ACTA VET. BRNO, 56, 1987: 315-330

# EFFECTS OF BREED, SEX, AGE, MANAGEMENT AND NUTRITION ON THE INCIDENCE OF TOXOPLASMA GONDII ANTIBODIES IN DOGS AND CATS

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Received January 13, 1987

Abstract

Svoboda M. and Vlasta Svobodová: Effect of Breed, Sex, Age, Management and Nutrition on the Incidence of Toxoplasma gondii Antibodies in Dogs and Cats. Acta vet. Brno, 56, 1987: 315-330.

The incidence of Toxoplasma gondii antibodies was studied in 1002 dogs and 620 cats in relation to their breed, sex, age, management and nutrition during 3 years. Comparison of the group of serologically negative dogs with that showing T. gondii antibodies revealed no significant differences between them in relation to their breed, sex, age and origin. In cats, on the other hand, significant differences were found depending on age / $P < 0.005$/ and breed /$P < 0.05$/ but effects of sex and origin were not observed.

T. gondii antibodies were found significantly less frequently in animals kept exclusively in flats /dogs - $P < 0.05$; cats - - $P < 0.005$/. They were also found significantly more frequently in cats that were in the habit of catching murine rodents /$P < 0.01$/ and other mammals and birds /$P < 0.01$/ and in dogs that were kept together with cats /$P < 0.01$/. The greatest differences in the prevalence of T. gondii antibodies were related to food composition and treatment. T. gondii antibodies were found significantly /$P < 0.005$/ less frequently in those dogs and cats that were fed exclusively heat-treated food. Where the animals were fed raw pork, beef and poultry meat, specific antibodies were detected significantly more frequently /dogs - $P < 0.05$; cats - $P < 0.01$/. A particular hazard for cats was ingestion of raw rabbit meat and liver.

Toxoplasmosis, cat, dog, antibody, raw meat feeding.

Public health considerations have recently prompted a number of studies on toxoplasmosis particularly in those animal species that have been in close contact with man for centuries. The objective of our investigation was to assess the incidence of Toxo-

plasma gondii antibodies in dogs and cats in relation to their ways of life in association with their breed, sex and age.

The key role of the cat in the spread of toxoplasmosis has been pointed out by Hutchison and Work (1969) and Hutchison et al. (1970). Jindřichová et al. (1975) examining 1027 people by means of the toxoplasmin skin test found positive reaction in 54 % of the subjects keeping cats in their households and in 42.7 % of the subjects not exposed to cats. Similar observations were reported from the USSR (Shevkunova et al. 1976) and the USA (Sengbusch and Sengbusch 1976). On the other hand, in Mongolia, e. g., where practically no cats are kept the proportion of positive reagents in a selected population was less than 1 % (Šerý 1979; Ruiz and Frenkel 1980), in their detailed study of the relation between the movement of cats, their food and contact with man, concluded that the highest prevalence of T. gondii antibodies in animals and humans exists where the movement of cats is free and uncontrolled. According to Ladiges et al. (1982) the risk of getting infected in handling cats increases with the titre of T. gondii antibodies shown by the animals. Their serological study revealed T. gondii antibodies in 28 % of domiciled cats and in 41 % of stray cats.

One of the main sources of toxoplasmosis among carnivores is seen in the intake of raw meat products from T. gondii - infected animals. In this connexion mention should be made of the incidence of toxoplasmosis in some species of farm animals. In cattle, toxoplasmosis is not a major problem: their antibody titres are low and the causative agent has been rarely isolated from the tissues (Čatár et al. 1969; Fayer and Frenkel 1979). In organs and tissues of slaugter pigs, on the other hand, T. gondii tissue cysts have been demonstrated rather frequently (Nikolov et al. 1979; Prošek and Hejlíček 1981). Durfee and Chien (1971) and Boch (1980) drew attention to the hazard of feeding pork to cats. In their experiments the quantity of oocysts excreted by cats was directly proportional to the quantity of ingested pork from serologically positive pigs. Another risk is the feeding of raw meat products coming from rabbits and sheep, i. e. animal species with the highest prevalence of toxoplasmosis (Šíma and Rašín 1973; Arnaudov et al. 1976; Boch et al. 1979; Bergmann et al. 1980; Sharma 1980; a. o.). Farm animals kept in small herds and flocks are affected with toxoplasmosis much more frequently than those coming from large herds and flocks (Hejlíček 1984).

A major role in the persistence of toxoplasmosis foci is to be ascribed to wild small mammals and birds. Isolation attempts made by Hejlíček et al. (1981) in 72 wild mammals and birds yielded positive results in 19.4 % of the animals examined. Hay et al. (1983) demonstrated T. gondii antibodies in 11 to 20 % of wild rodents examined in Scotland. Having conducted an extensive screening in the district of Strakonice, Hejlíček (1984) isolated T. gondii from 4 % of small mammals caught on the premises of small herds or in their close environs. On the other hand, his isolation attempts in 588 wild mammals coming from the environs of large herds were positive in only 3 instanc-

es, i. e. in 0.5 % of the animals examined. In urban conditions the potential reservoir of toxoplasmosis is the pigeon (Ippen et al. 1981). Rašín (1973) found T. gondii antibodies in 48 % of musk-rats examined. In his view the musk-rat is the rodent with the highest prevalence of toxoplasmosis and a major natural carrier of the disease. His examinations of the livers revealed specimens of Strobilocercus fasciolaris in 36 % of the musk-rats examined.

T. gondii antibody response of cats in relation to age was studied by Watson et al. (1982). They revealed T. gondii antibodies in only 7.7 % of kittens up to 10 months of age but in 74 % of adult cats. Dubey et al. (1977) studied T. gondii infection in cats in relation to age and sex. Having experimentally infected 25 cats between 1 week and 39 months of age with T. gondii tissue cysts, they found that more oocysts were excreted by cats up to 1 year of age than by the older animals and slightly more by males than females. However, the relation between the quantity of excreted T. gondii oocysts and sex of the infected cats could not be assessed statistically because of the small number of animals involved.

Part of protective measures against toxoplasmosis is deratization. Small rodents are regarded as a reservoir of T. gondii in nature and as the main source of infection for the definite host - the domestic cat. Another important factor in combatting toxoplasmosis is sanitation (Hejlíček et al. 1981; Hejlíček et al. 1982; Rutherford 1982).

## Materials and Methods

A total of 1002 dogs and 620 cats were examined for T. gondii antibodies during a 3-year period /1981-1984/. They included clinically healthy animals /140 dogs and 178 cats/ and patients /762 dogs and 442 cats/ of the Small animal clinic of the University of Veterinary Science, Brno. Almost 83 % of the dogs and cats came from urban environment /mainly Brno/ and 17 % of them came from villages. Further particulars are given in Tables 1 to 5. Surveys of the dogs according to their use and breed are shown in Table 1 and 2. A survey of the cats according to breed is presented in Table 3. The data on sex and age of the dogs and cats are shown in Tables 4 and 5. The group classification of breeds was carried out according to the valid FCI classification order (Fiorone 1973).

Besides the basic data /breed, sex, age and origin/ further case history facts /21 items in cats and 22 items in dogs/ were considered. These covered management and housing practices /animals either kept in flats or houses or allowed to move around freely/, contact with warm-blooded animals /cat, dog, rodents, other mammals and birds, pregnant women, small children, etc./, food composition /raw food, heat-treated food, sort of meat and viscera, etc./ so that an insight into the mode of life of the animals and possibly a clue to the source of infection could be obtained.

Table 1
Breeds of the dogs grouped according to their utilization

| Group | No. dogs | % |
|---|---|---|
| Police dogs | 396 | 39.52 |
| Watchdogs | 66 | 6.59 |
| Hunting dogs | 200 | 19.96 |
| Pets | 125 | 12.48 |
| Greyhounds | 11 | 1.09 |
| Crossbreds | 204 | 20.36 |
| Total | 1002 | 100.00 |

Table 2
Dog breeds ranked according to their representation in the sample examined

| Rank order | Breed | No. | % |
|---|---|---|---|
| 1. | German sheep-dog | 298 | 29.74 |
| 2. | Poodle | 79 | 7.88 |
| 3. | Boxer | 61 | 6.08 |
| 4. | Dachshund | 57 | 5.69 |
| 5. | Terrier | 51 | 5.09 |
| 6. | Bloodhound | 40 | 3.99 |
| 7. | Spaniel | 30 | 2.99 |
| 8. | Schnauzer | 25 | 2.50 |
| 9. | Collie | 25 | 2.50 |
| 10. | Beagle | 19 | 1.90 |
| 11. | Great Dane | 17 | 1.70 |
| 12. | Pekinese | 12 | 1.20 |
| - | Other breeds | 84 | 8.38 |
| - | Crossbreds | 204 | 20.36 |
| Total No. of dogs examined | | 1002 | 100.00 |

The animals were blood-sampled and serological examinations were then made using the Sabin-Feldman reaction, complement-fixation test and microprecipitation in agar gel. The procedures and the results of serological examination are the subject of other reports (Svoboda 1987a; Svoboda 1987b).

The object of the present study was to correlate the results of serological examination with the basic and extended anamnestic data. A punched card with all the data available was used for each animal and the major relations were evaluated statistically using the chi-squared test for table 2 x 2 and for contingency table k times m and the test of the difference

of two relative values. Where $f_1$ or $f_2$ /incidence of the phenomenon under study in the first and second samples/ ranged between 0.0 and 0.2 or 0.8 and 1.0, respectively, cyclometric transformation was applied (Reisenauer 1970).

The following statistical symbols are used throughout the study:

$\chi^2$ = chi-squared test
RV = test of the difference of two relative values
P = level of significance
NS = not significant
N = not tested because of a small number of cases in the group

## Results

Dogs in which T. gondii antibodies were demonstrated by serological reaction on at least one occasion /501 animals/ were compared with an equally large group of serologically negative dogs in Table 6. Statistical analysis revealed no significant differences between the two groups in relation to breed, sex, age and origin of the animals. Although between 1.1 and 3 years of age, dogs with specific antibodies were more numerous, this difference /by 20 animals/ was not signifant either. T. gondii antibodies were found more frequently in autumn and winter than in the other two seasons but not even this difference reached significance. The highest proportion of dogs with specific antibodies was found at the end of 1983.

A similar comparison between serologically negative cats /318 animals/ and cats in which T. gondii antibodies were detected by serological reaction on at least one occasion /302 animals/ is presented in Table 7. A significantly /$P < 0.05$/ higher proportion of cats without specific antibodies was found among European short-haired cats and a significantly /$\chi^2$ - $P < 0.05$/ higher proportion of cats with specific antibodies was found among animals of the other breeds - Siamese, Persian and crosses between the breeds. T. gondii antibodies were equally distributed among males and females and irrespective of their origin /town x village/. Age was an important factor in the incidence of T. gondii antibodies in cats. Animals up to 1 year old were serologically positive less frequently /$P < 0.01$/ than cats aged 1.1 to 3 years where the opposite was the case /$P < 0.01$/. The fact that the percentage of cats with specific antibodies increases with age was also demonstrated by the chi-squared test at the highest level of significance /$P < 0.005$/. In kittens up to 14 days of age T. gondii antibodies were found in only 2 /4.4 %/ out of 45 animals. In kittens between 14 days and 2 months of age T. gondii antibodies were revealed 7 times /18.4 % out of 38 animals/. From 2 months of age the proportion of cats with T. gondii antibodies rose considerably, amounting to 40 % at about 6 months of age. The incidence of T. gondii antibodies in cats was almost evenly distributed throughout the year, showing only a non-significant rise in autumn months. The highest proportion of cats with T. gondii antibodies was found during the second half of 1983.

Table 3
Breeds of the cats examined

| Rank order | Breed | No. | % |
|---|---|---|---|
| 1. | European short--haired cats | 560 | 90.32 |
| 2. | Persian cats | 36 | 5.81 |
| 3. | Siamese cats | 15 | 2.42 |
| 4. | Chartreuse cats | 2 | 0.32 |
| 5. | Russian blue cats | 2 | 0.32 |
| - | Crossbreds | 5 | 0.81 |
| Total No. of cats examined | | 620 | 100.00 |

Table 4
Sex of the dogs and cats examined

| Sex | Dogs | | Cats | |
|---|---|---|---|---|
| | No. | % | No. | % |
| Male | 641 | 63.97 | 293 | 47.26 |
| Fermale | 361 | 36.03 | 301 | 48.55 |
| Castrates /males/ | - | - | 19 | 3.06 |
| Castrates /females/ | - | - | 7 | 1.13 |
| Total | 1002 | 100.00 | 620 | 100,00 |

Table 5
Age of the dogs and cats examined

| Age range | Dogs | | Cats | |
|---|---|---|---|---|
| | No. | % | No. | % |
| up to 1 year | 254 | 25.35 | 296 | 47.74 |
| 1.1 to 3 years | 176 | 17.57 | 174 | 28.07 |
| 3.1 to 5 years | 140 | 13.97 | 41 | 6.61 |
| 5.1 to 7 years | 91 | 9.08 | 17 | 2.74 |
| 7.1 to 9 years | 80 | 7.98 | 30 | 4.84 |
| 9.1 to 11 years | 77 | 7.68 | 25 | 4.03 |
| 11.1 and more years | 184 | 18.37 | 37 | 5.97 |
| Total | 1002 | 100.00 | 620 | 100.00 |

Table 6
Serological findings in dogs in relation to their breed, sex, age and origin

| Characteristic under study | Serologically negative dogs | | Serologically positive dogs | | Statistical significance | |
|---|---|---|---|---|---|---|
| | No. | % | No. | % | RV | $\chi^2$ |
| Breed: | | | | | | |
| - police dogs | 190 | 37.92 | 206 | 41.11 | NS | |
| - watchdogs | 30 | 5.99 | 36 | 7.19 | NS | |
| - hunting dogs | 107 | 21.36 | 93 | 18.56 | NS | NS |
| - pets | 67 | 13.37 | 58 | 11.58 | NS | |
| - greyhounds | 6 | 1.20 | 5 | 1.00 | NS | |
| - crossbreds | 101 | 20.16 | 103 | 20.56 | NS | |
| Sex: | | | | | | |
| - male | 321 | 64.07 | 320 | 63.87 | NS | NS |
| - female | 180 | 35.93 | 181 | 36.13 | NS | |
| Age: | | | | | | |
| - up to 1 year | 127 | 25.35 | 127 | 25.35 | NS | |
| - 1.1 to 3 years | 78 | 15.57 | 98 | 19.56 | NS | |
| - 3.1 to 5 years | 72 | 14.37 | 68 | 13.57 | NS | |
| - 5.1 to 7 years | 49 | 9.78 | 42 | 8.38 | NS | NS |
| - 7.1 to 9 years | 45 | 8.98 | 35 | 6.99 | NS | |
| - 9.1 to 11 years | 39 | 7.78 | 38 | 7.59 | NS | |
| - 11.1 and more years | 91 | 18.17 | 93 | 18.56 | NS | |
| Origin: | | | | | | |
| - town | 414 | 82.63 | 413 | 82.44 | NS | NS |
| - village | 87 | 17.37 | 88 | 17.56 | NS | |
| Total | 501 | 100.00 | 501 | 100.00 | - | - |

Extended anamnestic data were available in 907 /90.52 %/ out of 1002 dogs examined. In the remaining 95 /9.48 %/ dogs they could not be obtained for various reasons. Comparison of anamnestic data between the group of dogs without T. gondii antibodies /extended case history facts were known in 460 out of 501 dogs/ and the group having specific antibodies /extended case history facts were available in 447 dogs/ in shown in Table 8. Dogs kept exclusively in flats had T. gondii antibodies significantly less frequently than the large group of dogs kept in houses. Also the chi-squared test showed that the incidence of specific antibodies was significantly /$P < 0.05$/ lower in dogs that were occasionally or generally allowed to move around freely. The next part of

Table 7
Serological findings in cats in relation to their breed, sex, age and origin

| Characteristic under study | Serologically negative cats | | Serologically positive cats | | Statistical significance | |
|---|---|---|---|---|---|---|
| | No. | % | No. | % | RV | $\chi^2$ |
| Breed: | | | | | | |
| - European | 295 | 92,77 | 265 | 87,75 | 0.05 | |
| - Persian | 17 | 5,35 | 19 | 6.29 | NS | |
| - Siamese | 4 | 1,26 | 11 | 3.64 | NS | 0.05 |
| - Russian blue | 1 | 0,31 | 1 | 0,33 | N | |
| - Chartreuse | 1 | 0,31 | 1 | 0,33 | N | |
| - Crossbreds | - | - | 5 | 1,66 | N | |
| Sex: | | | | | | |
| - male | 158 | 49,69 | 135 | 44,70 | NS | |
| - female | 153 | 48,11 | 148 | 49,00 | NS | NS |
| - castrates ♂ | 3 | 0.94 | 16 | 5,30 | 0.01 | |
| - castrates ♀ | 4 | 1,26 | 3 | 1,00 | N | |
| Age: | | | | | | |
| - up to 1 year | 186 | 58,49 | 110 | 36,42 | 0.01 | |
| - 1.1 to 3 years | 69 | 21,70 | 105 | 34,77 | 0.01 | |
| - 3.1 to 5 years | 17 | 5,35 | 24 | 7,95 | NS | |
| - 5.1 to 7 years | 11 | 3,46 | 6 | 1,99 | NS | NS |
| - 7.1 to 9 years | 14 | 4,40 | 16 | 5,30 | NS | |
| - 9.1 to 11 years | 7 | 2,20 | 18 | 5,96 | 0.05 | |
| - 11.1 and more years | 14 | 4,40 | 23 | 7,61 | NS | |
| Origin: | | | | | | |
| - town | 258 | 81,13 | 255 | 84,44 | NS | NS |
| - village | 60 | 18,87 | 47 | 15,56 | NS | |
| Total | 318 | 100,00 | 302 | 100,00 | - | - |

Table 8 deals with the contact of the dogs with warm-blooded animals. T. gondii antibodies were found significantly /$P < 0.05$/ less frequently in dogs that did not come into contact with warm-blooded animals except man. Conversely, specific antibodies were demonstrated significantly /$P < 0.01$/ more frequently in dogs kept together with cats. Contact of the dogs with rodents, game, etc., had no effect on the incidence and level of T. gondii antibodies. Almost 39 % of the dogs were fed mainly or exclusively raw meat or viscera. Out of the dogs without T. gondii antibodies, 33.7 % were fed raw meat and viscera, whereas among the dogs with specific antibodies the proportion of animals fed raw meat products was 44.1 %; the difference is significant /$P < 0.01$/. The most

Table 8

Serological findings in dogs in relation to extended anamnestic data

| Characteristic under study | Serologically negative dogs | | Serologically positive dogs | | P | |
|---|---|---|---|---|---|---|
| | No. | % | No. | % | RV | $\chi^2$ |
| Dogs kept: | | | | | | |
| - exclusively in flats | 152 | 33.05 | 112 | 25.05 | 0.01 | |
| - in houses | 275 | 59.78 | 295 | 66.00 | 0.01 | 0.05 |
| - under conditions allowing free movement | 33 | 7,17 | 40 | 8.95 | SN | |
| Contact with warm-blooded animals: | | | | | | |
| - no /except/ man | 160 | 34.78 | 126 | 28.19 | 0.05 | |
| - with cats | 222 | 48.26 | 260 | 58.17 | 0.01 | |
| - with rodents | 165 | 35,87 | 162 | 36.24 | SN | SN |
| - with other mammals and birds | 103 | 22.39 | 81 | 18.12 | SN | |
| - with gravid women and children up to 2 years | 60 | 13.04 | 64 | 14.32 | SN | |
| Food: | | | | | | |
| - heat-treated meat only | 305 | 66.30 | 250 | 55.93 | 0.01 | |
| - mainly raw meat | 155 | 33.70 | 197 | 44.07 | 0.01 | |
| of this | | | | | | |
| - pork | 20 | 4.35 | 23 | 5.15 | SN | |
| - beef | 70 | 15.22 | 91 | 20.36 | 0.05 | |
| - rabbit, venison | 14 | 3.04 | 22 | 4.92 | SN | |
| - poultry a.o. | 18 | 3.91 | 19 | 4.25 | SN | |
| - mainly raw organs | 155 | 33.70 | 197 | 44.07 | 0.01 | 0.005 |
| of them | | | | | | |
| - liver | 33 | 7.17 | 41 | 9.17 | SN | |
| - heart | 29 | 6.30 | 27 | 6.04 | SN | |
| - lung | 25 | 5.43 | 26 | 5.82 | SN | |
| - mesentery a.o. | 23 | 5.00 | 23 | 5.15 | SN | |
| - information lacking | 16 | 2.61 | 6 | 1.34 | SN | |
| Total | 460 | 100.00 | 447 | 100.00 | - | - |

frequently consumed meat was beef. The relation between composition of the ration /raw x heat-treated meat products/ and the incidence of T. gondii antibodies was also found to be highly significant /$P < 0.005$/ when assessed by the chi-squared test.

Table 9
Serological findings in cats in relation to extended anamnestic data

| Characteristic under study | Serologically negative cats | | Serologically positive cats | | P | |
|---|---|---|---|---|---|---|
| | No. | % | No. | % | RV | $\chi^2$ |
| Cats kept: | | | | | | |
| - exclusively in flats | 95 | 30.65 | 56 | 19.58 | 0.01 | |
| - in houses | 110 | 35.48 | 97 | 33.92 | SN | 0.005 |
| - under conditions allowing free movement | 105 | 33.87 | 133 | 46.50 | 0.01 | |
| Contact with warm-blooded animals: | | | | | | |
| - no /except man/ | 29 | 9.35 | 38 | 13.29 | SN | |
| - with dogs | 30 | 9.68 | 32 | 11.19 | SN | |
| - with other cats | 266 | 85.81 | 241 | 84.27 | SN | SN |
| - with rodents | 142 | 45.81 | 177 | 61.89 | 0.01 | |
| - with other mammals and birds | 100 | 32.26 | 133 | 46.50 | 0.01 | |
| - with gravid women and children up to 2 years | 37 | 11.94 | 42 | 14.68 | SN | |
| Food: | | | | | | |
| - heat-treated meat only | 88 | 28.39 | 43 | 15.03 | 0.01 | |
| - mainly raw meat of this | 222 | 71.61 | 243 | 84.97 | 0.01 | |
| - pork | 30 | 9.68 | 44 | 15.38 | 0.05 | |
| - beef | 68 | 21.94 | 93 | 32.52 | 0.01 | |
| - rabbit, venison | 25 | 8.06 | 39 | 13.64 | 0.05 | |
| - poultry a.o. | 27 | 8.71 | 43 | 14.03 | 0.05 | 0.005 |
| - mainly raw organs of them | 222 | 71.61 | 243 | 84.97 | 0.01 | |
| - liver | 41 | 13.23 | 62 | 21.68 | 0.01 | |
| - heart | 35 | 11.29 | 42 | 14.68 | SN | |
| - lung | 32 | 10.33 | 42 | 14.68 | SN | |
| - mesentery a.o. | 22 | 7.10 | 26 | 9.09 | SN | |
| - informating lacking | 52 | 16.77 | 58 | 20.28 | SN | |
| Total | 310 | 100.00 | 286 | 100.00 | - | - |

In cats, extended anamnestic data were available for 596 /96.13 %/ our of 620 animals examined and could not be obtained in the remaining 24 /3.87 %/ cases. Comparison of the anamnestic data between the group of cats without T. gondii antibodies /anamnesis known in 310 out of 318 cats/ and the group having specific antibodies /anamnesis known in 286 out of 302 cats/ is presented in Table 9. Cats kept exclusively in flats had T. gondii antibodies significantly /$P < 0.01$/ less frequently than cats living free and unattended. In the group of serologically positive animals, cats with uncontrolled movement were significantly /$P < 0.01$/ more numerous. This relation was also highly significant /$P < 0.005$/ when assessed by the chi-squared test. The next part of Table 9 deals with the contact of the cats with warm-blooded animals. T. gondii antibodies were found significantly more frequently in cats that were in the habit of catching mice or other small mammals and birds, i. e. in cats with uncontrolled movement. The other factors under consideration were not significant. Inquiries revealed that more than 78 % of the cats were fed predominantly or exclusively raw meat or viscera. As can be seen from Table 9, raw meat and viscera were consumed by 72 % of the cats without T. gondii antibodies and by almost 85 % of the serologically positive cats. The differences are significant /$P < 0.01$/. All kinds of raw meat were fed more frequently to serologically positive than to serologically negative cats; the differences reached various levels of significance. As to viscera, raw liver was fed significantly more frequently to cats with T. gondii antibodies. The inclusion in the ration of the other raw viscera had no significant effect on the incidence of T. gondii antibodies. The general relation between the composition of diet and the incidence of T. gondii antibodies proved highly significant /$P < 0.005$/ when assessed by the chi-squared test.

## Discussion

T. gondii antibodies were found in all the breeds of dogs to an almost equal extent. Specialized movement of the dog in a certain environment depending on its character and use had no significant effect on exposure to T. gondii and on specific antibody response. However, the question remains to which extent hunting dogs, e. g., that were kept in urban environment were actually used for hunting purposes. A different situation existed in cats. European short-haired cats which accounted for more than 90 % of animals in the sample had T. gondii antibodies significantly /$P < 0.05$/ less frequently than Siamese and Persian cats. A possible explanation for this may be seen in better adaption of European cats to our environmental conditions.

Practically all published evidence (Gaál 1976; Dubey et al. 1977) suggests that T. gondii occur almost equally in male and female animals. This was also the case in our study. The larger number of male dogs than bitches in our sample was responsible for their predominance over bitches in the group of animals with antibodies /320 : 181/ as well as in the group of those without antibodies /321 : 180/. Among cats with specific antibodies, male

castrates were strikingly more numerous than female castrates /16 : 3/.

Age had a substantial effect on the percentage of animals with T. gondii antibodies. This age dependence made itself particularly felt in cats where seroconversion was observed after the 2nd month of age, i. e., after the first ingestion of raw meat products or living feed by weaned kittens. The occurrence of specific antibodies in kittens of this age is largely due to primary infection (Dubey 1973; Frenkel 1982). In younger kittens T. gondii antibodies were found only sporadically. The occasional occurrence of T. gondii antibodies in kittens less than 3 weeks old can presumably be accounted for by diaplacental infection or colostrum-acquired immunity (Svoboda and Svobodová 1985). In dogs the occurrence of T. gondii antibodies in dependence upon age was much slower to develop. It should be taken into account that the proportion of dogs consuming raw meat is generally lower than is the case with cats /in our study it was 39 %) of dogs and 78 % of cats/. This is presumably one of the reasons why dogs come into contact with T. gondii gradually throughout their lives.

The findings of T. gondii antibodies in dogs and cats showed no relation to the fact whether the animals came from towns or villages but were in correlation with the incidence of rodents. The generally accepted factor of origin /town x village/ does not provide accurate information about the way of life of these animals and is not an objective indicator of their contact with rodents. This at least is the evidence emerging from our study, although it must be remembered that the majority of our village dogs came from the environs of Brno.

The management and housing practices under which dogs and cats are kept affect the percentage of animals with T. gondii antibodies to a considerable extent. Animals kept exclusively in flats /29 % of the dogs and 25 % of the cats/ or under constant supervision of the owner /e. g. on the leash/ when taken out had T. gondii antibodies significantly less frequently than animals that were allowed to move around freely. A large proportion of the former included Persian cats and pet dogs. The dependence on the mode in which animals are kept was more pronounced in cats than in dogs. This is in keeping with the different modes of life of the two animal species. The inquiries showed that almost 75 % of the cats were occasionally or generally allowed to move around freely. Although most of them were not stay cats in the strict sense of the word, their proportion was high and plays a major role in the spread of the infection. The proportion of stray dogs was only 8 %. From the epizootiological point of view the aforementioned evidence is a matter of concern particularly as regards cats and is in keeping with the conclusions of Ruiz and Frenkel (1980) that the toxoplasma antibody prevalence in animals and man is highest where cats are allowed to move around freely and without control.

Another factor associated with uncontrolled movement of dogs and cats is their contact with other warm-blooded animals. An objective assessment of all possible contacts of dogs and cats with other warm-blooded animals is not easy to obtain by questioning the owners. Nevertheless, it is worthy of note that T. gondii

antibodies were found significantly more frequently in dogs that were allegedly in regular contact with cats. Where cats are kept in a household, the prevalence of T. gondii oocysts in the environment is apparently higher and possibly also the incidence of toxoplasmosis in other animals in the household /rabbits, small rodents, etc./ is increased. T. gondii antibodies were found significantly more frequently in cats that were in the habit of catching mice or other small mammals and birds. The possibility of getting infected through ingestion of these animals in considerable. This appears from the results reported by Hejlíček et al. (1981) and Hejlíček (1984) who isolated T. gondii from 4 to 19 % of small mammals. Another factor to be considered is transplacental transmission of toxoplasmosis in small rodents (Jíra et al. 1965). All the aforementioned evidence underlines the importance of deratization measures in combatting toxoplasmosis (Hejlíček et al. 1982).

In our view, the most important factor involved in the spread of toxoplasmosis in both dogs and cats is the composition and treatment of food. T. gondii antibodies were found significantly less frequently in animals that were fed exclusively heat-treated food. This relation deserves consideration particularly in cats which consume raw meat products much more frequently than dogs. Involved in the prevalence of T. gondii antibodies in cats were all kinds of raw meat under study, though at various levels of significance, as well as raw liver. A major hazard is the feeding of raw rabbit meat as evidenced, e. g., in cat No. 754 that developed toxoplasmosis 6 days after ingestion of raw rabbit meat containing T. gondii cysts and died (Svoboda et al. 1986). In feeding those animals /mainly cats/ that refuse heat-treated meat products raw meat should be previously frozen at -20° C for at least 3 days to devitalize T. gondii tissue cysts (Hellesnes and Mohn 1977). This applies also to beef where T. gondii isolation attempts have occasionally been positive (Čatár et al. 1969). Also, commercial feeds for cats and dogs should be used to a larger extent.

Summarizing, a number of factors can be incriminated as responsible for T. gondii infection in dogs and cats. The most important of them, in our view, are the findings that 75 % of the cats and 71 % of the dogs were not under constant care of the owner, that 53 % of the dogs were in regular contact with cats, that the same percentage of cats were in the habit of catching mice and, most importantly, that 78 % of the cats and 39 % of the dogs were fed raw meat and viscera.

## Vliv plemene, pohlaví, stáří, způsobu chovu a výživy psů a koček na výskyt protilátek proti Toxoplasma gondii

V průběhu 3 let byl sledován výskyt protilátek proti Toxoplasma gondii u 1002 psů a 620 koček ve vztahu k plemeni, pohlaví, stáří, způsobu chovu a výživě vyšetřených zvířat. Porovnáním skupiny zvířat sérologicky negativních se skupinou zvířat s protilátkami proti Toxoplasma gondii nebyly u psů prokázány signifikantní rozdíly v závislosti na plemeni, pohlaví, stáří a jejich původu. Na-

proti tomu u koček se vyskytly statisticky významné rozdíly v závislosti na stáří /$P < 0,005$/ a mezi jednotlivými plemeny /$P < 0,05$/. Vliv pohlaví a původu koček se neuplatnil.

Protilátky proti Toxoplasma gondii měla statisticky významně méně často zvířata chovaná výlučně v bytě /psi - $P < 0,05$; kočky - $P < 0,005$/. Signifikantně častěji byly specifické protilátky zjišťovány tam, kde kočky lovily myšovité hlodavce /$P < 0,01$/, ostatní savce a ptáky /$P < 0,01$/ a těch psů, kteří byli chováni společně s kočkami /$P < 0,01$/. Nejvýraznější rozdíly v protilátkové prevalenci byly zjišťovány v závislosti na složení potravy a její úpravě. Protilátky proti Toxoplasma gondii měla signifikantně méně často ta zvířata, která byla krmena potravou výlučně tepelně opracovanou /psi i kočky - $P < 0,005$/. Tam, kde byla zvířata krmena syrovým masem vepřovým, hovězím a drůbežím, byl statisticky významně vyšší záchyt specifických protilátek /$P < 0,05$; $P < 0,01$/. Pro kočky bylo zvláště nebezpečné zkrmování syrového králičího masa a jater.

## Влияние породы, пола, возраста, способа содержаниа и питания собак и кошек на наличие антител против Toxoplasma gondii

Три года исследовали наличие антител против Toxoplasma gondii у 1002 собак и 620 кошек, учитывая породы, пол, возраст, способ содержания и питания обцледуемых животных. Сравнением с антителами против Toxoplasma gondii у собак не была установлена существенная разница в зависимости от породы, пола, возраста и их происхождения. В противовес этому, у кошек была установлена статицтически значимая разница в зависимости от возраста ($P < 0,005$) и между отдельными породами ($P < 0,05$). Влияние полов и происхождения кошек не имено места.

Антителами против Toxoplasma gondii статистически значимо реже отличалиць животные, содержимые исключительно в квартирных условиях (собаки - $P < 0,05$; кошки - $P < 0,05$). Специфические антитела были гораздо чаще установлены в случае, когда кошки ловили гризунов ($P < 0,01$), остальных млекопытающих и птиц ($P < 0,01$), и у собак, содержимых совместно с кошками ($P < 0,01$). Самая выразительная разница в превалентности антител была установлена в зависимости от состава и приготовления пищи. Антитела против Toxoplasma gondii гораздо менее часто встречались у животных, кормленных исключительно пищей, приготовленной на огне (собаки и кошки - $P < 0,005$). Животные, кормленные сырым мясом - свининой,говядиной и птицей - отличались более значимыми статистическими данными по специфическим антителам ($P < 0,05$; $P < 0,01$). Особую опасность для кошек представляло сырое мясо и печень кроликов.

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