

The malaria problem in peace and war : a consolidation of papers read at the annual meeting of the National Committee on Malaria, Memphis, Tenn., November 12, 1917, and the annual convention of the New Jersey Mosquito Eradication Commission, Atlantic City, N.J., January 31, 1918, materially revised, enlarged and brought down to date / by Frederick L. Hoffman.

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Hoffman, Frederick L. 1865-1946.

Publication/Creation

[Newark] : [Prudential Press], [1918]

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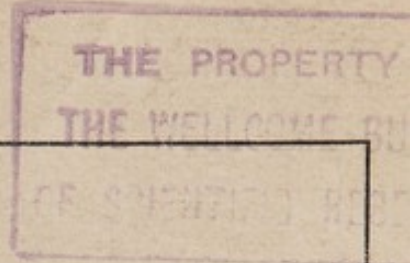
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THE MALARIA PROBLEM IN PEACE AND WAR

BY

FREDERICK L. HOFFMAN, LL. D.

Third Vice President and Statistician The Prudential Insurance Company of America,
Chairman Subcommittee on Statistics, National Malaria Committee, Author
of "A Plea and a Plan for the Eradication of Malaria Throughout the Western Hemisphere," etc.

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TO
MAJOR-GENERAL ^{W. C.} ~~C. W.~~ GORGAS
SURGEON-GENERAL, U. S. A.

Honorary Chairman National Committee on Malaria

In grateful appreciation of his distinguished services to the
cause of malaria eradication in Cuba
and the Panama Canal Zone and the prevention
and control of
malaria throughout the World

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**THE
MALARIA PROBLEM IN
PEACE AND WAR**

PART I

**MODERN MALARIA ERADICATION
METHODS AND RESULTS**

PART II

MALARIA IN RELATION TO WAR

THE
MALARIA PROBLEM IN
PEACE AND WAR

1918
PRUDENTIAL PRESS
NEWARK, N. J.
U. S. A.

PART I

MODERN MALARIA ERADICATION METHODS AND RESULTS

The immensity of the problem of malaria eradication would be absolutely appalling, were it not for the encouraging and increasing evidence of a material reduction in the rate of malaria frequency in practically every locality or section where modern methods of disease prevention and control have been vigorously and continuously carried into effect, although naturally with a widely varying degree of success in the results achieved. The possibilities of more or less complete malaria eradication in restricted areas are, therefore, no longer questioned by any one familiar with the recorded facts of a public-health problem of the utmost practical importance to large numbers of our own population and the peoples of other and still more afflicted countries.

MALARIA AND WAR

Malaria, while primarily a health and engineering problem of the semitropics and the tropics, is nevertheless a disease of world-wide distribution, and the menace of its occurrence and reintroduction into regions relatively or entirely free therefrom is best illustrated by its lamentable recurrence among the Allied armies in Flanders and northern France. Unhappily, the impressive lessons of past military experience have apparently been ignored, and "large numbers of troops are rendered inefficient for considerable periods by autumnal fever, as it is called, and this to an extent which seriously handicaps the military position."* As pointed out by Surgeon-Major E. Rist, of the French Scientific Mission, in an address before the American Public Health Association (October 19, 1917), there have occurred "a considerable number of cases of malaria in soldiers returned from Saloniki, Macedonia, and the Vardar-Valley," which is known to be "one of the most malaria-infested places in the world."† The fever, it is pointed out, is "of the worst

*A fairly extended descriptive account of acute contagious diseases in the French army by Surgeon-Major E. Rist, of the French Scientific Commission, was read before the general session of the American Public Health Association, October 19, 1917, at Washington, D. C., reprinted in the December issue of *The American Journal of Public Health*.

†"Salonika, however, not only suffers from bad government, but also from the marshes which surround it, and in summer many of its inhabitants flock to the healthier town of Kalameria, to the west. Miasmatic swamps unfortunately occupy a large portion of the northern coast of the Aegean, and they separate the interior of Macedonia more effectively from the coast than do its mountains."—Elisee Reclus, "The Earth and Its Inhabitants," Europe, Vol. I, p. 110.

tropical kind." The cases are treated in special hospitals, "located in such regions where, after a careful entomological survey, it has been proved that there are no anopheline mosquitoes. *No malarial hospital is allowed in a district where anophelines are present.*" It is to be hoped that these and other precautions will be adopted in the final organization of the Army Medical Service in connection with the control of the disease in southern cantonments and of the extra cantonment area under the supervision of the United States Public Health Service. For the problem is a much more serious and difficult one than is generally assumed by those who are not thoroughly familiar with the facts of past experience. The importance and the duty of complete protection, therefore, cannot be too emphatically insisted upon. The Government of Australia, with commendable foresight, has provided for an entomological survey of the areas in which returning soldiers are to be provided with homesteads and in which the prevalence of anopheline mosquitoes would constitute a permanent menace to the introduction of the disease into sections of Australia now relatively or entirely free therefrom.* Similar measures should be applied rigorously to every danger area in the South, and nothing should be left undone to especially safeguard Northern troops against the risk of malaria infection by any and all means at the command of the Army Medical Department and the United States Public Health Service.

ESSENTIALS OF PROPHYLAXIS

In the words of Craig, "The subject of prophylaxis in the malarial fevers is of the very greatest importance, for these fevers are preventable, and since the discovery of the plasmodia and the method of the transmission of these parasites by the mosquito, we are in a position to control the spread of fevers of malarial origin."† In the light of this knowledge and the vast amount of conclusive experience in malaria eradication throughout the world, the spread of the disease among large bodies of the men of the National Army would not only be a military calamity but obvious evidence of inefficiency in medical and sanitary administration.

It has also been pointed out by Craig that "The success of malarial prophylaxis is very largely a question of local conditions and the

*Service Publication No. 12, Quarantine Service, Commonwealth of Australia, Melbourne, 1917, Report on Malaria Mosquito Survey of Irrigation Areas in the Murray River District, by F. H. Taylor. The number of deaths from malaria in the Commonwealth of Australia during 1916 was only 50, equivalent to 1.0 per 100,000 of population.

†"The Malarial Fevers," by Charles F. Craig, M. D., New York, 1909; also Bulletin No. 6, Office of the Surgeon-General, Washington, 1914.

assistance given by the local and governmental authorities.”* He emphasizes four different methods of prophylaxis, but suggests especial application in conformity to variations in local conditions, for a method most useful in one section might be least useful in another. The four methods, not necessarily in the order of their importance, are

- 1 The prevention of the development of the plasmodia in man and the destruction of the plasmodia in infected individuals. Both these aims are accomplished by the administration of quinine, i. e., quinine prophylaxis.

- 2 Destruction of the mosquitoes transmitting malaria.

- 3 Protection of man from the bites of mosquitoes.

- 4 Education of the public regarding malarial prophylaxis.

DECLINE IN THE MALARIA DEATH RATE

The available knowledge on the malaria problem is fully sufficient for general practical purposes, although much unquestionably remains to be done to perfect the theory of adequate prophylaxis in matters of detail.† It is frequently a most difficult question to decide whether one approved method of prevention or another should be followed; but past experience has fully demonstrated the far-reaching possibilities of well-considered eradication measures. For many countries, but especially for the Southern States of the United States, the available statistical evidence is quite convincing that the mortality from malaria during recent years has been decidedly on the decline. This conclusion, however, applies more generally to Southern cities than to the rural sections, for many of which no trustworthy information can be secured at the present time. Combining the returns for seventeen representative Southern urban communities, with an aggregate estimated white population of 2,385,000 in 1916, it appears that the malaria death rate decreased during the last decade from 8.2 per 100,000 in 1907 to 4.3 in 1916. There was, therefore, an actual reduction in malaria frequency among the white population of 3.9 per 100,000, equivalent to 47.6 per cent. The decline, however, was neither persistent nor uniform, for there was apparently an increase in the rate between 1907 and 1909, when the mortality reached a maximum of 9.6. Subsequently thereto, however, the decrease was gradual and considerable, to the minimum rate of 3.9 previously referred to. For the colored population of the seventeen Southern cities, with an aggregate estimated population for the year 1916 of 734,725, the malaria death rate decreased from 49.9 per 100,000 in

*Bulletin No. 6, Surgeon-General's Office, August, 1914, Washington, D. C.

†For some exceptionally interesting recent observations on New Malaria Problems of To-day, see an editorial in *The Lancet*, December 15, 1917, p. 905.

1907 to 15.9 in 1916. There was, therefore, an actual reduction during the decade in the malaria mortality of the colored of 34.0 per 100,000 of population, equivalent to 68.1 per cent. The sanitary progress in the seventeen Southern cities considered as a group has clearly been of decided benefit to both the white and the colored population, with a consequential material saving in working-time, medical expense, etc. The death rate, of course, reflects to only a minor degree the full economic importance of malaria as a sickness problem. The details of the malaria death rate of Southern cities are given below:

MORTALITY FROM MALARIA IN SEVENTEEN SOUTHERN CITIES, 1907-1916

(Rate per 100,000 Population)

	WHITE			COLORED		
	Estimated Population	No. of Deaths	Rate	Estimated Population	No. of Deaths	Rate
1907.....	1,670,502	137	8.2	618,688	309	49.9
1908.....	1,705,739	153	9.0	635,986	295	46.4
1909.....	1,734,583	166	9.6	647,994	250	38.6
1910.....	1,784,991	133	7.5	672,653	233	34.9
1911.....	1,820,389	119	6.5	689,941	285	41.3
1912.....	1,850,884	129	7.0	702,206	244	34.7
1913.....	1,882,562	98	5.2	715,178	223	31.2
1914.....	1,911,393	89	4.7	726,908	183	25.2
1915.....	1,974,750	103	5.2	722,244	188	26.0
1916.....	2,003,850	86	4.3	734,723	177	15.9
<hr/>						
1907-1916.	18,339,643	1213	6.6	6,866,521	2,329	33.9

(The cities included in this investigation are Mobile, Ala., Washington, D. C., Jacksonville and Key West, Fla., Atlanta and Savannah, Ga., Louisville, Ky., New Orleans, La., Raleigh, N. C., Charleston, S. C., Memphis and Nashville, Tenn., Galveston and San Antonio, Texas, Richmond and Norfolk, Va., and Baltimore, Md.)

MALARIA IN SOUTHERN CITIES

It would unduly enlarge the present discussion to consider at length the reductions achieved in each and every one of the seventeen cities, which naturally vary widely, in consequence of essential differences in local methods of eradication and local conditions responsible for malaria prevalence. Especially significant, however, is the decrease in the

malaria mortality of the city of Memphis, where the local problem is one of exceptional complexity, on account of the proximity of a vast extent of infected territory,* which unquestionably accounts for a considerable proportion, if not the major proportion, of the malaria mortality of residents and non-residents combined. Between 1906 and 1916 the mortality from malaria of the white population of Memphis decreased from 65.4 per 100,000 to 24.4, or actually 41.0 per 100,000, equivalent to a reduction of 62.7 per cent. The corresponding decrease in the malaria mortality of the colored population has been from 232.6 at the beginning of the period to 63.7 at the end! The actual decrease in the mortality of the colored population was therefore 168.9 per 100,000, equivalent to 72.6 per cent. This extraordinary and gratifying reduction unquestionably reflects local sanitary progress of a high order and the efficacy of local antimalarial measures, which, it may be suggested, should be made the subject of an extended official report; for whatever specific method or means may have been adopted and carried into effect to bring about this remarkable change in health conditions is not merely a matter of serious concern to the city of Memphis, but to many other localities where local conditions may be more or less similar and where the attained reduction in the malaria death rate has been at a lesser rate. Equally encouraging, however, has been the reduction in the malaria death rate of the city of Nashville. During 1906 the malaria death rate of the white population was 22.3 per 100,000 of population, against a rate of only 1.2 in 1916; in other words, malaria in Nashville has practically been eradicated. For the colored population the corresponding reduction was from 45.2 per 100,000 at the beginning of the period to only 5.5 at the end! As a matter of fact, there was only one death from malaria among the white population of Nashville during 1916, estimated at 80,600, and only two deaths from this disease among the colored population, estimated at 36,500!

GOVERNMENT MORBIDITY STATISTICS

The foregoing observations have reference exclusively to the mortality from malaria in selected but representative urban centers of the Southern States. Through the United States Public Health Service, under the direction of Dr. H. R. Carter, efforts are being made to secure malaria morbidity statistics through the active cooperation of practising physicians of the South. The results have been sufficiently encouraging to warrant the continuation of this plan, though perhaps in a somewhat

*The river bottom-lands of eastern Arkansas.

modified form. If complete cooperation could be secured, the results would unquestionably be of the first importance. That the complete reporting of all cases of malaria and other fevers is not really a serious practical difficulty has been completely demonstrated in the State of Mississippi, where under the direction of Dr. W. S. Leathers, the State Health Officer, returns are now being made by nearly all the physicians of the State.

The procedure of the United States Public Health Service is to send out return-reply postcards to physicians in actual practice and to require a monthly statement of the number of cases of malarial fever treated during the period, according to race, type of disease and whether confirmed microscopically or not. This plan was initiated by the late Dr. R. H. von Ezdorf, who in 1915 presented the results of a first survey of malaria in the United States with reference to its prevalence and geographic distribution, based on 181,590 cards mailed to physicians and 24,072 replies received in return. It is therefore shown that 13.25 per cent. of the physicians made replies, the range being from a minimum of 8.02 per cent., for Louisiana, to a maximum of 16.54 per cent., for Arkansas. The number of cases of malaria reported was 81,085. The population considered was 15,112,000, equivalent to a morbidity rate of 5.36 per 1,000. According to Dr. von Ezdorf, "If the same ratio is carried out on the basis of complete returns, then the morbidity rate would be 40.4 per 1,000; that is, 4 per cent. of the population, or over 600,000 people, in the eight States suffered an attack of malaria." The States in question were Alabama, Arkansas, Florida, Kentucky, Louisiana, North Carolina, South Carolina and Tennessee.*

MALARIA IN ALABAMA AND LOUISIANA

In 1916 Dr. von Ezdorf made a supplementary report on "The Endemic Index of Malaria in the United States,"† including an estimate for twelve Southern States with a population of 25,000,000, a morbidity rate of four per cent., and an estimated mortality of one death from malaria out of every fifty to three hundred cases of the disease. In continuance of the work inaugurated by Dr. von Ezdorf, special reports have been made, among others, on malaria in Tennessee, Louisiana, Kentucky, eastern Texas, North Carolina, Alabama, etc. All of these reports indicate a maximum frequency of malaria

*For the State of Mississippi for the two years 1915 and 1916, the malaria morbidity rate as ascertained by trustworthy methods not at present followed by any other Southern State was 80.9 per 1,000, or 8.1 per cent.

†"Malarial Index Work," by R. H. von Ezdorf, Reprint No. 159, U. S. Public Health Reports, December 26, 1913, Washington, 1914. See, also, his "Anopheline Surveys," Reprint No. 272, April 30, 1915.

morbidity during the month of September. In Alabama for the year 1916 only twelve per cent. of the physicians circularized returned the schedules. It is therefore pointed out in the report that "While there must have been many more cases of malaria in the State, the reports of the physicians on which this study is based are sufficient to show whether malaria was present or absent in the several counties, and reasonably accurately the relative intensity of the infection in the counties." As an illustration of the results of this method of securing malaria morbidity returns by circularizing practising physicians, the following table is included for the State of Alabama. It may be said in this connection that there were three cases of hemoglobinuric fever* reported from Marengo County during the fourth quarter of 1916.

MALARIA MORBIDITY IN ALABAMA

1915-1916

(U. S. Public Health Service)

1915

Period	Inquiry Cards Sent to Physicians	Replies Received	Percentage of Replies	Counties Represented in Replies	Counties Not Heard From	Cases of Malaria Reported
January to March....	7,050	926	13.13	67	..	1,170
April to June.....	2,350	307	13.06	65	2	1,810
July to September....	2,350	257	10.94	63	4	4,535
October to December.	2,350	294	12.51	62	5	1,929

1916

January to March....	2,350	254	10.81	62	5	659
April to June.....	2,350	279	11.87	64	3	2,393
July to September....	2,350	261	11.11	64	3	6,261
October to December.	2,350	256	10.89	63	4	1,695

To facilitate a comparison with the returns for another typical Southern State in which malaria is relatively common, or at least in certain sections thereof, the following table for the State of Louisiana is included. There were ten cases of hemoglobinuric fever reported from five different parishes of Louisiana during the third and fourth quarters of 1916.

*For an extended discussion on hemoglobinuric fever, see "The Malarial Fevers, Haemoglobinuric Fevers," etc., by Chas. F. Craig, New York, 1909, part vi, p. 391, *et seq.*; "The Endemic Diseases of the Southern States," by Deaderick and Thompson, chapter on Blackwater Fever, p. 219, *et seq.*; "Blackwater Fever," by A. G. Newell, London, 1909; Report on Blackwater Fever, by Captain S. R. Christophers and Dr. C. A. Bentley, Calcutta, 1909; also a Report on Hemoglobinuric Fever in the Canal Zone, by W. E. Deeks, M. D., and W. M. James, M. D., Mount Hope, Canal Zone, 1911.

MALARIA MORBIDITY IN LOUISIANA

1915-1916

(U. S. Public Health Service)

1915

Period	Inquiry Cards Sent to Physicians	Replies Received	Percentage of Replies	Parishes Represented in Replies	Parishes Not Heard From	Cases of Malaria Reported
January to March....	7,500	692	9.23	63	2	1,456
April to June.....	2,070	320	15.46	60	5	2,754
July to September....	2,070	191	9.23	49	16	5,133
October to December.	2,070	191	9.23	49	15	3,249

1916

January to March....	2,070	142	6.86	55	9	2,239
April to June.....	2,070	128	6.18	48	16	3,178
July to September....	2,070	188	9.08	47	17	7,040
October to December.	2,070	136	6.57	44	20	2,450

Granting the decided limitations to investigations, the data are nevertheless of some practical value. They certainly emphasize the excessive prevalence of malaria in the months of July-September and a minimum occurrence of the disease during January-March. They require to be amplified considerably in matters of detail, and unquestionably much could be done to improve the tabular presentation of the results. The type of infection should be determined with greater accuracy, but at the outset it would not seem wise to overemphasize the method of diagnosis, whether clinical or microscopical. The accuracy and completeness of the method depend, of course, upon the active and intelligent cooperation of *every* physician practising in the areas reported upon. There are, unfortunately, convincing reasons for believing that many physicians fail in clearly realizing their professional duty to cooperate to the fullest extent required with the United States Public Health Service or the State health authorities.

LIMITATIONS OF MORBIDITY RETURNS

Uniformity in procedure in such an investigation is most essential, if the data are to be of value for comparative purposes. Where the State health administration is thoroughly efficient, as, for illustration, in the state of Mississippi, excellent results can be secured, and possibly even better results than through the United States Public Health Service. Adequate provision, however, requires to be made for promptness and

completeness in the tabulation and analysis of the returns. In this respect the method followed by the State of Mississippi is more satisfactory, for the information is made available within less than thirty days after the reports are received. Under our form of State health administration the United States Public Health Service is without power of legal compulsion in the making of the returns required. It has no jurisdiction over local health officers and practising physicians, so that efforts for an improvement in the accuracy of the Federal returns depend primarily upon a higher sense of realized duty on the part of the medical profession. Where such cooperation cannot be secured it would therefore seem best that the matter should be one of State administration, but as far as practicable the methods of procedure, the forms and blanks and the tabulation and analysis should be in conformity to those followed by the United States Public Health Service materially improved, of course, as experience would suggest.

REVIEW OF UNITED STATES MALARIA MORBIDITY STATISTICS

The serious limitations of the malaria morbidity statistics of the United States Public Health Service are best illustrated by a retrospective review of the data for selected Southern States for each of the last five years, showing, respectively, the number of cards sent out, the number of replies received from practising physicians and the percentage of such replies to the total.* The table following presents the data for the State of *Alabama*.

UNITED STATES PUBLIC HEALTH SERVICE MALARIA STATISTICS FOR THE STATE OF ALABAMA 1912-1916

Year	Cards Sent	Replies	Per Cent. of Replies
1912.....	4,551	1,036	22.8
1913.....	13,976	1,816	13.0
1914.....	28,117	3,247	11.5
1915.....	14,100	1,784	12.7
1916.....	9,400	1,050	11.2
Total.....	70,144	8,933	12.7

*These reports are published annually and are obtainable free of charge from the U. S. Public Health Service, Washington, D. C.

It is self-evident that the effort to secure malaria morbidity statistics for the State of Alabama by the method previously described in sufficient detail has fallen far short of the expected results. After reaching a maximum of 28,117 cards sent out, in 1914, the number was rapidly reduced to 9,400, in the year 1916. The reasons for this reduction are not explained in the official reports on malaria prevalence by States. The percentage of replies received decreased from a maximum of 22.8, for the year 1912, to a minimum of 11.2, for the year 1916. For practical purposes, therefore, the effort to secure malaria morbidity statistics for the State of Alabama through the efforts of the United States Public Health Service must be considered a failure. The average proportion of replies received for the five-year period for the State of Alabama was only 12.7 per cent.

For the State of *Arkansas* the returns have only been published for 1913 and 1914, with a resulting average percentage of replies of 17.4. The percentage of replies received decreased from 20.8 in 1913 to 16.5 in 1914. No information has been made public as to why the collection of data for the State of Arkansas was discontinued. For the State of *Florida* the returns are available for four years. The details of the investigation are presented in the table following:

**UNITED STATES PUBLIC HEALTH SERVICE MALARIA
STATISTICS FOR THE STATE OF FLORIDA, 1913-1916**

Year	Cards Sent	Replies	Per Cent. of Replies
1913.....	3,842	776	20.2
1914.....	11,603	1,273	11.0
1915.....	2,928	431	14.7
1916.....	3,928	498	12.7
Total.....	22,301	2,978	13.4

The number of cards sent out varied widely during the four years, but during 1916 about the same number was sent out as during the year 1913. The percentage of replies received, however, decreased from 20.2 in 1913 to 12.7 in 1916. The wide variation between the number of cards sent out and the number of replies received indicates that the results of the investigation are probably of very limited value. The average proportion of replies received for the State of Florida for the four-year period was 13.4 per cent.

For the State of *Georgia* it would appear that only one effort was made, during the year 1913, when 9,000 cards were sent out and 1,084 replies

were received, or 12.0 per cent. There is nothing to indicate in the reports for subsequent years why the effort to secure malaria morbidity statistics for the State of Georgia was discontinued. For the State of *Kentucky* the returns have been made public for the three years 1914-1916. The details of the investigation are presented in the next table:

**UNITED STATES PUBLIC HEALTH SERVICE MALARIA
STATISTICS FOR THE STATE OF KENTUCKY, 1914-1916**

Year	Cards Sent	Replies	Per Cent. of Replies
1914.....	20,990	3,334	15.9
1915.....	21,000	3,432	16.3
1916.....	14,000	1,519	10.9
<hr/>			
Total.....	55,990	8,285	14.8

The number of cards sent out increased slightly from 1914 to 1915, but was reduced by about one-third during 1916. For the three-year period the average number of replies received for the State of Kentucky was 14.8 per cent. Equally unsatisfactory have been the results for the State of *Louisiana*, as shown by the table below:

**UNITED STATES PUBLIC HEALTH SERVICE MALARIA
STATISTICS FOR THE STATE OF LOUISIANA, 1914-1916**

Year	Cards Sent	Replies	Per Cent. of Replies
1914.....	19,981	1,603	8.0
1915.....	13,710	1,394	10.2
1916.....	8,280	594	7.2
<hr/>			
Total.....	41,971	3,591	8.6

From a maximum of nearly 20,000 cards sent out in 1914, the number was reduced to less than one-half in 1916. The proportion of replies received changed from 8.0 per cent. in 1914 to 10.2 per cent. in 1915, reaching a minimum of 7.2 per cent. in 1916. The average for the State of Louisiana for the three-year period was only 8.6 per cent.

For *North and South Carolina* the returns are equally unsatisfactory. For both States the number of cards sent out during 1916 was very much below the number sent out during the previous two years. The proportion of replies received was lowest during 1916. The average

number of replies for the four-year period was practically the same for the two states, or 15.9 per cent. for North Carolina and 15.2 per cent. for South Carolina. The details of the analysis are presented in the table following:

UNITED STATES PUBLIC HEALTH SERVICE MALARIA
STATISTICS FOR NORTH AND SOUTH
CAROLINA, 1913-1916

NORTH CAROLINA			
Year	Cards Sent	Replies	Per Cent. of Replies
1913.....	1,849	408	22.1
1914.....	21,126	3,320	15.7
1915.....	11,094	1,759	15.9
1916.....	7,396	1,090	14.7
Total.....	41,465	6,577	15.9
SOUTH CAROLINA			
1913.....	5,100	950	18.6
1914.....	15,246	2,445	16.0
1915.....	7,650	1,045	13.7
1916.....	3,825	399	10.4
Total.....	31,821	4,839	15.2

In addition to the foregoing Southern States, the information is available for *Tennessee* and *East Texas*. The details of the investigation for Tennessee are presented in the next table:

UNITED STATES PUBLIC HEALTH SERVICE MALARIA
STATISTICS FOR THE STATE OF
TENNESSEE, 1913-1916

Year	Cards Sent	Replies	Per Cent. of Replies
1913.....	3,338	609	18.2
1914.....	39,594	4,724	11.9
1915.....	20,028	1,792	8.9
1916.....	13,352	963	7.2
Total.....	76,312	8,088	10.6

The table proves conclusively the limitations of the method at present made use of by the United States Public Health Service to secure

malaria morbidity statistics of intrinsic value for the several Southern States and the separate counties thereof. No reasons are advanced why the proportion of replies should have continuously diminished from 18.2 per cent. in 1913 to 7.2 per cent. in 1916. For the State of Tennessee during the four-year period the average proportion of replies received was 10.6 per cent. For East Texas the proportion of replies in 1915 was 16.0 per cent., but for 1916 only 11.7 per cent., or for the two years combined, 13.8 per cent.

DESCRIPTIVE DEFINITION OF ENDEMIC AREAS

It has seemed advisable to present these data in some detail, on account of the possibility that the Government statistics may be utilized for practical purposes, but in a very misleading manner. If the intrinsic value of these returns cannot be improved, and if, as a matter of fact, the tendency is strongly in the direction of a diminished trustworthiness, it would seem best to discontinue the collection and publication of such data altogether. It is suggestive in this connection that, although malaria is referred to at considerable length with regard to its scientific and other aspects in the last annual report of the Surgeon-General of the United States Public Health Service, there is no mention of the statistical returns obtained by means of circularizing the physicians of most of the Southern States, further than that the method itself is referred to as being employed "to ascertain as definitely as this means would allow the prevalence of malaria." In a general way, no doubt, the data were utilized by the Public Health Service for the ascertainment of the geographical distribution of malaria, it being said in the report that

There are three principal well-recognized endemic areas,—one large area and two smaller ones. The large endemic area covers the whole southeastern portion of the United States, having for its southern boundary the Gulf of Mexico; for its western boundary, a line drawn from Eagle Pass, on the Rio Grande, to Leavenworth, Kans.; for its eastern boundary, the Atlantic seaboard; its northern boundary a line drawn from Leavenworth, Kans., eastward some distance north of the Ohio river and extending to the Atlantic on a line with the northern boundary of Maryland. Of the two smaller endemic areas, one includes a section of the northern part of New Jersey, southeastern New York, Connecticut, Rhode Island, and part of the State of Massachusetts. The third recognized endemic area is in California, and includes the Sacramento and San Joaquin Valleys, which occupy a large portion of the central part of the State. It is probable that the New England endemic area actually extends southward to the large southern area of which it is really a part.

Since these observations are not sustained by definite statistical data such as might be forthcoming if the effort to circularize practising

physicians throughout at least the more or less endemic areas could be made more successful, these conclusions, of course, cannot be accepted as final. Granting that mortality data are less conclusive than accurate morbidity data when properly collected and otherwise adequate to the purpose, it would seem best for the time being to make more extensive use thereof and to encourage efforts in the direction of improved methods of death certification and the tabulation of joint causes, so as to meet the practical difficulty which arises out of a practice, more or less justified, of giving the preference to some other cause of death than malaria where two or more diseases are present at the same time. It is properly pointed out in this connection by the Surgeon-General of the United States Public Health Service in his report for 1917 that out of 13,000 cases of malaria in the United States Army during 1904-1914 there were only two deaths directly or specifically attributed to the disease, and that between 1907 and 1914 there were 7,000 cases of malaria without a death. In 1914 the highest malaria rate at any Army post in the United States was 73 per 1,000 mean strength at Washington Barracks in the District of Columbia. The second highest was at Fort Myer, Va., just outside of Washington, and the third highest at Fort Leavenworth, Kans. The frequency of malaria in a non-fatal form in the District of Columbia is therefore a much more serious medical problem than is generally recognized by both the medical profession and the public at large.*

Aside from this method of circularizing physicians in actual practice, the United States Public Health Service for some years has secured returns of the notifiable disease in large and small cities.† The inclusion of malaria has been most fortunate, and in time a consolidation of the report should prove of value. As pointed out, however, with reference to the returns for the year 1916, "some of the cities are apparently much more successful in obtaining reports of notifiable disease than are others." It is explained therefore that "This may be due to the greater activity of their health department or to a greater interest in the public welfare on the part of the practising physicians." The conclusion is therefore advanced that "The completeness of the notification of disease may be taken as a fairly dependable index of the efficiency of the health department and of the sanitary knowledge and training of its personnel." Furthermore, it is said that "To so great an extent is this true that the

*For additional observations on the frequency of malaria in the U. S. Army before the present war, see page 79. According to the reports of the Health Officer of the District of Columbia, the malaria death rate of Washington, D. C., during the two years 1914 and 1915 was only 0.8 for the white and 1.5 per 100,000 for the colored population. The rate decreased from 7.4 per 100,000 during 1901-1905 to 0.8 during 1911-1915.

†For a further discussion of malaria notification, see p. 75, *et seq.*

small number of cases reported in some cities indicates grossly incomplete reporting of cases and defective health administration, and not an actual freedom from disease." What is true of notifiable diseases in general is particularly true of malaria, the community importance of which is, unfortunately, quite often disregarded, by both the authorities and the physicians in general practice. The latter, however, are often much more to blame than the former. Physicians indifferent to statutory requirements intended to conserve the health and the welfare of the community are not likely to square their professional conduct otherwise with the highest considerations of the public good. The obligation of the physician to report each and every case of a notifiable disease is paramount to the success of the local health administration, and those derelict in this respect in the discharge of their public duty should be punished according to law and to the fullest extent. Conversely, a local or State board of health unwilling to enforce statutory requirements regarding the notification of infectious, contagious or otherwise transmissible diseases fails as conspicuously in its duty of conserving the public health, and the incompetent official or officials should be dealt with severely according to their deserts. The public health is no longer an academic problem, but a matter of the utmost practical importance, not only to the localities directly concerned, but to the States and to the nation of which they are a part.*

MALARIA IN MISSISSIPPI

At the present time the most satisfactory returns regarding malaria morbidity are those of the State of Mississippi. The rules and regulations governing morbidity reports are concise, but sufficient for the purpose. Section I reads that "It shall be and is hereby the duty of county health officers to secure a report from physicians each month of the diseases named in Section II of the Rules and Regulations of the State Board of Health governing the morbidity reports, as provided in Section 2487 of the Mississippi Code, 1906." Among the diseases included are malaria and typhoid fever. Section III provides that "Each and every licensed physician practising in the State of Mississippi who treats or examines any person suffering from or afflicted with, or suspected to be

*The inadequacy of the notification returns is most regrettable. The data as published by the Public Health Service in their present form cannot be utilized to much practical advantage. The responsibility for their inadequacy rests, of course, chiefly with the local health departments. In no direction, perhaps, could an active propaganda on the part of the National Malaria Committee be more effective than in a direct appeal to the citizenship of the communities concerned for the more complete reporting of all malaria cases on the part of the practising physicians and an insistent demand that physicians derelict in their duty to report such cases be dealt with according to law.

suffering from or afflicted with any of the notifiable diseases named in Section II, shall on the first day of the month following report the number of each disease or suspected disease to the County Health Officer of the County in which the patient resides or is temporarily located. Such reports shall show the number of cases of each disease by color or race. When the physician has not attended any cases of notifiable disease during the month, he shall report such fact to the County Health Officer." In practice these requirements have been sufficient for the purpose. Reports are received promptly from practically the entire body of practising physicians in the State of Mississippi. The accuracy and the completeness of the returns are a most commendable and notable achievement, for the notifiable diseases include also puerperal septicemia and all forms of tuberculosis and cancer. The returns constitute the first reasonably complete morbidity index by counties available for any single American State at the present time.*

COMPARATIVE FREQUENCY OF MALARIA AND TYPHOID

In the table following, the returns for malaria and typhoid fever are summarized for the two years 1915-1916, with distinction of race.

MORBIDITY AND MORTALITY FROM MALARIA IN MISSISSIPPI, 1915-1916

Year	WHITE				COLORED			
	Cases	Rate per 10,000	Deaths	Rate per 10,000	Cases	Rate per 10,000	Deaths	Rate per 10,000
1915.....	72,907	863.3	516	6.1	80,800	746.6	976	9.0
1916.....	76,521	894.5	505	5.9	82,258	750.4	921	8.4

MORBIDITY AND MORTALITY FROM TYPHOID FEVER IN MISSISSIPPI, 1915-1916

Year	WHITE				COLORED			
	Cases	Rate per 10,000	Deaths	Rate per 10,000	Cases	Rate per 10,000	Deaths	Rate per 10,000
1915.....	3,533	41.8	216	2.6	2,629	24.3	404	3.7
1916.....	3,240	37.8	205	2.4	2,795	25.5	463	4.2

The interesting fact is brought out by this comparison that both the morbidity and the mortality rate for malaria remained practically the

*A thoroughly critical and practically most valuable study of the malaria mortality of Baltimore, by Thayer and Hewetson, was published in The Johns Hopkins Hospital Reports of 1895, including a study of some fatal cases of malaria by Lewellys F. Barker; see, also, in this connection my analysis of the Statistical Experience Data of the Johns Hopkins Hospital, Baltimore, Md., 1892-1911, published as Monograph No. IV, New Series, Johns Hopkins Press, Baltimore, 1913.

same for the two races during the two years, with indications, however, of a slight decline in the mortality. For the year 1916 the malaria morbidity rate was 849.5 per 10,000 of population for the white population, against 750.4 for the colored. In contrast, however, the mortality rate was higher for the negroes, or, respectively, 5.9 per 10,000 for the whites and 8.4 for the colored.

There was a slight reduction in both the morbidity and the mortality from typhoid fever among the white population, and a slight increase among the colored. During the year 1916 the typhoid fever morbidity was 37.8 per 10,000 for the whites, against 25.5 for the colored; in contrast, however, the typhoid fever rate was 2.4 for the whites, against 4.2 for the colored. For both malaria and typhoid fever the death rates for the colored were decidedly in excess of the corresponding rates for the whites, although the relative disease incidence was less. How far the latter is accounted for by possible inaccuracies and deficiencies in the reports cannot be stated.

INFLUENCE OF RACE

It is of interest in this connection to emphasize briefly the relative fatality rates for the two diseases, according to race. Combining the returns for the two years, the fatality rate for malaria was 0.7 per cent. for the whites, against 1.2 for the colored. The corresponding rates for typhoid fever were 6.2 for the whites and 16.0 for the colored. These results are in conformity to other investigations, including the thoroughly trustworthy experience data of the Johns Hopkins Hospital.* With rare exceptions the fatality rate is higher for the negro in all the infectious diseases, including malaria.†

INFLUENCE OF TOPOGRAPHY

A discussion of the geographical distribution of malaria throughout Mississippi, with a due regard to geographic and topographic subdivisions of the State, would make a most interesting contribution to the subject.‡ Naturally, of special importance is the well-known excessive prevalence of the disease in the twelve so-called "Delta" counties. Physiographically Mississippi is divisible into nine regions, which

*The Statistical Experience Data of the Johns Hopkins Hospital, Baltimore, Md., 1892-1911, Monograph No. IV, New Series, The Johns Hopkins Hospital Reports, Baltimore, 1913.

†It should have been stated that the estimated white population of Mississippi is approximately 850,000 and the colored population about 1,096,000.

‡Mississippi State Geological Survey, E. N. Lowe, Director, Bulletin No. 12, "Mississippi, Its Geology, Geography, Soil and Mineral Resources," 1915, Jackson, Miss.

conform quite closely to the geologic structure of the State. For the present purpose, however, it has been necessary to limit the geographical correlation of malaria to five broadly defined topographical regions, which in general descriptive terms are as follows:

Section I.—Delta Counties (twelve), containing an approximate area of 7,712 square miles and a population of 368,463 for the census year 1910. This region, which is also known as the Yazoo Delta, according to the report of the Mississippi State Geological Survey, "embraces all that great flood plain deposit of the Mississippi River and its tributaries lying on the east side of the great river between Memphis and Vicksburg. It is a low-lying featureless expanse, sloping gently southward. Its altitude at the Tennessee line is 200 feet and at Vicksburg 100. The whole region was originally heavily timbered. Large forests still remain, but, on account of the valuable hardwood, are being rapidly cut over and the lands prepared for cultivation. While the average relief of this region is but slight, the higher lands lie adjacent to the streams, the interstream areas being low and more or less swampy. The soils are all alluvial and among the most fertile on earth. Until the completion of the levee, the annual overflows of the Mississippi retarded very much the development of the Delta. Since then development has been rapid, and with the completion of the drainage schemes* now being pushed in most parts of this region, two-thirds of the lands now unused will be reclaimed."†

Section II.—Southern River Counties (five), containing an approximate area of 2,661 square miles and a total population of 116,452 for the census year 1910. This consists in part of a wide stream margin of rugged precipitous hills known as the Loess or Bluff Hills, through which the streams have cut deep narrow gorges, whose sides in many places stand in vertical walls. This region of hills varies in width from five to fifteen miles, and, according to the official report of the Mississippi State Geological Survey, "follows the eastward curve of the Delta margin from Memphis to Vicksburg, then southward hugs the east bank of the Mississippi River to the Louisiana line. The region bordering immediately on the Mississippi River is low-lying and in sections very poorly drained. An admirable descriptive account of the local topographic

*Report on Belzoni drainage district in Washington County, Miss., 1912, U. S. Agricultural Experiment Stations Bulletin No. 244, A Report upon the Drainage of the Agricultural Lands of Bolivar County, Mississippi, 1909, U. S. Agricultural Experiment Stations Circular No. 81.

†Of special interest are the Soil Surveys for the Yazoo Area, by Jay A. Bonsteel and Party, reprinted from the Report on Field Operations of the Bureau of Soils for 1901, and the Soil Survey of the Smedes Area by Smith and Carter, included in the report for 1902. See, also, a most interesting Report on Holmes County, by Geib, in the Annual Report for 1908, and on Grenada County by Tharp and Hogan in the Report for 1915.

features has been made available through the Soil Surveys of Adams and Wilkinson Counties.*

Section III.—Interior Plateau Counties (twenty-five), containing an approximate area of 14,607 square miles and a total population of 544,989 for the census year 1910. This large area includes varying topographic and geological surface features. It occupies most of the central portion of the State east of the bluff formation bordering on the Delta counties and north of a line running approximately from Vicksburg to thirty-five miles south of Meridian. It includes a portion of the so-called "Black Prairie Belt," with a surface not only nearly level, but consisting of "open prairies almost devoid of tree growth. The soils are black calcareous clay loams, that do not, in the flatter areas, drain perfectly, but are very strong and productive. Throughout the region are areas of gentle elevation." The main portion of this area, however, is represented by the North Central Plateau, "which embraces all that portion of North Central Mississippi lying between the Flatwoods on the east and the bluffs overlooking the Delta on the west, and extending from the border of Tennessee south to a line drawn approximately from Canton to Meridian." The characteristic soil of this area "is a yellowish-brown loam containing a considerable proportion of silt and clay." Another but small area included is the so-called "Jackson Prairie Belt."†

Section IV.—Northeastern Hill Counties (fourteen), containing an approximate area of 6,869 square miles and a total population of 302,002 for the census year 1910. This area includes the so-called "Tennessee River Hills," which occupy the two extreme northeastern counties of the State and adjacent parts of those counties bordering them on the west and south, which "is a region of considerable elevation and rough topography." The soils of the hills are thin, red sandy and pebbly loams; those of the bottoms are rich black sandy loams. According to the official report of the Mississippi State Geological Survey, "the geological formations of this region are the indurated limestones, sandstones and chert beds of the Paleozoic Era, overlapping whose western and southern borders are the loose sands, clays and gravels of the Tuscaloosa and Eutaw of the Cretaceous." Included in this section is also a portion of the Pontotoc Ridge region, which, as its name indicates,

*Soil Survey of Adams County, Mississippi, by W. J. Geib, of the U. S. Department of Agriculture, and A. L. Goodman, of the Mississippi Geological Survey, Washington, 1911, Soil Survey of Wilkinson County, Mississippi, by W. E. Tharp, of the U. S. Department of Agriculture, and W. M. Spann, of the Mississippi Geological Survey, Washington, 1915.

†Soil surveys typical of this area are the one for Winston County, by Crabb and Hightower, published in the Report on Field Operations of the Bureau of Soils for 1912, and the one for Montgomery County, by Caine and Schroeder for 1906.

is "another region of high lands, bordering upon the west side of the northern half of the Black Prairies." The elevation of this region probably averages more than five hundred feet. The soil is, on the whole, a red sandy loam, derived from the weathering of the sands and marls of the Ripley formation.*

Section V.—Southern Long-Leaf-Pine Hill Counties (twenty-five), containing an approximate area of 14,513 square miles and a total population of 465,208 for the census year 1910. This region occupies practically the whole southern half of Mississippi south of Jackson and extends to the Gulf, representing practically a topographic unit, although subject to important variations in matters of minor physiographic detail. According to the Mississippi State Geological Survey, "It slopes gently from an altitude of more than four hundred feet at its northern border to sea-level at the Gulf." The soils are "red and yellow sandy loams, derived from the Pliocene, which is the prevailing surface formation east of the Pearl River. In the higher regions farther west the brown loam overlies the Pliocene to a great extent." The general surface of this region, "like that of its prototype farther north, is naturally dissected giving it an uneven topography, in which there are large areas of gently rolling or nearly level land." The chief feature of the whole region is the extensive forests of long-leaf pine, which originally covered its surface in one unbroken expanse.† It is of interest in this connection that it is in this section that the cantonment of Camp Shelby is located, in the vicinity of Hattiesburg County.‡

GEOGRAPHICAL DISTRIBUTION IN MISSISSIPPI

In the table following the malaria morbidity and mortality according to race has been correlated to the foregoing approximate physiographic divisions of the State of Mississippi. Since, unfortunately, the county boundary lines do not coincide with the more important topographic surface features, the correlation, of course, cannot possibly be made in precise conformity to the physiographic facts. The table, however, will serve the practical purpose of emphasizing, on the one hand, the

*A Report on the Soil Survey of Pontotoc County, by Bennett and Winston, was included in the Report of the Field Operations of the Bureau of Soils for 1906.

†The widely varying soil conditions of this extensive area are described in the Soil Survey of Wayne County, by Goodman and Jones, included in the Report of the Field Operations of the Bureau of Soils for 1911, the Soil Survey of the Scranton Area, by Lee, Allen and Winston, in the Report for 1909, the Soil Survey of the Forrest County Area, by Tharp and Spann, in the Report for 1911, and the Soil Survey of the McNeill Area, by Smith and Carter, in the Report for 1904.

‡According to the report of the Surgeon-General of the U. S. Public Health Service, the number of cases of malaria in the Hattiesburg district during the year 1916 was 2,049, which, on an estimated civil population of only 16,482, is equivalent to a malaria morbidity rate of 124.3 per 1,000.

far-reaching utility of intensive studies of malarial frequency with reference to surface features and, on the other, the approximate conclusiveness of the available data as an aid in the geographical study of the disease.*

MORBIDITY AND MORTALITY FROM MALARIA IN MISSISSIPPI, 1915-1916

County Group	Morbidity Rate per 1,000 Population		Mortality Rate per 100,000 Population	
	WHITE	COLORED	WHITE	COLORED
Delta Counties	247.7	135.0	170.8	141.4
Southern River Counties	118.0	69.7	76.9	110.9
Interior Plateau Counties	70.5	56.6	58.5	77.5
Northeastern Hill Counties	54.8	34.9	38.9	62.0
Southern Pine Counties	66.2	53.3	34.3	45.8

MALARIA IN THE YAZOO DELTA

The table reemphasizes the well-known fact that the Delta Counties are still an intensely malarial region, regardless of the commendable and considerable progress which has been made in the reduction of malaria frequency in this region during the last twenty years. The contrast between the malaria intensity in this section and that of the region described as the Northeastern Hill Counties is very marked. In course of time, when the statistics are available for a longer period of years, the conclusions regarding each and every county will, of course, be more trustworthy. It has therefore not seemed advisable to enlarge upon these aspects of the malaria question in Mississippi at the present time further than that in the table following the malaria morbidity and mortality rates by race for the two years 1915-1916 are separately given

*The Medico-Actuarial Investigation with reference to the relation of mortality to location has brought to light much interesting and important information. The facts, however, are rather too technical for an abbreviated discussion. The information on the mortality of the Southern States is contained in Volume V, issued in 1914. Among other interesting results it, for illustration, is shown that in the Delta counties only the ratio of actual to expected deaths was 160 per cent. among male applicants who had had an attack within two years of application and 159 per cent. among applicants who had had one attack more than two years prior to application or at an indefinite time in the past. In the other counties of the area under consideration the ratio of actual to expected deaths was 144 per cent. for applicants who had suffered one attack within two years of application and 115 per cent. for applicants who had suffered one attack between two and ten years prior to application. In general, the mortality in the Delta counties of Arkansas and Mississippi was about 30 per cent. greater than in the other counties. It is said further in the report that "The fourteen companies which contributed their Southern States' data experienced in the Delta Counties of Mississippi and Arkansas on all their business (including cases with a history of malaria) a mortality of 180 per cent., a higher mortality than among the cases with a history of malaria in the forty-three companies. In the counties of Mississippi and Arkansas other than Delta Counties, the mortality of the fourteen companies on all their business was 134 per cent. against 126 per cent. in the forty-three companies for the insured with a history of one attack of malarial fever."

for each of the twelve Delta Counties which constitute the so-called "Yazoo Delta" region.*

MALARIA IN THE DELTA COUNTIES OF MISSISSIPPI

1915-1916

County	Morbidity Rate per 1,000 Population		Mortality Rate per 100,000 Population	
	WHITE	COLORED	WHITE	COLORED
Bolivar.....	357.2	159.1	131.5	156.0
Coahoma.....	336.2	179.0	148.1	227.6
Holmes.....	236.7	145.0	95.8	116.4
Issaquena.....	248.2	53.8	61.0	178.1
Leflore.....	206.9	127.8	91.0	113.2
Quitman.....	178.2	76.0	262.1	132.1
Sharkey.....	198.6	66.1	216.3	45.0
Sunflower.....	445.6	218.1	446.4	153.8
Tallahatchie.....	99.6	89.9	208.3	134.1
Tunica.....	332.5	128.4	144.1	152.1
Washington.....	213.6	109.5	131.1	121.3
Yazoo.....	235.2	124.8	134.7	137.8

ERADICATION MEASURES IN BOLIVAR COUNTY MISSISSIPPI

This table is of special importance in view of the rather promising malaria eradication work carried on by the International Health Board in Bolivar County, which may be considered typical of the Yazoo Delta region. Unfortunately, no soil survey has as yet been published for this county, but one is available for the adjoining county of Coahoma, which represents approximately similar physiographic, geological and soil conditions.† The work of the International Health Board is limited to the eastern half of Bolivar County, containing an approximate area of 225 square miles and an estimated population of 1,924 white and 12,325 colored. It requires to be said in this connection that the International Health Board of the Rockefeller Foundation carried on four experiments in malaria control during 1916 at different points in the lower Mississippi Valley. According to the annual report of the Foundation for 1916,

*It is most regrettable that the boundary lines of the Delta Counties should not be more in conformity to the peculiar topography. Of a number of the counties only a relatively small portion of the area is strictly within the Delta, making an exact definition of the Delta area, as a whole, in accordance with county boundary lines impossible. In some descriptive definitions certain counties are included which are excluded in others.

†Soil Survey of Coahoma County, Mississippi, by F. Z. Hutton, in charge, W. E. Tharp, N. M. Kirk and H. W. Hawker, of the U. S. Department of Agriculture, and E. M. Jones, of the Mississippi Geological Survey, Washington, 1916.

"In each a different line of investigation was pursued, the object being to discover a practical method of control which the average rural community could afford." The experiment in Bolivar County is briefly described as follows:

An experiment was conducted under the administration of the Mississippi Department of Health, with Dr. W. S. Leathers as Administrative Director and Dr. C. C. Bass, of Tulane University, as Scientific Director. The practicality of control through detecting the carriers and freeing them of the malaria parasites, was tested. The experiment covered two hundred twenty-five square miles of territory, the size of the communities varying from nine to sixteen square miles, with an average population of one thousand. Adjoining communities were taken up one after another as facilities permitted, the work in each lasting about four weeks, with subsequent visits to insure thoroughness. Blood tests were taken. Quinine treatment was given to those found infected.

The experiment was continued during 1917 and will probably be carried forward for several years to come. The area of operations will, if possible, be extended to two or three adjoining counties which have given official assurances of financial cooperation.

QUININE PROPHYLAXIS

A full account has not as yet been made public by the International Health Board regarding the precise methods and attained results of this exceptionally interesting experiment in malaria control. The evidence of such control must naturally be more or less of a statistical nature. According to a statement furnished by the Board there has been a very marked reduction in the percentage of positive findings in the blood specimens examined during the year 1917 compared, weekly, with the corresponding results for the previous year. Thus, for illustration, during the week ending September 16, 749 blood specimens were examined in Bolivar County, of which 535 were positive, or 71.4 per cent. During the corresponding week of 1917 the number of specimens examined was 950, of which only 152 were positive, or 16 per cent. It, however, is not at all certain whether identical persons were examined; in fact, it is safe to assume that this was not the case. Nor is it certain whether identical areas were considered, but, quite to the contrary, the comparison is merely for blood counts at random, and the results are not, therefore, strictly comparable, though in a general way they, no doubt, justify the conclusion of a marked reduction in the prevailing degree of malarial infection as ascertainable by the microscopical examination of the blood. To be strictly comparable, the results should be for identical persons and identical areas, since the investigations

thus far made indicate a surprising degree of variation in the intensity of infection in the more than thirty different communities or units into which the field of operations has been divided.

MALARIA MORBIDITY OF BOLIVAR COUNTY

At the outset of the investigation a blood index was secured for the entire population under control.* There has, however, not been a corresponding complete reexamination. Considering the fact that most of the population is colored and that many have moved away, while others have come into the area, the task of precise comparison of results is possibly a hopeless one. The same conclusion may ultimately apply to the broader question of individual control, both as regards proper quinine treatment and the reexamination of the blood. It would therefore be premature to express an opinion upon this interesting experiment until an official report is forthcoming, which, it is to be hoped, will include a complete analysis of all the data secured during the period from the commencement of the experiment to the present time. One interesting statistical statement, however, may here be introduced, which being derived from other sources has a direct bearing upon the question under consideration. The following table shows the comparative frequency of malaria in Bolivar County during the first ten months of 1916 and of 1917:

COMPARATIVE FREQUENCY OF MALARIA IN BOLIVAR COUNTY, MISS.

(First ten months of 1916 and of 1917)

	White	Colored	Total
1916.....	2,335	7,361	9,696
1917.....	2,593	7,215	9,808
Increase.....	258	....	112
Decrease.....	....	146	....

MALARIA MORBIDITY OF WASHINGTON COUNTY

According to this table there was an actual *increase* in the number of reported cases of malaria in Bolivar County among the white population of 258, whereas there was a decrease of 146 cases among the colored.

*The word "control" is used in a very general sense. Actually, of course, the control exercised over the population is very limited. About the best and the most that can be done is to persuade employers of labor to give preference to those who habitually take quinine as a precaution against economic loss. The scarcity of the labor supply, however, precludes a far-reaching effect of such cooperation on the part of the employers. The difficulty with the negro is that he cannot be relied upon to keep his promises and that his statements with reference to the actual taking of quinine require to be accepted with reserve.

Relatively speaking, the malaria frequency in the county as a whole remained practically unchanged, regardless of the eradication efforts by quinine immunization alone. The fact, of course, must not be overlooked that the work heretofore has been limited to only one-half of the county, and that there is a possibility that cases of malaria were better reported during 1917 than during 1916, but the conclusion remains unchanged that in so far as the official returns can be relied upon there were 9,808 cases of malaria in Bolivar County during the first ten months of 1917, although the experimental work or efforts at control by means of immunization by doses of quinine* had been applied in the case of nearly half of the population for nearly three years. If these statistics are untrustworthy, they should be subjected to a critical examination by those directly concerned with the public viewpoint of the experiment or administration work in Bolivar County. They are the official data of the State Board of Health, the director of which is also the State Director of the malaria eradication measures of the International Health Board in Bolivar County. For purposes of comparison a table is here included for the adjoining county of Washington, in which no such eradication efforts have been carried on, but in which, nevertheless, there was an actual *decrease* in malaria frequency among both elements of the population of 1,205 cases, or a reduction from 5,273 cases during the first ten months of 1916 to 4,068 during the same period of 1917.

COMPARATIVE FREQUENCY OF MALARIA IN WASHINGTON COUNTY, MISSISSIPPI

(First Ten Months of 1916 and of 1917)

	White	Colored	Total
1916.....	1,354	3,910	5,273
1917.....	1,152	2,916	4,068
Increase.....	....	....	....
Decrease.....	202	1,003	1,205

ERADICATION MEASURES IN ASHLEY COUNTY, ARKANSAS

Aside from the experiment or demonstration in Bolivar County, the International Health Board has also carried on some very interesting work at Lake Village and Crossett, in the adjoining State of Arkansas, in cooperation with the United States Public Health Service, originally

*The dose required is ten grains a day for eight weeks in the case of adults, but half a grain for every year of life under twenty. Originally the dose recommended was required to be taken for four weeks only, but this period was found to be too short.

under the general supervision of the late Dr. R. H. von Ezdorf. This work was subsequently transferred to Dr. H. A. Taylor, of the International Health Board, and Assistant Surgeon R. C. Derivaux, of the United States Public Health Service. The work at Crossett, which is of the first importance, is briefly described in the annual report of the Rockefeller Foundation for 1916, in part, as follows:

The experiment at Crossett was based on mosquito control without major drainage operations. The work consisted of the draining and regrading of natural streams so as to secure rapid off-flow, the filling of bottoms, the digging of ditches, the removal of accumulated vegetation, and the systematic use of oil and other larvacidal substances by sprays and automatic drips. A remarkable decrease in the number of malaria calls resulted. During the last six months of 1915 there were 2,100 malaria calls in Crossett; during the last six months of 1916, 510 calls. In October, 1915, there were 600 calls; in October, 1916, 46 calls. In December, 1915, there were 100 calls; in December, 1916, the malaria index had been brought far below the normal winter level and was approaching the zero point. As a result of the steady decrease in malaria cases, community interest in Crossett was aroused to take over the work for 1917, with a view to making it permanent. A similar experiment was also undertaken and is now in progress at Hamburg, Arkansas.

This work has since been reported upon in considerable detail by the Public Health Service in a Bulletin on "Malaria Control: A Report of Demonstration Studies Conducted in Urban and Rural Sections."* It may be questioned whether a more important contribution to the practical question of malaria control in the Southern States has ever been made, or is likely to be made in the near future. The results are such as to justify the conclusion that the procedure adopted was in conformity to the most practical and permanently successful methods of eradication and control, with a due regard, of course, to local conditions, of which it may be said that in the main they were free from serious engineering or other difficulties. The town of Crossett is a model community owned entirely by a lumber company,† accurately laid out and occupying an area measuring about one-half by one mile. Eradication efforts are invariably more successful where the area under

*For a brief descriptive account of the activities of the U. S. Public Health Service in connection with Malaria Administration and Control Work, see the annual report of Surgeon-General Rupert Blue for the fiscal year 1917, p. 18, *et seq.* Of special interest is a statement of malaria index determination since July, 1916, according to which out of 4,116 persons examined, 254, or 6.19 per cent., were positive as to the presence of the malarial parasite in the blood. The proportion was highest for Greenville, Miss., or 21.65, and next highest for Franklin, Va., or 11.76 per cent. Reports of cases of hemoglobinuric fevers were received from physicians in Alabama, Arkansas, Florida, Louisiana, North Carolina, South Carolina, Tennessee and Texas. See, also, Reprint No. 443, "Extra-Cantonment Zone Sanitation," Washington, 1918.

†Public Health Bulletin No. 88, September, 1917, "Malaria Control: A Report of Demonstration Studies Conducted in Urban and Rural Sections," by R. C. Derivaux, Assistant Surgeon, U. S. Public Health Service, and H. A. Taylor and T. D. Haas, Field Directors, Washington, 1917.

control is relatively limited in extent.* The population of Crossett was 2,029, and the measures, directed chiefly against mosquito production, consisted of clearing, draining, filling and the use of oil and larvacides. According to the report made jointly by Drs. Derivaux, Taylor and Haas, "As ascertained by repeated parasite indices, a reduction of 77.33 per cent. was obtained, and a reduction of the total visits for malaria, as compared with records of the previous year, of 70.39 per cent. For the 'active' season, comprising the months from and including June to December, a reduction of visits of 82.07 per cent. was obtained from the number made in the same period of the year before. The total costs of the control operations aggregate \$2,506.40, a per-capita cost of \$1.23; control work is to be continued, and, much of the first work being of a permanent character, should cost substantially less."

ERADICATION MEASURES IN CHICOT COUNTY, ARKANSAS

In the nearby rural community of Lake Village, Chicot County, the same well-considered method of eradication was pursued, and studies of the efficacy of house-screening and of quinine-immunizing and sterilizing doses were conducted. It is said in the report that "A group of thirty-three houses was carefully screened at an average cost of \$14.77, and their occupants carefully observed, all known carriers being given quinine for sterilization. As shown by repeated parasite indexes, a reduction of 70.6 was obtained among 142 occupants; as the life of the screening installed should, with ordinary care, be at least two years, the per-family cost of screening is estimated at \$7.38 per family, or \$1.75 per capita."

In further explanation of the experiment in Chicot County, it is stated that "In a second series, quinine was given to 237 persons for immunization, and a reduction in malaria of 64.45 per cent. was obtained as ascertained by repeated parasite index examination; the per-capita cost for quinine issued was \$0.57. Of the sixty-nine carriers to whom quinine was given for sterilization, sixty-two remained under observation and were available for reexamination; of this latter number, three were found to have remained infected, a reduction or 'sterilization' rate of 95.17 per cent. The economic losses suffered by a negative group of 120 persons averaged \$11.21 per family, or \$2.52 per capita, whereas among the members of the groups under control the family loss averaged \$0.23, and that per capita \$0.06." These control experiments, as will

*The measures employed at Crossett for the control of malaria, according to Bulletin No. 88, "consisted exclusively of procedures directed against mosquito propagation, and have included drainage, clearing and training of streams, and control of artificial containers, etc., over an area about one half-mile square."

be noted, relate to only a relatively small population. In the Bolivar County experiments, it may be said, in this connection, the population under control, or attempted control, numbered 4,734 white and 20,303 colored.*

ENTOMOLOGICAL INVESTIGATIONS IN LOUISIANA

The experiments referred to are among the most encouraging present-day efforts in this country to establish community measures of control with a due regard to social and economic considerations. Possibly of even greater scientific interest, however, in the broader sense, is the remarkable work of the United States Bureau of Entomology at Mound, La., under the direction of Mr. (now Lieutenant) D. L. VanDine. This experiment has been described with reasonable thoroughness in an article in the *Scientific Monthly* of November, 1916.† The fundamental object which underlies the investigation is to secure definite data on the manner in which malaria affects agriculture, or, in other words, the underlying considerations are economic rather than medical or remedial. The experiment includes an entire plantation, admirably situated for such a purpose, on the west side of the Mississippi River, almost opposite the city of Vicksburg.‡ Perfect cooperation has been secured between the principal owner of the plantation, Mr. George S. Yerger, the physician in charge, Dr. Wm. P. Yerger, and the microscopical and entomological control through Messrs. W. V. King and J. K. Thibault, Jr. During the season of 1914 the survey work included a detailed study of 74 tenant families, who cultivated 1,800 acres of land, of which 1,191 acres were under a tenant system and 609 acres under the direct supervision of the plantation management by labor drawn from the tenant families on a day-wage basis. "The tenants averaged 16 acres per family, and the 74 families included a total of 299 individuals. The crops grown consisted of 743 acres of cotton and 448 acres of corn under the tenant system and 80 acres of cotton and 209 acres of corn, 200 acres of oats, 70 acres of cow-peas and 50 acres of lespedeza hay under the day-wage system. All time was reduced to adult time, or man days of labor. The time of a male over eighteen years of age was figured as full time, a male from twelve to eighteen years as one-half adult time, and from eight to twelve years as one-fourth. The time of a female was figured as one-half the time of a male. Reducing

*U. S. Public Health Bulletin No. 88 on Malaria Control, p. 55.

†Another discussion on the losses to rural industries through mosquitoes that convey malaria, by Mr. D. L. VanDine, occurs in *The Southern Medical Journal*, for March, 1915.

‡The topography of this locality is precisely shown on the topographic atlas sheet of Louisiana (Madison Parish), Mound Quadrangle, issued by the U. S. Geological Survey in 1910.

all the available labor on the plantation to adult time, the resulting equivalent labor was two adults to each of the seventy-four tenant families. The actual time lost through malaria consisted of 970 days for those treated by the plantation physician, 487 days representing cases not reported to the physician and 385 days lost by non-malarial members of the families in attending those who had the disease. There was a total loss of 1,842 days, which, reduced to adult time, and not taking account of illness in members of the families under eight years of age, amounted to 1,066 days of adult time, from May to October, inclusive. The time lost averaged 14.4 adult days for each family. There were 166 cases of malaria in 138 persons out of a total of 299 members of the tenant families. There was a loss of time equivalent to 6.42 adult days for each case of malaria."

RELATION TO CROP-PRODUCTION

In further explanation, it is said in the article referred to that "The effect of loss of time upon the crops can be measured by the ratio of the time lost through malaria to the difference between the available labor and labor requirements of the crops. It must be conceded that any loss of labor from any cause in the face of any surplus labor that exceeds the time lost cannot be considered as operating against the crops. In the case of no surplus labor or an actual deficiency, any time lost through malaria reacts at once upon the crops, the seriousness of the neglect to the crops depending upon the period in the planting, cultivating or harvesting the crops that the lost time occurs. *It will be shown that time lost through malaria during at least four months of the year falls at a period when there is a deficiency of labor and when the demands of the crops for labor are greatest.* For cotton, the principal crop, these periods are chopping, and hoeing, boll-weevil control and picking. Any neglect at these periods is a very serious matter and might mean total failure of a crop." Without enlarging upon the evidence subsequently presented by Mr. VanDine in considerable detail, it is sufficient for the present purpose to merely give the general conclusion: "Each family cultivated an average of 16 acres. The plantation depended upon the tenants for labor to cultivate an average of 8.23 acres each on the day-wage basis. This amounted to a total of 24.23 acres to be cultivated by the labor represented in each tenant family, and equivalent to 13.51 acres of cotton. The total loss of time of 13.79 families is equivalent to that of the total crop on 186.3 acres of cotton. With an average yield of one-half of a bale of cotton per acre, this would equal a total

loss of 93.15 bales of cotton. Allowing \$70 a bale for the lint and seed, this would amount to \$6,520.50."

RELATION OF CLIMATE TO INSECT LIFE

This most interesting and promising experiment is still in progress. An admirable set of records is kept, which in course of time will make an extraordinary amount of useful and conclusive information available. The blood-examination record, in part, includes such additional data as the recent malaria history, the recent ingestion of quinine, the use of chill tonics, the question of medical consultation, the final diagnosis and the ultimate termination of the disease, whether recovery or death. Blood smears are first identified and then referred to the consulting expert for confirmation. The character of the infection is noted; also the condition of the blood, and a reference is made to a previous infection. In addition thereto, an exceptionally complete collection has been made of all the important data relating to mosquito frequency, including density, direction of flight, etc. This information is being correlated to an admirable set of climatological observations. The only important factor omitted is the wind force, which must be considered unfortunate. Careful studies have been made of the labor requirements of cotton-production, as to both periods of activity and quantity in correlation to seasons of the year. Similar studies have been made of the essential agricultural requirements in the production of corn and oats. A complete survey is made of every house and family, with due regard to environmental conditions and their relation to mosquito prevalence and malaria. Prophylactic methods in force are taken note of, and a descriptive account is kept of every member of the family with a history of malaria, as to the form of fever, method of diagnosis, duration, treatment and general health. A history chart is also kept of other diseases treated by the physician, as a matter of collateral information. Aside therefrom is a statement from the plantation manager, Mr. Alexander Clark, as to the essential economic factors, such as the relation of the family to the plantation, the length of residence, the value of the land, the normal return per acre, the present return, and, finally, the estimated losses due to various causes. A record is kept of mosquito collections, of blood specimens, of predacious aquatic insects, of fish, of water-plants, also samples of soil, etc., and, finally, a summary of the anopheles collections, according to their precise determination and place of collection. There is also kept a summary of economic losses (differentiating the loss to the plantation and the loss to the family), loss in time, labor-shortage,

land lying idle, crop-shortage and decreased efficiency, the loss to the family (differentiating loss of time through malaria, through attendance on patients, through crop-shortage, through medical expenses and nursing, general ill health and death). The meteorological record is limited to minimum temperature, humidity, rainfall, sunshine or cloudiness and wind direction. The information accumulated under this experiment constitutes, as far as known, the most complete collection of data on malaria in its social and economic relations extant. If carried forward during a period of years, the data should prove invaluable in connection with every future study of the disease. There is the additional and considerable advantage of complete supervision and control through a small group of men thoroughly interested in the methods of the investigation, but free from any bias whatever as to the results. It is an investigation pure and simple, and not an attempt to prove the efficacy of one method of control or another. It admirably reflects the far-sighted policy of an important government department deserving of wide public appreciation.*

LAND RECLAMATION AND DRAINAGE

The economic aspects of malaria are, fortunately, much better understood at the present time than in the past. As evidence of progress in this direction, mention may be made of a special bulletin issued by the United States Chamber of Commerce, under date of October 27, 1916, on the "Reclamation of Swamp Lands and the Conquest of the Malaria-Bearing Mosquito." As observed in this bulletin,

The work of reclamation of any moment is an enterprise of comparatively recent times, but grows in volume and importance each year. It is practically all done by private enterprise, sometimes by individuals, sometimes by chartered companies, but more often by cooperative organizations having a legal status in the form of what are known as drainage districts. The districts are formed usually by the majority, sometimes two-thirds, of the persons who own the lands to be drained and who signify their desire, according to certain legal matters, that such lands be drained. If a petition be approved, then all action from that time is according to certain definite and carefully prescribed legal procedure and under the care and supervision of local or County and State authorities. Every possible precaution is exercised to make it a strictly business proposition, free from speculation and from exploitation for personal gain. Taxes are levied upon the land to pay the initial expenses, and after that drainage bonds, as they are called, are issued, for the continuing costs and for the completion of the work. Taxes are levied annually to pay the interest and principal on the bonds, which are a first lien on the land, the same as any State taxes. The

*It is hoped that in the near future the Bureau of Entomology will publish a reasonably complete account of this experiment, which would seem readily feasible of imitation in other and even more important localities of the South where rural economic progress is hindered by the prevalence of malarial disease.

bonds bear from five to six per cent. interest, and run from twenty to forty years, being generally on the amortization plan. They are usually regarded as sound securities and safe investments. Both laws and methods of procedure differ somewhat in details in the various States, but are essentially the same in the principles involved and the results attained.

Among the more conspicuous illustrations of successful drainage efforts in this country attention is directed to the Little River Drainage District of southeast Missouri and certain drainage districts of southern Louisiana. The magnitude of the drainage operations in southeastern Missouri is emphasized in the statement that the Little River drainage project alone embraces 560,000 acres of swamplands, equivalent to an area of 1,136 square miles, being about ninety miles long and from four to thirty miles in width. The cost of construction will amount to about \$5,000,000, and the work is now nearing completion. It is explained that the cost of drainage in Missouri has varied from about \$3 to \$7 per acre, but that to this must be added the cost of clearing the land when timbered, which varies from \$12 to \$50 per acre. Cleared land, it is said, ranges in price from \$50 an acre upwards. The soil is generally of unusual fertility, "since most of the land is alluvial deposit from some neighboring river. The soil is usually very rich in humus, because of centuries of decaying vegetable matter. As there is naturally an abundance of moisture, it possesses all the requisites of abounding yields."*

In the same bulletin is a brief statement regarding the remaining swamplands of the United States, the area of which is estimated as 79,000,000 acres, of which 52,665,000 acres represent permanent swamps, 6,826,000 acres wet grazing land, 14,757,800 acres periodically overflowed land, and 4,766,000 acres periodically swampy land. These 79,000,000 acres of swamplands, it is explained, are equal to seventy-five per cent. of the entire corn acreage, and their area is seventy-five per cent. greater than the acreage of both winter wheat and spring wheat combined. Aside, however, from the foregoing, it is estimated "that there are 150,000,000 acres of what is known and occupied as farm land, which is too wet for the most profitable cultivation, and whose production would be increased twenty per cent. by proper drainage.†

*Important descriptive accounts of this section are the following: "Missouri's Swamp and Overflowed Lands and Their Reclamation," by John H. Nolen, made to the Forty-seventh Missouri General Assembly, January, 1913, Jefferson City, Mo., also "The Little River Drainage District of Missouri," a review of its Securities, General Information, Engineer's Report and Attorneys' Opinion, Cape Girardeau, Mo., 1913.

†A useful contribution to this aspect of the malaria problem is Bulletin No. 32, on Agricultural Drainage in Georgia, published by the Geological Survey of Georgia, Atlanta, 1917, including important statistical data as regards the periodically overflowed and permanent swamplands and a full account of the drainage characteristics of Georgia and typical drainage projects in the Coastal Plain. Of value also is Farmers' Bulletin No. 815 of the U. S. Department of Agriculture, on Organization, Financing, and Administration of Drainage Districts, by H. S. Yohe, Expert on Drainage Organization, Washington, June, 1917.

MOSQUITO EXTERMINATION IN NEW JERSEY

Foremost among the States in which the most encouraging progress has been made in mosquito eradication and control is New Jersey. The efforts in the main have been directed towards the eradication of the mosquito as a nuisance and a discomfort, rather than as a menace to health, but there can be no question of doubt but that the results have also had a measurable effect upon malaria. The disease has not for many years been of serious frequency in the State of New Jersey, but in a mild form and as a complicating factor it has probably been more common than is generally assumed. The work in New Jersey rests primarily upon the initiative of the late Dr. John B. Smith, State Entomologist, and the indefatigable efforts of his successor, Dr. Thomas J. Headlee. The work that is being done is concisely set forth in the annual reports of the New Jersey Mosquito Extermination Association, according to which the average cost of mosquito freedom is less than fifteen cents per capita, which, in the words of the president of the Association, Dr. William Edgar Darnall, of Atlantic City, "is not much to pay for the health and wealth, the comfort and prosperity, that will follow its accomplishment." Dr. Darnall, quoting from the report of Dr. Headlee, points out in this connection that

Approximately 95,000 acres of the salt marsh have been rendered reasonably free from mosquito breeding. This has involved the cutting of 11,500,000 feet of ditches ten inches wide and thirty inches deep, or their equivalent, the building of 17.2 miles of dike, the installation of seventy-six sluice and tide-gates (representing 842 square feet of cross-section outlet opening), the installation of one four and one twelve-inch centrifugal pump and the connection of 100 acres of marsh with a large sewage-pumping plant. Approximately fifty per cent. of the reasonably permanent fresh-water mosquito-breeding pools, scattered over 315,000 acres of upland, has been permanently eliminated.

Facts of this character constitute the most encouraging evidence of a clear realization of the social and economic importance of mosquito eradication.* What holds true for New Jersey in a general way holds equally true for more southern communities in which the problem of mosquito eradication involves the larger question of malaria control. In New Jersey the anopheles mosquito is relatively rare, but sufficiently common to constitute a menace to the health of a large number of important communities in the event of the reintroduction of malarial disease through returning soldiers and others from infected communities, camps, cantonments, etc., in the South. What has been done is

*Of value in the consideration of local eradication efforts in this country is the North Shore Improvement Association: Report on Plans for the Extermination of Mosquitoes of the North Shore of Long Island, 1902.

best illustrated by a statement made by the president of the New Jersey Mosquito Extermination Association, reading that: "One and three-quarter millions of people of New Jersey have been given a very considerable measure of protection against the mosquito and at a cost of only \$210,000 (per annum), or a per-capita cost of about twelve cents."

MOSQUITO EXTERMINATION IN ESSEX COUNTY

Of especial importance is the work which has been done in Essex County, including the city of Newark. The law creating a County Mosquito Extermination Commission became operative in 1912. The extermination ratables on the Newark meadows, comprising land improvement and personal property, amounted to \$1,428,000. The values have increased every year, reaching \$3,750,000 by 1916. The tax income from these ratables increased from \$19,656 in 1912 to \$64,155 in 1916. The number of persons employed in the industries, etc., located in the meadow area* in 1912 was only 286, earning \$152,000 per annum; in 1916 the number employed was 6,341, with a yearly pay-roll of \$2,863,000. As observed by Dr. Frederick W. Becker, member of the Essex County Mosquito Extermination Commission, "Without mosquito extermination this wonderful industrial development would have been impossible, and it demonstrates clearly that *mosquito elimination is a paying proposition.*" In addition to this, attention may be directed to the fact that the new Port of Newark, including perhaps the largest ship-building plant in the country, and essential military establishments connected therewith, is located in this area, than which there is perhaps at the present time not a much more important one in its relation to the winning of the war, to the extent that the health of the army of men ultimately to be employed there is conserved, and that their comfort while at work is increased by the extermination or considerable reduction of the mosquito nuisance. The results secured will be out of all proportion to the expense incurred.

The practical value of mosquito extermination in New Jersey as an aid in malaria eradication is further emphasized by the statement that, against an average mortality from malaria of 27.3 per 100,000 during 1880-1884 and a rate as high as 3.7 per 100,000 during 1900-1904, the rate has been reduced to 1.7 during 1905-1909, to 0.8 during 1910-1914,

*A comprehensive report on the Drainage of the Hackensack and Newark Tide Marshes, by C. C. Vermeule, was included, as Part VI, in the Annual Report of the State Geologist of New Jersey for the year 1896. This was followed by an additional report published as Part V of the Annual Report for 1897. Much useful information, including maps in considerable detail, is contained in the annual report of the New Jersey Harbor Commission, Mr. J. Spencer Smith, President, for 1915.

to 0.5 during 1915 and, finally, to 0.3 during 1916. With the single exception of the year 1914, when the rate was the same, *the rate for 1916 was the lowest on record since 1880!* By contrast, in the State of Connecticut, where mosquito-eradication efforts have been less effective, the death rate during 1915 was 1.4 per 100,000, against 0.5 for New Jersey.

For Essex County the expenditures on account of mosquito extermination amounted to \$53,608.78 during the fiscal year 1916-1917. During 1915 the Essex County Mosquito Extermination Commission employed seventeen inspectors, thirty-five assistant inspectors and thirty-nine laborers, who ascertained 69,010 mosquito-breeding places, 115,956 places liable to become such, aside from making over 600,000 yard inspections. The report of the Commission for that year includes a chart showing the daily rainfall, the temperature and the wind movement. A map is also included showing the direction of flight and the sources of salt marsh mosquitoes and the comparative density of adult mosquitoes of all species. Supplementary data of the Commission show the correlation of rainfall and temperature to the number of adult mosquitoes caught per station throughout Essex County between June 6, 1917, and September 17, 1917. The several species are properly differentiated, and in amplification of the general chart there are curves showing the percentage composition of adult mosquitoes in collections from June 1, 1917, to September 12, 1917, and of the larvae collections during the period from July 25, 1917, to September 12, 1917. In final form, a chart exhibits the concentration of *C. Pipiens* in the four topographic divisions of Essex County during the period June 11 to September 19, 1917, to indicate the flight of the various broods by weeks throughout the period of record.

REVIEW OF THE WORK OF MOSQUITO EXTERMINATION COMMISSIONS

The literature of mosquito extermination efforts in New Jersey is of exceptional interest and practical importance. The first four annual proceedings of the New Jersey Mosquito Extermination Association constitute a most valuable source of practical information. Included in the proceedings of the First Annual Meeting is an account of the Anti-Mosquito Work in New York State, by Joseph J. O'Connell, M. D., Health Officer of the Port of New York, who properly points out that the work of mosquito eradication was initiated by his predecessor, Dr. Alvah H. Doty, who was one of the first to recognize the far-reaching

importance of Reed's discovery of the agency of the mosquito in the dissemination of yellow fever. At the Second Annual Meeting, following an address by the President of the Association, Dr. Ralph H. Hunt, on the "Anti-Mosquito Movement," a symposium of papers was presented on "Important Mosquito Control Problems That Have Been Met and Their Solution," followed by an address on "Mosquitoes and Their Relation to Man," by Dr. W. C. Gorgas, Surgeon-General of the United States Army, and one on the "Economic Value of Mosquito Work," by Dr. Jacob G. Lipman, Director of the New Jersey Agricultural Experiment Stations. These papers were followed by a discussion of the "Anti-Mosquito Work of the United States Department of Agriculture," by Dr. Leland O. Howard, Chief Bureau of Entomology, and one of the "Cost of Anti-Mosquito Work," by Dr. Thomas J. Headlee, Entomologist of the New Jersey Experiment Station, and executive officer in charge of the station's antimosquito work, and others. At the Third Annual Meeting attention was concentrated upon engineering questions, such as the "Place of Dikes, Sluices and Tide-Gates in Mosquito Extermination," "The Cost of Salt-marsh Drainage for Mosquito Control," "The Value of Experimental Study to the Practical Work of Mosquito Control" and a symposium on "The Taxpayers' View of Mosquito Control Work." At the Fourth Annual Meeting the proceedings were commenced with an address on "The Present Status of Mosquito Control in New Jersey," by Wm. Edgar Darnall, M. D., of Atlantic City, illustrated by maps and statistical tables, followed by a very practical address on the "Circulation of Water on the Drained Salt Marshes," by James E. Brooks, M. E., of Glen Ridge, N. J., and many others. A most important feature of these annual meetings is the concise presentation of the actual work which is being done in the several counties of the State and the cost and economic results which are being achieved. Among the additional papers read at the Fourth Annual Meeting, special reference requires to be made to an address on "The Malaria Problem of the South," by H. R. Carter, M. D., and another on "The Agricultural Utilization of the Salt Marsh," by Jacob G. Lipman, Ph. D. Aside from these annual reports of the New Jersey Mosquito Extermination Association, the Union County Extermination Commission has published six annual reports, and five similar reports have been published by the Atlantic County Mosquito Extermination Commission. At least one report has been issued by the Essex County Commission, and a most interesting educational folder

on the mosquito has been published by the State Department of Conservation and Development. A somewhat similar bulletin has been made available for educational purposes by the Nassau County Mosquito Extermination Commission, Freeport, New York. This organization is making a determined effort to secure weekly reports on malaria from all the physicians in Nassau County.*

MALARIA ERADICATION IN NEW YORK CITY

In New York City malaria eradication and mosquito extermination problems have continued to receive qualified consideration under the direction of Dr. Haven Emerson, the Health Officer of Greater New York. In a report of the Health Department for 1913, as an indication of the earlier recognition of the importance of active malaria-control measures, it is stated that

There were thirteen deaths from malaria during 1913 as compared with ninety in 1903. Deaths from this cause have steadily declined, and this diminution has been both real and apparent; real as a result of the anti-mosquito work, and apparent because of the laboratory facilities for accurate diagnosis offered the medical profession by the Department of Health, which eliminated other fevers that heretofore had been classified as malarial.

During the fifteen years 1902-1916, the number of deaths from malaria officially recorded in the City of New York was 705. The practical results of eradication measures are best indicated by the statement that during the year 1902 there were 125 recorded deaths from malaria, against only 10 deaths from this disease during 1916. Considered by quinquennial periods there were 423 deaths from malaria during the first five years, 208 during the second and only 74 during the third.

What has been done by the Health Department of New York City since 1913 is illustrated by a series of diagrams in a report on "Service Cost and Results of the Work of the Department of Health," made to ex-Mayor John P. Mitchell under date of December 31, 1917, in which it is said that in completing the constructive engineering program for the

*A thoroughly practical discussion of the mosquito question with reference to Migration as a Factor in Control, by Thomas J. Headlee, Ph. D., Entomologist of the New Jersey Agricultural Experiment Stations and State Entomologist, read before the American Association of Economic Entomologists, has been reprinted in the *Scientific American Supplement*, No. 2205, under date of April 6, 1918.

Some exceedingly interesting work in connection with mosquito eradication by means of salt-marsh drainage has been done in Nassau County. An exceptionally valuable report regarding local operations was issued by the Rockaway Peninsula Mosquito Extermination Association, under date of April 1, 1918. The work of this association, as far as known, is the largest exclusively private mosquito drainage project undertaken in this country. The area covered is given as 2,965 acres and the number of feet ditched as 1,292,267, averaging 435 feet per acre, at a cost of \$7.61 per acre.

elimination of the mosquito, all the large areas of salt and fresh water marsh in the city limits have either been drained or filled, or the work is contracted for and being rapidly brought to completion. The new acreage of marsh (fresh or salt) drained to prevent mosquito breeding, under contract and by the Department of Health force, was 30,764 acres during the five-year period 1913-1917; the linear feet of new drainage ditches dug to prevent mosquito breeding during the same period amounted to 9,952,514 feet, a maximum of 4,309,994 feet having been reached in 1916. Malaria prevails in Greater New York with a widely varying degree of intensity in the different boroughs. During the five-year period ending with 1916 the highest rate of prevalence as measured by the mortality returns occurred in the Borough of Richmond, or 6.3 per 1,000,000 of population, followed by the Boroughs of Brooklyn and Queens, with rates of 4.0 each, the Borough of Manhattan, with a rate of 1.9, and the Borough of Bronx, with a rate of 1.1. For Greater New York as a whole the average malaria-mortality rate for the period under review was 2.7 per 1,000,000 of population. The actual number of deaths from malaria during this period was seventy-four, of which three occurred in the Borough of Bronx, three in the Borough of Richmond, seven in the Borough of Queens, twenty-four in the Borough of Manhattan and thirty-seven in the Borough of Brooklyn.*

Of especial historical interest in this connection is a summary account of the work of the Department of Health of the City of New York, as carried on jointly by the Sanitary Bureau and the Bureau of Preventable Diseases, dated August, 1915. The report states, in part, that

"The successful anti-mosquito work of the Department of Health in certain parts of the city clearly indicates that the mosquito may be practically exterminated throughout Greater New York within the next five years, provided the work now being carried on be continued." Attention is drawn to Section 272 of the Sanitary Code, which makes it "the duty of those owning or having the management or control of any marsh land or other places where mosquitoes are bred and developed, to fill in or drain the same, or employ such other methods as will at all times prevent the breeding of mosquitoes in such places." This section, it is said, is reinforced by a provision of the Charter (Section 1197), which gives the Department of Health the right to do the necessary work and place a lien upon the property. Under Section 272 of the Sanitary Code, a

*Malaria is unfortunately not a reportable disease in Greater New York. It cannot be questioned that if the disease were made reportable much useful information would be secured of value to the health authorities in the furtherance of local control measures and general eradication efforts. Malaria was made a reportable disease in Massachusetts in September, 1914. During 1915 the number of cases was 112, with 6 deaths, or a fatality rate of 5.4 per cent. During 1916 only 97 cases were reported, with 4 deaths, or a fatality rate of 4.1 per cent. Since the fatality rate for Mississippi is less than one per cent. (see page 18), it is a fair assumption that there were probably ten times as many cases in Massachusetts as were officially reported.

considerable amount of draining, oiling, and pumping of ponds and marsh lands has been done, at the owners' expense, even singly or in groups, "in those sections where the value of the property justifies the procedure." This plan or method has been fully sustained or supported by the courts. It is pointed out that, "In this way, all the marsh lands at Bayside, Douglaston, and Little Neck have been drained on order of the Department of Health. In Flushing practically all the marsh land from Jackson Avenue to the head of the Vlegh has been drained. In the Bronx, all the marshes from the Hutchinson River to the Bronx River have been drained with the exception of about 350 acres, of which owners have not yet been found. The entire marsh area of Pelham Bay has been drained under contract by the Park Department, the work being carried on under the supervision of the Health Department's sanitary engineer. This improvement is being maintained under a separate maintenance contract. Thus far, practically no work has been done in Brooklyn. It is planned to drain the marsh lands in this Borough and all those remaining in the Borough of Queens, under the provision of the State law described above. It has been unnecessary to make use of the powers conferred by Section 1197, whereby the work could be done by the Department of Health and a lien placed on the property for the expenditure. Under the new law, which applies only to Brooklyn and Queens, the Department has prepared plans of areas to be drained, and has outlined areas which will be benefited and on which assessments may be placed."

Since October, 1905, and up to the date of the report, 23,560 acres of salt marsh area had been drained, by means of 8,584,084 lineal feet of ditches. In addition thereto, 247 acres of inland swamp area had been drained; at an aggregate cost for both areas of \$123,957 to the city, and \$182,470 to the owners. In 1915, however, there remained within the limits of the Greater City 9,000 acres of undrained salt marshes, and 1,000 acres of undrained inland swamp. It was estimated that the cost of draining the salt marsh area would be approximately \$15 per acre, but for the inland swamp area the cost was estimated at \$100 per acre. The expense of completing the drainage work in Greater New York was estimated at \$250,000, but it is pointed out that "By the elimination of the mosquito nuisance large areas had been made available for settlement, relieving the congested centers of the city." Attention is also directed to the fact that, "The rapid growth of the Boroughs other than Manhattan is well known and they are continuing to increase in population. While transportation will make them accessible, it is the comparative freedom from mosquitoes in the drained area which is making them habitable. There is no doubt that many outlying sections would show increased growth were it not for the mosquito nuisance. It is clearly the duty of the City to do its part toward making these outlying sections more desirable for residents.

These rather extended observations on malaria eradication and mosquito extermination work in Greater New York are of special interest as illustrating that the practical urgency of such efforts is not limited, as is frequently asserted or assumed, to the Southern States. In fact, there are reasons for believing that the diagnosis of malaria is

often not made in Greater New York, where the disease is merely a complicating factor and not of predominant importance.

PROBLEMS OF CLINICAL DIAGNOSIS

Since malaria is not a reportable disease in Greater New York, morbidity returns are unfortunately not available. Since the question of accuracy and completeness in both malaria morbidity and mortality statistics is raised with sufficient frequency to require some consideration, the following observations derived from the "System of Clinical Medicine," by Savill, are included for the purpose of convenient accessibility:

Malaria is rarely mistaken for other diseases; but the other disorders attended by intermitting pyrexia about to be described are very frequently mistaken for malaria. Clinically, this mistake would be avoided if it were remembered that malaria of true quotidian periodicity—daily recurrence—is very rare; and that tertian or quartan periodicity is absolutely pathognomonic; it occurs in no other disease. Therapeutically, the diagnosis may be established by full doses of quinine; if this be given intramuscularly, and fail to relieve, the attacks are certainly not malarial. The microscopic recognition of the parasite in the blood requires considerable experience, but it is always possible to find it in blood-films, provided the patient has not taken quinine for several days; this is an essential part of the examination, and is, of course, positive evidence.*

Savill also observes that death usually occurs from complications, without which malaria is not a very fatal disease, and he seems to hold that this conclusion applies to tropical countries as well as to those of the temperate zone. A. Rendle Short, in his "Index of Prognosis and End-Results of Treatment," remarks in this connection that it requires to be kept in mind that "A certain increase should perhaps be made in the death rate owing to the fact that malaria predisposes to intercurrent diseases such as dysentery and tuberculosis, and in persons with a fatty or a poisoned heart, as in beri-beri, it may by direct toxic effect cause a fatal termination of these diseases. Where the vessels are atheromatous, cerebral hemorrhage may occur as a result of the high blood-pressure common in some cases of malaria. Premature labor and abortion are not uncommon, either as a result of the disease or of injudicious treatment with quinine. Still-births and high infantile mortality are not infrequent in parturient women with malaria."

Considerable practical significance requires to be attached to these observations in the correct interpretation of malaria-mortality returns

*This statement cannot be accepted, in view of the well-known fact that the microscopical diagnosis of obviously frank cases of malaria is frequently impossible.

for localities or sections where the disease is generally assumed to be infrequent or practically absent, at least in a fatal form. That the diagnosis of malaria is often extremely involved is clearly emphasized in even an abbreviated form of the principal complications, more or less after the "Index of Differential Diagnosis," by Herbert French, as follows:

Amenorrhea; amaemia; arteriosclerosis; ascites; bronchitis, acute and chronic; bronchopneumonia; cholecystitis; cirrhosis liver; dysentery, bacillary; dysmenorrhea; haematemesis; hypertrophy liver; jaundice, catarrhal, haemolytic; menorrhagia; metrorrhagia; nephritis, acute, chronic; orchitis; paralysis agitans; paraplegia; perihepatitis; pneumonia, lobar; pregnancy; scurvy; splenomegaly with anaemia; thrombosis, brain; tuberculosis; typhoid fever; uncinariasis; valvular disease heart.

Of these perhaps the most important are the active congestion of the liver, albuminuria, pneumonia, hematuria, jaundice and spleen enlargement. Of recent years much has also been made of the possible interrelation of malaria and appendicitis. Dr. W. J. Hunt, of Glens Falls, New York, in 1904, reported an interesting series of cases of malaria which simulated appendicitis, emphasizing the conclusion that certainty in diagnosis was not always justified where a malarial infection was known to exist. Dr. Hunt made the observation at the time that there was so little malaria in the State of New York that the physicians of the State were far from familiar with the symptomatology of the disease, so that it was easier for the disease to be mistaken and to be overlooked by them than by physicians living in a malarial region. The possibility of malaria simulating appendicitis had made him exceedingly cautious in making a diagnosis of appendicitis in one coming from a malarial region. Graham E. Henson, in his work on malaria, refers to the differentiation of appendicitis from this disease, with special reference to a case originally reported as one of benign tertian malaria with very marked symptoms of appendicitis, as follows:

An initial chill, followed by a temperature of 99.2 degrees Fahrenheit, with intense pain over the region of the appendix, vomiting, and a marked rigidity of the right rectus, caused a tentative diagnosis of appendicular colic. The following day the condition had very much improved, and the patient was comparatively comfortable, but forty-eight hours from the initial symptoms, a chill, with all the previous accompanying symptoms intensified, and temperature of 106 F., which fell in a few hours to nearly normal, caused him to suspect malaria, at least as a complication. An examination of the blood revealed the tertian plasmodia in large numbers; antimalarial treatment was followed by a complete cessation of all abdominal symptoms, and the patient went on to a rapid recovery.

"Appendicitis," according to Henson, "can be differentiated from malaria, by the absence of plasmodia in the blood, and a marked leucocytosis, with great excess of polynuclears. Too much attention should not be paid to pain in the abdomen, as it is often a prominent symptom in malaria, as well as appendicitis." Henson also reported a case of tertian malaria simulating appendicitis in 1911, suggestive of at least the occasional occurrence of serious mistakes in diagnosis, and emphasizing the urgency "on all practitioners in malarious districts of the necessity for the examination of the blood for the malaria parasite, and the value of the procedure as a routine measure." The Florida case referred to by Henson is of special interest in connection with the reported frequency of appendicitis in certain counties of southern Georgia, all of which are known to be more or less malarious.

Since there are no references to malaria as a complicating factor in appendicitis or as a cause of mistaken diagnosis in the standard treatise on "Appendicitis," by Howard Kelly, nor in the discussion of the more prominent symptoms and complications in "The Malarial Fevers of Baltimore," by Thayer and Hewetson, it would seem appropriate to suggest that this rather neglected aspect of the disease may be deserving of more extended and qualified consideration.*

MALARIA ERADICATION IN CALIFORNIA

The foregoing observations regarding the differential diagnosis of malaria apply with special emphasis not only to New York, New Jersey and the New England States, but also to California. The vast area of the Northern or Sacramento Valley and the Southern or San Joaquin Valley has ever since the discovery of gold and the enormous influx of population from all parts of the globe been more or less seriously infected with malarial disease. In recognition of the practical importance of a better public appreciation of the malaria problem, a series of papers on the subject was presented before the Commonwealth Club of California, at its March meeting, 1916. The discussion included the report of a special committee on malaria in California, presented by Dr. George E. Ebricht, President of the State Board of Health, a report on the administrative work in the prevention of malaria, by Ray Lyman Wilbur, President of Stanford University, a discussion of methods of

*Dr. E. A. Codman in his *Study on Hospital Efficiency as Demonstrated by the Case Reports of the First Five Years of a Private Hospital* (Boston, 1918) included case No. 18 of a female, age 38, admitted on account of intermittent right-sided abdominal pain and one attack of jaundice of which the preoperative diagnosis was for gallstones. The operation disclosed no gallstones, but the appendix was removed. The complications included an attack of malaria in the second week, the presence of the parasite having been demonstrated by Dr. G. E. Shattuck.

malaria control, by William B. Herms, associate professor of parasitology in the University of California, and a presentation of the sources of malaria in California, by Dr. Karl F. Meyer, associate professor of tropical medicine in the University of California. In the report of the committee, attention is drawn to the fact that before 1850 malaria was unknown in California, and that the disease was brought to the Pacific Coast by emigrants from the Mississippi Valley, the Isthmus of Panama and Italy. The disease gained a permanent foothold in nine counties: Placer, Shasta, Sacramento, San Joaquin, Butte, Tehama, Fresno, Tulare and Kern. In these nine counties occur about seventy-five per cent. of the total deaths from malaria in the State. The economic cost of the disease is estimated by the State Board of Health at nearly \$3,000,000. The recommendations of the committee are:

- 1 That mosquito control districts be formed which shall cover all malaria infected areas in California and that this be done as rapidly as possible.

- 2 That if by the end of the year 1916 this plan be found ineffectual or unsatisfactory, the legislature should appropriate funds to be used by the State Board of Health to employ a sufficient number of inspectors to undertake the field work of malaria extermination under the present authority of the State Board of Health.

The observations of Prof. Herms are summarized as follows:

Malaria control practically synonymous with mosquito control. Need for survey to determine kinds of mosquitoes and their distribution. *Anopheles quadrimaculatus* the most dangerous mosquito. Two hundred thousand dollars needed from state for campaign of eradication. Local campaign. Oil for preventive. Right and wrong kinds; 28 to 32 degrees Beaume correct; treated stove oil. Drainage of breeding pools important. Waste of irrigation water favors the mosquito. Need for county ordinances. Danger from the quinine treatment by which parasite may become resistant to the remedy. Quinine can be made effective where mosquito control impracticable. Mosquito does not acquire malaria in swamps, but only from afflicted human beings. Changes undergone by parasite in human and insect host. Malaria propagated only when conditions are favorable to it.

According to Dr. Meyer, the method used in the survey of malarial conditions in California was limited to the examination of school-children. The results for Chico and Gridley are reported upon in detail. The need for educating the public and for extending the survey are recognized. Different methods of treatment are advised for cities and rural malarial districts. It is held that the infection of city-dwellers usually takes place in country districts. The reduction in frequency by quinine treatment is considered feasible. The chief obstacle to the

campaign against malaria is indifference or apathy on the part of the medical profession. The final recommendations are as follows:

- (1) An educational campaign in the rural communities and among the medical profession.
- (2) Instruction regarding the reduction of mosquito bites by advocating personal prophylaxis (mosquito curtains, screening of house, etc.).
- (3) Proper treatment and care of carriers.
- (4) Systematic quinine treatment in badly infected ranches and rural districts.
- (5) A campaign has to be based on a careful, systematic and scientific survey of all the conditions in the endemic region, before a campaign of eradication promises the best success.

The mortality from malaria in California during the last five years for which the returns are conveniently available is presented in the table below:

MORTALITY FROM MALARIA IN CALIFORNIA 1912-1916

Year	Population	Deaths	Rate per 100,000 Pop.
1912.....	2,577,137	80	3.10
1913.....	2,667,516	57	2.14
1914.....	2,757,895	52	1.89
1915.....	2,848,275	52	1.83
1916.....	2,938,654	54	1.84
Total.....	13,789,477	295	2.14

The results of this analysis fully sustain the apprehension of those familiar with the facts that malaria is of much more serious importance to the people of the State of California than is generally assumed to be the case. The disease is fortunately on the decrease, the malaria death rate having declined from 3.10 per 100,000 in 1912 to 1.84 in 1916. But assuming that the fatality rate is only 2 per 1,000, the number of cases of malaria in California is probably not much less than 25,000 per annum.*

Doctors Kelly and Geiger, of Berkeley, California, direct attention to the fact that, although for many years malaria has been known to be prevalent in the great central valleys of California and the foothills

*By geographical divisions the average malaria mortality of California for 1911-1915 per 100,000 of population has been as follows:

In contrast to an average rate of 2.6 for the State, the rate for the San Joaquin Valley was 5.6, for the North and East Mountain counties 8.3, and for the Sacramento Valley 13.8. For selected counties, however, the rates were as high as 32.9 for Shasta County, 22.8 for Yuba County, 19.7 for Kings County, 18.3 for Calaveras County, 16.2 for Amadore County, 15.7 for Butte County, 15.6 for Tehama County and 15.5 for Sutter County.

adjacent to them, no systematic attempt had been made to study the types and endemicity of the disease prior to 1915, when Drs. Meyer and Walker, associate professors of tropical medicine in the George Williams Hooper Foundation for Medical Research, began an investigation in order to determine the endemicity of malaria and the types of mosquitoes involved, but the investigation was discontinued after only a few weeks. Subsequently, however, following a conference with Prof. W. B. Herms, the author of a standard treatise on "Malaria, Cause and Control," and an address on "Successful Methods of Attack on Malaria in California," an inquiry was initiated, with the approval of the California State Board of Health, for the ascertainment of malarial conditions throughout the State. On account of other and more urgent investigations, however, the plan was not completely carried out, but in a contribution to *The Journal of the American Medical Association*, of May 5, 1917, Drs. Kelly and Geiger presented a brief report on the "Endemic Index of Malaria in the Northern Sacramento Valley, California," limited, however, to two localities, Orland, Glenn County, and Redding, Shasta County, with a population of 836 and 3,572, respectively, according to the census of 1910. The malarial index, based exclusively upon school-children, and in conformity with the methods perfected by the late von Ezdorf, was ascertained to be 4.7 per cent., which compares with 11.4 per cent. for Alabama, 10.1 per cent. for Arkansas, 7.8 per cent. for North Carolina, 11.9 per cent. for South Carolina, 31.2 per cent. for Mississippi and 9.8 per cent. for Virginia. It is explained, however, that the relatively low figure for California may in part have been the result of dissimilarities in methods of determining the index, for it is said that "Specimens were taken from school-children only and thin smears were used exclusively, while von Ezdorf took specimens from the general population and used thick as well as thin smears. Taylor found only one-fourth as many positive specimens using thin as he did using thick smears, so it is possible that by using the latter method our positive findings might have been increased, though at least half an hour was spent in the examination of each smear before reporting it negative." It is stated further that "The relatively high percentage of estivo-autumnal infections is of interest, particularly in Redding, where the number of cases of this type was the same as the tertian," but it is said "this is higher than the percentage reported by von Ezdorf, who found two tertian for every estivo-autumnal infection." The percentage of

carriers was ascertained to be the highest between ages 11 and 15. The results of the investigation are numerically too limited to be entirely conclusive, but the investigation is a most promising indication of progress in the right direction.*

ECONOMIC ASPECTS OF EXTERMINATION MEASURES

It is upon efforts like these that the ultimate practical solution of the malaria-reduction problem depends. It is, after all, a question of cost and economic results. It is, therefore, seemingly of the utmost importance that all methods of eradication, in this country at least, should rest upon economic as well as medical considerations: for even though it might be ideally possible to eradicate or control malaria by the most rigorous methods of quinine prophylaxis or the quinine immunization of the entire population, the results would be to small practical purpose unless the expense incurred was proportionate to the social and economic benefits resulting therefrom. Few communities, if any, are likely to incur heavy expenditures in behalf of a single method of malaria eradication or control, if a more comprehensive policy is likely to also serve a number of other important purposes and aid more effectively in securing the required results. Considered from this point of view, it is practically hopeless to separate the problem of malaria eradication from the broader question of mosquito extermination, or from the still more important considerations of minor and major drainage for agricultural and other purposes. The reclamation of the Newark Meadows has been of enormous value to Essex County, the State of New Jersey and the nation at large. If the prevailing type of mosquito had been the anopheles, or malaria-carrying species, and if malaria had been ten times, or even a hundred times, more frequent, there would not have been the public interest in the problem of malaria eradication or mosquito extermination if the outlook had not been also distinctly encouraging that the resulting economic benefits would be in proportion to the necessary expense. To the extent that extermination or eradication efforts rest upon an economic basis, the outlook for permanency in results is decidedly greater than in the case where the underlying considerations are purely medical, as is the case in quinine prophylaxis or quinine immunization, etc., for

*The most recent report on malaria in California is by Stanley B. Freeborn, M. S., Acting Consulting Parasitologist, California State Board of Health, Monthly Bulletin, April, 1918. This report reviews the history of eradication efforts since 1903, and presents an admirable summary of what has been done since the adoption of the Mosquito Abatement Districts Bill, chiefly with reference to San Rafael, Marin County, Los Molinos, Tehama County, and the Matadero Districts at Palo Alto. This district, it is pointed out, "no doubt contributes enormous supplies of mosquitoes to Camp Fremont." Nine mosquito abatement districts have now been organized with promising results.

the latter leaves the larger problem of general health and well-being practically unsolved. It directly benefits, unquestionably, the population concerned in the more or less complete elimination of malarial disease, but it fails to solve—since it cannot solve—problems of general sanitation, minor drainage, the elimination of stagnant water, etc. To the end that the solution of a number of sanitary problems can be concentrated in a single effort and made the subject of a single expenditure, the required public support is much more likely to be forthcoming and continue than where the eradication effort concerns only a single phase of a large and often extremely complex situation.*

MALARIA CONTROL WORK IN INDIA

In support of local mosquito-extermination and malaria-eradication measures thoroughly scientific investigations are urgently required, and, in fact, absolutely necessary if satisfactory results are to be achieved. There has not been in this country the active scientific interest in this respect which has been developed in tropical countries, especially in India, Ceylon, the Federated Malay States and the Straits Settlements.† It is probably true, of course, that malaria is not as serious a menace to health even in the most infected, highly endemic areas of this country as in certain tropical regions of Asia, Africa and South America, but the facts in support of this assumption have not as yet been ascertained with the required degree of thoroughness. No strictly scientific malaria survey, for illustration, has thus far been made of certain counties of southeastern Missouri, which are known to be intensely malarious; nor have such investigations been made of certain thoroughly infected counties of Arkansas, Mississippi and Louisiana, or been reported upon in conformity to the admirable descriptive accounts which are available for many and almost unknown localities of Asia, northwestern Argentine and the West Coast of Africa. Such work, for illustration, as has been done by the Special Malaria Department of the Corporation of

*Quinine immunization unquestionably is of real value in localities or sections where the inhabitants are chiefly natives, where an effective public health organization is wanting, where the density of population is low, where the climatic conditions are decidedly unfavorable, and where for topographic as well as for economic reasons mosquito eradication and control would be impossible. A typical section of this kind would be certain large portions of the lower Amazon River country in Brazil, where efforts to successfully establish American rubber plantations have been exceedingly difficult on account of the high mortality rate from malaria. Equally difficult and not far from disastrous was the early experience in the building of the Mamore Madeira Railway. Conclusions favorable to quinine immunization in strictly tropical and more or less primitive regions are hardly applicable to the malarial portions of such a thoroughly developed and highly civilized country as the United States, except as a temporary expedient in the most infected portions of the Yazoo Delta or the swamplands of southeastern Missouri.

†An extensive account of the antimalarial measures in the Straits Settlements is included in a treatise on "Rural Sanitation in the Tropics," by Malcolm Watson, M. D., New York, 1915.

Madras has not its equal at the present time in this country.* The Madras report includes maps, illustrations and statistics for 1916. The analysis of the malaria mortality is by wards and months, and according to sex. The statistics indicate a wide range in local frequency, from a minimum rate of 0.2 per 1,000 for one ward to a maximum rate of 4.2 for another. The rates for 1916 are in marked and gratifying contrast to the excessive rates prevailing in former years, for during the preceding quinquennial period the minimum rate of malaria mortality was 1.7 per 1,000, and the maximum 12.5. The precise ascertainment of local conditions in the different wards subject to a high or a low rate of mortality from malaria is the chief function of the officer in charge of the Madras Malaria Department. The investigations which he is required to make include mosquito surveys, of mosquito prevalence in wet fields or overflowed areas, the examination of children with reference to the existence of enlarged spleen, the taking of blood smears with reference to the ascertainment of infected persons, which during 1916 revealed an average of 5.96 per cent. and a range from a minimum of 1.7 per cent. to a maximum of 20.6 per cent. The report includes a digest of the dispensary statistics to which special attention is directed, in that they are said to "afford a fairly reliable index for any rise in malarial fevers in the localities served by these dispensaries, since blood smears are obtained from patients suffering from fever and resorting to the malaria dispensaries of the Corporation." The report also outlines the antimalarial measures which have been adopted, and of which there are seven principal divisions, as follows: (1) the cleaning of ponds, tanks and ditches, (2) petrolizing, (3) clearing rank vegetation, (4) introduction of larvacides (fish and ducks), (5) quininization, (6) reclamation and (7) drainage. These measures are all described in detail and illustrated by photographs, as a matter of record. The

*According to a report on the Vital Statistics of the Madras Presidency, transmitted by Consul Lucien Memminger, under date of November 28, 1917, for the calendar year 1916, "in consequence of war conditions it was not possible to carry out any special investigations in regard to malaria. Itinerating dispensaries were on duty in the districts of Chittoor, Ganjam, Godavari, Kurnool, and Vizagapatam, but in the absence of adequate supervision over the sub-assistant surgeons in charge there is doubt as to the value of the results attained. The experiment is, however, being continued and it has been decided to start three more dispensaries under civil assistant surgeons, who may be expected to need less supervision, to work in the malarial tracts of the Nellore, Cuddapah and Bellary districts. Considerable progress is being made in the drainage of water-logged areas in Madras city; the conditions in the tracts adjoining the Buckingham canal have improved materially in recent years, though much still remains to be done in the way of removing breeding places for mosquitoes, especially borrow pits along the railway line—and in other places minor remedial measures have been adopted." Special antimalarial measures were generally undertaken on a moderate scale by the local bodies concerned—some from their own funds and a few others from special grants obtained from the Government—under the supervision of the local sanitary officers: "(a) quinine administration to all the people in the affected tracts; (b) stocking of wells and tanks with larvicidal fish; (c) trimming of edges of all tanks, etc., removal of weeds and surface growth therefrom; (d) prohibition of wet cultivation in close proximity to human habitation wherever possible; (e) filling up of useless wells, ponds, etc.; (f) petrolizing of large collections of water."

expenditures on the part of the city of Madras on account of special malaria work during 1916 amounted to 67,342 rupees, of which 22,294 rupees was paid on account of investigation, prevention, treatment, etc., 1,902 rupees on account of conservancy work and repairs, 10,771 rupees on account of engineering staff; all of these items being grouped as permanent expenditures under the term "establishment." For general and reclamation work, etc., 10,056 rupees was expended; for oiling, cleaning, fishermen, bushcutting, and the purchase of liquid fuel, 11,328 rupees. For minor expenses, stationery, printing, laboratory equipment, contingencies, rents, farms, etc., 10,991 rupees. Converted into the American equivalent, the total cost was only \$21,846, which on the basis of the estimated population of Madras for 1916 represents a per-capita expenditure of four cents for malaria prevention work.*

MALARIA CONTROL WORK IN BURMA

Even more interesting and scientifically valuable special malaria work is carried on in a number of localities in the Far East, of which the very names are practically unknown in this country. In 1912, for illustration, a report was published by the Government of Burma on the investigation of malaria at Kyaukpyu, illustrated by a number of maps precisely locating infected areas and indicating the conditions predisposing to an excessive prevalence of the disease. This interesting report, which was made by the special malaria officer of Burma, Dr. N. P. O'Gorman Lalor, Major, I. M. S., includes a well-considered mathematical analysis of the spleen-census returns in conformity to the method originally suggested by Ross on the recommendations of Karl Pearson.† The most valuable features of the report, however, are the maps of subdivisions and local units clearly illustrating the topography and other features, such, for illustration, as running streams, overflowed marshes, rice fields, areas under cultivation, rank vegetation, etc. Such maps are absolutely essential if the work of malaria eradication is to be placed on a sound and permanent scientific foundation. Only by means of such local studies made by those thoroughly qualified to do so can the many

*The foot-note on page 54 has reference to the Presidency of Madras as a whole. For the City of Madras the most recent information is contained in the Administration Report of the Corporation of Madras for 1916-1917, which includes an admirable map prepared by the Anti-Malaria Section of the Special Works Department showing the Works Proposed and Carried out for Drainage of Tanks in Purasawakkam. The report itself is evidence that regardless of the war antimalaria measures are being carried forward in Southern India in conformity to well-considered sanitary engineering considerations.

†"The Prevention of Malaria," by Ronald Ross, London, 1910. Section 27-32, inclusive, on conditions required for the production of new infections in a locality, laws which regulate the amount of malaria in a locality, laws which regulate the number of anophelines in a locality, explanation of various phenomena, the measurement of malaria, the mortality and cost of malaria, pages 153-253.

new aspects of the malaria problem be presented and the new facts brought to light in connection with a subject which is far from having been exhausted as regards its scientific possibilities. Thus, for illustration, the report of Major Lalor contains a note on a parasitical fly which infests anopheles mosquitoes of a certain species at Kyaukpyu, and which is usually found adhering to the abdomen of the mosquito, with its proboscis deeply sunk through the chitinous integument, through which it sucks from the abdomen of the mosquito the blood with which the latter is engorged. The note regarding this parasite is illustrated by colored reproductions of original drawings and constitutes a valuable addition to economic and medical entomology.*

In the report by Major Lalor a series of tables of wind velocity and wind steadiness at Kyaukpyu is included, with reference to which it is said that "Comparing these facts with the extent to which mortality from malaria prevailed at Kyaukpyu during the years corresponding, it will be seen that lessened wind velocity and steadiness in June and July, 1908, was followed by an unusual rise in the curve of mortality for August and September." This rise, it is pointed out, "after due allowance for the mortality from other exceptional causes, must have been due to the increased malaria." For "If the relation is one of cause and effect, it can be accounted for by the fact that the absence of wind and stillness of the atmosphere favor the increased breeding and dispersion in houses of malaria-carrying anopheles."

MALARIA SURVEY OF CENTRAL PROVINCES, INDIA

Still more elaborate and scientifically instructive is the Report upon Malaria in the Central Provinces of India, by Major W. H. Kenrick. This report includes a number of exceptionally suggestive maps delineating the malarial areas, according to the degree of infection as determined by the spleen index. The intensely hyperendemic areas have the following features in common:

- (a) They possess a permanent supply of clear water, in the form of springs, seepage, or streams flowing from the mountain.
- (b) They are surrounded by forest which provides the densest shade and shelter to breeding grounds.
- (c) They are inhabited by dark-skinned aborigines, who, while being immune to the more serious results of infection, as malaria carriers keep up the endemic rate.

*A descriptive account of the parasites found in infected local anopheles is included in the Report on the Investigation of Malaria in the District of Katha issued by the Government Printing Office, Rangoon, Burma, September, 1913.

These tracts are said to be particularly fatal to the fairer-skinned non-aborigine and outsider, which accounts, from the economic point of view, for the fact that the colonization of these tracts has been found extremely difficult and has practically been left to the aboriginal tribes. In India, as elsewhere, under given conditions, localities or districts with a comparatively low rainfall may show an excessive incidence of malaria, or more general distribution of cases, than districts with a heavy rainfall, for, as observed by Major Kenrick, "within certain limits the actual quantity of rainfall is not an important factor in the distribution of endemic malaria." Conditions in connection with which rainfall is of importance and appears to influence the prevalence of the disease are the following:

(a) The rainfall should be sufficient to prevent the drying up of the springs, small streams, seepage water, etc., found in, and near to, the ranges of hills and forests.

(b) The prevailing winds during the latter part of the monsoon.

Of more general importance, however, it is held that

Geological formation has a bearing upon the distribution of endemic malaria only in so far as it determines the nature of the soil, with respect to growth of vegetation, retention of moisture, etc. The principal formation of the Provinces is that of the basaltic or volcanic rocks known as the Deccan trap, which occupies the greater portion of the majority of the districts. The region covered by these rocks consists usually of undulating planes, divided from each other by flat-topped ranges of hills, and its distinguishing features are the prevalence of long grass and the paucity of large trees, and the circumstance that almost all bushes and trees are deciduous. It is noticeable that the most highly endemic localities in the Provinces are found in the area bearing these distinguishing features.

In measuring the intensity of the endemic prevalence of the disease, the classification recommended by the Central Malaria Committee was adopted. This classification is as follows: "A hyperendemic locality is one in which the average spleen-rate among the children is above fifty per cent.; a highly endemic area, one in which this rate is between twenty-five and fifty per cent.; a moderately endemic area, one with the rate between ten and twenty-five per cent.; and lastly a healthy area, one in which the rate is below ten per cent."

The larger areas of the Central Provinces are fully described and illustrated by an admirable series of maps. With reference to the cotton area, which includes the districts of Buldana, Akola, Amraoti and Yeotmal of Berar, and Wardha and Nagpur of the Nagpur Division, it is of interest to note the conclusion that "The most noticeable feature

is the almost complete absence of endemic malaria from the open tracts cultivated with cotton." Upon the basis of such statistics as were available, the conclusion is advanced that "One might almost indicate the distribution of endemic malaria by a map showing the density of rural areas: the lower the average of density the higher the endemic rate." These observations may well be applied to the vast cotton areas of the Southern States, and particularly to those of the Mississippi Valley. In proportion as these areas have been thoroughly cleared and drained, the incidence of malaria has materially diminished, without any other factors of eradication or control. For purposes of comparison it may be stated that the density of the various districts of the cotton tract of the Central Provinces has a range from a minimum of 93 persons per square mile to a maximum of 247. The corresponding density for the Delta counties of the State of Mississippi is forty-eight persons per square mile for the total population and eight persons per square mile for the white population.*

RICE CULTIVATION AND MALARIA

A valuable contribution to the study of local conditions more or less directly responsible for an excessive degree of malaria frequency is a discussion of malaria and rice cultivation.† It is said that the characteristic physiography of the rice tract in the Central Provinces of India "is that of an extensive plain, covered by small embanked rice fields, comprising the basins of the Wainganga and Mahanadi Rivers, bounded on the north, east and south by hilly country with a belt of hill and jungle separating the valley of the Wainganga from the Chhattisgarh plains. Low undulations of unculturable gravel traverse the plain in places, otherwise it is unbroken except for small patches of scrub jungle and mango groves. On the borders where the hilly country merges into the plains, the cultivated area becomes irregular and broken up by the encroaching forest. The soil is largely of a yellow sandy nature, formed from metamorphic or crystalline rock."

The rivers of this area, except during the rainy season, consist merely of a series of stagnant pools, connected by a streamlet flowing along one side of a broad expanse of sand. Tanks constructed for drinking purposes

*The density of population (including both white and colored) of the Delta area has increased from 37 persons per square mile in 1900 to 48 in 1910. The probable density at the present time (1918) is between 55 and 60 per square mile, on account of the very rapid increase in the population of certain sections, in consequence of health improvement, railway extensions, the high price of cotton, etc.

†For observations on malaria, with special reference to the rice-growing counties of California, see page 48, *et seq.*

and for the irrigation of rice are exceedingly numerous, there being one or more in the neighborhood of every village, and as many as 28,500 tanks in one area alone. The majority of these tanks contain water weeds and grass. The climate is hot and dry. The mean rainfall is fifty-three inches. The method of cultivation is almost universally "broadcast sowing," transplantation being practised in a few places only. Irrigation is merely additional to the rainfall, and is most frequently resorted to where light, non-retentive soil predominates. Practically in every village there is some irrigation from tanks or rivers.

An examination of over thirty thousand children between the ages of two and ten years throughout this rice country suggests that, from the point of view of malarial endemicity, "the area should be divided into a healthy area with a spleen rate under ten per cent., an endemic area with a rate between ten and fifty per cent. and a hyper-endemic area with a rate above fifty per cent." According to this division the spleen rate in the healthy area was 4.3 per cent.; in the endemic area, 24.1 per cent., and in the hyperendemic area, 70.5 per cent. The latter are those in which "jungle and hill are found in excess and in close proximity to villages. The greater extent to which jungle and waste land, covered with long grass or scrub and in continuity with forest, replaces open cultivation, the more malarious an otherwise healthy rice tract becomes. Thus the borders of the cultivated rice plains at the foot of the mountain ranges, the narrow valleys through which the mountain streams debouch upon the plains, the small isolated patches of cultivation in forest clearings and the fringe of the plateaux, when bordered by jungle, are all hyper-endemic, whether irrigation be present or not; in these situations favorable breeding grounds with ample shade exist."

These observations have an important bearing upon the question of malarial frequency in the rice-producing areas of our Southern States.* The general experience even in irrigated areas has been far from distinctly unfavorable. Exceptions no doubt are met with, but as a general rule malaria is not of extraordinary frequency on the rice lands of Louisiana and southern Texas. The reasons are to be found in the foregoing explanation that our Southern lowlands are probably not as favorable to the breeding of malaria-carrying mosquitoes as the rice

*Important references to the health of the rice-producing areas of South Carolina and Georgia during the period when active operations were carried on occur in Fenner's Southern Medical Reports (New Orleans and New York, 1849-1850). One of the most interesting articles is by Thomas Y. Simmons, M. D., on Observations on the Fever which has Developed in the City of Charleston after exposure to the country air during the summer and autumn, which is commonly called "country fever." See, also, a report on "The Climatology and Epidemics of South Carolina," contributed to the Transactions of the American Medical Association, by Dr. Manning Simmons, of Charleston, in 1872.

tracts of the Central Provinces of India.* All that has reference to conditions of living, such as better housing, effective screening, surface drainage in the immediate vicinity of the homes, nourishing food, medical attendance, etc., is, of course, of a higher standard in this country. No thorough investigation, however, has been made to ascertain the relation which unquestionably exists between artificial irrigation in our rice-producing sections and the degree of malarial intensity. The conclusions advanced with reference to the rice-producing areas of Central India are therefore of both scientific and practical application to the problem of malaria eradication in this country. The conclusions advanced by Major Kenrick read that

We are justified in concluding that rice cultivation as carried out in the Central Provinces is harmful under certain conditions only, viz., when accompanied by irrigation in thickly wooded areas, or in the neighborhood of jungle, or of waste land covered by long grass or scrub, near jungle, in other words, with *irrigation and shade*.

MALARIA ADVISORY BOARD OF THE STRAITS SETTLEMENTS

Among other foreign reports on malaria eradication to which more extended references might have been made on this occasion, but which can only be very briefly referred to, is the Report of the Malaria Advisory Board of the Federated Malay States for the Year 1913,† which includes an excellent map, showing the area protected by Government antimalarial work, the swamps which are being filled in by the Department of Public Works, and, finally, antimalarial drainage work by private persons. In addition, the report contains a chart exhibiting the corrected total death rate and the corrected malaria death rate in correlation to the monthly rainfall for the period 1907-1913. This chart, however, is limited to the data for Kuala Lumpur Town, but the return is amplified by a chart showing the percentage of Indian recruits at police departments detained in hospital or given sick leave for malaria each month during the four years 1910-1914. The statistical evidence is readily convincing that the work of the Advisory Board has been effective and that malarial diseases are under

*Soil Survey of Acadia Parish, Louisiana, by Thomas D. Rice and Lewis Griswold, U. S. Department of Agriculture, Washington, 1904, Soil Survey of the Lake Charles Area, Louisiana, by W. H. Heileman and Louis Mesmer, U. S. Department of Agriculture, Washington, 1901, Soil Survey of Jefferson County, Texas, by William T. Carter, Jr., L. R. Schoenmann, T. M. Bushnell and E. T. Maxon, U. S. Department of Agriculture, Washington, 1915.

†Report of the Malaria Advisory Board of the Federated Malay States for the Year 1913, Kuala Lumpur, 1914.

control, with a definite tendency towards a material decline. Thus, for illustration, the corrected malaria death rate for Kuala Lumpur Town was 9.7 per 1,000 during 1907, and 10.7 during 1908; decreasing to 7.7 during 1909; increasing to 9.8 during 1910, and 9.9 during 1911; but decreasing to 5.8 during 1912, and 4.2 during 1913. It is regrettable that no later data should be available at the present time. It is of interest, however, to note that the average monthly percentage of cases of malaria treated in the hospital or given sick leave, which apparently has reference exclusively to Indian recruits brought in under labor contracts, increased from 35.75 per cent. in 1910 to 57.01 per cent. in 1911, decreasing to 27.33 per cent. in 1912 and to 11.3 per cent. in 1913. It is pointed out in explanation of the statistics that "these figures mean that in 1911, to take the worst case, every Indian at the depot was in hospital or given sick leave for malaria on an average seven times during the year. Very few places can show a sickness rate to compare with this, and when it is remembered that the men are picked healthy Sikhs and Pathans* of a high physical standard it will be realized what the condition of a labor force having a poor physical standard would have been under the circumstances. It may be mentioned that the improvement was obtained notwithstanding the large increase in the density of the population at the depot subsequently to 1911 when in consequence a large number of men were without the protection of a mosquito net at night. Quinine has only been given to men under hospital treatment or to those who come to ask for it." The improvement was therefore chiefly, if not exclusively, due to the drainage work undertaken by the Government or private enterprise, and the only malaria continuing consists apparently of cases in the neighborhood of the swamps within the town area, which were being filled in at the time, and on the limits of the area from which the disease had practically been eliminated. The conclusion is therefore justified that "in the light of the large reduction in malarial sickness following the measures undertaken and the rational nature of the procedure which has been adopted it may be considered that the case for the benefit to be obtained from anti-malarial drainage well carried out has been completely proved, and the Board has every reason to be satisfied that its policy is entirely justified in this respect."†

*For an account of the Pathan tribe, see "Ethnography of India," by Risley, *Census of India*, 1901, Vol. I, Calcutta, 1903. A recent descriptive account of the Sikhs has been reprinted in the *Scientific American Supplement*, No. 2204, for March 30, 1918.

†Exceptionally helpful in the study of methods of malaria investigation are the reports of the Government of India, especially the following: *Scientific Memoir* No. 2, "Malaria in India," by Captain S. P. James, Calcutta.

NEW METHODS OF EDUCATIONAL PROPAGANDA

Aside from drainage measures, however, it is self-evident that malaria prophylaxis in other directions was also carried out with a reasonable degree of thoroughness. Quinine prophylaxis seems to have been made use of to only a very limited extent, and possibly not further than in the actual treatment of the disease. Much has been done throughout India, Ceylon and Burma in the education of the natives with regard to the essential facts of the transmission of malaria through the anopheline mosquito.* Large posters, for illustration, are made use of in the Karachi Municipality, signed by the Health Officer, Dr. E. D. Shroff, who emphasizes four essentials:

- 1 BEWARE OF MOSQUITOES.
- 2 To harbour mosquitoes is to court Malaria.
- 3 That Malaria is propagated from Man to Man by Mosquitoes; and
- 4 That the disease is preventable.

The factors of prevention are set forth briefly, as follows:

- (a) Remove all water-holding tins, bottles and similar odds and ends, no matter how small or trivial;
- (b) Properly cover all cisterns, wells, tanks, etc., so as to prevent the access of mosquitoes to water;
- (c) Sprinkle Pesterine or Kerosine oil once a week on every collection of waste water;
- (d) Take Quinine regularly; and
- (e) Use Mosquito Nets.

This admirable poster is amplified by the following hints for the prevention of malarial fevers, which are given in full as an illustration of the thoroughness with which the work of mosquito extermination and malaria eradication is carried on in the Municipality of Karachi at the present time.

1902, Scientific Memoir No. 46, "Malaria in the Punjab," by Major S. R. Christophers, Calcutta, 1911, Scientific Memoir No. 6, First Report of the Anti-Malarial Operations at Mian Mir, 1901-1903, by Captain S. P. James, Calcutta, 1903, followed in 1904 by Scientific Memoir No. 9, Second Report of the Anti-Malarial Operations at Mian Mir, 1901-1903.

The causes of the apparent failure of the Mian Mir eradication measures are fully understood by those thoroughly familiar with all the facts. An exceptionally instructive discussion of "The Lessons of Mian Mir" was contributed to the *Journal of Tropical Medicine and Hygiene*, under date of May 16, 1910. It is explained in this discussion that "On account, however, of its large extent, the place was very unsuited for experimental work; as, to be of any use, each tentative operation must necessarily be extremely expensive, and so the initial error was made of dealing with a small plot only, leaving the contiguous area untouched." It is, however, maintained that in consequence of the measures adopted at Mian Mir the incidence of malaria was reduced to one-third of its previous average intensity.

*An interesting circular entitled "Some Facts About Malaria," with illustrations, has been issued by the Mississippi State Board of Health, in cooperation with the International Health Board, in the furtherance of an antimalaria campaign in Bolivar County, Mississippi. The main object of the circular is to emphasize the practical value of quinine treatment and prophylaxis.

MALARIA-PREVENTION RULES AND REGULATIONS OF THE
MUNICIPALITY OF KARACHI, BOMBAY PRESIDENCY
INDIA

It is the *duty* of every one employing labour:

- 1 To improve the condition of their servants' houses and to see that they are not unduly crowded.
- 2 To see that their compounds and the surroundings of their houses are kept as clean as possible, special attention being paid to the clearing away of old tin pots and pans, rank vegetation, manure and refuse.
- 3 To fill up or drain all small pools, ponds and collections of stagnant water near their houses.
- 4 To see that all cisterns and tanks and wells are properly covered. The Malaria Parasite is conveyed by a species of mosquito.

PRECAUTIONS TO BE TAKEN *INSIDE* THE HOUSE

- 1 The proper use of the mosquito net is the best and surest prophylactic measure that we have. The net should be of a small mesh and should be tucked in carefully all round the bed. If rods are used it should be hung inside them.
- 2 During the rains and whenever fever is prevalent, each member of your household, including your servants, should get 15 grains of quinine a week. The money will be well spent, in that it prevents fever occurring among the members of your household and being conveyed to others by the mosquitoes.
- 3 The general cleanliness of your house should receive much attention. It is found that mosquitoes rest in dark and dusty corners. The cleaner the house the fewer the mosquitoes. Bins or boxes should be provided for household refuse; the refuse will be removed by the Health Department.
- 4 It is advisable to have as few curtains and as little drapery as possible, as they harbour mosquitoes. Curtains should be light in color and of a washable material.
- 5 With regard to children on their going to bed, it is advisable to anoint their legs, arms, foreheads and necks with oil of eucalyptus, or menthol and vaseline or carbolic oil, and also when washing them, to use turpentine soap, as such measures tend to keep off mosquitoes.
- 6 Careful attention should be paid to water receptacles in bathrooms, and around the house. It is not advisable to keep "gurrahs" or "chatties" full of water in a bathroom. Those in use should be emptied daily. Special attention should be paid to the "gurrahs," kept for cooling soda water, and shallow trays filled with water, placed under the legs of meat-safes and sideboards.

PRECAUTIONS TO BE TAKEN *OUTSIDE* THE HOUSE

- 1 Small "kutchas" ponds and ditches exist in many gardens and compounds and are generally the breeding places of mosquitoes, which when mature readily fly into the house. Therefore, one of your first measures should be to have all ponds and ditches near your house filled up.

2 Frequently, there lie near the kitchen and outhouse old pots, kerosine tins, and other receptacles for water; a careful search for these should be made and, if found, they should be removed or destroyed.

3 If there is any well, it should be protected by a close fitting cover.

4 The system of flower garden irrigation tends to form pools where mosquitoes can breed. It should not therefore be carried out close to the house, and any small tanks or reservoirs in the garden when not in use should be treated with half a tumblerful of crude Petroleum Pesterine once a week, as this procedure stops the development of mosquitoes in them. All garden irrigation should be carried out by means of "pukka" masonry channels.

5 Excessive vegetation and undergrowth should not be allowed to exist near the house. Anopheles mosquitoes prefer cool, dark places for resting in during the day, so that excessive vegetation should be cleared away from near the doors and windows of sleeping rooms.

6 It is important to pay attention to the cleanliness of your servants' houses and their vicinity. Native servants frequently suffer from fever, and mosquitoes haunt their dark ill-ventilated houses. The following points need attention:

1 There is frequently a ditch or pond near the servants' house, where the mosquitoes breed. This should be searched for and filled up.

2 The houses of servants, especially menial servants, syces and mallies, are frequently overcrowded. As few servants as possible should be allowed to live in the compound.

3 Servants' houses should be thoroughly cleaned out and whitewashed twice a year. Personal attention to the surroundings of your servants will well repay the trouble, as you will not only have healthier and happier servants, but the members of your family will run less risk of catching fever.

MALARIAL FEVER IS CONVEYED BY ANOPHELES MOSQUITOES AFTER BITING A PERSON SUFFERING FROM MALARIAL FEVER

The mosquito lays eggs on any accumulation of water, however small, inside or outside the house, water in wells, empty flower pots, roadside pools, catch-pits, choked gutters, etc.

The Eggs look like pieces of soot on the water.

The Eggs hatch out into Larvae in 48 hours.

The Larvae look like small pieces of stick lying on the water until disturbed when they swim away backwards and sink to the bottom.

The Larvae become Pupae within a week.

The Pupae become Mosquitoes about 48 hours afterwards.

The Mosquito flies away to suck the blood of man or animal and returns to some water to lay eggs every few days, depositing several hundreds.

If the Mosquito sucks the blood of a person suffering from Malaria and bites a healthy person, the disease is conveyed, and twelve days after the healthy person may take an attack of fever.

Precautions:—Prevent the Mosquito breeding by getting rid of accumulations of water. Prevent the access of Mosquitoes to the water, or use Pesterine or Crude Petroleum to sprinkle over the water every seven days. Take fifteen grains of quinine weekly, and give fifteen grains of quinine weekly to your servants and children, during the malaria season.

Public Health Department,

Karach Municipality,

Karachi, April 1, 1914.

E. D. Shroff,

L. R. C. P. & S. E., D. P. H. (London)
Health Officer.

ERADICATION MEASURES IN ARGENTINA

The urgency of antimalarial measures is also, to an increasing extent, being recognized in Central and South America. In the front rank of practical eradication efforts reference requires to be made to the admirable efforts of the Department of National Hygiene of the Republic of Argentina. A valuable report, of nearly four hundred pages, on malaria, including numerous illustrations, maps and diagrams, prepared by Drs. Jose Penna and Antonio Barbieri, was published by the Department of the Interior of the Republic of Argentina in 1916 (*El Paludismo y su Profilaxis en la Argentina*). This report is in continuation of at least two previous important communications on the same subject issued by the Government of Argentina in 1912 and 1915.* The Provinces of Argentina, parts of which are especially affected by malaria and in which antimalarial work has been carried on during the last five years or more, are Tucuman, Salta, Jujuy, Catamarca, La Rioja and Santiago del Estero. In this rather remote region of the Argentine Republic, more or less contiguous to the eastern foothills of the Andes, the highest rate of malaria morbidity occurs in the central part of the Province of Salta, where the rate is 246.7 per 1,000. The lowest rate of incidence in the affected area (39.6 per 1,000) occurs in the Province of La Rioja, located in the southern extremity of the malaria belt, and about the same rate prevails in the northeastern portion of the Province of Salta. Broadly speaking, the relative frequency of malaria in Argentina decreases from the north to the south, or in conformity to diminishing temperature. The area affected by malaria represents approximately one-eighth of the total area of the Republic of Argentina. The estimated number of inhabitants of this area is about one million, which is also equivalent to about one-eighth of the estimated population of Argentina for the year 1914.

*La campana antipaludica en la Republica Argentina, Su Estado Actual. Memoria Informativa de la Campana Antipaludica, durante el Ano 1914.

ARGENTINA MALARIA MORBIDITY STATISTICS

It is explained in the report referred to that the mountainous regions of the north are almost ideal for the propagation of mosquitoes, and, consequently, the spread of malaria. In this respect there seems to be a similarity with the conditions in northern India, so admirably reported upon by Major Leonard Rogers (*Fevers of the Tropics*)* and Major Kenrick for the Central Provinces of India. The rivers which flow from the Andes Mountains frequently during the thawing season or after heavy rains inundate the lower valleys, the soil of which consists of an impervious stratum of clay,† giving rise to wide-spread stagnation during the spring and autumn months. Local problems are rather difficult of exact interpretation without the aid of maps showing the details of the topography, but the table below will serve the present purpose of emphasizing the wide range in local prevalence in the five most affected provinces of the Republic of Argentina, during the four years 1912-1915. During this period there were 521,361 cases of malaria, equivalent to a morbidity rate of 186.7 per 1,000 for the five provinces combined.‡

MALARIA MORBIDITY IN THE ARGENTINE REPUBLIC 1912-1915

Provinces	Aggregate Population 1912-15	Jan., Feb., March	Apr., May, June	July, Aug., Sept.	Oct., Nov., Dec.	Total	Morbidity Rate per 1,000 Inhabitants
Tucuman .	1,339,506	60,803	85,043	56,321	60,266	262,433	193.8
Salta	591,483	34,714	41,502	35,243	35,837	147,296	246.7
Jujuy	231,610	14,073	14,960	12,858	13,976	55,867	242.7
Catamarca	319,618	9,165	11,960	11,936	10,586	43,647	142.8
La Rioja . .	310,000	2,357	3,287	3,105	3,369	12,118	39.6
Total	2,792,217	121,112	156,752	119,463	124,034	521,361	186.7
Per cent.		23.2	30.1	22.9	23.8	100.0	

Of the 521,361 cases, 23.2 per cent. occurred during the first quarter of the year; 30.1 per cent., during the second; 22.9 per cent., during the third and 23.8 per cent., during the fourth. The months of April, May

*This is a monumental work rarely accessible to the student of the subject in this country. The title of the treatise is "Fevers in the Tropics, Their Clinical and Microscopical Differentiation, including the Milroy Lectures on Kala-Azar," by Leonard Rogers, M. D., F. R. C. P., F. R. C. S., B. S., I. M. S., London, 1908.

†The correlation of a high degree of malaria frequency to soil conditions is best illustrated in the Yazoo Delta of Mississippi. The typical soil formation is the Sharkey clay and the Yazoo clay, which are practically impervious and therefore retain surface water for long periods of time.

‡For the Delta Counties of Mississippi the corresponding average malaria morbidity rate is 247.7 for the white population and 135.0 per 100,000 for the colored. See, also, table on page 23.

and June are therefore the most malarial, corresponding to the reversed climatological conditions of the southern hemisphere. In the five provinces, about one-half, or 51.1 per cent., of all the cases occurred in the Province of Tucuman. To facilitate an understanding of the local climatological conditions, the table following shows, by seasons, the comparative temperature, the rainfall and the relative humidity of the city of Tucuman, the city of Buenos Aires and the city of New Orleans.

COMPARATIVE TEMPERATURE, RAINFALL AND HUMIDITY

(Temperature, Degrees Fahrenheit)

City of	January to March	April to June	July to September	October to December	Year
Tucuman.....	74.4	58.5	57.2	72.3	65.6
Buenos Aires.....	72.6	56.4	53.1	67.0	62.2
New Orleans.....	61.3	75.2	81.5	63.0	70.3

Rainfall (Inches)

Tucuman.....	19.1	6.3	1.3	11.7	38.4
Buenos Aires.....	10.2	8.6	7.6	10.4	36.8
New Orleans.....	11.0	19.2	20.5	10.3	61.0

Humidity (Per Cent.)

Tucuman.....	77	82	70	70	75
Buenos Aires.....	72	83	80	71	77
New Orleans.....	78	75	81	78	78

According to this table the highest average temperature in the city of Tucuman prevails during January-March, which coincides with the highest rainfall. The temperature is considerably less during the months April, May and June, when the morbidity from malaria reaches a maximum. During these months the rainfall was less than one-third of that of the preceding three months, but the humidity reaches a maximum of 82.1 per cent. Compared with Buenos Aires, the temperature conditions are somewhat but not materially higher than in Tucuman. The rainfall is about the same, but more evenly distributed throughout the year. The humidity is higher during the first three months of the year, but lower during the remainder. Compared with New Orleans the climatological conditions at Tucuman are apparently much more favorable, in that for the different seasons the average temperature, the average rainfall and the average humidity are nearly all distinctly lower

in the city of Tucuman. In addition thereto, the elevation at Tucuman is 1,480 feet, against sea-level at New Orleans. The predisposing conditions are therefore unquestionably more decidedly local or topographic, or physiographic, as the case may be, rather than climatological. The average malaria mortality rate of New Orleans for the five-year period 1912-1915 was 8.4 per 100,000, in comparison with a rate of 25.9 for the city of Tucuman. The general mortality of the Province of Tucuman, from all causes, during the decade ending with 1910 was 25.9 per 1,000 of population, but a maximum death rate of 32.5 per 1,000 prevailed during the months of October, November and December. The predominating causes are stomach and intestinal disease, pneumonia, nervous disorders and tuberculosis.

Impressed, unquestionably, with the facts disclosed by the malaria morbidity statistics of the northwestern provinces of the republic, the Argentine Government called a National Medical Conference to consider the question and make recommendations with reference thereto. As a first and essential step the Government enacted a law declaring malaria a notifiable disease and provided for free medical treatment, the free distribution of quinine, educational campaigns, the scientific study of preventive measures, the undertaking of sanitary engineering works and the establishment of laboratories in the principal cities. In addition thereto, a technical statistical office was organized and active work was commenced in 1911. Sanitary engineers were sent into the different infected provinces, for the purpose of first ascertaining the local conditions, and the required initial procedure included observations upon the probable quantity of quinine required and the installation of laboratories for blood examination, etc. The entire administration of the work was placed under the National Board of Health. Inspectors were assigned to the different sections most seriously affected with malaria, and regular tours of investigation were made at intervals of four months, frequently under great difficulties, on horseback in the more remote and sparsely settled sections. To and including the year 1914 the quantity of quinine distributed amounted to 1,032,924 grams, of which 87,000 grams were for prophylactic purposes. No exclusive reliance, however, was placed upon quinine prophylaxis, and sanitary engineering works were introduced with excellent results. Swamplands are being drained, stagnant pools are being treated with petroleum and low-lying areas are being filled in, the houses of malaria patients are being fumigated, etc. It is intimated that the Government could have been more

liberal in its appropriations, but evidently much has been achieved in so far as the statistical evidence of malaria eradication can be considered conclusive. An important railway company traversing the affected regions has actively cooperated with the Government by giving preventive treatment to its employees.* The table following brings out clearly the reduction in the ascertained infection of the population of four of the principal affected provinces during the period 1909-1915.

PERCENTAGE OF MALARIAL INFECTION IN ARGENTINA BY PROVINCES 1909-1915

Year	TUCUMAN Per Cent.	SALTA Per Cent.	JUJUY Per Cent.	CATAMARCA Per Cent.
1909	37.7	27.5	19.7	41.7
1910	31.9	11.2	16.8	46.9
1912	34.8	15.8	16.5	41.0
1913	23.9	14.3	13.7	36.2
1914	13.0	8.2	8.7	39.5
1915	12.9	5.8	8.2	21.8

MALARIA IN PERU AND ECUADOR

Where so much has been done in a remote region of the Argentine Republic it may safely be assumed that much antimalarial work is in progress also in other states and countries of South and Central America, for which the information is not so conveniently available. No report has as yet been made, for illustration, upon the plan initiated by the Peruvian Government in 1916, and briefly referred to at the time in "A Plea and a Plan for the Eradication of Malaria Throughout the Western Hemisphere."† There is, however, an interesting reference to the excessive incidence of malaria in the city of Guayaquil, Ecuador, and nearby territory in the report of a first expedition to South America of the Harvard School of Tropical Medicine. The statement is made that great difficulty was experienced in Guayaquil in the diagnosis of yellow fever, since about one-third of those admitted to the Yellow Fever Hospital were found to be suffering from malarial infection. The conclusion is advanced that "the correct differential diagnosis from malaria upon clinical grounds is frequently impossible; but on the other hand, the fact must be taken into account that in a city like Guayaquil, where

*For the translation of this important report I am obliged to one of my office assistants, Mr. A. F. Schopp.

†"A Plea and a Plan for the Eradication of Malaria Throughout the Western Hemisphere," by Frederick L. Hoffman, Prudential Press, Newark, 1916. (Copies available on request.)

during the year about ninety-five per cent. of the population are said to suffer from malaria, a concomitant infection with this disease and yellow fever may likewise exist, and that even though malarial parasites may be found in the blood, nevertheless the individual may likewise be infected with yellow fever."*

In a report on a "Geographical Reconnaissance Along the Seventy-third Meridian, including the Andes of Southern Peru," by Isaiah Bowman, of the American Geographical Society, a brief reference occurs to "the appalling mortality from malaria" at Rosalina, where "over sixty Indians died of malaria in one year." Malaria has also been a matter of serious concern to rubber-gatherers in the Peruvian forests, and "many of the river villages have been abandoned in consequence of its ravages and the disease has driven the Indians to permanent residence in the hills."†

MALARIA IN SWAZILAND AND CYPRUS

A considerable amount of new and most interesting information on malaria in Africa has become available during recent years, but extended references therefrom would unduly enlarge the present discussion. Of exceptional interest, however, is a brief account of an epidemic of malaria in Swaziland, included in the annual report of the resident commissioner, as follows: "The outstanding feature of the year was the unusually severe outbreak of malaria which began about the middle of December, 1916. It extended to the highest parts of the country where it has been found only occasionally before. Very virulent forms of the disease, resulting in death after an illness of from a few hours to a day or two, were fairly common amongst the natives of the low country. Free quinine distribution was made, as usual, at the various outstations. About the middle of the summer there was an exceedingly virulent epidemic of bacillary dysentery in the Hlatikulu district. About seventy people were affected and thirty of them died. The epidemic was promptly taken in hand and this succeeded in limiting it to a dozen kraals."

Of somewhat earlier date is a Report on the Prevention of Malaria in Cyprus, by Sir Ronald Ross, issued as a preliminary publication under

*Report of First Expedition to South America, 1913, Harvard School of Tropical Medicine, Cambridge, 1915.

†Among other references of value on malaria in Brazil and its relation to the exploration, settlement and economic development of the country, see "Notes of a Botanist on the Amazon and Andes," by Richard Spruce, two volumes, Macmillan & Co., London, 1908, "The Lower Amazon," by Algot Lange, New York, 1914, and "Through the Brazilian Wilderness," by Theodore Roosevelt, New York, 1914, with special reference to his own illness (pp. 197-198, 309 and 319-320).

date of January, 1914. This report emphasizes the suitability of Cyprus for a large antimalaria campaign, chiefly, however, in the direction of thoroughly effective methods of mosquito extermination. Sir Ronald Ross observes that the only country which in his opinion would lend itself better to mosquito eradication than Cyprus would be Ismailia, Egypt, on account of the absence of rainfall during the warm months of the year and for other reasons. He considers the method of quinine distribution "just as difficult in Cyprus as it is anywhere else, this difficulty depending upon the natural unwillingness of the people in Cyprus and elsewhere to take an unpleasant medicine for the rest of their lives." He, nevertheless, recommends that quinine distribution should be pushed with the greatest vigor amongst school-children, especially those with enlarged spleen. He also recommends the distribution of goldfish to all owners of irrigation systems. He ascertained by means of an actual spleen survey that the average spleen rate was 25.4 per cent., and as high as 100 per cent. in one district, while it was as low as zero in another. In the most heavily infected district of Larnaca, in which 756 children were examined, the spleen rate was 49.73 per cent. The report by Sir Ronald Ross is a model of brevity combined with thoroughness and a due regard of all the essential factors affecting the incidence of malaria and its prevention in the Island of Cyprus.* Such reports should be made for every American community or section in which the incidence of malaria is above the normal average. It need hardly be said in this connection that the conclusions of Sir Ronald Ross were based chiefly upon microscopical diagnoses, and it may be stated in conclusion that out of 503 cases microscopically examined, 470, or 94.4 per cent., were confirmed. The distribution of the different species of parasites was tertian, 48.5 per cent., quartan, 8.0 per cent., and aestivo-autumnal (malignant), 43.5 per cent.

COMPARATIVE PAN-AMERICAN MALARIA STATISTICS

The excessive incidence of malaria in certain sections of Central and South America is shown in the following table, derived from "The Mortality of the Western Hemisphere," issued by The Prudential Insurance Company in 1915. It has not seemed necessary for the present purpose to bring the data down to date.

*Of special importance to the student of methods in malaria investigation is the report by Sir Ronald Ross on "Prevention of Malaria in Mauritius," published by J. and A. Churchill, London, 1909.

COMPARATIVE MORTALITY FROM MALARIA

	Rate per 10,000 Population	Percentage of All Causes
Nicaragua (1908-1911).....	72.7	40.5
British Honduras (1907-1911).....	68.9	27.6
British Guiana (1906-1911).....	67.0	20.1
Para, Brazil (1906-1910)	43.7	19.5
Guayaquil, Ecuador (1909-1912).....	43.2	8.6
Panama Canal Zone—Civil Population— (1906-1912).....	39.2	13.1
Salvador (1908-1913).....	36.3	13.0
Venezuela (1905-1909).....	34.9	16.8
Trinidad-Tobago (1907-1911).....	21.9	9.0
Argentina (1907-1911)	15.0	7.0
Paramaribo, Dutch Guiana (1907-1912) ..	14.5	4.2
Saint Lucia (1907-1911).....	14.0	6.7
Bahia, Brazil (1905-1908).....	11.7	6.3
Porto Rico (1904-1908).....	11.4	5.0

This table reemphasizes the practical urgency of malaria eradication as a social and economic problem of serious concern to practically all the important countries of the Western Hemisphere.* The table fully sustains the far-reaching value of the resolution unanimously adopted by the Second Pan-American Scientific Congress, as Article 29 of the Final Act, reading as follows:

That all American countries inaugurate a well-considered plan of malaria eradication and control based upon the recognition of the principles that the disease is preventable to a much larger degree than has thus far been achieved, and that the education of the public in the elementary facts of malaria is of the first order of importance to the countries concerned.

Every authority on malaria eradication agrees that the practical solution of the question is primarily one of active and intelligent co-operation on the part of the Government and the many-varied associated activities of the general public. Regardless of the encouraging evidence

*In view of the special importance which is properly attached to the malaria experience in Panama, the following statistics are of interest: From a rate of 31.2 per 10,000 in 1906 the malaria mortality of white employees in the Panama Canal Zone was reduced to 2.8 in 1914, increasing to 6.4 in 1915; but no deaths occurred during 1916. The rate for the colored employees during the same period decreased from 102.4 in 1906 to 0.7 in 1916. In that year there were only 2 deaths from malaria among the colored employees. In the Panama Canal Zone the number of hospital malaria cases for white employees decreased from a maximum of 8,071 in 1907, or 75.4 per cent. of the employees, to only 180 cases in 1916, or 4 per cent. For the colored employees the number of hospital malaria cases decreased from 16,659 in 1906, or 79 per cent., to only 367 cases in 1916, or 1.3 per cent.

of malaria reduction in many sections of the world, the anticipated progress based upon the clear recognition of the causative factor in malaria dissemination has not been made. The work of the National Committee on Malaria of the United States has been limited to the discussion of more or less highly specialized aspects of the problem and the encouragement of Federal and State efforts and the admirable coordination of the work of the International Health Board in certain localities in the Southern States. If more rapid progress is to be made within a measurable period of time, much more is required than has heretofore been the case. The movement for malaria eradication will necessarily gain force in proportion as the economic aspects of the problem are more clearly realized and the achievements in particular localities are brought intelligently to public attention.*

WORKMEN'S COMPENSATION FOR MALARIAL DISEASES

An interesting case involving the question of workmen's compensation for malarial diseases was decided by the Industrial Accident Commission of California (No. 3126, December 12, 1916). This was the case of William Addison Tennant, applicant, *versus* State Department of Engineering, Flood Control Division, defendant. Applicant was employed by the defendant as chainman with a surveying party and claimed compensation for disability due to malaria contracted on or about September, 1916. For three months prior to this date applicant had been engaged in the survey of the Cosumnes River, near Galt, and the adjacent swamp country, during which time the party used as living-quarters houseboats on the river, which were furnished by the defendant. Mosquitoes were very prevalent in this region, and although screen tents were used at night for the protection of the employees, the testimony showed that the mosquitoes could not be kept out and that applicant was almost constantly exposed to insect bites. It appeared further that malaria was common in this region, but that no other member of the party was affected with it. The applicant attributed his attack to the bites of mosquitoes sustained while so engaged. The commission held that since the risk of contracting malarial fever was not a risk peculiar to the applicant's employment, but was a risk to which all persons residing in that locality were subjected, whether engaged as employees or not, the evidence was not sufficient to establish as a fact that the injury arose out of and was approximately caused by

*For a full account of the practical possibilities of cooperative action in the furtherance of antimalarial measures, see my "A Plea and a Plan for the Eradication of Malaria Throughout the Western Hemisphere."

the employment. The defendant was accordingly discharged from all liability on account of the claim asserted in this proceeding.

Serious objections lie against this decision, which certainly will hinder the cause of malaria eradication as a matter of general public and corporate policy. It has been the experience of the United States Geological Survey that men frequently are disabled for long periods of time in consequence of occupational exposure to the risk of malarial infection in the same manner or under much the same circumstances as set forth in the preceding case. There certainly can be no question of doubt but that in the event of similar cases being brought before the United States Employees Compensation Commission that compensation would be paid as a matter of simple justice, in clear recognition of the occupational malaria hazard in connection with such employment, for illustration, as levee-construction on the Mississippi River. As a general principle, the doctrine of compensation for occupational diseases is as yet so imperfectly developed in this country, and practically not at all in the Southern States, where malaria prevails most extensively, that the decision of the California Industrial Accident Board is not likely to stand the test of subsequent experience.

The theory of personal responsibility for conditions predisposing to malaria was considered in the United States at least as early as 1810, according to a brief account of a trial at law, in which the influence of water raised by a mill-dam on the health of the inhabitants in the neighborhood was considered and set forth in one of the Memoirs of the Connecticut Academy of Arts and Sciences. This trial was held before the Superior Court at Litchfield, in January, 1800. Unfortunately, the evidence presented was so conflicting and the underlying factors of disease transmission by the anopheline mosquito being unknown, the decision of the court was adverse to the plaintiff, and in favor of the owner of the dam, upon the ground that the same could not be proved to be a nuisance. This point of view, however, no longer prevails, and to the extent that suits of law are brought against offending owners violating local or State ordinance, the possibilities of more active cooperation on the part of the general public in malaria eradication and mosquito extermination will be more clearly realized. There appear to have been no final court decisions on the question of personal, corporate or public responsibility in pecuniary damages for malaria contracted in consequence of conditions within the definition of a personal menace or a public nuisance causing malarial infection in a serious or fatal form.

RECENT MUNICIPAL ORDINANCES ON LEGAL REQUIREMENTS FOR REPORTING OF MALARIAL DISEASES

As a first step in this direction, it is clearly necessary for each and every community more or less directly concerned in malaria eradication or mosquito extermination to adopt ordinances to prevent the breeding of mosquitoes and the maintaining of nuisances contributory thereto. Among encouraging evidences in this direction are the ordinances adopted by Crystal City, Mo., under date of January 8, 1916, the city of Dallas, Texas, under date of July 12, 1916, and the city of Tyler, Texas, under date of May 15, 1916. These are reported in full in the annual survey of Municipal Ordinances, Rules, and Regulations Pertaining to Public Health, issued by the United States Public Health Service during the year 1917.* Of special importance is a resolution of the Board of Health of the city of New Orleans, adopted March 14, 1916, providing for the compulsory notification of malaria, reading, in part, "That from and after this date malarial fever be included in the list of communicable diseases to be reported to the board of health of the city of New Orleans, and for the parish of Orleans." Malaria was also included in the list of communicable diseases required to be notified under an ordinance of the city of North Yakima, Washington, of April 10, 1916.

The urgency of malaria notification is strongly emphasized in the recommendations of the Health Survey of Middletown, Conn., by David Greenberg and Ira D. Joel, with an introduction by Prof. C-E. A. Winslow, of the Department of Public Health, Yale School of Medicine. According to Prof. Winslow's introduction "The problem of malaria in Middletown is a serious one, as it is in many other sections of Connecticut. From one-half of the physicians interviewed Mr. Greenberg and Mr. Joel obtained evidence of 200 cases treated during the current year, and though malaria is rarely a cause of death, the aggregate amount of sickness and disability which it creates is a serious burden upon the community. The mosquito problem of Middletown appears to be mainly due to small accumulations of stagnant water and requires supervision and treatment of these isolated spots rather than extensive drainage operations. It is important that an ordinance should be adopted declaring the exposure of cans, kettles, bottles, or other unscreened receptacles which may furnish opportunities for mosquito

*State laws and regulations pertaining to Public Health, adopted during 1915, Municipal Ordinances, Rules, and Regulations pertaining to Public Health, adopted during 1913 by localities having a population of over ten thousand in 1910.

breeding to constitute a nuisance." These observations are amplified by a concluding statement in the survey that "Malaria is a communicable disease, communicated from person to person through the bite of the malaria mosquito. To restrict the spread of this infection it must be treated like any other such disease, and hence we recommend as Recommendation No. 12, That malaria be made a reportable disease."

The occurrence of malaria in Connecticut is a matter of exceptional historical, medical and sanitary interest. The subject was referred to in the "Climatology of the United States," by Lorin Blodget (Philadelphia, 1857), who remarks that "The fact that there is now little or none of fever and ague in the Connecticut Valley and on the New England Coast is no disproof of its climatological adaptation to it, if local circumstances are favorable. Dr. Forry quotes from Dr. Holmes' Prize Dissertation on the Intermittent Fever of New England proof that intermittent fever has prevailed on the Connecticut River from our earliest colonial history."

In 1887 Dr. Franklin C. Clark, of Providence, R. I., contributed an interesting discussion of "Travels of Intermittent Fever in Rhode Island" to the Ninth Annual Report of the Rhode Island State Board of Health. In it reference is made to an outbreak of "a pestilential fever" which visited the colony of Massachusetts in 1633, which was attributed to large swarms of "humming flies." The discussion is illustrated by an exceptionally valuable map indicative of the gradual progress of the disease into new sections of the State, commencing with the outbreak of 1723 and continuing with the two most important outbreaks of 1830-1840 and 1880-1881. According to the Nineteenth Annual Report of the Rhode Island State Board of Health for 1895, public attention was directed to the prevalence of malarial diseases in the public schools of certain sections, and through the spring and early summer of that year frequent complaints had been heard from physicians and others in regard to the unusual amount of malarial disease, and "because of the interference of malarial sickness with school work," an investigation was made of the number of cases in the different schools of Providence, and 656 cases were ascertained, with, however, a reasonable question of doubt as to the accuracy of the diagnosis, involving possibly erroneous reporting of cases of typhoid fever.

Still more interesting as evidence of the present-day importance of malaria in certain New England States and the danger of local outbreaks in epidemic form is the following extract from the report of the Thirty-third Report of the State Board of Health of Connecticut, for the two

years ending September 30, 1914: "An interesting fact is that, previously to the Civil War, malaria had been for a long period almost unknown within the borders of the state. It appears to have been brought north by the soldiers returning from the war and was then carried by the *Anopheles* mosquitoes here present to almost every inhabited part of the state. It was very prevalent in the seventies and then gradually subsided. The reports of the Town Health Officers indicate that it has been more common again during the past two or three years, particularly in the southern and southwestern parts of the state, and possibly the Italian immigrant has had something to do with its reappearance. Greenwich has been one of the principal sufferers and in 1912 the number of cases was estimated at about nine hundred. A house to house canvass for cases and a vigorous anti-mosquito campaign has caused it to almost entirely disappear, so that few cases have been reported there during the past two summers."

There is, perhaps, at the present time no more fruitful field of specialized inquiry into the occurrence of malarial disease in the North than the State of Connecticut. A large amount of exceptionally valuable new material is available to continue the "Observations on the Etiology of the Malarial Diseases at Present Prevalent in Southwestern New England," by Rufus W. Griswold, M. D., of Rocky Hill, Connecticut, 1886. All the evidence derived from official and other sources sustains the conclusion that malaria as a disease and as a complicating factor in other diseases is much more common in New England at the present time than is generally assumed to be the fact.

PART II

MALARIA IN RELATION TO WAR

MALARIA IN THE CIVIL WAR

For a hundred years, at least, the military importance of malaria has been clearly recognized by army authorities. During our Civil War, largely on account of the fact that the military activities were practically confined to the Southern States, malaria became wide-spread among the troops, and, according to Prinzing's treatise on Epidemics Resulting from Wars,* "on an average, no less than fifty-two per cent. of the white troops and eighty-three per cent. of the colored troops contracted the disease per annum." Much valuable information on the subject is contained in the "Medical and Surgical History of the War," which is chiefly relied upon by Prinzing, who properly directs attention to the fact that the negro troops were by no means immune to the disease, but, quite to the contrary, contracted it much more frequently and suffered a great deal more severely from it than the whites. Granting the inherent defects of all military medical statistics, with reference to which the original information is frequently secured with exceptional difficulty, our Civil War data are nevertheless of much interest and practical value at the present time.† A convenient summary account of the prevalence of malaria among the Northern troops, both white and colored, is presented by Prinzing in the table following:‡

MORBIDITY AND MORTALITY FROM MALARIA DURING THE CIVIL WAR

(Rate per 1,000 Exposed to Risk)

	WHITE TROOPS		COLORED TROOPS	
	No. Patients	No. Deaths	No. Patients	No. Deaths
1861-1862.....	404.0	2.77	..	..
1862-1863.....	460.1	3.76	..	..
1863-1864.....	584.1	3.19	833.7	15.19
1864-1865.....	558.4	3.34	750.0	8.77
1865-1866.....	853.1	5.42	947.0	7.81

*"Epidemics Resulting from Wars," by Dr. Friedrich Prinzing, edited by Harald Westergaard, published by the Carnegie Endowment for International Peace, Oxford, 1916.

†The full title of this invaluable source of useful medical and statistical information is "Medical and Surgical History of the War of the Rebellion," Washington, 1888.

‡"Epidemics Resulting from Wars," page 180.

The total number of deaths from malaria among the white troops during the Civil War, with an average strength of 468,000 per annum for the white troops, was 8,140, or 17.4 per 1,000; while for the colored troops, with an average strength of 63,645 per annum, limited, however, to 1863-1866, the total number of deaths from malaria was 1,923, or 30.1 per 1,000 per annum.

MALARIA IN PRISON CAMPS

In Northern and Southern prisons the mortality from malaria was much less than expected, due, no doubt, to the extraordinary mortality from other causes. According to Prinzing, the annual rate per 1,000 from all causes among Confederate prisoners in Northern prisons was 230.7, of which the mortality from malaria was 12.6, and from typhoid and typhus fever, 13.6. In contrast, the mortality from diarrhea and dysentery, combined, was 73.0, and from inflammation of the lungs and pleurisy, 61.7.

In Southern prisons the conditions were still worse. Apparently in Andersonville alone the annual mortality was 792.8 per 1,000, of which the mortality from malaria was only 12.2, and from typhoid and typhus fevers, 20.5. In contrast, the mortality from diarrhea and dysentery, combined, was 465.6, and from inflammation of the lungs and pleurisy, 27.4.*

In Northern prisons the mortality from scurvy was 4.3 per 1,000, against a rate of 102.8 in Southern prisons. Such an extraordinary mortality from more immediately fatal diseases would naturally tend strongly to reduce the mortality from malaria, although in all probability malaria was a complicating factor in a large number and proportion of deaths due to other diseases.

METHODS OF QUININE PROPHYLAXIS

The possibilities of malaria prevention and control were recognized by the Army authorities of the day, but the difficulties to be overcome were enormous.† The true nature of malaria as a disease transmissible through the mosquito not being understood at the time, chief reliance was placed upon quinine prophylaxis. In amplification of suggestions with

*The annual mortality rate for Andersonville prison is based upon the six months' experience March 1 to August 31, 1864, when of an average number of 19,453 prisoners 7,712, or 39.6 per cent., died, equivalent to an annual rate of 792.8 per 1,000. (See Prinzing, *loco citato*, p. 181.)

†See Report P of the Sanitary Commission on the Nature and Treatment of Miasmatic Fevers, Washington, 1862.

reference to the use of quinine contained in the "Rules for Preserving the Health of the Soldiers," issued under date of July 13, 1861, the Sanitary Commission issued a special report of a committee appointed to prepare a paper on the use of quinine as early as 1862. This publication, though rarely referred to in the literature of the subject, was a most important document, which deserves to be much better known than is actually the case. The report concludes with words which may well be taken to heart at the present time, that "viewed in the light of humanity as well as of economy—both of men and money—the *prevention* of disease is of far greater importance than its cure, and your Committee venture to express the opinion that intelligent and judicious action on this important subject at the hands of the authorities would save much sickness and many valuable lives during the present campaign."*

MALARIA IN THE EUROPEAN WAR AREA

It requires no argument, of course, to prove that the importance of malaria in relation to war is more clearly recognized by modern military authorities. In a treatise on "Military Hygiene and Sanitation," Lieutenant-Colonel Frank R. Keefer, of the United States Medical Corps, quotes Major-General Gorgas as having given expression to the opinion that "when troops are marching through a malarious country the only practical measures for their protection is the administration of quinine." He adds, however, and wisely so, that "if a camp is occupied for more than a day or two the ground should, of course, be cleared and accumulations of water drained away or oiled."

*It is properly pointed out in an editorial in *The Lancet* (February 23, 1918) on Quinine in the Treatment and Prevention of Malaria that "At no time has it been more important than now to understand the exact method of administration of quinine by which the malaria parasite may best be attacked, no matter whether our knowledge is obtained by comparison of the practical experience gained empirically from treating patients or is to be inferred from the results of special research." In recognition of the practical importance of this question the British War Office early in 1917 arranged for a concentration of malaria cases returned from overseas in special hospitals in England for treatment by specially qualified medical officers who were invited to cooperate in a scheme for comparison of the practical results obtained from different lines of treatment. The reports which have been made have recently been summarized by Sir Ronald Ross, the adviser of the War Office, in an article contributed to the Proceedings of the Society of Tropical Medicine. According to the editorial in *The Lancet*, "The result from all the quinine treatments taken together was represented by some 27 per cent. of ascertained relapsing cases in a total of about 2,500 patients. At Oxford a control was afforded by 192 men who were watched without any quinine treatment at all, and of these 89 relapsed within 27 days, and 76 were presently judged not to be sufficiently well to allow of quinine treatment being withheld any longer; so that 86 per cent. of the untreated cases remained ill and 46.5 per cent. actually suffered from relapses during the period."

Of exceptional value is the conclusion that "The evidence that continued daily doses of only five grains afford a relatively slight protection against relapse is important, and no doubt accounts for much of the disappointment which has been expressed at the results of the prophylactic use of quinine in this dosage in the malarious areas of Macedonia, where relapses are so common among the large proportion of the force which has become infected." Equally suggestive is the further conclusion that "If the view is now to prevail that the failure of the prophylactic use of quinine under war conditions has been demonstrated, we hope that the causes of the failure and the nature of the proof will be fully analysed and discussed."

The malaria problem in its military aspects is, however, much more complex than is indicated by this brief reference to the subject in the text-book referred to.

In a recent treatise on "Sanitation in War," by Major P. S. Lelean, more extended consideration is given to the role of insects in war, with especial reference to mosquitoes, attention being directed to the fact that in western Europe the usual malaria-carrying mosquito is the species known as *Anopheles maculipennis*; in southern Europe the chief malaria-carriers are *A. maculipennis* and *A. superpictus*; in Egypt the principal disseminator is *A. (Cellia) pharoensis*. Since in most cases the services of a trained entomologist are required to differentiate the different species, or those that are known to be harmless from those that are not, Lelean suggests that "the only safe rule of conduct for the sanitary officer is to regard all mosquitoes, and especially all species of anopheles, as potentially dangerous, and immediately to search for and take the necessary steps to destroy the breeding places whenever mosquitoes resting in the characteristic Anopheline attitude, or the equally characteristic larvae are found." An additional recommendation is to the effect that "whenever possible, mosquito breeding-places should be destroyed by filling them in with earth or sand. Stagnant pools to which this treatment cannot be applied should be rendered harmless by oiling the surface, at least once a week, with a mixture of equal parts of green oil and petroleum, at the rate of half an ounce to the square yard." Aside from the foregoing, Lelean suggests the enforcement of all the well-known methods and precautions primarily directed against the extermination of the mosquito, rather than the immunizing of malaria-carriers.

MALARIA AND "TRENCH FEVERS"

The extent to which malaria has been a factor of military importance on the western front is not yet a matter of sufficient information to justify alarming conclusions. In a report by Surgeon A. M. Fauntleroy on the Médico-Military Aspects of the European War issued in 1915, the statement is made that "Except for an occasional recurrent attack of malaria in individuals who formerly contracted the disease while living in the south, there is no evidence of any ill effects from the presence of the few mosquitoes at the front." There are, however, reasons for believing that this statement is no longer in conformity to the facts, if, indeed, it was strictly accurate even at the time when the

observations were made. For, as observed in a treatise on "The Medical Diseases of the War," by Arthur F. Hurst, "The possibility of malaria must always be considered, and a blood film should be examined for the malarial plasmodium before making a definite diagnosis in cases of doubt, especially if the patient has previously had malaria, or when it is prevalent, as was the case during the summer in Salonica." The term "trench fever," which has become generally accepted, represents, probably, a group of diseases in which the diagnosis is often doubtful. How much of the so-called "trench fever," if any, is true malaria originally contracted on the western front or recurrent malaria among troops exposed to infection in more intensely malarial areas cannot at the present time be decided. Hurst calls attention to the fact that "The aestivo-autumnal form of malaria may closely resemble paratyphoid fever"; that "the differentiation can then only be made by a blood examination, as remissions may be slight, and typical rigors, though not uncommon in paratyphoid fever, do not always occur in malaria."

In an admirable treatise on "Military Hygiene," Havard properly points out that "Malarial fever, intermittent fever, ague, chills and fever, are different names for the same disease." In his observations on prophylaxis he directs attention to (1) the destruction of mosquitoes, (2) protection against mosquito bites, (3) the isolation and protection of malarial patients and (4) medical prophylaxis, chiefly quinization. Mason, in a "Hand Book for the Sanitary Troops," also concludes that in malaria "the sick must be protected against mosquitoes, so that the mosquitoes cannot get the disease, and the well must also be protected so that if there are any infected mosquitoes about they may not do any harm."*

The application of these observations to the European War and the solution of sanitary problems in this country in connection with military activities is self-evident. The risk of a wide-spread malarial recurrence in regions heretofore practically free therefrom is unquestionably much more serious than generally assumed.†

*The principal modern works of reference on military hygiene are: "Manual of Military Hygiene," by Valery Havard, M. D., New York, 1914, "A Complete Handbook for the Sanitary Troops of the U. S. Army and Navy," by Charles Field Mason, New York, 1917, "A Text-Book of Military Hygiene and Sanitation," by Frank R. Keefer, M. D., Philadelphia, 1917, "Sanitation in War," by Major P. S. Lelean, London, 1917.

†The effects of malaria on wounds have been discussed by Vandenbosche in a thesis presented to the University of Lyons (abstracted in the *Journ. de med. et de chir. prat.*, April 25, 1917), based upon his observations at Salonica. Of special importance is the conclusion that: "Unless the possibility of malaria be borne in mind, fever in a wounded man may mislead the most experienced surgeon into enlarging the wound." Vandenbosche further calls attention to malaria gangrene as fortunately rare; but he also mentions "cases in which a malaria attack simulating appendicitis has brought the patient to the operating table."

MALARIA IN THE WESTERN WAR AREA

Etienne, a French surgeon, in a discussion of the subject has directed attention to the revival of the ancient form of endemic malaria in the Seille Valley, which has always been infested with the malarial mosquito, but in which no new cases had occurred since 1888 until subsequently to the outbreak of the war. Cases first met with in 1915 were all in persons who had never been in tropical or other malarial regions. Etienne is of the opinion that "troops from Africa and French China have brought virulent malaria parasites into the country, and thus the mosquitoes are serving anew as intermediary hosts." In a letter contributed to the *Le Bulletin Medical*, Paris, of August 12, 1916, considerable new information is made public regarding the forms of malaria in the sphere of warfare at and in the vicinity of Salonica. The opinion is advanced that soldiers coming from France have become contaminated on their arrival, the positive diagnosis having been made in the bacteriological laboratories of the Eastern Army. A study of the blood shows the three principal forms of the malarial parasite. Since the primary form of malaria is not met with in France under normal conditions, the onset of the disease is generally not recognized by the patient, who "is greatly prejudiced because he does not receive his quinine at the outset." In the experience of the Eastern Army the attacks of primary malaria are followed at an early date by a series of daily intermittent attacks, even in the absence of a reinfection. In the absence of proper treatment "anemia appears, followed by enlargement of the spleen, and may pass on to a true cachexia with anasarca or simple edema of the legs and face, oliguria, palpitation, anorexia, diarrhea, apathy and torpor." Other complications have been observed in the experience of the French army, one case of anterior spinal general paralysis in a soldier having been reported as due to a malarial infection originally contracted by an officer who had left Bordeaux for Africa and developed malaria during a stay of eighteen days in the tropics.

MALARIA IN THE EASTERN WAR AREA

In appreciation of the seriousness of the situation in the Eastern Army the soldiers at and in the vicinity of Salonica are required to take daily five-grain doses of quinine as a preventive measure, in conformity, no doubt, to the point of view previously referred to, as having been given expression to by Major-General Gorgas, on the basis of his experience in Cuba and at Panama. This procedure has been severely criticized by E. Halford Ross, one of the foremost authorities on malaria eradica-

tion, who is of the opinion that quininization cannot possibly prove effective, or, in his own words, "It is almost heart-breaking for those of us who, having broiled for years in hot climates dealing successfully with disease, find now, after two decades of hard-gained knowledge, military authorities reverting to methods which are not only out of date and hard to carry out completely, but are also very costly." He holds that five grains of quinine is an item of considerable expense and that such methods of procedure are unnecessary if proper antimosquito measures are carried rigorously into effect.

In contrast to this point of view, evidence has been brought forward that in the Italian army the amount of malaria was reduced from fifty to five per 1,000 during a single decade, in response to systematic quinine prophylaxis. This experience, however, was previous to the war, when the difficulties of complete sanitary control have become enormous. According to a brief note in the London *Lancet*, of December 30, 1916, "Malaria, the most important of all tropical diseases, has been making its presence felt in some of the war-zones, causing mortality and invalidity among our expeditionary forces, particularly among the troops, both French and English, operating in the Valley of the Vardar, north of Salonica. In this unhealthy region many soldiers contracted malaria in spite of a daily prophylactic dose of five grains of quinine." Reference is then made to a discussion of the value of quinine prophylaxis at a meeting of the Society of Tropical Medicine and Hygiene, at which Dr. Angus Macdonald, of Kingston, Jamaica, read a paper on the Position of Malaria in Sanitary Administration. It is said that in this address "He maintained that continuous drugging with quinine might prevent attacks of malaria in anopheline countries, but statistics were still lacking to demonstrate the extent to which the use of this drug prevents the occurrence of the disease." This viewpoint was endorsed by Surgeon-General Sir David Bruce, who also expressed, from personal experience, some skepticism in regard to quinine as a prophylactic against malaria, adding that he wished that the matter could be "settled once for all by good evidence."*

*Of special value for this purpose should be the quinine immunization or prophylactic disinfection demonstration carried on by the International Health Board in Bolivar County, Mississippi, under the direction of Dr. C. C. Bass, of New Orleans. See page 28, *et seq.*

According to N. Samaja, in a contribution to the *Gazzetta degli Ospedali e delle Cliniche*, Milan, January, 1918, "Malaria is the one disease encountered most frequently now in the Italian military hospitals. Among 417 patients in his service at Bologna, 244 had malaria. Among the symptoms of intolerance of quinine, occasionally noted, hemorrhagic purpura was not exceptional, but the dose of quinine usually was large when this by-effect was observed. The attacks of hemorrhagic purpura followed whether the quinine was given by the mouth or subcutaneously, and in constantly smaller doses down to 0.10 grams, but the intensity of the purpura was less pronounced with the smaller doses."

MALARIA RECURRENCE IN BELGIUM AND NORTHERN FRANCE

With more specific reference to the western front, Renaux in an article contributed to the "Medical Archives of Belgium," Paris, January, 1917, remarks that "although acute malaria has long had only historical interest in Belgium, yet malaria has never died out completely there. A few chronic cases have been encountered from time to time in the last few decades. But the wartime conditions, the flooding of the country as a protection against the enemy, and defective hygienic measures have led to the flaring up anew of the old embers of malaria, and he had been able to identify nineteen cases in the Bourbourg and Gravelines hospitals. Malaria had not been suspected at first, and the cases had been labeled pneumonia, grip, febrile gastric disturbance, etc. None of these affected had ever been in tropical countries. The lack of any regularity in the recurrence of the fever aided in the overlooking of the true cause of the disturbances. Even when there was a regular rhythm in the fever, it varied from daily to tertian, and vice versa. Under quinine the men rapidly recovered, and only two returned with a recurrence. The parasites were of different sizes and seemed to represent a type midway between the quartan and the benign tertian. He noted in the blood of these patients numerous basophil punctuated red corpuscles, such as are considered typical of anemia and lead poisoning."

CLINICAL ASPECTS OF MALARIA CONTROL

Drs. Falconer and Anderson, in a communication to *The Lancet*, of April 21, 1917, on "Clinical Types of Subtertian Malaria as Seen in Salonika in September, October and November, 1916," including over 3,600 cases, stated that the majority of these cases "were of the simplest subtertian, double subtertian and irregular types of subtertian pyrexia, without local manifestations. These cases uniformly responded well to treatment with quinine. The most important group of cases with local symptoms, on account both of relative frequency and of difficulty of differential, were characterized by more or less urgent gastrointestinal symptoms. This group could be separated into several more or less definite types: Dysenteric, in which the stools, from six to fifteen in twenty-four hours, were fluid and feculent, without definite blood and mucus, while in a smaller number of cases the stools contained definite blood and mucus. It was possible in the great majority of these cases to demonstrate a superadded infection with one of the organisms of the

dysenteric group. Choleraic pernicious fever, of which but two cases were met with, and both cases died within fifteen hours on admission in spite of intravenous quinine and salines. Appendicular types, in which the cases strongly resembled appendicitis. There were twelve cases in this group, and the chief complaint was vomiting, and severe pain referred to the right iliac fossa, associated with moderate pyrexia and marked tenderness and rigidity in the same fossa. In most of the cases the rigidity was not constant. Leucocytosis was absent, but the typical relative lymphocytosis of malaria was present. All rapidly cleared up under quinine. Bilious remittent fever, from which thirteen of their fatal cases succumbed. Jaundice, with vomiting, bilious diarrhea, and mental confusion were chief symptoms. After quinine intravenously, they apparently improved, only to later succumb and die in coma or delirium. Pernicious fever with pulmonary symptoms, in which both numerically and as a cause of death, this was the next most important group, in which the patients' dominant symptoms were referred to the respiratory tract. Of the cases of malaria which terminated fatally, pulmonary complications of a pneumonic or bronchopneumonic character were present in seven, and were the immediate cause of the fatal issue. Among others were the bronchitic type, the pneumonic and bronchopneumonic type, including the deaths above mentioned, and in which the subtertian parasites were demonstrated in the blood. Cerebral cases, which formed a small but interesting group. There were nine cases of this type, due to local affections of the nervous system. Generalized edema with ascites, two cases. Gangrene of the feet comprised another group, consisting of three cases which showed evidence of gangrene of the toes. In all, thirty cases infected with malaria died, and with the exclusion of thirteen cases dying from complications, seventeen cases succumbed to uncomplicated malaria."

URGENCY OF DRASTIC PREVENTIVE MEASURES

It has seemed appropriate to quote the foregoing observations *in extenso*, on account of the large number of cases under observation and the thoroughly qualified scientific analysis of the facts. The experience proved conclusively the practical importance of the question from a military point of view and the imperative duty of the adoption of effective precautionary measures, aside, of course, from the necessary provision for the verification of the clinical diagnosis by the microscopical examination of the blood smears, etc. Errors of treatment are as

likely to prove of serious consequence as indifference to the adoption of precautionary measures, with or without reference to quinine prophylaxis. Captain H. Stott, of the India Medical Service, in a treatise on "Studies in Malaria," has included an interesting account of his experience of hyperpyrexial heat-stroke in Mesopotamia during 1915, which justified the conclusion that "in many cases it was evidence of a malarial infection," while in some others "it was connected with the enteric group of fevers." He adds, however, that the heat from the Persian Gulf during June, 1915, was intense, and the relative humidity of the atmosphere very high. Out of thirty-three European patients with heat-stroke, it was found that thirteen had an active concomitant malarial infection, and that in five more the presumptive evidence in favor of malaria was very strong. Captain Stott explains that "Usually the patient was struck down suddenly with a well-marked heat-stroke of 107 or 108 degrees Fahrenheit, and malarial parasites were subsequently found in the blood; no doubt definite cerebral malaria was present in some cases. Seven others of the thirty-three patients gave a positive Widal reaction that was sufficiently strong to be taken as evidence of an enteric group infection; typical typhoid ulceration in the jejunum and upper ileum was found in one case with a fatal ending. Two of the seven also had an active malarial infection. In eight only of the thirty-three cases of heat-stroke was there no clear evidence of any concomitant infective process."*

PRACTICAL MILITARY ASPECTS OF MALARIA CONTROL

These varied aspects of the malaria problem are but a fragmentary indication of the extreme complexity of its relation to military operations and the changed civil conditions subsequent to the reestablishment of peace. The experience which was had during our war with Spain, when malaria was reintroduced into certain sections of Connecticut by the troops returning from thoroughly infected areas in Cuba and Porto Rico, requires to be kept constantly in mind, if even more lamentable results are to be avoided at the present time. As observed by E. Halford Ross, the experience of the past is unhappily only too often set aside out of consideration of matters of temporary expediency. With commendable foresight, however, the Government of Australia has set an example of protective measures which may well receive consideration in this country at the present time. In behalf of the Quarantine Service

*For a more extended discussion of the climatological aspects of malaria, especially with reference to atmospheric conditions, see "A Plea and a Plan for the Eradication of Malaria," pp. 42 and 58, *et seq.*

of the Commonwealth of Australia, Mr. F. H. Taylor, Entomologist of the Australian Institute of Tropical Medicine, has prepared a Malaria Mosquito Survey of Irrigation Areas in the Murray River District, where preparations were being made to establish the Australian soldiers for agriculture and other purposes. As observed in the introduction to the report, by Dr. J. H. L. Cumpston, Director of Quarantine, "Owing to the return from military service abroad in New Guinea, Egypt, etc., of many men infected with malaria, it was considered to be a matter of fundamental importance that irrigation districts, where preparations were being made to establish many returned men, should be examined in order that the absence or prevalence of the malaria carrying species of mosquito should be determined. This decision was arrived at during a conference upon the question of malaria convened by Surgeon-General Fetherston, Director-General of Army Medical Services in Australia." The survey was made regardless of many practical difficulties, and the principal centers in the irrigation districts were examined and reported upon in sufficient detail for the end in view. It was ascertained without the chance of serious error that the malarial mosquito was to be found right through the irrigation area, with, possibly, two exceptions. It is said by Dr. Cumpston that not only was this so, but that "they were chiefly to be found close to human habitations, indicating that an increase in the human blood-supply available would probably be followed by an increase in the numbers of these species." The far-reaching conclusion was therefore advanced that "It is obvious that no man should be allowed to settle in these areas whose record shows that he has suffered while on service from malaria, or in whose blood the malarial parasites are found"; and, furthermore, that "Moreover, every endeavor should be made to create such conditions in these areas that malaria-carrying mosquitoes will not breed, as the casual introduction of infection may be productive of a serious outbreak of malaria."*

The risk of malaria in the summer and autumn campaign of 1915 was made the subject of an extended editorial discussion in *The British Medical Journal*, of July 24th of that year. After observing that the suggestion had been made, "and not without good reason," that there was a danger of malaria becoming prevalent in Flanders that autumn, it is said that though the disease had practically disappeared from

*According to the *Journal of the American Medical Association*, March 23, 1918, the City Council of Philadelphia has been requested by the Director of Public Works to appropriate an additional \$20,000 for a campaign to exterminate mosquitoes in the vicinity of the League Island Navy Yard and the Hog Island ship building plant, supplementary to an appropriation of \$10,000 previously made.

England, it still occurred in Holland, and that there were no good reasons, given the proper conditions, why the disease should not appear in Flanders that year. To appreciate the extent of the danger certain conditions are emphasized, as follows: "In the first place, a malaria-carrying mosquito must be present; in the second, human beings carrying gametocytes (that is, the sexual form of the malarial parasite) in their blood must be there to infect the mosquito; and in the third place, a suitable temperature must exist in order that the development of the parasite may take place in the insect host." As regards the first, the article points out that the *Anopheles maculipennis*, which is the chief malaria-carrier of Italy, Greece and the southern parts of Europe, "is present not only in Flanders and France, but, as a matter of fact, in England itself."* As regards malaria-carriers, or, in other words, persons harboring gametocytes in their blood, it is suggested that they are probably present, "because Indian troops are employed in Flanders at the present moment, and such being the case, the question arises whether malaria may be expected to break out." Practically, however, it is held this would depend entirely on the weather, and if the season should prove sufficiently hot, malaria might be expected. The high-temperature conditions favorable to the extensive development of malaria rarely prevail in England, nor in Flanders and the north of France. Sporadic cases of malaria in England usually occur during the late summer, that is, during the warmest time of the year.† With reference to the climatological conditions of Flanders and the north of France, it is said in the article referred to that this does not differ very much, and that a cold summer in one usually means the same condition in the other. As regards the season of 1915, it is stated that

So far the weather in England has been this year quite unsuitable for the development of the malarial parasite in the mosquito, and unless a very much warmer spell occurs in August and September, there will be little or no chance of a malarial epidemic or outbreak in the North of France. Another point of interest about the indigenous malarial cases in temperate climates, such as those

*According to a note in the *Scientific American*, of March 23, 1918, "Malaria was once common in certain parts of England, but as a result of drainage and the use of quinine, it was completely stamped out, notwithstanding the fact that anopheline mosquitoes remain in the country. The parasitic cycle was broken, and the insect was no longer infected. Now comes the report of a recrudescence of indigenous malaria in England. According to a circular issued by the Local Government Board, many men have contracted the disease while fighting on the western fronts, and have brought it home with them; thus they serve as foci of infection for the civilian population. Measures are being taken to deal with the carrier mosquitoes."

†In *The Lancet*, of October 20, 1917, are two interesting letters on Home-bred Malaria in England, the first of which is by Sir William Osler, who refers to a letter by Dr. H. B. Newham calling attention to the importance of distinguishing recurrences in soldiers from infected countries and the true home-bred malaria of England. He gives expression to the view that "In temperate climates districts from which malaria has disappeared have not, to my knowledge, been reinfected," and that therefore "The slight risk, then, from our malarial soldiers in this country may be faced cheerfully."

mentioned, is that they are generally of the benign tertian type, a form of malaria that is not specially dangerous or associated with a high death rate. The North of France and Flanders, like England, are too cold for the development of the malignant types of the disease.

The danger at the time was therefore rather in apprehension of an extensive outbreak among the British troops in the eastern war area, since in the Dardanelles the conditions as regards climate and temperature are similar to those found in Italy, Greece and Cyprus. The risk, however, was recognized to be "one of the difficulties with which the French and British forces have to contend, and the accounts which have hitherto reached this country seem to show that there is little or no malaria there and few mosquitoes." This favorable anticipation was, however, not realized in subsequent experience. An extensive outbreak of malaria among the soldiers of Flanders was reported upon in admirable detail in the *New York Sun* of September 24, 1917, on the basis of a description by the *Paris Medical*, with regard to which it is properly pointed out that the outbreaks "will serve to remind medical men to what extent soldiers at the front are suffering from a form of the disease imported from Macedonia."* In continuation, it is said that "In France and Flanders the ravages of malarial disease form a serious calamity. Large numbers of troops are rendered inefficient for considerable periods by autumnal fever, as it is called, and this to an extent which seriously handicaps the military position. So far no recent figures as to the amount of these diseases among the troops have been published, but it is well known that the amount is serious and that in several parts of the country large hospitals contain for the first time almost no patients except malarious patients."† According to an account by Dr. Carnot, in the *Paris Medical*,

The patients who are in the reserve hospitals of the Fifteenth district have for the most part a continued fever with stomachic distress and malarial parasites in the blood. We have also observed a number of cases more difficult to interpret, in which the first symptoms of malaria appeared in France a long time after the return of the troops. The disease is now marked by the severity of its features and by the large number of abnormal symptoms.

*R. Blanchard in the *Bulletin de l'Académie de Médecine*, Paris, remarks "That the English troops in Macedonia did not suffer from malaria by any means to the extent of the French troops." This result, it is claimed, was in consequence of the fact that the British military government considered the Macedonia campaign a "medical war," and placed medical matters in entire charge of medical officers, with highly favorable results for the health of the troops.

†For some exceedingly interesting and practically useful observations on the past occurrence of malaria in northern France and Flanders, see the observations on the "Geography of Malaria," by John Macculloch, M. D., in his treatise on "Malaria: An Essay on the Production and Propagation of this Poison," etc., Philadelphia, 1829, p. 183, *et seq.* During recent years the malaria mortality rate of Belgium has been 3.3 per 100,000 during 1901-1905, and 2.5 during 1906-1910. During the decade there were 1,027 deaths from malarial disease in Belgium, equivalent to considerably more than 100,000 cases.

In proper recognition of the seriousness of the situation, not only from a sanitary, but also from a military point of view, the French Government during 1917 sent a permanent malaria commission to the eastern front to take up the question of antimalaria prophylaxis. The decision to do so had been arrived at in January, 1917, following the studies of Drs. Edmond and Sergent, of the Pasteur Institute of Algeria, who were sent to Macedonia in December, 1916.

REPORT OF FRENCH MALARIA COMMISSION

An account of the work of the French Anti-Malaria Commission, by R. LeGroux, was published in the Bulletin of the Société de Pathologie Exotique, Paris, 1917, a translation of which, by Mrs. Carolyn G. Van Dine, has made the following observations available for the present purpose.

The Commission was under the direction of the Chief Medical Officer, Dr. Visbecq, who had been on the eastern front since the campaign of the Dardanelles, and who, after a long stay in Indo-China, had become thoroughly familiar with questions of prophylaxis and organized methods of eradication and control. Dr. Visbecq had the assistance of Prof. Laveran, the original discoverer of the malaria parasite. The Commission consisted of four administrative officers, twenty physicians, and one hundred men qualified to administer quinine, and three hundred men from the army assigned for special sanitary purposes. The area under observation was divided into districts, and a complete endemic index was made to place the anopheline prophylaxis measures on a sound basis of positive knowledge and to subsequently control the methods of quinine prophylaxis or immunization of both the inhabitants and the soldiers; in other words, the Commission from the outset concentrated its efforts upon both anopheline prophylaxis and quinine prophylaxis, it being said in the report that "In these two lines, the plans of the Pasteur Institute of Algeria, those of Sir Ronald Ross and those of Major-General Gorgas at Panama were taken into account with profit, and that any measure having given good results, even to the smallest degree, had not been overlooked. In the first rank of these measures, the Commission puts the use of the mosquito-bar and the daily administration of quinine.

FRENCH METHODS OF PROPHYLAXIS

Anopheline prophylaxis, it is explained in the report, was being carried out by an active warfare against the larvae of the mosquitoes, and

not by extensive drainage undertakings which would involve a whole region. The destruction of breeding-places by means of the use of oil or a mixture, according to circumstances, was directed chiefly to the small pools near the camps or halting-places, by clearing away vegetation and by straightening the course of slow-moving streams. All of this work was chiefly performed by the three hundred members of the sanitary corps specifically entrusted with its execution. The campaign against the adult mosquito was in the main confined to the use of the mosquito-bar. Some of these bars for the head had unfortunately been found to be of improper construction, but finally a model recommended by Prof. Simpson of London had been adopted. A model protective tent had been recommended by the Pasteur Institute, being of light weight and water-proof, but nevertheless presenting inconveniences which it seemed impossible to overcome, particularly as regards effective ventilation on very hot nights. As a slight means of additional protection from the bites of mosquitoes, the use of ointments containing essential oils, etc., was recommended, but it was emphasized that the protection was only temporary.

The work of the mosquito brigades, as developed at Panama, is referred to by the Commission as having been adopted at the outset, as likely to prove of especial advantage.* The men were therefore instructed in the methods of capturing and destroying adult mosquitoes in the interior of buildings, including, among other methods, the use of cresyl vapors, in accordance with the recommendations of Bouet-Roubaud.

The quinine prophylaxis as carried out under the direction of the Commission in the Eastern Army was chiefly by doses of chloral-hydrate of quinine, provided by the central pharmacy of the military forces. The doses were three grains, taken daily twice or three times, according to circumstances. There seems to have been no serious difficulty in inducing the adult inhabitants of the area under control to take quinine in this form. For children quinine confections were made use of in conformity to the method followed by the general government of Algeria. In accordance with the recommendation of the Pasteur Institute, a solution of quinine in oil had been prepared, containing as a base twenty centigrams of quinine per cubic centimeter, of which ten drops were considered sufficient for the prevention of malaria in nursing infants. It was clearly recognized that the preventive quinization

*Of practical importance on this aspect of the subject is a treatise on "Mosquito Control in Panama," by Joseph A. LePrince, New York, 1916.

of the troops required exceptional care, and it was found necessary to watch constantly and often to command the soldiers under supervision to take the prescribed doses in accordance with the rules. As an effective control measure an occasional urinalysis is recommended, with the aid of the Tanret reaction.

Not satisfied with direct measures of prophylaxis the Commission initiated an educational propaganda to instruct the troops of the danger of mosquitoes and of the usefulness of quinine when taken as a preventive.* By means of notices, postcards and other illustrations, the soldiers were made to understand the role of the mosquito in the spread of the disease and the importance of its prevention by means of the taking of systematic doses of quinine. Among others, a series of ten postcards, illustrating in a readily comprehensive form the essential facts of malaria control, cover the following phases of the question in its public aspect:

- 1 The necessity of protecting oneself from mosquitoes if one would live long.
- 2 The advisability of using protective ointments effectively.
- 3 The inadvisability of staying near to water for the purpose of fishing or for any other reason.
- 4 The advisability of sleeping under mosquito-bars and of effectively preventing the entrance of mosquitoes.
- 5 The duty of as carefully guarding the mosquito-bar as the soldiers' gun and ammunition.
- 6 The duty of repairing promptly the smallest hole in the mosquito-net.
- 7 The duty of taking quinine carefully in accordance with the instructions.
- 8 The duty of taking quinine every day and of doing so willingly.
- 9 The advisability of proving conclusively that the quinine has been taken daily in accordance with the rules.
- 10 The obligation of taking quinine and following other protective suggestions against malaria as a duty to the country and oneself.

Aside from these ten cards of instruction, notices were made use of emphasizing among others the following essential facts:

- 1 To keep in good health it should be understood that there are certain mosquitoes which convey the parasite of malaria by their bites.
- 2 The use of the mosquito-bar against these mosquitoes will make it possible to rest well and to sleep free from flies and mosquitoes. It should therefore be properly taken care of, and all necessary precautions must be used to make the bar effective.
- 3 Quinine is an effective remedy for malaria and a protection against the parasite, since the soldiers may be bitten by mosquitoes in spite of mosquito-

*Some of the French Anti-Mosquito Cartoons have been reprinted in *The American Journal of Public Health*, for February, 1918. They were communicated by Prof. S. M. Gunn, Associate Director of the Tuberculosis Commission to France.

bars. Quinine properly taken enters the blood and kills the parasite, and either frees the person affected from the disease or makes the fever less severe.

4 Quinine should be taken every day, irrespective of the duties of the work or other circumstances, as an effective precaution against malarial infection.

That these efforts have been in a measure effective is apparently substantiated by the following brief statement in *The British Medical Journal*, of November 17, 1917, although it is conceded that in the French army in Macedonia "malaria is still a most serious cause of disability, regardless of an observed decline."

It is reported that the health of the French army in Macedonia showed a considerable improvement during the first nine months of this year as compared with last year. The typhoid admission-rate was 1.38 per 1,000, and that of dysentery 7.43. Malaria is still the most serious cause of disability, but even here there has been a notable decline. In August the rate was 23.8 in 1917, as compared with 39.16 in 1916, and in September it was 29 in 1917, as compared with 74.6 in 1916. It is further to be noted that only about one-sixth of the admissions in September were new cases. The improvement is attributed to attention to the sanitation of localities, to the free distribution of mosquito nets, and to a daily dose of quinine, the taking of which is carefully supervised.

MODERN CONCLUSIONS BASED UPON WAR EXPERIENCE

The most recent observations on malaria in its relation to war are a group of five leading articles in *Le Progrès Médical*, for December 8, 1917, briefly reviewed in *The Medical Record*, of February 2, 1918. It is said in part that

Bernard regards malaria as second in importance to none of the war plagues. Not only was it of the highest significance in the warfare at the Dardanelles, Salonica, and Macedonia, but from these foci it has been transplanted throughout the whole of France. This author gives a complete general review of the subject which does not lend itself to a brief epitomization. An extensive bibliography is appended. Certain paragraphs are of special interest. Quinine has been used heroically and cinchonism has occurred in an unprecedented degree, but the general symptoms pale into insignificance in comparison with the local accidents which follow intramuscular injections of the drug into the buttocks. Large and deep abscesses and extensive sloughing are accidents often recorded and illustrated. The distinction between primary and secondary malaria is carefully maintained throughout. Owing to the fact that quinine tends in time to lose its efficacy we are confronted by a special type of quinine-foci or quinine-resistant paludies to whom large doses and intensive treatment may be necessary when relapses occur; for in these subjects the drug will no longer prevent relapses.

Reference is made to the work of Garin and Pasquier, who conclude from a study of hospitalization that "hospitals for malarial subjects

should have an altitude of not less than 1,000 meters, in order to protect the civilian population." A second paper by Bernard is referred to, in which there is a discussion of the case of natives presumably infected by returning troops. The term autochthonous malaria is made use of to indicate a recrudescence of old native malaria in the war zone.

The serious importance of malaria in its relation to war becomes more evident as the results of extensive experience in the war area are made available for critical consideration. It is therefore most gratifying to note that the available information on the subject and its special application to the medical service of the war have been summarized in a treatise on "Malaria: Clinical and Haematological Features and Principles of Treatment," by P. Armand-Delille, P. Abrami, G. Paisseau and Henri Lemaire. Preface by Prof. Laveran, Member of the Institute, edited by Sir Ronald Ross, K. C. B., F. R. S., LL. D., D. Sc., Lieut.-Col., R. A. M. C. This work is based on the writers' observations on malaria in Macedonia during the present war in the French Army of the East. It is emphasized in the announcement of the work that "A special interest attaches to these observations in that a considerable portion of their patients had never had any previous attack. The disease proved to be one of exceptional gravity, owing to the exceptionally large numbers of the *Anopheles* mosquitoes and the malignant nature of the parasite (*plasmodium falciparum*)." Fortunately, it is said, "an ample supply of quinine enabled the prophylactic and curative treatment to be better organized than in previous colonial campaigns, with the result that, though the incidence of malaria among the troops was high, the mortality was exceptionally low."

Of additional interest in this connection are the observations on malaria in a very recent treatise on "Typhoid Fevers and Paratyphoid Fevers," by Vincent and Muratet, translated by J. D. Rolleston, reading, in part, that

In hot countries, especially along the Mediterranean coast (Salonica, Greece, Turkey, Syria, Asia Minor, etc.) malaria often assumes a continuous type, with digestive disorders, dry and coated tongue, bilious vomiting, diarrhea, swollen and tender liver, large spleen, headache, insomnia, etc. The febrile state is prolonged in patients who are not treated with quinine. These forms of so-called tropical malaria, which are sometimes very severe, are often confounded with typhoid and paratyphoid fevers.

With further reference to differential diagnosis, or serious complications, it is said by the same authors that

In hot climates and in the East, and all the countries along the shores of the Mediterranean where malaria, papatacci fever (three-day fever), recurrent fever and Malta fever are prevalent, these diseases very often assume a typhoid disguise which may mislead the doctor. Laboratory examination will lead to the adoption of the prophylactic measures required by an exact diagnosis. No rational prophylaxis, therefore, can be carried out either in the army or in the civil population without aid from the laboratory.

All of these observations and much additional evidence from foreign sources justify the serious apprehension regarding malaria as a factor not only in military efficiency but in its possible reaction upon the health of the population at large. The importance of the disease is, of course, clearly recognized by the military authorities, and much depends upon a thoroughly effective cooperation on the part of the civil authorities in charge or control of the sanitary conditions of areas outside of the military reservations. The experience which has thus far been had seems to convey the assurance that reasonably adequate precautions have been taken to safeguard the health of Northern troops in Southern cantonments and of the civil population more or less in contact with the troops on their return to localities where the anopheline mosquitoes are the common variety and therefore properly a cause of apprehension on the part of the public.

MALARIA PREVALENCE IN ARMY CANTONMENTS

The statistics of the Army Medical Department for the period of the week of October 12, 1917, to the week of January 25, 1918, inclusive, are presented in the table following, with regard to which it, however, requires to be kept in mind that absolute accuracy is not claimed therefor by the authorities, in view of the extreme difficulty of securing complete returns, especially as to the precise mean strength of the men exposed to risk. Their main object is to furnish general information as to the health of the Army and to give to the public at large a reasonable degree of assurance concerning the administrative efficiency of the Army Medical Department. Limited for the present purpose exclusively to malaria morbidity, the statistics indicate that at the commencement of the mobilization malaria was a fairly perceptible disease factor, particularly at the camps established for the National Guard. The value of the table lies rather in its future use as a reasonably trustworthy index of health conditions at home and abroad during the malaria season, which in this country extends, broadly speaking, from June to October.

MALARIA MORBIDITY OF THE UNITED STATES ARMY

(Rate per 1,000 Mean Strength)

Week of	Regular Army	National Army (All Camps)	National Guard (All Camps)	American Expeditionary Forces
Oct. 12, 1917.....	4.8	5.8	14.2	..
19.....	2.7	4.1	8.9	..
26.....	4.7	8.1	9.7	..
Nov. 2.....	1.8	5.3	7.4	..
9.....	1.9	3.0	5.9	..
16.....	1.6	2.4	5.0	..
23.....	1.7	2.0	5.4	0.9
30.....	0.2	5.7	1.8	..
Dec. 7.....	0.5	1.0	1.1	2.0
14.....	1.3	0.8	1.7	..
21.....	1.0	0.6	2.1	0.3
28.....	..	0.2	1.7	..
Jan. 4, 1918.....	0.8	0.3	1.1	..
11.....	1.7	0.2	1.9	0.8
18.....	0.4	0.2	1.4	0.2
25.....	0.8	0.3	1.5	..

As is well known the admission rate for malarial fever in the United States Army has been gradually reduced from extraordinary proportions during the year of the Spanish American War (1898), when it attained to a maximum rate of 694.64 per 1,000 to a minimum of 24.75 during the year 1913. The corresponding reduction in the non-effective rates during more recent years was from 4.46 per 1,000 during 1903 to 0.53 during 1913. Regarding these results it is pointed out in a discussion of the Prophylaxis of Malaria with Special Reference to the Military Service, by Charles F. Craig, Captain, Medical Corps, United States Army, that

The decrease of malaria in the Army has been brought about largely by measures directed against the mosquitoes transmitting the disease, and the protection of man from the bites of these insects. Quinine prophylaxis has probably had but little to do with this reduction, as the use of this method has been very limited. Neither has the control treatment by microscopic examinations of the blood and the treatment of "carriers" and latent infections operated to any extent in reducing the disease in the Army, as these methods have been very little used, and it is believed that had these methods been widely employed the reduction of malaria would have been much more marked and much more rapid than it has been.

Craig strongly urges the adaptation of prophylactic measures to local conditions, based upon the qualified ascertainment of all the factors which require to be taken into account. He suggests that while "Under some conditions we may be able to practically eradicate mosquitoes, under others this measure may be impossible, and quinine prophylaxis will have to be substituted, together with measures for the protection of man from the bites of mosquitoes." He concludes that "In many, if not most, localities the best results will be secured by the combination of several prophylactic measures," and he is not at all in sympathy "with those who insist that either upon the destruction of mosquitoes or the prophylactic use of quinine alone we must depend for success in the prevention of the malarial fevers."

MALARIA IN THE UNITED STATES ARMY MEDICAL EXPERIENCE

In conclusion, the following summary statement of the Army medical experience with reference to the comparative frequency of malaria and typhoid fever in the United States Army during the five years ending with 1915 will prove useful as a trustworthy basis for estimating the comparative minimum hazard of malaria as a factor in military operations. The statistics are all derived from the annual reports of the Surgeon-General of the Army.*

Among the officers the admission rate on account of malaria was 19.12 per 1,000 of mean strength, against a comparative admission rate from typhoid fever of only 0.23. The non-effective rate on account of malaria was 0.61 per 1,000, against a non-effective rate on account of typhoid fever of only 0.10. Among American troops (enlisted men) the malaria admission rate was 26.26 per 1,000 of mean strength, against a typhoid fever admission rate of 0.23. For white enlisted men only the malaria admission rate was 27.09, against a typhoid fever admission rate of 0.24. For the colored troops the malaria admission rate was 12.14 per 1,000, against a typhoid fever rate of only 0.09. The non-effective rate on account of malaria was 0.60 per 1,000 for enlisted men, against 0.05 on account of typhoid fever. For white troops the non-effective rate on account of malaria was 0.62 per 1,000, against a rate of 0.05 for typhoid fever; while for the colored troops the non-effective rate on account of malaria was 0.25 per 1,000, against 0.01 on account of typhoid fever. For the continental United States only, exclusive of Alaska, the malaria

*Only the original statistics, however, have been derived from the Annual Reports of the Surgeon-General. The rates for the quinquennial period are original calculations.

admission rate for enlisted men was 12.17 per 1,000 of mean strength, against 0.24 for typhoid fever. For white troops only the rates were 12.49 for malaria and 0.24 for typhoid fever. For colored troops the rates were 4.04 per 1,000 for malaria and 0.18 for typhoid fever.

The non-effective rates for enlisted men of the continental United States, exclusive of Alaska, were 0.27 per 1,000 mean strength for malaria, against 0.06 for typhoid fever. For white troops only the rates were 0.27 and 0.06 per 1,000, respectively; and for colored troops the rates were 0.08 and 0.02, respectively, per 1,000 of mean strength.

For enlisted American troops in *Alaska* the malaria admission rate was 2.11 per 1,000, against no admissions on account of typhoid fever; and the non-effective rate on account of malaria was 0.04.

For *Hawaii* the admission rate for malaria was 3.94 per 1,000, against a rate of 0.17 for typhoid fever; the non-effective rate in Hawaii on account of malaria was 0.10 per 1,000, against 0.02 for typhoid fever.

For the *Philippine Islands* the admission rate on account of malaria was 95.03 per 1,000 against 0.29 for typhoid fever; the respective non-effective rates were 1.97 for malaria and 0.06 for typhoid fever. For the native troops in the Philippine Islands the malaria admission rate was 191.03 per 1,000, against a typhoid fever rate of 0.57; the non-effective rates were, respectively, 3.41 for malaria and 0.10 for typhoid fever.

For *Porto-Rico* native troops the admission rate on account of malaria was 44.46 per 1,000, against 0.32 for typhoid fever; the non-effective rates were respectively 0.73 for malaria and 0.03 for typhoid fever.

The army experience for the five-year period, therefore, reemphasizes conclusions drawn from general experience that the economic importance of malaria as a cause of disability in civil or military service demands decidedly more serious and qualified consideration than has heretofore been the case. The further conclusion may be advanced that the white troops in the continental United States experience a much higher malaria admission rate and non-effective rate than the colored troops, but that they suffer most from malaria in the Philippine Islands, where, however, the admission and non-effective rates for native troops are about twice as high as those of white troops serving under more or less identical conditions.

Finally, the evidence is conclusive that even in Alaska and Hawaii malaria is of some importance, although no doubt introduced from localities where infected anopheles mosquitoes are the cause of the disease. In Porto Rico, however, the native troops suffer con-

siderably from malaria, or, approximately, to the extent of four times the corresponding admission rate among the white troops of the continental United States.* Officers of the United States Army experience a lower admission rate than enlisted men serving at home and abroad, but practically the same non-effective rate prevails among both officers and enlisted men.

The experience of the United States Army with reference to malaria during a period of peace, when adequate attention could be given to the most effective prophylactic measures, suggests the practical value of a critical examination of the data and their application to the solution of eradication problems at Army posts and barracks at which the disease is known to prevail to a more or less excessive degree.† For, after all, in malaria it is never a question of the mortality or the morbidity in the aggregate for large areas or states or countries, but, first and last, in its practical application it is a local question demanding highly specialized consideration of all local factors predisposing to malarial disease prevalence of more or less serious extent. This conclusion applies as much to military operations as to civil life, to peace conditions as well as to war and to the Army as much as to the population at large.

*During recent years the mortality from malaria has been considerably on the increase in Porto Rico. The average malaria mortality rate per 100,000 of population by single years during the last five years has been as follows: 99.9 in 1912, 48.8 in 1913, 64.5 in 1914, 110.4 in 1915, and 158.4 in 1916.

†An exceptionally valuable report on "Extra-Cantonment Zone Sanitation," by J. A. Watkins, M. D., U. S. Public Health Service, with special reference to conditions at Camp Shelby, near Hattiesburg, Miss., was issued under date of December 21, 1917 (Reprint No. 443). The report includes a full descriptive account of mosquito eradication measures incorporated in an ordinance passed by the city authorities of Hattiesburg, Section 1 of which reads that "It shall be unlawful to have, keep, maintain, cause or permit, within the incorporated limits of Hattiesburg, Miss., any collection of standing or flowing water in which mosquitoes breed or are likely to breed, unless such collection of water is treated so as to effectively prevent such breeding."

The enforcement of this Section is provided for in part by Section 5, which reads that "Should the person or persons responsible for conditions giving rise to the breeding of mosquitoes fail or refuse to take necessary measures to prevent the same within three days after notice has been given to them, the health officer is hereby authorized to do so, and all necessary costs incurred by him for this purpose shall be a charge against the property owner or other person offending as the case may be."

The necessity for drastic action in the Hattiesburg cantonment district is made evident by the malaria morbidity reports for Forrest County, indicative of a normal malaria frequency rate of from 80 to 100 per 1,000 of population.



