through the soil are not straight or of uniform diameter for any measurable distance, in fact they are wholly irregular, which Greene and Ampt recognize, for they describe them as 'irregular in area, length, direction and shape.'" Furthermore, exactness in the increment of rainfall per unit of soil surface is not assured in the Russian type, since no control of surface run-off is provided. Certain studies at the Tennessee Station have required separate collections of percolates and the surface run-off from rainfall within lysimeter walls, and from observations made in these studies we are convinced that the factor of run-off can not be disregarded.

The Russian type of installation has economy as a point in its favor, but it will not prove economical unless its operation affords dependable results. The requisite expenditure of time, money and scientific labor will have been made before the validity of the results is determined.

Dr. Joffe states, "It is well to remember that such an outfit may be installed anywhere and if the data obtained were either unsatisfactory or *(in)complete*[5] for any particular purpose, the lysimeter funnels might easily be dug out and placed elsewhere." The implied uncertainty carried by this statement will hardly appeal to those who have labored to perfect types of containers that have proved to be dependable for study of soil and subsoil horizons to a depth of six feet.

The suggestion of a new type of equipment for the study of fundamental objectives arouses interest, and an *a priori* criticism would not be advanced by us if the Russian equipment were not offered as essential to a "rational" procedure in studies made by us and others through the use of related types of equipment. We readily concede that individual workers are entitled to the prerogative of choosing the apparatus that they believe will best serve their respective needs. We do not concede, however, that the introduction of a new and comparatively untried type of lysimeter justifies the inference that the use of an extensively tried and proved type is irrational.

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5 In a communication to the writers, Dr. Joffe requested that this word be corrected to read "complete."

SPECIAL ARTICLES

TRANSMISSION OF EXPERIMENTAL TRACHOMA BY CONTACT

DR. NOGUCHI'S work, already confirmed in the United States and Europe, associates etiologically *Bacterium granulosis* with human trachoma. This association is based, first on the frequent, probably constant, presence of the bacterium in the lesions; and also on the fact that when *Bacterium granulosis* is inoculated into rhesus monkeys and chimpanzees by subconjunctival injection, corresponding granulomatous lesions are produced. Experienced ophthalmologists have identified the experimentally produced lesions with the typical lesions of human trachoma, and there are great similarities between the two shown by the microscope.

The usual course of the development of the lesions in inoculated monkeys, as described in Dr. Noguchi's monographic article,[1] is, first the appearance of the granular lesions on the upper inoculated conjunctiva; then on the lower membrane, and later the extension of the lesions to the upper and lower conjunctivae of the opposite, uninjected eye.

This succession of events indicates quite unmistakably that while for the initiation of the lesions in apes a subconjunctival injection of the culture may be necessary or is the surest way of establishing infection, the subsequent processes depend on the contact of the lesions, or the secretions from the lesions, with the uninjected conjunctivae.

In order to procure this contact infection beyond doubt, four rhesus monkeys were caged together. Two of the four had advanced granular lesions produced in the one case by the injection of Albuquerque strain No. 1 isolated by Dr. Noguchi in 1926, and in the second by the injection of the same strain recovered in 1928 (Tyler) from the eye lesions of a monkey previously injected with the same Albuquerque strain. The remaining two monkeys were normal, with entirely smooth conjunctivae, at the time of exposure.

The animals were placed together in a roomy cage on November 8, 1929. They were examined eighteen days later, or on November 26. The two monkeys already affected showed, of course, advanced lesions. The two exposed monkeys, which had normal conjunctivae on November 8, now showed in each instance granulomatous lesions affecting the upper and lower conjunctival membranes of both eyes.

There seems, therefore, no doubt that *Bacterium granulosis* can be carried to and made to infect the uninjured conjunctiva of *Macacus rhesus* through ordinary contact. This possibility, already shown by the extension of the lesions from the injected to the uninjected eye by Dr. Noguchi, is now shown to be

1 Hideyo Noguchi, "The Etiology of Trachoma," Supplement No. 2, *Jour. Exper. Med.*, 1928, xlviii.

capable of achievement through the caging together of inoculated and uninoculated animals.

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THE LIFE HISTORY OF THE SWINE KIDNEY WORM

INTRODUCTION

STEPHANURIASIS, or kidney worm disease of swine, as determined in the course of the investigations which are briefly reported in this paper, is a more or less generalized parasitic infestation, of relatively long duration, the causative agent being a nematode known to zoologists as *Stephanurus dentatus,* commonly called the swine kidney worm. The parasites invade the abdominal viscera, notably the liver, pancreas and spleen; the thoracic viscera, notably the lungs; the circulatory system, especially the portal vein and its branches, the gastro-hepatic artery and the posterior vena cava; the thoracic and abdominal cavities, the lumbar muscles, the diaphragm, the outer coat of the stomach and intestine, the perirenal fat, the kidneys and other organs and tissues. Coincident with the sojourn of the parasites in the various parts of the body, profound pathological changes are produced in the parasitized organs, tissues and cavities of the host which may terminate fatally either in the early or later stages of the life cycle of the parasite, or else these pathological processes may produce a condition of severe emaciation which is accompanied by an anemia in most cases.

The writers' investigations, which have already been partly reported in abstract,[1] have cleared up the cause of a pathological condition of the liver of swine which is responsible for the condemnation of livers in abattoirs, these livers usually having been designated by meat inspectors as "parasitic livers" without adequate evidence, however, as to the parasitic origin of the lesions and as to the kind of parasite involved. The investigations reported in this paper have definitely established the fact that in most, if not all, cases so-called "parasitic livers" contain either active or healed lesions which have been produced by *Stephanurus dentatus,* and have thus cleared up a problem of considerable importance and interest from the view-point of meat inspection.

COURSE OF LIFE CYCLE

1. *Preparasitic stages.*—Under laboratory conditions, at a temperature of about 26° to 27° C. the preparasitic stages of the development of *S. dentatus* were completed in from five to six days. Eggs obtained from gravid females and cultured in water or on a charcoal and feces mixture hatched in from twenty-four to forty-eight hours, and the larvae reached the first lethargus about twenty-four hours after hatching. The second lethargus was reached about forty-eight hours later, and the infective stage, that of the third stage larva, was usually attained about twenty-four hours after the onset of the second lethargus. Low temperatures have been found to retard the development of the eggs and larvae, and at temperatures sufficiently low not only was development arrested but the vitality of the eggs and larvae was destroyed. Thus, at a temperature of about 10° C., the eggs were not only unable to develop, but their vitality was completely destroyed in ten days. At temperatures ranging from 1.5 to $-3.8°$ C. the vitality of eggs was destroyed in about twenty-four hours.

It has been determined that the preinfective larvae are readily destroyed by low temperatures. After having been kept at a temperature of 10° C. for a week, a culture of such larvae was removed to room temperature. Microscopic examination disclosed the fact that the larvae were inactive and had not yet attained the infective stage. Within a short period after the culture was removed from the refrigerator the larvae underwent a granular degeneration. The infective larvae also were found to be deleteriously affected by low temperatures and their vitality was rapidly destroyed by freezing. At a temperature of $-19°$ C. the vitality of the infective larvae was destroyed in nine hours, but after six hours' exposure to this temperature some of the larvae were still viable. When the larvae were air dried on a slide their vitality was destroyed in about thirty minutes, but shorter periods of exposure did not prove fatal to all larvae. A fifteen- to twenty-minute exposure to drying showed many dead larvae; others recovered from such exposure following the addition of a drop of water.

2. *Experiments on skin penetration.*—The infective larvae of *Stephanurus dentatus* were found to be incapable of penetrating the intact skin of pigs. In several experiments infestation did not result following the exposure of the skin of the abdomen and of the inguinal and axillary regions to rich cultures of infective larvae. Under experimental conditions the larvae were found to be incapable of penetrating the skin of a three-day-old mouse stretched tightly across a cork ring, which was floated in a beaker containing physiological salt solution at a temperature of 37.8° C. When larvae were placed on the scarified skin of pigs or when they were injected subcutaneously infection resulted, the course of development being similar to that which followed the administration of larvae by mouth.

[1] *Journal of Parasitology,* vol. 15, No. 2, 1928.