기 생 충 학 잡 지 제25권 제1호
The Korean Journal of Parasitology
Vol. 25, No. 1, 13~23, June, 1987

Toxoplasma Antibodies by Indirect Latex Agglutination Tests in Zoo Animals

Won-Young Choi, Jae-Eul Yoo, Ho-Woo Nam
Department of Parasitology & Catholic Institute of Parasitic Diseases, Catholic University Medical College, Seoul, Korea

Chang-Young Oh & Sung-Won Kim
Seoul Grand Park

Ken Katakura & Akio Kobayashi
Department of Parasitology, Jikei University School of Medicine, Tokyo, Japan

INTRODUCTION

Toxoplasmosis is a typical zoonosis by *Toxoplasma gondii* which infecting mammals and birds with very low specificity. It is a worldwide etiological agent except Antarctic Continent. Generally, it is known that 20~30% of adult human and several ten percent of animals are infected by *T. gondii*, but infection rates are different in geographical distributions. *Toxoplasma* is transmitted by the ingestion of either oocysts excreted in the feces of infected cats or bradyzoite tissue cysts from infected animals. But, it is unknown which is more important route. Kobayashi(1977) estimated the average percentage of cats secreting oocysts of 1~2%, and demonstrated percentage in some countries, about 1% in Japan, 1.4% in Germany, 1.3% in America, and 0.6% in Hawaii. And, many reports described the infection rates in domestic animals. Of these, Jacobs *et al.* (1960) screened in pigs, sheep, and cows, Janitschke *et al.* (1964) in pigs, Nobuto(1967) in pigs, and Choi(1969) and Choi *et al.* (1984) in pigs.

Many serological tests have been developed for the detection of antibodies of *T. gondii*. Of these, the most reliable is the cytoplasm modifying or "dye" test of Sabin and Feldman(1948). It is sensitive and so far it is the most specific test for toxoplasmosis. The indirect fluorescent antibody test (IFAT) overcomes some of the disadvantages of the dye test using killed *Toxoplasma* as antigen. Although titers obtained by IFAT are comparable to those in the dye test, it has disadvantages that a microscope with UV light is required and fluorescent antispecies globulin is required for each species to be tested and false-positive titers may occur in patients with antinuclear antibodies (Araujo *et al.*, 1971). Other serological tests, namely, the indirect hemagglutination test (IHA), the agglutination test, and the enzyme-linked immunosorbent assay (ELISA), each has some advantages. IHA (Jacobs and Lunde, 1957) and agglutination (Fulton and Turk, 1959) tests are easy to perform but they need further evaluation for specificity for titers. And, the complement fixation test and ELISA (Voller *et al.*, 1976) are useful, but these depend upon the antigenic preparation. Recently, the sensitivity and specificity of indirect latex agglutination test have been improved in reaction conditions by Tsubota *et al.* (1977) and tested by Kobayashi *et al.* (1977), it is now used widespread in diagnosing and studying toxoplasmosis.

* This work was supported by the Catholic Medical Center Research Fund of 1985.

Accordingly, it is quite worthy of studying not only human toxoplasmosis, cats as final host, and domestic animals as transmitter of *Toxoplasma*, but also the wild animals as reservoir hosts of *Toxoplasma*. In this study, we demonstrate the indirect latex agglutination titers in the sera of wild animals which are conserved in Seoul Grand Park.

MATERIALS AND METHODS

Sera of 216 cases (111 species) were obtained from the animals conserved in Seoul Grand Park, including 131 cases in mammals (68 species), 75 cases in birds (36 species), and 10 cases in reptiles (7 species) from October 1983 to June 1986. Sera were absorbed into PKU filter papers and then dried under room temperature.

Antigen and reagents used in this study were obtained from Eiken Chem. Co., Japan as a kit "Toxotest-MT (EST 06)."

Indirect latex agglutination antibody titers were determined according to the method of Kobayashi *et al.* (1978). Briefly, two pieces of the discs of 3mm diameter from the blood-absorbed PKU filter paper were eluted in 50μl of buffer (0.2M aminomethylpropanol, pH 8.0) for 30 min. using a micromixer, then diluted serially. Sensitized latex antigen 'Eiken' was fully suspended and added to each hole, vortexed, and incubated for 24hr at room temperature. Antibody titers were determined by the last dilution number which precipitated latex agglutination of middle class dispersion.

RESULTS

Animals were examined on the antibody titers of *Toxoplasma* by the indirect latex agglutination test, 20 out of 131 cases (15.3%) in mammals (Table 1 and 2), 2 out of 75 cases (2.7%) in birds (Table 3 and 4), and none in reptiles (Table 5 and 6), according to species, 15 out of 68 species (22.1%) in mammals, 2 out of 36 species (5.6%) in birds showed positive antibody titers when the titers of 1 : 32 or higher were regarded as positive as summarized in Table 7 and 8.

In mammals, it appeared as positive in 2 out of 6 cases (1 out of 3 species) in marsupials, 1 out of 15 cases (1 out of 11 species) in primates, 1 out of 1 case in bats, 6 out of 13 cases (5 out of 10 species) in carnivores, 1 out of 12 cases (1 out of 3 species) in odd-toed ungulates, 9 out of 80 cases (6 out of 38 species) in even-toed ungulates, and none in rodents and whales,

Table 1. *Toxoplasma* antibody titers by indirect latex agglutination tests in mammals in Seoul Grand Park

No.	Scientific name	Common name	Titer	Sampling date	Remarks
Order Marsupials (6 cases in 3 species)					
1	*Macropus robustus*	Wallaroo	1 : 64	84. 4.26	U.S.A.
2	〃	〃	1 : 256	85. 9.23	Australia
3	〃	〃	0	86. 6.30	U.S.A.
4	〃	〃	0	〃	〃
5	*Wallabia parma*	Parma wallaby	0	85. 8.29	Japan (U.S.A.)
6	*W. eugenii*	Tammer wallaby	0	85.11. 4	Korea
Order Primates (15 cases in 11 species)					
7	*Nycticebus coucang*	Slow Loris	0	85. 8.20	Japan (U.S.A.)
8	〃	〃	0	〃	〃
9	*Aotes trivigatus*	Douroucouli	0	〃	Japan
10	*Saimiri sciureus*	Common Squirrel Monkey	0	85. 7.15	〃
11	〃	〃	0	85.12.13	〃
12	*Cebus appella*	Brown Capuchia	0	85. 9.10	U.S.A.
13	*Ateles paniscus*	Black Spider Monkey	1 : 128	85. 8.17	U.S.A.

No.	Scientific name	Common name	Titer	Sampling date	Remarks
14	*Cercopithecus neglectus*	Grass Monkey	0	87. 1. 9	France (U.S.A.)
15	*Erythrocebus patas*	Red Guenon	0	86. 3.19	U.S.A.
16	*Colobus polykomos*	Southern Black & White Colobus	0	83.11. 2	〃
17	*Symphalangus syndactylus*	Siamang	0	86. 7. 7	〃
18	*Hylobates lar*	White-handed Gibbon	0	85.11.16	Japan
19	〃	〃	0	〃	〃
20	*Pan troglodytes*	Chimpanzee	0	85. 7.28	Germany
21	〃	〃	0	87. 1. 9	〃
Order Bats (1 case in 1 species)					
22	*Pterptera giganteus*	Indian Flying Fox	1 : 64	85.12.28	Australia
Order Rodents (2 cases in 1 species)					
23	*Ratufa indica*	Indian Giant Squirrel	0	85. 7.23	Japan
24	〃	〃	0	85. 7.24	〃
Order Whales (2 cases in 1 species)					
25	*Tursiops gillii*	Gill's Dolphin	0	86. 3.23	U.S.A.
26	〃	〃	0	86. 6. 8	Korea
Order Carnivores (13 cases in 10 species)					
27	*Potos flavus*	Kinkajou	0	86. 5.13	U.S.A.
28	*Helarctos malayanus*	Malayan Sun Bear	1 : 256	85.10.31	〃
29	*Genetta genetta*	Common Genet	0	85.12.30	〃
30	*Canis mesomelas*	Black-backed Jackel	0	85.12.29	Germany
31	〃	〃	0	87. 1. 7	France (U.S.A.)
32	*Lycaon pictus*	African wild Dog	0	85. 9.10	U.S.A.
33	*Caracal caracal*	Caracal	1 : 128	85.12. 6	U.S.A.
34	〃	〃	1 : 32	87. 1. 9	France (U.S.A.)
35	*Prionailurus bengalensis euptilura*	Amur Leopard Cat	1 : 16	85.12.12	Korea
36	*Panthera onca onca*	Amazon Jaguar	0	86. 1. 1	
37	*Panthera tigris*	Tiger	1 : 64	85. 6.28	Korea
38	〃	〃	1 : 64	85. 9.10	〃
39	*Acinonyx éubatus*	Cheetah	1 : 64	85. 7.23	Japan
Order Odd-toed Ungulates (12 cases in 3 species)					
40	*Equus asinus*	Domestic Ass	0	84. 4.26	U.S.A.
41	*E. przewalskii caballus*	Domestic Horse	0	85.10.16	Korea
42	〃	〃	0	〃	〃
43	〃	〃	0	〃	〃
44	〃	〃	0	〃	〃
45	〃	〃	0	〃	〃
46	〃	〃	0	〃	〃
47	〃	〃	0	〃	〃
48	〃	〃	0	〃	〃
49	〃	〃	1 : 128	83.10. 3	Germany
50	〃	〃	0	85. 8.21	U.S.A.
51	*Tapirus indicus*	Malayan Tapir	0	84. 4.26	U.S.A.
Order Even-toed Ungulates (80 cases in 38 species)					
52	*Choeropsis liberiensis*	Pigmy Hippopotamus	0	86. 1.13	Japan
53	*Camelus ferus bactrianus*	Bactrian Cammel	1 : 64	83.10.22	Japan
54	*Camelus dromedarius*	Dromedary	0	86. 4.21	〃
55	*Lama guanicoe*	Guanaco	1 : 32	85. 7. 2	U.S.A.

No.	Scientific name	Common name	Titer	Sampling date	Remarks
56	*Lama guanicoe*	Guanaco	0	85. 7. 28	U.S.A.
57	〃	〃	0	85. 8. 13	〃
58	*Dama dama*	Fallow deer	0	85. 12. 13	〃
59	*Axis (Hyelaphus) procinus*	Hog Deer	1 : 64	85. 12. 6	〃
60	〃	〃	0	85. 5. 13	〃
61	〃	〃	0	86. 7. 14	Japan
62	*Axis axis*	Axis deer	0	86. 1. 7	〃
63	〃	〃	0	〃	〃
64	*Cervus (Rusa) unicolor*	Indian Sambar	1 : 16	83. 12. 9	Korea
65	*C. (Rucervus) duvauceli*	Barasingha	0	85. 10. 18	Korea
66	〃	〃	0	86. 3. 18	U.S.A.
67	*C. (Sika) nippon*	Sika Deer	1 : 32	85. 11. 21	Korea
68	〃	〃	0	〃	〃
69	〃	〃	1 : 32	〃	〃
70	〃	〃	0	〃	〃
71	〃	〃	1 : 64	〃	〃
72	〃	〃	1 : 64	〃	〃
73	〃	〃	0	86. 10. 13	〃
74	*C. (S,) n. nippon*	Japanese Deer	1 : 32	85. 12. 14	Japan
75	*Cervus (Sika) nippon yezoensis*	Ezo Deer	0	85. 10. 16	U.S.A.
76	*C.(S.)n. yakusima*	Yak Sika	0	83. 11. 30	Korea
77	〃	〃	0	86. 3. 26	〃
78	〃	〃	0	〃	〃
79	*C.(S.)n. taiouanus*	Formosa Deer	0	85. 7. 25	Japan
80	〃	〃	0	85. 11. 28	〃
81	*Hydropotes inermis argyropus*	Korean Water Deer	0	87. 1. 6	Korea
82	*Tragelaphus strepsiceros*	Greater Kudu	0	85. 11. 28	U.S.A.
83	〃	〃	0	86. 8. 2	〃
84	*T. angasi*	Nyala	0	86. 4. 21	Japan
85	〃	〃	0	86. 4. 27	〃
86	〃	〃	0	86. 5. 16	U.S.A.
87	*T. spekei*	Sitatunga	0	85. 8. 17	〃
88	*Taurotragus oryx*	Eland	0	85. 12. 12	Korea
89	〃	〃	0	86. 5. 8	U.S.A.
90	*Boselaphus tragocamelus*	Nilgai	0	85. 12. 16	〃
91	*Bubalus (Bubalus) arnee bubalis*	Domestic Water Buffalo	1 : 32	85. 9. 3	Japan
92	*Syncerus caffer*	African Buffalo	0	86. 3. 18	Japan
93	*Bison bonasus*	European Bison	0	85. 12. 8	U.S.A.
94	*Alcelaphus buselaphus*	Kaama caama	1 : 16	86. 3. 31	〃
95	〃	〃	0	86. 8. 21	〃
96	*Hippotragus niger*	Sable Antelope	0	86. 9. 4	〃
97	〃	〃	0	86. 9. 30	〃
98	*Oryx gazella dammah*	Scimitar-horned Oryx	0	85. 11. 20	〃
99	〃	〃	0	〃	Germany
100	〃	〃	0	86. 3. 28	〃
101	〃	〃	0	86. 6. 22	〃

No.	Scientific name	Common name	Titer	Sampling date	Remarks
102	*Oryx gazella gazella*	South African Oryx	0	85. 7.22	U.S.A.
103	〃	〃	0	86. 7. 4	〃
104	〃	〃	0	〃	〃
105	*Antilope cervicapra*	Blackbuck	0	86. 2.11	〃
109	〃	〃	0	86. 6.21	〃
107	〃	〃	0	〃	〃
108	〃	〃	0	86. 7.25	〃
109	*Saiga tatarica mongolica*	Mongolian Saiga	0	84. 5.13	Japan
110	〃	〃	0	85. 7.28	〃
111	〃	〃	0	85. 8.22	〃
112	〃	〃	0	〃	〃
113	〃	〃	0	85. 9.16	U.S.A.
114	〃	〃	0	86. 1. 8	Japan
115	*Oreamnos americanus*	Rocky Mountain goat	0	85. 9. 2	U.S.A.
116	〃	〃	0	85. 9.24	〃
117	〃	〃	0	85.10.17	〃
118	〃	〃	0	85.11. 4	〃
119	*Capra ibex*	Ibex	0	85. 9.27	〃
120	*C. aegagrus hircus*	Domestic Goat	0	83.12.30	Korea
121	〃	〃	0	86. 5.10	〃
122	*Caprini farconeri*	Markhor	0	86. 9. 9	〃
123	*Hemitragus jemalahicus*	Himalayan Tahr jemalahicus	0	86. 2.24	U.S.A.
124	*Ammotragus lervia*	Barbary Sheep	0	85. 9. 4	Korea
125	〃	〃	0	85.10. 2	〃
126	*Ovis ammon aries*	Domestic Sheep	0	83.12.30	〃
127	〃	〃	0	86. 4.27	Japan
128	*O. dalli*	Dall's Sheep	0	85.11.17	U.S.A.
129	*Gazella (Gazella) dorcas*	Dorcas Gazelle	0	85. 7.29	U.S.A.
130	〃	〃	0	85. 8. 8	〃
131	〃	〃	0	85.10.16	〃

Table 2. Positive *Toxoplasma* antibody titers in mammals

Order	No. of Positive* / No. of cases	No. of Positive / No. of species
Marsupials	2/6	1/3
Primates	1/15	1/11
Bats	1/1	1/1
Rodents	0/2	0/1
Whales	0/2	0/1
Carnivores	6/13	5/10
Odd-toed Ungulates	1/12	1/3
Even-toed Ungulates	9/80	6/38
Total	20/131	15/68

* Indirect latex agglutination antibodies of 1 : 32 or higher are regarded as positive,

as shown in Table 2.

In birds, 1 out of 21 case (1 out of 7 species) in gallinaceous birds and 1 out of 6 cases (5 species) in parrots appeared to have the positive antibody titers of *Toxoplasma* as shown in Table 4. And, none of reptiles showed positive.

As shown in Table 9, frequencies of positive *Toxoplasma* antibody titers were high in 1 : 64, 9 cases in mammals followed by 1 : 32, 6 cases, 1 : 128, 3 cases, and 1 : 256, 2 cases, respectively. Two positive cases in birds appeared to be 1 : 64.

Table 3. *Toxoplasma* antibody titers by indirect latex agglutination tests in birds in Seoul Grand Park

No.	Scientific name	Common name	Titer	Sampling date	Remarks
Order Ciconiformes (2 cases in 2 species)					
1	*Ciconia ciconia*	White Stork	0	85. 8. 13	U.S.A.
2	*Eudocimus ruber*	Scarlet Ibis	0	85. 11. 17	Japan
Order Flamingos(4 cases in 2 species)					
3	*Phoenicopterus chilensis*	Chilean Flamengo	0	86. 3. 14	Korea
4	〃	〃	0	86. 12. 22	Japan
5	*Phosniconaias minor*	Lessar Flamengo	0	86. 1. 8	〃
6	〃	〃	0	86. 1. 13	〃
Order Anseriformes(27 cases in 6 species)					
7	*Cygnus cygnus*	Whooper Swan	0	86. 2. 27	Korea
8	*C. melanocoryphus*	Black-necked Swan	0	85. 9. 21	Japan
9	*Anser erythropus*	Lessar Whitefronted Goose	0	85. 9. 16	Korea
10	〃	〃	0	85. 9. 23	Japan
11	*A. indicus*	Bar-headed Goose	0	85. 8. 8	U.S.A.
12	*Tadorna tadorna*	Common Shelduck	0	85. 9. 15	Germany
13	*Anas platyrhynchos*	Domestic Duck	0	86. 6. 19	Korea
14	〃	〃	0	〃	〃
15	〃	〃	0	〃	〃
16	〃	〃	0	〃	〃
17	〃	〃	0	〃	〃
18	〃	〃	0	〃	〃
19	〃	〃	0	〃	〃
20	〃	〃	0	〃	〃
21	〃	〃	0	〃	〃
22	〃	〃	0	〃	〃
23	〃	〃	0	〃	〃
24	〃	〃	0	〃	〃
25	〃	〃	0	〃	〃
26	〃	〃	0	〃	〃
27	〃	〃	0	〃	〃
28	〃	〃	0	〃	〃
29	〃	〃	0	〃	〃
30	〃	〃	0	〃	〃
31	〃	〃	0	〃	〃
32	〃	〃	0	〃	〃
33	〃	〃	0	〃	〃
Order Raptor(1 case in 1 species)					
34	*Haliaeetus albicilla*	White-tailed Sea Eagle	0	86. 1. 17	Korea
Order Gallinaceous Birds(21 cases in 7 species)					
35	*Lophortyx californica*	California Queil	0	85. 7. 22	Japan
36	〃	〃	0	85. 7. 24	〃
37	*Meleagris gallopavo gallopavo*	Domestic Turkey	0	85. 7. 24	Korea
38	〃	〃	0	〃	〃
39	〃	〃	0	〃	〃
40	〃	〃	0	〃	〃
41	〃	〃	0	86. 6. 10	〃
42	*Pavo cristatus*	Indian Peafowl	0	83. 11. 30	〃

No.	Scientific name	Common name	Titer	Sampling date	Remarks
43	*Pavo cristatus*	Indian Peafowl	0	85. 10. 15	Korea
44	*Acryllium vulturinum*	Vulturine Guineafowl	0	83. 11. 2	U.S.A.
45	〃	〃	0	85. 11. 20	〃
46	*Numida meleagris*	Helmeted Guineafowl	0	86. 6. 10	Korea
47	〃	〃	0	〃	〃
48	〃	〃	0	〃	〃
49	〃	〃	0	〃	〃
50	〃	〃	0	〃	〃
51	〃	〃	0	〃	〃
52	〃	〃	0	〃	〃
53	〃	〃	0	〃	〃
54	*Lophophorus impejanus*	Himalayan Monal Pheasant	1 : 64	83. 11. 21	U.S.A.
55	*Lophura ignita*	Crested Fireback Pheasant	0	〃	〃
Order Cranes(3 cases in 3 species)					
56	*Grus vipio*	White-necked Crane	0	86. 2. 24	Korea
57	*Balearica pavonia*	Crowned Crane	0	85. 12. 10	〃
58	*Psophia cepitans*	Common Trumpeter	0	85. 9. 9	U.K.
Order Pigeons(3 cases in 3 species)					
59	*Oneopopelia transquebarica*	Red Turtle Dove	0	85. 7. 15	U.S.A.
60	*Lophohaps plumfera*	Plaumed Ground Dove	0	85. 9. 6	〃
61	*Ocyphaps lophotes*	Crested Brested Bronze-Wing Pigeon	0	85. 7. 15	Japan
Order Cuckoos(1 case in 1 species)					
62	*Turacus donaldsoni*	Donaldson's Tourako	0	85. 8. 5	U.S.A.
Order Parrots(6 csaes in 5 species)					
63	*Kakatoe galerita*	Yellow-crested Cockatoo	0	85. 11. 17	Japan
64	*K. sulphurea*	White Cockatoo	1 : 64	85. 7. 17	〃
65	*Ara macao*	Scarlet Macaw	0	85. 7. 24	〃
66	〃	〃	0	85. 10. 31	〃
67	*A. chloroptera*	Red-blue green macaw	0	86. 3. 3	U.S.A.
68	*A. ararauna*	Blue-&-yellow Macaw	0	85. 9. 17	Japan
Order Piciformes (2 cases in 2 species)					
69	*Ramphastos sulfuratus*	Rainbow-billed Toucan	0	85. 9. 27	U.S.A.
70	*R. vitellinus*	Channel-billed Toucan	0	86. 3. 19	U.K.
Order Passerine Birds(5 cases in 4 species)					
71	*Urocissa erythrorhynca*	Red-billed Blue Magpie	0	86. 3. 19	Japan
72	*Gracula reigiosa*	Javan Hill Mynah	0	85. 8. 27	〃
73	*Gracula reigiosa*	Javan Hill Monah	0	85. 12. 17	Korea
74	*Lamprotornis chalybaeus*	Blue-eared Glossy Starling	0	85. 7. 27	Japan
75	*Leucopsar rothschildi*	Rothschild's Mynah	0	〃	U.S.A.

Table 4. Positive *Toxoplasma* antibody titers in birds

Order	No. of Positive / No. of cases	No. of Positive / No. of species
Ciconiformes	0/2	0/2
Flamengos	0/4	0/2
Anseriformes	0/27	0/6
Raptors	0/1	0/1
Gallinaceous Birds	1/21	1/7
Cranes	0/3	0/3
Pigeons	0/3	0/3
Cuckoos	0/1	0/1
Parrots	1/6	1/5
Piciformes	0/2	0/2
Passerine Birds	0/5	0/4
Total	2/75	2/36

Table 5. *Toxoplasma* antibody titers by indirect latex agglutination tests in reptiles in Seoul Grand Park

No.	Scientific name	Common name	Titer	Sampling date	Remarks
Order Turtles (2 cases in 2 species)					
1	*Clemmys (C.) guttata*	Spotted Turtle	0	85. 8. 8	Japan
2	*Chinemys reevesii*	Reeve's Turtle	0	〃	U.S.A.
Order Scaly Reptiles (8 cases in 5 species)					
3	*Varanus (Varanus) salvator*	Two-banded Monitor	0	84. 4. 9	Japan
4	〃	〃	0	85. 9.23	〃
5	*Python reticulatus*	Reticulate Python	0	85.10.31	Korea
6	〃	〃	0	86. 5. 1	Japan
7	*P. molurus*	Indian Python	0	85. 7.23	U.S.A.
8	〃	〃	0	85. 7.26	〃
9	*P. regius*	Royal Python	0	85. 9. 4	〃
10	*Eryx johnii*	John's Sand Boa	0	85. 9. 9	〃

Table 6. Positive *Toxoplasma* antibody titers in reptiles

Order	No. of Positive	No. of Positive
	No. of cases	No. of species
Turtles	0/2	0/2
Scaly Reptiles	0/8	0/5
Total	0/10	0/7

Table 7. Positive cases of *Toxoplasma* antibody titers in animals in Seoul Grand Park

Groups	No. of cases	Positive	
		No. of cases	%
Mammals	131	20	15.3
Birds	75	2	2.7
Reptiles	10	0	0
Total	216	22	10.2

Table 8. Positive species of *Toxoplasma* antibody titers in animals in Seoul Grand Park

Groups	No. of species	Positive	
		No. of species	%
Mammals	68	15	22.1
Birds	36	2	5.6
Reptiles	7	0	0
Total	111	17	15.3

Table 9. Frequency of positive *Toxoplasma* antibody titers in animals in Seoul Grand Park

Groups	Titers				Total
	1 : 32	1 : 64	1 : 128	1 : 256	
Mammals	6	9	3	2	20
Birds		2			2
Total	6	11	3	2	22

DISCUSSION

Toxoplasma is a worldwide etiological agent infecting over two hundred of species of mammals and birds including human. Many reports demonstrated that cats and domestic animals as a transmitter of *Toxoplasma* as well as human toxoplasmosis itself. In Korea, Soh *et al.* (1960) reported first the human cases as 5.6% positive out of 373 by skin test using toxoplasmin. Afterwards, Moon(1965) isolated *Toxoplasma* from measly pigs. And, Choi(1969) found *Toxoplasma* cysts in the diaphragm of 38.3% tested pigs and obtained 32.7% of positive dye test from the sera of pigs. Nakayama *et al.*(1970). described 14.3% positive in Koreans by indirect hemagglutination test, Lim *et al.*(1980) screened the patients of Obstetrics and Gynecology, then suggested the relationships between abortion or neonatal death and toxoplasmosis.

Diagnosis of toxoplasmosis is performed by the

isolation of *Toxoplasma* from patients, histopathological test and serological tests. But, serological tests are used widely to diagnose toxoplasmosis generally. Many methods have been used, but indirect latex agglutination test is used widespread because of its easiness to perform and its comparable sensitivity and specificity after the improvement by Tsubota *et al.*(1977) and by Kobayashi *et al.*(1977). This method resulted in the agreement of 94.4% with the results of dye test(Kobayashi *et al.*, 1977). With this method, Choi *et al.* (1982) obtained 4.3% positive out of 412 patients of St. Mary's Hospital, Kim and Choi(1983) obtained 7.2% of positive out of 874 patients of Seoul Red Cross Hospital. And Choi *et al.* (1983) screened 573 patients in National Seoul Mental Hospital that resulted in 1.9% of positive cases, especially high percentages in hypochondriac of 7.4% of positive. Later, Choi *et al.* (1984) examined 515 swine sera in outskirts of Seoul which resulted in 12.4% positive cases. And, Choi *et al.* (1985) screened 377 pregnant women and 43 pelvic tumor patients of Kangnam St. Mary's Hospital which resulted in 0.5% in the former and 7.0% in the latter.

Besides human toxoplasmosis, cats as a final host and domestic animals such as sheep, cows, and swine as a transmitter of *Toxoplasma* have been examined actively. In this study, we could examine the indirect latex agglutination antibody titers of 216 cases of wild animals conserved in Seoul Grand Park with a thought that they might play a role as reservoir host of *Toxoplasma*. Marsupials, carnivores, and even-toed ungulates in mammals seemed to be more sensitive to *Toxoplasma*, especially 50% of carnivores examined showed positive *Toxoplasma* antibody titers. But, we could not find any positive cases in rodents that had been known to be sensitive to *Toxoplasma*, this might be resulted from the number of cases examined. And, only two cases showed positive antibody titers in birds, and in reptiles we could not find any cases of positive in 10 cases. Therefore, we could identify once more the host range of *Toxoplasma* as mammals and birds. This study was carried out to elucidate the degree of propagation among the wild animals which might be thought as reservoir host, high percentages in some animals was suggested its function as a reservoir host.

SUMMARY

Total of 216 animals conserved in Seoul Grand Park were examined on the antibody titers of *Toxoplasma* by the indirect latex agglutination test, 20 out of 131 cases (15.3%) in mammals, 2 out of 75 cases (2.7%) in birds, and none in reptiles, according to species, 15 out of 68 species (22.1%) in mammals, 2 out of 36 species (5.6%) in birds showed positive antibody titers when the titers of 1 : 32 or higher were regarded as positive.

In mammals, it appeared as positive in 2 out of 6 cases (1 out of 3 species) in marsupials, 1 out of 15 cases (1 out of 11 species) in primates, 1 out of 1 case in bats, 6 out of 13 cases (5 out of 10 species) in carnivores, 1 in 12 cases (1 species out of 3) in odd-toed ungulates, 9 out of 80 cases (6 species out of 38) in even-toed ungulates, and none in rodents and in whales.

In birds, 1 out of 21 cases (1 out of 7 species) in gallinaceous birds and 1 out of 6(5 species) in parrots appeared to have the positive antibody titers of *Toxoplasma*.

And, none of reptiles showed positive.

Frequencies of positive antibody titers were high in 1 : 64, 9 cases in mammals, followed by 1 : 32, 6 cases, 1 : 128, 3 cases, and 1 : 256, 2 cases, respectively. Two positive cases in birds appeared to be 1 : 64.

REFERENCES

Araujo, F.G., Barnett, E.V., Gentry, L.O. & Remington, J.S. (1971). False-positive anti-*Toxoplasma* fluorescent antibody tests in patients with antinuclear antibodies. *Appl. Microbiol.*, **22**:270-275.

Choi, W.Y.(1969) The isolation of *Toxoplasma gondii* from pork and the dye test of swine sera. *J. Catholic Medical College*, **16**:229-235.

Choi, W.Y., Yoo, J.E. & Kim, W.K. (1982) *Toxoplasma* antibodies by indirect latex agglutination tests in St. Mary's Hospital patients. *Korean J. Parasit.*, **20**:33-37.

Choi, W.Y., Yoo, J.E, Chung, C.S., Paik, K.K. & Cho, S.N. (1983) *Toxoplasma* antibodies by indirect latex agglutination tests in National Seoul Mental Hospital patients. *Korean J. Parasit.*, **21**:281-285.

Choi, W.Y., Yoo, J.E., Kim,W.S. & Kang, S.Y. (1984) *Toxoplasma* antibodies by indirect latex agglutination tests in pig sera. *Korean Central J. Med.*, **46**:419-423.

Choi, W.Y., Choi, H.R. & Rha, J.G.(1985) Significance of *Toxoplasma* antibody titers by indirect latex agglutination tests in pregnant women and pelvic tumor patients. *Korean J. Parasit.*, **23**:300-304.

Fulton, J.D. & Turk, J.L. (1959) Direct agglutination test for *Toxoplasma gondii*. *Lancet*, **11**:1068-1069.

Jacobs, L. & Lunde, M.N.(1957) A hemagglutination test for toxoplasmosis. *J. Parasitol.*, **43**:308-314.

Jacobs, L., Remington, J.S. & Melton, M.L. (1960) A survey of meat samples from swine, cattle, and sheep for the presence of encysted *Toxoplasma*. *J. Parasitol.*, **46**:23-28.

Janitschke, K. (1964) Untersuchungen von Schlachtschweinen auf *Toxoplasma* Infektion. *Z. Parasitenk.*, **25**:5.

Kim, T.J. & Choi, W.Y. (1983) *Toxoplasma* antibody titer by indirect latex agglutination test in Seoul area. *J. Catholic Medical College*, **36**:133-137.

Kobayashi, A., Nirai, N., Suzuki, Y., Nishikawa, H. & Watanabe, N. (1977). Evaluation of a commercial *Toxoplasma* latex agglutination test. *Jpn. J. Parasit.*, **26**:175-180.

Kobayashi, A., Watanabe, N., Suzuki, Y. & Hirai, N. (1978) A simple mass-screening method for toxoplasmosis-detection of the antibodies from blood-absorbed filter paper discs using the indirect latex agglutination test. *Jpn. J. Parasit.*, **27**:483-487.

Rim, H.J., Lee, S.K., Lee, J.W. & Kwak, J.W. (1972) Distribution of *Toxoplasma* antibodies among mothers and her new borns and eye disease patients. *New Medical J.*, **15**:1331-1336.

Moon, J.B.(1965) A study on the *Toxoplasma*(1) isolation of *Toxoplasma* from pig. *The Research Reports of the Office of Rural Development*, **8**:143.

Nakayama, I., Aoki, T., Rim, H.J. & Cho, S.Y. (1970) The incidence of *Toxoplasma* antibodies among people in Korea, as revealed by hemagglutination test. *Jpn. J. Parasit.*, **19**:583-592.

Sabin, A.B. & Feldman, H.A.(1948) Dyes as microchemical indicators of a new immunity phenomenon affecting a protozoan parasite (*Toxoplasma*). *Science*, **108**:660-663.

Nobuto, K.(1967) Investigation on the actual conditions among the natural infection of *Toxoplasma* in pigs. *Jpn. J. Parasit.*, **16**:222.

Soh, C.T., Lee, S.J. & Ahn, Y.K. (1960) Latent infection by *Toxoplasma gondii* in Korea. *Yonsei Med. J.*, **1**:52-54.

Tsubota, N., Kiraoka, K., Sawada, Y., Watanabe, T. & Ohshima, S. (1977) Studies on latex agglutination test for toxoplasmosis (2) Evaluation of the microtiter test as a serological test for toxoplasmosis in man. *Jpn. J. Parasit.*, **26**:286-290.

Voller, A., Bidwell, D.E., Banlett, A., Fleck, D.G, Perkins, M. & Oladehim B. (1976) A microplate enzyme immunassay for *Toxoplasma* antibody. *J. Clin. Path.*, **29**:150-153.

=국문초록=

동물원 동물에서의 Latex응집반응에 의한 *Toxoplasma*항체가

가톨릭醫大 寄生蟲學敎室 및 寄生蟲病硏究所
崔 源 永·劉 載 乙·南 皓 祐

서울大公園 動物部
吳 昌 泳·金 成 元

東京慈惠會醫大 寄生蟲學敎室
片 倉 賢·小 林 昭 夫

서울대공원에서 사육중인 각종동물을 대상으로 *Toxoplasma*의 보유숙주로서의 가능성을 간접 Latex 응집반응을 이용하여 항체가를 검토하였다. 포유류, 조류 및 파충류중 가능한 범위내에서 PKU여과지에 혈액을 흡착시킨 후 건조시켜서 조사하였다.

131개체의 포유류에서 20개체(15.3%), 조류에서는 75개체에서 2개체(2.7%)가 *Toxoplasma* 양성 항체가를 가진 것으로 나타났으며, 종별로는 68종의 포유류에서 15종(22.1%), 36종의 조류에서 2종(5.6%)이었으며, 조사한 10개체(7종)의 파충류는 모두 음성으로 나타났다.

포유류에서는 캉가루목의 6개체에서 2개체(3종중 1종), 원숭이목의 15개체중 1개체(11종중 1종), 박쥐목의 1개체(1종), 개목의 13개체중 6개체(10종중 5종) 말목의 12개체중 1개체(3종중 1종), 소목의 80개체 중 9개체(38종중 6종)가 양성으로 나타났으며, 쥐목과 고래목에서는 음성이었다.

조류에서는 닭목에서 1개체, 앵무목에서 1개체만이 양성이었다.

항체가별로는 포유류에서 1:64가 9개체, 1:32가 6개체, 1:128이 3개체, 1:256이 2개체로 나타났으며, 조류에서의 2 양성 개체는 모두 1:64의 항체가를 보였다.