GEOGRAPHICAL DISTRIBUTION OF LEPTOSPIRA-POSITIVE FIELD RODENTS IN JAPAN

Many papers have been published on leptospira-positive rodents in selected areas of Japan. *Rattus norvegicus*, *R. rattus*, and *R. rattus alexandrius* trapped in urban areas and certain swamp rice fields in rural areas were found to carry *L. icterohaemorrhagiae* (Ido et al., 1916; Higuchi, 1930; Kitaoka, Inoue and Kubo, 1935). *Microtus montebelli* and *Apodemus speciosus speciosus* were reported to carry *L. hebdomadis* (Ido, Ito and Wani, 1917) and *L. autumnalis* (Koshina, Shiozawa and Kitayama, 1924; Abe et al., 1933; Kitaoka and Ogawa, 1942), respectively. The latter two species of rodents are caught generally in the field and forest in rural areas. Up to the present, at least nine serotypes of pathogenic leptospira, *L. icterohaemorrhagiae*, *L. hebdomadis*, *L. autumnalis*, *L. australis* (Shiozawa and Kubo, 1938), *L. canicola* (Kitaoka, 1940; Yamamoto, 1940), *L. bataviae* (Kitaoka, 1951), *L. pyrogenes* (Yamamoto and Hashiguchi, 1944; Kitaoka, Maida and Inoue, 1950), *L. javanica* (Kobayashi, Kusaba and Ueki, 1972) and *L. grippotyphosa* (Kitaoka et al., unpublished data), have been isolated from the rodent in Japan. With field rodents and other animals trapped in a country-wide survey on rickettsia-positive animals (Tamiya, 1962), attempts have been made to know what species of animals are leptospira positive and to elucidate geographical distribution of such animals in Japan excluding the Okinawa Islands.

Of all animals trapped in 428 areas in Japan during the period 1955-1962, 4,108 were used in this investigation. The animals were identified finally by Dr. Y. Imai-zumi, the National Science Museum (Natural History Institute), Tokyo. They were comprised of 35 species and their geographical distribution is given in Table I and was illustrated in more details in a book (Tamiya, 1962). The kidneys to be tested were fixed in 5% formalin and stained by Levaditi method. The section of the stained kidney was examined under a microscope; leptospire were morphologically confirmed in the lumen of the convoluted tubules of the kidney (Fig. 1).

Figure 2 indicates geographical distribution of leptospira-positive and -negative animals in 428 areas in 38 prefectures from Wakkanai, the northernmost town in Hokkaido, to Amami Oshima Island, the southernmost island in Kagoshima prefecture. In some areas repeated surveys were performed in different seasons, but generally a single survey of an area was conducted during a certain season. Our former surveys (Kitaoka et al., 1935; Kitaoka and Ogawa, 1942) on leptospira-positive field rodents revealed that the heavier the body weights of rodents, the higher the leptospira-positive rate in the kidneys. Accordingly, negative areas on the map do not strictly mean no-epidemicity in leptospira-positive small animals. One hundred and twenty-five of 428 areas surveyed were found to be leptospira-positive. These areas included Shiretoko Peninsula, Hokkaido in the north, and Amami Oshima Island, Kagoshima prefecture in the south.

Table II indicates the species of field rodents and other small animals trapped for leptospira surveillance in eight districts in Japan. One hundred and forty-six of

TABLE I

Leptospira-positive rates of small animals trapped in Japan, 1955-1962

Small animal	District								Total	Per cent
	Hok-kaido	Tohoku	Kanto	Chubu	Kinki	Chu-goku	Shi-koku	Kyu-shu		
A.a.a.	0/11	2/50	0/41	1/83	0/12	0/22	0/3	0/2	3/224	1.3
A.a.c.						0/11			0/11	0
A.a.h.	1/56								1/56	1.8
A.a.s.								0/10	0/10	0
A.a.y.								0/6	0/6	0
A.s.a.	2/52								2/52	3.8
A.s.d.								0/48	0/48	0
A.s.i.			0/33						0/33	0
A.s.n.						2/87			2/87	2.3
A.s.s.		4/147	6/340	35/503	0/92	19/388	2/143	17/182	83/1795	4.6
A.s.sa.				0/10					0/10	0
A.s.t.								0/1	0/1	*
As.a.		0/2		0/3			0/2		0/7	0
C.d.d.							0/1		0/1	*
C.r.b.	7/366								7/366	1.9
C.r.m.	0/1								0/1	*
E.k.		0/1	2/8	4/120					6/129	4.7
E.s.o.						0/13			0/13	0
E.s.s.					0/10	0/23	0/3		0/36	0
G.j.		0/6							0/6	0
M.c.c.								1/1	1/1	*
M.m.		0/167	0/8	22/458	0/2	0/9			22/644	3.4
M.m.m.				0/1					0/1	*
M.m.o.								0/1	0/1	*
R.n.	2/14	5/15	5/97	3/42		0/3	2/59	0/57	17/287	5.9
R.r.		0/8	0/85	0/4			0/39	1/43	1/179	0.6
S.m.r.								0/7	0/7	0
S.s.sa.	0/4								0/4	0
S.s.sh		0/2							0/2	*
S.u.	0/7								0/7	0
U.t.c.							0/7		0/7	0
U.t.h.		0/7	0/2	0/14	0/16	0/4			0/43	0
U.t.m.						0/4			0/4	0
U.t.t.								1/7	1/7	14.3
To.o.o.								0/18	0/18	0
Total	12/511	11/405	13/614	65/1238	0/132	23/562	4/257	20/383	146/4104	3.6
Percent	2.3	2.7	2.1	5.3	0	3.7	1.6	5.2	3.6	

A.a.a.:	<i>Apodemus argenteus argenteus</i>	E.s.s.:	<i>Eothenomys smithi smithi</i>
A.a.c.:	<i>Apodemus argenteus celatus</i>	G.j.:	<i>Glirulus japonicus</i>
A.a.h.:	<i>Apodemus argenteus hokkaidi</i>	M.c.c.:	<i>Mus caroli caroli</i>
A.a.s.:	<i>Apodemus argenteus sagax</i>	M.m.:	<i>Microtus montebelli</i>
A.a.y.:	<i>Apodemus argenteus yakui</i>	M.m.m.:	<i>Mus musculus molossinus</i>
A.s.a.:	<i>Apodemus speciosus ainu</i>	M.m.o.:	<i>Mus musculus orii</i>
A.s.d.:	<i>Apodemus speciosus dorsalis</i>	R.n.:	<i>Rattus norvegicus</i>
A.s.i.:	<i>Apodemus speciosus insperatus</i>	R.r.:	<i>Rattus rattus</i>
A.s.n.:	<i>Apodemus speciosus navigator</i>	S.m.r.:	<i>Suncus murinus riukiuanus</i>
A.s.s.:	<i>Apodemus speciosus speciosus</i>	S.s.sa.:	<i>Sorex shinto saevus</i>
A.s.sa.:	<i>Apodemus speciosus sadoensis</i>	S.s.sh.:	<i>Sorex shinto shinto</i>
A.s.t.:	<i>Apodemus speciosus tusimaensis</i>	S.u.:	<i>Sorex unguiculatus</i>
As.a.:	<i>Aschigomys andersoni</i>	U.t.c.:	<i>Urotrichus talpoides centralis</i>
C.d.d.:	<i>Crochidura desi-nezumi desi-nezumi</i>	U.t.h.:	<i>Urotrichus talpoides hondonis</i>
C.r.b.:	<i>Clethrionomys rufocanus bedfordiae</i>	U.t.m.:	<i>Urotrichus talpoides minutus</i>
C.r.m.:	<i>Clethrionomys rutilus mikado</i>	U.t.t.:	<i>Urotrichus talpoides talpoides</i>
E.k.:	<i>Eothenomys kageus</i>	To.o.o.:	<i>Tokudaia osimensis osimensis</i>
E.s.o.:	<i>Eothenomys smithi okiensis</i>

Fig. 1. Leptospire in the lumen of the convoluted tubules of the kidney of *Apodemus speciosus speciosus*, male, body weight 50 g, trapped in Nobeoka, Miyazaki prefecture, Kyushu on August 17, 1957. Stained by Levaditi method ($\times 600$).

4,104 animals tested comprising 35 species were leptospira-positive. There were the following 12 species: *Apodemus argenteus argenteus*, *A. argenteus hokkaidi*, *A. speciosus ainu*, *A. speciosus navigator*, *A. speciosus speciosus**, *Clethrionomys rufocanus bedfordiae*, *Eothenomys kageus*, *Mus caroli caroli*, *Microtus montebelli**, *Rattus norvegicus**, *Rattus rattus**, and *Urotrichus talpoides talpoides*. Four species marked with asterisks had been found to be leptospira-positive. The remaining eight species were found for the first time to be positive. The average positive rate was 3.6%. The rates for individual species of rodents were 5.9% for *R. norvegicus*, 4.6% for *A. speciosus*, 3.8% for *A. speciosus ainu*, and 3.4% for *M. montebelli* (*U. talpoides talpoides* was positive at 14.3% in an examination). It can be said that the more positive spots located in one area, the higher the incidence of leptospirosis cases, for example, in Niigata,

TABLE II
Monthly fluctuation of leptospira-positive rates in small animals trapped in various areas in Japan, 1955-1962

Small animal	Month						
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
A.a.a.	0/10	1/19	0/6	0/5	0/31	2/46	0/19
A.a.c.	0/1		0/4			0/4	
A.a.h.		0/4	0/1		0/2	1/25	0/3
A.a.s.							
A.a.y.		0/6					
A.s.a.						2/19	0/3
A.s.d.		0/48					
A.s.i.							
A.s.n.	0/9		0/18			0/26	
A.s.s.	0/85	6/214	14/281	0/111	1/148	9/120	3/149
A.s.sa.							
A.s.t.	0/1						
As.a.							0/2
C.d.d.		0/1					
C.r.b.	0/20	0/25	0/26	0/23	0/20	5/91	0/8
C.r.m.							
E.k.	0/12	2/11	0/4	0/3	0/12	0/13	0/3
E.s.o.			0/10			0/3	
E.s.s.		0/9	0/1	0/8			
G.j.						0/6	
M.c.c.							
M.m.	0/17	3/16	0/28	1/60	0/60	0/98	0/33
M.m.m.							
M.m.o.							0/1
R.n.	0/15	0/2	0/5	0/7	0/6	1/25	2/41
R.r.	1/38	0/9	0/2	0/2			0/20
S.m.r.							
S.s.sa.			0/3				
S.s.sh.				0/2			
S.u.		0/6					
U.t.c.		0/4					
U.t.h.	0/1	0/20	0/2	0/2	0/6		
U.t.m.			0/2				
U.t.t.		0/4					0/1
To.o.o.							
Total	1/209	13/398	14/393	1/223	1/285	20/276	5/283
Percent	0.5	3.3	3.6	0.4	0.4	4.2	1.8

Month					Total	Per cent
Aug.	Sep.	Oct.	Nov	Dec.		
0/6	0/46	0/10	0/12	0/14	3/224	1.3
	0/2				0/11	0
0/13	0/7		0/1		1/56	3.6
		0/10			0/10	0
					0/6	0
0/16	0/12		0/2		2/52	3.8
					0/48	0
0/2			0/15	0/16	0/33	0
	2/34				2/87	2.3
7/69	10/186	11/168	1/157	21/107	83/1795	4.6
		0/4	0/6		0/10	0
					0/1	*
		0/2	0/3		0/7	0
					0/1	*
0/72	2/60	0/11	0/10		7/366	1.9
0/1					0/1	*
0/2	1/14	2/30	1/11	0/14	6/129	4.7
					0/13	0
	0/18				0/36	0
					0/6	0
1/1					1/1	*
1/145	5/29	3/32	2/65	6/61	21/644	3.4
	0/1				0/1	*
					0/1	*
2/81	0/4	1/30	0/15	11/56	17/287	5.9
0/32	0/5	0/16	0/37	0/18	1/179	0.6
0/7					0/7	0
			0/1		0/4	0
					0/2	*
	0/1				0/7	0
	0/3				0/7	0
	0/1	0/5	0/5	0/1	0/43	0
	0/2				0/4	0
				1/2	1/7	14.3
				0/18	0/18	0
11/447	20/425	17/310	4/340	39/307	146/4104	3.6
2.5	4.7	5.3	1.2	12.7	3.6

Fig. 2. Geographical distribution of leptospira-positive small animals all over Japan, 1955-1962. A similar figure appears on page 212 "Vaccines in Japan", Maruzen Co. Ltd., Tokyo, 1962 (in Japanese).

Miyagi, Ibaraki, Shizuoka and some other areas.

Table II shows the relation between the positive rate and the month at which time the small animals were trapped. The positive rate ranged from 1.2 to 12.7 % in a period from February through March and from June through December.

Investigation of serotypes of leptospira in leptospiral animals and identification of leptospiral isolates from them should be made next, since classification and identi-

fication of serotypes, known and unknown, of leptospira found in animals, especially in the newly discovered eight species of leptospiral animals are practically important to study epidemiology of leptospirosis and its control. In addition, those eight species (*A. argenteus argenteus*, *A. argenteus hokkaidi*, *A. speciosus ainu*, *A. speciosus navigator*, *Clethrionomys rufocanus bedfordiae*, *Eothenomys kageus*, *Mus caroli caroli*, and *Urotrichus talpoides talpoides*) are to be added to the lists of leptospiral host animals (US Department of Public Health, 1966).

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