

## ANIMAL SUSCEPTIBILITY TO *TRYPANOSOMA HIP- PICUM*, THE EQUINE TRYPANOSOME OF PANAMA

WITH SPECIAL REFERENCE TO CATTLE AS AN UNHARMED  
HOST AND PROBABLE RESERVOIR OF IMPORTANCE

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A fatal equine trypanosomiasis is endemic on the Isthmus of Panama. It is generally known throughout the Republic as "Murrina" and "Derrengadera." It made its first appearance in the animals of the Panama Canal Zone in 1909 and was described by Darling (1) in 1910. He named the pathogenic agent *Trypanosoma hippicum*. The disease was probably not introduced from outside sources since its clinical picture had been known before the construction period of the Panama Canal.

Since Darling's time on the Isthmus very little has been done to continue a search for a natural vector or vectors of the disease and to study wild and domestic animals in regard to their susceptibility to this trypanosome. Our studies concerning these questions began in December, 1929 when the disease again appeared in an epidemic manner in a breeding herd at the Miraflores Farm and at points in the Republic near the Canal Zone. Our work is still in progress but we have been able to amplify some of the work of Darling. Dunn (2) has established the fact that the local vampire bat (*Desmodus rotundus murinus* Wagner) is a natural vector of the disease on the Isthmus. In view of his important discovery, we now consider it of value to publish what information we have assembled on the susceptibility of wild and domestic animals that are found in contact with horses and mules on the trails, in the pastures or in the stables and to indicate any animals that have been found with a naturally acquired infection.

Darling (3) was able to experimentally infect and kill the

following animals: Horse, mule, dog, kitten, rabbit, guinea pig, white rats and mice, wild rats and mice, raccoon, opossum, coati and monkeys (*Cebus* and *Nyctipithecus*). He also infected and noted spontaneous recovery in a domestic pig, an adult cat, an agouti and three of his wild rats. The only refractory animal reported in his series was the calf in which he failed to recover the trypanosome or produce clinical evidence of illness. He found no naturally infected animals and concluded that the disease was



FIG. 1. THE VAMPIRE BAT, *DESMODUS ROTUNDUS MURINUS*

distinctly a disease of mules and horses and that cattle were not susceptible. We have rechecked his list of animals and also added some other possible contact animals (table 1). Many of these species of animals had naturally acquired harmless types of trypanosomes but none contained a naturally acquired *T. hippicum* infection.

A native chicken (cockerel) was given 0.8 cc. of blood intraperitoneally from a guinea pig whose blood stream contained

many *T. hippicum* but no trypanosome was ever found in the blood film of the cockerel. This chicken never showed symptoms and is still living and in good health thirteen months after the inoculation.

TABLE 1

*Susceptible of infection and die within a few weeks*

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Dog
Guinea pig
Rabbit
White rats and mice
Wild rats and mice
Squirrel or Arditá, <i>Sciurus gerrardii morulus</i> Bangs
Armadillo, four toed, <i>Dasypus novemcinctus fenestratus</i> Peters
Sloth, three toed, <i>Bradypus griseus griseus</i> (Gray)
Sloth, two toed, <i>Choloepus hoffmanni</i> Peters
Porcupine, <i>Coendoumexicanum laenatum</i> Thomas
Agouti, Nequi, <i>Dasyprocta punctata dariensis</i> Goldman
Agouti, conejo pintado, <i>Cuniculus paca virgatus</i> (Bangs)
Opossum, <i>Didelphis marsupialis etensis</i> Allen
Coati, <i>Nasua narica panamensis</i> Allen
Tapir, <i>Tapirella bairdii</i> (Gill)
Capybara or poncho, <i>Hydrochoerus isthmus</i> Goldman
Bat, <i>Phyllostomus hastatus panamensis</i> Allen
Bat, <i>Hemiderma perspicillatum aztecum</i> Saussure
Bat, <i>Rhogeessa tumida</i> Allen
Bat, <i>Glossophaga soricina Leachii</i> (Gray)
Bat, <i>Artibeus jamaicensis jamaicensis</i> , Leach
Bat, Vampire, <i>Desmodus rotundus murinus</i> Wagner
Monkey, Chiriqui titi, <i>Saimiri orstedii orstedii</i> (Reinhardt)
Monkey, Mono titi, <i>Leontocebus geoffroyi</i> (Pucheran)
Monkey, night monkey, <i>Aotus zonalis</i> Goldman
Monkey, black howler, <i>Alouatta palliata inconsonans</i> Goldman
Monkey, brown howler, <i>Alouatta palliata palliata</i>
Monkey, white face, <i>Cebus capucinus capucinus</i> (Linnaeus)
Monkey, white face, <i>Cebus capucinus imitator</i> Thomas
Monkey, red spider, <i>Ateles geoffroyi</i> Kuhl
Monkey, black spider, <i>Ateles dariensis</i> Goldman
Monkey, old world, <i>Macacus rhesus</i>

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Iturbe (4) and others state that in South America spontaneous infections with an equine trypanosome (*T. venezuelense*) have been found in the Capybara (*Hydrochoerus hydrochoeris*), the dog, fox and certain monkeys. The Capybara is not found

above South America except for the species *Hydrochoerus isthmius* Goldman, that is found in the valley of the Tuira river in the Province of Darién, R. de P. Here it is known locally as the *Poncho* and is believed to be the same species found in the Atrato valley of Colombia. The boundary line between Panama and Colombia is the water shed between the valleys of the Tuira and Atrato rivers. We have examined ten of these animals in the Tuira river valley, seven killed and three living specimens. The latter were brought back in good condition to study at the laboratory. One of the animals showed a few large trypanosomes

TABLE 2

*Susceptible of infection. May live many months*

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Horse
Mule
Cat, domestic
Deer, white-tailed, <i>Odocoileus chiriquensis</i> Allen
Deer, brocket, <i>Mazama satorii reperticia</i> Goldman
Wild hog, collared peccary, <i>Pecari angulatus bangsi</i> Goldman

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TABLE 3

*Susceptible of infection. Recover spontaneously. Carry infection for a long period without symptoms*

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Goat, native
Sheep (Algerian breed)
Hog, native, domestic
Cattle

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similar to the harmless one so frequently found in cattle. We could not transfer it to guinea pigs. Two of these animals were then given a strain of *T. hippicum* and both developed trypanosomiasis. One of them died in fifteen days and the other in twenty days following the inoculation. The third animal that was not inoculated has grown in weight from 21 to 46 pounds and has not contracted the disease although living most of the time in contact with infected animals. There are very few horses and mules in the Tuira valley near the colonies of these animals but none of them revealed trypanosomes and no history of the disease could be obtained. The local Capybara is more

sensitive to *T. hippicum* infection than the guinea pig. It cannot, therefore, remain a reservoir for the parasite for more than a few weeks.

Our local monkeys (5) die in from fifteen to twenty-eight days when inoculated with *T. hippicum* notwithstanding the fact that all of our monkey species are subject to spontaneous infections of their own kind of harmless trypanosomes (6). An adult, old world, female monkey (*Macacus rhesus*) that had been given blood from 62 wild monkeys of local species that were carrying their own type of naturally acquired trypanosomal infection failed to show in her blood films any of these parasites. About one year after this experiment she was given an intraperitoneal injection of a strain of *T. hippicum*. Her blood films became positive in three days time and she was so ill on the seventh day with a severe trypanosomiasis that she was sacrificed in order to use her parasites to build an antigen.

We have always taken every opportunity to examine dogs living in close contact with herds of horses and mules during the progress of an epidemic of murriana but have never yet found a dog with a spontaneous infection of *T. hippicum* although the dog makes a good laboratory animal for the study of the trypanosome. We do not consider that any of the animals listed in table 1 can carry the infection over a period lasting longer than a few weeks. During this period they could of course form a dangerous reservoir.

The animals listed in table 2 can carry the infection over a long period of months but their infections are light with the exception of the horse and mule and mechanical transfers should be difficult. In the case of the vampire bat, a natural vector which consumes a large amount of blood each night, it might be able to pick up the infection. It is possible to examine and quarantine the solipeds but the other animals can form an unprotected menace.

Table 3 contains the list of domestic animals that form the greatest menace as a reservoir in contact with horses and mules. In our particular region goats and sheep are not numerous and hogs are seldom found in large herds on the same range with

horses and mules. Cattle and horses do range together all over the Republic and it is probable that the more resistant individuals among the solipeds and the cattle carriers of *T. hippicum* keep the disease endemic.

*Goat experiment.* This was a male, juvenile, native animal in good condition and whose blood films were negative for trypanosomes. A guinea pig inoculated from its blood also proved to be negative.

January 13, 1932, it was given intraperitoneally 1.5 cc. of jugular vein blood from horse 200 that was positive for abundant *T. hippicum* at the time. It never did show a large number of trypanosomes in its blood films. It became negative to guinea pig tests in June, 1932, and was killed and examined. It was fat and had run the complete course without symptoms.

*Sheep experiment.* This was a fat, female, adult Algerian sheep raised on the Isthmus. Guinea pig tests and blood film examination revealed no *T. hippicum* infection. On November 6, 1931, it was given an intraperitoneal injection of 1 cc. of heart's blood from guinea pig 189. This pig had an abundance of *T. hippicum* in its blood at the time. The blood of the sheep became positive to film examination on November 8 and remained positive to blood film examinations almost daily for a period of three months.

The sheep never developed symptoms of the disease and was killed and examined in June, 1932. It was fat and revealed no lesions that could be attributed to trypanosomiasis.

*Domestic hog experiment.* A male juvenile pig, weighing forty-eight pounds. Born on the Isthmus. Guinea pig and blood film tests revealed no trypanosomes. On November 6, 1931, it was given a subcutaneous inoculation of 1 cc. of blood from guinea pig 189 that was positive for *T. hippicum* at the time. Eight days later the hog's blood film revealed the presence of *T. hippicum*. Its blood films were never positive after the month of November but guinea pigs inoculated from the hog as late as December 18, 1931, still developed the infection. It never showed symptoms and was killed in February, 1932, and examined. It was very fat, had gained 28 pounds in weight. It revealed no lesions attributable to the trypanosome.

*Calf experiment.* This was a bull calf about eight months old. It was born on the Isthmus. An examination revealed no trypanosomes

but its blood film did show that it had piroplasmiasis and its hide contained several dozens of fly larvae (*Dermatobia hominis*). On August 21, 1931, it was given an intrajugular inoculation of 2 cc. of blood from guinea pig 149. This guinea pig's blood was abundantly positive for *T. hippicum* at the time. The blood film of the calf first showed *T. hippicum* on September 4 (fourteen days after the inoculation). The films of September 5 and 6 and November 5 and 26 also showed a few trypanosomes but none were found in other daily films. Guinea pigs inoculated once a week from this calf developed trypanosomiasis until January 13, 1932, a period of almost four months. The calf recovered from its piroplasmiasis and grew in a normal manner. It never showed symptoms of trypanosomiasis. It was castrated in July, 1932, but there was no reappearance of the trypanosomes. It was then placed on pasture and allowed to range there until September 26, 1932, when it was again placed in the Veterinary Station for observation. At this time it was suffering from a broken horn but its blood films and guinea pig inoculations have failed to reveal a trypanosomal infection. It was given an intrajugular inoculation of 2.5 cc. of blood from guinea pig 440 which carried a *T. hippicum* infection on October 1, 1932, but it has not thus far (October 21) developed a new infection.

The results obtained with this calf upset the view we have held since 1909 that cattle were refractory to this form of trypanosomiasis. Near the close of this experiment, an opportunity came to survey some cattle that had been on the same range with a herd of horses and mules that had suffered an epidemic of murrina or equine trypanosomiasis. No horse or mule in this herd had been positive for a few months prior to the time these 135 head of cattle were taken from the pasture to the packing house. On December 29, 1931, these cattle were slaughtered and we were permitted to make thick blood films and to inoculate a guinea pig from each animal. None of the blood films revealed trypanosomes.

From 2 to 4 cc. of blood was taken from the jugular vein of each animal and injected into the peritoneal cavity of a guinea pig. It was necessary to transport these guinea pigs a distance of 50 miles by truck and train at the end of the day's work at the packing house and 68 of them died before a satisfactory period of incubation had passed so we do not know what the cattle they represented may have shown. The remainder of the guinea pigs (67) lived for a few weeks and three of them (4.5 per cent) developed *T. hippicum* infections. The first pig became positive thirteen days after inoculation, the second became

positive on the fourteenth day and the third one on the twenty-seventh day.

These strains killed the guinea pigs in the usual period of time (about a month) that a strain taken from the horse requires. We used these cattle strains on two horses and these animals developed the regular clinical picture and died of the disease.

We have thus far been unable to secure enough unharmed vampire bats and a spontaneous cattle carrier of the trypanosome to learn what the chances are for infecting a bat from such a light carrier of *T. hippicum* but efforts are under way to secure this information. Undoubtedly the rapid spread of this disease depends on animals, such as the horse and mule, with a peripheral blood containing an abundance of the trypanosome. The disease is frequently present in a herd for two or three months before its character impresses itself on an owner. Cattle ranging with such a herd can conceivably acquire the infection through the bite of the vampire bat and since cattle can carry the infection for months they are probably the main reservoir that holds the disease in a locality and allows it to gain another foothold among equines.

#### SUMMARY

1. A study has been made of animal susceptibility to the equine trypanosome of Panama (*T. hippicum*) using as many wild and domestic animals as could be collected that are found in contact with horses and mules in the stable, pastures or on the trails.

2. The only animals in the series studied that disclosed a spontaneous infection with *T. hippicum* were the horse, mule and cattle.

3. Cattle that had ranged with a herd of horses and mules during an epidemic of this equine trypanosomiasis were examined a few months after the last case had appeared. The blood films of the cattle did not reveal trypanosomes but the use of 2 to 4 cc. of blood injected into the peritoneal cavity of a guinea pig disclosed the fact that 4.5 per cent of the cattle were light carriers of *T. hippicum*. The strain recovered from the cattle developed the usual clinical picture of murrina in the two



horses tested and killed them in the usual period of time. A calf was experimentally given the infection and was positive to guinea pig inoculation over a period of about four months. It developed no symptoms and recovered spontaneously.

4. Other susceptible animals in the series capable of carrying a light infection a long time and ending in a spontaneous recovery were the hog, sheep and goat.

5. Susceptible animals in the list that ran a prolonged course ending in death were the domestic cat, the white tailed deer, the brocket deer, the collared peccary or wild hog.

6. Most wild and domestic animals can be experimentally infected and killed in a few weeks. The chicken was the only refractory experiment in the series.

7. This form of trypanosomiasis is distinctly a *disease* of the solipeds, particularly of the horse and mule. The fact that cattle can carry *T. hippicum* for a long period of time without injury and that cattle range in large numbers with horses and mules at night as well as day throughout the Republic makes these animals probably the most important reservoir in maintaining the presence of the disease in our region. The vampire bat feeds with equal freedom on equine and bovine animals and they live for almost a month after they acquire the infection and suffer no loss of appetite for blood meals until within a few hours of death.

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