but again, these do not appear amenable to a simple explanation. Weather, numbers and species of animals, economics, and other factors undoubtedly influence the differences between States.

National Office of Vital Statistics' reports of human cases through September 1950 show low peaks in March and June, but have the least fluctuations of any year and indicate a yearly total which should be around 3,300, the lowest year since 1942.

Estimates of the True Number of Human Brucellosis Cases in the United States, 1949

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The reported morbidity figures for brucellosis do not represent the true incidence of the disease because they are not exclusively new cases. Due to the chronic nature of the disease, a significant portion of the reported attacks are either relapses, chronic exacerbations, or reinfections. The reported figures are then more closely akin to prevalence. In addition, it has been the opinion of a number of reliable workers with the disease that the reported figures are gross underestimates of the true ones.

While no reliable measures of the actual number of unreported cases are available, there are data available which will provide some estimates of the number of attacks to be expected under certain specified conditions.

The first method which will be considered is the application of epidemiologic observations. Jordan and Borts (1) and Magoffin, *et al.*, (2) as well as others, have presented figures to show the high attack rates in packing-house and rendering-plant workers, veterinarians, and animal production farmers. Intermediate attack rates were found for butchers, processors, stock buyers, and stock handlers and relatively low rates for housewives, children, and the remainder of the population.

Brucellosis in cattle is known in every State. Bang's tests conducted by the Bureau of Animal Industry for the fiscal year 1949 showed reactors in every State except California, where no tests were made. The percentage of reactors found varied from 0.8 in North Carolina to 11.1 in Louisiana, with three-fourths of the States lying between 2.0 and 7.0 percent. No figures are available for swine on an official basis, but local surveys indicate somewhat similar levels of reactors. The percentage of reactors in cattle was not related to the numbers of reported human attacks by States. If, therefore, it is assumed that the specific occupational risks are fairly constant from State to State and reliable in certain States as far as reporting methods are concerned, then specific occupation attack rates can be calculated for a number of reference States and these rates applied to United States population figures to estimate the totals for the Nation.

Maximum accuracy in specific occupation attack rates will be provided if populations are selected to most nearly represent the source of cases. The available data for attacks of brucellosis by occupation in Minnesota, Iowa, Illinois, and Wisconsin during 1949 are presented in table 1. Bureau of the Census figures were available for packing-house workers, farmers, children, housewives, and the remainder of the population. The number of veterinarians in the United States was obtained from the American Veterinary Medical Association National Directory. Farmers were defined as those engaged in animal husbandry, including dairy and livestock farms, plus subsistence farms and general farming. Undoubtedly, farms are not perfectly split this way. Many farmers will have a few animals

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around, and some subsistence farms will have none. Children's rates were considerably more constant when only rural-farm children were considered. The same was true for rural housewives. No population figures could be specifically determined for those workers such as butchers, rendering-plant workers, stock buyers and handlers, dairy workers, and others having contact with animals or their products. Since this group is rather intimately related to slaughter, it appeared most appropriate to add these cases to those of packing-house workers. By adding all packing-house workers, and those processing meat as well, into one population, the variability of the rate for this group of cases was reduced by 60 percent. The remaining cases of known occupation gave most stable rates in the rural population. The populations for these various occupation groups are listed in table 2 for the four study States and for the entire country.

Occupation-specific rates were calculated using

Table 1
BRUCELLOSIS CASES BY OCCUPATION IN MINNESOTA, IOWA, ILLINOIS, AND WISCONSIN FOR 1949

STATE	Veterinarians	Packing-house Workers	Other Animal Contact Workers	Farmers	Housewives	Children 0-14	Other Known	Subtotal	Unknown	Total
Wisconsin	2	19	7	115	36	14	47	240	—	240
Iowa	9	28	13	173	51	19	65	358	23	381
Illinois	-	-	-	176	124	14	74	388	116	504
Minnesota	4	47	3	141	33	20	41	289	61	350

Table 2
SPECIFIC OCCUPATION AND AGE GROUPS ESTIMATED FOR 1949

STATE	Veterinarians, 1949 Directory of AVMA	All Packing-house and Prepared Meat Workers, 1947 Census of Mfg.	Male Farmers, Animal Husb. General and Subsistence Farms, 1945 Adjusted to 1949	Female Farmers, Same Classes, 1949	Rural Farm Children 0-14, 1940 Adjusted to 1949	Rural Women Engaged in Own Homework, 1940 Adjusted to 1949	Remainder of Rural Population, 1940 Adjusted to 1949 Estimate
			(000)	(000)	(000)	(000)	(000)
Illinois	800	40,198	188.9	3.6	276.4	540.6	1,196.0
Iowa	740	22,910	261.5	4.0	268.1	380.5	581.1
Minnesota	403	15,235	243.7	6.0	283.6	339.6	610.0
Wisconsin	502	8,497	256.2	11.1	263.0	359.5	663.9
United States Totals	12,903	258,798	5,238.4	228.1	10,416.6	14,177.0	33,555.8

Table 3
AVERAGE ATTACK RATES BY OCCUPATION FOR MINNESOTA, IOWA, ILLINOIS, AND WISCONSIN FOR 1949

Occupation Group	Average Annual Rates (100,000)	Standard Deviation of Rate (%)
Veterinarians	950.6	28
Packing-house Plus Other Animal Contact Workers	295.2	22
Animal Farmers	72.8	15
Rural Housewives	16.0	24
Rural Farm Children	6.87	9
Remainder (Rural)	8.53	14

methods presented by Pearl (3). These average rates, based on data from the four States, are shown in table 3. Estimated numbers may then be calculated for each occupation group and State or national totals found by combining the appropriate occupation-specific estimated attacks.

There were 10,709 estimated cases for the United States in 1949 as compared to 4,143 cases officially reported by the National Office of Vital Statistics. The standard deviations of the rates for the average specific population units of the four States, used to calculate the rates, vary from 9 to 28 percent as shown in table 3. Extrapolating and combining the occupational groups gives a standard deviation for the total cases in the United States of 17 percent. The 1 percent confidence limits will be 7,000 and 14,400 cases. In other words, if the hypotheses are acceptable, then there is only 1 percent probability that the true number of attacks of brucellosis which would be found if all States reported and investigated brucellosis by the same system and with the same diligence as the four study States, would lie outside the limits of 7,000 and 14,400 for the United States for 1949.

A second estimate has been made on the basis of laboratory results provided through the cooperation of certain State laboratories. Due to the variability of laboratory methods and the variability of utilization of State laboratory facilities by the private practitioner in different States, the inherent error of such an estimate will be large.

From Minnesota data, the probability was determined of each agglutination titer of 1:80 or above being a culturally positive case. The expected culturally proved cases for the 10 States (Colorado, Indiana, Iowa, Illinois, Kentucky, Minnesota, New York, Ohio, Virginia, and Wisconsin), were 480. In Minnesota there were 4.5 times as many additional cases, supported by other evidence but with no cultural proof. This factor applied to 480 would give a total of 2,600 cases irrespective of culture Again extrapolating by the ratio of 2,068 known cases in these States to 4,310 for the United States gives an estimate of 5,400 cases which might be discovered by epidemiologic investigation of all agglutination titers which were found to be positive at 1:80 or a greater dilution in State laboratories. This is certainly an underestimate as far as number of laboratory results is concerned because State laboratories perform only a fraction of the total serum agglutination tests, and no data from commercial laboratories are available.

The prevalence and incidence of human brucellosis cannot be accurately determined at this time because of the indefinite status of many of the laboratory criteria for the diagnosis of the disease. The evaluation of clinical symptoms in the reporting of brucellosis is even more difficult. To aid in obtaining more accurate reports of human cases, it is necessary that standard laboratory procedures for the determination of antibodies be developed such as the method used in testing cattle where a standard antigen and procedure is followed. In addition, it is necessary for the clinician to tabulate all his evidence including the history of animal exposure or the ingestion of contaminated food products of animal origin. To control and eventually eradicate any disease of man or animal, it is necessary to have accurate methods of diagnosis and reporting. The Communicable Disease Center has the laboratory diagnosis of human brucellosis under study and, along with the many other health agencies which are investigating this problem, it is hoped that an acceptable standard laboratory method of diagnosing human brucellosis will be developed.

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