follows: Place fifty grams of dry soil in the cup, in the case of sandy soils 100 grams, add 5 cc of 1N KOH, fill cup with distilled water one and one half inches from the top and stir it by the motor for nine minutes. The mixture is then washed into a cylinder having a total capacity of about 1,130 cc. The hydrometer is placed in the cylinder and the latter is filled clear to the top with the hydrometer still in it in order to facilitate the reading of the hydrometer from the top of the liquid column. The hydrometer is then taken out, and the mixture is stirred vigorously for about a minute, using one palm as a stopper. The cylinder is placed on the table and the time is quickly noted, preferably by a stop watch. The hydrometer is put in the mixture and at the end of fifteen minutes the reading is noted. Just about half a minute before the fifteen-minute period is up, however, the hydrometer is pushed down gently in order to avoid any lagging. The reading, which is grams per liter, is divided by the weight of sample taken, and the result is percentage of colloids in that soil. The temperature of the mixture is also noted and the necessary correction made. All readings must be reduced to 67° F., which is the temperature at which the hydrometer was calibrated. A change of 1° F. makes a difference of about 0.35 per cent. of colloids. For temperatures above 67° F. the corresponding amount is added to the percentage indicated by the hydrometer, and for temperatures below 67 the amount is subtracted.

The hydrometer gives an average measurement of the densities for the entire column of liquid, down to where the solid soil column is formed. To make allowance for the water required to saturate the soil, 1,050 cc of water is added to every fifty grams of soil. A special cylinder is made which, when filled entirely with soil and hydrometer in it, will contain 1,050 of water, and thus the necessity of having to measure the water every time is eliminated. An ordinary 1,000 cc cylinder may also be used by making a mark of the proper volume.

The method may appear empirical, but it really gives quite absolute results. The results it yields are also absolutely comparable for different soils. For instance, the rate of settling of soil particles is governed largely by their size. This being the case, then the amount of material staying in suspension at any given time has about the same average size of particles for the different soils. The hydrometer, when floating, is governed entirely by physical laws without any outside factors entering or any personal element entering into it. Its readings, therefore, are quite accurate.

Since the hydrometer method gives absolutely comparable results for the different soils, and since the results show a very close relationship with the results of the heat of wetting method, it probably means then that the heat of wetting method for determining the colloidal content of soils has been a correct method. Evidently, both methods tend to measure the same thing.

From all our present knowledge, it appears that the hydrometer method can be employed to determine the colloidal content of soils, quite accurately. The method is also very rapid, the colloidal content of more than three soils can be determined in less than one hour, using only one hydrometer.

The hydrometer can also be used to measure the rate of settling of soil particles from which a distributed curve should be worked out.

Referring once more to the dispersing machine there are two things that must be strictly guarded against, the first is that the cup must have the baffles or wires in it, and the second is that the paddle or button on the stirring rod tends to wear out in sandy soils. When it becomes flat it must be replaced, because in the flat condition it loses its stirring efficiency. With these two precautions to watch out for, it can be said that this machine is most wonderful for dispersing soils for any purpose.

The detailed report of this work will appear in *Soil Science* shortly.

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SPECIAL ARTICLES

THE LIFE HISTORY OF TAPEWORMS OF THE GENUS MESOCESTOIDES

THE generic name *Dithyridium* Rudolphi, 1819, has been used by zoologists to designate agamic cestodes having an elongate body and containing an invaginated scolex which bears four suckers but lacks both hooks and a rostellum. These larval parasites have been reported from a variety of mammalian and non-mammalian hosts, in most cases in relation with the body cavity and its membranes and viscera. In one instance they have been reported from the voluntary muscles and the heart. Morphologically these larvæ appear to occupy a position intermediate between those of pseudophyllid and cyclophyllid cestodes, their general body shape resembling that of the former, whereas the scolex is suggestive of a cyclophyllid tapeworm.

Although there has been some speculation as to the relationship of these larvæ to known strobilate tapeworms, no conclusive experimental work designed to elucidate the ultimate development of Dithyridium

larvae has been published up to the present time.[1] Neumann (1896), Ransom (1907) and some other investigators have been struck by the morphological similarity of the scolex of Dithyridium and that of the genus Mesocestoides parasitic in the intestine of various mammals and birds. Neumann appears to have been the first investigator who suggested a connection between Dithyridium and Mesocestoides. Unfortunately, that investigator postulated what appears to be an unsound biological hypothesis to account for this relationship and his experimental work designed to test his hypothesis is decidedly inconclusive, a fact which he himself recognized. Neumann was inclined to regard Dithyridium as an erratic, immature cestode (Mesocestoides) which succeeded in reaching the body cavity apparently as a result of perforating the stomach or intestinal wall or in some other manner and which was destined to perish in this location without completing its further development. He also postulated a direct life cycle for Mesocestoides and expressed the opinion that the ingestion of hexacanth embryos of this tapeworm by a suitable host probably results in the development of a mature strobilate tapeworm in the intestine.

Recent investigations by the present writer have shown Neumann's interpretation of Dithyridium to be erroneous. Not only have these parasites a typical larval organization, consisting of a simple unsegmented ribbon-shaped body and an invaginated head provided with four suckers, but in common with other infective larval tapeworms they are capable of reaching maturity in the small intestine of a suitable definitive host. When ingested by a susceptible host Dithyridium develops into a strobilate tapeworm belonging to the genus Mesocestoides. Dithyridium thus bears the same morphological and biological relationships to Mesocestoides as Sparganum bears to Diphyllobothrium and as Cysticercus bears to Tænia.

Briefly stated, the writer succeeded in rearing Mesocestoides in dogs and cats as a result of feeding them Dithyridium obtained from the peritoneal cavity and lungs of a mongoose. As early as forty-six days after ingestion of Dithyridium, gravid segments of Mesocestoides were found in the feces of dogs which prior to experimental infection were ascertained to be free from cestodes. Fifty-one days after experimental ingestion of five live specimens of Dithyridium, five mature specimens of Mesocestoides were recovered from a cat at necropsy. Before ingesting the larvæ the cat was free from tapeworms so far as fecal examinations showed anything. As Mesocestoides has never been found in native dogs and cats in the Eastern United States, it seems safe to assume that that no such worms were present.

On the basis of these experiments, which it is hoped will be supplemented by the results of additional feeding tests which are now in progress, it may be safely concluded that the definitive host becomes infected with Mesocestoides as a result of devouring a carcass or a portion of a carcass of an animal harboring Dithyridium and that the latter is not a tapeworm which has accidentally strayed from its course but is a true larva in a normal location in an intermediate host.

It still remains to be determined whether the hexacanth embryos contained in the egg capsule of each gravid proglottid of Mesocestoides are capable of infecting the intermediate host directly, as is known to be the case in cyclophyllid cestodes whose life histories have been determined, or whether the embryos undergo their earlier larval development in an invertebrate, intermediate host before they can metamorphose into infective larvæ in a vertebrate, intermediate host. The answer to this question must await the results of experiments which are now in progress.

While this investigation was in progress an abstract[2] of a paper in Russian by Skrjabin came to the writer's attention. Among other references to Professor Skrjabin's recent work in helminthology was the statement that he had found that mice are the intermediate hosts of *Mesocestoides lineatus*.

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[1] This manuscript was submitted for publication on April 8 and while it was in the hands of the editor Professor Henry published a paper (Rec. de méd. vét., v. ciii, no. 8, April 30, 1927) reporting experimental results essentially similar to those covered in this paper.

ACCLIMATIZATION OF BUFO TADPOLES TO ETHYL AND METHYL ALCOHOLS[1]

THAT animals may become immune to toxic substances that ordinarily will destroy them is too well known to call for comment. Since the work of such pioneers as Sewall and Erlich a mass of information has been collected on this subject. Yet in one phase, at least, the experimental data are not consistent. Studies of the resistance that organisms exhibit towards alcohol after they have been immersed in a weak solution of it for some time have failed to produce uniform results. Daniel ('09) has made rather an extensive study of the effects of ethyl alcohol upon Stentor and Spirostomum, subjecting them for various periods of time to a weak solution of the alcohol, and then killing them along with controls in a stronger solution. In general he holds that the ani-

[2] Berl. tierarztl. Wchnschr., v. 42 (52), Dec. 24, 1926.

[1] Contribution from the Department of Zoology, University of Michigan.