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LAWRENCE H. DUNN

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REPRINTED FROM
THE AMERICAN JOURNAL OF TROPICAL MEDICINE
VOL. XIII, NO. 5, SEPTEMBER, 1933

Made in United States of Auerica

Reprinted from The American Journal of Tropical Medicine
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During the past three years an extensive investigation of the diseases and ectoparasites of both wild and domestic animals, birds, reptiles, etc., of Panama has been carried on at this laboratory. In the course of this work a considerable amount of interesting information pertaining to the ecological relations and host selection of some of the ectoparasites was obtained. One of the many interesting features observed in this work is that concerning the host selection of the tick, *Ornithodorus talaje* Guern.

Although this tick has been found on various animals and birds in other parts of South America its only hosts in Panama of which we had definite information previous to undertaking our animal investigations were man and the rat. The hosts on which it has recently been found, however, indicate that it is much more general in its selection than was heretofore believed.

Investigations concerning relapsing fever in the New and Old Worlds that have been made during recent years have shown that various animals are not only susceptible to infection with spirochetes causing this disease but also that a number of animals have been found with natural infections. A report (1) on animals found naturally infected in Panama has been given in a recent paper. In view of this the possibility of mammals proving to be the source of origin in many cases of human infection may easily be realized. Since *Ornithodorus talaje* is a transmitting agent of relapsing fever in Tropical America these findings in relation to animals having a natural infection of spirochetosis causes the host selection of these ticks to be of considerable importance from the standpoint of possible animal reservoirs of the disease.

An annotated list of the hosts on which *O. talaje* has been found in Panama is given in the following pages:

MAN

In a recent paper (2) I presented a report concerning a house at Gatun, Canal Zone, becoming infested with *O. talaje* and the human inhabitants being attacked by them and the irritation and suffering caused by their bites. This is the only instance in my experience where a reasonable amount of certainty was present in regard to this species attacking man. Specimens that apparently were collected in native houses in some of the interior villages of Panama have been received from time to time. I am inclined to believe, however, that this tick preys mainly on rats and the lower domestic animals and fowls of a household instead of the human inhabitants and that man is more a host of necessity than of choice. Matheson (3) in reporting on a house in Ransomville, N. Y., being infested with *O. talaje* writes: "How this tick reached there can only be surmised. It probably maintained itself in the heated house and fed on the occupants or more proably on mice or rats or the cat and dog though none of these is listed as its normal host. Mrs. Neuman did not say that members of the household were ever troubled by its bite."

A second species of *Ornithodorus, O. venezuelensis,* is also present in Panama and is very abundant in some of the houses in the interior villages. This species has habits similar to those of the bedbug since it lives in beds and other articles of furniture and the walls of houses and emerges at night to feed. This species seems to accept man as its normal host. *Ornithodorus talaje* and *venezuelensis* resemble each other and since the latter species was not named and described until 1921 it is believed that *venezuelensis* has been mistaken for *talaje* and other species of *Ornithodorus* in South America on several occasions. A mention of some of these probable mistakes was given by me in a previous paper (4). A mistake of this kind certainly occurred in Panama where, owing to an unfortunate error in either the identification or labeling of specimens, *venezuelensis* was for a number of years commonly accepted for *talaje*. In an earlier paper (5) the name *talaje* was wrongly used throughout the article in place of *venezuelensis*. In another paper (6) some notes on the prevalence and habits of

both species were presented under the single name of *O. talaje*. This explanation is given in an attempt to show that probably many of the attacks on humans that have been blamed on *talaje* were in reality due to *venezuelensis*. This is not meant as a statement that I believe *O. talaje* never attacks man but to imply that they probably do so only when more suitable hosts are not at hand.

RAT

Studies made on the ectoparasites of rats in the cities of Panama and Colon have shown that many of these rodents are commonly infested with the larval form of *O. talaje*. The larvae of this tick have been found in considerable numbers on two species of rats, the brown rat, *Mus norvegicus*, and the black rat, *Mus rattus*, that most commonly choose their habitats in, or near, dwelling houses, warehouses, barns, stables, etc., in the two cities from which the rats were obtained. Infestation of the roof rat, *Mus alexandrinus*, seems to be infrequent. A large percentage of the brown rats were found to be acting as hosts for the larvae. Some of the individual rats were so heavily infested that they were kept alive in breeding jars for several days in order to ascertain the number of engorged larvae that dropped from them. In 1921, 58 larvae were collected from a brown rat captured at the city dump in Panama. During the same observations 21 larvae were taken from a brown rat captured in a tenement house on 12th Street, Panama, and 47 were collected from a brown rat captured at Dock No. 4 in Colon. The latter demonstrated that some of the rats in the city of Colon were infested almost as heavily as those in Panama. In 1930 a brown rat captured in the garret of a house on 14th Street, Panama, was found to have 43 larvae attached to it. The percentage of black rats found infested with the larvae has proved to be considerably lower than that found on the brown rats. The infestation of individual rats also seemed to be much lighter in the black rat.

On most of the occasions on which *O. talaje* has been found on rats it was the larval stage only that was present. This is to be expected, however, since the larvae of this species remain attached to the host for several days before becoming engorged while the

nymphal and adult stages require only a brief period, usually less than an hour, in which to secure a meal of blood. These two more mature stages evidently remain hidden in the nests, dens, or immediate vicinity of the resting places of the animals selected as hosts from which to obtain their food supply when necessary.

This gives much less chance of finding the later stages on rats and other animal hosts than of the larvae that remain attached for the longer periods. This observation also applies to infestation of animals other than rats, the larvae only being found on nearly all hosts from which *O. talaje* has been obtained.

Darling (7) in writing on the rat in relation to the dissemination of relapsing fever in Panama states as follows:

> Rats, therefore, may and do play a part in the dispersal of the ticks and presumably of the infective agent (*Spirochaeta novyi*) of the relapsing fever of Panama. The dispersal of *Mus rattus* into suburban and interior districts as a result of the struggle for survival now going on between *Mus rattus* and *Mus norvegicus*, a struggle which has been in progress and plainly apparent in Panama in recent years, will lead inevitably to the dissemination of the transmitting agent (*Ornithodorus talaje*) of the cause of relapsing fever into places where it does not now exist.

In the light of our more recent knowledge it would appear to me that, in Panama at least, *O. talaje* may act as an important agent in transmitting the spirochete of relapsing fever from animal to animal but that *O. venezuelensis* must be seriously considered as a vector of the organism from animal to man and from man to man.

DOG

During July, 1931, 7 dogs were received at this laboratory to be examined for blood and intestinal parasites and ectoparasites prior to, or after, being sacrified. One of these animals came from Panama city and the other 6 from the village of Santa Rosa on the Chagres River. These dogs were either vagrants or in such poor condition that the owners wished to be rid of them. Each animal was closely examined for ectoparasites immediately after it was chloroformed. Ticks, fleas, lice, etc., of various kinds were

present in abundance on these dogs. Larvae of *O. talaje* were found on 2 of the animals from Santa Rosa. Fourteen larvae of this species of tick were collected from one of these dogs and 2 from the other.

CAT

In the months of June, July and August, 1931, a number of vagrant cats were collected in various parts of the Republic of Panama and brought to this laboratory to be humanely destroyed. One hundred of these were examined for ectoparasites. This number included several lots of the animals that were captured in different localities. Two lots were collected near the village of Parita, in the Province of Herrera. One of these two lots consisted of 28 cats, 12 of which were found to be infested with larvae of *O. talaje* and the other included 22 animals with 8 infested. This gave a total of 50 cats from Parita with 20 infested with *O. talaje*. Five cats out of 13 received from the village of Santa Rosa on the Chagres River were infested. One captured in the Savannah region outside the City of Panama was also found to have several of the larvae attached to it. Thirty-two of the cats that were captured in the alleys and open lots in the City of Panama and one that was obtained from Ancon, in the Canal Zone, were included in the number examined but none of these were found to be infested. Three cats from the village of New San Juan, in the Chagres River valley, were also found to be free of the ticks. Of the 100 cats examined a total of 26 proved to be infested with *O. talaje*. Several of these cats were rather heavily infested, 32 of the larval ticks being found on one of the animals from Parita and 24 were collected from another from the same place. One specimen of a second stage nymph of *O. talaje* was also found on one of the cats from Parita.

MONKEY

Studies on the parasites in the blood and intestinal tracts of monkeys have been carried on very extensively by visiting scientists and the regular personnel of this laboratory during the past three years. This work has resulted in a considerable number of

monkeys of various species being purchased. Many of these were obtained through several animal dealers in the City of Panama who purchased the monkeys from various sources and then resold them to the laboratory. When it was desired to have monkeys as direct as possible from their native habitat and without any prolonged contact with humans they were obtained through natives commissioned to catch them in the jungle expressly for us. This latter class were in captivity for a period of from one to ten days before being received at the laboratory. During this time they were usually kept in captivity in the houses of their captors or in outhouses nearby where they probably would be in fairly close contact with the human and animal occupants of the houses. All the monkeys received were examined for ectoparasites as soon as possible after they arrived and before they were allowed any contact with monkeys or other animals in our animal houses or yards. A total of 444 monkeys, representing six genera and ten species or subspecies, were examined for ectoparasites during the three years this work was carried on. Of this number 8 were found to be infested with the larval stage of *O. talaje*. These infested animals included three genera and four species or subspecies, ... being brown howling monkeys, *Alouatta palliata palliata* Gray,[1] three white faced monkeys, one *Cebus capucinus capucinus* (Linnaeus) and two *Capucinus capucinus imitator* Thomas, and one titi monkey, *Saimiri orstedii orstedii* (Reinhardt). Thirty-six of the *O. talaje* larvae were collected from one of the brown howlers, 30 were taken from another of the same species and 28 were found on one of the white faced monkeys. Nearly all the larvae found on these monkeys were filled with blood to some extent and many were nearly fully engorged. This would indicate that some of them had been attached to the animals for at least two days and probably longer. The 4 infested howlers all came from Parita, in the Province of Herrera, and had been recently captured. Three of them formed part of a lot of 21 monkeys that had been captured especially for this laboratory and it is quite probable that they become infested

[1] This name may be in error since it is possible that the monkeys listed here as *Alouatta palliata palliata* may have since been described as a new species.

while being held at the house of their captor before they were turned over to us. It was rather surprising to find the white faced monkeys infested since these animals are very active in examining their skin and picking over their hair and in ridding themselves of parasitic insects.

OPOSSUM

During 1931 and 1932 a total of 82 opossums, *Didelphis marsupialis etensis* Allen, was received at this laboratory. These animals were either alive when received or had been placed each in a separate muslin sack as soon as killed and the mouth of the sack tied tightly to prevent the escape of any ectoparasites. They were captured or killed in several locations in various sections of Panama and the Canal Zone, being taken in the area about Ancon and Summit in the Canal Zone and in Panama they were collected near Parita and Potuga, in the Province of Herrera, Alhajuela, in the Chagres River valley, and in the Sabanas district east of the City of Panama. The opposums and also the sacks in which the dead ones were brought in were examined as soon as possible after they were received and a considerable number of ectoparasites of various kinds were found. Larvae of *O. talaje* were found on 13, or 15.8 per cent, of these opossums. Nine of these infested animals were captured at Ancon, 2 at Parita and 2 at Potuga. Since 18 opossums were received from Ancon, the 9 infested ones equaled 50 per cent of the total number obtained from that area. Sixty-one of these opossums were received alive and their blood was examined for parasites. Six, or 9.8 per cent, were found to have spirochetes of relapsing fever in their blood. This fact is very significant in its relation to *O. talaje* as being the probable vector.

CHICKEN

On numerous occasions I have been informed by various individuals in Panama and Colombia that chicken roosts sometimes become heavily infested with *O. talaje*. The first time, however, for me to actually find this tick on a fowl was in September, 1930. A chicken purchased in the City Market in Panama was found to

have many small ticks attached to it. This was observed by Mr. Joaquin Benavides, Chief Laboratory Technician at this laboratory, who collected specimens of the ticks and brought them to me. On examination these were found to consist of several larvae of *Argas persicus* and one larva of *O. venezuelensis*. The day following the examination of these ticks the chicken died and the carcass was brought to me. This was placed in a muslin sack and the opening of the latter tied tightly with twine and hung up at room temperature in order to allow the ticks to detach. During the next three days 39 larvae of *Argas persicus* and 5 *O. talaje* in the larval stage were collected from the sack. After three days the carcass was so putrid that it was disposed of. A few days later Mr. Benavides made an examination of several of the cages in which chickens are confined in the Market and found a few specimens of *A. persicus*, *O. venezuelensis* and *O. talaje* in the crevices of the cages. On September 24, 1930, twelve days after receiving the first infested fowl a second chicken with larvae of *O. talaje* attached to it was brought to me. Several weeks later I visited the market place and found about the same conditions as those encountered by Mr. Benavides, specimens of *A. persicus* and both species of *Ornithodorus* being collected by me at this time. These findings lead me to believe that pobably all domestic fowls may be accepted as hosts by *O. talaje*.

SNAKE

On July 1, 1931, a snake that was captured in the long grass in an open area in a suburb of the City of Panama was brought to this laboratory. It proved to be a rainbow boa, *Epicrates cencris* Linnaeus, about 4½ feet in length. It was a constricting snake and non-venomous. Mr. Arthur L. Brody, Assistant Medical Entomologist, examined this snake and found 6 larvae of *O. talaje* attached to it. These were nearly replete and were reared to later stages for definite classification. It was a surprise to find *O. talaje* attached to this cold-blooded host. Quite probably the snake became infested while in some burrow or den in search of rodents or other prey.

SUMMARY

Observations on *Ornithodorus talaje* in Panama have shown that this tick may select human, mammalian, avian and reptilian hosts.

ACKNOWLEDGMENTS

I wish to acknowledge with many thanks and appreciation the assistance of Mr. Arthur L. Brody, former Assistant Medical Entomologist at this laboratory, in the examination of the greater number of the animals mentioned in this paper and in the collecting of the larvae of *O. talaje*. Thanks are also extended to Mr. Joaquin Benavides for the aid he kindly rendered in connection with the observations on the infested fowls.

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