tory.) In no instance was there any primary intestinal tuberculosis. This institution admits only infants under 12 months and discharges them when they reach the age of 2 years. Raw milk obtained from untested cows has been the only milk used for six years.

Our experience in Albany is in accord with observations in this country and in France and Germany. Ho't found no case of primary intestinal tuberculosis in 119 children dying from tuberculosis. Bovaird found two cases in 125 autopsies; Northrup, three in 125; Hand, ten in 115 autopsies on tuberculous children.

In Great Britain the primary involvement of the intestine is much more frequent than in other countries. Shennan, in Edinburgh, found primary intestinal lesions in 28 per cent. of his autopsies, and the figures in London and other parts of England range from 18 to 30 per cent. No satisfactory explanation has yet been made to account for this great difference and no light was shed by the present investigation.

Primary intestinal tuberculosis in young children is claimed by many writers to be of bovine origin. Theobald Smith studied five cases of primary intestinal tuberculosis, and only one of the five was proved to be of the bovine type. The Royal British Commission studied sixty cases of human tuberculosis, but in the abstract of their report in the *British Medical Journal* no mention is made of how many of these were primary intestinal. Nevertheless, of these sixty cases, only fourteen were of the bovine type. Young children do not expectorate, but swallow all bronchial secretions and crawl around in the dust and dirt, placing every movable article in their mouths so that the chance of infection with the human bacillus is very great.

Comby, before the International Congress of Tuberculosis in 1905, made the emphatic statement that, from his observations, milk played no appreciable part in the spread of tuberculosis in children. Human or family contagion is the greatest danger and one that should not be minimized.

Sterilized milk is almost universally used for infant feeding in Paris, and, while it has resulted in a marked diminution in the death rate from intestinal diseases, yet the mortality from tuberculosis in young children has increased.

Statistics from all sources show that tuberculosis is relatively rare in the first six months of life and that the greatest number of cases occur between the second and sixth year. If tuberculous milk was such a great source of danger, the greater number of cases would appear before the second year.

It is feared that little has been said in this paper to bring this important problem nearer a solution. Authorities we all respect are at variance over this issue. Clinical evidence has been, in the main, negative. The literature is so voluminous and contradictory that it is impossible to make any definite declaration of the present status of the transmissibility of bovine tuberculosis.

That tuberculous cattle are a menace to public health and give the disease through their milk in rare instances has been proved. Efforts to stamp out the disease in cattle should be made, but the attention of the public should not be diverted from the great and very real danger of human contagion. Whether this takes place through the respiratory or digestive tract is immaterial.

In view of the practical bearing of this question from a sanitary, hygienic and dietetic point of view and the evident confusion and lack of positive knowledge, I

would earnestly urge that this Section take up a further and systematic study of bovine tuberculosis and its transmission through milk. A committee to consist of a pathologist, bacteriologist, veterinarian and two medical (clinicians) men could be formed to make a report at each meeting of the work that is being done in different countries and to urge and see that a differential bacteriologic examination be made in all suspected cases not alone of intestinal involvement, but of the bronchial glands, lungs and tonsils.

FURTHER EXPERIMENTS WITH THE WOOD-TICK IN RELATION TO ROCKY MOUNTAIN SPOTTED FEVER.*

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CHICAGO.

Experiments which I previously reported show that the adult male and female and the nymph of the Rocky Mountain woodtick (*Dermacentor occidentalis*) are able to acquire and transmit spotted fever.¹

In this paper experiments will be reported which show: 1, That the larva may acquire the disease and remain infective during the nymphal stage; 2, that the virus may be transmitted from an infected female to her young through the eggs; 3, that the virus exists in both the gut and the salivary glands of the infected tick.

I. INFECTION OF THE LARVA.

In these experiments the possibility of the larvæ having acquired the disease from the female parent through the egg was excluded by testing the females on healthy guinea-pigs before they deposited their eggs, and it is to be understood that all the larvæ used in these experiments came from females which had been tested in this way and found uninfected.

When from one-third to three-quarters of the eggs of one or more females had hatched, the bottle which contained them was placed in a tick-proof cage with a guinea-pig. As the eggs hatched, the living larvæ were removed from the bottle and placed on the guinea-pig, where they were left to feed or to drop off until ready to feed. Within a few days the guinea-pig was inoculated with spotted fever and the course of the fever and the condition of the animal were observed daily. When the larvæ had fed sufficiently they fell from the animal and crawled up on the canvas which covered the cage. From this location they were removed and placed in boxes to await moulting and the nymphal stage, and when a sufficient number had reached this stage they were placed in a fresh cage with a healthy guinea-pig on which they were allowed to feed.

It was considered preferable to carry on the experiments in this way, i. e., to infect as larvæ and to test as nymphs, rather than to attempt both steps during the larval stage. The latter course would have involved serious difficulties, and, moreover, the results have a more practical bearing when it is shown that the tick, having acquired the disease as a larva, remains infective after reaching the nymphal stage.

Larval Infection 2.—On July 8 several thousand normal larvæ were placed with an infected guinea-pig (670). A large number fed, dropped off and were isolated, and when they began to moult were placed with a normal guinea-pig (717). After a period of six days the temperature of the latter rose to 105.7 F., and on

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* From the Department of Pathology of the University of Chicago.

¹ THE JOURNAL A. M. A., Aug. 4, 1906, p. 358; Oct. 6, 1906, p. 1067; July 6, 1907, p. 24. Jour. of Infec. Dis., Jan. 1, 1907, p. 141.

subsequent days it registered 105, 106, 105.4 and 105 F. The animal was found dead on July 20, after six days of fever and twelve days after it was placed with the ticks.

The condition at autopsy was typical for spotted fever in the guinea-pig. The spleen was enormously enlarged, fairly firm, cyanotic and granular. The inguinal, axillary and mesenteric lymph glands were deeply congested or hemorrhagic, and the surrounding areolar tissue was congested. The kidneys and suprarenal glands were enlarged and congested. The liver was somewhat enlarged. The heart and lungs appeared normal. No hemorrhages had occurred in the external genital organs. The guinea-pig was a female, and hemorrhages are less constant in the vulva than in the scrotum. Cultures on agar slants made from the heart, spleen and kidney remained free from growth. Twelve enlarged nymphs were removed from the pig and cage, and this may be taken as a fair index of the number which had fed.

Guinea-pig 732 likewise was infected by the remaining nymphs, the animal making an eventual recovery.

Of the several thousand larvæ placed with the infected guinea-pig, 670, only a small proportion fed during the course of the fever. Under the title of Larval Infection 7 the remaining larvæ were exposed to infection on guinea-pig 637, which was inoculated on the fourth day after being placed with the larvæ. This animal had been used previously in testing ticks found in nature, but had not been infected, a fact which was shown by the typical course of fever which followed inoculation.

The larvæ which fed on guinea-pig 637 were collected and after they had reached the nymphal stage were placed with a normal guinea-pig (725). The temperature of the latter rose to 104.7 F. on the sixth day and death occurred three days later. Although this is a rapid course for spotted fever, the anatomic changes were characteristic. They were, enlarged and intensely congested lymph glands; enlarged, cyanotic and rather firm spleen, and incipient scrotal hemorrhages. No gross changes were discoverable in the other organs, and inoculations of agar slants from the liver, spleen and heart's blood showed no growth. At least seven nymphs had bitten the guinea-pig. In order to corroborate this result further a monkey was inoculated from an emulsion of the liver, spleen, kidney and suprarenal gland. The temperature of this animal on the second day rose to 104 F., and on subsequent days registered 105.8, 104.7, 105.4, 104.1 F., and death occurred on the seventh day after inoculation. The following were the essential changes seen at autopsy: Beginning hemorrhages in the skin of the eyebrows and cheeks; the whole perineum was cyanotic and showed a roseolar eruption; the lymph glands everywhere were enlarged and congested but were not hemorrhagic; the spleen was greatly enlarged, rather firm and cyanotic. No changes could be noted in other organs. The virus was again passed through another guinea pig which reacted typically and the strain was then dropped.

Still another test was made with the nymphs which remained. After an incubation period of five days the guinea-pig (739) showed a temperature of 105.3 F. and died six days later with characteristic anatomic changes. No ordinary microbes could be cultivated from the tissues. At least six nymphs had fed on the guinea-pig.

Larval Infection 4.—On July 10 about 2,000 normal larvæ were placed with guinea-pig 659 and a few days later the animal was infected by inoculation. The

guinea-pig died on July 21 and was replaced by another (688) which was infected similarly and died on August 2. A third guinea-pig (714) was introduced on this date, was inoculated on August 5 and died August 14. All three animals presented the course and anatomic changes of spotted fever.

The larvæ which had fed were collected and after hatching as nymphs 360 were placed with a normal guinea-pig (726), the nymphs being added as they moulted. None of the nymphs became attached for seven to ten days, and about ten days after feeding was discovered a course of fever began in the guinea-pig and the latter died in six days, showing the characteristic anatomic changes of spotted fever.

In a similar manner the nymphs of Larval Infection 6 killed two guinea-pigs successively (731 and 751), and the combined nymphs of Experiments 2 and 7 produced spotted fever in guinea-pig 674, which eventually recovered.

II. TRANSMISSION OF THE VIRUS FROM THE INFECTED FEMALE TO HER YOUNG, THROUGH THE EGG.

On hypothetical grounds these so-called heredity experiments were performed in two groups: First, certain females were exposed to infection before they were impregnated, by permitting them to feed on guinea-pigs which had been inoculated with spotted fever. This was done in Experiments 3 and 5. Second, the ticks of Experiments 4 and 6 had been impregnated before their infection was attempted. This course was pursued, since it has been suggested in the literature that failure in hereditary transmission may depend on the time of infection with relation to the impregnation of the female. After impregnation many of the ova begin to enlarge, and, if the female is provided with food, they become surrounded by a denser pellicle. Presumably a microbe could penetrate such eggs less readily than the more minute and more delicate, immature, ova or germ cells of the unimpregnated female.

In this instance, however, the point just discussed is not an essential one, since the most satisfactory results which I obtained involved females which were impregnated before their infection was attempted. Casual observation of the manner in which the eggs mature makes it clear why the conception mentioned is to a certain extent irrelevant in so far as the probability of infection of the eggs is concerned. If one exposes the viscera of a fully developed female, which is on the point of laying its eggs it is seen that only a small proportion of the ova have matured, *i. e.*, have reached the limit of size and the appearance which they habitually obtain before extrusion. Hundreds of smaller and still smaller ova are seen in the sac as one follows it back, a fact which makes it apparent that the eggs are matured *seriatim*, the food which is found in the greatly distended alimentary sac being gradually consumed in the meantime. Hence, even in the thoroughly ripened female one finds many minute and delicate ova which apparently would be susceptible to penetration.

None of the females used in these experiments was infected in the first instance. They were among ticks which had been collected from animals and from the woods during the search for infected ticks in nature, and each had fed on a normal guinea-pig for a period much longer than that required for the transmission of the disease.

If a female failed to enlarge after prolonged feeding and after the passage of abundant feces the result was considered as proof that she had not been impregnated.

It is not my intention to analyze all the experiments in detail at this time. In addition to reporting two positive transmissions through the egg, I may mention the fact that short courses of fever were produced by the larvæ in several instances, without the development of cutaneous phenomena. Immunity tests are still to be made with such animals, in order to determine whether these occurrences represented mild attacks of spotted fever.

The technic was similar to that used in the experiments termed Larval Infections, *i. e.*, the larvæ, as soon as hatched, were placed with normal guinea-pigs in tick-proof cages.

Both experiments concern Heredity Experiment 4, in which infection of the ticks took place subsequent to their impregnation; that is to say, the ticks were not allowed to feed on infected guinea-pigs until the character of their enlargement after feeding on normal guinea-pigs indicated that they had been impregnated. The rather scant supply of guinea-pigs rendered it impossible to prove the infectivity of all females before the eggs were laid. This was done in several instances, however, and all which were so tested proved to be infected. Concerning the two experiments to be reported, the infectivity of the larvæ is ample proof that the females had been previously infected.

The precaution was taken to perform the experiments in entirely new cages, so that the larvæ had no opportunity to come in contact with spotted fever virus other than that contained in the female parent.

Females 7 and 9 of Heredity Experiment 4 fed on four infected guinea-pigs from May 22 until June 14, and at this time they were ready for oviposition.

Experiment with Female 7.—This female was removed from an infected guinea-pig June 14; it began laying eggs June 27; hatching began on or about July 27. It was estimated that about 2,000 eggs were laid.

Beginning on July 30 the larvæ, as they hatched, were placed with a normal guinea-pig (707). Inasmuch as they do not feed for some days after hatching, immediate results could not be anticipated.

On August 22 or 23 the temperature of the guinea-pig rose to 104.5 F., the following day to 105.5 F., in the vicinity of which point it remained until the animal died August 28. The following notes were made at autopsy: The lymph glands are deeply congested and considerably enlarged and the surrounding areolar tissue is congested. The spleen is about twice its normal size, is fairly cyanotic and moderately firm, resembling the spleen of spotted fever when death occurs at an early stage. The kidneys are congested and degenerated, and the suprarenals are congested and enlarged. The appendages of the testicles show a good deal of congestion. There is no enlargement of the scrotum and no hemorrhages have occurred into it. (I have stated hitherto that these scrotal changes are sometimes missed when death occurs early.) Other organs appear to be unchanged.

Agar slants inoculated from the heart's blood, from the liver and the spleen, remained free from discoverable growth.

Two hundred and eleven enlarged larvæ were removed from the cage, hence this number at least had bitten the guinea-pig.

In order to verify the suspicion that this animal had died of spotted fever, an emulsion of its spleen and liver was injected into guinea-pig 746. The temperature of this animal was recorded as follows on successive days: 103.7, 102.7, 104.1, 105.5, 105.6, 105.4, 105.8, 105.3, 104.8, 104 and 102.2 F. Death occurred on the fourteenth day following inoculation.

Autopsy Notes: Lymph glands are enlarged and deeply congested or hemorrhagic; spleen is greatly enlarged, cyanotic and fairly firm; kidneys are swollen and congested; the scrotum is greatly enlarged and intensely hemorrhagic, and the tunica vaginalis is deeply congested. No gross changes are seen in other organs.

The diagnosis of spotted fever was made positively.

Experiment with Female 9.—This female was removed from an infected guinea-pig June 14; it began laying eggs June 28; hatching began about July 28. Several hundred eggs were laid.

Beginning on July 31 the larvæ were placed with a normal guinea-pig (710) as rapidly as they hatched. Ticks were first seen attached after thirteen days and the first enlarged larvæ were removed on the fifteenth day. Ten or eleven days later the temperature of the animal rose and continued within the limits of 104.3 and 105.3 F. for seven or eight days. Following this the fever subsided and the animal recovered. Slight enlargement of the scrotum after several days of fever was the only condition, aside from the temperature, which suggested spotted fever.

Inasmuch as in some other animals in these experiments the disease had run a similar course, with eventual recovery, it was suspected that the condition represented a mild attack of spotted fever. In order to decide this point if possible, 3 c.c. of blood were drawn from the heart of guinea-pig 710 during the height of fever and injected into a normal guinea-pig (749). The following course of the temperature in this animal was observed on successive days: 102.4, 103.4, 103.4, 105.6, 104.8, 106.7, 106.4, 106, 104.6, 105.4, 104.4, 104, 104.2 and 103.5 F. The guinea-pig recovered. On the fourth day the scrotum began to swell, and on the tenth day the swelling was extreme and extensive hemorrhages had appeared. With recovery the hemorrhagic areas in the scrotum became gangrenous, and following separation of the sloughs a deformed and cicatricial scrotum remained.

A positive diagnosis of spotted fever in this animal was made, and the diagnosis was confirmed later by a severe immunity test, in which no reaction occurred.

Approximately two hundred larvæ had bitten guinea-pig 710.

The results of these two experiments prove, without question, that the virus of spotted fever may pass from an infected female to her young through the egg. The practical importance of this fact will, to a certain extent, depend on the viability of the virus in larvæ which have been infected in this manner; this is to say: Will such ticks be infective in their subsequent nymphal and adult stages? Although one probably should not try to forecast results, the positive results which I have obtained in infecting normal larvæ and nymphs suggest that larvæ which have acquired their disease through the egg will also prove infective when they have reached the adult stage. This suspicion is particularly well founded since the process of moulting does not destroy the infection in either the larva or the nymph.

II. THE INFECTIVITY OF THE SALIVARY GLANDS AND THE ALIMENTARY SAC OF THE DISEASED TICK.

I wish to report a single experiment in which the salivary glands and the alimentary sac of an infected male tick (No. 15) were dissected out and injected separately into normal guinea-pigs. Male tick 15 had been infected by feeding on a diseased guinea-pig and its infectivity was proved on normal guinea-pig 677.

One can not well remove the alimentary sac without contaminating all other viscera with its contents. On the other hand, one can grasp a salivary gland with forceps near the excretory orifice and, after a little careful dissection, remove the entire gland without rupturing it.

Hence in this experiment the salivary glands were removed first and without rupturing the alimentary sac, after which the latter was removed without regard to remaining structures. The glands and the sac were then triturated separately in sterile salt solution and injected,

the salivary glands being inoculated into guinea-pig 683 and the alimentary sac into 694.

From the date of inoculation, July 15, the following record of the temperature of guinea-pig 683 was made on successive days: 104, 102.4, 102.3, 105.7, 105.7, 105.8, 105.9, 105.1, 105.4, 105.4, 104.1, 103.2, 102.1, 102.6, 102.7 F., etc. There was eventual recovery. Four days after inoculation the scrotum began to swell and on the seventh day it was extremely hemorrhagic and enlarged. On recovery the hemorrhagic areas sloughed. The course of fever and scrotal changes in guinea-pig 684 were similar, though not so extreme.

On August 8 both animals were given immunity tests with three cubic centimeters of infected blood, a quantity which contained from thirty to sixty minimum pathogenic doses. Neither animal showed any reaction to the second inoculations.

In a repetition of this experiment two ticks should be used, the salivary glands being taken from one and the alimentary sac from the other.

It seems probable that the virus passes from the alimentary sac of the tick to the salivary glands; possibly this can be determined experimentally. Indeed, since the oviducts and the eggs of the female are invaded, at least in certain instances, it is not unlikely that spotted fever exists as a generalized infection in the tick for a greater or less period. Whether it eventually becomes localized in certain organs is a question for future investigation. However this may be, the disease is often, if not always, a comparatively harmless incident for the tick.

SUMMARY.

I have established the following points concerning the relationship of the Rocky Mountain woodtick to the spotted fever of western Montana:

1. Infected ticks exist in the so-called infected districts in nature.
2. Both the adult male and the adult female may acquire the disease by feeding on an infected animal, and may transmit it to a normal susceptible animal for a period of several weeks thereafter.
3. During either of its intermediate active stages, larval or nymphal, the tick may acquire the disease in the same manner, retain it during moulting, and prove infective when it reaches the subsequent active stage.
4. The infected female may transfer the disease to her young through the egg. It is possible that this does not happen in all instances, and it is quite certain that the brood of an infected female may include many uninfected larvæ. This seems to have been proved in three of my experiments in which the infectivity of the females had been proved before oviposition; the larvæ in these experiments failed to infect normal guinea-pigs.
5. The virus exists in both the salivary glands and the gut of infected ticks at a certain time, and since it also invades the generative organs of the female the condition is probably one of a generalized infection, at least for a period. The disease is not highly destructive for the tick.

At least two important steps may now be taken in an aggressive fight against the disease: First, a thorough dissemination of the knowledge that the tick is the agent of infection; second, a massive reduction of the number of ticks in infected districts by means now used in the destruction of the cattle-tick of the southern states. Extermination of the tick in the mountains will not be possible so long as native wild animals inhabit

the soil and roam the hills. On the other hand, it is known locally that the number of ticks in the Bitter Root Valley has increased enormously as greater numbers of domesticated animals have been introduced, and the latter now seem to be the chief hosts for the tick.

Special Article

TRAVEL NOTES FROM SOUTH AMERICA.

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CHICAGO.

III. *THE MEDICAL PROFESSION, MEDICAL SOCIETIES AND MEDICAL JOURNALS OF RIO DE JANEIRO.

The South American physicians are men with excellent preliminary education, as a college degree is one of the requirements of entrance exacted by the medical schools, and during their six years of training as students of medicine these men acquire a good knowledge of their profession. After graduation, many of them spend a year or more as assistants in hospitals, where they become familiar with the practical work of their future careers. Some of them, after graduation or expiration of their hospital service, go to some of the larger medical centers in Europe, most frequently to Paris, in quest of more knowledge before they assume the responsibilities of an independent practice. On the whole, the physicians here occupy a much higher position in the esteem of the public than in our country. They are influential members of the community in social and public affairs and occupy many positions of trust and influence. Rio de Janeiro is well supplied with physicians; the population as given by the last census is less than 700,000, and I counted the names of 735 physicians in the city directory; that is more than one physician for every thousand inhabitants.

Young men seem to take kindly to the study of medicine. The present number of medical students, considering the small population of Brazil, is unusually large. They are distributed as follows: Medical School of Rio de Janeiro, 1,700; Medical School of Bahia, 500; Medical School of Rio Grande do Sul, 175; total, 2,375. This means that the medical profession of Brazil will be more crowded in the future than it is now. Brazil offers no inducements for foreign practitioners. A foreigner, in order to obtain a license to practice, must be a graduate of a recognized medical school and must pass a satisfactory examination in Portuguese or Latin before a committee selected from the faculty of the Medical School of Rio de Janeiro. The existing overcrowded condition of the medical profession and the stringent requirements for obtaining a license have kept out physicians from foreign countries, as there are very few in Rio de Janeiro, Santos and Petropolis. I was given to understand, too, that the wealthy and influential Brazilians and Portuguese show a decided preference for the physicians of these nationalities and place little confidence in outsiders. Most of the physicians have offices in the business part of the city, but are not congregated together in large buildings, as in Chicago and other western cities. The fees, on the whole, are higher than in our country, but are regulated rather by the reputation of the practitioner, than by an established fee bill. Physicians who are well known, especially the professors in the medical colleges, command large fees, but the mass of the profession here, as everywhere else, is underpaid for its work.

The physicians whom I met were courteous and obliging, anxious to give a good insight into their work and the merits of the institutions which they represented. Here I must make special mention of Dr. Alvaro Ramos, 76 Rua de Hospicio. I met him last year in Lisbon at the meeting of the International Medical Congress. When the director of the Misericordia Hospital showed us through the institution, we met him accidentally in one of the wards. The meeting was as hearty

* This series of articles was commenced September 14.