

# LEPTOSPIROSIS AS AN ANIMAL AND PUBLIC HEALTH PROBLEM IN LATIN AMERICA AND THE CARIBBEAN AREA<sup>1</sup>

Boris Szyfres<sup>2</sup>

*The public health and economic consequences of leptospirosis are of growing concern. A major disease of livestock throughout the world, it is also striking man at an increasing rate, particularly in the developing countries. Control will depend largely on knowledge of its distribution through identification of Leptospira serotypes.*

## The Problem of Leptospirosis in Developed and Developing Countries

Leptospiral infection affects domestic, peridomestic, and wild animals as well as man. It is currently recognized as a problem of increasing public and animal health importance throughout the world, especially in the developing countries.

The impact of leptospirosis on health in the developed countries tends to be diminishing thanks to widespread mechanization of rural activities, improved personal and environmental hygiene, and the broad application of preventive measures against the disease in domestic animals. In these countries the disease is less and less an occupational hazard, and the cases that do occur are now more associated with recreational activities, such as swimming in contaminated water or contact with dogs. It is quite likely, too, that the economic losses caused by the disease in animals (abortion, reduced milk production, calf mortality, and retarded growth) are also on the decline in these countries owing to the increased availability of diagnostic facili-

ties, greater awareness of the disease on the part of veterinarians and livestock owners, and vaccination of animals with preparations of proven efficacy.

In 1954 the United States Department of Agriculture estimated the country's losses from bovine leptospirosis at about US\$100 million (58). Although we do not know of a more up-to-date comparative estimate, it is evident from the literature (25, 59) that the widespread use of bacterins against the *pomona* serotype has markedly reduced the number of outbreaks as well as the reactor rates, thus reducing the economic effects of the disease. And the new bacterins against *grippotyphosa* and *hardjo*, alone or combined with *pomona*, will undoubtedly contribute even more to the strengthening of control. But even so, leptospirosis is still one of the major livestock diseases in the United States of America (60).

In the developing countries, however, especially those of Latin America and the Caribbean area, the situation is quite different. About 50 per cent of the population still lives in rural areas in close contact with a large variety of animals and exposed to high risk of infection. The application of modern technology to agricultural practices has come slowly. Manual labor predominates, and man is in continuous physical contact with an environment that is con-

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<sup>1</sup>Reprinted from Pan American Health Organization, *VIII Inter-American Meeting on Foot-and-Mouth Disease and Zoonoses Control*, PAHO Scientific Publication 316, Washington, 1976, pp. 115-130; also appearing in Spanish in *Bol Of Sanit Panam* 81, 1976.

<sup>2</sup>Consultant, Pan American Zoonoses Center, Ramos Mejia, Argentina.

taminated with animal urine, the principal source of leptospiral infection. The veterinarian and the livestock owner in the Latin American and the Caribbean countries are virtually powerless to fight the disease owing to the absence of diagnostic laboratories and the lack of immunogens. Leptospirosis vaccine is either not produced at all, or if it is, there is no official control and it is of doubtful efficacy.

In a large part of tropical and subtropical America the ecological conditions—abundant rainfall, natural water courses, high temperatures, and large variety of animal species—are well suited for the spread of leptospires to animals and to man. Moreover, there is a plentiful supply of some of the universal reservoir hosts and carriers of various leptospiral serotypes, among them: the common rat (*Rattus norvegicus*), which is the main host of *icterohaemorrhagiae*; the pig, principal reservoir of *pomona* and *tarassovi*; and the domestic mouse (*Mus musculus*), host of *ballum*.

Little is known about the infection's distribution in Latin America or its impact on health and the economy. Unfortunately, in most of the countries what has been done in the way of diagnosis and research has been more the result of the interest of a few workers than an organized, programmed activity under official aegis. Until countries have a laboratory infrastructure capable of diagnosis and epidemiologic research, and until national surveillance systems are established, our knowledge and understanding of the disease will remain fragmentary.

### Leptospirosis as a Public Health Problem

In Latin America and the Caribbean area the diagnosis of human leptospirosis is generally associated with a serious hepatonephritic syndrome frequently caused by *icterohaemorrhagiae*. However, it is known that the anicteric type is much more frequent than the icteric, and that serious clinical manifestations may not be apparent even in

*icterohaemorrhagiae* infection. The physician in Latin America thinks of leptospirosis when a patient has icterus and when there are epidemiologic reasons for suspecting the disease. Rarely, however, does he consider it when presented with an anicteric case. Thus, many persons suffering from the disease are not properly diagnosed on clinical examination. If a serologic test for leptospirosis is requested by the examining physician, it is frequently performed incorrectly because of lack of knowledge of the epidemiologic situation in the region and ignorance of the appropriate laboratory techniques. There are still many laboratories that rule out leptospirosis in their diagnostic reports simply because the study serum did not react to *icterohaemorrhagiae* or *canicola*.

As in other areas of the world, human leptospirosis can take the form of sporadic cases or epidemic outbreaks. Obviously, diagnosis most often fails with the sporadic kind. In addition to the problem of diagnostic failures, the reporting of cases is practically nonexistent. Knowledge of cases is reduced to information reported in the literature by interested physicians working in hospitals or health services.

Epidemic outbreaks occur in the region as a result of environmental changes such as floods, or in connection with recreational or occupational activities. Examples of such outbreaks may be mentioned. In Brazil various outbreaks are known to have occurred following floods, which caused the migration of rodents to cities. In 1941 there was one in the city of Porto Alegre (15) as a result of flooding by the Guaíba River. There were 45 cases of leptospirosis, of which four were fatal. A few years later, in 1946, an epidemic took place in Marquês de Abramante Federal Colony, Paraná (40), with 180 cases and 44 deaths. Most recently outbreaks occurred in Recife, Pernambuco. In 1966 (5), after two successive inundations, there was a severe epidemic in this city with 181 cases and death coming to 3.3 per cent. The predominant serotype was *icterohaemorrhagiae* (170

cases), although there were also cases attributable to *australis* and *pomona*. In 1970 (13) a second outbreak in Recife resulted in 102 cases and six deaths. Nine leptospiral strains were isolated, of which eight were *icterohaemorrhagiae* and one was *grippotyphosa*. Simultaneously with the first outbreak in Recife there was also one in Rio de Janeiro. From January 1966 to April 1967 a total of 140 cases were reported. Of the 48 which were recognized during the first four months of 1967, 18, or 37 per cent, died (8).

The Caribbean area is a special situation. In Barbados leptospirosis is one of the main causes of human morbidity. In this country of about 250,000 inhabitants, a total of 28 leptospirosis patients entered the Government hospital in 1970 and 14 died (44). The epidemiologic aspects of the disease are still not completely clear. Serologic examination of the patients indicated that the etiologic agent belongs to the Autumnalis group. A leptospiral strain recently isolated from a rat in Barbados was identified at the Pan American Zoonoses Center as *fort-bragg* of the Autumnalis serogroup. It proved to be highly virulent in hamsters. Quite possibly the rat (*Rattus rattus*) is indeed the reservoir host for this serotype and the principal source of infection for man. Serologic surveys of cattle on the island gave high reactor rates to serotypes of the Autumnalis and Hebdomadis groups. Cross-absorption of bovine sera with different antigens of the Autumnalis group indicated that the serotype responsible for the reactions was also *fort-bragg*. It is possible that rats are also the principal source of infection for bovines. The relationship between bovine and human infection remains unknown (44).

A large variety of leptospiral serotypes are endemic throughout much of tropical America. Only systematic studies and continuing surveillance can define the magnitude of the public health problem. Examples may be seen in several of the Caribbean and Central American countries.

In Puerto Rico (4) only 15 cases of proven

leptospirosis were observed in the San Juan City Hospital during 1948 and 1949, 13 of them being icteric. However, in a four-year systematic search launched at the end of 1948, a total of 208 cases were discovered. Of these, 106 (53.9 per cent) were anicteric, as compared with only two anicteric cases seen previously. Fatality was 13 per cent for the icteric and 6 per cent for all cases. The increased number of cases was not due to an epidemic but rather to improved surveillance and research. Most of them were recognized during the annual rainy season, the number declining as the rainfall diminished. Leptospores were isolated from 73 of the human cases, and of these 75 per cent were *icterohaemorrhagiae* and 10 per cent were *djatzi* (a serotype of the Bataviae group). The remaining strains were divided between *ballum*, *grippotyphosa*, *borincana* (a new serotype of the Hebdomadis group), and *alexi* (a new serotype of the Pyrogenes group). A total of 1,931 blood samples from the general population and from army recruits was found to have a reactor rate of 13.9 per cent. The highest rates were from areas with the heaviest rainfall, and from rural areas as compared with cities. High infection rates were proven through isolation from rats, mongooses, and domestic mice. Of the cattle sera examined, 32.5 per cent had significant titers, mainly for *borincana*. In summary, leptospirosis in Puerto Rico has the following features: a great number of human cases have been observed; six different serotypes have been isolated; the infection is highly prevalent in domestic and peridomestic animals; and the reactor rate in the general human population is also high.

Studies similar to those in Puerto Rico have been conducted in other Caribbean countries, such as Jamaica and Trinidad and Tobago, where a high degree of endemicity of the disease was also found in the general population, especially in rural areas. In Jamaica a survey carried out between 1967 and 1971 (24) demonstrated a high prevalence of reactors, varying from 13 per cent in the

general population to 35 per cent in a group of sugarcane workers. A clinic attending this latter group (Monymusk) found, out of a total of 276 patients suffering from fever of unknown origin, 65 per cent with significant titers for leptospirosis. In all cases the predominant serotype was *icterohaemorrhagiae*—in man, domestic animals, and wildlife. From the patients mentioned, 22 leptospiral strains were isolated. The majority of these were *icterohaemorrhagiae*, followed by *jules* (Hebdomadis group) and *canicola*.

In Panama (17, 38) outbreaks have been described involving multiple serotypes at a time among soldiers doing maneuvers.

From Argentina (8) there have been reports of outbreaks associated with water, from rivers or creeks contaminated with domestic animal urine, most of which were due to *pomona* (indicating that the contamination of the water was due to swine and cattle). The *pomona* serotype appears to be, at least in Argentina, the principal agent of human leptospirosis, and is responsible for the clinical form of the disease in cattle and swine. Sporadic cases of human infection are also caused by other serotypes such as *icterohaemorrhagiae*, *canicola*, and *grippotyphosa*.

In Chile (34) an analysis conducted between December 1955 and May 1959 among 110 patients admitted to Santiago's Ramón Barros Luco Hospital revealed *pomona* as the predominant serotype (48.1 per cent), followed by *canicola* (27.3 per cent) and *icterohaemorrhagiae* (23.7 per cent). Some 85 per cent of these patients were from the rural or suburban areas. Two groups were recognized as particularly at risk—agricultural irrigation workers and swineherds. This occupational aspect of the disease is emphasized by both the fact that males were predominantly affected and by the age of the patients (average 24 years).

Serologic surveys and seroepidemiologic studies are important in establishing the status of the disease. Yet very few statistically valid surveys have been carried out in Latin America. The limited work that has been done so far—serologic testing in the general population, in occupational groups, and in patients with fever of unknown origin in several of the countries—at least points to the size of the problem, indicates possible infection rates, and suggests the more prevalent serotypes which are likely to be encountered in a given environment.

Table 1. Human leptospirosis: Results of serologic surveys in the general population and occupational groups, South America, 1960–1973.

Country	Year and reference	Place	No. of specimens	% positive	Predominant serogroups
Argentina	1963 (7)	B. Aires <sup>a</sup>	726	6.6	Hebdomadis, Canicola
	1967 (2)	Abattoir	107	18.7	Tarassovi, Grippotyphosa
Bolivia	1973 (36)	Santa Cruz	142	4.9	Grippotyphosa
Brazil	1966 (9)	Abattoir			
		São Paulo	372	3.0	Icterohaemorrhagiae, Canicola
	1964–68 (12)	Hospitals <sup>b</sup>	6586	13.7	Icterohaemorrhagiae, Canicola
Colombia	1970 (49)	Workers <sup>c</sup>	1766	5.7	Icterohaemorrhagiae, Canicola
	1966 (20)	Abattoir			
Peru	1960 (27)	Manizales	97	2.0	Pomona, Autumnalis
		Market			
			Lima	112	2.7
Surinam	1966 (29)	San Martín Dept.	500	16.2	
	1969 (62)	Jungle	1020	27.9 <sup>d</sup>	Australis, Tarassovi

<sup>a</sup> Primarily from the city and province of Buenos Aires.

<sup>b</sup> Patients from the hospitals in Greater São Paulo.

<sup>c</sup> Includes municipal sanitation workers (9.7% positive), sewer workers (0.5%), and agricultural workers (5.4%).

<sup>d</sup> Titers starting at 1:10.

Table 2. Human leptospirosis: Results of serologic surveys in the general population and occupational groups, Middle America, 1948-1972.

Country	Year and reference	Area and occupation	No. of specimens	% positive	Predominant serogroups
Guatemala	1963 (1)	Coast and Pacific mountain range	59	3.4	Bataviae
Haiti	1962-63 (35)	Agricultural workers Gulf of Gonave	786	3.3	Pomona, Icterohaemorrhagiae, Canicola <sup>a</sup>
Jamaica	1967-71 (24) (24)	General population Raymonda <sup>b</sup>	1286 258	12.9 32.9	Icterohaemorrhagiae Icterohaemorrhagiae, Hebdomadis
Mexico	1972 (61)	Various states	10362	18.2	Icterohaemorrhagiae, Pomona
Panama	1960 (63)	Ranch population	55	23.6	Bataviae
Puerto Rico	1948-52 (4)	General population	1931	13.9	Bataviae, Icterohaemorrhagiae

<sup>a</sup> Only antigens used.

<sup>b</sup> Sugarcane workers.

In Tables 1, 2, and 3 an attempt has been made to tabulate data available to date from serologic testing in man.

The variation in techniques used, number of antigens, and diagnostic criteria makes comparative analysis impossible. Special attention needs to be given to this problem in the future so that steps will be taken toward assuring standardization of diagnostic criteria. Still, these shortcomings notwithstanding, the information in hand indicates broadly a prevalence of reactors in the general population ranging from 3 to 18 per cent; in professional groups, from 2 to 32 per cent; and in patients with fever of unknown origin, from 10 to 50 per cent. The

serogroups most commonly encountered in these studies were Icterohaemorrhagiae, Canicola, Pomona, Hebdomadis, Grippityphosa, Australis, and Bataviae.

Tables 4 and 5 provide information by country on the different serotypes isolated from man. A comparison of the data from other countries with those obtained from Jamaica and Puerto Rico bears out the importance of systematic surveys on human patients over significant periods of time. It is only through such studies that the spectrum of serotypes involved in human leptospirosis in a given region or country can be determined. This is also true for animal leptospirosis.

Table 3. Human leptospirosis: Results of serologic examinations in hospital patients, Caribbean area, 1962-1973.

Country	Year and reference	Area; symptoms	No. of specimens	% positive	Predominant serogroups
Cuba	1969 (45)	Northeast region; jaundice and FOU <sup>a</sup>	73	69.9	
	1973 (22)	Havana; jaundice and FOU	80	10.0	Icterohaemorrhagiae
Haiti	1962-63 (35)	Gonave; jaundice and FOU	93	30.1	Icterohaemorrhagiae
Jamaica	1967-71 (24)	Monymusk; FOU	308	50.9	Icterohaemorrhagiae, Hebdomadis
Trinidad and Tobago	1962 (16)	FUO	150	9.3	Grippityphosa, Canicola

FUO = Fever of unknown origin.

Table 4. *Leptospira* serotypes isolated from man, South America.<sup>a</sup>

Country	Serogroup	Serotype
Argentina	Icterohaemorrhagiae	<i>icterohaemorrhagiae</i>
Brazil	Icterohaemorrhagiae	<i>icterohaemorrhagiae</i>
	Canicola	<i>canicola</i>
	Grippotyphosa	<i>grippotyphosa</i>
	Andamana	<i>andamana</i>
	Pyrogenes	<i>alexi</i>
	Hebdomadis	<i>wolffi</i>
Colombia	Canicola	<i>canicola</i>
Chile	Pomona	<i>pomona</i>
Uruguay	Icterohaemorrhagiae	<i>icterohaemorrhagiae</i>

<sup>a</sup>Total: 7 serogroups, 7 serotypes.

### Leptospirosis as an Animal Health Problem

Epizootic outbreaks of leptospirosis in cattle, due principally to *pomona*, have been recognized mainly in Argentina and Chile. *Pomona* infection in cattle is recognized most often because of abortion and hemoglobinuria, which are the most evident and dramatic signs of the disease's presence. In South America, however, many cases of lepto-

spirosis go unrecognized owing to the concomitant high prevalence of brucellosis, which is usually assumed to be the cause of bovine abortions. In extensive regions of Latin America and the Caribbean area where tick infestation is widespread, leptospirosis may also be confused with hemoprotozoan infections. Several bovine outbreaks have originated in infected pigs.

In many of the countries of the Region, as

Table 5. *Leptospira* serotypes isolated from man, Central America and the Caribbean area.<sup>a</sup>

Country	Serogroup	Serotype
Cuba	Icterohaemorrhagiae	<i>icterohaemorrhagiae</i>
	Canicola	<i>canicola</i>
Jamaica	Hebdomadis	<i>kremastos</i> (?)
		<i>jules</i>
	Pyrogenes	<i>abramis</i>
	Icterohaemorrhagiae	<i>icterohaemorrhagiae</i>
		<i>monymush</i>
	Pomona	<i>pomona</i>
	Canicola	<i>canicola</i>
Panama and Canal Zone	Icterohaemorrhagiae	<i>weaveri</i>
	Tarassovi	<i>bravo</i>
Puerto Rico	Icterohaemorrhagiae	<i>icterohaemorrhagiae</i>
	Bataviae	<i>bataviae</i>
		<i>djatzi</i>
	Canicola	<i>canicola</i>
	Pyrogenes	<i>alexi</i>
	Ballum	<i>ballum</i>
	Grippotyphosa	<i>grippotyphosa</i>
	Hebdomadis	<i>borincana</i>
Trinidad and Tobago	Icterohaemorrhagiae	?
	Hebdomadis	<i>kremastos</i>
		<i>trinidad</i>
		<i>tabiquete</i>

<sup>a</sup>Total: 9 serogroups, 17 serotypes.

Table 6. Bovine leptospirosis: Results of serologic surveys, South America, 1960-1973.

Country	Year and reference	Area	No. of specimens	% positive	Predominant serogroups
Argentina	1968 (8)	Various provinces	17,816	55.0	Hebdomadis, Pomona
Bolivia	1973 (36)	Santa Cruz	520	71.0	Hebdomadis
Brazil	1960-68 (48)	São Paulo <sup>a</sup>	15,080	23.6	Hebdomadis, Pomona
Colombia	1966 (19)	Caldas	244	14.7	Grippotyphosa, Canicola
Chile	1967 (37)	Southern region	879	58.7	Icterohaemorrhagiae, Hebdomadis
	1971 (64)	Southern region	1,021 <sup>b</sup>	68.7	Hebdomadis, Pomona
Ecuador	1973 (8)	Pichincha	1,780	12.0	Pomona <sup>c</sup>
Peru	1966 (32)		4,178	10.0	Australis, Hebdomadis, Pomona
Uruguay	1965-68 (8)		1,736	39.3	Hebdomadis, Ballum

<sup>a</sup> From various states, primarily São Paulo.

<sup>b</sup> Clinically suspect animals.

<sup>c</sup> Only antigen used.

it can be seen in Tables 6 and 7, reaction to serotypes of the Hebdomadis group is high. In Argentina, for example, the rate was over 50 per cent in the animals examined. The Pan American Zoonoses Center has from the beginning had a very special interest in determining the serotype(s) associated with such reactions. With improved techniques for isolating leptospire, the Center was recently able to single out six strains

from bovine kidneys obtained in slaughterhouses, which it typed as *hardjo*. This serotype was also isolated in Peru. As it is known, *hardjo* is the cause of abortion in cattle in Canada and the United States of America. This serotype is difficult to isolate and to adapt to the culture media commonly used for leptospire. The isolation of *hardjo* in Argentina (43) and in Peru (30) possibly explains part of the enigma of the high re-

Table 7. Bovine leptospirosis: Results of serologic surveys in Mexico, Central America, Panama, and the Caribbean area, 1948-1974.

Country	Year and reference	Area	No. of specimens	% positive	Predominant serogroups
Mexico	1968-70 (23)		2,293	22.2	Hebdomadis, Pomona
	1972 (61)	Mexico City, Veracruz, Tamaulipas	139	38.8	
Guatemala	1963 (1)	Pacific Coast	122	41.8	Hebdomadis
	1965 (54)		451	21.5	Tarassovi, Hebdomadis
Nicaragua	1966 (11)		262	43.8	Hebdomadis, Pomona
Panama	1963 (41)		333 <sup>a</sup>	36.9	Hebdomadis, Grippotyphosa
			138 <sup>b</sup>	49.3	
Barbados	1972-73 (10)		476	52.5	Autumnalis, Hebdomadis
Dominican Republic	1973 (39)		210 <sup>c</sup>	85.7	Hebdomadis, Pomona
Guyana	1973 (10)		439	48.9	Hebdomadis
Jamaica	1967-71 (24)		681	24.9	Icterohaemorrhagiae, Hebdomadis
Puerto Rico	1948-52 (4)		288	32.5	Hebdomadis, Bataviae
Trinidad and Tobago	1974 (10)		45	35.5	Grippotyphosa, Hebdomadis

<sup>a</sup> From 19 normal dairy herds.

<sup>b</sup> From 2 dairy herds with abortions.

<sup>c</sup> From suspect animals.

activity to *Hebdomadis*. It remains to be found out whether or not other serotypes of the same serogroup intervene, as in Brazil (serotypes *wolffi* and *gaicurue*). Workers in the Soviet Union (55) attribute the high rate of *Hebdomadis* reactors to subclinical infective doses, which they believe have an immunizing effect.

From leptospirosis outbreaks and studies carried out at slaughterhouses it has been possible to isolate the following serotypes from bovines: *canicola*, *icterohaemorrhagiae*, *paidjan* (Bataviae group), *ballum*, the new *galtoni* (Canicola group), and *peruviana* (Australis group).

As can be seen in Tables 6 and 7, serologic reaction to different serotypes in apparently normal bovines is high, ranging from 10 per cent to more than 50.

Table 8 summarizes the isolation of serotypes in bovines in Latin America. As it can be seen, there are 10 different serotypes from seven serogroups. *Pomona*, the most important pathogenic serotype for bovines in Latin America, was found to be present in five of the six countries where bacteriologic investigations have been conducted. In addition, serotypes of the *Hebdomadis* group were isolated in three of these six countries.

As in many other parts of the world, swine leptospirosis is widespread in the Americas. Two principal serotypes, *pomona* and *tarassovi*, have been isolated. In Argentina, Brazil, Chile, and Peru *canicola* has also been isolated. Brazil has the three serotypes mentioned, *icterohaemorrhagiae*, and a new serotype of the Tarassovi group which was assigned the name *guidae* (Table 9). Among domestic animals swine are one of the most important reservoirs for leptospiruses. In addition to being themselves victims of the infection, especially with *pomona*, they constitute an important source of infection for man, cattle, and horses. The infected pig develops prolonged and abundant leptospiruria and is thus a first-class maintenance host. The Pan American Zoonoses Center has been conducting research over the past three years in slaughterhouse pigs (42). Of 130 kidneys from apparently healthy pigs, leptospiruses were isolated from 70, or about 54 per cent. The strains were: *tarassovi* (60 per cent), *pomona* (34.2 per cent), and *canicola* (1.4 per cent)—three strains being lost before they could be classified. Of 192 sera obtained at random in the same slaughterhouse, 64.5 per cent gave significant titers for *pomona* and 63.5 per cent for *tarassovi*. This study

Table 8. *Leptospira* serotypes isolated from cattle, South America.<sup>a</sup>

Country	Serogroup	Serotype
Argentina	Canicola	<i>canicola</i> <i>galtoni</i>
	Pomona	<i>pomona</i>
	Bataviae	<i>paidjan</i>
Brazil	<i>Hebdomadis</i>	<i>hardjo</i>
	<i>Icterohaemorrhagiae</i>	<i>icterohaemorrhagiae</i>
	Pomona	<i>pomona</i>
Chile	<i>Hebdomadis</i>	<i>wolffi</i> <i>gaicurue</i>
	Pomona	<i>pomona</i>
	Pomona	<i>pomona</i>
Peru	<i>Icterohaemorrhagiae</i>	<i>icterohaemorrhagiae</i>
	Australis	<i>peruviana</i>
	<i>Hebdomadis</i>	<i>hardjo</i>
Venezuela	Ballum	<i>ballum</i>
Dominican Republic	Pomona	<i>pomona</i> <sup>b</sup>

<sup>a</sup>Total: 7 serogroups, 10 serotypes.

<sup>b</sup>Provisional classification.

Table 9. *Leptospira* serotypes isolated from swine, South America.

Country	Serogroup	Serotype
Argentina	Canicola	<i>canicola</i>
	Pomona	<i>pomona</i>
	Tarassovi	<i>tarassovi</i>
Brazil	Icterohaemorrhagiae	<i>icterohaemorrhagiae</i>
	Canicola	<i>canicola</i>
	Pomona	<i>pomona</i>
	Tarassovi	<i>tarassovi</i>
Colombia	Pomona	<i>pomona</i>
Chile	Pomona	<i>pomona</i>
	Canicola	<i>canicola</i>
Peru	Pomona	<i>pomona</i>
	Tarassovi	<i>tarassovi</i>
	Canicola	<i>canicola</i>
Venezuela	Pomona	<i>pomona</i>

<sup>a</sup>Total: 4 serogroups, 5 serotypes.

clearly shows that special attention needs to be paid to this animal species in any future epidemiologic studies or control activities. A similar conclusion can be inferred from the serologic results obtained in different countries of the Region (Table 10). The rate of reactors in swine has a range similar to that for bovines: from 6.9 to 50 per cent. *Pomona* is generally the more prevalent serotype.

Equines have a leptospiruria of rather short duration and probably play only a limited role in the epizootiology of the infection, even though they themselves are often victims. Equines present a variable clinical picture in different parts of the world. Generally they are persistent serologic reactors, responding to different serotypes depending on the environment. Few samples of

Table 10. Leptospirosis in swine: Results of serologic surveys in Latin America and the Caribbean area, 1960-1974.

Country	Year and reference	Area	No. of specimens	% positive	Predominant serogroups
Argentina	1968 (8)		1334	49.5	Pomona, Icterohaemorrhagiae
	1973 (42)	Buenos Aires <sup>a</sup>	193	64.5	Pomona, Tarassovi
Barbados	1972-73 (10)		214	28.5	Autumnalis, Hebdomadis
Bolivia	1973 (36)	Santa Cruz	102	6.9	Pomona
Brazil	1960-68 (48)	São Paulo <sup>b</sup>	3242	19.5	Pomona, Canicola
	1973 (53)	São Paulo <sup>a</sup>	275	17.0	Pomona, Canicola
Colombia	1970 (46)	Antioquia	43	27.9	Pomona
Guatemala	1963 (1)	Pacific Coast	120	27.5	Pomona, Autumnalis
Guyana	1973 (10)		286	16.0	Canicola, Pomona
Jamaica	1967-71 (24)		675	28.7	Icterohaemorrhagiae, Hebdomadis
Mexico	1969-70 (23)		398	12.5	Australis, Ballum
	1972 (61)	Mexico City and 4 states	1459	51.5	
Peru	1960 (28)	Callao <sup>a</sup>	494	20.0	Autumnalis, Pomona
Trinidad and Tobago	1974 (10)		52	38.0	Canicola, Pomona
Uruguay	1965-68 (8)		508	39.0	Pomona, Tarassovi

<sup>a</sup>Specimens from abattoirs.

<sup>b</sup>Primarily from the State of São Paulo.

Table 11. Equine leptospirosis: Results of serologic survey, South and Middle America, 1960-1973.

Country	Year and reference	Area	No. of specimens	% positive	Predominant serogroups
Argentina	1968 (8)		682	51.0	Pomona, Ballum
Bolivia	1973 (36)	Santa Cruz	101	75.2	Hebdomadis, Pyrogenes
Brazil	1960-68 (48)	São Paulo <sup>a</sup>	811	22.8	Pomona, Canicola
Colombia	1966 (19)		60	30.0	Autumnalis, Pomona
Guatemala	1963 (1)		86	4.6	Pomona, Autumnalis
Jamaica	1967-71 (24)		543	32.7	Icterohaemorrhagiae, Hebdomadis
Mexico	1972 (61)	Mexico City	176	28.9	
Uruguay	1965-68 (8)		274	51	Tarassovi, Pomona

<sup>a</sup> From various states, primarily from São Paulo.

equine sera have been examined in Latin America. As it can be seen in Table 11, all the countries except Guatemala had reactor rates above 20 per cent. A few strains were isolated but not typed.

The world literature reports few outbreaks of leptospirosis in sheep, and most of them have been attributed to *pomona* or *grippotyphosa*. In Argentina (8) one was described in a flock of 1,000 sheep with 8 per cent morbidity and 39 per cent case fatality. The infection, as confirmed by isolation, was due to *ballum*. In 889 samples from various parts of Argentina 12.7 per cent reactivity

was found, predominantly to *ballum*. High rates of reactivity in sheep were observed in São Paulo, Brazil (47) (34 per cent in 400 samples), as they also were in goats (55 per cent in 127 samples), with responses predominantly to *canicola*, *icterohaemorrhagiae*, and *pomona*.

Of the remaining domestic animals, the dog is a most important reservoir of leptospire. In Latin America, as in other parts of the world, *canicola* and *icterohaemorrhagiae* have been isolated. In addition, *pyrogenes* has been isolated in Argentina, and *paidjan* and *tarassovi* in Peru (Table 12). The rate

Table 12. *Leptospira* serotypes isolated from dogs, Latin America and the Caribbean area.<sup>a</sup>

Country	Serogroup	Serotype
Argentina	Canicola	<i>canicola</i>
	Pyrogenes	<i>pyrogenes</i>
Brazil	Icterohaemorrhagiae	<i>icterohaemorrhagiae</i>
	Canicola	<i>canicola</i>
Colombia	Icterohaemorrhagiae	<i>icterohaemorrhagiae</i>
	Canicola	<i>canicola</i>
Peru	Canicola	<i>canicola</i>
	Tarassovi	<i>tarassovi</i>
	Bataviae	<i>paidjan</i>
Uruguay	Icterohaemorrhagiae	<i>icterohaemorrhagiae</i>
Venezuela	Icterohaemorrhagiae	<i>icterohaemorrhagiae</i>
Cuba	Canicola	<i>canicola</i>
Puerto Rico	Icterohaemorrhagiae	<i>icterohaemorrhagiae</i>
Trinidad and Tobago	Canicola	<i>canicola</i>

<sup>a</sup>Total: 5 serogroups, 5 serotypes.

Table 13. *Leptospira* serotypes isolated in South America.<sup>a</sup>

Group	Serotype	Argentina	Brazil	Colombia	Chile	Ecuador	French Guiana	Surinam	Peru	Uruguay	Venezuela	Bolivia	Paraguay
Icterohaemor- rhagiae	<i>icterohaemor- rhagiae</i>	X	X	X	X	<sup>b</sup>	X	X	(X)	<sup>b</sup>	<sup>b</sup>	—	—
Canicola	<i>canicola</i>	X	X	X	X				X		X		
	<i>galtoni</i>	X		X									
Ballum	<i>ballum</i>	X	X								X		
Pyrogenes	<i>pyrogenes</i>	X											
	<i>alexi</i>		X										
Australis	<i>peruviana</i>								X				
Grippotyphosa	<i>grippotyphosa</i>	X	X										
Hebdomadis	<i>hardjo</i>	X							X				
	<i>szwajizak</i>		X										
	<i>wolffi</i>		X										
	<i>guaicurue</i>		X										
Bataviae	<i>bataviae</i>	X											
	<i>paidjan</i>	X							X				
	<i>argentinaensis</i>	X											
	<i>brasiliensis</i>		X										
Pomona	<i>pomona</i>	X	X	X	X			X		X			
Tarassovi	<i>tarassovi</i>	X	X						X				
	<i>guidae</i>		X										
Andamana	<i>andamana</i>		X										

<sup>a</sup>Total: 11 serogroups, 20 serotypes (7 new).<sup>b</sup>Serotype unknown.

of serologic reactors in Latin American cities is generally high, the predominant response being to *canicola* in some regions and *icterohaemorrhagiae* in others. In Lima (26), out of 444 dogs examined, 46.4 per cent had antibodies; 26 leptospiral strains were isolated. Of 357 samples from different parts of Argentina, 26.7 per cent were positive, with responses to *icterohaemorrhagiae* predominating (6). Similarly, in São Paulo *icterohaemorrhagiae* predominated over *canicola*.

Peridomestic and wild animals, including rodents as well as other mammals, are important reservoirs for leptospires. While leptospirosis in rats has been demonstrated in many Latin American countries, few studies have been carried out in other wild hosts outside of Argentina, Brazil, Jamaica,

Nicaragua, Panama, Puerto Rico, and Trinidad and Tobago.

#### Distribution of Serotypes in the Region

Isolation and knowledge of the most prevalent serotypes is essential if diagnosis, epidemiology, and control activities are to be established on a rational basis.

Despite all the difficulties and deficiencies which have been noted earlier, some progress has been made in knowledge of leptospirosis. When Alexander (3) of the WHO Reference Laboratory in Washington, D.C.,<sup>3</sup> published his paper on distribution of the infection in Latin America in 1960, he listed only 11

<sup>3</sup>Division of Veterinary Medicine, Walter Reed Army Medical Center.

Table 14. *Leptospira* serotypes isolated in Mexico, Central America, and the Caribbean area.

Group	Serotype	Barbados	Cuba	Jamaica	Mexico	Nicaragua	Puerto Rico	Dominican Republic	Trinidad and Tobago
Icterohaemorrhagiae	<i>icterohaemorrhagiae</i>	<sup>c</sup>	X	X	<sup>d</sup>		X		<sup>d</sup>
	<i>naam</i>			X					
	<i>monymusk</i>			X					
	<i>bog-verre</i>			X					
Canicola	<i>canicola</i>	<sup>c</sup>	X	X		X	X		X
	<i>portland-verre</i>			X					
Ballum	<i>ballum</i>		X				X		
	<i>castelloni</i>	X							
Pyrogenes	<i>pyrogenes</i>					X			
	<i>varela</i>					X			
	<i>abramis</i>			X					
	<i>alexi</i>						X		
Autumnalis	<i>autumnalis</i>					X			
	<i>fort-bragg</i>	X							
Australis	<i>nicaragua</i>					X			
Pomona	<i>pomona</i>		X	X	X			<sup>d</sup>	
Hebdomadis	<i>sejroe</i>				X				
	<i>kremastos</i>								X
	<i>jules</i>			X					
	<i>tabaquite</i>								X
	<i>recreo</i>					X			
	<i>trinidad</i>								X
	<i>wolffi</i>			X					
<i>mini</i>			X						
Bataviae	<i>bataviae</i>							X	
	<i>diatzi</i>							X	
Tarassovi	<i>rama</i>					X			

<sup>a</sup>Total: 11 serogroups, 28 serotypes (11 new).

<sup>b</sup>Excluding Panama and the Canal Zone.

<sup>c</sup>Provisional classification.

<sup>d</sup>Serotype unknown.

serotypes which had been isolated and typed. Of these, seven had been confirmed in Middle America and five in South America.

Today, over 50 serotypes, from 15 serogroups, are known to occur and have been isolated in Latin America and in the Caribbean area (Tables 13, 14, 15). From Argentina alone 12 different serotypes have been isolated. This is an impressive achievement, especially in such a short period of time. Various of the serotypes are autochthonous and have not been observed in other continents. There is no doubt that still more serotypes are yet to be isolated and typed. There

is practically no information available from a number of countries, including Ecuador, El Salvador, Honduras, and Paraguay.

### Summary and Final Considerations

Human and animal leptospirosis is widespread throughout the Americas. The disease has a major impact on public health and the economy in the countries of Latin America and the Caribbean area.

The lack of diagnostic laboratories, standardized techniques and diagnostic criteria, systematic surveillance, and report-

ing makes it impossible to have a true picture of its status.

Nevertheless, systematic studies carried out by research workers in some countries, together with serologic surveys conducted in the human population at large, occupational groups, hospital patients, and animal populations, give an idea of the magnitude of the problem not only in terms of infection rates but also with respect to the leptospiral serogroups most prevalent in the different areas.

The data indicate that in a great part of Latin America and the Caribbean area leptospirosis is endemic and involves multiple serotypes. Outbreaks have been described in association with environmental changes, especially flooding, migration, and population density of rodents, and also, on a more limited basis, recreational activities such as swimming in contaminated waters.

According to the limited seroepidemiologic data available, it is estimated that 3 to 18 per cent of the general population, 2 to 32 per cent of those belonging to exposed occupational groups, and 10 to 50 per cent of patients with fever of unknown origin have leptospiral antibody. The most predominant serogroups are *Icterohaemorrhagiae*, *Canicola*, *Pomona*, *Hebdomadis*, and *Bataviae*.

Known outbreaks of bovine leptospirosis have been mainly due to *pomona*. Its presence has been demonstrated in five of the six countries in which bacteriologic studies have been carried out. This is the most important pathogenic serotype for the bovine species in Latin America. In most of the countries serologic reaction to the different serotypes is high, ranging from 10 to 50 per cent, with response to *Hebdomadis* group antigens the most prevalent. In Argentina and Peru *hardjo* has been isolated. *Wolffi* and *guaicurue* of the *Hebdomadis* group have been demonstrated in Brazil. The role of these serotypes in Latin American outbreaks is not known, but it is presumed that *hardjo*, as elsewhere, produces abortions, atypical mastitis, and metritis.

The most prevalent serotype in pigs is

Table 15. *Leptospira* serotypes isolated in Panama and the Canal Zone.

Group	Serotype
<i>Icterohaemorrhagiae</i>	<i>icterohaemorrhagiae</i> <i>weaveri</i>
<i>Canicola</i>	<i>canicola</i>
<i>Pyrogenes</i>	<i>abramis</i> <i>alexii</i>
<i>Cynopteri</i>	<i>cynopteri</i> <i>canalzonae</i>
<i>Australis</i>	<i>pma</i>
<i>Pomona</i>	<i>tropica</i> <i>proechimys</i>
<i>Grippotyphosa</i>	<i>grippotyphosa</i>
<i>Hebdomadis</i>	<i>borincana</i> <i>maru</i> <i>szwajizak</i> <i>gorgas</i> <i>beye</i>
<i>Bataviae</i>	<i>kobbe</i> <i>balboa</i> <i>claytoni</i> <i>paudjan</i>
<i>Tarassovi</i>	<i>bravo</i> <i>chagres</i> <i>atchafalaya</i> <i>gatuni</i>
<i>Panama</i>	<i>panama</i> <i>crisobalt</i>
<i>Shermani</i>	<i>shermani</i>

<sup>a</sup>Total: 12 serogroups, 27 serotypes (2 new serogroups and 7 new types)

*pomona*, probably followed in frequency by *tarassovi*. Many of the *pomona* cases in cattle originate in pigs. The serologic reaction rate is similar to that found in bovines and ranges, depending on the geographic area, from 6.9 to about 50 per cent.

Few equine sera have been examined; most of the countries except Guatemala have reactor rates above 20 per cent. The few isolations from horses have not been identified.

With respect to canine leptospirosis, the serotypes *canicola* and *icterohaemorrhagiae* are predominant in dogs of Latin America and the Caribbean area, as in other parts of the world; in addition, *pyrogenes* was isolated in

Argentina and *tarassovi* and *paidjan* in Peru. The rates of serologic reactors are generally high.

Leptospirosis in rats was demonstrated in many countries, but few studies have been carried out in wildlife outside of Argentina, Brazil, Jamaica, Nicaragua, Panama, Puerto Rico, and Trinidad and Tobago.

The most important advance in the past 15 years has been the greater understanding of the distribution of serotypes through their bacteriologic isolation in various countries. At present more than 50 serotypes, from 15 serogroups, have been isolated in Latin

America and the Caribbean area. Several of them are autochthonous and have not been described from other geographic areas.

In view of the present status of leptospirosis, the strengthening of public and animal health services in this area is a must. To this end it will be necessary to train personnel in diagnosis and in surveillance, as well as to establish or reinforce diagnostic laboratories. Another clear need is the production of a vaccine for animal use. And finally, it is important to disseminate knowledge on the disease among physicians, veterinarians, and livestock owners.

### SUMMARY

As a major livestock disease, leptospirosis cuts significantly into the world's supply of animal protein through its consequences of abortion and calf mortality, retarded growth, and reduced milk production. Evidently, such losses have severe economic implications as well.

The disease's impact has been somewhat diminished in the developed countries thanks to mechanization of rural activities, improved personal and environmental hygiene, and broad application of preventive measures, including the administration of bacterins, in domestic animals. Still, even in these circumstances it remains a serious problem.

In the developing countries, in which large percentages of the population live in close contact with animals, the spread of infection is much greater. Moreover, the ecology of tropical and subtropical America—with its abundant rainfall, natural water courses, and high temperatures—is particularly favorable for the transmission of

leptospire. In such conditions the human disease is a growing threat as well.

The spread of leptospirosis, both in animals and man, is facilitated by the fact that infection from many of the serotypes can exist without presenting serious clinical manifestations. Hence the importance of laboratory diagnosis. Systematic studies over time of serotype distribution, coupled with wide and improved surveillance, will be a key factor in bringing the disease under control. According to the limited seroepidemiologic data available, 3 to 18 per cent of the general human population, 2 to 32 per cent of those belonging to exposed occupational groups, and 10 to 50 per cent of patients with fever of unknown origin have leptospiral antibody. The most predominant serogroups are *Icterohaemorrhagiae*, *Canicola*, *Pomona*, *Hebdomadis*, and *Bataviae*. So far more than 50 serotypes, from 15 serogroups, have been isolated from man and animals in Latin America and the Caribbean area.

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