anthelmintic significantly reduced the length of the lumen larvae of Group I, its affect on the length of the tissue phase larvae, and on the lumen worms of Group III was not significant.

8. Wormal was effective in reducing the number of lumen and tissue phase larvae of Group I and was uneffective against the lumen worms of Group III.

9. Wormal was not as toxic to chickens of Group III in Experiment 5 as it was to the chicks of Group III in Experiment 6. In the latter experiment the treated group lost 159 gm after the 1st day of treatment and in both experiments did not regain the growth rate of the controls.

10. Nikophen, the anthelmintic used in Experiments 7 and 8, was effective against the length of the lumen larvae of Group I and Group III; but not so against the tissue phase larvae of Group I.

11. This anthelmintic reduced the members of lumen larvae and the tissue phase larvae of Group I but did not affect the numbers of the lumen larvae of Group III.

12. The toxicity of Nikophen was noticed in the loss of weight of the chickens of Group III 2 to 4 days following treatment. In Experiment 7 the treated birds regained the growth rate of the controls; but in Experiment 8 they did not.

13. Aureomycin which was used in Experiment 9, significantly increased the length of the lumen larvae of the treated groups, I and III. It did not affect the length of the tissue phase larvae.

14. This anthelmintic did not significantly reduce the number of larvae of any group.

15. The affect of this anthelmintic which was administered at the rate of 8 mgm daily, was beneficial to the growth rate of the treated chickens.

16. When 32 mgm of aureomycin were administered in one single dose, it did not affect the length or number of larvae from the lumen or tissue phase of the groups.

17. While it did significantly reduce the number of lumen worms recovered from Group III, it did not affect the length.

18. Aureomycin was beneficial in increasing the growth rate of the treated birds.

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THE EFFECTS OF CERTAIN ANTHELMINTICS ON THE TISSUE PHASE LARVAE OF ASCARIDIA GALLI (SCHRANK, 1788)

by

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A review of the literature pertinent to the effects which resulted from the penetrating habit of certain helminth larvae suggested this investigation which concerned itself with the effects of certain currently available commercial anthelmintics and aureomycin, a potential anthelmintic, on adults and tissue phase larvae of Ascaridia galli (syn. A. perspicillum and A. lineata) as well as the effects of these anthelmintics on the host Gallus domesticus.

The experimental animals with the exception of those in Experiment I, which utilized White Leghorns, were all White Rock Chickens purchased as day-old chicks from a commercial hatchery. They were raised under laboratory conditions and were fed a standard commercial ration free of low level aureomycin.

Ten experiments involving 400 chickens and 4 commercially available anthelmintics and one antibiotic, have been performed. Each experiment involved 40 chickens which were divided into 4 groups, namely: I, II, III, and IV. At three weeks of age all 40 chickens received 100+ 10 embryonated ova of A. galli. Eleven days after, to the chickens of Groups I and III were administered the commercially directed dose of the anthelmintic used in the experiment. Groups II and IV were untreated but infected controls. The dosage of aureomycin was decided upon by the writer.

Twenty-four hours after the administration of the anthelmintic and continuing at 24 hour intervals for 10 days, one member of Group I (anthelmintic) and one member of Group II (control) were killed. On the 11th day all the birds of Group III (anthelmintic) and Group IV (control were killed.

From Groups I and II the lumen worms were collected by flushing and the tissue phase larvae were recovered after digestion of the intestines of each chicken. From Groups III and IV the worms were recovered by flushing the intestines. All worms were counted and measured.

Daily weight records were kept for Groups III and IV beginning on one day prior to administration of the anthelmintic and continuing until the chickens were killed 11 days later. The results of the experiments are as follows:

1. The combined results of Experiments 1 and 2 which utilized Chicken Pharmacy Pills as the anthelmintic, revealed that this anthelmintic did not remove significantly greater numbers of lumen or tissue phase larvae from the treated birds than from the control birds.

2. Chicken Pharmacy Pills were effective in retarding the growth of lumen larvae of the birds in Groups I and III.

3. The treated birds of Group III showed signs of toxicity produced by Chicken Pharmacy Pills one day after receiving treatment. This toxicity was expressed a weight loss of 431 gm among the chickens of Group III when compared with no weight loss in Group IV. Recovery to the level of the growth rate of Group IV was never made.

4. Combined results of Experiments 3 and 4 in which the anthelmintic was Dr. Mayfield Large Roundworm Tablets, showed that while the anthelmintic did not significantly affect the length of the lumen and tissue phase larvae of Group I as compared to Group II, it did reduce the number of worms to a degree

approaching the 5 per cent level in the former, and to the 5 per cent level of significance in the latter.

5. Anthelmintic retarded the length but not the number of lumen worms of Group III.

6. Treated birds of Group III in their loss of weight, showed signs of toxicity produced by Dr. Mayfield Large Roundworm Tablets on the 2nd day after treatment. They failed to regain the level of growth rate of the controls, Group IV.

7. Combined results of Experiments 5 and 6 in which Wormal was used as the anthelmintic, showed that while this anthelmintic significantly reduced the length of the tissue phase larvae, and on the lumen worms of Group III was not significant.

8. Wormal was effective in reducing the number of lumen and tissue phase larvae of Group I and was uneffective against the lumen worms of Group III.

9. Wormal was not as toxic to chickens of Group III in Experiment 5 as it was to the chicks of Group III in Experiment 6. In the latter experiment the treated group lost 159 gm after the 1st day of treatment and in both experiments did not regain the growth rate of the controls.

10. Nikophen, the anthelmintic used in Experiments 7 and 8, was effective against the length of the lumen larvae of Group I and Group III; but not so against the tissue phase larvae of Group I.

11. This anthelmintic reduced the members of lumen larvae and the tissue phase larvae of Group I but did not affect the members of the lumen larvae of Group III.

12. The toxicity of Nikophen was noticed in the loss of weight of the chickens of Group III 2 to 4 days following treatment. In Experiment 7 the treated birds regained the growth rate of the controls; but in Experiment 8 they did not.

13. Aureomycin which was used in Experiment 9, significantly increased the length of the lumen larvae of the treated groups, I and III. It did not affect the length of the tissue phase larvae.

14. This anthelmintic did not significantly reduce the number of larvae of any group.

15. The affect of this anthelmintic which was administered at the rate of 8 mgm daily, was beneficial to the growth rate of the treated chickens.

16. When 32 mgm of aureomycin were administered in one single dose, it did not affect the length or number of larvae from the lumen or tissue phase of the groups.

17. While it did significantly reduce the number of lumen worms recovered from Group III, it did not affect the length.

18. Aureomycin was beneficial in increasing the growth rate of the treated birds.