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Authors: WELLS, E.A., D'ALESSANDRO, A., MORALES, G.A., and ANGEL, D.

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MAMMALIAN WILDLIFE DISEASES AS HAZARDS TO MAN AND LIVESTOCK IN AN AREA OF THE LLANOS ORIENTALES OF COLOMBIA

E.A. WELLS,[□] A. D'ALESSANDRO,[□] G.A. MORALES[□] and D. ANGEL[□]

Abstract: Development of the Llanos Orientales of Colombia, and access to underdeveloped areas in the Llanos, may create disease hazards to man and domestic animals or introduce exotic pathogens, creating reservoirs of infection for domestic animals and acting as limiting factors on the native wild species. A survey of wild animals common to the Llanos revealed a number of parasites indigenous to the area. A total of 59 mammalian species, representing eight orders were examined. Haematzoa were represented by *Trypanosoma cruzi*, *T. evansi* and *T. rangeli*. Eight species of ticks were found: *Amblyomma cajennense*, *A. auricularium*, *A. rotundatum*, *A. maculatum*, *A. longirostre*, *A. paca*, *Ixodes luciae* and *Boophilus microplus*. Four species of fleas were found: *Rhopalopsyllus lugubris lugubris*, *R. australis tupinus*, *R. cacticus saevus* and *Polygenis klagesi samuelis*. A species of *Echinococcus* was commonly found in *Cuniculus paca*. Serologic titers and/or isolations of pathogenic viral and bacterial agents generally indicated that the wildlife population had not been exposed to the diseases common to the domestic population. A low prevalence of titers to Venezuelan equine encephalomyelitis was found in *Cebus apella* and *Proechimys* sp. Neutralizing antibodies to Group B viruses were found in *Proechimys* sp., *Coendor* sp. and *Nectomys squamipes*. Antibodies to Group C viruses were found in *Proechimys* sp. Serologic titers to *Leptospira sejro* and *L. tarassovi* were found in *Proechimys* sp. and *Didelphis marsupialis*. *L. tarassovi* was isolated from *Proechimys* sp. Titers to *Brucella* were not found in 164 animals. The significance of these findings are discussed.

INTRODUCTION

The eastern plains (Llanos Orientales) of Colombia form part of the eastern border of the tropical Andes, described as "among the most active pioneer settlement and colonization zones in Latin America".² The present study was designed to demonstrate that opening undeveloped or underdeveloped areas in Latin America is accompanied by disease hazards to man, to livestock, and to wildlife.^{10,20} Introduced species may con-

tract important clinical infections by intruding into existing sylvatic cycles and, moreover, may introduce pathogens new to the native animal population, creating reservoirs of infection.

In Colombia, previous studies have been made in the Llanos Orientales,^{1,16} and also in the adjacent areas of Panama and Colombia where hazards to human health were examined along proposed sea level canal routes.^{7,8,17} The present article consolidates and adds to informa-

[□] Centro Internacional de Agricultura Tropical (CIAT) A.A.67-13, Cali, Colombia. Present address: 18, The Croft, Sudbury, Suffolk, United Kingdom CO 10 6HP.

[□] Tulane University International Center for Medical Research (ICRM/CIDEIM), Cali, Colombia.

[□] CIAT. Present address: Servicio Internacional para Desarrollo Agropecuario, SIDA, Casilla 495-A, Quito, Ecuador.

[□] CIAT.

TABLE 1. Check list of mammalian species captured in the wildlife studies at Carimagua, Colombia, October 1972-December 1975. Nomenclature after Morris (1965).

Mammalian Order	Species	Common name in English	Common name in Spanish used in the Colombian Llanos
Marsupials	<i>Didelphis marsupialis</i>	Common opossum	Chucha común
	<i>Caluromys lanatus</i>	Woolly opossum	"
	<i>Metachirus nudicaudatus</i>	Rat-tailed opossum	Chucha mantequera
	<i>Marmosa murina</i>	Murine opossum	Chucha de cola gruesa
	<i>Lutreolina crassicaudata</i>	Thick-tailed opossum	"
	<i>Caluromys philander</i>	Philander opossum	Chucha
Bats	<i>Rhynconycteris naso</i>	Proboscis bat	Murciélago de proboscis
	<i>Saccopteryx bilineata</i>	White lined bat	Murciélago de línea blanca
	<i>Noctilio labialis</i>	Bull dog bat	Murciélago bulldog
	<i>Phyllostomus hastatus</i>	Spear nosed bat	Murciélago ne nariz de lanza
	<i>Phyllostomus discolor</i>	"	"
	<i>Phyllostomus elongatus</i>	"	"
	<i>Mimon crenulatum</i>	Long tongued bat	Murciélago de lengua larga
	<i>Glossophaga soricina</i>	Yellow-shouldered bat	Murciélago de espalda amarilla
	<i>Sturnira lilium</i>	Short tailed bat	Murciélago de cola corta
	<i>Carollia perspicillata</i>	"	"
	<i>Rhinophylla pumilio</i>	Tent making bat	Murciélago que hace cuevas
	<i>Uroderma bilobatum</i>	American fruit-eating bat	Murciélago fructivoro
	<i>Artibeus lituratus</i>	"	"
	<i>Artibeus cinereus</i>	"	"
	<i>Artibeus jamaicensis</i>	Common bat	Murciélago común
	<i>Myotis nigricans</i>	"	"
	<i>Myotis sp.</i>	"	"
	<i>Eptesicus brasiliensis</i>	Big brown bat	Murciélago pardo grande
	<i>Lasiurus borealis</i>	Hairy tailed bat	Murciélago de cola peluda
	<i>Molossus major</i>	Velvety free-tailed bat	Murciélago de pelo corto
	<i>Eumops auripendulus</i>	Mastiff bat	"
	<i>Eumops bonariensis</i>	"	"
<i>Molossops planirostris</i>	Dog faced bat	Murciélago cara de perro	

TABLE 1. (continued)

Primates	<i>Cebus apella</i> <i>Aotus trivirgatus</i>	Brown capuchia Douroucouli	Mono maicero Mono de noche
Edentates	<i>Tamandua longicaudata</i> <i>Dasyppus kappleri</i> <i>Dasyppus novemcinctus</i> <i>Dasyppus sabanicola</i> * <i>Priodontes giganteus</i> <i>Myrmecophaga trydactyla</i>	Long-tailed tamandua Kappler's armadillo Nine banded armadillo Armadillo Giant armadillo Giant ant eater	Oso de cola larga Armadillo de Kappler Armadillo de 9 bandas Armadillo Armadillo gigante Oso hormiguero
Lagomorphs	<i>Sylvilagus floridanus</i>	Eastern cottontail	Conejo sabanero
Rodents	<i>Hydrochoerus hydrochaeris</i> <i>Cuniculus paca</i> <i>Dasyprocta fuliginosa</i> <i>Cavia porcellus</i> Coendou sp. <i>Sciurus igniventris</i> <i>Proechimys</i> sp. <i>Neotomys squamipes</i> <i>Neacomys spinosus</i> <i>Zygodontomys brevicauda</i> <i>Sigmodon alstoni</i> <i>Oryzomys concolor</i> <i>Oryzomys delicatus</i>	Capybara Paca Agouti Cavie Tree porcupine Tree squirrel Spiny rat Water rat Bristly mouse Cane rat Cotton rat Rice rat "	Chiguire Lapa o Guagua Picure Curi Puercoespín Ardilla Rata espinosa Rata de agua Ratón espinoso Ratón gris " " Ratón rojo "
Carnivores	<i>Cerdocyon thous</i> <i>Felis pardalis</i> <i>Felis jaguarondi</i> <i>Bassaricyon gabbii</i> <i>Potos flavus</i>	Crab eating fox Ocelot Jaguarondi Bushy tailed olingo Kinkajon	Zorro Ocelote Jaguar Olingo de cola peluda Perro de monte
Ungulates	<i>Tayassu albirostris</i> <i>Sus scrofa</i> <i>Odocoileus virginianus</i>	White lipped peccary Wild domestic pig White tailed deer	Venado de cola blanca

*Species not listed by Morri.

tion, some of which was previously available only in annual reports.^{3,4,5}

MATERIALS AND METHODS

The study area included the Carimagua experimental station of the Instituto Colombiano Agropecuario (ICA) and the neighbouring ranches of Caviona, Nueva Colombia, Carraba, Altagracia, La Portuguesa, and La Florida. The total area approximated 500 km².

Carimagua experimental station is located 350 km east of Villavicencio, the capital of the Department of Meta, at approximately 4-1/2°N 71-1/2°W. Annual rainfall in the region is from 1,800 to 2,000 mm, distributed from April through November. There is a marked dry season from mid-December through late March. The mean annual temperature is 26-27 C with an average minimum of 20 C, an average maximum of 33 C and extremes of 14 C and 35 C. The elevation is 150-157 m. The topography is characterized by very smooth interfluvial savannahs with slopes of less than 0.5%. Side slopes seldom exceed 3% as they drop to well-defined drainages lined with gallery forests of deciduous hardwood and palm.

Trapping or shooting of free-ranging wild animal species was conducted from October, 1972 to December, 1975.

Trapped species were transported to the laboratory and anaesthetized by ether inhalation and bled from the heart. Blood was inoculated into a culture medium suitable for the growth of *Trypanosoma cruzi* and other steracorarian trypanosomes,^{1*} and into white laboratory rats to detect the salivarian trypanosome, *T. evansi*.¹² Thick and thin blood smears and sera were prepared from the same samples and stained with Giemsa.

Animals were killed by increasing the anaesthetic dose and necropsies were performed. Ectoparasites were collected into glass vials, and intestinal contents stored in sealed containers with for-

maldehyde solution. Specimens were taken from kidneys for the culture of *Leptospira*.⁹ Specimens also were taken of any unusual lesion and fixed in 10% formaldehyde solution.

The same procedure was carried out *in situ* in the field for those animals which were shot. However, blood samples were taken at the time of necropsy, usually from a major vein in the abdominal cavity.

The microscopic slide agglutination test was used for *Leptospira*. All tests were kindly performed in the Panamerican Center of Zoonosis, (CEPANZO) Buenos Aires, Argentina. Search was made for antibodies to *Brucella* using the plate and tube agglutination, and mercaptoethanol tests in sera from 164 animals representing 20 species from seven Orders.

Sera from 175 animals representing 21 species were examined for neutralizing antibody to Venezuelan equine encephalomyelitis (VEE), and 14 animals representing four species were examined for antibody to Eastern equine encephalomyelitis (EEE) and Western equine encephalomyelitis (WEE). All tests were kindly performed in the Microbiology Department, School of Medicine, University of Valle, Colombia.

RESULTS

Fifty-nine mammalian species, representing eight Orders were captured and identified: marsupials - 6; bats - 23; primates - 2; edentates - 6; lagomorphs - 1; rodents - 13; carnivores - 5; and ungulates - 3 (Table 1). Not all mammalian species known to exist in the Llanos Orientales were represented in the collections, for example *Desmodus rotundus* (vampire bat) and *Mazama* sp. (brocket deer), but the list is the most exhaustive known for a defined area.

Ectoparasites: Eight species of hard ticks were collected and identified from 12 wild mammalian hosts representing five Orders (Table 2). Four species of fleas

TABLE 2. Species of hard ticks (Acarina: Ixodidae) found in the Carimagua area infesting wild mammalian hosts from October, 1972 to December, 1975.

Mammalian host		
Order	Species	Tick species
Marsupials	<i>Didelphis marsupialis</i>	<i>Amblyomma cajennense</i> <i>Ixodes luciae</i>
	<i>Metachirus nudicaudatus</i>	<i>A. cajennense</i>
Edentates	<i>Dasyops kappleri</i>	<i>A. auricularium</i> <i>A. cajennense</i>
	<i>Dasyops sabanicola</i>	<i>A. auricularium</i>
	<i>Myrmecophaga tridactyla</i>	<i>A. cajennense</i>
	<i>Tamandua longicaudata</i>	<i>A. cajennense</i>
Rodents	<i>Sigmodon alstoni</i>	<i>A. auricularium</i>
	<i>Hydrochoerus hydrochaeris</i>	<i>A. cajennense</i> <i>A. rotundatum</i> <i>A. maculatum</i> <i>Boophilus microplus</i>
	<i>Coendu</i> sp.	<i>A. longirostre</i>
	<i>Cuniculus paca</i>	<i>A. paca</i>
Carnivores	<i>Cerdocyon thous</i>	<i>A. maculatum</i>
Ungulates	<i>Odocoileus virginianus</i>	<i>A. cajennense</i> <i>B. microplus</i>

were detected and identified. *Rhopalopsyllus lugubris lugubris* was collected from *Cuniculus paca*, *Dasyops kappleri* and *Didelphis marsupialis*; *R. australis tupinus* from *C. paca*, and *D. marsupialis*; *R. cacticus saevus* from *C. paca*, and *Polygenis klagesi samuelis* from *Proechimys* sp. and *Nectomys squamipes*. *Cuterebra* sp. larvae occasionally were seen infesting rodents but no quantitative data was collected.

Hemoparasites: Hemoparasite infections detected were principally trypanosomes (Table 3). Recovery of *Trypanosoma cruzi* from *Proechimys* sp. and *Potus flavus* represent new records for these genera, and in *Dasyprocta fuliginosa* and *Dasyops kappleri*, new records for these species. *Trypanosoma rangeli* in *Proechimys* was a new Colombian record.¹⁹ *Trypanosoma evansi* was found only in *Hydrochoerus hydrochaeris*, all of which were apparently healthy animals.

Bacteria: Low titers were found for *L. sejro* and *L. tarassovi* in *Proechimys* sp. and *D. marsupialis*. Numerous efforts to culture the organisms finally revealed *L. tarassovi* in *Caluromys philander* and *L. australis* in *Proechimys* sp.

No positive or suspicious results were obtained for antibodies to *Brucella* in all animals tested.

Virus: Antibodies to VEE were found in *Cebus apella* (1/2) and *Proechimys* sp. (4/110) (Table 4).

In addition, sera from 163 and 162 animals (both numbers representing 19 species) were examined for Group B and Group C arboviruses, respectively. Neutralizing antibodies to Group B viruses were found in *Proechimys* sp. 4/110, *Coendor* sp. (1/2) and *Nectomys squamipes* (3/4). Antibodies to Group C viruses were found in *Proechimys* sp. (2/110) (Table 4).

Helminths: Intestinal contents were stored for future examination and

TABLE 3. Hemoparasite infections of mammalian wildlife identified at Carimagua, Colombia, October 1972-December 1975.

Mammalian host		
Order	Species	Hemoparasite
Marsupials	<i>Didelphis marsupialis</i>	<i>Trypanosoma cruzi</i> <i>Trypanosoma rangeli</i> <i>Trypanosoma</i> sp. a piroplasm
Bats	<i>Phyllostomus hastatus</i> <i>Glossophaga soricina</i> <i>Sturnira lilium</i> <i>Carollia perspicillata</i> <i>Myotis nigricans</i> <i>Myotis</i> sp. <i>Lasiurus borealis</i> <i>Molossus major</i>	<i>Trypanosoma</i> sp. <i>Trypanosoma</i> sp. <i>Trypanosoma</i> sp. <i>Plasmodium</i> sp. <i>Trypanosoma</i> sp. <i>Trypanosoma</i> sp. <i>Plasmodium</i> sp. a microfilaria a piroplasm <i>Trypanosoma</i> sp. <i>Plasmodium</i> sp. a microfilaria a piroplasm <i>Trypanosoma</i> sp. a piroplasm
Primates	<i>Cebus apella</i> <i>Dasypus kappleri</i> <i>Priodontes giganteus</i>	<i>Trypanosoma cruzi</i> <i>Trypanosoma rangeli</i> <i>Trypanosoma</i> sp. <i>Trypanosoma cruzi</i> <i>Trypanosoma</i> sp.
Rodents	<i>Hydrochoerus hydrochaeris</i> <i>Cuniculus paca</i> <i>Dasyprocta fuliginosa</i> <i>Proechimys</i> sp. <i>Zygodontomys brevicauda</i>	<i>Trypanosoma evansi</i> <i>Trypanosoma cruzi</i> <i>Trypanosoma cruzi</i> <i>Trypanosoma cruzi</i> <i>Trypanosoma rangeli</i> <i>Bartonella</i> -like sp.
Carnivores	<i>Felis pardalis</i> <i>Potos flavus</i>	a piroplasm <i>Trypanosoma cruzi</i> <i>Trypanosoma rangeli</i>

visceral lesions caused by helminths were noted. A parasite and associated egg lesions in the liver of three *D. marsupialis* resembled *Capillaria hepatica*. Another helminth commonly was found in the kidneys of *Hydrochoerus hydrochaeris*, but could not be identified. Cysts of *Echinococcus* sp. were found in 38 of 94 *C. paca*, in 2 of 15 *D. fuliginosa* and in 1 of 384 *Proechimys* sp.

DISCUSSION

Complementary collections of ticks from domestic animals at Carimagua revealed *Amblyomma maculatum*, *Anocentor nitens* and *Boophilus microplus* infesting Zebu and Zebucriollo cattle, *Anocentor nitens* infesting horses and *Rhipicephalus sanguineus* infesting dogs. *A. maculatum* and *B. microplus* therefore were demonstrated on both wild and domestic animal hosts.

TABLE 4. Mammalian sera tested for virus antibodies using the plate complement fixation test (number positive/number tested), Carimagua, Colombia, October 1972-December 1975.

Mammalian Order	Species	VEE	EEE	WEE	GpB	GpC
Marsupials	<i>Didelphis marsupialis</i>	0/20			0/20	0/20
	<i>Metachirus nudicaudatus</i>	0/1			0/1	0/1
	<i>Marmosa murina</i>	0/4			0/4	0/4
	<i>Marmosa</i> sp.	0/1			0/1	0/1
Primates	<i>Cebus apella</i>	1/2			0/2	0/2
Edentata	<i>Dasypus sabanicola</i>	0/2			0/2	0/2
	<i>Priodontes giganteus</i>	0/1	0/1	0/1		
Lagomorphs	<i>Sylvilagus floridanus</i>	0/1			0/1	0/1
Rodents	<i>Hydrochoerus hydrochaeris</i>	0/4	0/3	0/3	0/1	0/1
	<i>Cuniculus paca</i>	0/15	0/9	0/9	0/6	0/6
	<i>Dasyprocta fuliginosa</i>	0/1	0/1	0/1		
	<i>Cavia porcellus</i>	0/1			0/1	0/1
	<i>Coendou</i> sp.	0/1			1/2	0/2
	<i>Proechimys</i> sp.	4/110			4/110	2/110
	<i>Nectomys squamipes</i>	0/4			3/4	0/4
	<i>Neacomys spinosus</i>	0/1			0/1	0/1
	<i>Zygodontomys brevicauda</i>	0/1			0/2	0/1
	<i>Oryzomys concolor</i>	0/2			0/2	0/2
Carnivora	<i>Cerdocyon thous</i>	0/1			0/1	0/1
	<i>Felis pardalis</i>	0/1			0/1	0/1
	<i>Felis jaguarondi</i>	0/1			0/1	0/1
Total sera		5/175	0/14	0/14	8/163	2/162

Although not detected in this study, *Amblyomma cajennense* also infests cattle. The information is important to any future tick control or eradication program.

The presence of *T. cruzi* emphasized the need both for the type of building construction which discourages the breeding of the reduviid bug vectors and for the routine serological screening of personnel for infection. *T. evansi* in capybara¹² demonstrated the need to examine this species as a possible reservoir host.

Leptospirosis of cattle in the Llanos Orientales is an important disease.⁵ Serological evidence indicates that 11 serotypes infect cattle, the most prevalent being *L. hardjo*, *L. sejroe*, *L. wolfii*, *L. hebdomadis* and *L. tarassovi*. A relatively low prevalence was detected in the wild animal population. In addition, no evidence of brucellosis was found; however, the prevalence in Llanos cattle is low.⁵ The transmission of these diseases to the Llanos by imported cattle can be assumed; increasing cattle density, and, therefore, cattle-wildlife contact may create important wildlife reservoirs.

The discovery of the *Echinococcus* cysts requires urgent determination of the species. If the species is infective to man or domestic animals, a potential exists for an important health hazard to man or disease of cattle of major economic importance.

The results briefly described stimulated specific investigations. A survey of avian species for ecto- and hemoparasites has been completed

(Furness — in preparation). The carrier status of *H. hydrochaeris* for *T. evansi* was established,¹² the probable usefulness of *Proechimys* as a laboratory host defined,¹¹ and serological evidence collected that isolations of this trypanosome from the horse and the dog as well as the *H. hydrochaeris* shared common agglutinating antigens confirming common species identity.¹⁵ Routine serological screening of the laborers at Carimagua research station for *T. cruzi* was initiated.⁵ The helminth infection of the capybara kidneys has been identified as a new species of filaria⁶ and intensive work continues on the identity of the *Echinococcus*.^{13,19}

CONCLUSIONS

This research was conducted with minimal human and material resource and was, by the nature of the exercise, incomplete. Nevertheless, potentially important disease situations were revealed.

However, not only do these situations require monitoring, but other specific investigations are needed. A specific example is the relationship of wildlife to bovine anaplasmosis (*Anaplasma marginale*), bovine babesiosis (*Babesia argentina* and *B. bigemina*), and bovine trypanosomiasis (*Trypanosoma vivax*), all of which are endemic in the cattle population.^{5,21}

The potential importance of mammalian wildlife diseases in relation to developing cattle areas was demonstrated and an input of this nature is an obvious requirement in any human and animal disease surveillance system.

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