Comparison of the prevalence and distribution of antibodies to Toxoplasma gondii in an urban and a rural population suggests that factors responsible for transmission of human toxoplasmosis are common to both groups.

Distribution of Toxoplasma Antibodies in Comparable Urban and Rural Groups

By COLVIN L. GIBSON, Ph.D.

ONE of the major gaps in our knowledge of human toxoplasmosis is the means by which man comes into contact with, and becomes infected by, the causative agent, *Toxoplasma gondii*. Numerous studies in various parts of the world have made it clear that serum antibodies to *T. gondii* are widely prevalent in humans, suggesting that infection is relatively common although frequently inapparent, but little information has been published regarding the environmental factors which may contribute to the spread of this infection.

A recent study by the author and his colleagues of a rural Negro population near Memphis, Tenn., gave a clear picture of the distribution of *Toxoplasma* antibodies in that particular group (*1*). It showed that the prevalence of antibodies is about the same in both sexes; that the titers fall into a bimodal distribution suggestive of a nonspecific reaction at the lowest titers; that the chance of finding antibodies increases with age; and that young people tend to have higher titers than older people.

That study, however, did not allow us to pinpoint any of the factors that might be working to produce such a distribution of titers. Nor did it permit us fruitfully to compare that population with any other group. The present study was therefore undertaken to attack the question of environmental factors in the transmission of toxoplasmosis by comparing the antibody status of the rural Negro population with that of a comparable urban group.

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Methods

Figure 1 shows the geographic region in which this study was made. The urban sample consisted of 627 serums taken at random from the students of a large junior-senior high school in the city of Memphis. The students, all Negroes, ranged in age from 11 through 19 years. The rural sample consisted of 445 serums from persons in the same age group, also Negroes, taken at random throughout Fayette County, but chiefly from the area south of the Wolf River, which is shown shaded on the map.

Most of the serums from the rural population which we tested in the present study were included in the larger rural sample, represent-

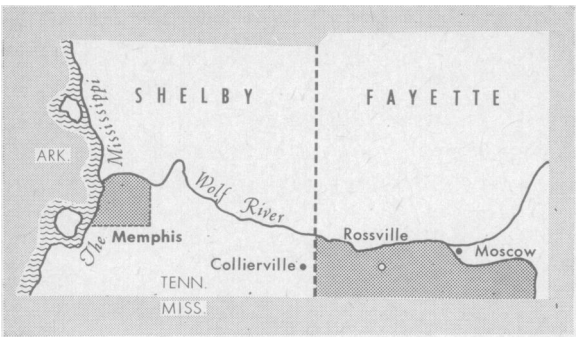


Figure 1. Location of urban and rural populations from which serums were collected. The urban sample was composed of Memphis residents; the rural sample, of Fayette County residents, chiefly those in the area south of the Wolf River.

ing 987 persons of all ages, analyzed in a previous report (*1*). In order to relate the present study of a restricted age group to the overall prevalence in rural Fayette County, we show in figure 2 the prevalence rates for all ages, as previously reported. Rates reported for other parts of the world by various investigators are also included for purposes of comparison. In general, the antibody prevalence in rural Fayette County was greater than the level found in England (*2*) but less than that found in the Netherlands (*3*), in Germany (*4*), and in Austria (*5*). In the present report we shall be concerned only with the small portion of the curve from 11 through 19 years of age.

All the serums in both our samples were tested by the Sabin-Feldman dye test. The technique originally described by these investigators, including inactivation at 56° C. for 30 minutes, was used (*6*). Serums were tested undiluted and at progressive fourfold dilutions (1:4, 1:16, 1:64, and so forth) until the end point was reached. Frequent comparative tests on unknown serums by our laboratory and several other research laboratories in the United States have always shown good agreement, a fact which lends confidence to our results.

Results

The results obtained by the dye test for each of the sample populations are summarized in the table.

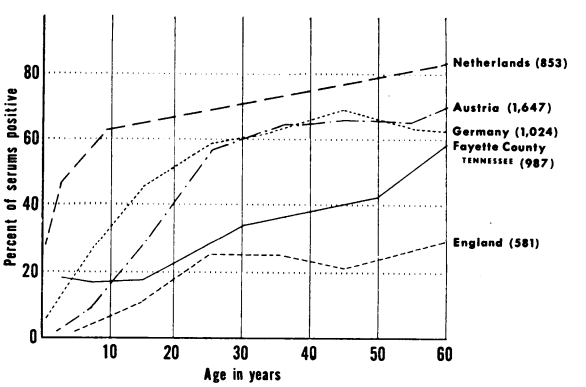
The prevalence of positive serums was 20.1± 2.3 percent for urban males and 20.7±2.2 percent for urban females. Comparable rates for the rural group were 19.9±2.6 percent for males and 17.8±2.6 percent for females. Statistical analysis indicated that the slight differences in overall prevalence of positive serums between males and females in each population were not significant. (P values were 0.85 and 0.58 for the urban and rural groups, respectively.) Even when an analysis was made of each 1-year age group, no significant difference between the sexes could be detected. The greatest divergence occurred in the 11-year-old rural group, in which 24.3 percent of 37 males and 9.1 percent of 33 females were positive. Statistical analysis of these data using the formula

$$\sigma_\Delta = \sqrt{(p \times q)/N_1 + (p \times q)/N_2}$$

gave a probability value of 0.09, which indicates that the observed difference between the sexes in this group probably is not significant. Since we failed to find a significant difference between males and females with respect to the prevalence of positive titers, data for the sexes were combined in all later calculations unless otherwise indicated.

One possible exception should be noted to the conclusion that there is no significant difference between males and females with regard to the prevalence of positive serums. For serums positive at the undiluted level, there was a highly suggestive difference between the sexes in the urban sample. Only 7 of 298 males (2.3

Figure 2. Prevalence of Toxoplasma antibodies by age, as reported for various parts of the world (*1–5*). Figures in parentheses show number of serums tested.



Distribution of serums positive for Toxoplasma antibodies by titer for urban and rural populations in Tennessee

Habitat and age in years	Number of serums tested	Number of serums positive							Percent of serums positive (all titers)
		Undiluted	1:4	1:16	1:64	1:256	1:1,024	All titers	
Urban									
11	13	0	0	0	0	0	0	0	0.0
12	70	6	1	6	3	0	0	16	22.8± 5.0
13	129	5	1	10	11	1	0	28	21.7± 3.7
14	101	4	1	8	6	2	0	21	20.8± 4.1
15	116	8	2	7	6	0	1	24	20.7± 3.8
16	102	4	0	7	5	1	1	18	17.6± 3.8
17	62	3	3	2	2	2	0	12	19.4± 5.0
18	25	0	1	2	1	3	0	7	28.0± 9.0
19	9	0	0	1	1	0	0	2	22.2±13.9
Total	627	30	9	43	35	9	2	128	20.4± 1.6
Males	298	7	5	23	19	6	0	60	20.1± 2.3
Females	329	23	4	20	16	3	2	68	20.7± 2.2
Rural									
11	70	2	1	1	6	1	1	12	17.2± 4.5
12	62	3	3	3	4	2	0	15	24.2± 5.4
13	72	6	0	2	3	4	1	16	22.2± 4.9
14	63	3	2	5	2	1	1	14	22.2± 5.2
15	57	2	0	4	1	0	0	7	12.6± 4.4
16	42	1	0	1	1	2	0	5	11.9± 5.0
17	39	0	0	2	1	2	2	7	17.9± 6.1
18	33	0	0	3	4	1	0	8	24.2± 7.5
19	7	0	0	0	0	0	0	0	0.0
Total	445	17	6	21	22	13	5	84	18.9± 1.9
Males	231	6	4	12	14	7	3	46	19.9± 2.6
Females	214	11	2	9	8	6	2	38	17.8± 2.6

percent) had undiluted positive titers as contrasted with 23 of the 329 females (7.0 percent).

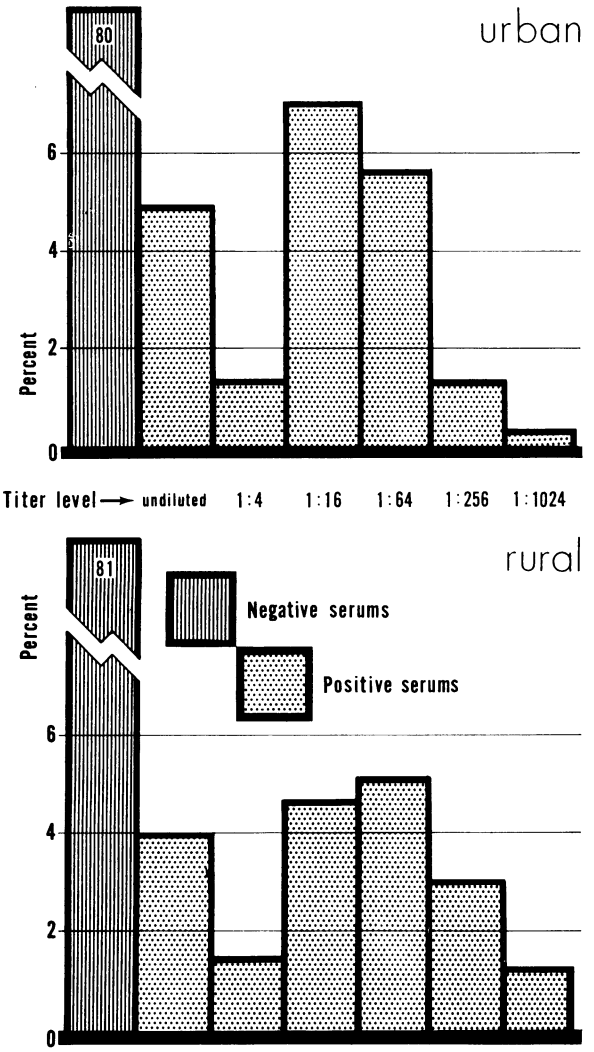
The difference between these rates is highly significant statistically ($P = 0.005$), but at present we cannot offer an explanation for this difference. A similar trend can be detected in the rural sample, in which 6 out of 231 males (2.6 percent) and 11 out of 214 females (5.1 percent) had undiluted positive serums, but the difference here is not statistically significant ($P = 0.16$).

Both the urban and the rural populations showed a distinct bimodal distribution of titers, with an unexpectedly large number of serums positive at the undiluted level. This distribution is illustrated graphically for all ages combined in figure 3. The large number of undiluted positives is consistent with the hypothesis of a nonspecific reaction, but we do not know what significance, if any, these low titers have in the epidemiology of toxoplasmosis.

The upper modal titer for the urban population falls at a dilution of 1:16, while the upper modal titer for the rural group is 1:64. This shift cannot be related to age, since both groups include persons from 11 through 19 years, and analysis of the individual age samples does not reveal any trend in this direction. To determine whether the shift of modal titer actually is significant, we tested the data by the chi-square method. For this purpose, the positive serums were divided into two groups, those positive at a dilution of 1:16 or lower and those positive at a dilution of 1:64 or higher. The probability value derived from this calculation is slightly more than 0.05, suggesting that the shift in modal titer between the urban and the rural group may not be significant.

An entirely different picture is obtained, however, when we group together those serums having titers of 1:256 or higher as opposed to those positive at a dilution of 1:64 or lower. With this grouping, the probability value is only 0.009, indicating that the difference between the

Figure 3. Distribution of all serums tested, by titer, showing bimodality and shift of upper modal titer.



two populations is of considerable significance. Thus the rural population shows a strong tendency to produce high titers, but we do not know what the significance or cause of this tendency may be.

For both sexes and all ages combined, 20.4 ± 1.6 percent of the 627 serums tested from the urban group were positive (all titers), as compared with 18.9 ± 1.9 percent of the 445 serums from the rural group. Somewhat lower rates are obtained when only titers of 1 : 16 or higher are considered positive, on the assumption that the lower titers may represent nonspecific reactions in accordance with the bimodal distribution of titers which we previously mentioned. The rates in this case are 14.2±1.4 percent for the urban sample and 13.7 ± 1.6 for the rural group. But whether we consider all titers or only those of 1 : 16 or higher, the numerical difference between the urban and rural rates is small, and statistical analysis verifies that it is merely a reflection of sampling variation. The probability values are 0.48 for all titers and 0.76 for titers of 1 : 16 or higher. Thus it is clear that there is no significant difference in prevalence of antibodies between the urban and rural populations of our study.

Conclusions

The examination of serums from comparable urban and rural Negro populations in Tennessee has shown that the two groups are essentially the same with respect to the prevalence and titer distribution of antitoxoplasmic antibodies. If we accept the presence of these antibodies as an indication of previous infection with *T. gondii*, then we must conclude that, at least insofar as the populations which we studied are concerned, persons living in urban or rural environments have an equal chance of becoming infected with this parasite. (For a discussion of the specificity of these antibodies, see reference 1.) From the epidemiological standpoint, this means that for an explanation of the transmission of this infection we probably must look not to factors associated primarily with one environment or the other but rather to factors common to both. Elucidation of these factors should be the goal of future research in this field.

Summary

With the Sabin-Feldman dye test, 627 serums from an urban Negro population and 445 serums from a comparable rural population were tested for antitoxoplasmic antibodies. All persons tested were 11 to 19 years old.

Analysis of the results with respect to the prevalence and distribution of titers showed that there is no difference between the sexes at any age; that the titers have a bimodal distribution in both the urban and rural groups, with an abnormally large number of undiluted

positive serums; that, although there is a difference in the upper modal titer between the two groups, it probably is not significant; that the rural group shows an unexplained tendency to produce titers of 1:256 or higher; and that the prevalence of positive titers is essentially similar in the urban and rural populations, both when all titers are considered together and when only titers of 1:16 or higher are considered.

The similarity between the urban and rural populations suggests that the factors responsible for transmission of human toxoplasmosis are common to both environments rather than being peculiar to one or the other.

REFERENCES

(*1*) Gibson, C. L., Eyles, D. E., Coleman, N., and Smith, C. S.: Serological response of a rural Negro population to the Sabin-Feldman cytoplasm-modifying test for toxoplasmosis. Am. J. Trop. M. & Hyg. In press.

(*2*) Beverley, J. K. A., Beattie, C. P., and Roseman, C.: Human *Toxoplasma* infection. J. Hyg., Lond. 52: 37–46, March 1954.

(*3*) Verlinde, J. D., and Makstenieks, O.: Toxoplasmosis in Nederland. Ned. tschr. geneesk. 95: 2050–2059, July 14, 1951.

(*4*) Keller, W., and Vivell, O.: Über die klinische und epidemiologische Bedeutung des Antikörpernachweises gegen das *Toxoplasma gondii* mit dem Sabin-Feldmanschen Farbtest. Ztschr. f. Kinderh. 71: 42–60, January 1952.

(*5*) Thalhammer, O.: Die erworbene Toxoplasmose. Eine kritische Übersicht. Wien. Ztschr. inn. Med. 36: 1–29, January 1955.

(*6*) Sabin, A. B., and Feldman, H. A.: Dyes as microchemical indicators of a new immunity phenomenon affecting a protozoan parasite (*Toxoplasma*) Science 108: 660–663, Dec. 10, 1948.

Dental Manpower Resources

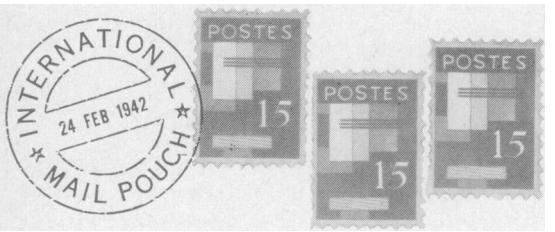
The demand for dental care is expected to increase more rapidly than the number of practicing dentists and dental hygienists in 11 western States.

Of the 95,000 dentists who are expected to be practicing in the United States by 1975, about 16,000 will be located in the west. This would be an increase of 4,000 over the number practicing in the region during 1955, but still it would be 5,000 short of the number needed to maintain supply at the current level. It will be roughly 20,000 under the number required to meet the higher per capita demands for care which are expected at the end of the 20-year period.

Currently, western schools are graduating only 400 dentists annually. To meet demand, they must graduate an average of 1,600 a year between 1960 and 1975.

Dental hygienists must also be trained in greater numbers. Additional training programs are needed in junior and 4-year colleges. The west needs approximately 800 dental hygiene graduates a year, compared with the fewer than 70 now being supplied.

These requirements are stated in "Dental Manpower Requirements in the West," a survey covering Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. The survey was undertaken at the request of the Western Interstate Commission for Higher Education and was conducted by the Division of Dental Resources, Public Health Service, in cooperation with the American Dental Association and the W. K. Kellogg Foundation.



These paragraphs, based on overseas reports from public health personnel with missions and field parties of the International Cooperation Administration, give a glimpse into health work abroad. The original material appears in an administrative publication distributed by the Public Health Division of the ICA.

First Movie

An Arabic language moving picture on sanitation shown for the first time in a Jordan village attracted an audience exclusively of men and boys. In Jordan villages it is not the custom for women to appear at public gatherings in male company. Rather than give up the time needed for a duplicate showing for the women, a sanitarian persuaded the villagers to separate the women and girls from the men and boys by an open aisle. This device permitted the women and girls to see their first movie; it was in fact the first movie for anyone in the village.

—ARTHUR L. DOPMEYER, *acting chief, Cooperative Department for Health and Sanitation, United States Operations Mission, Jordan.*

Latrines for Pilgrims

Yumbel (population 5,000), seat of the shrine of San Sebastian in Chile, receives as many as 50,000 pilgrims on the peak day of the festival and 80,000 during the week. They arrive on foot, horseback, in oxcarts, autos, trucks, special trains, and even in boxcars. For the first time in the history of the festival, health officials provided latrines for the visitors: 45 prefabricated structures placed in groups around the plaza and walled off to facilitate traffic control and cleaning several times a day. A fee of 5 pesos was charged, if user was able to pay. Although free service was not denied, 50,000 pesos were collected. The church will pay for the installation cost (280,000 pesos) with funds collected from the pilgrims. It is planned to install 15 more latrines at other points next year. A 10,000 liter tank, a deep well, and chlorinator were installed to supplement the town's usual water supply. The visitors were impressed with the latrines and inquired about means of obtaining them for installation elsewhere.

—PHILIP L. RILEY, *acting chief, Division of Health and Sanitation, United States Operations Mission, Chile.*

Population Gain

For the first time in the recorded history of Orchid Island, 50 miles off the southeast coast of Taiwan, there seems to be a gain in population as a consequence of DDT spraying for malaria control. Only 1 out of 12 on the island is over 45 years old. The island has no roads, no footpaths more than 18 inches wide. There isn't a wheel to be seen. The children fish. The women grow taros. The older men watch the children. The men wear only a closely tailored fig leaf. The women seem to cover themselves where they happen to be cold.

—JAMES P. WARD, M.D., M.P.H., *chief public health officer, International Cooperation Administration Mutual Security Mission to Taiwan.*

Hard Going

Heavy floods, deep mud, and washed out bridges forced two physicians to abandon their jeep en route to the Okinawan Colony on the Rio Palmetillas in Bolivia. They crossed two swollen rivers and 5 kilometers of mud on foot to visit the colonists who were preparing to receive about 160 Okinawan immigrants. The colony kindly supplied horses for the return trip. At that point, the physical condition of the villagers was better than that of the doctors.

—GEORGE ADAMS, M.D., M.P.H., *chief, Health and Sanitation Division, United States Operations Mission, Bolivia.*