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PROCEEDINGS OF THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON

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A redescription of *Trichomonas gallinarum* Martin and Robertson, 1911, from the chicken and turkey. ENA A. ALLEN.

INTRODUCTION

A trichomonad associated with certain cases of enterohepatitis or "blackhead" in turkeys, chickens and guinea fowls was tentatively placed by the writer in 1936 in the genus *Pentatrichomonas*, pending further studies on its identity. Since then, evidence has been accumulated which indicates that this flagellate is identical with *Trichomonas gallinarum*, described by Martin and Robertson (1911) from the chicken and with *T. pullorum* Weinzirl (1917), also from the chicken. The fifth anterior flagellum and the characteristic movements of this trichomonad were not noted by Martin and Robertson, whose description of this organism was rather inadequate. The present writer now believes, as does Wenyon (1926), that flagellates of the genus *Trichomonas* may have from "three to five anterior flagella," and that differences within these limits in the number of free anterior flagella do not justify the erection of distinct genera. Under this definition, the flagellate in question which was previously described as *Pentatrichomonas* is included in the genus *Trichomonas*.

MATERIAL AND METHODS

The specimens of *Trichomonas gallinarum* described in this paper were obtained from cecal contents and liver lesions of chickens and turkeys from widely separated poultry farms. Most of this material was obtained in the vicinity of Beltsville, Maryland, with some additional material from the District of Columbia, Virginia, Tennessee, Ohio, Colorado, and Pennsylvania. Living trichomonads from these sources and from cultures prepared from cecal contents and liver lesions were used in ascertaining the number of flagella. In order to retard motion and to make the flagella more easily seen the Kofoid, Kornhauser, and Swezy (1919) modification of Donaldson's iodine-eosin stain, with further modifications by the author, was used as follows: Two parts of a saturated solution of eosin in physiological saline and 1 part of a 5 per cent solution of potassium iodide in physiological saline saturated with iodine, were mixed just before using. Small amounts of cecal material or culture fluid containing living trichomonads were mixed with 1 drop of the stain and to this mixture was added 1 drop of a saturated solution of thymol in distilled water. This treatment extended and emphasized the flagella. For the study of other morphological characteristics, permanent slides made from cultures and cecal material from chickens and turkeys were fixed in Schaudinn's fluid and stained with sun ripened haematoxylin. Material from numerous cases of fowl trichomoniasis was collected and studied from time to time over a period of 10 years. Measurements of the long axis of the body did not include the axostyle.

OBSERVATIONS

The five-flagellate trichomonads prevalent in the ceca of chickens and turkeys were morphologically similar to those described as *T. gallinarum*, except for the number of anterior free flagella and slight differences in size. Martin and Robertson described only four anterior flagella. Evidently these authors failed to see

the fifth anterior flagellum because this structure is usually shorter than the others and often adheres closely to one of them when the flagella are at rest. The dimensions of *T. gallinarum* given by Martin and Robertson were 5.4 to 7 μ long by 5 to 6 μ wide, and agreed closely to the average (6.6 μ long by 5 μ wide) for the five-flagellate form seen in the present study. Shape, internal structures, and localization in the host were identical.

Trichomonas gallinarum Martin and Robertson, 1911

Synonyms.—Pentatrichomonas sp. Allen, 1936; *Trichomonas pullorum* Weinzirl, 1917.

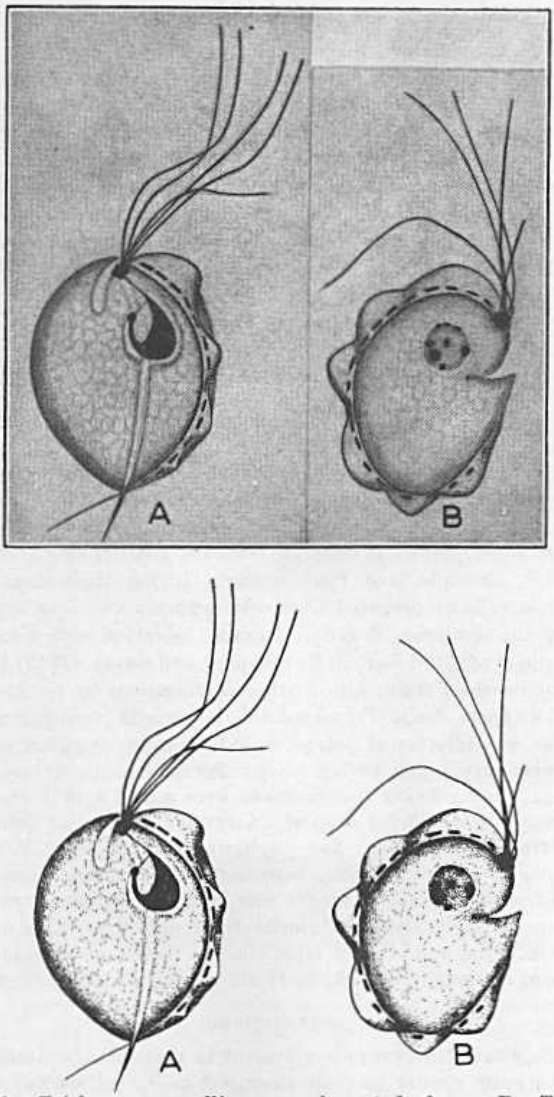

FIG. 1. A—*Trichomonas gallinarum*, elongated form. B—*T. gallinarum*, rounded form; in such specimens the posterior end is pointed forward, forming with the anterior end an open groove which somewhat resembles a cytostome.

Morphology of stained specimens (*Fig. 1*).—One hundred fixed and stained trichomonads from cecal smears of chickens and turkeys measured 3.3 to 6.6 μ (average 5 μ) wide by 5 to 8.3 μ (average 6.6 μ) long; only 2 individuals had a width of 3.3 μ and few had a length of 8.3 μ. The organisms are usually almost spherical, but elongated specimens are more or less pear-shaped. There are 5 anterior free flagella and 1 that borders the margin of the undulating membrane, ending posteriorly as a free flagellum. The undulating membrane is attached along one side of the body and exhibits a flowing, wave-like motion due to its marginal flagellum. At the base of the undulating membrane, and parallel to it, is the parabasal body, which has the appearance of a heavy dark line in stained specimens. A row of rectangular bodies, which also stain like chromatin, extend the full length of the parabasal body and are parallel to it. The slender, rod-like axostyle extends from the blepharoplast posteriorly through the center of the body to the exterior, becoming a short projection of variable length at the posterior end, being relatively long in extended individuals and not discernible in rounded-up specimens. The cytostome is a small, curved groove at the anterior end of the body on the side opposite the undulating membrane. At the anterior end, near the inner edge of the cytostome and above the nucleus, is a group of small granules which form the blepharoplast. To this structure are attached the anterior flagella, the marginal flagellum of the undulating membrane, the parabasal body, the axostyle and the fine fiber or rhizoplast which connects it with the nucleus. The nucleus lies in the anterior end of the body; it varies in shape from oval to spherical, and shows considerable variation in the distribution of chromatin.

Behavior of living specimens.—*T. gallinarum* has characteristic movements which readily distinguish it from other trichomonads. The organisms show rapid, jerky, whip-like movements of the flagella and continuous movements of the undulating membrane, turning a little to the left or right and often completely around, but with little or no progress forward. This behavior is quite distinct from the quick darting movements of *T. columbae* which progresses forward so rapidly that an individual organism soon passes from the field of vision. *T. gallinarum* ingests solid objects, including bacteria, starch, blood cells and other small cells or granules.

Localization and pathogenicity.—This flagellate is usually found in the ceca of certain fowls, but in chronic cases of long duration it may also enter the liver. *T. gallinarum* was found in one flock of guinea fowls (Allen, 1936), but it is not known to be pathogenic for these birds. Chickens usually carry this organism, but in this host, it is rarely pathogenic. Occasionally very young chickens have an acute phase of the infection in which there is a cecal diarrhea sometimes followed by death. In rare cases, adult chickens, having a chronic infection, develop a type of enterohepatitis which is usually fatal. Turkeys are more susceptible to infections of *T. gallinarum* than chickens. Young turkeys, not well feathered, also may have the acute phase of the infection, but with a higher mortality rate than has been found to be the case with young chickens. Adult turkeys with chronic infections of *T. gallinarum* often develop a severe enterohepatitis with cecal and liver lesions, usually causing death.

SUMMARY AND CONCLUSION

The five-flagellate trichomonad parasitic in the ceca of chickens and turkeys has been described and is considered to be identical with *Trichomonas gallinarum* Martin and Robertson, 1911. Since the name *Trichomonas gallinarum* is well established and since it is believed that the genus *Trichomonas* should include all trichomonad flagellates which have from 3 to 5 anterior flagella, the name *Trichomonas gallinarum* should be retained for this poultry flagellate. This parasite is often

associated with cecal diarrhea in young turkeys and enterohepatitis, involving liver and cecal lesions in older turkeys.

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Investigations on possible intermediate hosts, other than oribatid mites, for *Moniezia expansa*.

WENDELL H. KRULL, U. S. Bureau of Animal Industry.

INTRODUCTION

Beetle mites have been shown by Stunkard (1937), Stoll (1938), Krull (1939a), and Shorb (1939) to harbor cysticercoids of the common sheep tapeworm, *Moniezia expansa,* and so far as is known, these mites are the only organisms that have been incriminated as intermediate hosts of this parasite. Stunkard (1938a) has also reported that oribatid mites serve as intermediate hosts for *Cittotaenia ctenoides* of the rabbit. The reports mentioned above suggest that oribatid mites are the only intermediate hosts for anoplocephaline tapeworms and the almost cosmopolitan distribution of these mites makes this assumption theoretically possible. The definite determination of the limitation of intermediate hosts is a point requiring solution before control measures for those tapeworms, which are of economic importance, can be adequately and successfully promulgated.

Available evidence so far obtained indicates that pasture organisms other than beetle mites probably do not harbor the cysticercoids of *Moniezia expansa.* Facts which support this belief consist of reports of invertebrates of various kinds having been fed to susceptible definitive hosts or examined for cysticercoids with negative results. Mönnig (1929) attempted to infect an unusually large number and variety of organisms by feeding to them eggs of *M. expansa;* Stunkard (1938b) reported failure to infect ants and tyroglyphid mites; Lebour (1915) and Joyeux (1920) also failed to infect various invertebrates; and Flattely (1922) examined organisms from contaminated pastures and fed beetles to experimental animals with negative results.

WRITER'S OBSERVATIONS

During the summer of 1937, while working on the Moniezia life history problem at Beltsville, Maryland, organisms of various kinds were collected from a contaminated sheep pasture and fed to lambs which had been kept under conditions that preclude extraneous infections with helminths. The extent to which the pasture, from which the organisms were collected, was contaminated is shown by the following experiment: An area 120 feet by 30 feet was fenced and a 4-months-old tapeworm-free lamb was transferred to this pen on June 17. This lamb became accustomed to the pen and began to graze on June 19; it was removed from this lot a month later. A week following its removal from the lot, this animal was killed and 39 immature specimens of *M. expansa* were recovered.

The following invertebrate organisms were collected from this pasture and fed to tapeworm-free lambs: Ants, 2707; beetles, 362; centipedes and millipedes,

57; crickets and grasshoppers, 107; cockroaches, 7; earthworms, 42; lepidopterous larvae, 31; mites, 4; pillbugs, 57; slugs, 3; springtails, 44; and spiders, 36. Furthermore, one lamb was given 906 oribatid mites representing species other than *Galumna emarginata*. All lambs were free from tapeworms on post-mortem examination.

The reactions to the presence of tapeworm eggs of several invertebrates which failed to serve as intermediate hosts for anoplocephaline tapeworms were observed. *Cyclops* spp. were usually attracted to the eggs, but the reactions of these copepods varied somewhat. Small *Cyclops* were noted to pick up eggs and manipulate them for a while without being able to ingest them, while large specimens were able to open the eggs and ingest the pyriforms, discarding the surrounding membranes. The large *Cyclops* usually gorged themselves with pyriforms, and occasionally ate the entire egg. *Cyclops* usually were not attracted to eggs containing dead larvae. Some of the *Cyclops*, observed to ingest larvae, were kept under observation under a compound microscope for periods as long as 3½ hours during which time the larvae became active; a few escaped from the pyriforms and these were observed to be surrounded by a very delicate membrane. None of the larvae penetrated the digestive tract of the copepods.

Mosquito larvae were observed to ingest the eggs readily; however, the eggs passed through the digestive tract unchanged. The repeated ingestion of the same eggs eventually destroyed them without rupturing the outer coverings.

Millipedes were found to be the most voracious feeders of all organisms studied, being able to devour several gravid proglottides within a few minutes. These organisms would also ingest fecal pellets and could subsist equally well on either fecal material or tapeworm fragments. No indication of tapeworm infection was ever found in the millipede, although it appeared that some of the larvae were freed from their surrounding membranes during the passage of the eggs through the digestive tract of the experimental animal.

From the above evidence it appears likely that, of the various organisms occurring on pastures, only certain oribatid mites are capable of serving as intermediate hosts of *M. expansa* and related tapeworms.

Stoll (1935) and others have shown by field experiments that pastures may retain their infectivity for relatively long periods, including two winters, after the source of tapeworm contamination had been removed. This would seem to indicate a rather interesting situation not, as yet, definitely explained. Under ordinary pasture conditions it would hardly seem reasonable that infective material could remain viable to the extent indicated by the ease with which lambs could become infected with tapeworms by grazing on such pastures. Furthermore, laboratory experiments involving the longevity of *Moniezia* eggs would support this conclusion.

Of numerous experiments carried out by the writer to determine the survival of the tapeworm larvae in eggs, the most favorable conditions were those in which the eggs were kept moist or in water at a temperature of 36° to 38° F. Under such conditions, a few eggs remained viable for periods as long as 325 days. Eggs survived freezing, with alternate periods of thawing, at temperatures varying from 17° to 24° F. for as long as 103 days, but the per cent of viable eggs was considerably reduced. Eggs that were allowed to dry at room temperature until the shape was distorted and then transferred to water usually did not remain viable for periods longer than 21 days. A few of the eggs kept in water at room temperature and not exposed to drying lived as long as 60 days.

The life span of oribatid mites is not known, and very little information on this point is available in the reports of Michael (1884), Jacot (1937), Stunkard (1938b), and Krull (1939b), who have maintained these mites in the laboratory.

However, it appears reasonable to assume that a period of more than a year would be an unusual life span for this type of mite.

DISCUSSION

While it may be possible, on the basis of the above data, to account for the long periods of infectivity of a pasture, and even to account for the long periods of survival recorded in the literature, it seems more reasonable to assume that there may be environmental conditions which influence the longevity of the tapeworm eggs. Such conditions may be brought about by the activity of invertebrate organisms, thus making the eggs available for oribatid mites for longer periods than would otherwise be possible. Field observations indicate that various invertebrates, particularly ants, are important in the distribution of the tapeworm eggs and, no doubt, transport them to places where conditions of survival are more favorable than they would be where the eggs were deposited by the definitive host.

Ants are omnipresent and have been observed by the writer to drag gravid proglottides over many feet of pasture during which the tapeworm fragments come in contact with many blades of grass. Before the proglottides become too dry many of the eggs from the ruptured proglottides were observed to remain on the grass. Furthermore, ants were observed immediately or eventually to take the proglottides into the ground. As soon as this happens the eggs are removed from such conditions as direct rays of the sun, excessive drying and extremes of temperature, all of which may hasten their destruction.

Centipedes were observed to be exceedingly fond of proglottides of *Moniezia*, and since the eggs were, except in a few cases, not destroyed by passage through the alimentary tract, these organisms would also be of importance because they retire to situations and would deposit their excrement containing the tapeworm eggs where chances of their survival would be enhanced. Earthworms must also be reckoned with in this connection, since in addition to the possibility of eating the tapeworm eggs present in the upper layers of soil and then passing them with their excreta, these annelids burrow into the soil making sizeable cavities into which the eggs could easily be washed by rain and later brought to the surface through the activity of earthworms or other soil inhabiting organisms.

SUMMARY

Evidence has been presented to indicate that oribatid mites are probably the only organisms which serve as intermediate hosts of the sheep tapeworm, *Moniezia expansa*.

Field observations suggest that certain invertebrates, including ants, centipedes, and earthworms, may carry the eggs of *Moniezia* into the soil and deposit them in locations favorable for their survival, thus making them available to the intermediate hosts over a longer period than would otherwise be possible.

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A new taenioid cestode, *Cladotaenia foxi*, from a falcon. ALLEN MCINTOSH, U. S. Bureau of Animal Industry.

On March 27, 1940, Mr. J. B. Fox, Washington, D. C., brought to the Zoological Division of the Bureau of Animal Industry for identification some gravid proglottids of a cestode which had been collected from the feces of a duck hawk, requesting identification and a possible treatment for removing the parasite. The bird had been in captivity for about a year and had been trained for use in the art of falconry. The proglottids were determined as being those of a species of *Cladotaenia* and were then fed to a white mouse. No remedy for the removal of the cestode from the falcon was recommended, but Mr. Fox stated that he intended to treat the bird with a "rhubarb and river sand" remedy which he had obtained from an old book on falconry. Two days later Mr. Fox returned with a 2½-inch chain of cestode proglottids which had been passed by the hawk following the administration of the remedy. Since this treatment had not proved successful in removing the scolex of the worm, Dr. Paul D. Harwood suggested the experimental trial of a mixture that was being tested as a taeniacide in poultry. On April 1, Mr. Fox returned to the laboratory with a number of tapeworms which had been passed by the bird following the administration of the proposed treatment. The worms were found on examination to be complete specimens representing a new species belonging to the genus *Cladotaenia*. The species is described herein and named in honor of the collector.

Cladotaenia foxi, n. sp.

Description.—Species of average size; type 172 mm long by 2.43 mm wide at broadest point, consisting of 187 proglottids. Scolex (Fig. 1, A) globose, 490 μ wide; rostellum prominent, 70 μ long by 110 μ wide, provided with a double circlet (Fig. 1, B) of 58 hooks, those of anterior circlet 30 μ long and those of posterior circlet 27.5 μ long; suckers 130 to 140 μ in diameter. Mature proglottids present after about the 125th segment; in this area the length of the mature proglottid may be greater, equal to, or less than its width. A fairly typical mature proglotidd (Fig. 1, D) was 1.6 mm long by 2.43 mm wide. Genital pores lateral, irregularly alternate, slightly anterior to equatorial level of proglottid where margin is slightly projected. Gravid proglottids (Fig. 1, E) longer than wide, 5.36 mm by 2.28 mm.

Male reproductive system.—Testes 100 to 130 in number, about 50 to 70 μ in diameter, arranged in two longitudinal fields, not forming commissure posterior to ovary. Cirrus sac oval or pyriform, 80 μ by 120 μ; vas deferens forming numerous loops before entering cirrus sac.

Female reproductive system.—Ovary two-winged, multilobed, 210 μ long by 280 μ wide; vitellarium posterior to ovary, 100 μ by 270 μ; shell gland small, oval, about 50 μ by 80 μ, between ovary and vitellarium. Uterine stem in mature seg-

ments extending only slightly beyond cephalic margin of ovary; in fully gravid proglottids the uterus is confined to median portion of posterior third of proglottid and usually provided with 5 to 7 lateral pouches on each side. Onchospheres 20 μ by 30 μ, with embryonic hooks 6 to 7 μ long; middle embryonic shell oval, 35 μ by 45 μ; eggs (Fig. 1, F) examined in water showed a distended outer shell membrane which measured from 85 to 90 μ in diameter.

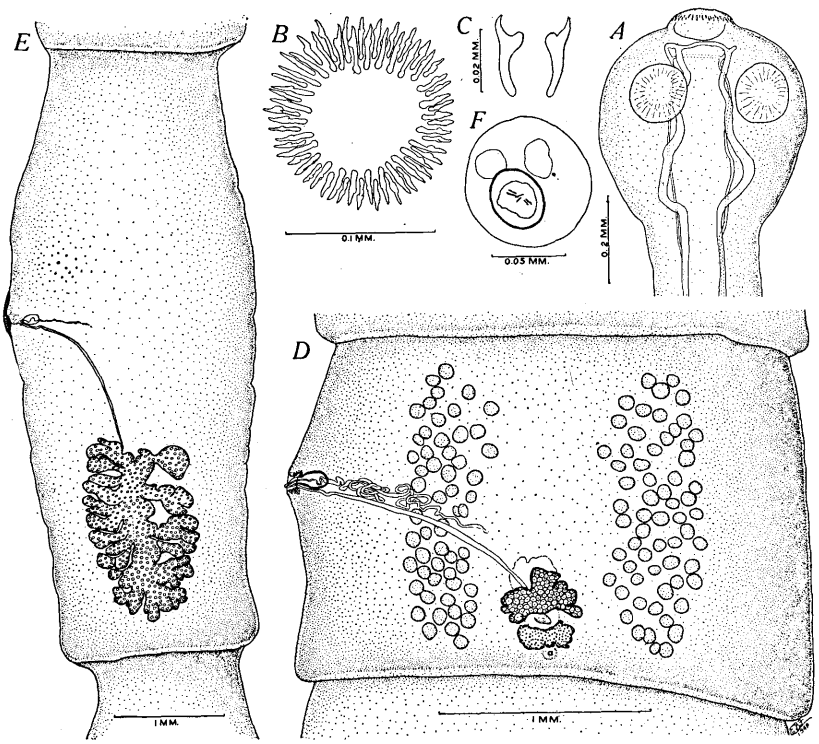

FIG. 1. *Cladotaenia foxi*, n. sp. A—Scolex. B—Cephalic aspect of rostellum showing double circlet of hooks. C—Hooks, lateral view. D—Mature proglottid. E—Gravid proglottid. F—Egg.

Cysticercus.—Four gravid proglottids were fed to a white mouse and 6 weeks later numerous small cysts, each containing a larva, were present beneath liver capsule. In sections, a cysticercus 450 μ long by 150 μ wide was inclosed within cyst, the latter 600 μ long by 350 μ wide; cyst surrounded by connective tissue capsule about 100 μ thick.

Habitat.—Small intestine of definitive host, *Falco peregrinus anatum;* liver of experimental intermediate host, *Mus musculus.*

Distribution.—Washington, D. C.

Specimens.—U.S.N.M. Helm. Coll. No. 44444 (type), No. 44445 (paratypes), and No. 44422 (cysticerci).

Remarks.—*Cladotaenia foxi,* with its characteristic short uterus, may be readily distinguished from all the other members of the genus except *C. armigera* Volz, 1900, which also has a uterus that does not reach cephalad of the level of the genital pore. The latter species has 42 rostellar hooks, 32.4 to 39.6 μ long, and with from 60 to 70 testes to a proglottid, while *C. foxi* has 58 rostellar hooks, 27.5 and 30 μ

long, and from 100 to 130 testes to a proglottid. The shape and size of the various parts of the rostellar hooks of *C. foxi* also appear to differ sufficiently from those of *C. armigera* to be of aid in separating the two species.

PREVIOUS RECORDS OF *CLADOTAENIA* FROM NORTH AMERICA

Jones (1930, Jour. Parasitol. **16**: 159) has given what appears to be the first record of *Cladotaenia* from this country, reporting *C. globifera* (Bloch, 1782) from *Circus hudsonius* and *Asio flammeus*. Scott (1930, Jour. Parasitol. **17**: 115; 1931, *idem* **18**: 49) reported *Cladotaenia* spp. from the liver of *Cynomys leucurus* and experimentally from *Buteo regalis* (= *Archibuteo ferrugineus*). Erickson (1938, Amer. Midland Nat. 20: 585) also reported *Cladotaenia* sp. from *Peromyscus maniculatus*, as did Penner (1938. Jour. Parasitol. **26** (Sup.): 25) from *Accipiter cooperi, Peromyscus leucopus noveboracensis, Microtus pinetorum scalopsoides*, and experimentally, from laboratory mice.

Of the material reported above only that studied by Jones has been available to the writer. The specimens are not in the best of condition, but those from the marsh hawk, *Circus hudsonius*, show that the testes may meet to form a broad commissure posterior to the ovary and vitellarium, and the gravid uterus extends to the level of the genital pore. These characters are sufficient to separate the marsh hawk species from that described in this paper as *Cladotaenia foxi*.

THE GENUS *CLADOTAENIA* COHN, 1901

The genus *Cladotaenia*, with *C. globifera* (Batsch, 1786) as type, is characterized as follows: Rostellum armed with a double circlet of hooks; segments usually longer than wide; genital pores irregular alternate; testes arranged in two lateral fields; uterus sacculate or with lateral ramifications as in the genus *Taenia*.

Considerable confusion exists as regards the identity of *Taenia globifera* Batsch and *T. cylindracea* Bloch. Several writers since Batsch (1786), and even Goeze (1782), have stated or intimated that the tapeworm described as *Taenia globifera*, from *Buteo buteo* (= *Falco buteo*, = *Buteo vulgaris*), was identical with *Taenia cylindracea* Bloch, 1782. This synonymy does not seem plausible in light of the known facts. Bloch gave *Falco lanarius, Falco buteo*, and *Turdus viscivorus* as hosts of his *T. cylindracea*, but considering the relative host specificity existing among the tapeworms, it seems probable that he was dealing with more than one species and possibly more than one genus of cestode. Bloch's description and illustration of *T. cylindracea* show that the worm he studied was a double-pored species of the subfamily Dipylidiinae and could not belong to the genus *Cladotaenia*. Since *Turdus viscivorus* is an unlikely host for a species of *Cladotaenia*, or of a member of the Dipylidiinae, and accepting Batsch's statement that the 4 worms he had from *Falco buteo* (type host of *Taenia globifera*) were different from *T. cylindracea* Bloch, it seems reasonable to assume that the material upon which Bloch based his description and figures of the latter species was from *Falco lanarius*. It is, therefore, the writer's opinion that this cestode, *Taenia cylindracea* Bloch, should be transferred to the subfamily Dipylidiinae. It cannot be argued that this group of cestodes does not occur in birds of the order Accipitriformes because one species, *Diplopylidium avicola* (Fuhrmann), has been reported from *Gyps kolbi* (Daud.) (= *Gyps coprotheres* (Forster)). The most logical place for *Taenia cylindracea* appears to be in the genus *Diplopylidium* Beddard, 1913, and the transfer is accordingly made, the new combination being *Diplopylidium cylindracea* (Bloch, 1782), n. comb.

The specimens upon which Batsch based his description of *T. globifera* had been collected from a young *Falco buteo*, and briefly described and figured by Goeze (1782) as "Taenia *brachium globulosum.*" Neither Goeze's nor Batsch's descrip-

tions and figures of this worm are adequate to enable it to be placed with certainty in any of the genera now recognized as valid. Morrell (1895) described a worm from *Buteo vulgaris* (=*Buteo buteo*) which he regarded as *T. globifera* Batsch. Since, as stated above, Batsch's description and figures are inadequate, it seems proper in order to avoid further confusion to accept Morrell's description of the worm from *Buteo vulgaris* (=*Buteo buteo*) as being that of the species named *T. globifera* by Batsch.

As present constituted, the genus *Cladotaenia* Cohn, 1901, contains the following species: *Cladotaenia armigera* (Volz, 1900); *C. circi* Yamaguti, 1935; *C. fania* Meggitt, 1933; *C. feuta* Meggitt, 1933; *C. foxi* n. sp.; *C. freani* Ortlepp, 1938; *C. globifera* (Batsch, 1786), type; *C. mirsoevi* Skrjabin and Popov, 1924; *C. secunda* Meggitt, 1928; and *C. vulturi* Ortlepp, 1938.

The effect on the growth-rate of young chickens of infections of the tapeworm *Hymenolepis carioca*. GEORGE W. LUTTERMOSER, U. S. Bureau of Animal Industry.

It is only within the last few years that any concerted effort has been made to determine experimentally the effect of pure infections of tapeworms on chickens and domestic animals. Taylor (1933, Vet. Jour. 89: 500–504) reported no perceptible injury to eight 10-week-old chicks harboring, in some cases, as many as 3,900 *Davainea proglottina* each. However, Levine (1938, Jour. Parasitol. 24: 550–551) found that 13 weeks after infection seventeen 7-week-old White Leghorn chicks infected with from 1,900 to 5,600 *D. proglottina* each weighed 12 per cent less than the 17 control birds. Harwood and Luttermoser (1938, Proc. Helminth. Soc. Wash. 5: 60–62) reported that the growth-rate of twenty-nine 2-week-old Rhode Island Red and White Leghorn chicks was retarded by *Raillietina cesticillus* infections ranging in numbers from 15 to 155 worms each. Ackert (1938, Jour. Parasitol. 24 (Sup.): 14) observed that *R. cesticillus* infections of 4 to 25 worms each not only retarded the growth-rate of 3- to 4-month-old White Leghorn chickens but also reduced the sugar and hemoglobin content of the blood.

In this paper, the results of experiments planned to determine the effects of experimental infections with the tapeworm *Hymenolepis carioca* on the growth-rate of laboratory-reared chicks, which were fed an adequate diet, are presented.

EXPERIMENTAL PROCEDURE

Twenty Rhode Island Red chickens, approximately 2 weeks old, were paired according to weight and sex, and one bird of each pair was given about 1,000 cysticercoids of *H. carioca*, which were obtained from experimentally infected beetles, *Onthophagus hecate*. The other chick of each pair served as a control. Both infected and uninfected birds were maintained under conditions designed to prevent extraneous infection with parasites. They were fed a diet consisting of corn meal, 35 pounds; rolled oats, 23 pounds; ground wheat, 15 pounds; bran, 8 pounds; meat and bone scrap, 5 pounds; skim milk, 6 pounds; fish meal, 4 pounds; oyster shell, 1.5 pounds; linseed meal, 2 pounds; salt mixture (96.8 pounds salt mixed with 3.2 pounds manganese sulfate), 0.5 pound; and fortified cod liver oil, 0.1 pound. The weights of both the experimental and control birds were recorded weekly for a period of 6 weeks after infection; the effects of the infection on the growth-rate was determined by analysis of these data.

EXPERIMENTAL DATA

Table 1 shows that the difference in mean gain of the controls and the experimental birds in Experiments 1 and 2 was slightly less than 1 per cent at the end of

TABLE 1.—*Effect on growth-rate of young Rhode Island Red chicks of infections of Hymenolepis carioca*

Experiment No.	Number[a]		Age when infected	Date infected	Mean number cysts administered	Mean gain in weight			Difference in mean gain	Number worms at autopsy
	Infected	Controls				Period after infection	Infected group	Control group		
			Weeks		*Average*	*Weeks*	*Grams*	*Grams*	*Per cent*	*Average*
1	10	10	2	11/29/39	1,000	3	195.6	195.9	0.15	532.6
						4	313.5	314.0	0.22	
						6	522.0	536.9	2.70	
2	10	10	4	12/15/39	1,000	3	253.3	255.5	0.86	917.0
						4	376.1	377.0	0.23	
						6	691.3	678.5	1.85	

[a] Birds in infected and control groups paired as regards weight and sex.

the 4th week after infection. At the end of the 6th week following infection, the controls in Experiment 1 had gained 2.7 per cent more than the experimental birds, but in Experiment 2 the experimental birds had gained 1.85 per cent more than the control birds. In Experiment 1, the average difference in mean gain of the two groups of chickens for the 3rd, 4th, and 6th weeks was found to be about 1 per cent, the control birds being slightly heavier than the experimental birds. In Experiment 2, the average difference in the mean gain of the two groups of birds for the same period was less than 1 per cent; in this instance the experimental birds were slightly heavier than the controls. On postmortem, an average of 533 tapeworms was found in 5 experimental birds of Experiment 1, and an average of 917 worms in the same number of experimental birds of Experiment 2.

DISCUSSION

The findings herein reported show that *Hymenolepis carioca* was not injurious to young chicks reared under the conditions of the experiment. Failure of this worm to produce harmful effects on its host may have been due to the fact that this parasite lacks rostellar and sucker hooks, as well as to a natural resistance developed by the host because of having received a well balanced diet. Since *Raillietina cesticillus, R. echinobothrida,* and *Davainea proglottina* possess either rostellar or sucker hooks, or both, and have been found to cause injury to infected birds, there is a possibility that these hooks may destroy considerable tissue, thus interfering with the physiological functioning of the intestine. At present, very little information regarding the influence of tapeworm infections on the growth-rate of young chickens receiving a deficient diet is available.

SUMMARY AND CONCLUSIONS

1. Twenty 2- to 4-week-old Rhode Island Red chicks were fed 1,000 cysticercoids of *H. carioca* and their growth rates compared with those of 20 controls for a period of 6 weeks.

2. The growth-rate of the experimental birds was practically the same as that of the controls.

3. Tapeworm infections resulting from the feeding of 1,000 cysticercoids of *H. carioca* did not seem to retard the growth-rate of laboratory-reared chicks when kept on a well-balanced diet.

A redescription of *Onchocotyle emarginata* Olsson, 1876 (Trematoda: Monogenea). EMMETT W. PRICE, U. S. Bureau of Animal Industry.

In 1876, Olsson (K. Svenska Vetensk.-Akad. Handl. n. F. **14** (1): 1–35) described as *Onchocotyle emarginata* a monogenetic trematode from the gills of *Raja clavata.* This species was based on a single specimen which appeared to be mutilated, having only two instead of the customary six haptoral suckers. This form was unusual since it showed the vitelline follicles extending into the haptoral appendix. So far as may be determined from the original description and figures, the eggs were ovoidal and not provided with polar prolongations, and the large hooks of the haptoral suckers were of a different type from those of species generally included in the genus *Onchocotyle.* Sonsino (1891, Atti Soc. Tosc. di Sci. Nat., Pisa, proc. verb., **7**: 253–265) regarded this form as identical with *O. appendiculata* (Kuhn) and subsequent authors have either ignored the species or have concurred in Sonsino's conclusion. However, the type of egg and haptoral hooks, together with the fact that it was found on a ray instead of a shark suggests immediately that Sonsino was in error and that the species is related to those forms occurring on rays and skates, which have been placed by Cerfontaine (1899, Arch. Biol. **16** (3): 345–478) in the genus *Rajonchocotyle.*

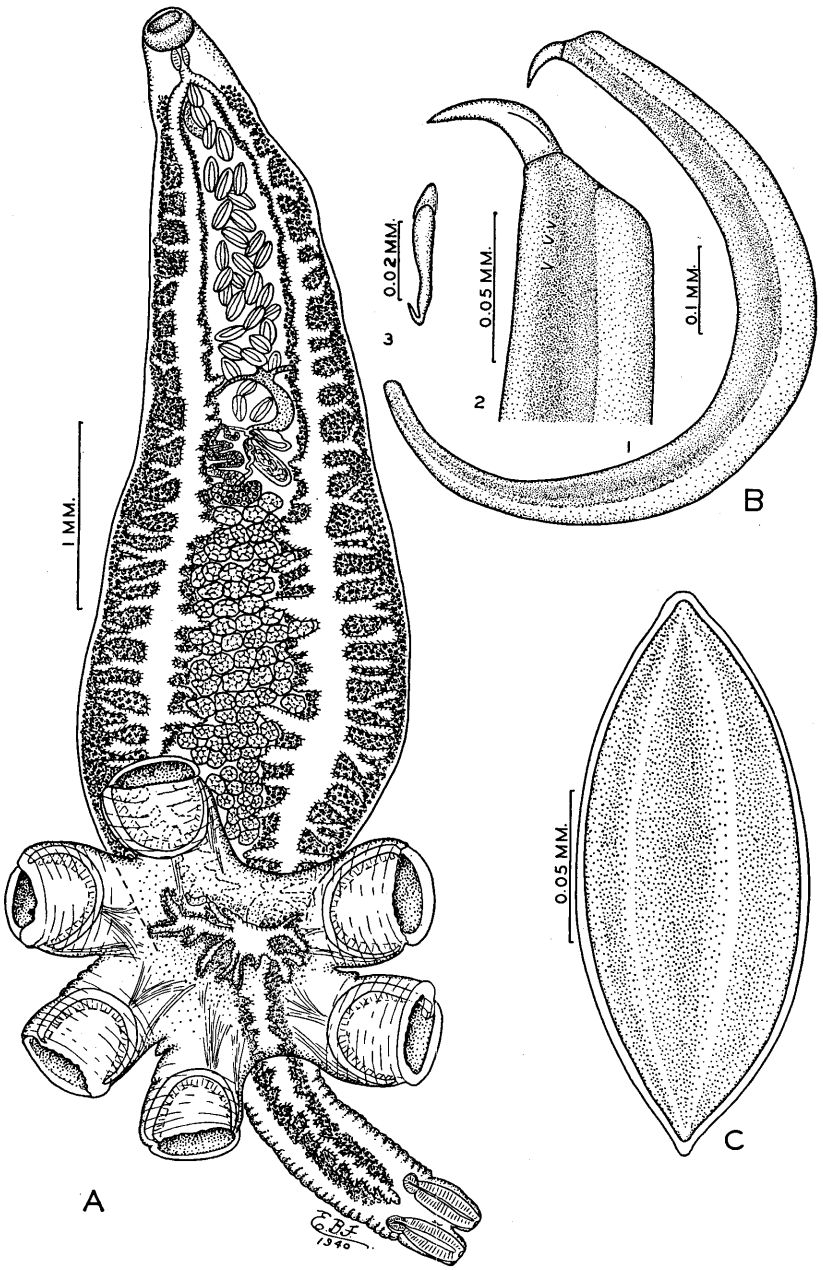

Fig. 1. *Rajonchocotyloides emerginata* (Olsson). A—Complete worm, ventral view. B—Haptoral hooks (1, large hook from sucker; 2, tip of large hook; 3, small hook from haptoral appendix). C—Egg. Original.

In reviewing the flukes belonging to the group generally referred to as the Onchocotylidae, one specimen was available through the courtesy of Dr. E. Idris Jones of London, England, which appears to be the same species as that described by Olsson as *Onchocotyle emarginata.* This specimen was collected at Plymouth from the gills of *Raja clavata* and is apparently a part of the material reported by Baylis and Jones (1933, Jour. Marine Biol. Assoc. United Kingdom 18 (2): 627–634) as *O. appendiculata* (Kuhn). Since this form is closely related to species of *Rajonchocotyle,* and would ordinarily be included in that genus were it not for the fact that the vitellaria extend into the haptoral appendix, the writer is proposing for it the new genus *Rajonchocotyloides.* The erection of this genus is necessary in order to conform with a similar action being taken in a paper now in preparation in which those species showing an extension of the vitellaria into the haptoral appendix, and previously placed in the genus *Squalonchocotyle* Cerfontaine, are being transferred to a new genus.

Rajonchocotyloides emarginata (Olsson, 1876)

Synonyms.—*Onchocotyle emarginata* Olsson, 1876; *O. appendiculata* Sonsino, 1891, nec Kuhn, 1829.

Description.—Body proper 5 mm long by 1.8 mm wide in posterior third (Fig. 1, A). Oral sucker about 285 μ in diameter. Haptor about 2.5 mm in diameter, bearing 6 suckers arranged in more or less circular formation and with an appendix 1.36 mm long by 510 μ wide, terminating in a pair of muscular suckers. Haptoral suckers about 595 μ in diameter, each containing a large hook (Fig. 1, B 1 and 2) about 1.14 mm long; appendicular suckers about 322 μ long by 150 μ wide, constricted proximally. Between the two suckers of the appendix is a small hook (one of the pair normally present) which measures about 40 μ in length (Fig. 1, B 3). Pharynx 150 μ long by 115 μ wide; esophagus very short, bifurcating to form the intestinal limbs, the latter provided with median and lateral diverticula, and uniting at posterior end of body proper, giving off several short diverticulata into haptor and continuing as a single cecum into haptoral appendix almost as far as the base of the suckers. Genital aperture at level of intestinal bifurcation, 475 μ from anterior end of body. Testes numerous, exact number not ascertainable, occupying inter-intestinal field from distal pole of ovary to within a short distance of posterior end of body proper. Ovary consisting of several loops, situated to right of median line, and at or slightly anterior to equator of body proper. Seminal receptacle relatively large, to left and in zone of ovary. Vitelline reservoir relatively long, preovarial. Vitellaria extending from about 510 μ from anterior end of body to near tip of appendicular cecum, the follicles lying along the intestinal tract. Uterus long; eggs football-shaped, 170 to 197 μ long by 80 to 97 μ wide, provided with meridional bands (Fig. 1, C).

Host.—*Raja clavata* L.

Location.—Gills.

Locality.—Europe (Plymouth, England).

Specimen.—U.S.N.M. Helm. Coll. No. 36697.

The specimen described above is somewhat smaller than the one upon which Olsson based his description of *Onchocotyle emarginata,* but in view of the obvious contraction of the posterior half of the body of the Plymouth specimen, this difference in size is not regarded as significant. The egg sizes of the two specimens are in relatively close agreement. The fact that both specimens were from the same host, and show such obvious similarity in the extension of the vitellaria into the haptoral appendix, makes it unlikely that the specimen described in this paper could represent a species distinct from that described by Olsson.

A note on the genera *Nematospiroides* Baylis, 1926, and *Sincosta* Roe, 1929 (Nematoda, Heligmosomidae), with descriptions of two new species of *Nematospiroides*. G. DIKMANS, U. S. Bureau of Animal Industry.

The genus *Nematospiroides,* with *Nematospiroides dubius* as type species, was proposed by Baylis (1926) for some nematodes collected from the small intestine of the wood mouse, *Apodemus sylvaticus.* In the same year Schulz (1926) described as *Heligmosomoides skrjabini,* n. sp. some nematodes collected from the small intestine of *Mus musculus hortulanus* and *Sylvaemus* (*Apodemus*) *sylvaticus ciscaucasicus* in Northern Caucasus. These two worms resembled each other very closely in general morphology but differed in that a dorsal ray was apparently absent in *Nematospiroides dubius* and present in *Heligmosomoides skrjabini.* Baylis (1927) states that after his attention had been called by Schulz to the similarity of the nematodes described by them in 1926 he reexamined his original material and discovered that *Nematospiroides dubius* possessed a dorsal ray similar in appearance to that described and figured for *Heligmosomoides skrjabini,* and concluded that *H. skrjabini* was identical with *N. dubius,* and since the description of *N. dubius* was published before that of *H. skrjabini,* the latter name became a synonym of the former.

Roe (1929) described as *Sincosta aberrans* some nematodes collected from the small intestine of a "wild mouse" in New Jersey. In the description of the bursa Roe stated "dorsal ray absent." Shortly after the description of this worm was published, Baylis in correspondence called Mr. Roe's attention to the similarity of *Nematospiroides dubius* and *Sincosta aberrans.* Later Chandler (1932) made *Sincosta* a synonym of *Nematospiroides* without stating the reason for his action. The finding by the present writer of some nematodes clearly belonging in either the genus *Sincosta* or the genus *Nematospiroides* prompted a reexamination of Roe's original material but in spite of a most careful study of the available males, no dorsal ray could be demonstrated. Some time ago, however, some nematodes collected by Mr. G. M. Spurlock from the small intestine of *Mus musculus musculus* in California and tentatively identified as *Sincosta aberrans* Roe, 1929, were submitted to the Zoological Division for examination. A study of these specimens revealed the presence of a dorsal ray similar to that reported for *Nematospiroides dubius;* this ray was located within the bursa at a level deeper than the proximal termination of the externo-dorsal rays, that is, in the same position as that described by Baylis for *N. dubius.* Since these nematodes agreed in other respects to *N. dubius* they were regarded as that species and the collector notified to that effect.

Because of the general similarity in structure and because other nematodes provisionally identified as *Sincosta aberrans* proved on closer examination to be *Nematospiroides dubius,* the writer concurs in Chandler's opinion that *Sincosta aberrans* should be considered as a synonym of *Nematospiroides dubius.*

In the U. S. National Museum Helminthological Collection there are some nematodes collected in 1893 by Dr. Albert Hassall from the small intestine of *Microtus pennsylvanicus* (= *Arvicola riparius*), the material consisting of 4 males and 2 females. These worms resemble *Nematospiroides* in general morphology but they differ from *N. dubius* in the markedly greater length of the spicules. Similar nematodes were collected by the writer from the small intestine of a muskrat, *Ondatra zibethica,* obtained through the courtesy of the Bureau of Biological Survey. No dorsal ray was demonstrated in these specimens, but in some other worms from the small intestine of *Clethrionomys gapperi* (= *Evotomys gapperi*) and belonging in the genus *Nematospiroides,* a dorsal ray similar in position and structure to that described for *N. dubius* was found. These nematodes are described in this paper as new species of *Nematospiroides.*

Nematospiroides longispiculatatus, n. sp.

Description.—Head surrounded by a cuticular inflation common to this group of nematodes, 27 to 30 μ wide without the cuticular inflation, or 35 to 40 μ wide with the cuticular inflation; length of inflation 70 μ. Oesophagus 700 to 800 μ long. Excretory pore located about 350 μ from head end; position of nerve ring not determined.

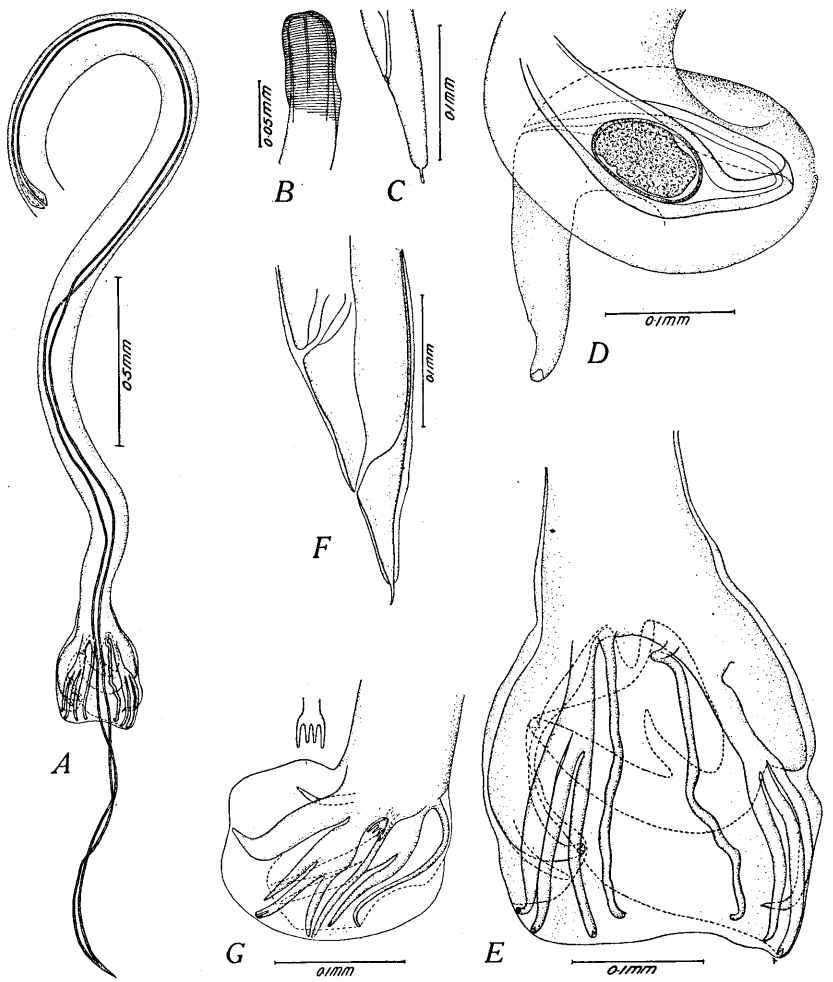

FIG. 1. A–E—*Nematospiroides longispiculatus*. A—Spicules. B—Anterior end. C—Tail end of female from *Ondatra zibethica*. D—Tail end of female from *Microtus pennsylvanicus*. E—Bursa of male. F–H—*Nematospiroides carolinensis*. F—Tail end of female. G—Bursa of male. H—Dorsal ray (diagrammatic).

Male 5.5 to 6.5 mm long by 140 μ wide immediately in front of bursa. Bursa asymmetrical, with the right lobe considerably larger than the left. Ventral, lateral, and externo-dorsal rays arising separately, the ventro-lateral ray being the largest; the lateral rays have a common stem, the externo-lateral ray being a little shorter than the other laterals and diverging ventrad near the tip; the medio-lateral and

postero-lateral rays are about equal in size and almost parallel, reaching the margin of the bursa; the externo-dorsals are long and slender, originating slightly above the posterior margin of the body and running a more or less wavy course toward the posterior margin of the bursa, but they do not, however, reach this margin; no dorsal ray could be found in any of the 4 male specimens available for examination. Spicules 3.9 to 4 mm long.

Female from 12 to 13 mm long and about 150 to 160 μ wide in region of vagina. In the specimens available for examination, the anterior part of the body was irregularly coiled and twisted and the posterior part was straight except for a twist of about a turn and a half at the extreme end. As in other members of the family Heligmosomidae, there is a single ovary and a single uterus. The position of the ovejector could not be made out with certainty. Distance from vulva to tip of tail 210 to 220 μ; distance from anus to tip of tail about 60 μ. Eggs from 80 to 90 μ by 40 to 45 μ.

In the specimens from *Microtus pennsylvanicus* no "spike" was seen on the tail end, but there appeared to be a slight projection on the tip of the tail which may have been the remains of a "spike" that had broken off in the process of handling. In the specimens from the muskrat, *Ondatra zibethica,* however, the tail end of the female is truncated and surmounted by a "spike" 12 μ long.

Hosts.—Microtus pennsylvanicus (Syn.—*Arvicola riparius*) and *Ondatra zibethica.*

Location.—Small intestine.

Locality.—Washington, D. C. and New Jersey, U.S.A.

Specimens.—U.S.N.M. Helm. Coll. No. 2288 (cotypes) and 30455.

Nematospiroides carolinensis, n. sp.

Description.—Male 4 mm. long, based on the only entire male specimen available. Bursa typical of genus. Dorsal ray extremely difficult to locate, apparently situated more or less within bursa and generally either hidden or obscured by genital cone. Spicules 1.8 to 1.9 mm long and, in the specimens examined, not very noticeable and only slightly chitinized.

Female length uncertain; no entire mature female present. Spike about 15 μ long present at the end of the tail. Distance from anus to tail from 60 to 70 μ; and distance from anus to vulva from 95 to 110 μ. Ovejector single, 175 μ long and situated about 700 μ from end of tail. There is a long vagina as in other members of the genus. Uterus filled with eggs, but no eggs present in either ovejector or vagina. Eggs in uterus 60 to 65 μ long by 40 to 45 μ wide.

Host.—Clethrionomys gapperi (Syn.—*Evotomys gapperi*).

Location.—Small intestine.

Locality.—Great Smoky Mountains, North Carolina, U.S.A.

Specimens.—U.S.N.M. Helm. Coll. No. 30454 (cotypes).

In the length of the specules and the location of the dorsal ray, this species resembles very closely *Heligmosomoides yorkei* Schulz 1926, but the shape and direction of the rays of the bursa of *H. yorkei* as figured by Schulz are markedly different from those observed in our specimens.

The species of *Nematospiroides* may be distinguished from each other by the following key:

1. Spicules less than 1 mm long ..... *N. dubius*
   Spicules more than 1 mm long 2
2. Spicules 1.8 to 1.9 mm long ..... *N. carolinensis*
   Spicules 3.9 to 4 mm long ..... *N. longispiculatus*

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A method of culturing large numbers of *Haemonchus contortus* larvae from eggs in cattle feces. GEO. E. CAUTHEN, U. S. Regional Animal Disease Research Laboratory, Auburn, Alabama.

Attempts to culture larvae of *Haemonchus contortus* from eggs in large amounts of cattle feces, by usual methods involving either sterile sheep manure or bone charcoal, did not yield satisfactory results, in this laboratory. For this reason an effort was made to find a more suitable medium.

Considering the difference in moisture content between cattle and sheep feces, it was assumed that a medium that would absorb more water and assure better aeration than would either dry sheep manure or bone charcoal, would give satisfactory results. Sphagnum moss, suggested by Dr. B. T. Simms, director of this laboratory, was found to possess these qualities to a high degree.

The success in culturing large amounts of feces sphagnum moss is indicated from the following results: The feces from two 8-month-old calves, experimentally infected with *H. contortus*, were used. Thirty-eight cultures were made, using amounts of feces ranging from 652 to 4,380 grams, with an average of 2,300 grams per culture. Two-and-one-half and three-gallon pails were used as containers. Sphagnum moss that had been previously sterilized in a steam retort was used in the proportions of approximately 7.5 to 10 grams per 100 grams of feces. The larvae were recovered after 6 to 7 days by means of a large Baermann apparatus. The total number of larvae was determined and the per cent of development computed upon the basis of the number of eggs in the feces to the number of larvae recovered. The percentage of eggs developing was found to vary from 17.94 to 97.98 per cent, with an average of 54.91 per cent. This represented from 16,000 to 548,0000 larvae per culture.

To accommodate such bulky cultures an enlarged Baermann apparatus was devised from galvanized sheet metal and screen wire. This apparatus consists of a funnel, 30 inches in top diameter and 27 inches high, and a $\frac{1}{4}$-inch-mesh wire strainer, 4 inches deep, that rested in the top of the funnel. The small end of the funnel tapered to a $\frac{1}{2}$-inch tube, to which a $\frac{5}{8}$-inch rubber tube was attached. This rubber tube was the proper size for a 15 cc tapered centrifuge tube to be slipped on and still be held in position similar to the apparatus described by Bozicevich (1938, Pub. Health Rept., 53 (48): 2130–2138). A double layer of cheese cloth was placed between the strainer bottom and the culture to be baermannized.

Most of the larvae migrated from the culture and finally came to rest in the centrifuge tube. A clamp inserted above the centrifuge tube allowed its removal without disturbing the water in the funnel. A small percentage of the larvae remained on the funnel wall. After withdrawal of the water through a glass tube suspended in the center and almost to the bottom of the funnel, the remaining larvae were washed from the funnel sides into a beaker and allowed to settle.

The larvae were stored, until needed, in 130 cc vials half filled with sphagnum

moss. Enough water was added to make the moss moist. Most of the larvae migrated up above the moss onto the wall of the vial. The method of storing larvae on moist filter paper as described by Taylor (1938, Nature 141: 205) might also be employed.

No water was added to the feces used in the 38 cultures described above. However, later cultures prepared from the gummy feces of young milk-fed calves were diluted with water before mixing with moss. The amount of water added varied from one-half as much water as feces, to equal parts of water and feces. The amount of moss per unit of feces was not determined. However, the resulting mixture of feces and moss contained more moisture than did the 38 cultures of feces from 8-month-old calves.

There were two noticeable characteristics of the sphagnum moss cultures as follows: There was little tendency either toward heating and thereby killing the larvae or toward drying out the culture. In fact, 1-pint jar culture was moist when baermannized 142 days after being prepared. In contrast to other culture methods tried, the characteristic disagreeable odor of the fecal cultures was reduced to a minimum. In addition to the advantages just noted, the convenience of preparing and using sphagnum moss makes it very desirable for use in culturing large numbers of *Haemonchus contortus* larvae from eggs in cattle feces.

The prevalence of larvae of *Trichinella spiralis* in the hearts, livers, stomachs, and kidneys of experimentally infected swine. CHARLES H. HILL, U. S. Bureau of Animal Industry.

INTRODUCTION

The occurrence of larvae of *Trichinella spiralis* in heart muscle tissue of man has been reported by various investigators including Zenker (1860, Arch. Path. Anat. 18: 561–572), Frothingham (1906, Jour. Med. Research 15: 483–490), Prym (1923, Centralbl. Allg. Path. u. Path. Anat. 34: 89–94) and Spink (1935, Arch. Int. Med. 56: 238–249). *Trichinella* larvae have also been reported from the myocardium of white rats by Graham (1897, Arch. Mikros. Anat. 50: 219–275) and by Dunlop and Weller (1933, Proc. Soc. Expt. Biol. and Med. 30: 2161) and from the same location in guinea pigs by Zoller (1927, Virchows Arch. Path. Anat. 265: 430–443). Frothingham (*loc. cit.*) also demonstrated trichina larvae in liver and other tissues of human cadavers. Recently Horlick and Bicknell (1929, N. England Jour. Med. 201: 816–819) reported the occurrence at necropsy of trichina larvae in the pancreas and kidneys, as well as in the mucosa, submucosa and muscularis of the intestinal tract of a patient 26 days after the onset of symptoms which were attritbuted to infection with this parasite.

METHODS

The investigation herein reported involved swine of various ages that had been experimentally infected with 20,000 to 100,000 (estimated) larvae each, 25 to 35 days prior to necropsy. Portions of 52 hearts, 38 livers, and 38 stomachs, and the kidneys from 19 swine were examined. In order to avoid including in the digestions any tissues other than those of the organs being examined, the following procedures were adopted: the hearts were opened and thoroughly washed, and the large blood vessels were removed at the sites of attachment. Large areas of tissue surrounding the insertion of both the oesophagus and the small intestine into the stomach were removed and discarded. The ureters were removed from the kidneys. In the case of livers, only the posterior one-third of the lobes were digested. The various organs were ground separately and digested in battery jars, following a procedure outlined by Schwartz (1939, Proc. Helminth. Soc., Wash. 6: 35–37).

FINDINGS

The results of examinations for trichina of the various organs were as follows:

Of the 52 hearts examined, 5 contained trichinae; the numbers of larvae per individual sample ranged from 1 to 13. Five of the 38 stomach samples contained trichinae, the number of larvae per individual sample ranging from 7 to 41. In the case of the samples from 38 livers, 7 contained trichinae, the numbers ranging from 1 to 6 per individual sample. None of the kidneys examined were infected.

The trichina larvae recovered from the various tissues were active and appeared normal and in the infective stage. Whether or not such larvae were capable of infecting another susceptible host animal, and whether or not they were encapsulated in the tissues was not determined. However, in the absence of evidence to the contrary, it should be assumed that trichina larvae occurring in the tissue of hearts, stomachs, and livers of swine may be infective and that such tissue, therefore, should be thoroughly cooked, or otherwise processed so as to kill the trichinae, before being eaten.

Preliminary observations on the efficacy of diphenylamine for the removal of intestinal nematodes from dogs. JAMES E. GUTHRIE, U. S. Bureau of Animal Industry.

Phenothiazine, which is effective for the removal of many of the nematode parasites of ruminants (Habermann *et al.* 1940, Proc. Helminth. Soc. Wash., **7** (1): 16–18), has not been found satisfactory for use in dogs. In order to determine whether a chemically similar substance might be more effective than phenothiazine in these animals, a number of experiments with diphenylamine was performed. Diphenylamine ($C_6H_5NHC_6H_5$) is a crystalline substance having a strongly pungent odor and slightly burning taste. It is more soluble in water than phenothiazine ($C_6H_4NHC_6H_4S$) which is made from diphenylamine and sulphur.

The tests reported herein were conducted at the Beltsville Research Center, Beltsville, Md. The drug was administered in gelatin capsules to dogs after a fasting period of 24 hours. The feces were collected daily and examined for parasites in the usual manner. When no additional worms were eliminated the animals were killed and the entire intestinal tract examined for the presence of parasites remaining after treatment. The usual length of time from treatment until necropsy was 4 days in the case of dogs. The results obtained are shown by the following protocols:

Dog No. 28; weight 40 pounds; dose 10 grams; 19 hookworms and 81 whipworms eliminated after treatment. At necropsy 33 hookworms and 1 whipworm were recovered. Efficacy 36 per cent for hookworms and 98 per cent for whipworms.

Dog No. 26; weight 15 pounds; dose 3 grams; 10 ascarids were removed by the treatment. At necropsy 7 ascarids were recovered. Efficacy 59 per cent for ascarids.

Dog No. 32; weight 45 pounds; dose 10 grams; 25 hookworms, 1 immature ascarid and 216 whipworms were passed subsequent to treatment. At necropsy 14 hookworms and 20 whipworms were recovered. Efficacy 64 per cent for hookworms and 91 per cent for whipworms.

Dog No. 24; weight 22 pounds; dose 5 grams; 13 hookworms and 2 ascarids were eliminated after treatment. At necropsy 1 hookworm and 1 ascarid were present. Efficacy 92 per cent for hookworms and 66 per cent for ascarids.

Dog No. 27; weight 55 pounds; dose 10 grams; 128 hookworms and 101 whipworms were passed after treatment. At necropsy 42 hookworms and 60 whipworms were present. Efficacy 75 per cent for hookworms and 62 per cent for whipworms.

Dog No. 36; weight 35 pounds; dose 10 grams; 39 whipworms were eliminated after treatment. At necropsy 7 hookworms and 3 whipworms were recovered. Ineffective for the removal of hookworms and 92 per cent effective for whipworms.

Dog No. 37; weight 45 pounds; dose 5 grams; 2 hookworms and 13 whipworms were passed after treatment. At necropsy 7 hookworms and 3 whipworms were recovered. Efficacy 22 per cent for hookworms and 81 per cent for whipworms.

From the data presented above, it may be seen that diphenylamine administered in doses of 3 to 10 grams per dog removed 64.2 per cent of 291 hookworms from 6 dogs, 61.9 per cent of 21 ascarids from 3 dogs and 83.6 per cent of 537 whipworms from 5 dogs. At no time were any symptoms of intoxication observed which could be attributed to the effects of treatment.

Endoparasites of aged horses and mules at the Beltsville Research Center of the U. S. Department of Agriculture. A. O. FOSTER and R. T. HABERMANN, U. S. Bureau of Animal Industry.

Specific information on the identities of horse parasites in the United States is limited to scattered, parenthetical records in articles on parasitism in equines and to a few helpful but incomplete lists of species by Yorke and Macfie (1919), Riley (1921), Cram (1924), Price (1928), and Morris (1932). There is, moreover, almost no acceptable information upon the quantitative occurrence of the large strongyles and cylicostomes in horses in this country, other than a few isolated records, e.g., the figures given by Wright (1931, *vide infra*) for the number of cylicostomes recovered from one horse and one mule.

In order to throw more light on these phases (i.e., the qualitative and quantitative) of equine parasitism in this country, the authors have prepared for this report a list of the species of endoparasites which have been encountered during the past year in horses and mules used for experimental purposes at the Beltsville Research Center, Beltsville, Md., and, in addition, are presenting data on the number of cylicostomes and large strongyles which were harbored by some of these animals.

The parasites were recovered from 13 horses and 1 mule used for critical testing of the anthelmintic efficacy of phenothiazine, and from 3 to 4 times that number of animals which the senior author observed at necropsy following death from experimental infections of encephalomyelitis or infectious anemia. The quantitative data are derived from the first group. All of the animals were old, probably not less than 10 years in any case, and had been obtained originally from nearby posts of the U. S. Army, where, for reasons probably not directly associated with parasitism, they had been judged unfit for further service.

The following parasites were encountered:

Cestoda: *Anoplocephala magna*, a part of a specimen screened from the feces of one horse.

Nematoda: *Strongylus equinus, S. edentatus, S. vulgaris.*
Tridontophorus serratus, T. minor, T. brevicauda.
Craterostomum mucronatum.
Oesophagodontus robustus.
Gyalocephalus capitatus.
Poteriostomum imparidentatum, P. ratzii.
Cyathostomum coronatum, C. labratum.
Cylicocercus catinatus, C. goldi, C. pateratus.
Cylicostephanus calicatus, C. poculatus, C. longibursatus, C. minutus.
Cylicocyclus elongatus, C. nassatus, C. insigne, C. leptostomus.
Cylicodontophorus bicoronathus, C. euproctus.
Parascaris equorum.

Oxyuris equi.
Probstmayria vivipara.
Habronema muscae, H. microstoma.
Setaria equina.
Onchocerca cervicalis (= *O. reticulata?*)
Botfly larvae: *Gastrophilus intestinalis.*

It will be noted that the above recordings represent a relatively complete list of the definitely valid species of helminthic parasites known from the domestic equines. Other species of endoparasites, not accidental invaders, which have been reported from horses and mules in the United States, and not included in the above list, are *Anoplocephala perfoliata, A. mamillana, Triodontophorus tenuicollis, Cylicodontophorus ultrajectinus, Draschia megastoma, Trichostrongylus axei, Dictyocaulus arnfieldi,* and 3 species of botfly larvae, *Gastrophilus nasalis, G. haemorrhoidalis,* and *G. inermis.* Other species like *Cylicocyclus radiatus, Cylicostephanus hybridus, C. asymetricus,* and *Cylicobrachytus brevicapsulatus,* although relatively rare forms, will probably be found in equines of the United States. The few remaining valid species are limited either in geographical distribution or in the kind of host (i.e., horse, mule, or donkey) which they normally parasitize.

The numbers of cylicostomes and large strongyles harbored by these animals are of interest not only because such data are very scarce, but also because they represent the worm burdens of relatively old animals, and older horses have been shown to harbor fewer worms than younger ones (Foster, 1937). The only previous information comparable to the present data is that furnished by Wright (*loc. cit.*) who records 9,060 cylicostomes from an 18-year-old mule and 18,280 from a 10-year-old mare. Among 9 animals of the present series, on which complete quantitative data were obtained, the numbers of large strongyles (*Strongylus* spp.) varied from 0 to 40 and of cylicostomes from 8,122 to 81,962. The average was 12 large strongyles and 30,625 cylicostomes per animal. Another animal, however, on which only partially complete data were obtained, passed 32 large strongyles and 106,790 cylicostomes after medication with phenothiazine. The number of cylicostomes in the above cases was estimated by sampling methods.

So far as is known, every horse is subjected to some degree of parasitic invasion. While it appears probable that even 1 parasite does some harm to its host, the damage produced by even a seemingly large number of strongylid worms is usually so slight as to escape notice. In a series of 86 mature horses and mules in the Panama Canal Zone, raised under the best methods so far devised for parasite control, Foster (*loc. cit.*) found an average of about 1,000 strongylid worms per animal although there were no discernible symptoms of strongylosis. In Russia, Bederke (1931) examined minutely the worm infestations of 3 horses, 2 of which showed intestinal catarrh and anemia, and found 52,000 and 200,000 worms, respectively, in the animals with symptoms, and 32,000 in the third which had shown no marked symptoms.

It is suggested by these data and those presented above that equines harboring approximately 1,000 strongylid worms are very lightly infected, and that this figure represents the minimum level of infestation obtainable under the best methods of parasite control. It appears further that infestations up to 30,000 worms probably do not usually cause noticeable symptoms, while infestations of 50,000 and over may cause symptoms of typical strongylosis. The point of transition between a subclinical and a clinical infestation in the average horse appears, therefore, to lie roughly in the vicinity of from 30,000 to 50,000 worms.

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Notes on amphibian parasites. A. C. WALTON, Knox College, Galesburg, Illinois.[1]

Through the courtesy of Mr. John Mohr of the University of California, a number of parasites taken from amphibia collected at various points around the Gulf of Mexico were turned over to the writer for identification. The hosts were captured in Mexico, in Cuba, in Florida, and in Louisiana. With few exceptions the parasites were nematodes of the genera *Aplectana* and *Cosmocercoides*.

Cylindrotaenia americana Jewell, 1916, were parasites of *Bufo compactilis* and of *Scaphiopus hammondii multiplicatus* (both collected near Coyoacan, D. F., Mexico, by John Bass during October, 1939).

Larval forms of *Eustrongylides* sp? were taken from *Hyla septentrionalis* (collected by John Bass in Cuba on December 12, 1939).

Larval forms of the mite, *Hannemannia penetrans* Ewing, 1931, came from *Eleutherodactylus ricordii* (collected November 3, 1939, at Englewood, Florida).

Cosmocercoides dukae (Holl, 1928) Travassos, 1931, were found in *Bufo terrestris* (November 14, 1939) and *Microhyla carolinensis* (November 24, 1939) from Englewood, Florida, and in *Bufo valliceps* (collected at New Orleans, La., on December 13, 1939).

The genus *Aplectana* is represented by at least three species, one of which cannot be identified since only female material is available. The other two species are regarded as new, one of them being of rather widespread distribution.

Aplectana mexicana, n. sp. (Fig. 1)

Description.—Based on male specimens. Possession of distinct lips, short pharynx, esophagus ending in a differentiated bulb, narrow lateral alae extending nearly the entire length of the body, relatively short equal spicules, and the type of the accessory piece, place these specimens in the genus *Aplectana*.

Male: Length, 3.811–4.446 mm; greatest width, 0.181–0.183 mm; length of pharynx, 0.044–0.054 mm; length of esophagus, 0.363–0.413 mm; length of neck of bulb, 0.036–0.054 mm; dimensions of bulb, 0.072 mm × 0.09 mm; head-nerve ring distance, 0.29–0.295 mm; head-excretory pore distance, 0.41–0.435 mm; cloaca-tail distance, 0.163–0.181 mm; spicule length, 0.19–0.218 mm; accessory piece length, 0.078–0.079 mm; caudal papillae arrangement, 6 pairs precloacal, 7 pairs postcloacal, and 1 median unpaired precloacal, in position.

Host.—Young adult of *Bufo simus* (collected by John Bass near Coyoacan, D. F., Mexico, on October 5, 1939).

Habitat.—Intestine of host.

Type specimens.—Cotypes are deposited in the Collections of the United States National Museum (No. 42047).

Discussion.—Examinations of many of the species of the genera *Aplectana* and

[1] Contribution from the Biological Laboratories of Knox College, No. 66.

Oxysomatium has led the writer to the conclusion that the only consistent difference between the two appears in the relative number of caudal papillae in the male, in the position of the uteri, and in the presence or absence of narrow lateral alae. In *Aplectana* both uteri normally lie cephalad to the vulva, which opens near the middle of the body; in the male the number of caudal papillae is usually less than 14 pairs; lateral alae are present in both sexes; and the spicule length is generally less than one-tenth that of the body. In *Oxysomatium* the uteri are primarily amphidelphic; the vulvar opening is usually posterior to the middle of the body; distinct lateral alae are normally absent in both sexes; the caudal papillae of the male are numerous; and the spicules may extend to one-third of the length of the body. Distinctness of lip formation, presence or absence of chitinized valves in the esophageal bulb, and the internal or external hatching of the embryos vary too greatly to be of more than specific value in the taxonomy of these forms. In final analysis, none of the criteria used are of consistantly generic value, and even histological and cytological characteristics fail to afford a reliable basis for generic separation. The retention of the genus *Aplectana* as separate from the genus *Oxysomatium* is therefore more a matter of convenience than it is of a taxonomic necessity.

The present material is to be separated as a definite species on the basis of the relative proportions of the various organs as well as on the number and arrangement of the caudal papillae. It most nearly resembles *A. crucifer* Travassos, 1925 (from *Bufo crucifer*, Brazil), but definitely differs in the arrangement and number of the caudal papillae and in the form of the spicules.

Aplectana hamatospicula, n. sp. (Fig. 2)

Description.—Based on both male and female specimens. With the characteristics of the genus, and specifically identified by the very distinctive structure of the spicules.

Male: Length, 2.09–3.045 mm; greatest width, 0.109–0.122 mm; length of pharynx, 0.045–0.05 mm; length of esophagus, 0.435–0.48 mm; length of neck of bulb, 0.044–0.05 mm; dimensions of bulb, 0.08×0.08 mm to 0.09×0.09 mm; head-excretory pore distance, 0.461–0.47 mm; head-nerve ring distance, 0.236–0.245 mm; cloaca-tail distance, 0.127–0.145 mm; spicule length, 0.236–0.245 mm; accessory piece length, 0.07–0.072 mm, well cuticularized; caudal papillae sessile, with 1 median and 4 pairs of precloacals, and 7 pairs of postcloacals. The spicules are hamate at their distal ends and have the tips covered by cuticularized cap-like structures.

Female: Length, 3.412–4.2 mm; width at vulva, 0.145–0.185 mm; length of pharynx, 0.05–0.052 mm; length of esophagus, 0.472–0.525 mm; length of neck of bulb, 0.044–0.05 mm; dimensions of bulb, 0.09×0.09 mm to 0.1×0.1 mm; head-excretory pore distance, 0.48–0.508 mm; head-nerve ring distance, 0.254–0.28 mm; anus-tail distance, 0.162–0.22 mm; vulva-tail distance, 1.089–1.3 mm; egg sizes (larvated), 0.055×0.085 mm to 0.065×0.109 mm.

Hosts.—*Bufo peltocephalus* (3 individuals from Santiago, Cuba, collected on November 1, 4, and 8, respectively, of 1939); *Hyla eximia* (collected November 6, 1939, at Coyoacan, D. F., Mexico); and *Microhyla carolinensis* (from Englewood, Florida, collected on November 22, 1939).

Habitat.—Large intestine of host.

Type specimens.—Cotypes are deposited in the Collections of the United States National Museum (No. 42048).

Discussion.—The present form differs from all of the other described species of the *Aplectana-Oxysomatium* complex in the possession of the peculiar process on the dorsal side of the distal end of the spicule. This is not at all similar to the bifurcation of the tips of the spicules as reported for *Aplectana (?) membranosa*

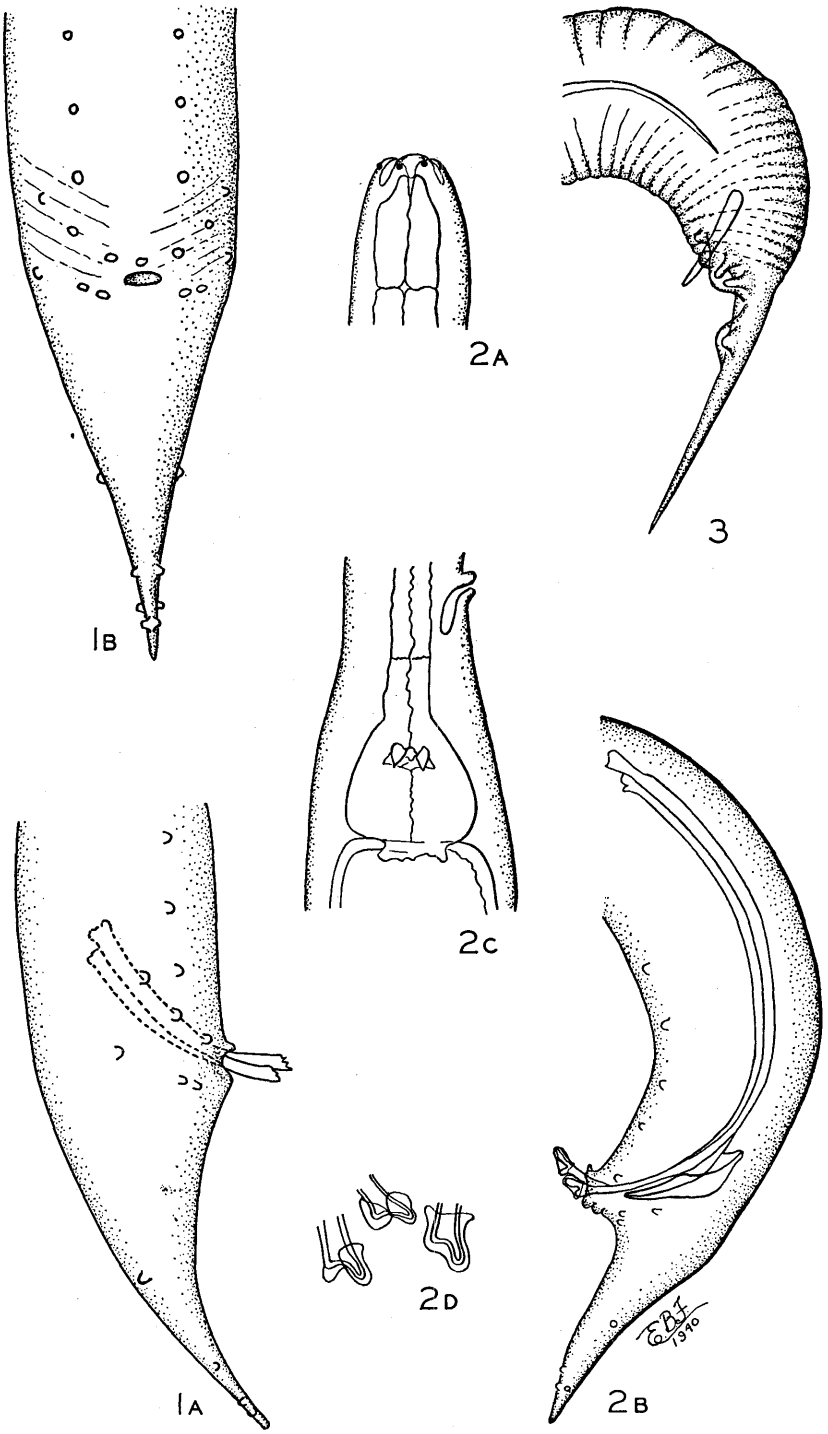

FIG. 1. *Aplectana mexicana.* A—Lateral view of tail of male. B—Ventral view of tail of male. FIG. 2. *Aplectana hamatospicula.* A—Head of female. B—Lateral view of tail of male. C—Esophageo-intestinal junction of male. D—Details of tip of spicules, showing variations in the sheath. FIG. 3. *Pharyngodon bassii,* lateral view of tail of male.

(Schneider, 1866) Miranda, 1924, or for *A. pusilla* Miranda, 1924. In addition, the tips of the spicules of the new species are sheathed. In this respect *A. hamatospicula* resembles *A. perezi* (Gendre, 1911) Yorke & Maplestone, 1926, *A. chamaeleonis* (Baylis, 1929) Travassos, 1931, *A. hylambatis* (Baylis, 1929) Travassos, 1931, and *A. brumpti* Travassos, 1931, but in these forms the spicules have rounded or pointed tips that lack any indication of any modification. Because of the shape of the tip of the spicule the specific name of *hamatospicula* is given to the new form.

Eleutherodactylus ricordii (collected at Englewood, Florida, on November 4, 1939) harbored immature female specimens of *Aplectana*. No specific identification can be given.

Microhyla carolinensis (collected at Englewood, Florida, on October 21, 1939) contained immature males and females of an Aplectanid species. These may be young forms of *Aplectana hamatospicula*, adults of which have been collected from the same species of host from the same locality, and taken at the same time of the year, but the specimens are not mature enough to show the adult structures upon which the species differentiation depends.

Bufo valliceps (taken near New Orleans, Louisiana, on October 5, 1939) contained adult female aplectanids quite different from any thus far reported from North American hosts. They resemble closely certain South American species, viz., *A. micropenis* Travassos, 1926, and *A. vellardi* Travassos, 1926, but in the absence of male material no species designation is attempted.

The genus *Pharyngodon* is represented by 4 species as parasites of Amphibia. Of these 4, only *P. spinicauda* (Dujardin, 1845) Seurat, 1917 (first described from a reptilian host, but later reported from *Triturus vulgaris*—Europe) is represented by both sexes, the other 3 species being based on female material only. The present collection contains both male and female specimens of another species of *Pharyngodon*, affording the first example of a species that can be established on material of purely amphibian origin.

Pharyngodon bassii, n. sp. (Fig. 3)

Description.—Based on male and female specimens. With the characteristics of the genus.

Male: Length, 1.74 mm; greatest width, 0.122 mm; length of esophagus, 0.3 mm; diameter of bulb, 0.075 mm; head-nerve ring distance, 0.156 mm; head-excretory pore distance, 0.42 mm; cloaca-tail distance, 0.13 mm; length of tail spike, 0.1 mm; spicule length, 0.045–0.048 mm; caudal papillae arrangement of 1 pair precloacal and 3 pairs postcloacal, with only the 2 middle pairs being pedunculate.

Female: Length, 3.2–3.6 mm; width at vulva, 0.26 mm; length of esophagus, 0.492–0.5 mm; diameter of bulb, 0.085 mm; head-nerve ring distance, 0.193 mm; head-excretory pore distance, 0.7 mm; anus-tail distance, 0.3 mm; head-vulva distance, 1.689–1.72 mm; segmenting eggs with 2 opercula measure 0.07×0.21 mm.

Host.—*Hyla septentrionalis* (collected by John Bass in Cuba on December 12, 1939).

Habitat.—Large intestine of the host.

Type specimens.—Cotypes are deposited in the Collections of the United States National Museum (No. 42088).

Discussion.—The male of *Pharyngodon bassii* is distinguishable from that of *P. spinicauda* by the different number and arrangement of the caudal papillae, by the structure of the caudal alae, and by the shape and size of the spicules. The females are distinguishable from those of *P. spinicauda* only on the basis of egg size. The absence of the buccal plates separates this species from *P. armatus* Walton, 1933. The shape of the tail and the relative proportions of the various body structures, including the ova, separates the new form from *P. batrachiensis*

Walton, 1929. The species mentioned by Wilkie, 1930, was not named or described, therefore no comparison can be made. Malan, 1939, gives a chart of the various species of the genus *Pharyngodon*. Reference to that chart indicates that the new species is distinct from any of the reported reptilian parasites as well as from those taken from amphibian hosts.

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The tolerance of 40 varieties of narcissus to a combined hot-water and formalin treatment based on the 1938–1939 experiments.[1] F. S. BLANTON, Bureau of Entomology and Plant Quarantine, and B. G. CHITWOOD, Bureau of Plant Industry, U. S. Dept. of Agriculture.

INTRODUCTION

The most satisfactory treatment known for the control of the bulb and stem nematode, *Ditylenchus dipsaci* (Kühn) Filipjev, is a 2-hour presoak in water at 70 to 80° F. immediately followed by 4 hours at 110° F. with formalin added to the treating bath at the rate of 1 part commercial formalin to 200 parts of water. The purpose of the experiment reported herein was to determine the amount of injury, if any, one might expect from such a treatment on diverse varieties of

[1] The writers are grateful to A. Frylink and Sons who loaned the bulbs for these tests. They are indebted to L. B. Reed, of the Bureau of Entomology and Plant Quarantine, for the statistical analysis.

narcissus. The criterion selected to determine the possible injury was the difference of increase in bulb weight between the treated and untreated samples. The same bulbs used in these tests are to be used over a period of years; the two lots of each variety (treated and untreated in 1938–1939) will be alternated in subsequent years.

METHODS

The bulbs were treated on Sept. 13, 1938. The beginning of the 4-hour treatment was counted from the time the bulbs reached the desired temperature. Since the bulbs were all small only 30 minutes were allowed to bring them up to 110° F. after they were submerged in the treating bath previously heated to 110° F. After treatment the bulbs were dried, then weighed individually, and both treated and untreated bulbs were dipped in 2 per cent ethyl mercury chloride (Ceresan) as a precautionary measure against basal rot; they were then planted. There were 100 bulbs to each variety except Croesus, in which case there were 2 lots of 100 bulbs each. Half of the bulbs were treated and half were left untreated to serve as checks.

Lots of 10 check bulbs and 10 treated bulbs of the same variety were planted in adjacent rows, each variety appearing in 5 different places in the field, constituting 5 replications. The bulbs were dug in August, 1939, and after they had dried sufficiently they were again weighed individually. For the statistical analysis the sampling unit was the percentage difference between the weight of a group of 10 identically treated bulbs before they were planted and their weight after they were dug.

RESULTS

For every variety the average increase in weight of the 5 lots of check bulbs was greater than the average increase of the 5 lots of treated bulbs of the same variety. In figure 1 the bars represent the differences between these two averages. The varieties are arranged in figure 1 according to their divisions (Classified List of Daffodil Names, London, 1937), and within the division they are arranged according to the magnitude of the differences between the two mean percentages. The varieties Cheerfulness and Odorus Plenus are each placed in the divisions representing their probable parentage, these being division 8 and 7 respectively.

In recording the weights at harvest the bulbs affected by basal rot were discarded and their original weights deducted from the total planting weight of the

TABLE 1.—*Analysis of variance in the tolerance of 40 varieties of narcissus to a combined hot water and formalin treatment based on 1938–1939 experiments*

Source of variation	D F	Sum of squares	Variance
Main plots			
Between variety-lots[1]	40	158,115	3,953
Between blocks	4	23,341	5,835
Error (a)	160	40,378	252
Total between main plots	204	221,834	.....
Subplots			
Between treatments	1	132,301	132,301
Interaction treatment × Variety-lots	40	28,966	724
Error (b)	164	20,650	126
Total within main plots	205	181,917	.....
Grand Total	409	403,751	.....

[1] Since the two lots of the variety Croesus had different crop histories, they have been tested separately in the analysis.

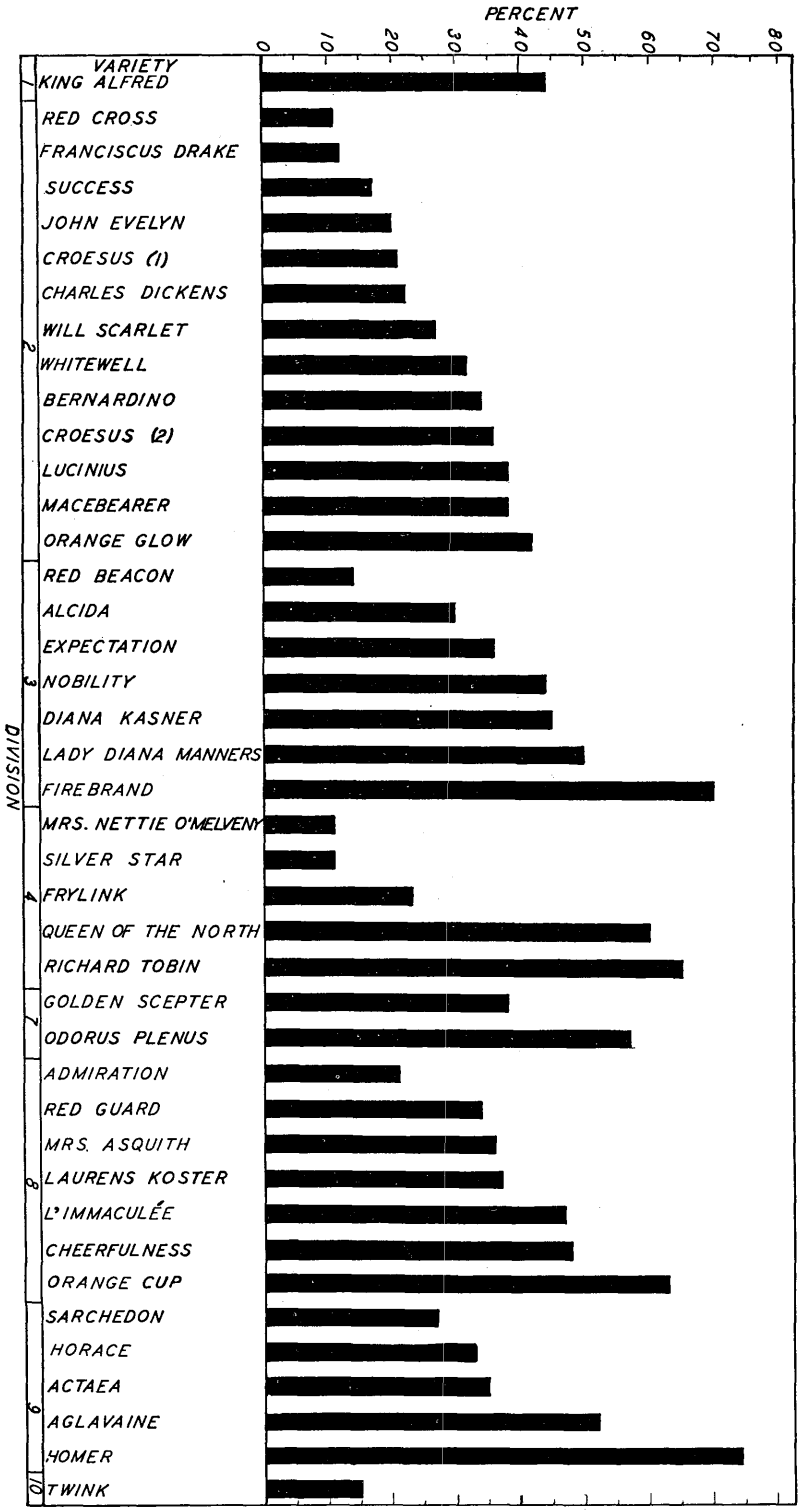

FIG. 1. Differences in the mean percentage increase in weight of untreated bulbs over the mean percentage increase in weight of bulbs treated with formalin 1: 200 at 110° F. for 4 hours after a 2-hour presoak in water at 70 to 80° F. for 40 varieties of narcissus. (Length of bar must be 14 per cent to indicate a significant difference and two bars must differ by 20 per cent to indicate significance.)

lot. This did not work in favor of the treatment as might be supposed, since a statistical analysis of the variance in the occurrence of basal rot showed that this difference, in favor of the treatment, was not significant. There was a total of 75 affected bulbs, 47 of which occurred in the check and 28 in the treated bulbs.

INTERPRETATION

An analysis of variance on the whole experiment was made and the results are indicated in table 1.

From the estimate of error as obtained from table 1, the standard error of the difference between the percentage increase in weight of the check bulbs and that of the treated bulbs was computed. In figure 1 the length of a bar must be at least 14 per cent to show a significant difference and 19 per cent to indicate a highly significant difference. The difference between any two bars must be 20 or 26 per cent to indicate significance at levels of 19: 1 or 99: 1.

The difference in the mean increases of one lot of the variety Croesus was 36 per cent and for the other lot 22 per cent. Both values may be regarded as highly significant. The difference of 14 per cent between the two bars, however, was not significant.

CONCLUSION

A treatment for 4 hours at 110° F. in formalin of 1: 200 dilution with an aqueous presoak for 2 hours at 70 to 80° F. may be expected to cause some reduction in the yield of narcissus bulbs of most varieties. The extent of this reduction will probably vary with the classified division, the variety, and possibly with different lots of the same variety.

Preliminary tests of methyl bromide as a nematocide. A. L. TAYLOR and C. W. MCBETH, Bureau of Plant Industry, U. S. Department of Agriculture.

Methyl bromide has been extensively tested by the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, for the control of insects in nursery stock, fruits, vegetables, seeds and soil. Numerous species of plants are not harmed by chemical concentrations which kill insects. Methods of treatment are discussed in a mimeographed circular published by that Bureau (B.E.P.Q. 499. June, 1939). The white fringed beetle, *Pontomorus leucloma* (Boh.) was entirely eliminated from potting soil by applications of 40 cc of methyl bromide per cubic yard (Hawkins, L. A. 1939. Bur. Ent. & Plant Quar. Circ. E–84). An emulsion containing methyl bromide and methyl alchol has been used for control of grubs of the Asiatic beetle in Azalea beds (Flor. Exch. and Hort. Trade World, 94(5): 20, 1940).

Methyl bromide has also been used in attempts to control nematodes in living plants. Clematis infested by the root-knot nematode, *Heterodera marioni* (Cornu) Goodey, were exposed to 2½ pounds of the chemical in 1000 cubic feet of space for 2½ hours without apparent effect on either nematodes or plants (N. J. Agr. Expt. Sta. Nursery Disease Notes 12(2): 5–8. 1939). Chrysanthemum plants infested by the chrysanthemum foliar nematode *Aphelenchoides ritzema-bosi* (Schwartz) were fumigated with methyl bromide at the rate of 3 pounds to 1000 cubic feet of space at 70° F. and under 15 inches of sustained vacuum. Young, recently hatched larvae were apparently killed, but other stages of the nematode were not killed. Plants were slightly injured (Christie, J. R. and Cobb, Grace Sherman. 1940. Proc. Helminth. Soc. Wash. 7(1): 62).

EXPERIMENTS

Sandy loam soil infested by *H. marioni* was placed in a fumigation box of 1 cubic meter capacity. The soil formed a layer 15 cm deep over perforated pipes

in the floor of the box. Moisture content of the soil was 5.2 per cent and temperature was 27° C. at beginning of treatment. Approximately 53 cc of methyl bromide were introduced into the box through the pipes. This amount corresponds to 5.6 pounds per 1000 cubic feet of space.

The methyl bromide was the regular commercial grade having a boiling point of about 4.6° C. and was measured at 0° C. (This should not be confused with the mixture of 25 per cent methyl bromide in methyl alcohol which is also obtainable commercially.)

The fumigation box remained closed for 72 hours and the soil was then removed, placed in pots, and cucumbers were planted. Stand of cucumbers in the treated soil was a little better than that in similar soil which was not treated. Roots from both treated and untreated soil were uniformly and heavily infested by root-knot nematodes.

In a similar experiment, 80 cc of methyl bromide were used to treat soil having a moisture content of 3.3 per cent and a temperature of 30° C. Stand of cucumbers in untreated soil was only about one-third of that in treated soil. Roots from treated soil were extraordinarily long and numerous and were free from root-knot and other disease symptoms. Roots from untreated soil were heavily infested by *H. marioni* and were short and discolored. Many plants in the controls damped off, but there was no sign of this disease in the fumigated soil. Growth of tops corresponded to root development in the two lots of soil. Free-living nematodes were numerous in the untreated soil and absent in the treated soil.

One hundred and fifty tomato plants heavily infested by root-knot nematodes were fumigated in the box, using 23 cc of methyl bromide. This amount corresponds to 2½ pounds of methyl bromide to 1000 cubic feet of space. Plants were left in the closed box for 18 hours. Fifty similar plants were left untreated. When removed from the box, the fumigated plants appeared to be unharmed, so all the plants were transplanted to steam-sterilized soil. More than half the treated plants died within a week and less than 10 per cent survived more than 2 weeks. Control plants survived and grew normally considering their heavy root-knot infestation. The surviving fumigated plants were defoliated and the roots severely injured, but a few produced new roots and leaves and some even bore fruit. New roots of treated plants were only lightly infested by nematodes, while those of untreated plants were heavily infested. Microscopic examination of the roots of the treated plants indicated that adults, eggs, and larvae in the galls less than 2 mm in diameter had been killed, but adult females and eggs in the larger galls were not harmed. No larvae were found in the larger galls.

Methyl bromide was also used to fumigate a plot arranged for steam sterilization by the buried tile method. This plot contains 12 lines of drain tile spaced 18 inches apart and buried 18 inches under the soil. The tile lines are connected in 3 groups of 4 lines each, each group being designed to sterilize 225 square feet of soil. The soil surface was covered with glue-coated kraft paper to check escape of the gas and methyl bromide was introduced into 2 of the groups of tile lines. One section of 4 lines received 1½ pounds of methyl bromide, another similar section received 3 pounds of methyl bromide and the third section was left untreated. Soil temperature was 25° C. and soil was moderately damp at the time of treatment. The paper cover was removed after 3 days and lima beans were planted in continuous rows across the plot. Examination of the roots of these at the end of 1 month gave the following results:

Soil treated with 1½ pounds of methyl bromide—8 per cent of plants infested by *H. marioni.*

Soil treated with 3 pounds of methyl bromide—28 per cent of plants infested by *H. marioni.*

Untreated soil—93 per cent of plants infested by *H. marioni*.

Roots from untreated soil were moderately to heavily infested, while those from treated soil were lightly infested. The excess of infested plants where 3 pounds of methyl bromide was used was probably due to washing in of nematodes after treatment. This section was on the low side of the plot and several heavy rains fell during the growing period.

DISCUSSION

While it should be emphasized that the above experiments were of a preliminary nature, the results clearly indicate that methyl bromide is an effective soil nematocide for use against the root-knot and free-living nematodes.

Increased root and top growth of cucumber plants in fumigated soil was undoubtedly partly due to control of root-knot. The absence of damping off indicates that bacteria and fungi were also controlled; therefore, it seems possible that increased growth may also have been partly due to control of these factors and to the stimulating effect of soil sterilization.

Eradication of root-knot nematodes from living tomato plants by fumigation with methyl bromide appears to be impractical.

Fumgiation of the tiled plot suggests a method of applying methyl bromide to soil in greenhouse benches and seed beds.

SUMMARY

Methyl bromide appears to be an effective soil nematocide for use against the root-knot and free-living nematodes. Satisfactorily results were obtained in preliminary trials using 80 cc of methyl bromide to treat a layer of soil 15 cm thick in a fumigation box of 1 cubic meter capacity. Fair results were obtained using 1½ pounds of methyl bromide to treat 225 square feet of soil when the chemical was applied through hollow tile lines buried 18 inches under the soil and 18 inches apart. Some evidence was found that the chemical also controls fungi and bacteria in the soil. An attempt to eliminate root-knot nematodes from tomato plants by fumigation with methyl bromide was unsuccessful. Nematodes in the larger galls were not killed and most of the plants were killed or severely injured.

Anomyctus xenurus, a new genus and species of Tylenchoidea (Nematoda).

MERLIN W. ALLEN, U. S. Bureau of Plant Industry, Salt Lake City, Utah.

About 25 specimens of this new species were secured from soil collected near the roots of shadscale, *Atriplex confertifolia* (Torr. and Frem.) S. Wats., west of Utah Lake, Utah, the desert habitat of the sugar-beet nematode, *Heterodera schachtii* Schmidt. All of these specimens appeared in one of 14 soil collections made in this area, indicating that the species is rather uncommon. The genus is related to *Aphelenchus*, *Aphelenchoides* and similar forms but because of the present unclassified status of this group it can be designated only as one of the Tylenchoidea.

Anomyctus, new genus

Diagnosis.—Tylenchoidea: Wing area marked by 3 longitudinal striae. Lip region set off by constriction, bearing a shallow, sclerotized, bowl-shaped, frontal disc. Spear linear without basal knobs. Esophageal glands free in the body cavity, the dorsal one greatly developed, the 2 submedian ones small, obscure and located close to the median bulb. Intestine connected directly to bulb. Ovary single, outstretched. Posterior uterine branch rudimentary. A pair of very minute lateral caudal pores open in the second annule from the terminus.

Type species.—*Anomyctus xenurus*, n. sp.

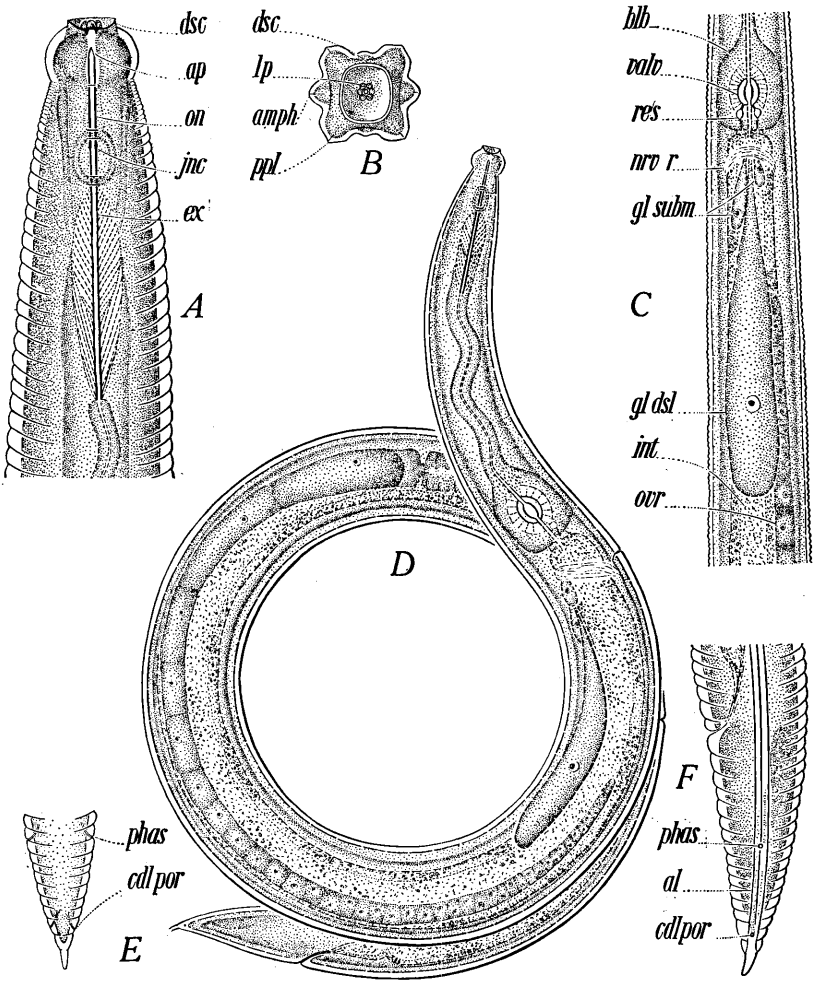

FIG. 1. *Anomyctus xenurus.* A—Anterior portion of body; *dsc,* frontal disc; *ap,* spear aperture; *on,* spear; *jnc,* junction of spear and extension; *ex,* spear extensions; ×1350. B—*En face* view of head; *dsc,* frontal disc; *lp,* liplets; *amph,* amphid, on outer margin of lateral lip; *ppl,* papilla on submedian lip; ×1350. C—Dorsal view of posterior portion of neck region; *blb,* bulb; *valv,* valve; *res,* reservoir in duct of submedian gland as it appears when filled with glandular secretion; *nrv r,* nerve ring; *gl subm,* submedian esophageal glands; *gl dsl,* dorsal esophageal gland; *int,* intestine; *ovr,* ovary; ×500. D—Female; ×500. E—Ventral view of tail; *phas,* phasmid; *cdl por,* caudal pore; ×1000. F—Lateral view of tail; *phas,* phasmid; *al,* wing area; *cdl por,* caudal pore; ×1000.

Anomyctus xenurus, new species

Diagnosis.—Total length = 0.68 mm; $\alpha = 28.7$, $\beta = 5.9$, $\gamma = 23$, $V = {}^{48}76^{6}$.

With characters of the genus as given above. Width of head nearly one-half the width of the neck at base. Body cylindroid, the diameter being nearly constant between the base of the neck and anal opening. Cuticle rather coarsely striated, the annules in latitude of the uterus being 1.8 μ in width, those at the base of the spear 1.6 μ, then diminishing in width anteriorly until those at the

base of the lip region are only about 0.3 μ wide. Lip region bearing 6 obscure lips and an inner circle of 6 liplets surrounding the oral opening in the heavily sclerotized bowl-like frontal disc. This disc is probably formed by the fusing of the cheilorhabdions. The papillae are located on the outer margins of the submedian lips, while the amphids are on the outer margins of the lateral lips which are slightly posterior to the submedians. Spear 35 μ long, linear, without basal knobs, its guiding apparatus consisting of an inconspicuous ring at the base of the vestibule and a somewhat more conspicuous collar a short distance posterior to the first ring. Basal portion of the spear surrounded by an elongate bundle of muscular tissue.

Esophagus rather slender to the median bulb. Bulb slightly elongate and three-fourths the body width. Dorsal esophageal gland opening into the lumen of the bulb anterior to the valve. Submedian esophageal glands opening into the posterior portion of the valve. The ducts of the esophageal glands within the bulb are enlarged into small reservoir-like chambers which frequently appear as globular swellings and apparently serve as receptacles for the gland secretions. These chambers are best seen in living specimens. Intestine set off from bulb by only a narrow constriction. Nerve ring encircling the intestine one-half body width behind bulb. Excretory pore opposite nerve ring. Submedian esophageal glands on either side of intestine and extending 1 body width or less behind nerve ring. Dorsal esophageal gland extending 4 body widths posterior to bulb, gland one-half as wide and one-fourth as thick as width of body. Nucleus of dorsal gland usually centrally located. Ovary single, outstretched forward, the anterior end extending to the vicinity of the dorsal esophageal gland and containing about 40 oöcytes arranged in single file. Eggs one-half body width and 3 times as long as wide. Uterus 3 body widths in length, separated from the ovary by a sphincter muscle. Vulva a transverse slit without conspicuous lips. Posterior uterine branch rudimentary, extending 1½ body widths posterior to vulva. Rectum 1¾ times anal body diameter. Phasmids located near middle of tail. A pair of caudal pores is situated near the terminus; sometimes they are seen to produce thread-like strings of secretions. Tail ending in a small, slightly blunt terminal process. Males unknown and gravid females contain no spermatozoa, indicating that males ordinarily do not exist.

Above description based on living specimens. Illustrations and measurements from fixed specimens mounted in glycerine.

Type locality.—Desert two miles west of Utah Lake above the abandoned Mosida irrigation project, Utah.

***Rhabditis chitwoodi*, n. sp., a nematode found in diseased *Sagittaria* corms, with remarks on *Rhabditis conica* (Reiter), n. comb.** JONAS L. BASSEN, U. S. Bureau of Entomology and Plant Quarantine.

Numerous large nematodes were found in corms of diseased *Sagittaria* sp. from Wisconsin inspected for export certification by Mr. O. G. Fitzgerald of the New York office of the Bureau of Entomology and Plant Quarantine. The nematodes were referred to the author, also stationed at the New York office, for specific determination. There was no evidence of fungous pathogens as a cause of the diseased condition and no attempt was made to isolate the bacteria present. *Pristionchus aerivora* (Cobb, 1916) Chitwood, 1938, and a new species of *Rhabditis* were identified.

In the original material males and females of the *Rhabditis* were present in equal numbers. The sex ratio is the same in thriving cultures reared on an artificial medium (nutrient agar, pH 7.3). When a culture begins to degenerate

marked abnormalities in the sex ratio are observed and ensheathed larvae appear. The food in these cultures is common air- and water-borne bacteria. Fungus growth acts as a deterrent to the growth of the nemas.

Mature females when placed in water are extremely active and quick in their movements despite their large size. Their uteri are filled with large numbers of eggs (80 to 100) containing first-stage larvae. The species is clearly viviparous, since in many specimens the hatched larvae in the uteri were observed thrashing about vigorously in their efforts to escape the maternal prison. Under low power of the microscope the prerectal part of the intestine is readily distinguishable from the anterior part by the lighter color of its cell inclusions.

Rhabditis chitwoodi, n. sp.

Description.—Cuticle about 1.5 μ in thickness, with fine transverse striations. The distance between striae is 1.5 μ. Besides the transverse striation, the cuticle exhibits longitudinal ridges about 1.5 μ wide, extending the entire length of the body; between these longitudinal ridges in each interstrial area are 2 rod-like structures due to cuticular punctation. The labial region is not set off from the

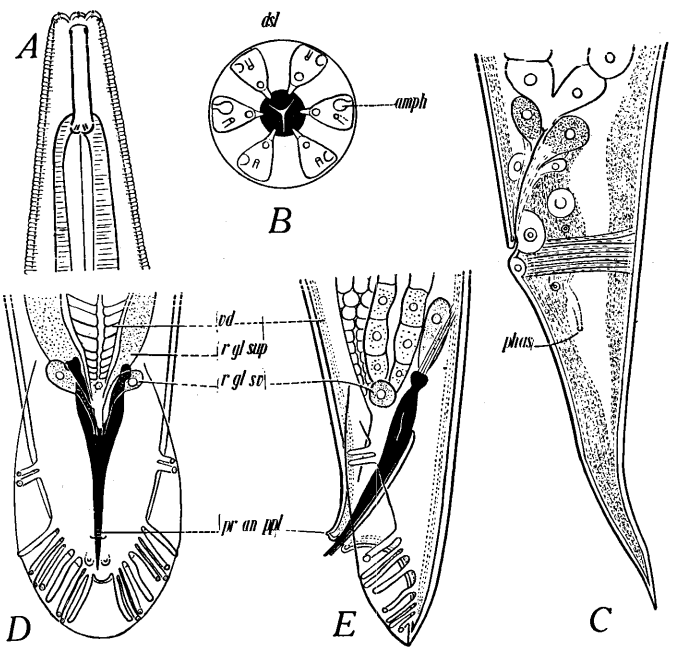

FIG. 1. *Rhabditis chitwoodi*, n. sp. A—Lateral view of anterior end; ×466. B—*En face* view of head, free hand; *amph*, amphid. C—Posterior end of female, lateral view; *phas*, phasmid; ×466. D—Male tail end, ventral view; *vd*, vas deferens; *sv r gl*, subventral rectal glands; *r gl sup*, supplementary rectal glands; *pr an ppl*, preanal supplementary papilla; ×466. E—Male tail, lateral view; ×466.

rest of the body; lips 6, discrete, with an internal circle of 6 and an external circle of 10 papillae. The amphids are pore-like, situated dorso-laterally on the lateral lips. Stoma rhabditoid, 30 (27 to 33) μ long and 6 μ wide. Cheilorhabdions not clearly set off from the prorhabdions, appearing as a short, slightly thicker apical portion; distinct glottoid apparatus present. Esophagus typically rhabditoid, divisible into corpus with oval middle bulb, isthmus, and terminal valvular bulb.

Excretory pore on a level with top of terminal esophageal bulb. The excretory

apparatus consists of a short cuticularized terminal canal which leads into a sinus cell connected posteriorly with 2 very large subventral excretory cells. From the sinus cell there are 2 pairs of lateral canals, one pair extending cephalad and the other pair extending caudad. It is difficult to follow these lateral canals to their termination. Auxiliary excretory system absent.

The female reproductive system is amphidelphic. Ovaries 2, reflexed, their blind ends located at a point approximately on a level with the vulva. Vulva protruding slightly from the body; a distinct seminal receptacle is absent; fertilization chamber filled with numerous spherical sperms. The female tail is conical, almost attenuate. Phasmids about one-half anal diameter below anus.

Male reproductive system with a single reflexed testis. Two large ejaculatory glands present, distinctly set off from the vas deferens; the duct of these glands unites with the vas deferens anterior to the head of the spicules. A pair of small supplementary rectal glands present, extending about 2½ anal body diameters anterior to head of spicules. These supplementary rectal glands unite with the cloaca slightly below the head of the spicules. Spicules of equal length, capitate, fused for two-thirds their length distally. Gubernaculum approximately two-thirds the length of the spicules. Bursa peloderan, not fused anteriorly. A conspicuous preanal supplementary papilla present. Bursal papillae 10, in 2 groups; 2 preanal, 8 postanal. The postanal papillae while forming a single group are spaced in relation to one another (numbered successively from first preanal papilla caudad) as follows: 3, 4, 5, 6–7–8, 9, 10. Of the 10 papillae, 3, 7, and 10 terminate dorsally and the remainder ventrally. The first two preanal papillae do not reach the edge of the bursa, 3 extends slightly beyond the edge, 5 and 9 reach the edge, and the remaining papillae vary in the distance to the edge of the bursa as in figure D.

Measurements.—Female: Total length = 2 mm (1.4 to 2.5); $\alpha = 19.5$ (15.4 to 22.2); $\beta = 7$ (5.2 to 7.9); $\gamma = 14.9$ (11.3 to 17.9); V = 53%; Eggs = (average) 51 μ by 32 μ. Male: Total length = 1.3 mm (0.98 to 1.55); $\alpha = 19.6$ (18 to 22.7); $\beta = 6$ (5.2 to 7.8); $\gamma = 37.2$ (33 to 45); spicule length = 63 μ (59 to 69); gubernaculum length = 42 μ (36 to 50).

Diagnosis.—*Rhabditis* closely resembling *R. strongyloides* Schneid., 1860, in striation of cuticle, in fusion of the spicules for two-thirds their length distally, and in presence of preanal supplementary papilla. The present species differs, however, in that the lips are not set off from the body, that the female tail is longer, conical, almost attenuate, and that a distinct seminal reservoir is absent. The prerectal portion of the intestine in both species appears lighter in color than the anterior portion. An easily recognizable difference exists, however, in the more tapering appearance of the intestine as it approaches the rectum in *R. chitwoodi* as against the bowl-shaped appearance at the same level in *R. strongyloides*. The species is easily separated from *R. terricola* Duj., 1845, *R. cylindrica* Cobb, 1898, *R. icosiensis* Maupas, 1916, and *R. conica* (Reiter), new rank, on the basis of the extent of the fusion of the spicules and the lips not being set off as in all these species.

Discussion.—*Rhabditis chitwoodi* evidently belongs to the group of closely allied species which includes *R. terricola, R. strongyloides, R. cylindrica, R. icosiensis,* and *R. conica.* All these species agree in that the males possess fused spicules and are peloderan. It is significant that they likewise possess similar reproductive characteristics; they are all prolific and usually viviparous.

An examination of material of *Rhabditis pellio* var. *conica* Reiter, 1928, herein designated in a new rank, resulted in placing it in the above group rather than as a variety of *R. pellio* Schneid., 1866. Reiter hesitantly made this species a variety of *R. pellio,* even though he indicated more points of similarity with *R. terricola* (= *R. teres* Schneid., 1866) than with the former. Since Reiter made the shape of

the female tail a principal diagnostic character in his key to the species of *Rhabditis*, he was forced to place this species as a variety of *R. pellio*. A more natural division of the species of *Rhabditis* is one based on the presence or absence of fusion of the spicules.

The new species described herein is dedicated to Dr. B. G. Chitwood of the Bureau of Plant Industry, U. S. Department of Agriculture, Babylon, N. Y., who has examined specimens and confirmed the species as new, and who has given many helpful suggestions in the preparation of this paper.

The writer wishes to thank Mr. G. Thorne of the Bureau of Plant Industry, U. S. Department of Agriculture, Salt Lake City, Utah, for the loan of specimens of *Rhabditis conica*.

***Panagrolaimus hygrophilus*, n. sp., a nematode found in decayed tubers of the waterlily root, *Nelumbium nucifera* Gaertn.** JONAS L. BASSEN, U. S. Bureau of Entomology and Plant Quarantine.

Tubers of *Nelumbium nucifera* in regular cargo shipments from Cuba, inspected at New York by inspectors of the Bureau of Entomology and Plant Quarantine, are occasionally found to harbor various saprophytic nematodes. One lot of these tubers which exhibited an internal wet rot contained numerous slender nematodes of the genus *Panagrolaimus*.

An agar culture and fixed specimens of this form were sent to Dr. G. Steiner of the Bureau of Plant Industry, United States Department of Agriculture, Washington, D. C., for specific identification. Subsequent determination indicated this form as new to science. The name *Panagrolaimus hygrophilus* is therefore proposed for this species.

Specimens of *Panagrolaimus hygrophilus* were readily kept alive in Syracuse watch glasses with water containing pieces of host tissue. After 2 months in such cultures, there was no marked diminution in the prolific population first observed. The species is hermaphroditic or parthenogenetic, since males were never found in any of the cultures. In order to determine the rate of growth of a population in a water culture, preadult females were individually isolated in deep microscope well slides containing varying amounts of *Nelumbium* tissue. The highest number of larvae produced by a single female over a period of 6 days was 120. The eggs are laid in either an unsegmented or few-celled stage and the larvae reach maturity in from 5 to 8 days at room temperature. In nutrient agar cultures the females are in the main viviparous, and resistant larvae are formed under adverse conditions. The presence of a moderate fungus growth of a species of *Fusarium* did not inhibit the development of the nematodes. In tap water alone preadult females failed to mature.

Panagrolaimus hygrophilus n. sp.

Description.—Female slender, with long, conical, almost attenuate tail. Cuticle with fine, transverse striae, less than 1.5 μ wide. The lateral fields bordered by the alae are approximately 3.5 μ wide and extend almost the entire length of the body. Between the bordering lateral alae there are 2 additional, much fainter alae. The head is not set off from the rest of the body. Lips 3, faint, round, hardly bilobed; fusion of the lips evidently more complete in this species than in other members of the genus. In en face view, the internal circle of 6 papillae, 2 on each lip, show up very clearly; 4 papillae of the external circle, 2 on each ventro-submedial lip were also noted. The amphidial pores open on the lateral surface at the height of the outer circle of cephalic papillae. In a dorsal view of the head, the ducts and amphidial pouch show up very well. The stoma is divisible into three regions, cheilostom, protostom, and telostom. The rhabdions of each

region differ markedly in the extent of sclerotization. As a result the stomatorhabdions appear to be broken up into sclerotized and nonsclerotized areas which are not well defined. The homology of the stomatorhabdions with the basic rhabditoid type is indicated in figure 1, A.

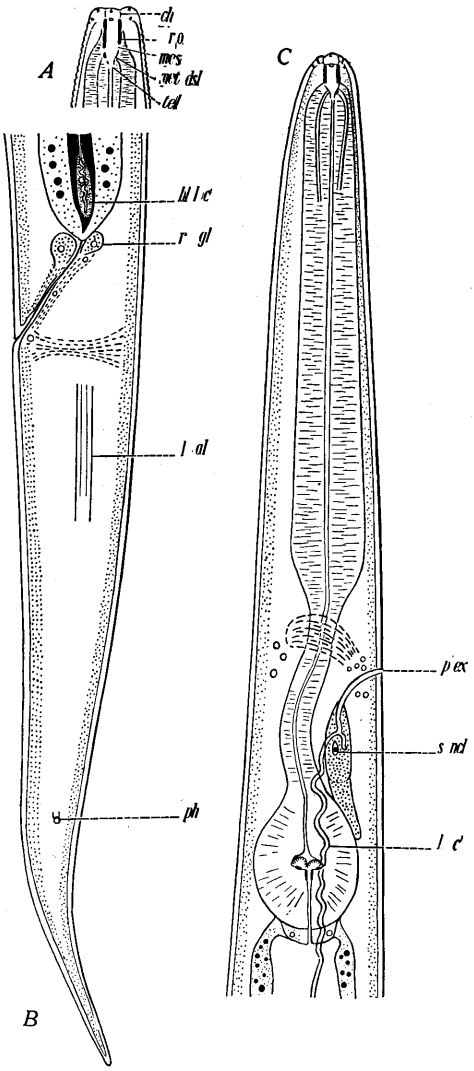

FIG. 1. *Panagrolaimus hygrophilus*, n. sp. A—Lateral view of head; *ch*, cheilorhabdions; *pro*, prorhabdion; *mes*, mesorhabdion, nonsclerotized; *met dsl*, dorsal metarhabdion; *tel*, telorhabdion, nonsclerotized; × 666. B—Lateral view of posterior end of another specimen; *bl l c*, blind end of lateral canal; *r gl*, rectal gland; *l al*, lateral ala; *ph*, phasmid; × 666. C—Lateral view of anterior end; *p ex*, excretory pore; *s ncl*, nucleus of sinus cell; *l c*, lateral canal; × 666.

Esophagus strongly muscular throughout; divisible into a cylindrical corpus which surrounds the base of the prorhabdions, a narrow cylindrical midregion, the isthmus, only one-third the length of the corpus, and an oval bulb with a

well developed valvular apparatus. Cervical papillae not observed. Excretory system of the "inverted-U type," consisting of a long, cuticular, terminal duct; a well developed sinus cell with a large sinus nucleus; one subventral excretory cell connected with the sinus cell and two posterior lateral canals. The existence of a single subventral excretory cell in lateral view of toto mounts indicates the possibility of a second cell thus far not observed, since they are usually paired. Further study is needed to clarify this point, however. The lateral canals were traced to their terminus on a level with the rectum. At the blind ends the canals are enlarged and the lumen is extensively coiled. Female reproductive system prodelphic; anterior reflexure at about 32 per cent of body length; uterus with a short, postvulval, uterine branch, about 1 body diameter in length; oviduct and ovary straight; blind end of ovary from one-third to 3 body diameters anterior to anus. Eggs few, maximum of 12 in uterus at any one time. Rectum about 26 μ to 30 μ in length; rectal glands 3, 1 dorsal and 2 subventral. Tail long, conical, posterior third narrowing sharply to a fine but usually obtuse terminus. Phasmids at approximately two-thirds the distance from anus to tip of tail.

Measurements.—♀: total length = 1.04 to 1.57 mm; $\alpha = 27$ to 34; $\beta = 5.4$ to 6.8; $\gamma = 7.4$ to 9.2; V = 50 to 58.7 per cent; Eggs = (average) 55 μ by 21 μ.

Diagnosis.—Syngonic *Panagrolaimus* resembling *Panagrolaimus rigidus* (A. Schneider, 1866) Thorne, 1937, but differing in the following respects: (a) body more slender; (b) lips 3, not duplex, low, more broadly rounded; (c) tail longer, over 5 anal diameters; (d) males absent.

Type locality.—Cuba.

Type host.—*Nelumbium nucifera* Gaertn.

Thanks are due to Mr. Max Kisliuk, Jr., Inspector in Charge, Division of Foreign Plant Quarantines, Bureau of Entomology and Plant Quarantine, New York, N. Y., for his constant interest and cooperation in the writer's study of nematode material at the port of New York, and to Mr. W. S. Fields of the same office for the aid which he has given in the identification of fungi associated with nematodes in plant material. Dr. G. Steiner, of the Bureau of Plant Industry, United States Department of Agriculture, has been extremely helpful in allowing the writer to compare notes on this species.

MINUTES

Two hundred fifth to two hundred twelfth meetings

The 205th meeting was held October 18, 1939. The following officers were elected for the year: E. E. Wehr, president; C. W. Rees, vice-president; E. M. Buhrer, corresponding secretary-treasurer; J. F. Christensen, recording secretary. Dr. Mario Mollari was elected to membership. Among the visitors were Juliette M. Oliveira and the Hon. Miriam Rothschild, who presented papers. Other papers were given by Sarles, Foster and Christie.

The 206th meeting was held November 15, 1939. Dr. Otto was reelected to the Editorial Committee of the Proceedings. Mr. J. L. Bassen was elected to membership. Dr. Steiner introduced G. Rahm of Switzerland, who presented a paper on studies on the resistance of nematodes, tartigrades and rotifers to low temperatures. Papers were presented by Steiner, Habermann and Farr.

The 207th meeting was held December 20, 1939. The recording secretary read a letter from the Washington Academy of Sciences announcing their intention to publish a series of monographs. Interested members of affiliated societies were invited to communicate with Mr. Henry B. Collins, Jr., Smithsonian Institute, Chairman of the committee on monographs. Mr. J. L. Avery was elected to membership. Dr. Price was reelected resident vice-president to represent the Society

in the Washington Academy of Sciences. Papers were presented by Price, Steiner, McIntosh, Harwood, Cram, Allen, Schwartz and Rees.

The 208th meeting was held January 17, 1940. Dr. Steiner announced that the financial report of the Ransom Memorial Fund would be published in the next issue of the Proceedings. Dr. Schwartz commented on the December meetings of the American Society of Parasitologists at Columbus, Ohio. Papers were presented by Steiner, Spindler and Kates.

The 209th meeting was held February 21, 1940. It was decided that the May meeting be held at Beltsville and a committee, headed by Dr. Dikmans, was appointed to make arrangements. The recording secretary read a letter of greeting to the Society from Henry B. Ward. Papers were presented by Luttermoser, Jerstad, Guthrie, Lotze and Rees.

The 210th meeting was held March 20, 1940. Dr. Dikmans announced plans for the May meeting at Beltsville, and $15 to $20 of Treasury funds were made available to defray costs. Dr. Guthrie was elected to membership and Dr. Sarles reinstated. Papers were presented by Dikmans, Shorb and Otto. Dr. Shahan, of the Pathological division, Bureau of Animal Industry, discussed current knowledge of equine encephalomyelitis.

The 211th meeting was held April 17, 1940. Vice-president Rees presided in the absence of Dr. Wehr. Papers were presented by Cort, Christensen, Rees and Farr. Dr. Schwartz commented on the progress of work at the U. S. Regional Animal Disease Laboratory, Auburn, Alabama.

The 212th meeting was held at the log lodge at Beltsville, Md., on May 18, 1940. This meeting was entirely social. A picnic lunch was served at 5:00 P.M. by members of the Society to approximately 100 people, including members, with their wives, families, friends and special guests from the School of Hygiene, Baltimore.

JOHN F. CHRISTENSEN,
Recording Secretary.

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