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## A STUDY OF THE BLACKTONGUE-PREVENTIVE ACTION OF 16 FOODSTUFFS, WITH SPECIAL REFERENCE TO THE IDENTITY OF BLACKTONGUE OF DOGS AND PELLAGRA OF MAN

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Some of the results of our study of the problem of an experimental animal for pellagra were briefly summarized in a communication published two years ago (1), and have been presented in detail in two recent publications. In the first of these Goldberger and Wheeler (2) reported the production in the dog, by feeding pellagra-producing diets, of a pathological condition considered by them to be identical with the spontaneously occurring canine disease known to American veterinarians as blacktongue.<sup>1</sup> The clinical resemblance of this canine disease to pellagra in man was discussed and was considered so striking as to be, in itself, practically conclusive of the identity of these two conditions. In harmony with and supporting this view was also the suggestion of a common etiology indicated by the successful production of the canine disease by feeding with pellagra-producing diets. In the second communication, Goldberger, Wheeler, Lillie, and Rogers (3) reported a series of feeding experiments with yeast from the results of which they concluded that experimental blacktongue is due to a deficiency in diet that is capable of being corrected by something present in abundance in yeast. This demonstration of the presence of the blacktongue preventive in yeast, a substance in which the pellagra preventive (factor P-P) was also known to be present in abundance (4), was considered to increase somewhat the probability that blacktongue and pellagra are fundamentally identical

<sup>1</sup> Synonyms: Stuttgart dog epizootic; typhus der Hunde (dog typhoid); typhus of dogs; gastro-enteritis hemorrhagica; southern canine plague; sore mouth of dogs.

conditions. In this connection it is of interest [to note] that Denton (5), in a study of the tissue changes in experimental blacktongue, has found that the lesions of the skin, mouth, pharynx, esophagus, and colon in the canine disease are very similar to those in pellagra, and that histologically the lesions in experimental blacktongue duplicate those in pellagra.

In the body of this report reference will be made to differences between certain of the results of our study and those of an apparently similar study by Underhill and Mendel (6). The divergence in our results is of interest, since we have heretofore considered it highly probable that the pathological condition experimentally induced in the dog by Chittenden and Underhill and studied by Underhill and Mendel was identical with the experimental condition studied and identified by us as blacktongue (2). The extensive report of their work (7) which has just come to our attention presents some clinical details which not only seem in themselves significant of a difference in the two pathological conditions, but also suggest that we had heretofore, perhaps, underestimated the significance of certain other clinical differences. Thus we find in this report that a "troublesome skin rash" appears to have been common in the condition with which Underhill and Mendel have worked. We have encountered none such in our dogs. On the other hand, while we have observed a pellagra-like dermatitis of the scrotum in some 40 to 50 per cent of attacks in our male dogs, there is no mention of the occurrence of such an eruption in the condition studied by Underhill and Mendel. Again, in the condition studied by us—namely, blacktongue—there is a definitely marked febrile stage which does not seem to occur in the Chittenden-Underhill syndrome studied by Underhill and Mendel; for they nowhere make mention of it, not even in their full report. These clinical differences seem to us of such importance that, in spite of the striking clinical similarity in certain other respects, doubt now arises as to the identity of the Chittenden-Underhill "pellagra-like" syndrome. Until this doubt is definitely resolved one way or another, it would seem premature to discuss, and we therefore do not attempt to discuss, the differences between the results reported by Underhill and Mendel and those recorded by ourselves in the present and in a preceding communication (3).

In the present communication we present some further results of our study of experimental blacktongue. These results deal with the blacktongue preventive potency of certain selected foodstuffs, 16 in number, with special reference to the relation of experimental blacktongue of dogs to pellagra of man.

## METHODS AND CRITERIA

The general methods of caring for and feeding our experimental animals have already been described (2) (3). We may recall, however, that the experimental diets were, as a rule, freshly prepared each day. The daily allowance of food was, in general, intended to be no more than enough for the maintenance of normal body weight. An exception was made in the case of young growing animals, to which more than this allowance was offered. It may be recalled, too, that it has been our practice to use our dogs repeatedly with or without intermediate periods of stock feeding as might be demanded by the purpose of the experiment. In stock feeding, a definite food mixture has been used, principally our diet No. 156, the composition and evidence of the adequacy of which have been given in a preceding communication (2).

In testing for the blacktongue preventive we have employed both the curative and the preventive procedure, singly or in combination. Since, as we have in a preceding communication (2), already indicated the clinical course of experimental blacktongue, especially in the invasional stage, may normally be of an intermittent or relapsing character, we attach no significance to a seemingly favorable therapeutic result in cases in which the treatment is begun early unless confirmed by the results of a preventive test. On the other hand, consistently unfavorable results of treatment under such favoring circumstances have been considered trustworthy indications of a poverty in or lack of the blacktongue preventive, provided that the test dose has been a liberal one. Our experience with experimental blacktongue has led us to consider the rise in temperature which occurs in the advanced stage of the disease as a mark of gravity (2). Only very exceptionally does the attack normally remit after this temperature rise has taken place. We have, therefore, been disposed to consider clinical recovery from the attack (that is, disappearance of all manifestations of the disease with recovery of appetite) following treatment begun at this advanced grave stage as significant, but have, nevertheless, always required confirmation by the preventive test before drawing final conclusions with respect to the presence of the preventive in the substance thus found to be active. Isolated cases of the apparent failure of treatment under these unfavorable circumstances have been considered as without significance.

In testing the individual foodstuffs, one, or exceptionally both, of two types of test diet have been employed. In the first the components other than the foodstuff under investigation are believed to have contributed none or but an insignificant amount of the blacktongue preventive; in the second, some, at least, of the basic components may have contributed or probably did contribute a substantial quota of the preventive. This difference in character of



basic diet should be kept in mind in evaluating and comparing the indications of preventive potency, since the results yielded by the former may probably be considered as due virtually entirely to the action of the foodstuff tested, whereas those of the latter must be considered as a summation effect due to the combined action of the basic components and of the test foodstuff.

So far as our data permit, an appraisal has been made of the blacktongue preventive potency of each foodstuff. In view of the lack of a better practicable standard for such purpose, our appraisal is simply a judgment, in broad terms, of the preventive adequacy of such a quantity as, according to conventional practice, represents the daily allowance for an average adult human male.

The experimental disease in the dog and its diagnosis have been described in a preceding report (2); we need recall only that the earliest distinctive buccal signs are a vivid red injection of the mucosa of the floor of the mouth or a peculiar reddening of the mucosa of the upper lip in the form of bilaterally symmetrical patches, or of both. We have considered the first appearance of these mouth lesions as marking the beginning of the attack of blacktongue. We have conformed to this rule in all cases, even in those relatively few instances in which the pellagralike dermatitis of the scrotum appeared in advance of the mouth lesions. Thus marked, the beginning of the experimental disease, when this is induced by feeding our basic diet No. 123 (or certain of its modifications, namely diets No. 209, No. 195, and No. 268), is only very exceptionally delayed beyond about 60 days after the beginning of the feeding (2). We have therefore been inclined to consider a very notable prolongation of this period, particularly when manifested in more than one of a group of test animals, as significant of the presence in the test diet of the blacktongue preventive in an amount that is somewhat larger than that presumably contained in our standard basic diet.<sup>1</sup> Since other factors, not yet understood, such, for instance, as self-imposed starvation or semistarvation and other possibly co-existing deficiencies or maladjustments of dietary essentials, may and probably do influence the duration of what for convenience may be designated as the deprivation period, we have tried to exercise due caution in the interpretation of such indications.

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<sup>1</sup> Our basic experimental diets of the type exemplified by our diet No. 123 (Table 1) contain, we judge, a small amount of the blacktongue preventive derived from its natural-food components, principally corn meal and cowpeas. We have the impression that the "synthetic" type of diet of purified foodstuffs which, presumably, is entirely free of the blacktongue preventive, is not as satisfactory an experimental diet, principally because of a more unfavorable effect on appetite leading to earlier and more marked self-imposed starvation or semistarvation.

## MAIZE

The idea that the maize in the diet is in some way concerned in the causation of pellagra has, as is well known, been entertained by students of that disease almost from the time of its first recognition. It seems to have arisen in part, at least, because maize constituted a very large part of the diet of the populations among whom, in the Old World, the disease was endemic. In the United States, maize also is a conspicuous element in the diet of the population in the area where the disease is most prevalent. Both in the Old and in the New World, therefore, maize is more or less prominently associated with the occurrence of pellagra. While the extreme position of certain zeists that there is no pellagra without maize is now no longer tenable, the association is no doubt very common. One is justified in concluding, therefore, that maize is very poor in or lacks the pellagra preventive.

In constructing our experimental diets, based as they are on diets found in association with the occurrence of pellagra, maize was from the first included as a conspicuous element. The basic diet most frequently used by us for the experimental production of blacktongue (diet No. 123, shown in Table 1) contains 400 grams of maize meal per 2,400 calorie ration. This is a large amount of cereal, constituting as it does two-thirds of the weight of the dry ingredients of the diet. Notwithstanding this, however, as has in a preceding communication (3) already been set forth, dogs fed this diet (including certain of its modifications) have developed blacktongue within a period which only exceptionally exceeded a duration of about 60 days. This would indicate that, as measured by the requirements of the dog, maize contains little if any of the blacktongue preventive. Incidentally, it may be noted that cornstarch would also appear to be very poor or lacking in the blacktongue preventive since, as previously reported (3), two dogs fed a diet (No. 281) containing 366 grams of cornstarch per 2,400-calorie portion promptly developed the disease.

The maize meal used in our basic diet No. 123 (including its modifications) does not, however, represent quite the whole kernel, since a small part of the bran is removed by sifting as if for human consumption. It seemed desirable, therefore, to test a meal from which nothing had been taken away. But as it did not seem to us probable that the difference in the meal represented by the small amount of bran removed in sifting would of itself appreciably influence the result of feeding, and as we wished, if possible, to determine whether the maize kernel contains an appreciable amount of the blacktongue preventive, it was determined to work with a diet containing as large an amount of whole meal as possible and yet one that so far as could then be judged was adequate for maintenance in all other respects. With these considerations in mind we carried out Experiment 1.

## EXPERIMENT 1

This was a test of the blacktongue preventive action of whole white maize meal which was incorporated in test diets No. 149 and No. 149A. (Table 2.) These diets, which are identical except that the butterfat of one is quantitatively replaced by cod-liver oil in the other, are a slight modification of a maize diet studied by McCollum, Simmonds, and Pitz (8), and by them considered complete for normal growth of the rat to normal adult size, and for that reason selected by us for this study. Each contains 450 grams of whole-maize meal in a ration of slightly less than 2,400 calories. Suitable portions of one or the other of these diets were offered daily to each of seven test animals, dogs 29, 40, 52, 54, 57, 65, and 73. One of these dogs served during two separate periods, so that eight tests in all are to be considered. The significant details relating to each of the test animals are presented in the following:

*Dog 29.*—Male. Acquired May 9, 1923, between which date and January 11, 1924, served in a number of experiments and suffered four attacks of blacktongue, the latest of which began January 7, 1924. On a miscellaneous stock diet from January 11 to February 5, 1924.

February 5, 1924: In good condition; weighs 11.1 kilograms; begins test diet No. 149. (Table 2.)

On February 17, 1924, at the end of a period of 12 days, presented the first signs of an attack of blacktongue, an injection of the floor of the mouth. Further history not relevant.

*Dog 40.*—Male. Whelped in the laboratory June 26, 1923, and reared on a stock diet. Up to February 20, 1924, served in a number of experiments and suffered two attacks of blacktongue, the later one of which began February 19, 1924. On a stock diet for reconditioning from February 20 to March 11, 1924. March 11, 1924: In good condition; weighs 9.2 kilograms; begins diet No. 149. On April 23, 1924, at the end of a period of 43 days, presented the first signs of an attack of blacktongue, an injection of the floor of the mouth. Weight was 11 kilograms. Further history not relevant.

*Dog 52.*—Bitch. Acquired September 25, 1923. Up to February 20, 1924, served in a number of experiments and suffered two attacks of blacktongue, the later one of which began February 18, 1924. On a stock diet for reconditioning from February 20 to March 11, 1924.

March 11, 1924: In good condition; weighs 9.7 kilograms; begins test diet No. 149. On July 31, 1924, at the end of a period of 142 days, presented the first signs of an attack of blacktongue, an injection of the floor of the mouth. Weighs 10 kilograms. Further history not relevant.

*Dog 54.*—Bitch. Acquired September 25, 1923. Up to January 11, 1924, served in a number of experiments and suffered an attack of blacktongue which began November 28, 1923. On reconditioning diets from January 11 to March 25, 1924.

March 25, 1924: In good condition; weighs 8.1 kilograms; begins test diet No. 149A. (Table 2.)

On June 5, 1924, at the end of a period of 72 days, presented the first signs of an attack of blacktongue, an injection of the floor of the mouth and a slight reddening of the mucosa of the upper lip on each side. Weighs 8 kilograms. Further history not relevant.

*Dog 57.*—Male. Acquired September 25, 1923. Up to January 15, 1924, served in a number of experiments and suffered two attacks of blacktongue, the latter of which began December 13, 1923. From January 15 to February 5, 1924, on a miscellaneous stock diet for reconditioning.

February 5, 1924: In good condition; weighs 9.7 kilograms; begins test diet No. 149.

On February 23, 1924, at the end of a period of 18 days, presented the first signs of blacktongue, an injection of the floor of the mouth, of the mucosa of the cheeks, and of the anterior faucial pillars. Weighs 10 kilograms. Begins reconditioning diet.

February 25, 1924: Redness of mucosa of the floor and cheeks is less pronounced.

February 26, 1924: Redness has practically completely faded. Weighs 9.9 kilograms.

March 25, 1924: In good condition; weighs 10.1 kilograms; begins test diet No. 149A.

On April 11, at the end of a period of 17 days, presented the beginning signs of an attack of blacktongue, an injection of the floor of the mouth. Further history not relevant.

*Dog 65.*—Bitch. Acquired January 28, 1924. Kept on a miscellaneous stock diet to February 5, 1924.

February 5, 1924: In good condition; weighs 6.7 kilograms; begins test diet No. 149.

April 22: Weighs 7.7 kilograms.

On April 27, 1924, at the end of a period of 77 days, presented the first signs of an attack of blacktongue, a reddening of the mucosa of the floor of the mouth. Further history not relevant.

*Dog 73.*—Bitch. Acquired March 19, 1924. On stock diet up to April 1, 1924.

April 1, 1924: In good condition; weighs 7.7 kilograms; begins test diet No. 149A.

July 8, 1924: Weighs 10.2 kilograms.

On July 12, 1924, or 102 days after beginning the test, this animal presented an injection of the mucosa of the floor of the mouth suggestive of a beginning attack of blacktongue. Two days later this was no longer perceptible, nor was there any reappearance of signs of blacktongue during a further period of observation of 38 days which ended August 19, 1924, on which date this experiment was discontinued.

*Results and conclusions.*—Six of the seven dogs developed blacktongue in from 12 to 142 days after beginning the test. The seventh (dog 73) presented evanescent evidence very suggestive but not conclusive of blacktongue at the end of a period of 102 days. The observation of this animal was discontinued at the end of 140 days, so that the possibility is not excluded that a definite attack of blacktongue would have developed had the observation period been longer. One of the test animals (dog 57) served during two separate periods and developed an attack of blacktongue in each. Thus the six animals in which definite evidence of blacktongue developed experienced, in all, seven attacks. Six of these appeared at the end of periods of not over 77 days in duration, and the seventh (dog 52) at the end of a period of 142 days.

The unusually long interval before the development of the attack in one and the occurrence of but evanescent indications of an attack in another of the experimental animals, even though the observa-

tion period in the latter was but 140 days, suggest, by contrast with our experience with basic diet No. 123 (including certain of its modifications (3)), that the test diets under consideration may have possessed slight preventive properties. The difference is not very notable and, such as it is, can not be attributed, altogether at least, to the character and increased quantity of the maize, since one of the test diets (No. 149), unlike our standard basic diet (No. 123), contained some butter, which, as will presently be seen, while a poor source is not entirely devoid of the preventive factor, a fact that was not fully appreciated when this experiment was planned. This experiment is therefore not conclusive. Notwithstanding this, however, the evidence quite clearly indicates that, at best, this cereal is a very poor source of the blacktongue preventive.

Recalling the indications of its poverty in or lack of the pellagra preventive it would appear that maize, if it contains any, is a poor source of the preventive for both blacktongue and pellagra.

### WHEAT

The important place among the cereals held by wheat and a desire to compare it with maize led us to test its blacktongue preventive potency. The following experiment was accordingly carried out.

#### EXPERIMENT 2

For the present purpose, wheat ground in this laboratory into a meal was, without sifting, incorporated in a diet, No. 128, the composition of which is shown in Table 3. This, as may be seen by reference to Table 1, is essentially diet No. 123, the maize meal of which has been quantitatively replaced by the ground wheat, of which there are, therefore, 400 grams in each 2,400-calorie portion. Some of this diet was daily offered to each of eight test animals—dogs 5, 9, 13, 14, 29, 38, 44, and 47. The significant details relating to each are briefly as follows:

*Dog 5.*—Bitch. Acquired November 8, 1921. Has served in a number of experiments and has suffered two attacks of blacktongue, the later one of which began August 28, 1923. On stock diet from September 8, 1923, to January 29, 1924. Whelped a litter of seven pups November 25, 1923, six of which survived and were weaned in good condition January 17, 1924.

January 29, 1924: In good condition; begins diet No. 128. (Table 3.)

On August 2, 1924, at the end of a period of 186 days, presented the first signs of blacktongue, a reddening of the mucosa of the cheeks. To this there was added on August 3 a reddening of the mucosa of the floor of the mouth and of that of the upper lip on the left side. Further history is not relevant.

*Dog 9.*—Male. Acquired April 1, 1923. Has served in a number of experiments and has suffered four attacks of blacktongue of which the latest began February 12, 1924. On stock diet from February 13, to March 11, 1924. March 11, 1924: In good condition; begins diet No. 128.

On July 31, 1924, at the end of a period of 142 days, presented the first signs of an attack of blacktongue, a reddened patch on the mucosa of the upper lip, in the region of the canines, on each side, and a slight reddening of the mucosa of the floor of the mouth. Further history is not relevant.

*Dog 13.*—Male. Acquired April 7, 1923. Up to November 28, 1923, served in several experiments and suffered three attacks of blacktongue, of which the latest began November 24, 1923. On a reconditioning diet from November 28 to December 11, 1923.

December 11, 1923: In good condition; begins diet No. 128.

On February 20, 1924, or at the end of a period of 71 days, presented an injection of the floor of the mouth which was slightly more pronounced the next day, February 21. This reddening then persisted without notable change for some 48 hours, then rapidly faded so that the mouth was normal on February 25.

On July 11, or at the end of an additional period of 142 days, presented renewed signs of blacktongue, an erythematous patch on the mucosa of the upper lip on each side in the region of the canines and a slight reddening of the floor of the mouth. Further history not relevant.

*Dog 14.*—Male. Acquired April 7, 1923. Up to November 28, 1923, served in several experiments and suffered four attacks of blacktongue, of which the latest began October 30, 1923. On a reconditioning diet from November 28 to December 11, 1923.

December 11, 1923: In good condition; begins diet No. 128.

On June 24, 1924, or at the end of a period of 196 days, presented the first signs of an attack of blacktongue, a slight reddening of the mucosa of the floor of the mouth. Further history not relevant.

*Dog 29.*—Male. Acquired May 9, 1923. Up to November 27, 1923, served in several experiments and suffered three attacks of blacktongue, of which the latest began October 18, 1923. On a reconditioning diet from November 27 to December 11, 1923.

December 11, 1923: In good condition; begins diet No. 128.

On January 7, 1924, at the end of a period of 27 days, presented the first signs of an attack of blacktongue, a reddening of the mucosa of the floor of the mouth.

*Dog 38.*—Male. Whelped in the laboratory June 26, 1923. Up to February 20, 1924, served in several experiments and suffered two attacks of blacktongue, the second one of which began February 14, 1924. On a reconditioning diet from February 20 to March 11, 1924.

March 11, 1924: In good condition; begins diet No. 128.

On June 24, 1924, at the end of a period of 105 days, presented the first signs of an attack of blacktongue, a reddening of the floor of the mouth. Further history not relevant.

*Dog 44.*—Male. Whelped in the laboratory June 26, 1923. Up to December 27, 1923, served in one experiment and suffered an attack of blacktongue which began October 28, 1923. On a reconditioning diet from December 27, 1923, to January 29, 1924.

January 29, 1924: In good condition; begins diet No. 128.

On August 13, 1924, at the end of a period of 197 days, presented the first signs of an attack of blacktongue, reddened patches on the mucosa of the upper lip on each side. Further history not relevant.

*Dog 47.*—Male. Acquired August 18, 1923. Up to November 28, 1923, served in an experiment and suffered an attack of blacktongue, which began September 28, 1923. On a reconditioning diet from November 27 to December 20, 1923. December 20, 1923: In good condition; begins diet No. 128.

On January 7, 1924, at the end of a period of 18 days, presented the first signs of an attack of blacktongue, a reddening of the floor of the mouth. Further history not relevant.

*Results and conclusions.*—As is evident, all eight of the test animals developed blacktongue. It is noteworthy, however, that in but two of the dogs did the attack have its onset at the end of periods shorter than 71 days. In five of the eight animals the first signs of the attack made their appearance at the end of periods varying between 105 and 197 days—that is, after periods very definitely longer than is the rule in the case of dogs fed diet No. 123. This delay in the development of the disease would appear to indicate that diet No. 128 had exercised appreciable but incomplete blacktongue preventive action and, therefore, that whole wheat contains the blacktongue preventive, but in small amount. Compared with the result of the experiment with whole maize, the outcome of the test of whole wheat suggests that this is probably a slightly better source of the blacktongue preventive than is the maize.

### WHEAT GERM

While the preceding experiment with whole wheat was under way, tests were made of the blacktongue-producing potency of a number of diets in which were included varying amounts of commercial wheat germ as a source of "vitamin B." The results of one of these tests which happened to be with a diet that included an unusually large quantity of the wheat germ, suggested rather strongly that this germ might possess definite blacktongue-preventive action. This led us to carry out the following experiment:

### EXPERIMENT 3

This was a test of the blacktongue-preventive action of ether-extracted wheat germ. The wheat germ was a commercial product from which we had extracted the fat by percolation with ether (U. S. P.) at air temperature.<sup>1</sup> It was incorporated in a diet, No. 197, the composition of which is shown in Table 4. As may be seen, each 2,400 calorie portion contains 180 grams of the extracted germ. It may be noted, too, that it contains a considerable amount of cornstarch; notably less, however, as was noted in the preceding section in connection with maize, than has been found to be lacking in appreciable blacktongue-preventive action. This diet is somewhat similar to our basic diet No. 123 (Table 1), from which it differs notably, however, in that the wheat germ and the starch of the former completely replace the corn meal and cowpeas of the latter. Suitable portions of the diet were daily offered to each of nine test

<sup>1</sup> Various batches of this ether-extracted wheat germ were found by Assistant Chemist C. G. Remsburg, in the Division of Chemistry of the Hygienic Laboratory, to contain from 0.02 to 0.34 per cent of "ether extract."

animals, dogs 54, 61, 65, 70, 71, 78, 86, 87, and 88. The significant details relating to each are presented in the following:

*Dog 54*.—Bitch. Acquired September 25, 1923. Up to June 17, 1924, served in several experiments and suffered two attacks of blacktongue of which the second began June 5, 1924. On stock diet for reconditioning from June 17 to July 23, 1924. On an experimental diet, which included some wheat germ, from July 23, 1924, to May 26, 1925.

May 26, 1925: In good condition; begins wheat-germ diet No. 197. (Table 3.) On September 19, 1925, at the end of 136 days, this animal presented a slight but very suggestive reddening of the mucosa of the floor of the mouth, which, however was no longer perceptible 24 hours later. No further evidence suggesting blacktongue appeared during the remainder of the period of observation, which ended May 26, 1926. In good condition at the end of one year on the wheat-germ diet.

*Dog 61*.—Male. Whelped in the laboratory November 4, 1923. Up to May 27, 1924, served in one experiment and suffered one attack of blacktongue, which began May 21, 1924. On reconditioning diet from May 27 to July 23, 1924. From July 23, 1924, to May 26, 1925, on an experimental diet, which included a considerable amount of wheat germ.

May 26, 1925: In good condition; begins wheat-germ diet No. 197.

On January 5, 1926, or at the end of a period of 224 days, there were noted the first signs of an attack of blacktongue, which ended in death on January 20, 1926.

*Dog 65*.—Bitch. Acquired January 28, 1924. Up to May 27, 1924, served in one experiment and suffered an attack of blacktongue. On stock diet for reconditioning from May 27 to July 23, 1924. On an experimental diet, which included wheat germ from July 23, 1924, to May 26, 1925.

May 26, 1925: In good condition; begins wheat-germ diet No. 197.

On February 3, 1926, at the end of 253 days, this animal presented a slight but suggestive reddening of the mucosa of the floor of the mouth and of the cheeks which, however, had completely faded 24 hours later. No further evidence suggesting blacktongue appeared during the remainder of the period of observation, which ended May 26, 1926. In good condition at the end of one year on the wheat-germ diet.

*Dog 70*.—Male. Whelped in the laboratory November 25, 1923. Up to May 14, 1924, served in one experiment and suffered an attack of blacktongue, which began May 13, 1924. On stock diet for reconditioning from May 14 to July 23, 1924. On an experimental diet, which included wheat germ, from July 23, 1924, to May 26, 1925.

May 26, 1925: In good condition; begins wheat-germ diet No. 197.

On September 15, 1925, or at the end of a period of 112 days, presented the first signs of an attack of blacktongue, reddened lesions on the mucosa of the upper lip opposite the canines, and an injection of the floor of the mouth. Further history not relevant.

*Dog 71*.—Male. Whelped in the laboratory November 25, 1923. Reared on miscellaneous stock diets. On an experimental diet, which included wheat germ, from July 23, 1924, to May 26, 1925.

May 26, 1925: In good condition; begins wheat-germ diet No. 197.

May 26, 1926: Completes one year on the wheat-germ diet in good condition; has presented no recognizable evidence of blacktongue during the year.

*Dog 78*.—Male. Acquired June 9, 1924. On an experimental diet which included wheat germ from July 23, 1924, to May 26, 1925.

May 26, 1925: In good condition; begins wheat-germ diet No. 197.



On August 11, 1925, at the end of a period of 77 days, presented the first signs of an attack of blacktongue, which ended in death during the night of August 22-23, 1925.

*Dog 86.*—Bitch. Whelped in the laboratory October 12, 1924. On stock diet to April 28, 1925. From April 28 to May 26, 1925, on an experimental diet which included wheat germ.

May 26, 1925: In good condition; begins wheat-germ diet No. 197.

On December 27, 1925, at the end of 215 days, presented a suggestive reddening of the mucosa of the floor of the mouth which gradually faded during the succeeding 48 hours. Presented no other evidence of blacktongue at any time during a further period of observation which ended May 26, 1926. In good condition at the close of the year on the wheat-germ diet.

*Dog 87.*—Bitch. Whelped in the laboratory October 12, 1924. On stock diet up to April 28, 1925. From April 28 to May 26, 1925, on an experimental diet which included wheat germ.

May 26, 1925: In good condition; begins wheat-germ diet No. 197.

May 26, 1926: Completes one year on the wheat-germ diet. Is in good condition. Has presented no recognizable evidence of blacktongue at any time during this feeding period.

*Dog 88.*—Male. Whelped in the laboratory October 12, 1924. On stock diet to April 28, 1925. From April 28 to May 26, 1925, on an experimental diet which included wheat germ.

May 26, 1925: In good condition; begins diet No. 197.

On December 18, at the end of a period of 206 days, presented the first signs of an attack of blacktongue, reddened lesions of the mucosa of the upper lip, reddening of the mucosa of the floor of the mouth and of that of the cheeks. Further history not relevant.

*Results and conclusions.*—From the foregoing it appears that four of the nine test animals, namely, dogs 61, 70, 78, and 88, developed definite attacks of blacktongue at the end of 224, 112, 77, and 206 days, respectively; three (dogs 54, 65, and 86) presented suggestive but fleeting evidence of blacktongue at the end of 136, 253, and 215 days, respectively; while two presented no recognizable evidence of the disease during the period of observation of one year. The notable delay in the development of two of the four definite attacks, the occurrence of but evanescent signs in three, and of no recognizable evidence whatever in two of the test animals would seem clearly to indicate that diet No. 197 had exercised definite but not fully complete blacktongue-preventive action, and, thus, that commercial wheat germ contains the blacktongue preventive. Considering quantity, and also that, so far as can be judged, the other components of the test diet (No. 197) probably contributed little or nothing to its blacktongue-preventive potency, it may be concluded that wheat germ is a relatively good, if not rich, source of the blacktongue preventive. Since wheat-germ diet No. 197 contains less than one-half as much wheat germ as diet No. 128 (Experiment 2, Table 3) contains of whole wheat, and since the protective action of the wheat-germ diet seems to have been, if anything, more marked than that of the whole-wheat diet, even with its included cowpeas, it would seem per-

missible to infer that gram for gram extracted wheat germ contains more than twice as much of the blacktongue preventive as does whole wheat.

It may here be noted that the favorable outcome of the foregoing study in the dog suggested the desirability of a similar study in human pellagra with the result elsewhere (9) already reported, that a daily supplement of 150 grams of commercial wheat germ was found effective as a preventive of the human disease. It is apparent, therefore, that commercial wheat germ contains and may be rated as a relatively good source of the preventive for both the human and the canine disease, pellagra and blacktongue.

### COWPEA

The cowpea (*Vigna sinensis*) is one of the favorite legumes of our Southern States, the area in which pellagra is most prevalent. It not infrequently appears as a component of diets associated with pellagra. Its pellagra-preventive potency was studied in 1919 by Goldberger and Tanner (4), who concluded that the dry cowpea has little, if any, pellagra-preventive value. More recently Goldberger and Wheeler (9) were led to study this legume again and found that a supplement of 150 grams a day had a beneficial, delaying, but not quite a complete preventive action, and thus concluded (a) that the pellagra preventive is present in the cowpea, but in relatively small amount, and (b) that it is at least appreciably inferior in pellagra-preventive potency to the wheat germ.

Our experience with the cowpea in experimental blacktongue parallels quite closely the foregoing experience with it in the human disease, as may be seen in the following experiments:

### EXPERIMENT 4

This was a test of the blacktongue-preventive action of the dried California black-eyed pea, one of the favorite varieties of the cowpea. It was incorporated in a diet, No. 286, the composition of which is shown in Table 5. As may there be seen, a 2,400-calorie portion of that diet contains 360 grams of the dried legume. Suitable portions were daily offered to each of five test animals, namely, dogs 15, 40, 52, 113, and 114. The significant details relating to each are briefly as follows:

*Dog 15.*—Male. Acquired April 14, 1923. Has served in several experiments and has suffered four attacks of blacktongue, the latest of which began December 25, 1924. On stock diet from December 21, 1926, to March 3, 1927.

March 3, 1927: In good condition; weighs 10.2 kilograms; begins cowpea-diet No. 286. (Table 5.)

On June 28, at the end of a period of 117 days, presented the first signs of an attack of blacktongue, a faint red patch on the mucosa of the upper lip opposite the canine teeth of each side and an injection of the floor of the mouth. The

attack slowly progressed with some remissions, and by July 12 was well marked and, besides showing distinctive buccal lesions, was characterized by a well-marked scrotal eruption. On the latter date the dog was killed with illuminating gas for histopathological study (5).

*Dog 40.*—Male. Whelped in the laboratory June 26, 1923. Has served in several experiments and suffered three attacks of blacktongue, of which the latest began April 23, 1924. On stock diet from December 21, 1926, to March 3, 1927. March 3, 1927: In good condition; weighs 11.2 kilograms; begins test diet No. 286. On July 9, at the end of a period of 98 days, presented the first buccal signs of blacktongue, a slight band of erythema on the mucosa of the upper lip of each side and an injection of the mucosa of the faucial pillars. A scrotal eruption appeared on June 28. By July 11 the mouth lesions had become very pronounced and treatment was started. Further history not relevant.

*Dog 52.*—Bitch. Acquired September 25, 1923. Has suffered several attacks of blacktongue, the latest of which began October 6, 1925. On stock diet from December 21, 1926, to March 3, 1927.

March 3, 1927: In good condition, weighs 10.4 kilograms; begins diet No. 286. July 12: In good condition; weighs 10.3 kilograms; has presented no indications of blacktongue; but by reason of the development of blacktongue by some of the other dogs of this lot, the experiment is this day discontinued.

*Dog 113.*—Bitch. Acquired January 17, 1927. On stock diet to March 3, 1927. March 3, 1927: In good condition; weighs 9.5 kilograms; begins diet No. 286. July 8: Three days ago presented a very suggestive injection of the floor of the mouth and a flushing of the mucosa of the cheeks. Yesterday there was present also an ill-defined reddened band on the mucosa of the upper lip. To-day the mouth appears normal.

July 12: Food consumption has for several weeks been on a declining scale. Weighs 7.8 kilograms. Experiment is this day discontinued.

*Dog 114.*—Male. Acquired February 17, 1927. On stock diet to March 3, 1927.

March 3, 1927: In good condition; weighs 9.4 kilograms; begins diet No. 286. May 10: Appetite considerably dulled and food consumption diminished during the past seven or eight days; weighs 9 kilograms. On May 15, at the end of a period of 73 days, presented the first signs of an attack of blacktongue, an injection of the mucosa of the floor of the mouth. Further history not relevant.

*Results and conclusions.*—Thus, three of the test animals developed blacktongue at the end of 73, 98, and 117 days, respectively, and one (dog 113) presented very suggestive but transient indications of blacktongue at the end of 127 days. Only one (dog 52) of this lot of test animals presented no recognizable evidence of blacktongue at any time during the experimental period of 131 days. Clearly, cowpeas diet No. 286 was inadequate to prevent the development of blacktongue. The development of but transient signs of the disease in one and of none at all in another of the five dogs would, however, appear to suggest a slight delaying or protective action. That this interpretation is probably correct is indicated by the result of the following experiment with a larger ration of cowpeas.

## EXPERIMENT 5

This was a further test of the blacktongue-preventive action of the dried California black-eyed pea, or cowpea. For this purpose it was incorporated in diet No. 299 (Table 6), but the quantity per 2,400-calorie portion was increased to 450 grams, or 25 per cent more than in diet No. 286 (Table 5). Suitable portions of this test diet were daily offered to each of five test animals, namely, dogs 40, 52, 113, 114, and 125. It may be noted that four of these animals (dogs 40, 52, 113, and 114) served in experiment 4 with cowpea-diet No. 286. The significant details relating to each of the animals are as follows:

*Dog 40.*—On stock diet for reconditioning from July 12 to August 23, 1927.

August 23, 1927: The attack of blacktongue which, as noted in the preceding experiment, began on July 9 rapidly cleared up under treatment. In good condition; weighs 12.1 kilograms; begins cowpea diet No. 299. (Table 6.)

April 10, 1928: Has presented no recognizable evidence of blacktongue since the beginning of this experiment seven and a half months ago; weighs 11.5 kilograms.

*Dog 52.*—On stock diet from July 12, the termination of the preceding experiment, to August 23, 1927.

August 23, 1927: In good condition; weighs 11.2 kilograms; begins test diet No. 299.

April 10, 1928: Has presented no recognizable evidence of blacktongue since the beginning of the present experiment seven and a half months ago; weighs 10.2 kilograms.

*Dog 113.*—On stock diet for reconditioning from July 12 to August 23, 1927.

August 23, 1927: In good condition; weighs 10.2 kilograms; begins test diet No. 299.

April 10, 1928: Food consumption has been variable; weighs 8.4 kilograms; has presented no recognizable evidence of blacktongue during the seven and one-half months since the present experiment began.

*Dog 114.*—On stock diet for reconditioning from June 30 to August 23, 1927,

during which period all evidence of the attack of blacktongue which, as noted in connection with the preceding experiment, began May 15, completely cleared up.

August 23, 1927: In good condition; weighs 10.7 kilograms; begins test diet No. 299.

April 10, 1928: Presented transient buccal signs of blacktongue October 27–November 4; November 19–20, 1927, and February 18–19, 1928; weighs 9.8 kilograms; has presented no recognizable indications of blacktongue since the disappearance of the suggestive but evanescent lesion of the upper lip noted February 18, 1928.

*Dog 125.*—Bitch. Acquired May 25, 1927. On stock diet to August 23, 1927.

August 23, 1927: In good condition; weighs 7.7 kilograms; begins test diet No. 299.

April 10, 1928: Has lost some weight; weighs 6.5 kilograms; is lively and in good condition; has presented no recognizable evidence of blacktongue during the seven and one-half months since the experiment began.

*Results and conclusions.*—The result of this experiment with diet No. 299 presents a very distinct contrast to that of the immediately preceding one with diet No. 286. Of the five test animals on diet No. 299 only one (dog 114) developed any indications of blacktongue,

and these were mild and transient. The other four at no time during the experimental period of  $7\frac{1}{2}$  months (231 days) presented any recognizable evidence of the disease. Cowpea-diet No. 299 would thus seem to possess distinctly appreciable, even though not fully complete, blacktongue-preventive action. Considering the quantity of the cowpea in the test diet, we may conclude that while the cowpea (California black-eyed pea) contains the blacktongue preventive, it contains it in a relatively very small amount, probably not more than, if as much as, about one-half that contained in ether-extracted wheat germ. Recalling the experience above cited with the cowpea in human pellagra, it is evident that this dry legume, while containing it, is a poor source of the preventive for both pellagra and blacktongue.

### SOY BEAN

In 1918 Goldberger and Tanner (4) studied the pellagra-preventive value of the dry soy bean and found that pellagra developed in several patients notwithstanding that they had daily ingested what was regarded as a liberal daily quantity, approximately 85 grams (3 ounces), as a supplement to the diet of the institution in which the study was made. This experience in the human disease suggested the desirability of testing the preventive action of this legume in the canine disease. This was accordingly done very early in our study of experimental blacktongue. In that test the experimental diet used (No. 110, the composition of which is shown in Table 7) was a simplified replica of the soy bean supplemented diet that had failed in the prevention of pellagra in the above-mentioned study of Goldberger and Tanner. The result of that test, using three dogs as test animals, duplicated the experience in the human disease; it failed of any indications of blacktongue-preventive action.

The quantity of soy beans included in the diet used in that experiment appearing to us as relatively large, the frank failure in blacktongue prevention seemed conclusive. But, as our investigations proceeded, we came increasingly to feel that the action of a larger quantity of this legume should be studied before final conclusions as to preventive potency could properly be drawn. Accordingly, we have quite recently tested the preventive action of the soy bean anew as shown in the following experiment:

### EXPERIMENT 6

This was a test of the blacktongue-preventive action of the dried soy bean (mammoth yellow variety) when incorporated in a diet (No. 287), the composition of which is shown in Table 8. As may be seen, each 2,400-calorie portion contains 360 grams of the bean. It may be noted, too, that, like wheat-germ diet No. 197, it contained cornstarch as a conspicuous component quantitatively. Suitable

portions of this diet were daily offered to each of five test animals, namely, dogs 29, 59, 84, 112, and 116. The significant details relating to each of these animals are as follows:

*Dog 29.*—Male. Acquired May 10, 1923. Has suffered several attacks of blacktongue, the latest of which began April 17, 1925. On yeast-containing test diets from May 25, 1925, to March 15, 1927. On stock diet from March 15 to April 6, 1927.

April 6, 1927: In good condition, weighs 10.1 kilograms; begins soy-bean diet No. 287. (Table 8.)

May 3: Food consumption has been excellent since beginning the soy-bean diet; weighs 10 kilograms.

June 7: Appetite and food consumption were excellent up to May 16. Since that date the food consumption has been somewhat variable; weighs 9.6 kilograms.

July 5: Appetite has been increasingly variable and food consumption somewhat reduced during the past month; weighs 9.4 kilograms. Presents this morning suggestive buccal signs of blacktongue, reddened patches of mucosa of the upper lip on the left side and flushing of the mucosa of the cheeks.

July 8: Mouth lesions have faded.

July 21: A slow decline in weight continues. Presents this morning a definite reddening of the floor of the mouth and slight reddening of the mucosa of the upper lip of each side.

July 22: Mouth appears normal this morning.

August 16: Weighs 8.7 kilograms. Suggestive buccal signs of blacktongue, reddening of the floor of the mouth and of the mucosa of the cheeks again in evidence.

August 18: Mouth is well-nigh normal this morning.

September 17: Presents this morning, at end of a period of 164 days, definite beginning signs of blacktongue, a reddened bandlike patch on mucosa of the upper lip of each side, reddening of the floor of the mouth.

September 27: Buccal lesions have become quite pronounced. Weighs 7.2 kilograms. Diet changed for reconditioning. Further history not relevant.

*Dog 59.*—Bitch. Whelped in the laboratory November 4, 1923. Has served in one experiment but has not had blacktongue. On stock diet from March 17, 1927, to April 6, 1927.

April 6, 1927: In good condition; weighs 6 kilograms; begins soy-bean diet No. 287.

April 10, 1928: Has been on the soy-bean diet one year, during which period has at no time presented any recognizable evidence of blacktongue. Weighs 5.6 kilograms. Experiment is discontinued.

*Dog 84.*—Male. Acquired March 2, 1925. Has suffered an attack of blacktongue, which began April 23, 1925. On yeast-containing diets from May 23, 1925, to March 15, 1927. On stock diet from March 15, 1927, to April 6, 1927. April 6, 1927: In good condition; weighs 10.6 kilograms; begins soy-bean test diet No. 287.

April 10, 1928: Appetite and food consumption variable but fairly good until about January 1, 1928. Since then the food consumption has become markedly reduced with coincident marked loss in weight. Weighs 6.1 kilograms; is much emaciated; mucous membranes are pale; is lively. Has presented no recognizable evidence of blacktongue at any time during the period of the experiment, now a full year in duration and terminated this day.

*Dog 112.*—Bitch. Acquired December 22, 1926. Except for a period of nine days—March 8–17—on stock diet to April 6, 1927.

April 6, 1927: In good condition; weighs 7.3 kilograms; begins soy-bean diet No. 287.

April 10, 1928: In good condition; weighs 8.2 kilograms. Has presented no recognizable evidence of blacktongue at any time during the experimental period of one year. Experiment is discontinued.

*Dog 116.*—Male. Acquired February 16, 1927. Except for the period March 9–17 on stock diet to April 6, 1927.

April 6, 1927: In good condition; weighs 7.2 kilograms; begins soy-bean diet No. 287.

April 10, 1928: In good condition; weighs 6.9 kilograms. Has presented no recognizable evidence of blacktongue during the experimental period of one year. Experiment is discontinued.

*Results and conclusions.*—Of the five test animals one (dog 29) developed an attack of blacktongue; the others presented no recognizable evidence of the disease at any time during the experimental period of one year. This would seem to indicate that soy-bean test diet No. 287 possessed definitely appreciable but not fully complete blacktongue-preventive action, and thus that the soy bean, in contrast with the indications of our earlier experience with a smaller quantity of this legume, contains the blacktongue preventive, but in a relatively small amount. This amount would appear to be appreciably more than in the cowpea and considerably less than in the extracted wheat germ.

The experience with the soy bean in pellagra, above cited, would seem to indicate, and was at first interpreted as indicating, a complete lack of preventive properties, just as the result of our earlier test of the soy bean in blacktongue was interpreted as an indication of a complete lack of blacktongue-preventive properties. It is clear that the interpretation with respect to the blacktongue preventive was not justified, and it must therefore be equally clear that the interpretation of the experience in pellagra must be considered inconclusive. No test of the soy bean in pellagra in more liberal amount than that in the study above cited has been made, so that it is not possible to state, on the basis of actual trial, that the soy bean actually contains the pellagra preventive as we have found that it does of the blacktongue preventive. So far as it goes, however, the experience in the human disease is, at least, not inconsistent with that in the experimental disease of the dog.

### MILK

The importance of milk as a food and the evidence of its pellagra-preventive value afforded by an epidemiological study of the relation of diet to pellagra incidence (10) and, still more, the direct demonstration by Goldberger and Tanner (11) that milk contains the essential pellagra-preventive factor or factors, led us, very early

in the course of our study, to begin tests of its blacktongue-preventive action. The results of these early tests (which dealt with dried milk, with fresh skim milk, and with a market buttermilk) tended to indicate that milk had but feeble blacktongue-preventive action. For various reasons, which need not be detailed, we did not consider those tests conclusive, and, therefore, have more recently carried out another study of milk (fresh skim milk) the details and results of which we present in the following:

#### EXPERIMENT 7

This was a test of the blacktongue-preventive action of a fresh skim milk for which we are indebted to Dr. L. A. Rogers, Director of the Research Laboratories of the Bureau of Dairy Industry of the Department of Agriculture. The milk when delivered to us was freshly separated. As a rule, departed from only over the week end or other holiday, this milk in 2-quart glass jars was allowed to stand in an ice box for not more than 24 hours before being used. Then, although already machine separated, as much of the bottom layer as was needed was siphoned off and, after being warmed slightly, offered to the test animals.<sup>1</sup> The milk, unless otherwise specified, was given by drench, an all-metal syringe of convenient capacity being used. The daily dose was at the rate of approximately 30 c. c. per kilogram of normal body weight. It was given as a supplement to basic blacktongue-producing diet No. 123. (Table 1.) The test animals were five dogs—numbered 54, 65, 68, 71, and 110. The significant details relating to each of these animals are as follows:

*Dog 54.*—Bitch. Acquired September 25, 1923. Up to May 26, 1926, served in several experiments and suffered a number of attacks of blacktongue, the occurrence of the latest of which was suggested by an evanescent redness of the mucosa of the floor of the mouth on September 19, 1925. On stock diet for reconditioning from May 26 to August 3, 1926.

August 3, 1926: In good condition; weighs 8.7 kilograms; begins diet No. 123 with a daily supplement of 285 c. c. of skim milk, which this animal laps greedily. August 4, 1927: Presents to-day, one year since beginning this test, a slight injection of the mucosa of the floor of the mouth.

August 6: The floor of the mouth continues injected. In addition the mucosa of the upper lip presents two reddened patches on each side opposite the canines.

August 7: Lip lesions have about faded out; floor continues somewhat injected.

August 9: Mouth is normal in appearance.

September 7, 1927: In good condition; weighs 8.5 kilograms; has been taking the skim milk, nearly always by lapping, for 13 months. Between August 4 and August 9, 1927, or at the end of one year, presented mild, evanescent signs of blacktongue. Further history not relevant.

*Dog 65.*—Bitch. Acquired January 28, 1924. Up to May 26, 1925, served in two experiments and suffered two attacks of blacktongue, the second of which

<sup>1</sup> Four samples of this skim milk examined by Assistant Chemist C. G. Rensburg in the Division of Chemistry, Hygienic Laboratory, were found to vary in fat content between 0.05 and 0.40 per cent.



was doubtful and was represented merely by an evanescent reddening of the floor of the mouth and mucosa of cheeks on February 3, 1926. On stock diet for reconditioning from May 26 to August 3, 1926.

August 3, 1926: In good condition; weighs 8.3 kilograms; begins diet No. 123 with a daily supplement of 270 c. c. of skim milk.

September 7, 1927: Has been receiving a daily supplement of 270 c. c. of skim milk by drench since August 3, 1926, or 13 months. Has presented no recognizable evidence of blacktongue during this period. Is in good condition.

• Weighs 9.3 kilograms. Further history not relevant.

Dog 68.—Bitch. Whelped in the laboratory November 25, 1923. Up to May 26, 1926, served in two experiments, but did not have blacktongue. On stock diet from May 26 to August 3, 1926.

August 3, 1926: In good condition; weighs 9.3 kilograms; begins diet No. 123 with a daily supplement of 300 c. c. of skim milk by drench.

September 7, 1927: In good condition; weighs 9.8 kilograms. Has been receiving the milk supplement for 13 months. Has presented no recognizable evidence of blacktongue during this period. Further history not relevant.

Dog 71.—Male. Whelped in the laboratory November 25, 1923. Up to May 26, 1926, served in two experiments but had no blacktongue. On stock diet from May 26 to August 3, 1926.

August 3, 1926: In good condition; weighs 10.5 kilograms; begins diet No. 123 with a daily supplement of 330 c. c. of skim milk by drench.

September 9, 1926: Presents to-day, 37 days after beginning the test of skim milk, the first signs of an attack of blacktongue, an injection of the mucosa of the floor of the mouth. Further history not relevant.

Dog 110.—Bitch. Acquired October 29, 1926. Up to December 8, 1926, on stock diet.

December 8, 1926: In good condition; weighs 10.4 kilograms; begins diet No. 123 with a daily supplement of 315 c. c. of skim milk by drench.

September 7, 1927: In good condition; weighs 11.9 kilograms. Has been getting the skim milk daily for 9 months. Has presented no evidence of blacktongue during this period. Experiment is this day discontinued. Further history not relevant.

*Results and conclusions.*—Of the five test animals, one (dog 71) developed a well marked attack of blacktongue at the end of a period of 37 days; one (dog 54) developed slight transient evidence of an attack at the end of one year; the other three presented no recognizable evidence of blacktongue during the period of observation, which was one year for two and nine months for the third of these animals. Recalling that, in our experience, feeding with basic diet No. 123 has regularly resulted in an attack of blacktongue within a period only exceptionally longer than about two months, it follows that the skim milk supplement exercised a definitely appreciable but not fully complete blacktongue-preventive action. It may be concluded, therefore, that milk contains the blacktongue preventive, but that somewhat more than 30 c. c. daily per kilogram of body weight, at least of skim milk, may be needed to secure complete protection when used to supplement such basic diet as our No. 123.

In this connection it is of interest to recall that, in their study of the pellagra-preventive action of buttermilk, Goldberger and Tanner (11)

found that a supplement of 1,200 c. c. (40 ounces) was adequate for the complete prevention of the disease in their patients and incidentally expressed the opinion that a somewhat smaller quantity might possibly have served equally well. How much smaller was at the time not definitely stated, but we judge, on the basis of general observation and experience with milk, that this could probably have been some 200 or 300 c. c. In other words, it seems to us probable that about 900 or 1,000 c. c. of buttermilk as a supplement to the type of diet received by those patients would have been adequate for pellagra prevention with but little, if any, margin for safety.<sup>1</sup> It thus appears that milk contains the preventive for both blacktongue and pellagra, but, considered in relation to effective quantity, contains it in relatively small amount.

### BUTTER

Very early in our study of blacktongue we began an investigation of butter. At the outset this was done in order to determine to what extent, if at all, the action of butter in blacktongue resembled that in pellagra. Working at the Georgia State Sanitarium with butter locally produced, Goldberger and Tanner (11) had found this ineffective in several cases of pellagra in patients weighing 51 to 57.5 kilograms, in spite of a daily consumption that for periods of three to upward of five months had averaged approximately 135 to 145 grams. In order to make the comparison of the effectiveness of butter as rigid as possible, our study in the dog was begun with some of the same butter as that used by Goldberger and Tanner in pellagra. Later, learning that Underhill and Mendel had found butter a potent curative and preventive agent in the Chittenden-Underhill syndrome in the dog (6),<sup>2</sup> a pathological condition which, at that time, it seemed probable might be identical with the experimental disease, blacktongue (12), with which we were working, we extended our study to include a test of butter secured from the same source (a creamery in Vermont) as that of some with which Underhill and Mendel worked. In this connection it may be noted that, since it seemed possible that butter from a northern dairying locality, such as that which formed the source of the butter used by Underhill and Mendel, might be more potent in the factor preventing blacktongue, and thus possibly also pellagra, than butter from the nondairying region in the vicinity of the Georgia State Sanitarium in central Georgia, Goldberger and Wheeler thought it worth while to make some

<sup>1</sup> Since a majority of those patients weighed about 60 kilograms, it would follow that somewhat less than 20 c. c. of buttermilk per kilogram of body weight served in that study as a pellagra preventive. Since, on the other hand, somewhat more than 30 c. c. of skim milk per kilogram of body weight of dog is needed for full prevention of blacktongue, it may be suggested that the dog's requirement for the preventive factor is probably about twice as large as man's per kilogram of body weight.

<sup>2</sup> We are under obligation to the courtesy of Professors Underhill and Mendel for advance information of their finding with regard to butter, and for aid in securing for our use a supply of butter from the same source (in Vermont) as that of their own.

pellagra-preventive trials with some of this same northern butter. The results of these trials proved no more favorable, however, than of those previously reported with butter locally produced (1). They concluded, therefore, that while the pellagra preventive may be present in butter, the quantity of butter that must be eaten before its pellagra-preventive action becomes appreciable is so large as to indicate that this preventive, if present in the butter, is present in practically negligible quantity. As will presently be seen, our experience with butter in experimental blacktongue is in harmony with that just cited in pellagra, and thus very different from that reported by Underhill and Mendel (6) (7).

In the study of butter that we wish now to present we have used products from three distinct sources, namely, Milledgeville, Ga.; Beltsville, Md.; New Haven, Conn.

The Milledgeville butter was, as already stated, some of the same butter as that used by Goldberger and Tanner (11) in a study of its pellagra-preventive potency. It was part of the supply of the Georgia State Sanitarium which secured it in batches of a few pounds from farmers of the vicinity. In June, 1923, a considerable quantity of this butter was melted, the fat siphoned into glass jars, and thus sent by express to the Hygienic Laboratory. At the Hygienic Laboratory it was stored in the refrigerator room. This butter—or more precisely, butterfat—will be referred to as our Milledgeville butterfat.

The Beltsville butter was a batch of butter specially prepared for us October 2-3, 1923, from sweet cream of cows, 25 to 50 per cent pasture fed, of the Beltsville farm of the Bureau of Dairy Industry, United States Department of Agriculture, for which we are indebted to Dr. L. A. Rogers, director of its research laboratories. It was kept by us in the laboratory ice box until used.

The butter secured from New Haven was actually from a creamery in Vermont, and, as already explained, was the same as that from which Underhill and Mendel secured their butter. It was laid down early in July, 1924. Some of this butter was used as above stated in a study of pellagra prevention at the Georgia State Sanitarium (1). It was kept in cold storage at New Haven, Conn., until October, when a batch was forwarded to us at the Hygienic Laboratory. At the laboratory it was stored in its original form in wooden tubs or, after conversion into butterfat, in glass jars in the laboratory refrigerator room, from which small batches were, from time to time, withdrawn and kept in an ice box until used. Depending upon whether it was used in its original form or as butterfat, this product will be designated as Vermont butter or Vermont butterfat.

Our study of butter (including butterfat) is detailed in experiments 8-12, which follow:

## EXPERIMENT 8

This was, first, a preventive test of Milledgeville butterfat and, second, a therapeutic test of Beltsville butter in immediately succeeding periods in the same animal, dog 47. The significant details are as follows:

*Dog 47.*—Male. Acquired August 18, 1923. On a stock diet to September 11, 1923.

September 11, 1923: In good condition. Weighs 9.2 kilograms. Begins Milledgeville butterfat diet No. 115, the composition of which is shown in Table 9.

It may be remarked that basically and in blacktongue-producing potency this diet is much the same as the diet (No. 34), with which Goldberger and Wheeler (2) first succeeded in inducing blacktongue in the dog.

September 25: Weighs 9.2 kilograms. Daily food consumption during the past two weeks has averaged approximately 970 grams, representing 62 grams of butterfat, or fully 6.5 grams of butterfat per kilogram of body weight.

September 28: There are present this morning, at the end of a period of 17 days of butterfat diet No. 115, the first signs of an attack of blacktongue, an injection of the floor of the mouth, a reddening of the mucosa of the cheeks and of that of the upper lip opposite the canines.

October 4: Given 100 grams of fresh lean beef on September 28, September 29, and on October 2, so as to retard the progress and mitigate the severity of the attack preparatory to treatment with Beltsville butter, which is begun to-day with diet No. 115B, the composition of which is shown in Table 10.

October 16: Weighs 10.6 kilograms. The daily food consumption since the change to Beltsville butter diet No. 115B has averaged approximately 1,080 grams, representing 86 grams of Beltsville butter or fully 8 grams of butter per kilogram of body weight.

October 18: Presents this morning, 14 days since beginning the Beltsville butter diet No. 115B, buccal signs of the beginning of a relapse of the attack of blacktongue, an injection of the floor of the mouth. Further history not relevant.

*Result.*—The ingestion of the Milledgeville butterfat in a daily quantity that averaged fully 6.5 grams per kilogram of body weight was inadequate to prevent the development of an attack of blacktongue in this animal, nor was the ingestion of the Beltsville butter at a daily rate of fully 8 grams per kilogram of body weight adequate appreciably to effect the further progress or relapse of the attack.

## EXPERIMENT 9

This, like the second period of the preceding experiment, was a test of the therapeutic potency of Beltsville butter. It was carried out in two animals, dogs 17 and 29, the significant details and results of which are as follows:

*Dog 17.*—Bitch. Acquired April 14, 1923. Up to October 16, 1923, served in two experiments and suffered two attacks of blacktongue, the second of which began October 9, 1923.

October 16, 1923: The buccal lesions of blacktongue that made their first appearance a week ago have subsided. Received 100 grams of fresh lean beef, therapeutically, on each of the past three days in order to mitigate the severity and retard the progress of the attack in preparation for the test of butter.

Weights 10.4 kilograms. Begins Beltsville butter diet No. 115B, the composition of which is shown in Table 10.

October 21: Has been eating well, having regularly consumed all of the daily allowance of 1,000 grams of food, representing 80 grams of Beltsville butter, or fully 7.5 grams of butter per kilogram of body weight. Presents this morning, five days after beginning the butter treatment, faint patches of redness on the mucosa of the upper lip opposite the canine teeth; the mucosa of the floor of the mouth is suggestively injected.

October 22: Mouth appears about normal this morning. Yesterday ate approximately 1,165 grams of food, representing 93 grams of butter.

October 24: Floor of mouth again slightly reddened. Weighs 10.7 kilograms.

October 25: Injection of the floor of the mouth is somewhat more pronounced.

October 27: The buccal lesions of blacktongue have become still more pronounced and more extensive. During the past five days has consumed a daily average of approximately 930 grams of food, representing 75 grams of butter.

October 31: The buccal lesions have faded markedly during the past two or three days. Weighs 11 kilograms. Has consumed during the past four days a daily average of approximately 930 grams of food, representing 75 grams of butter, or fully 6.5 grams of butter per kilogram of body weight.

November 5: The buccal lesions have gradually reappeared during the past four days and are well marked this morning, 21 days after beginning treatment. Weighs 10.8 kilograms. Has consumed during the past five days an average of approximately 920 grams of food, representing 73 grams of butter a day, or fully 6.5 grams of butter per kilogram of body weight. The butter diet, seeming to be ineffective, is discontinued. Further history not relevant.

*Dog 29.*—Male. Acquired May 9, 1923. Up to October 9, 1923 had experienced two attacks of blacktongue, the second of which began September 30, 1923.

October 9, 1923: The attack of blacktongue that began nine days ago has subsided. Mouth is normal. Received 100 grams of lean fresh beef daily October 3-7 and 50 grams yesterday in order to retard the development and mitigate the severity of the attack in preparation for the test of butter. Weighs 10.4 kilograms. To-day begins Beltsville butter diet No. 115B, the composition of which is shown in Table 10.

October 16: Weighs 11 kilograms. Has eaten daily during the week an average of approximately 950 grams of food, representing 76 grams of Beltsville butter, or fully 6.5 grams of butter per kilogram of body weight.

October 18: Mucosa of the floor of the mouth is slightly reddened.

October 20: Injection of the floor of the mouth is more pronounced this morning.

October 23: Mouth appears about normal this morning. Weighs 11.2 kilograms.

Daily food consumption during the past week has averaged 650 grams, representing 52 grams of butter, or fully 4.5 grams of butter per kilogram of body weight.

October 24: Floor of the mouth is again slightly injected.

October 25: Reddening of the mucosa of the floor of the mouth is quite pronounced this morning.

October 27: Reddening of the floor of the mouth persists.

October 30: Mouth is well-nigh normal this morning. Weighs 11.3 kilograms.

Daily food consumption during the past week has averaged approximately 680 grams, representing 56 grams of butter or but little short of 5 grams of butter per kilogram of body weight.

November 1: Mouth is again about normal.

November 13: The mucosa of the floor of the mouth has, during the past week, become progressively more intensely reddened. In addition the mucosa of the

upper lip and of the cheeks has also become reddened, so that the animal now (34 days after beginning the Beltsville butter diet) presents well marked buccal lesions of blacktongue. Weighs 11.5 kilograms. The average daily food consumption during the past two weeks fell to 600 grams, representing 48 grams of butter or fully 4 grams per kilogram of body weight. Further history not relevant.

*Result.*—Thus, as in experiment 8, notwithstanding that the treatment with Beltsville butter was begun in both animals under favorable conditions, and that both ingested the butter at what would seem to be a liberal rate (which at the outset was fully 7.5 and 6.5 grams per kilogram of body weight, respectively), in neither animal was the progress of the attack appreciably affected.

#### EXPERIMENT 10

This was a further test of the blacktongue-preventive potency of Milledgeville butterfat which was now, it may be noted, 15 months old. The test animals were three dogs, numbered 5, 13, and 48. Each of the dogs was daily offered a liberal allowance of diet No. 180A containing the butterfat. The composition of this diet is shown in Table 11. The significant details relating to each animal are as follows:

*Dog 5.*—Bitch. Acquired November 8, 1921. Up to August 19, 1924, served in a number of experiments and suffered three attacks of blacktongue, the latest of which began August 2, 1924. On stock diet for reconditioning from August 19 to September 23, 1924.

September 23, 1924: In good condition. Weighs 7.7 kilograms. Begins Milledgeville butterfat diet No. 180A. (Table 11.)

October 1: Has been eating well. Weighs 7.8 kilograms. Has consumed during the past eight days a daily average of approximately 820 grams of food, representing 40 grams of butterfat, or 5 grams of butterfat per kilogram of body weight.

November 1: Has continued to eat well during the past month. Weighs 8.2 kilograms. Has regularly consumed the daily allowance of 800 grams of food, representing 38 grams of butterfat or fully 4.5 grams of butterfat per kilogram of body weight.

December 1: Food consumption has held up well. Weighs 8.8 kilograms. Has taken daily during the past month an average of approximately 770 grams of food, representing 37 grams of butterfat or fully 4 grams of butterfat per kilogram of body weight.

December 23: This morning, at the end of a period of 91 days, presents the first signs of an attack of blacktongue, a reddening of the mucosa of the floor of the mouth. Weighs 8.4 kilograms. Food consumption fell off markedly after the first of the present month, the daily average for the past 22 days being but 560 grams, which represents approximately 27 grams of butterfat or fully 3 grams of butterfat per kilogram of body weight. Further history not relevant.

*Dog 13.*—Male. Acquired April 7, 1923. Up to August 19, 1924, served in several experiments and suffered five attacks of blacktongue, of which the latest began July 11, 1924. On reconditioning diet from August 19 to September 23, 1924.

September 23, 1924: In good condition, weighs 9 kilograms, begins Milledgeville butterfat diet No. 180A.

October 1: Has been eating well. During the past eight days has consumed an average of approximately 935 grams of food, representing 45 grams of Milledgeville butterfat, or approximately 5 grams per kilogram of body weight.

November 1: Weighs 9.8 kilograms, has continued to eat well having regularly consumed during October the daily allowance of 1,000 grams of food, representing approximately 48 grams of butterfat, or fully 4.5 grams of butterfat per kilogram of body weight.

November 11: Weighs 10 kilograms. During the past 10 days has regularly consumed all of the daily allowance of 1,000 grams of food, representing 48 grams of butterfat.

December 1: Weighs 10 kilograms. During the past 20 days appetite was somewhat diminished. The daily food consumption for this period averages approximately 845 grams, representing 40 grams of butterfat, or approximately 4 grams of butterfat per kilogram of body weight.

January 1, 1925: Weight was 9.9 kilograms day before yesterday. Food consumption was further reduced during the past month; the daily intake has averaged but 715 grams, representing approximately 34 grams of butterfat, or a little short of 3.5 grams of butterfat per kilogram of body weight.

January 6: This morning, at the end of a period of 105 days, presents the first signs of an attack of blacktongue, a reddening of the mucosa of the floor of the mouth and of that of the cheeks. During the past five days the daily food consumption has averaged approximately 655 grams, representing 31 grams of butterfat. Weighs 9.8 kilograms. Further history not relevant.

*Dog 48.*—Bitch. Acquired August 20, 1923. Up to August 5, 1924, served in several experiments and suffered two attacks of blacktongue, of which the second began May 20, 1924. From August 5 to September 23, 1924, was on a reconditioning diet.

September 23, 1924: In good condition. Weighs 6.2 kilograms. Begins Milledgeville butterfat diet No. 180A.

October 1: Weighs 6.6 kilograms. Has been eating well. Has regularly consumed all of the daily allowance of 800 grams of food, representing 38 grams of Milledgeville butterfat or fully 5.5 grams of butterfat per kilogram of body weight.

October 28: Weighs 7 kilograms. Has continued to eat well, regularly consuming all of the daily allowance of 800 grams of food, representing 38 grams of butterfat, or slightly short of 5.5 grams of butterfat per kilogram of body weight.

November 4: Weighs 6.8 kilograms. Has been leaving some of the food nearly every day during the past seven days. The daily consumption has averaged approximately 580 grams, representing about 28 grams of butterfat, or approximately 4 grams of butterfat per kilogram of body weight.

December 2: Weighs 6.8 kilograms. During the past four weeks the daily food consumption has averaged approximately 565 grams, representing about 27 grams of butterfat, or slightly short of 4 grams of butterfat per kilogram of body weight.

December 30: Weighs 6.8 kilograms. The daily food consumption during the past four weeks has averaged approximately 540 grams, representing 26 grams of butterfat, or fully 3.5 grams of butterfat per kilogram of body weight.

January 27, 1925: Weighs 6.9 kilograms. During the past four weeks the daily food consumption has averaged approximately 540 grams, representing about 26 grams of butterfat, or slightly over 3.5 grams of butterfat per kilogram of body weight.

February 24: Weighs 6.7 kilograms. During the past four weeks the daily food consumption has averaged approximately 440 grams, representing about 21 grams of butterfat, or at a rate of approximately 3 grams of butterfat per kilogram of body weight.

March 10: During the past two weeks food consumption declined to a daily average of approximately 320 grams, representing 15 grams of butterfat. Weight has declined to 6.2 kilograms. Presents this morning, 168 days since beginning the Milledgeville butterfat diet, the first signs of an attack of black-tongue, a reddening of the mucosa of the floor of the mouth and slightly reddened patches on the mucosa of the upper lip opposite the canines. Further history not relevant.

*Result.*—It appears from the foregoing that all three test animals developed black-tongue, notwithstanding a liberal daily ingestion of the butterfat. The first significant buccal signs of the disease made their appearance in these animals at the end of 91, 105, and 168 days, respectively. This result, it may be noted, is in harmony with the result of the test of the same butterfat in Experiment 8 when it was but 3 months old.

#### EXPERIMENT 11

This was a study of Milledgeville butterfat (diet No. 180A) and of Vermont butterfat (diets No. 180B and No. 180C) in separate but immediately succeeding periods in each of four test animals, namely, dogs 9, 44, 66, and 73. When its use was begun, the Milledgeville butterfat was 15 to 16 months old, while the Vermont product, when it came into use, was about 6 months old in one case (dog 9) and about 11 months old in each of the other three cases. The significant details relating to each of the animals are briefly as follows:

*Dog 9.*—Male. Acquired April 1, 1923. Has served in several experiments and has suffered five attacks of black-tongue, of which the latest began July 31, 1924. On reconditioning stock diets from August 19 to October 1, 1924.

October 1, 1924: In good condition. Weighs 10.5 kilograms. Begins Milledgeville butterfat diet No. 180A, the composition of which is shown in Table 11.

November 11: Weighs 11.6 kilograms. Has been eating well, regularly consuming the daily allowance of 1,100 grams of food, representing approximately 53 grams of Milledgeville butterfat, or fully 4.5 grams of butterfat per kilogram of body weight.

November 25: Weighs 12 kilograms. Appetite has been less consistently good during the past two weeks. The daily food consumption has averaged approximately 1,030 grams, representing 49 grams of butterfat, or 4 grams per kilogram of body weight.

December 9: Weighs 11.7 kilograms. Appetite still further dulled. Daily food consumption during the past two weeks averages approximately 800 grams, representing 38 grams of butterfat, or upward of 3 grams per kilogram of body weight.

December 11: Presents this morning a slight, somewhat suggestive, streaky injection of the floor of the mouth.

December 18: The streaky redness of the floor persisted a few days, then faded. Mouth is about normal.



- December 23: Weighs 11.7 kilograms. Food consumption during the past two weeks has averaged approximately 880 grams per day, representing 42 grams of butterfat, or fully 3.5 grams per kilogram of body weight.
- December 25: This morning, at the end of a period of 85 days, presents the first definite signs of an attack of blacktongue, an injection of the mucosa of the floor of the mouth.
- January 3, 1928: During the past 11 days food consumption has been considerably reduced, the daily average for this period being approximately 550 grams, representing 26 grams of butterfat. The buccal lesions (erythematous bands on the mucosa of the upper lip, reddened mucosa of the cheeks and of the floor of the mouth) now being well marked and the appetite having become reduced, it is deemed desirable to try to retard or arrest the progress of the attack preparatory to a change in the butter of the diet. Accordingly, 22 grams of dried brewery yeast is administered to-day.
- January 4: Another dose of 22 grams of dried brewery yeast is administered and the diet is changed to Vermont butterfat diet No. 180B, the composition of which (shown in Table 11) is identical, except as to the butterfat, with that of Milledgeville butterfat diet No. 180A.
- January 6: A third dose of 22 grams of yeast was administered yesterday. Yeast treatment is discontinued effective to-day. All buccal lesions have faded, and the appetite seems to be restored. Ate all food offered yesterday and the day before. Weighs 11.7 kilograms.
- January 13: Weighs 11.8 kilograms. Has been eating well during the past week, regularly consuming the daily allowance of 1,100 grams of food, representing approximately 53 grams of Vermont butterfat, or fully 4 grams per kilogram of body weight.
- February 3: Weighs 11.5 kilograms. Appetite has become dulled during the past week. The daily food consumption during this period has averaged approximately 730 grams, representing 35 grams of butterfat, or approximately 3 grams per kilogram of body weight.
- February 24: Weighs 10.9 kilograms. Appetite has become further reduced during the past three weeks. The daily food consumption has averaged but 470 grams, representing approximately 23 grams of butterfat, or fully 2 grams per kilogram of body weight. Presents to-day, 51 days after the change from the Milledgeville to the Vermont butterfat diet, the first buccal signs of an attack, or perhaps of a relapse, of blacktongue. Further history not relevant.
- Dog 44.*—Male. Whelped in the laboratory June 26, 1923. Up to August 19, 1924, served in two experiments and suffered two attacks of blacktongue, the latest of which began August 13, 1924. On a reconditioning diet from August 19 to September 23, 1924.
- September 23, 1924: In good condition. Weighs 11.8 kilograms. Begins Milledgeville butterfat diet No. 180A. (Table 11.)
- October 1: Weighs 11.6 kilograms. Has been eating well. Food consumption has averaged approximately 1,175 grams per day, representing about 59 grams of butterfat, or approximately 5 grams per kilogram of body weight.
- November 1: Weighs 11.8 kilograms. Daily food consumption during the past month has averaged approximately 1,380 grams, representing 66 grams of butterfat, or approximately 5.5 grams per kilogram of body weight.
- December 1: Weighs 11.5 kilograms. Daily food consumption for November has averaged approximately 1,370 grams, representing about 65 grams of butterfat or approximately 5.5 grams per kilogram of body weight.
- December 23: Weighs 10.6 kilograms. Food consumption has gradually diminished. During the past 22 days it has averaged approximately 990 grams,

representing 47 grams of butterfat per day, or slightly over 4 grams per kilogram of body weight.

December 27: This morning, 95 days since the butterfat diet was begun, the mucosa of the floor of the mouth is found very suggestively reddened.

December 28: Mouth appears normal.

January 1, 1925: Food consumption during the past nine days has been much better than during the earlier part of December, averaging approximately 1,380 grams of food, representing 66 grams of butterfat daily.

February 1: Weighs 10.9 kilograms. The daily food consumption during January has averaged approximately 1,430 grams, representing about 68 grams of butterfat, or fully 6 grams per kilogram of body weight.

March 1: Weighs 10.9 kilograms. During the past month the daily food consumption has averaged approximately 1,300 grams, representing about 62 grams of butterfat.

April 1: Weighs 10.7 kilograms. During March the daily food consumption has averaged approximately 1,380 grams, representing 66 grams of butterfat, or approximately 6 grams per kilogram of body weight.

May 1: During April the daily food consumption averaged approximately 1,500 grams, representing 72 grams of butterfat.

May 26: Weighs 12.2 kilograms. Since the beginning of this month the daily food consumption has averaged approximately 1,470 grams, representing about 71 grams of butterfat, or fully 5.5 grams per kilogram of body weight. There has been no evidence suggesting blacktongue since the evanescent reddening of the mucosa of the floor of the mouth noted December 27, 1924, five months ago. Begins this day Vermont butterfat diet No. 180C, the composition of which is shown in Table 11.

June 1: The daily food consumption since the change in diet has averaged approximately 1,200 grams, representing about 57 grams of Vermont butterfat.

July 1: Weighs 12 kilograms. Food consumption during June has averaged approximately 1,170 grams, representing about 56 grams of butterfat per day, or fully 4.5 grams per kilogram of body weight.

July 17: Three days ago weighed 12 kilograms. Daily food consumption since the beginning of this month has averaged approximately 1,050 grams, representing 50 grams of butterfat, or approximately 4 grams of butterfat per kilogram of body weight.

Presents this day—52 days since beginning the Vermont butterfat diet—a suggestive reddening of the floor of the mouth. A reconditioning diet is begun this day.

July 18: The injection of the floor of the mouth has faded. Further history not relevant.

*Dog 66.*—Male. Whelped in the laboratory November 25, 1923. Reared on stock diets. Between April 22 and June 9, 1924, served in one experiment without any manifestations of blacktongue. On stock diet between June 9, 1924, and September 23, 1924.

September 23, 1924: In good condition. Weighs 10.4 kilograms. Begins Milledgeville butterfat diet No. 180A. (Table 11.)

October 1: Weighs 10.2 kilograms. Since beginning this test has regularly eaten all of the daily allowance of 1,100 grams of food, representing about 53 grams of Milledgeville butterfat, or approximately 5 grams per kilogram of body weight.

October 8: Weighs 10.1 kilograms. Has regularly been eating all of the daily allowance of 1,200 grams of food during the past week.

- October 22: Weighs 10.4 kilograms. During the past two weeks the daily food consumption has averaged approximately 1,420 grams, representing 68 grams of butterfat, or fully 6 grams per kilogram of body weight.
- November 4: Weighs 11 kilograms. During the past two weeks has been regularly consuming all of the daily allowance of 1,700 grams of food, representing about 82 grams of butterfat, or almost 7.5 grams per kilogram of body weight.
- November 11: Weighs 11 kilograms. During the past week the food consumption has averaged approximately 1,680 grams a day, representing 81 grams of butterfat, or fully 7 grams per kilogram of body weight. The mucosa of the floor of the mouth is this morning, 49 days since beginning the Milledgeville butterfat diet, suggestively reddened.
- November 12: Injection of the floor of the mouth about as yesterday.
- November 14: Injection of the floor of the mouth has become much reduced.
- November 16: The mucosa of the floor of the mouth is normal in appearance this morning. During the past five days the appetite appears to have been slightly dulled, the daily food consumption averaging approximately 1,340 grams, representing 64 grams of butterfat.
- December 2: Weighs 11 kilograms. During the past 16 days the food consumption has averaged approximately 1,570 grams, representing 75 grams of butterfat, or slightly short of 7 grams per kilogram of body weight.
- January 6, 1925: Weighs 11.4 kilograms. During the past five weeks the daily food consumption has averaged approximately 1,510 grams, representing 72 grams of butterfat, or fully 6 grams per kilogram of body weight.
- February 3: Weighs 10.7 kilograms. During the past four weeks the daily food consumption has been somewhat diminished, averaging approximately 1,450 grams per day.
- March 3: Weighs 10.5 kilograms. During the past four weeks the daily food consumption has averaged approximately 1,440 grams, representing 69 grams of butterfat, or nearly 6.5 grams per kilogram of body weight.
- March 5: Since the subsidence of the suggestive reddening of the mucosa of the floor of the mouth—first noted on November 11, 1924, four months ago—this animal has presented no buccal lesions suggestive of blacktongue until this morning. This morning, 163 days since beginning the test, there is again present a suggestive injection of the mucosa of the floor of the mouth.
- March 7: Floor of mouth continues suggestively reddened.
- March 8: Mouth again appears normal.
- March 10: Weighs 10.9 kilograms. During the past week has regularly eaten the daily allowance of 1,700 grams of food, representing approximately 82 grams of butterfat, or fully 7 grams per kilogram of body weight.
- March 26: Mucosa of floor of mouth again slightly but suggestively reddened.
- March 27: Mouth again normal.
- April 7: Weighs 10.5 kilograms. During the past four weeks the daily food consumption has averaged approximately 1,310 grams, representing 63 grams of butterfat, or approximately 6 grams per kilogram of body weight.
- May 26: Weighs 11 kilograms. During the past seven weeks the daily food consumption has averaged approximately 1,475 grams, representing 71 grams of butterfat. Has presented nothing suggesting blacktongue since the evanescent injection of the floor of the mouth noted March 26. Begins this day Vermont butterfat diet No. 180C. (Table 11.)
- June 11: Two days ago weighed 10.8 kilograms. Food consumption during the past 16 days has been somewhat diminished, averaging approximately 1,190 grams a day, which represents 57 grams of Vermont butterfat, or fully 5 grams of butterfat per kilogram of body weight.

Presents this morning, 16 days after beginning the Vermont butterfat diet and 261 days since beginning the test, definite buccal signs of an attack of black-tongue, a well-marked reddened patch on the mucosa of the upper lip opposite the canines on both sides, slight reddening of the mucosa of the cheeks and marked reddening of the floor of the mouth. Further history not relevant.

- Dog 73.*—Bitch. Acquired March 19, 1924. Up to August 18, 1924, served in one experiment. Presented evanescent signs suggesting blacktongue on July 12, 1924. From August 19 to September 23, 1924, on reconditioning diets.
- September 23, 1924: In good condition. Weighs 10.4 kilograms. Begins Milledgeville butterfat diet No. 180A. (Table 11.)
- October 21: Weighs 9.7 kilograms. Daily food consumption during the past four weeks has averaged approximately 660 grams, representing 32 grams of Milledgeville butterfat, or fully 3 grams per kilogram of body weight.
- November 18: Weighs 9.6 kilograms. During the past four weeks the daily food consumption has averaged 610 grams, representing 29 grams of butterfat, or approximately 3 grams per kilogram of body weight.
- December 16: Weighs 9.4 kilograms. During the past four weeks the daily food consumption has averaged approximately 750 grams, representing 36 grams of butterfat, or fully 3.5 grams per kilogram of body weight.
- January 13, 1925: Weighs 9.6 kilograms. During the past four weeks the daily food consumption has averaged approximately 730 grams, representing 35 grams of butterfat, or fully 3.5 grams per kilogram of body weight.
- March 10: Weighs 10.7 kilograms. During the past eight weeks the daily food consumption has averaged approximately 680 grams, representing 33 grams of butterfat, or approximately 3 grams per kilogram of body weight.
- April 7: Weighs 9.4 kilograms. Appetite has for some time been increasingly variable and, in general, considerably diminished. During the past four weeks the daily food consumption has averaged approximately 460 grams, representing 22 grams of butterfat, or fully 2 grams per kilogram of body weight.
- May 26: Weighs 9.8 kilograms. During the past seven weeks appetite has in general been better. The daily food consumption for this period has averaged approximately 720 grams, representing 35 grams of Milledgeville butterfat, or approximately 3.5 grams per kilogram of body weight. Begins Vermont butterfat diet No. 180C. (Table 11.)
- June 23: Weighs 10 kilograms. During the past four weeks the daily food consumption has averaged approximately 690 grams, representing 33 grams of Vermont butterfat or fully 3 grams per kilogram of body weight.
- July 7: Weighs 9.7 kilograms. During the past two weeks the daily food consumption has averaged approximately 600 grams, representing 29 grams of butterfat, or approximately 3 grams per kilogram of body weight.
- July 11: The mucosa of the floor of the mouth presents a very suggestively reddened area at about its center this morning—46 days after beginning the Vermont butterfat diet, and 291 days after beginning the Milledgeville butterfat diet.
- July 13: The injection noted day before yesterday has faded. Weighs 9.8 kilograms.
- July 17: Food consumption during the past 10 days has averaged approximately 640 grams, representing 31 grams of butterfat, or fully 3 grams per kilogram of body weight. The feeding with the butterfat diet is this day discontinued. During the period of 297 days of the butterfat feeding this animal presented the suggestive but very evanescent indications of blacktongue noted July 11, 1925.

*Result.*—We find, then, that each of the four test animals developed some evidence of blacktongue which was definitely marked in two, dogs 9 and 66, but was not more than strongly suggestive in each of the other two. The amount of butterfat ingested daily varied with each animal and in the same animal at different times in accordance with variations in appetite during the progress of the feeding. The daily rate at its highest varied among the dogs between 3.5 and 7 grams per kilogram of body weight for the Milledgeville butterfat and between 3 and 5 grams for the Vermont product. It is notable that the highest rate of consumption was in one of the dogs (dog 66) that developed a definitely recognizable attack of blacktongue.

#### EXPERIMENT 12

This was a preventive test of the Vermont butterfat and was carried out in four animals, dogs 52, 60, 63, and 64. The butter was about 3 months old when the feeding of the first three of these animals began and about 7 months old when the feeding of the fourth began. The butterfat was incorporated in two diets—No. 180B (Table 11) and No. 180C (Table 11), respectively. These diets were offered separately in immediately succeeding periods to each of three of the test dogs (dogs 52, 60, and 64). In the fourth animal (dog 63) the feeding comprised but a single period and was with diet No. 180B. These diets differed in but one respect, namely, that No. 180C contained no tomato juice. The elimination of tomato juice from the diet was decided upon when certain other of our studies indicated what had not been suspected theretofore—that tomato juice might itself possess preventive action and thus by its inclusion, even in small amounts, tend to affect the result of the feeding. The significant details relating to each of the test dogs are briefly presented in the following:

*Dog 52.*—Bitch. Acquired September 25, 1923. Has served in several experiments and has suffered three attacks of blacktongue, the latest of which began July 31, 1924. On reconditioning diets from August 19 to October 15, 1924.

October 15, 1924: In good condition. Weighs 9.8 kilograms. Begins Vermont butterfat diet No. 180B. (Table 11.)

October 28: Weighs 9.8 kilograms. Has regularly consumed the daily offering of 1,000 grams of food, representing 48 grams of Vermont butterfat, or slightly less than 5 grams per kilogram of body weight.

November 25: Weighs 10.4 kilograms. Appetite continues excellent. Only once during the past four weeks was any (about 50 grams) of the daily allowance of 1,000 grams left uneaten.

February 10, 1925: Appetite continued excellent throughout the past 11 weeks. Only twice during this period was any (490 grams and 150 grams, respectively) of the daily allowance of 1,000 grams left uneaten. Weight has gradually risen and is 11.5 kilograms to-day.

February 24: Weighs 11.4 kilograms. During the past two weeks appetite has been variable and the food consumption was diminished, averaging approximately 700 grams, representing 34 grams of butterfat, daily.

March 24: Appetite has continued variable and became further dulled during the past four weeks, the daily food consumption averaging approximately 540 grams, representing 26 grams of butterfat. Weighs 9.9 kilograms.

Presents this morning, 157 days since beginning the Vermont butterfat diet, the first signs of blacktongue, a streaky reddening of the mucosa of the floor of the mouth.

March 25: The reddening of the mucosa of the floor of the mouth is more extensive and more vivid.

March 26: The reddening of the floor of the mouth persists.

March 27: The mouth lesion has completely faded.

March 31: Weighs 10.3 kilograms. During the past four days the appetite has been excellent, the animal regularly eating all of the daily allowance of 1,000 grams of food, representing 48 grams of butterfat, or approximately 4.5 grams of butterfat per kilogram of body weight.

April 14: During the past two weeks has regularly eaten all of the daily allowance of 1,000 grams of food. Weighs 10.6 kilograms.

April 28: Left some of the daily allowance of food four times during the past two weeks so that the daily food consumption has averaged 860 grams, representing 41 grams of butterfat. Weighs 10.5 kilograms.

May 12: During the past two weeks food consumption again was excellent, the daily allowance of 1,000 grams of food, representing 48 grams of butterfat, being regularly consumed. Weighs 10.6 kilograms.

May 26: Appetite variable during past two weeks. Daily food consumption has averaged approximately 830 grams, representing 40 grams of butterfat. Weighs 10.3 kilograms. Begins to-day Vermont butterfat diet 180C, thus excluding tomato juice from the ration.

June 23: Weighs 10.2 kilograms. During the past four weeks the daily food consumption has averaged approximately 930 grams, representing 45 grams of butterfat, or approximately 4.5 grams of butterfat per kilogram of body weight.

July 7: Daily food consumption during the past two weeks has averaged approximately 780 grams, representing 37 grams of butterfat. Weighs 10.3 kilograms.

July 17: During the past 10 days the daily food consumption has averaged approximately 900 grams, representing 43 grams of butterfat. Three days ago weighed 10.2 kilograms. Is in good condition. The butterfat feeding is discontinued this day, 275 days after it began. During this period transient buccal signs of blacktongue were in evidence between March 24 and March 27.

*Dog 60.*—Male. Whelped in the laboratory November 4, 1923. Reared and maintained on stock diets up to October 15, 1924.

October 15, 1924: In good condition. Weighs 6.5 kilograms. Begins Vermont butterfat diet No. 180B.

December 16: Weighs 7.7 kilograms. Appetite has been excellent. Has regularly consumed all of the daily allowance of 1,100 grams of food, representing approximately 53 grams of butterfat, or fully 6.5 grams per kilogram of body weight.

December 30: During the past two weeks has twice left a little (220 grams and 140 grams, respectively) of the daily allowance of 1,100 grams of food. Weighs 7.8 kilograms.

January 13, 1925: Appetite has been quite variable and food consumption somewhat reduced during the past two weeks. The daily food consumption has

averaged approximately 820 grams, representing 39 grams of butterfat. Weighs 7.3 kilograms.

January 17: Presents a desquamative lesion of the skin of the scrotum; it was first observed about two weeks ago.

February 10: During the past four weeks the daily food consumption has averaged approximately 1,020 grams, representing 50 grams of butterfat. Weighs 7.4 kilograms.

February 28: Scrotal lesion persists and has become somewhat more extensive.

March 10: During the past four weeks the daily food consumption has averaged approximately 970 grams, representing 47 grams of butterfat. Weighs 7.5 kilograms.

March 24: Desquamation of skin of scrotum persists.

April 7: During the past four weeks the appetite has continued to be variable.

The daily food consumption has averaged approximately 830 grams, representing 40 grams of butterfat. Weighs 7.1 kilograms.

May 26: During the past seven weeks the appetite continued variable. The daily food consumption has averaged approximately 880 grams, representing 42 grams of butterfat. Weighs 7 kilograms. Begins this day Vermont butterfat diet No. 180C.

June 23: Appetite has diminished further during the past four weeks, the daily food consumption averaging approximately 730 grams, representing 35 grams of butterfat. Weighs 6.8 kilograms.

July 14: During the past three weeks the daily food consumption became further reduced, averaging but 510 grams, which represent 24 grams of butterfat. Weighs 6.4 kilograms. Presents this morning, 49 days since the modification in diet eliminating tomato juice, and 272 days since the beginning of the butterfat diet, the first buccal signs of an attack of blacktongue, erythematous bandlike lesions on the mucosa of the upper lip. The scrotum shows some ragged tabs of epidermal flakes marking the periphery of the lesion that has persisted in variable degree for about six months. Further history not relevant.

*Dog 63.*—Male. Whelped in the laboratory November 4, 1923. Has served in one experiment and suffered an attack of blacktongue, which began June 2, 1924. On reconditioning diets from June 3 to October 15, 1924.

October 15, 1924: In good condition. Weighs 7 kilograms. Begins Vermont butterfat diet No. 180B.

December 30: Weighs 8 kilograms. Appetite has been uniformly excellent. Has regularly consumed the daily allowance of 1,200 grams of food, representing approximately 58 grams of the Vermont butterfat, or fully 7 grams per kilogram of body weight.

February 24, 1925: During the past two months the appetite has been variable and the food consumption has been somewhat diminished, averaging approximately 1,040 grams a day which represents approximately 50 grams of butterfat. Weighs 7.4 kilograms.

February 28: Has for some time presented an ill-defined, mealy sort of desquamation of the skin of the scrotum. It is now more marked and involves nearly all of the ventral aspect of the scrotum, which is also reddened.

March 5: The scrotal lesion has persisted. In addition there are present this morning, 141 days since beginning the butterfat diet, the first buccal signs of an attack of blacktongue, a slight reddening of the mucosa of the floor of the mouth. Appetite during the past nine days has been fairly good. The daily food consumption has averaged 1,110 grams, representing 53 grams of butterfat. Further history not relevant.

*Dog 64.*—Bitch. Whelped in the laboratory November 4, 1923. On stock diets to February 28, 1925.

- February 28, 1925: In good condition. Weighs 6.8 kilograms. Begins Vermont butterfat diet No. 180B.
- March 17: Weighs 6.8 kilograms. Appetite has been excellent. Has regularly consumed all of the daily allowance of 1,000 grams of food, representing approximately 48 grams of the Vermont butterfat, or at a rate of approximately 7 grams of butterfat per kilogram of body weight.
- March 31: During the past two weeks the daily food consumption was slightly reduced, averaging approximately 870 grams representing 42 grams of butterfat. Weighs 6.7 kilograms.
- May 26: During the past eight weeks the appetite has been variable; the daily food consumption has averaged approximately 860 grams, which represents 41 grams of butterfat. Weighs 6.8 kilograms.
- Begins to-day Vermont butterfat diet No. 180C, thus excluding tomato juice from the ration.
- June 23: During the past four weeks the appetite has become increasingly capricious. The daily food consumption has averaged approximately 710 grams, representing 34 grams of butterfat.
- June 27: Presents this morning, 32 days since beginning the butterfat diet without tomato juice, and 114 days since beginning the test of Vermont butterfat, a suggestive injection of the mucosa of the floor of the mouth.
- June 28: The reddening of the floor of the mouth has faded out.
- July 14: During the past three weeks the appetite continued capricious. The daily food consumption has averaged 770 grams, representing 37 grams of butterfat. Weighs 6.9 kilograms.
- July 17: Animal is in good condition. Has presented no further evidence suggestive of blacktongue since the evanescent injection of the floor of the mouth noted three weeks ago. Experiment is discontinued at the end of an observation period of 139 days for this animal.

*Results and conclusions.*—Thus it appears that all four test dogs developed some evidence of blacktongue. This was of such a character in three of the animals as to permit of a definite diagnosis in them, but was too slight in the fourth (dog 64) to be more than suggestive. It should, perhaps, be noted that in the latter animal the experimental period was relatively short—139 days—so that the possibility is not excluded that more definite evidence would have appeared if that period had been longer. In the three animals with definitely recognizable attacks, these attacks began at the end of 157, 272, and 141 days, respectively. It is pertinent to note that the consumption of the experimental diets was such as to represent during certain high periods an ingestion of butterfat that varied among the dogs between 5 and 7 grams per kilogram of body weight.

Turning now to a consideration of the results of the experiment with butter (including butterfat) as a whole, we find that in the three animals (dogs 47, 17, and 29) in which it was tested by the curative procedure, no beneficial effect was recognized, although in each instance treatment was begun under very favorable conditions and with, in effect, very large doses of a then recently prepared (Beltsville) butter. In the preventive tests 12 dogs were used; all developed some evidence of blacktongue, but this was slight, at most only sugges-



tive, in three, or 25 per cent of them. In those in which a definite attack was recognizable, this began in all but one (dog 47) at the end of unusually long periods. This delay in the onset, coupled with the large proportion of animals presenting but slight and uncertain evidence of an attack, suggests that the butter (including the butterfat) had an appreciable preventive action. Considered in relation to dosage, that is, in relation to the quantities of butter ingested per kilogram of body weight of dog, the preventive potency of the butter would seem to have been of a rather feeble order. This appears, perhaps, more clearly if one considers that the average human adult male would have to ingest upward of 350 grams of butterfat a day to equal relatively the average amount ingested by some of the dogs. Even allowing for the relatively smaller requirement by the human, which, as suggested by our experience with milk (see preceding section), would appear to be about one-half that of the dog when related to body weight, the amount of butterfat that would have to be ingested by the average human adult male for complete protection would have to exceed 175 grams per day. It would seem permissible to conclude, therefore, that, while not devoid of it, butter is a relatively very poor source of the blacktongue preventive, a conclusion that, as above already remarked, is in harmony with the experience with butter in human pellagra.

#### COD-LIVER OIL

The well-known richness of cod-liver oil in certain vitamins very early suggested the desirability of investigating it as a possible source of the blacktongue preventive. Tests of the curative and preventive action of cod-liver oil were therefore undertaken concurrently with some of our earlier tests of butter.

The cod-liver oil used in this study was some of the same supply as that tested in pellagra prevention by Goldberger and Tanner (11) at the Georgia State Sanitarium, and by them found ineffective when ingested by their patients at a daily rate of 2 grams per kilogram of body weight. It may be noted that when tested in rats this cod-liver oil was found to be rich in vitamin A (unpublished data).

Curative tests with this oil in four dogs with blacktongue with a daily dosage of 2 grams per kilogram of body weight failed in every instance to effect any appreciable beneficial result. Since interpretation of the preventive test is beset with fewer difficulties than the curative, and can therefore be made with greater confidence of its soundness, we carried out the following experiment:

#### EXPERIMENT 13

This was a test of the blacktongue preventive action of the before-mentioned cod-liver oil. The oil was incorporated in a diet, No. 114, the composition of which is shown in Table 9, and suitable calorie

portions were offered daily to each of three test animals—dogs 17, 29, and 48. The significant details relating to each of these dogs are as follows:

*Dog 17.*—Bitch. Acquired April 14, 1923. Up to August 10, 1923, served in one experiment and suffered an attack of blacktongue, which began July 3, 1923. On a stock diet from August 10 to September 11, 1923.

September 11, 1923: In good condition. Weighs 11.1 kilograms; begins test diet No. 114. (Table 9.)

September 18: Weighs 11 kilograms. Daily food consumption during the week since beginning the test has averaged approximately 875 grams, representing 56 grams of cod-liver oil, or approximately 5 grams of the oil per kilogram of body weight.

September 25: Weighs 10.7 kilograms. Daily food consumption during the past week has averaged approximately 895 grams, representing 57 grams of cod-liver oil, or fully 5 grams of the oil per kilogram of body weight.

October 2: Weighs 10.3 kilograms. Appetite has fallen off. The daily food consumption during the past week has averaged approximately 700 grams, representing 45 grams of cod-liver oil, or fully 4 grams per kilogram of body weight.

October 9: Weighs 10.2 kilograms. The daily food consumption during the past week has averaged approximately 655 grams, representing 42 grams of cod-liver oil, or 4 grams of oil per kilogram of body weight.

Presents this morning, at the end of a period of 21 days, the first signs of an attack of blacktongue, an injection of the floor of the mouth and reddening of the anterior faucial pillars. Further history not relevant.

*Dog 29.*—Male. Acquired May 9, 1923. Up to July 27, 1923, served in one experiment and suffered an attack of blacktongue, which began July 23, 1923. On a stock diet from July 27 to September 11, 1923.

September 11, 1923: In good condition; weighs 11 kilograms; begins diet No. 114.

September 18: Weighs 10.5 kilograms. Daily food consumption during the week since beginning the cod-liver diet has averaged approximately 650 grams, representing 42 grams of cod-liver oil, or approximately 4 grams of oil per kilogram of body weight.

September 25: Weighs 10.4 kilograms. Daily food consumption during the past week has averaged approximately 605 grams, representing 38 grams of cod-liver oil, or fully 3.5 grams per kilogram of body weight.

September 30: Presents this morning, at the end of a period of 19 days, the first evidence of an attack of blacktongue, an injection of the floor of the mouth. Further history not relevant.

*Dog 48.*—Bitch. Acquired August 20, 1923. On stock diet to September 11, 1923.

September 11, 1923: In good condition. Weighs 5.9 kilograms. Begins test diet No. 114.

October 2: Weighs 5.5 kilograms. The daily food consumption during the three weeks since beginning this test has averaged approximately 565 grams, representing 36 grams of cod-liver oil, or fully 6 grams of the oil per kilogram of body weight.

October 30: Weighs 5.7 kilograms. Daily average food consumption during the past four weeks has been approximately 625 grams, representing 40 grams of cod-liver oil, or approximately 7 grams of the oil per kilogram of body weight.

November 6: Weighs 5.4 kilograms. Presents this morning, 56 days after beginning the test diet, the first evidence of an attack of blacktongue, an injection of the floor of the mouth.

*Result and conclusion.*—All three test animals developed blacktongue, the first signs of which appeared at the end of 21, 19, and 56 days, respectively, notwithstanding the daily ingestion of the cod-liver oil which, during certain periods, averaged 5, 4, and 7 grams per kilogram of body weight of the respective animals. This result is in harmony with the indications of our curative trials and indicates that cod-liver oil contains little, if any, of the blacktongue preventive. It is in harmony also, it may be noted, with the results of the tests of this cod-liver oil in the human disease, so that cod-liver oil would seem to be poor in or lacking the preventive for both blacktongue and pellagra.

### COTTONSEED OIL

The importance of cottonseed oil among the edible oils suggested the desirability of an inquiry into its blacktongue-preventive potency. The following experiment was accordingly carried out:

#### EXPERIMENT 14

The cottonseed oil<sup>1</sup> to be tested was incorporated in a diet, No. 302, the composition of which is shown in Table 12, and a suitable calorie portion of this was offered daily to each of six test animals, dogs 29, 50, 54, 110, 122, and 123. The significant details relating to each of the animals are as follows:

*Dog 29.*—Male. Acquired May 10, 1923. Has suffered several attacks of experimental blacktongue, the latest of which began September 17, 1927. On stock diet for reconditioning from September 27 to November 23, 1927. November 23, 1927: In good condition; weighs 9.7 kilograms; begins test diet No. 302.

December 6: Weighs 10.2 kilograms. Has been eating well, regularly consuming the daily allowance of 1,000 grams of food, representing 46 grams of the cottonseed oil, or nearly 4.5 grams of the oil per kilogram of body weight.

December 9: Has continued to eat all food offered daily. Presents this morning, 17 days after starting the test, the first signs of an attack of blacktongue, a reddening of the mucosa of the floor of the mouth and of that of the upper lip on the left side. Progressive attack. Died December 19.

*Dog 50.*—Male. Acquired September 25, 1923. Up to May 25, 1927, served in various experiments and suffered several attacks of blacktongue, the latest of which began about May 8, 1927. On stock diet from May 25 to September 7, 1927.

September 7, 1927: In good condition; weighs 14.2 kilograms; begins test diet No. 302.

September 13: Weighs 14 kilograms. Daily food consumption since beginning the test diet has averaged approximately 740 grams, representing 34 grams of the cottonseed oil, or slightly short of 2.5 grams per kilogram of body weight.

<sup>1</sup> A commercial preparation marketed for domestic use under the name of Wesson Oil.

September 20: Weighs 14.2 kilograms. During the past week the daily food consumption has averaged approximately 850 grams, representing 39 grams of the oil, or fully 2.5 grams per kilogram of body weight.

September 27: Weighs 14 kilograms. Average daily food consumption during the past week has been approximately 880 grams representing 40 grams of the oil or a little over 2.5 grams per kilogram of body weight. Presents this morning, 20 days after beginning the test diet, the first signs of an attack of blacktongue, a sharply delimited red band on the mucosa of the upper lip of each side, reddening of the mucosa of the floor, cheeks, and fauces. Further history not relevant.

*Dog 54.*—Bitch. Acquired September 25, 1923. Up to September 7, 1927, served in several experiments and suffered a number of attacks of blacktongue, of which mild, evanescent evidence of the latest was present between August 4 and August 9, 1927. On stock diet from September 7 to October 12, 1927.

October 12, 1927: In good condition; weighs 9.7 kilograms; begins test diet No. 302.

October 18: Weighs 9.3 kilograms. Daily food consumption since beginning the test diet has averaged approximately 840 grams, representing 38 grams of the cottonseed oil or fully 4 grams per kilogram of body weight.

October 25: Weighs 9.6 kilograms. During the past week has regularly consumed the daily allowance of 900 grams of food, representing 41 grams of the oil, or fully 4 grams per kilogram of body weight.

November 8: Weighs 8.9 kilograms. Appetite much dulled during the past two weeks. Daily food consumption during this period has averaged approximately 380 grams, representing 22 grams of the oil or fully 2 grams per kilogram of body weight.

November 12: Presents this morning, 31 days after beginning the test, the first signs of an attack of blacktongue, a reddened patch of mucosa of the upper lip on each side and an injection of the floor of the mouth. Further history not relevant.

*Dog 110.*—Bitch. Acquired October 29, 1926. Up to September 7, 1927, served in one experiment but developed no evidence of blacktongue. On stock diet from September 7 to October 12, 1927.

October 12, 1927: In good condition; weighs 12.7 kilograms; begins test diet No. 302.

October 18: Weighs 12.6 kilograms. Since beginning the test diet daily food consumption has averaged approximately 940 grams, representing 43 grams of the oil, or a little short of 3.5 grams per kilogram of body weight.

October 25: Weighs 12.7 kilograms. During the past week has regularly consumed the daily allowance of 1,000 grams of food, representing 46 grams of the oil, or fully 3.5 grams per kilogram of body weight.

November 1: Weighs 12.5 kilograms. Appetite has become somewhat dulled. Daily food consumption during the past week has averaged approximately 760 grams, representing 35 grams of the oil, or fully 2.5 grams per kilogram of body weight.

November 15: Weighs 12.3 kilograms. Daily food consumption during the past two weeks has averaged approximately 690 grams, representing 32 grams of the oil, or fully 2.5 grams per kilogram of body weight.

November 19: Presents this morning, 38 days after beginning the test, the first evidence of an attack of blacktongue, an injection of the floor of the mouth. Further history not relevant.

*Dog 122.*—Bitch. Acquired May 11, 1927. On stock diet to September 7, 1927.

September 7, 1927: In good condition; weighs 8.1 kilograms; begins test diet No. 302.

September 13: Weighs 7.9 kilograms. Daily food consumption since beginning of test has averaged approximately 720 grams, representing 33 grams of the oil, or fully 4 grams per kilogram of body weight.

September 20: Weighs 7.9 kilograms. Daily food consumption during the past week has averaged approximately 755 grams, representing 34 grams of the oil, or slightly over 4 grams per kilogram of body weight.

September 27: Weighs 7.9 kilograms. Daily food consumption during the past week has averaged approximately 720 grams of food, representing 33 grams of the oil, or fully 4 grams per kilogram of body weight. Presents this morning, 20 days after beginning the test, the first evidence of blacktongue, an injection of the floor of the mouth. Further history not relevant.

*Dog 123.*—Bitch. Acquired May 11, 1927. On our stock diet No. 156 up to September 7. Threw a litter of seven pups June 29, which were successfully nursed and were weaned in good condition on August 9.

September 7, 1927: In good condition; weighs 7.8 kilograms; begins test diet No. 302.

September 13: Weighs 7.5 kilograms. Daily food consumption since beginning the test has averaged approximately 800 grams, representing 37 grams of the oil, or but little short of 5 grams per kilogram of body weight.

September 20: Weighs 7.3 kilograms. Food consumption during the past week has averaged approximately 610 grams, representing 28 grams of the oil, or fully 3.5 grams per kilogram of body weight.

October 4: Weighs 6.9 kilograms. Appetite has been dulled. Food consumption during the past two weeks has averaged approximately 470 grams, representing 22 grams of the oil, or fully 3 grams per kilogram of body weight.

Presents this morning, 27 days since beginning the test, the first evidence of blacktongue, an injection of the mucosa of the floor of the mouth.

*Result and conclusion.*—As appears in the foregoing, the high levels of food consumption among the test animals represented a consumption of fully 2.5 grams of the cottonseed oil per kilogram of body weight in one of them (dog 50), fully 3.5 grams in two (dogs 110 and 123), fully 4 grams in two (dogs 54 and 122), and nearly 4.5 grams in one (dog 29). Notwithstanding this, however, all six of the dogs developed blacktongue, the first buccal signs of which appeared at the end of periods of from 17 to 38 days. It would seem, therefore, that the test diet was without appreciable preventive action and, thus, that the cottonseed oil contained little, if any, of the blacktongue preventive.

No specific study of the effectiveness of cottonseed oil in pellagra has been made. Judged on the basis of general experience it seems unlikely that this oil contains the pellagra preventive in significant amounts.

#### LEAN BEEF

Very early in our study of experimental blacktongue, occasion arose for testing the curative value of fresh beef muscle, a food that there was reason to believe contained (10) (11), and later was demonstrated to contain, a good supply of the pellagra preventive (1). Since then we have repeatedly used fresh beef as a therapeutic agent. Our experience has been consistently favorable. We shall not detail

any of this, however, preferring instead to present the results of two experiments in which the more convincing preventive test of this food was carried out.

#### EXPERIMENT 15

This was a test of the blacktongue preventive action of fresh lean beef. Fresh round steak was first carefully trimmed free of gristle, tendon and visible fat, run through a meat chopper, and then incorporated in diet No. 196, the composition of which is shown in Table 13. This diet is essentially our basic blacktongue-producing diet No. 123 (Table 1), the casein of which has been replaced by a quantity of fresh lean beef calculated to yield the same amount of protein as does the casein. Of this diet suitable calorie portions were daily offered to each of five test animals, dogs 42, 62, 68, 69, and 76. The significant details relating to each animal are briefly as follows:

*Dog 42.*—Male. Acquired June 26, 1923. Up to June 24, 1924, served in several experiments and suffered three attacks of blacktongue, the latest of which began April 2, 1924. In a test of yeast from June 24, 1924, to May 26, 1925, without presenting any evidence of blacktongue.

May 26, 1925: In good condition. Weighs 11.7 kilograms. Begins test diet No. 196.

May 26, 1926: Has been on diet No. 196 for one year. Weighs 13 kilograms.

Is now and has throughout the year been in good condition and without any recognizable indications of blacktongue.

*Dog 62.*—Male. Whelped in the laboratory November 4, 1923. Reared and maintained on stock diets until June 24, 1924. In a test of yeast from June 24, 1924, to May 26, 1925, during which presented transient evidence of blacktongue March 24, 1925.

May 26, 1925: In good condition. Weighs 7.9 kilograms. Begins diet No. 196.

May 26, 1926: Completes one year on diet No. 196. Weighs 8.8 kilograms.

Has presented no indications of blacktongue at any time during the year.

*Dog 68.*—Bitch. Whelped in the laboratory November 25, 1923. Reared and maintained on stock diets until June 24, 1924. In a test of yeast from June 24, 1924, to May 26, 1925, during which presented evanescent indications of blacktongue September 27, 1924.

May 26, 1925: In good condition. Weighs 8.1 kilograms. Begins diet No. 196.

May 26, 1926: Completes one year on diet No. 196. Weighs 9.6 kilograms.

Has presented no evidence of blacktongue during the year.

*Dog 69.*—Male. Whelped in the laboratory November 5, 1923. Reared and maintained on stock diets until June 24, 1924. In a test of yeast from June 24, 1924, to May 26, 1925, during which presented no evidence of blacktongue.

May 26, 1925: In good condition. Weighs 8.3 kilograms. Begins test diet No. 196.

May 26, 1926: Completes one year on diet No. 196. Weighs 9.1 kilograms.

Has presented no evidence of blacktongue during the year.

*Dog 76.*—Male. Acquired June 9, 1924. In a test of yeast from June 24, 1924, to May 26, 1925, during which presented no evidence of blacktongue.

May 26, 1925: In good condition. Weighs 9.2 kilograms. Begins diet No. 196.

May 26, 1926: Completes a year on diet No. 196 without having presented any signs of blacktongue. Weighs 10.1 kilograms.

*Result and conclusion.*—It appears from the foregoing that none of the five test animals presented any recognizable evidence of blacktongue during the experimental period of one year. Clearly, the fresh lean beef furnished enough, and possibly more than enough, of the blacktongue preventive for the complete protection of these animals during the specified experimental observation period.

#### EXPERIMENT 16

This was also a test of the blacktongue-preventive action of lean beef, but differed from the preceding experiment, first, in that the lean beef was dried and, second, that during the second of the two feeding periods of which the experiment consisted, the dried beef was boiled for about one and one-half hours with certain of the other ingredients of the test diet. During the first feeding period diet No. 196A (Table 13) was used, and during the second, diet No. 196B (Table 13). These were identical diets excepting only that in No. 196A the dried beef was stirred into the cooked food, while in No. 196B the dried beef was cooked as already mentioned. These diets, like diet No. 196, were essentially our basic blacktongue-producing diet No. 123, the casein of which was completely replaced by lean beef which, in this instance, however, was first dried.

The dried beef was prepared by taking the fresh chopped beef of the preceding experiment and first drying it at room temperature under the electric fan, then grinding coarsely, and finally drying (for about 18 hours) in a current of warm air. Thus dried, it was finely ground and stored ready for use. Fresh batches were prepared from time to time as needed.

The test animals were five dogs, numbered 41, 89, 90, 98, and 99, to each of which the test diet was offered in suitable calorie portions. The significant details relating to each of the animals are as follows:

*Dog 41.*—Bitch. Whelped in the laboratory June 26, 1923. Up to March 11, 1926, served in several experiments and suffered three attacks of blacktongue, the latest of which began March 4, 1925. On stock diet from March 11 to March 30, 1926.

March 30, 1926: In good condition; weighs 10.9 kilograms; begins diet No. 196A. October 28, 1926: In good condition. Weighs 10.8 kilograms. Diet changed to No. 196B, thus beginning the second period of the experiment.

April 6, 1927: Has been on the dried-beef diets fully one year, during which period has not presented any evidence of blacktongue. Had a mild attack of an infective stomatitis between March 10 and March 15.<sup>1</sup> Is in good condition. Weighs 10.6 kilograms. Experiment discontinued.

*Dog 89.*—Bitch. Whelped in the laboratory October 12, 1924. Up to March 11, 1926, served in one experiment, but suffered no blacktongue. On stock diet from March 11 to March 30, 1926.

<sup>1</sup> At this time we had an epidemic of this condition among our animals. Dogs in a number of different experiments then in progress were more or less severely attacked. The condition and its differentiation from blacktongue were briefly described in a previous communication (2).

March 30, 1926: In good condition; weighs 4.8 kilograms; begins diet No. 196A.  
October 28, 1926: In good condition; weighs 4.7 kilograms; diet is changed to No. 196B.

April 6, 1927: About March 10 developed an infective stomatitis, since when there has been a very marked reduction in food consumption, with a great loss in weight. Weighs 2.8 kilograms. Has presented no recognizable evidence of blacktongue. Experiment is discontinued.

*Dog 90.*—Male. Whelped in the laboratory October 12, 1924. Up to March 11, 1926, served in one experiment, but did not develop blacktongue. On stock diet from March 11 to March 30, 1926.

March 30, 1926: In good condition; weighs 7.1 kilograms; begins test diet No. 196A.

October 28: In good condition; weighs 6.8 kilograms; diet is changed to No. 196B.

April 6, 1927: Developed a mild infective stomatitis about March 12, with which was associated a reduced food consumption; weighs 6.7 kilograms; is in good condition; has presented no evidence of blacktongue. Experiment is discontinued.

*Dog 98.*—Male. Acquired January 18, 1926, when about 9 weeks old, at which time weight was 1.6 kilograms. On stock diet until March 30, 1926.

March 30, 1926: In good condition; weighs 4.9 kilograms; begins diet No. 196A.

October 28: In good condition; weighs 6.2 kilograms; diet is changed to No. 196B.

April 6, 1927: Had evidence of a mild infective stomatitis between March 19 and March 25. Is in good condition; weighs 6.6 kilograms. Has presented no evidence of blacktongue. Experiment is discontinued.

*Dog 99.*—Male. Litter mate of dog 98. Acquired January 18, 1926, when about 9 weeks old, at which time weight was 2.8 kilograms. On stock diet until March 30, 1926.

March 30, 1926: In good condition; weighs 8 kilograms; begins diet No. 196A.

October 28: In good condition; weighs 11.7 kilograms; diet is changed to No. 196B.

February 12, 1927: Taken sick about two weeks ago. Has a bloody nasal discharge, a purulent ophthalmia, and a cough. The dog is gassed. At necropsy there are found patches of consolidation scattered through both lungs. Nature of the infection not determined. No recognizable evidence of blacktongue.

*Results and conclusions.*—None of the five-test animals presented any recognizable evidence of blacktongue during either dietary period which, together, extended over fully 1 year for four dogs and 10 months for the fifth dog. The latter animal acquired a complicating infection which led to its elimination about two months before the expiration of the year that would normally have constituted the experimental observation period.

Recalling that dogs on basic blacktongue-producing diet No. 123 may be expected to develop the disease at the end of a period only exceptionally longer than about 60 days, it would appear that both the dried beef as such (in diet No. 196A) and the dried beef after boiling one and one-half hours retain much, if not all, of the preventive potency of the fresh beef.

The results of the foregoing experiments with beef muscle clearly indicate that, in relation to the type of basic diet employed, the



quantity used was fully adequate for preventive purposes. How much less would serve equally well we have so far not attempted to determine. It is difficult, or impossible, therefore, to appraise the relative preventive potency of the lean beef; but since the minimum adequate preventive quantity would seem to be not more, and may possibly be somewhat less, than the quantity tested, it is clear that lean beef is a good, if not a rich, source of the blacktongue preventive just as it is of the pellagra preventive, as was noted above.

### PORK LIVER

Our study of the blacktongue-preventive action of meat includes, in addition to the test of lean beef detailed in the preceding, one of pork liver which we present in the following experiment:

#### EXPERIMENT 17

This was a test of the blacktongue-preventive action of dried pork liver. Livers were secured fresh from a local abattoir. Since they were, as a rule, received at the laboratory late in the afternoon, they were stored over night in the laboratory refrigerator room. Next morning, after trimming them as free as possible of ligamentous tissue, they were run through the meat chopper. The livers thus minced were spread out in pans and kept under the electric fan at room temperature, with repeated stirring, until nearly dry. This required some 48-72 hours. They were then again run through the meat chopper, after which the drying was continued and completed in a current of warm air. This final drying took about 18 hours. The liver so dried was then finely ground and stored. Enough was prepared at the beginning of the experiment to supply our requirements during the first seven months of this study. The dried liver used during the last four months of the eleven-month experimental period was prepared in small batches about every two weeks and by a slightly different procedure. In this method the minced fresh livers were heated in a double boiler, without any addition of water, for about 15 minutes to, at least, partially coagulate the protein before being put under the fan to dry. This greatly expedited the drying at air temperature, the duration of which was reduced to some 24-36 hours. The other steps in the procedure were as already described. The dried liver was incorporated in a diet, No. 292, the composition of which is shown in Table 14. By comparison with dried beef diet No. 196B (Table 13), it may be seen that liver diet, No. 292, was essentially identical with this dried beef diet, except that the dried liver quantitatively replaced the dried beef. It may be noted as an additional point of similarity to diet No. 196B that in the preparation of diet No. 292 the dried liver was cooked for about 1½ hours with certain of the other ingredients. By reference to Table 1 it may be

seen further that the dried liver diet was essentially basic diet No. 123, the casein of which was almost completely replaced by dried liver.

Suitable portions of the liver diet were daily offered to each of five test animals, dogs 90, 95, 98, 117, and 118. The significant details relating to each are as follows:

*Dog 90.*—Male. Whelped in the laboratory October 12, 1924. Up to April 6, 1927, had served in two experiments but had no blacktongue. On stock diet from April 6 to May 12, 1927.

May 12, 1927: In good condition; weighs 7.2 kilograms; begins test diet No. 292.  
April 10, 1928: In good condition; weighs 7.2 kilograms. Has presented no recognizable evidence of blacktongue at any time during the experimental period of 11 months.

*Dog 95.*—Acquired November 30, 1925. Has served in one experiment but has had no blacktongue. On stock diet from March 15 to May 12, 1927.

May 12, 1927: In good condition; weighs 8.2 kilograms; begins diet No. 292.  
April 10, 1928: In good condition; weighs 9.1 kilograms. Has presented no recognizable evidence of blacktongue during the observation period of 11 months.

*Dog 98.*—Male. Acquired January 18, 1926. Has served in one experiment but has not had blacktongue. On stock diet from April 6 to May 12, 1927.

May 12, 1927: In good condition; weighs 6.5 kilograms; begins liver diet No. 292.

April 10, 1928: Weighs 7.1 kilograms; in good condition. Has presented no recognizable evidence of blacktongue at any time during the experimental period of 11 months.

*Dog 117.*—Bitch. Acquired April 9, 1927. On stock diet to May 12, 1927.

May 12, 1927: In good condition; weighs 7.8 kilograms; begins diet No. 292.  
April 10, 1928: Appetite and food consumption have been consistently good throughout since the beginning of the experiment 11 months ago. Gained in weight during the first three months. Then during the succeeding seven months, that is, until about the end of February, 1928, the weight oscillated between 9 and 9.5 kilograms. Since early in March, although the food consumption has continued excellent, weight has slowly declined, reaching 8.5 kilograms on April 3. To-day weighs 9.3 kilograms, this gain being coincident with an increase in food allowance. About March 31 it was noted that there was a slight weakness in coordination in the hind legs which was chiefly noticeable in walking, especially on a wet slippery floor. This has persisted and is now seemingly more marked. The nature of this neurological condition, which seems identical with that of dog 119 of experiment 19, is not understood. Is lively and playful. Does not present and has not presented at any time during the period of 11 months any recognizable evidence of blacktongue.

*Dog 118.*—Bitch. Acquired April 9, 1927. On stock diet to May 12, 1927.

May 12, 1927: In good condition; weighs 7.8 kilograms.

April 10, 1928: Weighs 9.8 kilograms. Is in good condition. Has presented no recognizable evidence of blacktongue during the experimental period of 11 months.

*Results and conclusions.*—It appears from the foregoing that none of the five test dogs presented any recognizable signs of blacktongue during the experimental period of 11 months. Recalling that dogs fed basic diet No. 123 (Table 1) may be expected to develop black-

tongue within a period only exceptionally longer than about 60 days (2), and recalling further that test diet No. 292 differs from diet No. 123 essentially only in that dried pig's liver replaces nearly all of the casein of the latter diet, it clearly follows that the difference in the results of the feeding must be attributed to the liver. We may conclude, therefore, that dried and cooked pork liver contains the blacktongue preventive; and since the minimum preventive quantity would seem to be not more, and may be, or probably is, less, than that indicated by the quantity contained in diet No. 292, the liver may be considered as, at least, a good, if not rich, source of the blacktongue preventive. Liver has not, as yet, been studied by us in pellagra.

### SALMON

In much of the rural area and in many of the isolated industrial communities of the southern part of the United States where pellagra is most prevalent, the fresh meat supply is very restricted or there is none at all from about the first of March until some time in October or November. During this period fresh meat is in some measure replaced by preserved meat of some kind, including fish. Among the preserved fish, canned salmon is perhaps the most conspicuous. We therefore thought it worth while to test the blacktongue preventive action of canned salmon, as is shown in the following:

### EXPERIMENT 18

In this study of the blacktongue-preventive action of canned salmon we used a canned Alaska chum salmon. The chum salmon is one of the cheaper varieties and was chosen for study for that reason. The entire contents of the can (of 1 pound (454 grams) size), thus including skin and bone, were incorporated in a diet, No. 294, the composition of which is shown in Table 15. As may be seen by reference to Tables 1 and 13 this diet is very similar to basic diet No. 123 and to beef-containing diet No. 196. The amount of salmon included (300 grams per 2,400 calorie ration) was largely arbitrary, although in part influenced by the quantity of lean beef included in diet No. 196. Suitable portions of this diet were offered daily to each of five test animals, dogs 60, 64, 73, 89, and 120. The significant details relating to each are briefly as follows:

*Dog 60.*—Male. Whelped in the laboratory November 4, 1923. Has suffered several attacks of blacktongue, the latest of which, very evanescent and doubtful, was in evidence June 7, 1926. On stock diet from March 15 to May 27, 1927. May 27, 1927: In good condition; weighs 8.2 kilograms; begins salmon test diet No. 294.

April 17, 1928: In good condition; weighs 8.6 kilograms; has at no time during the experimental period of ten and a half months presented any recognizable evidence of blacktongue.

*Dog 64.*—Bitch. Whelped in the laboratory November 4, 1923; has suffered several attacks of blacktongue, the latest of which, evanescent and uncertain, was in evidence September 29, 1926; on stock diet from March 15 to May 27, 1927.

May 27, 1927: In good condition; weighs 7.6 kilograms; begins test diet No. 294.

April 17, 1928: In good condition; weighs 7.8 kilograms; has at no time during the experimental period of ten and a half months presented any recognizable evidence of blacktongue.

*Dog 73.*—Bitch. Acquired March 19, 1924; has suffered several more or less marked attacks of blacktongue, the latest of which began December 17, 1925; on stock diet from March 15 to May 27, 1927.

May 27, 1927: In good condition; weighs 10.5 kilograms; begins test diet No. 294.

April 17, 1928: In good condition; weighs 11 kilograms; has at no time during the experimental period of ten and a half months presented any recognizable evidence of blacktongue.

*Dog 89.*—Bitch. Whelped in the laboratory October 12, 1924; has served in two experiments without developing blacktongue; on stock diet from April 6 to May 27, 1927.

May 27, 1927: In good condition; weighs 4.1 kilograms.

April 17, 1928: In good condition; weighs 4.8 kilograms; has presented no recognizable evidence of blacktongue at any time during the experimental period of ten and a half months.

*Dog 120.*—Bitch. Acquired April 9, 1927; on stock diet to May 27.

May 27, 1927: In good condition; weighs 7.1 kilograms; begins test diet No. 294.

April 17, 1928: In good condition; weighs 9.5 kilograms; has presented no recognizable evidence of blacktongue at any time during the experimental period of ten and a half months.

*Results and conclusions.*—As is evident from the foregoing, none of the five test animals presented any recognizable evidence of blacktongue during the experimental period of 10½ months. Clearly the test diet exercised complete preventive action. It may therefore be concluded that canned chum salmon contains the blacktongue preventive. The quantity of salmon in the test diet would appear to be a liberal one. How much less might have been equally effective can not be stated.

A comparable study of salmon in pellagra is under way, but is not sufficiently advanced to justify the expression of any judgment as to the outcome.

### EGG YOLK

The importance of the hen's egg in the human diet, especially in the diet of children and invalids, and the possibility of its availability under climatic and other conditions which would restrict or make impracticable the supply of fresh meat, suggested the desirability of a test of its blacktongue-preventive action. As the yolk is the portion generally considered to contain the vitamins of the egg, we decided to work with the yolk, and for reasons of practical convenience decided to work with the dried yolk.

We began the study with a commercial preparation of dried, powdered egg yolk, of which we incorporated 100 grams in a 2,400-

calorie ration. As two of the five dogs to which such diet was fed developed blacktongue at the end of 42 and 52 days, respectively, and since we knew nothing of the history of this dried yolk, it was deemed desirable to replace the commercial product with one freshly prepared by ourselves. Accordingly the experiment with the commercial dried yolk was discontinued and the dogs were put on stock diet for reconditioning. Following this the study was resumed and the following experiment was carried out:

#### EXPERIMENT 19

This was a test of the blacktongue-preventive action of dried egg yolk. Market eggs of excellent quality were boiled hard. The yolks were then separated from the white and run through the meat chopper, after which they were spread out in pans and dried under the fan at room temperature for about 18 hours. The drying was then continued and completed in a current of warm air during an additional period of about 24 hours. So dried, and coarsely ground, the yolks were stored ready for use. Fresh batches were prepared about every two weeks.

The dried egg yolk was incorporated in the diet, No. 293B, shown in Table 16. Except for the character of the dried yolk this diet, it may be remarked, is identical with that in which the commercial powdered egg yolk was tested. It contains, as Table 16 shows, 100 grams of our dried yolk, corresponding to the yolks of about 12 average eggs, in each 2,400 calorie ration. Suitable portions of this diet were daily offered to each of five animals, dogs 41, 63, 67, 70, and 119. The significant details relating to each are as follows:

*Dog 41.*—Bitch. Whelped in the laboratory June 26, 1923. Up to April 6, 1927, had suffered three attacks of blacktongue, of which the latest began March 4, 1925. On stock diet from April 6 to May 12, 1927. On a commercial dried egg yolk diet from May 12 to June 30, 1927. On stock diet from June 30 to August 2, 1927.

August 2, 1927: In good condition; weighs 11.7 kilograms; begins dried egg yolk test diet No. 293B.

On October 31, or at end of a period of 90 days, presented a suggestive reddening of the mucosa of the floor of the mouth, which was more pronounced next day and then gradually faded so that it was no longer recognizable on November 5, 1927.

April 10, 1928: Has presented no recognizable evidence of blacktongue since the transient indications present between October 31 and November 5, 1927. Weighs 10.7 kilograms. Appears in good condition.

*Dog 63.*—Male. Whelped in the laboratory November 4, 1923. Has served in several experiments and has suffered several attacks of blacktongue, the latest of which began June 28, 1927, while on a commercial dried egg yolk diet. On stock diet from June 30 to August 2, 1927.

August 2, 1927: In good condition; weighs 9 kilograms; begins test diet No. 293B. On October 28, or at the end of a period of 87 days, presented the first signs of an attack of blacktongue, a sharply limited bilaterally symmetrical erythema in

bandlike form on mucosa of the upper lip, a reddening of the mucosa of the floor of the mouth and of the cheeks and faucial pillars. Attack became progressively more pronounced necessitating the withdrawal of this animal from the experiment on November 1. Further history not relevant.

*Dog 67.*—Male. Whelped in the laboratory November 25, 1923. Presented suggestive but evanescent evidence of blacktongue January 13, 1927. Suffered a definite attack of blacktongue, which began June 23, 1927, while on a commercial dried egg yolk diet. On stock diet from June 30 to August 2, 1927.

August 2, 1927: In good condition; weighs 9.9 kilograms; begins test diet No. 293B.

On November 29 presented a suggestive reddening of the floor of the mouth which was no longer perceptible two days later.

On February 9, 1928, presented some very suggestive erythematous patches on the mucosa of the upper lip, which were no longer perceptible on February 11.

On March 6 presented evanescent but very suggestive erythematous patches on the mucosa of the upper lip and a reddening of the mucosa of the floor of the mouth.

On March 20, at the end of a period of 231 days, presented definite beginning signs of an attack of blacktongue, bilaterally symmetrical erythematous bands on the mucosa of the upper lip, reddening of the mucosa of the floor, cheeks, and faucial pillars. This slowly progressed and became so grave by April 5 that treatment was begun, but the attack ended in death April 7-8, 1928.

*Dog 70.*—Male. Whelped in the laboratory November 25, 1923. Has presented several attacks of blacktongue, the latest indications of which were in evidence August 10, 1926. On a commercial dried egg yolk diet from May 12 to June 30, 1927. On stock diet from June 30 to August 2, 1927.

August 2, 1927: In good condition; weighs 10.3 kilograms; begins egg yolk diet No. 293B.

April 10, 1928: Weighs 9.6 kilograms; in good condition. Has presented no recognizable evidence of blacktongue at any time during the experimental period of eight months.

*Dog 119.*—Bitch. Acquired April 9, 1927. On a commercial dried egg yolk diet from May 12 to June 30, 1927. On stock diet June 30 to August 2, 1927.

August 2, 1927: In good condition; weighs 8.2 kilograms; begins diet No. 293B.

April 10, 1928: About March 22 there was noted as present a weakness or incoordination in the movements of the hind limbs and a slightly high-stepping action of the forelegs, which have persisted. The nature of this neurological manifestation is not clear. Weighs 8.9 kilograms. Seems lively and playful. Has presented no recognizable indications of blacktongue.

*Results and conclusions.*—As appears in the foregoing, two of the test animals (dogs 63 and 67) developed definite attacks at the end of 87 and 231 days, respectively, while a third presented very suggestive but transient indications of blacktongue. The remaining two of the five test animals presented no recognizable evidence of the disease during the experimental period of fully eight months.

This result indicates quite clearly that the dried egg yolk in the test diet had not exercised adequate blacktongue preventive action. A delaying or partially protective action seems, however, to be definitely suggested, thus indicating that egg yolk contains the blacktongue preventive but, at least when dried and cooked, in relatively

small amount. Although there appears to be no good reason to believe that the drying and cooking to which the yolk was subjected would be likely appreciably to affect the blacktongue preventive contained therein, nevertheless, until this possibility can be definitely excluded, no final conclusion as to the relative richness of the yolk in the blacktongue preventive is warranted by the results of the foregoing experiment. It seems permissible, nevertheless, to suggest in a tentative way that, if, as seems on the whole probable, the potency of the egg yolk is not materially diminished by drying, the cooked yolk, as such, is, gram for gram, inferior in blacktongue preventive potency to fresh beef, pork liver, and wheat germ.

Egg yolk has not yet been tested by us as to its preventive value in human pellagra.

### TOMATOES

It may be recalled that the diet used by Goldberger and Wheeler in the first experiment which resulted in the production of blacktongue (2) included tomato juice as one of the components. Tomato juice was, therefore, subsequently included in several experimental diets under the impression that it was without appreciable blacktongue-preventive action. In connection with one such diet, however, in which an amount of juice larger than ordinary was included in order to insure an abundance of "vitamin B," the attacks of blacktongue were so much delayed in their appearance as to suggest that, as in the case of yeast (3), we may not have taken sufficient account of the possibilities of the factor of quantity. This suggested the desirability of a more specific inquiry into the blacktongue-preventive potency of the tomato. Together with certain other considerations it also suggested the desirability of a similar inquiry into its pellagra-preventive potency. A test of the latter was, accordingly, carried out at the Georgia State Sanitarium by Goldberger and Wheeler (13), who, as a result, found that when the daily quantity is sufficiently liberal, the pellagra-preventive action of tomatoes becomes unmistakable. As will be seen, the results of our studies in the dog, presented in the following experiments, lead to the same conclusion with respect to their blacktongue-preventive action.

### EXPERIMENT 20

This was a test of the curative and the preventive action of tomatoes, or, more precisely, of the juice pressed from canned tomatoes. The tomatoes were a commercial product of good quality in cans containing about 1 kilogram. The contents of the required number of cans were thrown on a cloth and, in this, hand pressed, and the juice was collected for use. This was done daily. A measured amount—at first about 12 c. c., later increased to 20 c. c., and finally to about 30 c. c. per kilogram of body weight—was daily

administered by drench, using a convenient metal syringe, as a supplement to basic blacktongue producing diet No. 123. (Table 1.) The test animals were five dogs, numbered 13, 50, 66, 81, and 82. Four of these (dogs 50, 66, 81, and 82) were each in the early stage of an attack of blacktongue when the test was begun. The significant details relating to each of the animals are as follows:

*Dog 13.*—Male. Acquired April 7, 1923. Up to January 18, 1925, served in several experiments and suffered six attacks of blacktongue, of which the latest began January 6, 1925. On stock diet from January 18 to February 18, 1925.

February 18, 1925: In good condition. Weighs 11.2 kilograms. Begins basic blacktongue-producing diet No. 123 with a daily supplement of 132 c. c., or about 12 c. c. per kilogram of body weight, of tomato juice by drench.

September 12: Weighs 10.3 kilograms. Appetite has been dull and food consumption has been on a reduced level. On July 31, presented evanescent signs suggestive of blacktongue. The daily dose of tomato juice is this day increased to 210 c. c., or about 20 c. c. per kilogram of body weight.

March 13, 1926: Weighs 9.7 kilograms. Has presented no definite signs of blacktongue since the suggestive evanescent indications that were present on July 31, 1925. Since some of the other test animals have developed blacktongue, however, an increase in the daily dose to 315 c. c., or about 30 c. c. per kilogram of body weight, is made to-day.

November 17, 1926: Weighs 9.3 kilograms. Has presented no recognizable evidence of blacktongue in over a year. Experiment is discontinued.

*Dog 50.*—Male. Acquired September 25, 1923. Up to June 23, 1925, served in various experiments and suffered several attacks of blacktongue, the latest of which began June 14, 1925.

June 23, 1925: Had been on basic diet No. 123 for some time and now has an attack of blacktongue, which began June 14. Weighs 12.1 kilograms. Begins treatment with a daily dose of 144 c. c., or 12 c. c. per kilogram of body weight, of tomato juice as a supplement to diet No. 123, which continues to be offered.

September 12: Mouth lesions cleared up promptly. Presented a scrotal lesion of uncertain significance early in July. Weighs 12 kilograms. The daily dose of tomato juice is this day increased to 240 c. c., or 20 c. c. per kilogram of body weight.

March 13, 1926: Presented transient signs suggestive of blacktongue September 17 and November 11, 1925, and January 9, February 16, and March 7, 1926. It is deemed desirable, therefore, to increase the dose of tomato juice to 345 c. c., or about 30 c. c. per kilogram of body weight, effective to-day. Weighs 11.2 kilograms.

March 15, 1927: Weighs 12 kilograms. Presented evanescent signs of blacktongue on March 16, 1926, but has presented none since that date. In good condition. Experiment is discontinued.

*Dog 66.*—Male. Whelped in the laboratory November 25, 1923. Reared on stock diets. Between April 22, 1924, and June 19, 1925, served in two experiments and suffered an attack of blacktongue, a relapse of which began June 11, 1925.

June 19, 1925: The signs of blacktongue first noted June 11 have become well marked. Began treatment with a daily dose of 132 c. c., or about 12 c. c. per kilogram of body weight, of tomato juice yesterday and begins basic diet No. 123 to-day. Weighs 10.5 kilograms.

September 12: The buccal lesions of blacktongue present when treatment began gradually improved and by the end of June the mouth was about normal.

Transient signs of blacktongue were again in evidence, however, on August 22



and August 25. Buccal lesions reappeared September 9; have persisted and are more pronounced to-day. It is decided, therefore, to increase the dose of tomato juice to 230 c. c., or to about 20 c. c. per kilogram of body weight, effective to-day. Diet No. 123 has continued to be offered. Weight four days ago was 11.5 kilograms.

December 17: The signs of blacktongue have several times faded only to reappear—that is, the attack has taken on a chronic relapsing form characterized by marked weakness in the hind legs. The general condition of the animal has been on a decline. Weighs 8.2 kilograms. The tomato-juice treatment is this day supplemented with autoclaved yeast, the administration of which is begun in a dose of 23 grams in gelatine capsules.

January 20, 1926: Weighs 9.6 kilograms. Condition has greatly improved. Signs of blacktongue have cleared up. The autoclaved yeast, which has been given daily, is discontinued. The daily dose of tomato juice is this day increased to 345 c. c., or to about 30 c. c. per kilogram of normal body weight.

December 3, 1926: Presented an evanescent but suggestive injection of the floor of the mouth February 12 and again on May 12. This morning presents very suggestive buccal lesions. During May and June presented a very suggestive desquamative lesion of the scrotum. Three days ago weighed 9.8 kilograms.

January 8, 1927: Buccal lesions noted a month ago gradually faded out. Suggestive reddened lesions on mucosa of upper lip and an injection of the floor are present this morning. A weakness in hind legs similar to that from which he had practically recovered on the yeast treatment has been developing for about a week. The animal walks with difficulty. In walking, the hind legs are spread out so much that the pelvis barely clears the floor. Four days ago weighed 7.9 kilograms. General nutrition poor; eating poorly.

January 18: Condition becoming more unfavorable. Buccal mucosa is pale. Flaccid paraplegia is, if anything, more pronounced. Emaciated. As a whole this animal would seem to be suffering from a chronic blacktongue complicated by self-imposed semistarvation. Gassed. Tissues taken by Dr. James Denton for histopathological study. The chronicity of the disease extending over a period of a year suggests a partially protective action of the tomato juice.

*Dog 81.*—Male. Acquired October 13, 1924. On stock diet to November 21, 1924.

December 27, 1924: Has been on basic diet No. 123 since November 21 and this morning presents the first signs of an attack of blacktongue, an injection of the mucosa of the floor of the mouth and of the cheeks. Weighs 10.4 kilograms. Begins treatment with tomato juice in a daily dose of 126 c. c., or about 12 c. c. per kilogram of body weight, as a supplement to diet No. 123.

January 2, 1925: Signs of blacktongue have faded. Buccal mucosa is about normal.

April 10: An evanescent reddening of the floor of the mouth was observed on January 23. Not again observed until three days ago, since when it has become more pronounced and definite. The daily dose of tomato juice is, therefore, increased this day to 189 c. c., or about 18 c. c. per kilogram of body weight. Weighs 11.1 kilograms.

April 13: Mouth appears normal this morning.

November 7: Early in August there appeared a desquamative dermatitis of the scrotum which, ill defined at first, gradually developed more distinctive characters. It has persisted, undergoing repeated changes in intensity. Since August 22, suggestive but transient buccal lesions have number of times appeared and each time faded. They have latterly tended to become more pronounced and definite. Food consumption has been much reduced recently.

Four days ago weighed 9.7 kilograms. Died suddenly this forenoon as the result of a gastric hemorrhage.

The mild relapsing course over a period of some 10 months suggests a delaying of partially protective action of the tomato juice.

*Dog 82.*—Bitch. Acquired October 13, 1924. On stock diet to November 21, 1924.

December 23, 1924: Has been on basic diet No. 123 since November 21, 1924, and this morning presents the first signs of an attack of blacktongue, reddened lesions on the mucosa of the upper lip, reddening of the mucosa of the floor of the mouth and of the cheeks. Weighs 11.5 kilograms. Begins treatment with tomato juice in a daily dose of 140 c. c., or about 12 c. c. per kilogram of body weight, as a supplement to diet No. 123.

December 27: The attack of blacktongue has become more pronounced. The temperature this morning is 40°. More potent therapy being indicated, the dog is given 23 grams of brewery yeast in capsules in place of the tomato juice.

January 3, 1925: Condition has improved markedly. Mouth is nearly normal. Has received a daily dose of 23 grams of yeast. This is discontinued and the treatment with a daily dose of 140 c. c. of tomato juice is resumed.

March 8: Presents this morning reddened patches on the mucosa of the upper lip and some injection of the floor of the mouth. Weighs 12.7 kilograms.

March 12: Buccal lesions have faded.

April 7: Floor of mouth is suggestively reddened.

April 8: Mouth appears normal.

April 16: Mucosa of cheeks and of floor of mouth suggestively reddened.

April 19: Mouth again normal.

April 28: Mucosa of cheeks and of floor of mouth suggestively reddened.

April 29: Buccal lesions have faded.

September 12: The daily dose of tomato juice is made 280 c. c., or about 20 c. c. per kilogram of body weight. Weighs 14 kilograms.

March 13, 1926: Has presented no evidence of blacktongue in nearly a year. The dose of tomato juice is nevertheless increased to 420 c. c., or to about 30 c. c. per kilogram of body weight. Weighs 13 kilograms.

November 17: Since last April has a number of times passed tarry-looking bowel evacuations. Has been eating well. Weighs 14.5 kilograms. Has presented no recognizable evidence of blacktongue since April 29, 1925—that is, during about 18½ months. Experiment is discontinued.

*Results and conclusions.*—From the foregoing it appears that the dose of tomato juice (about 12 c. c. per kilogram of body weight) tried at the outset was inadequate both in treatment and prevention. But later, following the use of larger doses (20 to 30 c. c. per kilogram) a very definite preventive effect became appreciable (dogs 13, 50, 82), but this was not fully adequate for two of the animals (dogs 66, 81). It may be concluded, therefore, that tomatoes possess blacktongue-preventive action, but that this is of a feeble order, upward of 30 c. c. per kilogram of body weight (of the canned tomato juice) may be needed for complete protection when used as a supplement to such diet as our No. 123 (Table 1). This result is thus in close agreement with the experience of Goldberger and Wheeler, cited in the foregoing, in the human disease. The canned tomato, therefore, contains the preventive for both blacktongue and pellagra, but, considering quantity, contains it in relatively small amount.

## CARROTS

As a result of their study of the Chittenden-Underhill syndrome in dogs, Underhill and Mendel (6) reported in May, 1925, that they had found carrots particularly effective in alleviating that syndrome when it was once initiated. Since it had already been suggested (12) that the Chittenden-Underhill syndrome in dogs was probably identical with blacktongue, it seemed desirable to test the efficacy of carrots in the experimental condition with which we were working and which we identified as blacktongue. The following experiment was accordingly carried out.

It may be noted that concurrently with this study in dogs, Goldberger and Wheeler (13) carried out a study of carrots in the human disease and found that the ingestion of the cooked equivalent of some 400 to 450 grams of this vegetable daily was inadequate to prevent pellagra in insane pellagrins weighing 46 to 63 kilograms; the attacks appeared after somewhat longer periods than their experience had led them to expect, thus suggesting a delaying or slightly protective effect of which, however, they could not be sure.

### EXPERIMENT 21

This was a test of the curative and the preventive action of carrots in experimental blacktongue. The test animals were five dogs, Nos. 44, 60, 63, 64, and 70. The experiment was begun as a therapeutic study, each one of the animals presenting more or less marked buccal signs of an early stage of the experimental disease. This phase of the experiment lasted about two months and was followed by a period of about one month of reconditioning on stock diet. The preventive test started immediately after this reconditioning period.

The carrots were dressed as for human consumption, run through a meat-chopping machine, and then, with the smallest practicable amount of water, cooked for about two hours in a double boiler. Thus prepared and tender they were offered daily to each animal in definite weighed amounts apart from the basic blacktongue-producing diet. In the later stage of the study a small amount of the basic diet was mixed with the carrots ration of each animal. As a rule, the carrots were offered to the dogs before noon of each day. What was found uneaten a few hours later was forcibly fed. A small, negligible amount was unavoidably wasted in connection with this forced feeding.

The therapeutic dose with which the study was begun represented 180 grams of the raw dressed vegetable per dog per day. As the animals were not of uniform weight, the dose in relation to weight varied from about 15 to 25 grams per kilogram. This was increased

to 270 grams, or from about 25 to 40 grams per kilogram of body weight, during about the last two weeks of this phase of the study.

The preventive dose begun with was the equivalent of 300 grams of raw dressed carrots per dog per day, or from about 25 to 40 grams per kilogram of body weight. After a period of three months this was increased to 600 grams per dog per day, or to about 50 to 85 grams per kilogram of body weight.

The basic diet used during the first period was our blacktongue producing diet No. 209 on which, indeed, four of the test animals (dogs 44, 60, 63, and 64) had developed the attacks for which they were given the carrots by way of treatment. The fifth dog had developed the attack on another diet, but was given diet No. 209 when treatment with carrots was begun. Diet No. 209 is our diet No. 123 (Table 1), the white corn meal of which was quantitatively replaced by yellow meal (3). During the preventive period of the test, basic diet No. 123 was used. The significant details are briefly as follows:

*Dog 44.*—Male. Whelped in the laboratory June 26, 1923. Served in several experiments and suffered three attacks of blacktongue, of which the latest began September 1, 1925, while on test diet No. 209.

September 15: The attack of blacktongue, the first signs of which appeared September 1, is now well defined but still mild. Weighs 12.1 kilograms. Continues on diet No. 209 and begins treatment with cooked carrots, the equivalent of 180 grams of the raw dressed vegetable, or about 15 grams per kilogram of body weight per day.

November 4: Weighs 11.3 kilograms. The mouth lesions present September 15 slowly faded, but almost at once began to reappear and have gradually become well defined and characteristic. The daily allowance of carrots is therefore increased effective to-day to the equivalent of 270 grams, or about 25 grams per kilogram of body weight, of the raw vegetable.

November 19: No beneficial effect being appreciable, the administration of carrots and basic diet No. 209 are discontinued and stock diet for reconditioning is begun. Weighs 11.4 kilograms.

December 17: All evidence of blacktongue rapidly cleared up following inauguration of the stock diet. Weighs 11.9 kilograms. In good condition. Begins basic diet No. 123 with a supplement of cooked carrots, representing 300 grams, or about 25 grams per kilogram of body weight, of the raw vegetable.

March 16, 1926: Slight but very suggestive indications of blacktongue appeared February 4. They soon faded, but have several times since then alternately reappeared and faded. Although not in evidence to-day, it is deemed desirable nevertheless to increase the daily supplement of carrots to the equivalent of 600 grams, or about 50 grams per kilogram of body weight, of the raw dressed vegetable. Weighs 12.6 kilograms.

March 15, 1927: On May 13, 1926, presented a slight but suggestive erythema of the scrotum which gradually faded and was entirely gone three days later. Has presented no buccal evidence of blacktongue in fully a year. Weighs 11.4 kilograms. Experiment is discontinued.

*Dog 60.*—Male. Whelped in the laboratory November 4, 1923. Served in several experiments and has suffered two attacks of blacktongue, the latest of which began September 13, 1925, while on test diet No. 209.

September 15, 1925: The buccal lesions of the attack, the first signs of which appeared two days ago, are mild but definite this morning. Weighs 7.4 kilograms. Begins treatment with boiled carrots, of which the equivalent of 180 grams, or about 25 grams per kilogram of body weight, of the raw dressed vegetable is to be administered daily.

November 6: The mouth lesions present when feeding of carrots began faded and were no longer recognizable five days later. A suggestive evanescent injection of the floor of the mouth was present October 3. Weighs 7.4 kilograms. The daily dose of carrots is this day increased to the equivalent of 270 grams, or about 35 grams per kilogram of body weight, of the raw dressed vegetable.

November 19: Suggestive buccal signs of blacktongue appeared two days ago. They are still faintly perceptible this morning. Begins stock diet for reconditioning.

December 17: Two days after the change to the stock diet all mouth signs were gone. General condition has improved. Weighs 8.1 kilograms. Resumes the test of carrots by beginning basic diet No. 123 with a daily supplement of cooked carrots equivalent to 300 grams, or about 35 grams per kilogram of body weight, of the raw dressed vegetable.

March 16, 1926: During the past two or three weeks has repeatedly presented slight, evanescent and more or less strongly suggestive buccal signs of blacktongue. Still presents some injection of the floor of the mouth which appeared three days ago. Weighs 7.5 kilograms.

The daily allowance of boiled carrots is this day increased to the equivalent of 600 grams, or about 70-80 grams per kilogram of body weight, of the raw dressed vegetable.

April 28: The mouth lesions present on March 16 faded in the course of the succeeding two or three days, but have alternately reappeared and faded two or three times since. Mouth is normal this morning. Weighs 7 kilograms.

May 26: A marginated scrotal dermal lesion began to develop about May 1. It gradually increased in extent and became desquamative. It has alternately paled and brightened a number of times, and then gradually cleared up so that the scrotum is well-nigh normal this morning. Buccal lesions of blacktongue reappeared May 13 and gradually became quite pronounced, but have practically completely faded. Weighs 7 kilograms.

June 7: Floor of mouth presents a suspicious injection.

June 9, 1926: Mouth is about normal.

May 15, 1927: Has presented no evidence of blacktongue since early last June, that is, during a period of about nine months. Weighs 7.5 kilograms. Experiment is discontinued.

*Dog 63.*—Male. Whelped in the laboratory November 4, 1923. Has served in several experiments and has suffered three attacks of blacktongue, the latest of which began August 29, 1925, while on test diet No. 209.

September 15, 1925: The attack of blacktongue, the first signs of which appeared August 29, has become definitely marked, but is still mild. Weighs 6.8 kilograms. Diet No. 209 is continued. Begins treatment with boiled carrots in a daily dose representing 180 grams, or about 25 grams per kilogram of body weight, of the raw dressed vegetable.

November 6: The buccal signs of blacktongue have alternately faded and reappeared a number of times since the treatment with carrots was begun. Weighs 7.2 kilograms. The dose of boiled carrots is this day increased to an equivalent of 270 grams, or about 35 grams per kilogram of body weight, of the raw vegetable.

November 19: In spite of the increased dose of carrots the buccal lesions of blacktongue have become more severe. Temperature was 40° yesterday and

is 39.9° this morning. Diet No. 209 and carrots are discontinued and stock diet is begun. Two days ago weighed 6.5 kilograms. Eating poorly.

November 21: The condition of the animal seeming to be grave, it was given a dose of 7 grams of a dried yeast extract yesterday and another today. Refused all food yesterday.

December 7: Condition has rapidly improved. Appetite returned a day or two after the second dose of the yeast extract and has been eating well since.

December 17: In good condition. Weighs 7.1 kilograms. Begins diet No. 123 with a daily supplement of the cooked equivalent of 300 grams, or about 40 grams per kilogram of body weight, of raw dressed carrots.

January 23, 1926: Presents this morning strongly suggestive buccal sings of blacktongue.

March 16: The mouth lesions noted January 23 became more pronounced, then faded only to reappear and are appreciable this morning. It is deemed desirable, therefore, to increase the allowance of carrots. Effective to-day the cooked equivalent of 600 grams, or about 80 grams per kilogram of body weight, of raw dressed carrots is offered and is to be offered daily.

June 27: The mild buccal lesions present on March 16, when the allowance of carrots was increased, gradually faded but soon reappeared only to fade again. This alternate appearance and disappearance has been two or three times noted; the latest appearance of a slight injection of the floor of the mouth was yesterday but is not appreciable this morning. A very strongly suggestive dermal scrotal lesion made its appearance on May 12 but had cleared up by May 25. Weighs 6.6 kilograms.

May 15, 1927: During the past 8½ months there has been no evidence suggestive of blacktongue. Weighs 7.6 kilograms. Experiment is discontinued.

*Dog 64.*—Bitch. Whelped in the laboratory November 4, 1923. Has suffered two attacks of blacktongue, the latest of which began September 12, 1925, while on test diet No. 209.

September 15, 1925: Slight buccal signs of the attack which began three days ago are in evidence. Weighs 6.8 kilograms. Continues diet No. 209 and begins treatment with cooked carrots in a daily dose equivalent to 180 grams, or about 25 grams per kilogram of body weight, of the raw vegetable.

November 6: The mouth lesions present when treatment was begun faded and were no longer appreciable five days later. On October 20 a suggestive injection of the floor of the mouth was again in evidence, but faded during the succeeding three days. Weighs 6.6 kilograms. The daily allowance of boiled carrots is this day increased to the equivalent of 270 grams, or about 40 grams per kilogram of body weight, of the raw dressed vegetable.

November 19: Strongly suggestive mouth lesions reappeared two days ago and continue in evidence this morning. Diet No. 209 and treatment with carrots discontinued and stock diet is begun for reconditioning.

December 17: Mouth has been normal in appearance since November 21. In good condition. Weighs 7.2 kilograms. Begins diet No. 123 with a daily supplement of boiled carrots equivalent to 300 grams, or about 40 grams per kilogram of body weight, of the raw dressed vegetable.

March 16, 1926: Presented a suggestive injection of the floor of the mouth on February 20, which had largely faded by February 23. It was again in evidence for two or three days beginning March 2 and reappeared three days ago, but has completely faded. Weighs 6.2 kilograms. The daily allowance of boiled carrots is to-day increased to the equivalent of 600 grams, or about 85 grams per kilogram of body weight, of the raw vegetable.

October 1: Presented a suggestive injection of the mucosa of the floor of the mouth on March 21, which faded in three or four days. Has been free of any

suggestion of blacktongue until two days ago (about six months) when a suggestive reddening of the floor of the mouth was in evidence but is no longer appreciable. Weighs 7 kilograms.

March 15, 1927: There has been no suggestion of blacktongue since the evanescent injection of the floor of the mouth in evidence September 29, 1926—five and a half months ago. Weighs 7.3 kilograms. In good condition. Experiment discontinued.

*Dog 70.*—Male. Whelped in the laboratory November 25, 1923. Has served in several experiments and has suffered two attacks of blacktongue, the latest of which began September 15, 1925, while on wheat germ diet No. 197.

September 18, 1925: Three days ago weighed 9.6 kilograms. The attack of blacktongue, the first signs of which appeared three days ago, is now well marked. Begins diet No. 209 with a supplement of boiled carrots equivalent to 280 grams, or about 30 grams per kilogram of body weight, of the raw dressed vegetable.

September 28: The mouth lesions became quite severe, but have shown a marked improvement during the past three or four days. Has taken none of the basic diet since September 21, but a little of it was mixed with the boiled carrots yesterday and so forcibly fed. Weighs 7.8 kilograms. Beginning to-day the daily dose of boiled carrots will be the equivalent of 180 grams, or about 20 grams per kilogram of body weight, of the raw vegetable.

October 7: The mouth is now about normal in appearance.

November 19: Buccal lesions suggestive of blacktongue reappeared about two weeks ago and have gradually become more definite. Weighs 9.2 kilograms. Diet No. 209 and carrots discontinued and stock diet for reconditioning begins.

December 17: Weighs 9.4 kilograms. Is in good condition. Begins diet No. 123 with a daily supplement of boiled carrots—the equivalent of 300 grams, or about 30 grams per kilogram of body weight, of the raw dressed vegetable.

March 16, 1926: Has presented evanescent, but suggestive, buccal signs of blacktongue which were in evidence on February 4 and again three days ago and which are more definite to-day. Weighs 10.2 kilograms. The allowance of boiled carrots is this day increased to the equivalent of 600 grams, or about 60 grams per kilogram of body weight, of the raw vegetable.

March 18: Mouth is about normal again.

June 10: Slight but suggestive buccal lesions appeared a week ago but are no longer appreciable.

June 19: Some suggestive injection of the floor of the mouth reappeared a week ago but is no longer recognizable.

July 7: A suggestive injection of the floor of the mouth appeared July 1, but has faded.

July 17: The distinctive erythematous bandlike lesion on the mucosa of the upper lip has appeared this morning. Has a suggestive scrotal lesion, which made its appearance two days ago.

July 19: Mouth lesions have faded. Scrotal lesion is less marked.

July 21: Scrotum practically normal.

August 16: Suggestive buccal lesions again appeared on August 10 but have completely faded. Four days ago weighed 9.5 kilograms.

March 15, 1927: Has presented no evidence of blacktongue since early last August—that is, during a period of about seven months. Weighs 10.2 kilograms. Experiment is discontinued.

*Results and conclusions.*—In none of the five test animals during the first or exclusively curative phase of the study could a beneficial effect be recognized.

In the initial stage of the preventive test the ingestion daily of a quantity of boiled carrots representing 300 grams, or about 25 to 40 grams per kilogram of body weight, of the raw dressed vegetable failed to prevent completely the development of evidence of blacktongue in any one of the test animals. The increase in the allowance of boiled carrots to the equivalent of 600 grams, or to about 50 to 85 grams of the raw vegetable per kilogram of body weight, was followed by a slow clearing up of the evidence of blacktongue, with subsequent freedom from all indications of the disease during periods of observation of between  $5\frac{1}{2}$  and 10 months. Thus over 40 grams of the vegetable per kilogram of body weight were required as a supplement to our basic diet No. 123 before a blacktongue preventive action became definitely appreciable. This would seem to indicate that carrots contain the blacktongue preventive, but in relatively small amount. The failure in pellagra prevention reported by Goldberger and Wheeler (13), cited in the foregoing, would thus appear to be entirely consistent with this result in the canine disease.

#### RUTABAGAS

Shortly after beginning the study of carrots, presented in the foregoing, we undertook a study of the blacktongue preventive action of the rutabaga turnip. At about the same time a pellagra-preventive study of this vegetable was begun by Goldberger and Wheeler (13) at the Georgia State Sanitarium. It was at first planned to work with the common white turnip in both investigations, but finding that an adequate supply of this vegetable throughout the year would be less certain than that of the rutabaga, the latter was finally selected for study in both. The results of the study of pellagra prevention, already reported by Goldberger and Wheeler (13), indicate that the cooked dressed rutabaga contains so little of the pellagra preventive that the daily ingestion of the equivalent of 1 pound of the raw dressed vegetable was without recognizable pellagra preventive action. The determination of what the ingestion of a larger quantity might have shown with respect to preventive potency was not attempted.

Our study of the rutabaga in blacktongue is presented in the following:

#### EXPERIMENT 22

This was a test of the blacktongue preventive action of the rutabaga turnip when fed as a supplement to our basic blacktongue-producing diet No. 123. (Table 1.)

The rutabagas were peeled as for human consumption, run through a meat chopper, and then cooked in a small amount of added water in a double boiler for about two hours. Thus cooked and tender they were offered daily in weighed amounts to each dog apart from



the basic diet. As it soon appeared that the dogs would take the cooked rutabagas better if mixed with some of the other food, this practice was adopted and maintained to the end of the experiment. As in the case of the carrots, the ration of rutabagas was served the dogs shortly before noon of each day. What was found unconsumed a few hours later was forcibly fed. Incidentally, as with the carrots, a small, negligible part of the rutabaga ration was unavoidably wasted.

The preventive dose begun with was the same as that with carrots, namely, the cooked equivalent of 300 grams of the raw dressed vegetable per dog per day. As the test animals differed somewhat in weight, this made a dose that varied for the respective animals between 25 and 35 grams per kilogram of body weight. At the end of about six weeks of this dosage one of the animals manifesting suggestive evidence of blacktongue, and thus of a probable preventive inadequacy, the daily allowance was at once doubled for all of this lot of dogs in order, if possible, to insure a preventive effect. The allowance thus increased was maintained to the close of the experiment, which lasted in all about 13½ months.

Four test animals, dogs 67, 73, 93, and 95 were used. The significant details relating to each of the animals are as follows:

*Dog 67.*—Male. Whelped in the laboratory November 25, 1923. Reared and maintained on stock diets up to February 2, 1926.

February 2, 1926: In good condition. Weighs 9.6 kilograms. Begins basic diet

No. 123 and a daily supplement of boiled rutabagas representing 300 grams, or about 30 grams per kilogram of body weight, of the raw dressed vegetable.

March 16: Presented, two days ago, a slight injection of the floor of the mouth, which was distinctly perceptible yesterday but is entirely gone this morning. This evanescent but suggestive indication of blacktongue and, thus, of a preventive inadequacy of the allowance of the rutabagas, makes an increase desirable in order if possible to insure a preventive effect. Accordingly, the daily supplement of boiled rutabagas is this day increased to the equivalent of 600 grams, or about 60 grams per kilogram of body weight, of the raw dressed vegetable.

January 13, 1927: Presents this morning an ill-defined, faintly reddened patch on the mucosa of the upper lip in the region of the canine teeth of each side. Mucosa of the cheeks is slightly flushed and that of the floor of the mouth is slightly injected. Weighs 7.8 kilograms.

January 14: Mouth is normal this morning.

March 15, 1927: Except for the evanescent but suggestive indication of blacktongue in evidence January 13, 1927, this animal has been free of recognizable indications of blacktongue during a period of one year. Experiment is discontinued.

*Dog 73.*—Bitch. Acquired March 19, 1924. Up to December 19, 1925, suffered: two uncertain, evanescent, and one definite attack of blacktongue, the latest of which began December 17, 1925. On stock diet for reconditioning from December 19, 1925, to February 2, 1926.

February 2, 1926: In good condition. Weighs 9.4 kilograms. Begins basic diet No. 123 and a daily supplement of boiled rutabagas representing 300 grams, or about 30 grams per kilogram of body weight, of the raw dressed vegetable.

March 16, 1926: Has presented no suggestion of blacktongue, but by reason of suggestive indications presented by dog 67, the daily supplement of boiled rutabagas is this day doubled. Weighs 9.9 kilograms.

March 15, 1927: Has presented nothing suggestive of blacktongue during the period of 13½ months since the beginning of the experiment. Weighs 9.5 kilograms. In good condition. Experiment discontinued.

*Dog 93.*—Male. Acquired November 5, 1925. On stock diet to February 2, 1926.

February 2, 1926: In good condition. Weighs 12.2 kilograms. Begins basic diet No. 123 with a daily supplement of boiled rutabagas representing 300 grams, or about 25 grams per kilogram of body weight, of the raw dressed vegetable.

March 16, 1926: Has presented nothing suggestive of blacktongue, but, as in the case of dog 73, the daily supplement of boiled rutabagas is doubled. Weighs 12.9 kilograms.

March 15, 1927: Has presented nothing suggesting blacktongue during the period of 13½ months since the beginning of the experiment. In good condition. Weighs 13.7 kilograms. Experiment is discontinued.

*Dog 95.*—Male. Acquired November 30, 1925. On stock diet to February 2, 1926.

February 2, 1926: In good condition. Weighs 8.6 kilograms. Begins basic diet No. 123 with a daily supplement of boiled rutabagas representing 300 grams, or 35 grams per kilogram of body weight, of the raw dressed vegetable.

March 16, 1926: As in the case of dogs 73 and 93, the daily supplement of boiled rutabagas is this day doubled. Weighs 8.6 kilograms.

March 15, 1927: Has presented no indications of blacktongue during the experimental period of 13½ months. Food consumption has been variable; has lost some in weight, which is 7.3 kilograms. Experiment is discontinued.

*Results and conclusions.*—Of the four test animals, one (dog 67) presented transient but suggestive indications of blacktongue about 40 days after beginning the experiment and while receiving daily the boiled equivalent of about 30 grams of the raw dressed vegetable per kilogram of body weight. The same animal again presented evanescent signs suggesting blacktongue about 10 months after beginning a daily allowance of the boiled equivalent of about 60 grams of the raw dressed vegetable per kilogram of body weight. None of the other three animals (dogs 73, 93, and 95) presented any evidence of blacktongue at any time during the test period of 13½ months. It would appear therefore that the rutabagas contain the blacktongue preventive, but in relatively small amount, since the cooked equivalent of upward of 60 grams of the raw dressed vegetable per kilogram of body weight may be needed for complete protection of the dog.

It may be noted that the failure reported by Goldberger and Wheeler (12) to recognize any pellagra preventive effect following the daily ingestion of the cooked equivalent of one pound of raw dressed rutabagas is entirely consistent with this result in blacktongue.

## RELATION OF BLACKTONGUE TO PELLAGRA

In the foregoing we have presented the results of our study of the blacktongue-preventive action of a series of foodstuffs of considerable variety, numbering 16 in all. Since the principal object of that study has been to secure evidence concerning the relation of the blacktongue preventive to the pellagra preventive and, thus, of blacktongue to pellagra, an attempt has been made to correlate the blacktongue-preventive potency of each foodstuff to its pellagra-preventive potency where this was known.

As will have been seen, 11 of the foodstuffs (namely, maize, wheat germ, cowpea, soy bean, milk, butter, cod-liver oil, lean beef, tomato, carrot, and rutabaga) have been studied for their preventive action in both conditions. In the case of eight of these (maize, wheat germ, cowpea, milk, butter, cod-liver oil, lean beef, tomato) our knowledge of their preventive potency or lack of it for the two conditions under consideration is of such character as to permit of a rough but sufficiently satisfactory comparison for the present purpose; in each one of these eight the preventive potency for pellagra is, as has been pointed out, strikingly similar to that for blacktongue.

With respect to 3 of the 11 foodstuffs, namely, the soy bean, carrot, and rutabaga, our knowledge of their pellagra-preventive potency is not sufficient to permit of satisfactory comparison with their blacktongue-preventive action. Such general indications as are afforded, however, justify the expectation that additional investigation of their preventive potency for pellagra will reveal this to be similar to their preventive potency for blacktongue.

In brief, then, it seems clearly indicated that, so far as they have been studied, the foodstuffs that appear to be good sources of the blacktongue preventive also appear to be good sources of the pellagra preventive; those that appear to be poor sources of, or lacking in, the blacktongue preventive likewise appear as poor sources of, or lacking in, the pellagra preventive. This, it should be noted, is not a mere similarity in distribution of the respective preventive essentials among the foodstuffs—it is a similarity in the potency of the action of those foodstuffs in the respective pathological conditions and, thus, this would seem to constitute evidence of weight pointing to the identity of the preventive essentials and, therefore, to the identity of blacktongue and pellagra.

Considering the foregoing evidence in conjunction with the evidence presented in our previous communications (2), (3), namely, the striking clinical resemblance of the disease in the dog to the disease in man, the suggestion of a common etiology indicated by the successful production of the disease in the dog by feeding pellagra-producing diets, the effectiveness of dried yeast and a dried aqueous extract of yeast as preventives of both conditions, together with the

fact of the successful production of a pellagra-like condition in the albino rat by feeding a diet deficient in a food essential which is indistinguishable from the preventive of blacktongue<sup>1</sup> (14), as well as with the evidence revealed by Denton's study (5) showing that there is a marked similarity in the gross and microscopic tissue changes of blacktongue and pellagra—considering all this evidence as a whole, it would seem highly probable, if not certain, that experimental blacktongue and pellagra are essentially identical conditions and, thus, that the preventive of blacktongue is identical with the pellagra preventive or factor P-P.

If this conclusion is, as we believe, sound, it manifestly follows that the results of tests of preventive action carried out in the dog are applicable to the disease in man and, thus, that the indications presented in the foregoing with respect to the blacktongue-preventive potency of certain of the foodstuffs (liver, salmon, egg yolk) not yet studied directly in pellagra may be accepted as having corresponding significance for that disease. We would, accordingly, recommend liver, salmon, and egg yolk for use in the treatment and prevention of pellagra.

#### SUMMARY AND CONCLUSIONS

The blacktongue-preventive potency of 16 foodstuffs has been studied and correlated to the pellagra preventive potency (or lack of it) of those, eleven in number, for which this was known, with the following results:

*Maize*, if it contains any, is a poor source of the preventive for both blacktongue and pellagra.

Whole *wheat* contains the blacktongue preventive, but in small amount.

Commercial *wheat germ* contains, and may be rated as a relatively good source of, the preventive for both blacktongue and pellagra.

The *cowpea* contains, but is a poor source of, the preventive for both blacktongue and pellagra.

The *soy bean* contains the blacktongue preventive, but in relatively small amount, appreciably more, however, than the cowpea, but considerably less than the extracted wheat germ. So far as it goes the experience with the soy bean in the human disease is, at least, not inconsistent with that in the experimental disease of the dog.

*Milk* contains the preventive for both the human and the canine disease, but contains it in relatively small amount.

*Butter*, while not devoid of it, is a relatively very poor source of the blacktongue preventive, a conclusion that is in harmony with the experience with butter in pellagra.

*Cod-liver oil* would seem very poor in or lacking the preventive for both blacktongue and pellagra.

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<sup>1</sup> Since the experimental pellagra-like condition in the albino rat appears to be due to a deficiency of the same food essential as is experimental blacktongue, that is to say, since these two conditions appear to be etiologically indistinguishable, proof of the identity of blacktongue and pellagra is also, of course, proof of the fundamental identity of the condition in the rat and the disease (pellagra) in man.

*Cottonseed oil* contains little, if any, of the preventive for blacktongue. No specific study of the effectiveness of this oil in pellagra has been made; on the basis of general experience it seems unlikely that this oil contains the pellagra preventive in significant amounts.

*Beef muscle* is a good source of the preventive for both blacktongue and pellagra.

*Pork liver* is a good source of the blacktongue preventive; it has not yet been studied in pellagra.

*Canned salmon* contains the blacktongue preventive. A study of its effectiveness in pellagra is in progress.

*Egg yolk* contains the blacktongue preventive; a specific study of its value in pellagra has not yet been undertaken.

The canned *tomato* contains the preventive for both blacktongue and pellagra, but in relatively small amount.

The *carrot* contains, but is a relatively poor source of, the preventive of blacktongue. Its reported failure in pellagra prevention is consistent with the indications of its feebleness as a blacktongue preventive.

The *rutabaga* turnip contains, but is a relatively poor source of, the blacktongue preventive. Its failure in pellagra prevention is consistent with its poverty in the blacktongue preventive.

So far as they have been studied, the foodstuffs that appear to be good sources of the blacktongue preventive also appear to be good sources of the pellagra preventive; those that appear to be poor sources of, or lacking in, the blacktongue preventive likewise appear to be poor sources of, or lacking in, the pellagra preventive.

Considering the available evidence as a whole, it would seem highly probable, if not certain, that experimental blacktongue and pellagra are essentially identical conditions and thus that the preventive of blacktongue is identical with the pellagra preventive, or factor P-P.

On the basis of the indications afforded by the test in the dog, liver, salmon, and egg yolk are recommended for use in the treatment and prevention of pellagra in the human.

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(Tables 1-16 follow)

TABLE 1.—Composition of basic blacktongue-producing diet No. 123<sup>1</sup>

[Total calories, 2,400]

Articles of diet	Quantity	Nutrients		
		Protein	Fat	Carbohydrate
	Grams	Grams	Grams	Grams
Corn meal <sup>2</sup> .....	400	33.6	18.8	296.0
Cowpeas ( <i>Vigna sinensis</i> ) <sup>3</sup> .....	50	10.7	.7	30.4
Casein (purified) <sup>4</sup> .....	60	52.0	.....	.....
Sucrose.....	32	.....	.....	32.0
Cottonseed oil.....	30	.....	30.0	.....
Cod-liver oil.....	15	.....	15.0	.....
Sodium chloride.....	10	.....	.....	.....
Calcium carbonate.....	3	.....	.....	.....
Total nutrients.....	.....	96.3	64.5	358.4
Nutrients per 1,000 calories.....	.....	40.1	26.9	149.3

<sup>1</sup> The corn meal, cowpeas (previously coarsely ground), and salt are stirred into water and cooked in a double boiler of enamel ware for about 1½ hours. Then the other ingredients are well stirred in, the total weight being brought to 2,400 grams with water (so that 1 gram represents 1 calorie), and this finished mixture is served to the dog ad libitum.

<sup>2</sup> Whole maize meal (white) sifted as for human consumption.

<sup>3</sup> The variety known as the California black-eyed pea.

<sup>4</sup> Commercial casein leached for a week in daily changes of acidulated water, after McCollum (15).

TABLE 2.—Composition of maize diets No. 149<sup>1</sup> and No. 149A<sup>1</sup>

[Total calories, 2,354]

Articles of diet	Quantity	Nutrients		
		Protein	Fat	Carbo- hydrate
	<i>Grams</i>	<i>Grams</i>	<i>Grams</i>	<i>Grams</i>
Whole white cornmeal.....	450	<sup>1</sup> 45.5	<sup>1</sup> 22.5	328.0
Casein (purified) <sup>2</sup> .....	90	78.8		
Salts <sup>3</sup> .....				
Cod-liver oil.....	8		8.0	
Butterfat (in diet No. 149).....	30		30.0	
Cod-liver oil (in diet No. 149A).....				
Total nutrients.....		124.3	60.5	328.0
Nutrients per 1,000 calories.....		52.9	25.7	139.6

<sup>1</sup> The maize meal is stirred into water and boiled one and one-half hours. The other ingredients are then added and well stirred in, the total weight being brought to 2,354 grams with water (so that 1 gram represents 1 calorie). The finished mixture is served to the dog in suitable calorie portion.

<sup>2</sup> The factors used are those given by Henry and Morrison ("Feeds and Feeding") for dent corn.

<sup>3</sup> Commercial casein leached for a week in daily changes of acidulated water, after McCollum (15).

<sup>4</sup> McCollum's well-known salt mixture 185 (Am. Jour. Physiol., 1916, vol. 41, p. 357).

TABLE 3.—Composition of wheat diet No. 128<sup>1</sup>

[Total calories, 2,400]

Articles of diet	Quantity	Nutrients		
		Protein	Fat	Carbo- hydrate
	<i>Grams</i>	<i>Grams</i>	<i>Grams</i>	<i>Grams</i>
Wheat meal (whole kernel).....	400	<sup>1</sup> 49.6	<sup>1</sup> 8.4	293.6
Cowpeas ( <i>Vigna sinensis</i> ).....	50	10.7	.7	30.4
Casein (purified) <sup>2</sup> .....	60	52.0		
Sucrose.....	24			24.0
Cottonseed oil.....	38		38.0	
Cod-liver oil.....	15		15.0	
Sodium chloride.....	10			
Calcium carbonate.....	3			
Total nutrients.....		112.3	62.1	348.0
Nutrients per 1,000 calories.....		46.8	26.0	145.0

<sup>1</sup> The wheat meal, cowpeas (previously coarsely ground), and sodium chloride are stirred into water and cooked about one and one-half hours. Then the other ingredients are well stirred in, the total weight being brought to 2,400 grams with water (so that 1 gram represents 1 calorie). The finished mixture is served to the dogs in suitable portions.

<sup>2</sup> Factors used as given by Henry and Morrison ("Feeds and Feeding") for wheat, "all analyses."

<sup>3</sup> Commercial casein leached for a week in daily changes of acidulated water, after McCollum (15).

TABLE 4.—Composition of wheat-germ diet No. 197<sup>1</sup>

[Total calories, 2,400]

Articles of diet	Quantity	Nutrients		
		Protein	Fat	Carbo- hydrate
	<i>Grams</i>	<i>Grams</i>	<i>Grams</i>	<i>Grams</i>
Wheat germ (ether-extracted).....	180	52	0.2	112
Casein (purified) <sup>2</sup> .....	50	44		
Cornstarch.....	240			216
Sucrose.....	32			32
Cottonseed oil.....	49		49.0	
Cod-liver oil.....	15		15.0	
Salt mixture <sup>3</sup> .....	22			
Total nutrients.....		96	64.2	360
Nutrients per 1,000 calories.....		40	26.7	150

<sup>1</sup> The wheat germ, starch, and cottonseed oil are stirred into water and cooked about 1½ hours. The other ingredients are then well stirred in and the final weight is brought to 2,400 grams with water (so that 1 gram represents 1 calorie). The finished mixture is served to the dogs in suitable calorie portions.

<sup>2</sup> Commercial casein leached for a week in daily changes of acidulated water, after McCollum (15).

<sup>3</sup> After Osborne and Mendel (16).

TABLE 5.—Composition of cowpea diet No. 286<sup>1</sup>

[Total calories, 2,400]

Articles of diet	Quantity	Nutrients		
		Protein	Fat	Carbo- hydrate
	Grams	Grams	Grams	Grams
Cowpeas ( <i>Vigna sinensis</i> ).....	360	77.0	5.0	218.9
Casein (purified) <sup>2</sup> .....	60	53.2	.3	-----
Sucrose.....	30	-----	-----	30.0
Cornstarch.....	80	-----	-----	72.0
Cottonseed oil.....	46	-----	46.0	-----
Cod-liver oil.....	15	-----	15.0	-----
Salt mixture <sup>3</sup> .....	15	-----	-----	-----
Total nutrients.....	-----	130.2	66.3	320.9
Nutrients per 1,000 calories.....	-----	54.25	27.62	133.7

<sup>1</sup> The cowpeas (previously coarsely ground), sucrose, and starch were stirred into water and cooked about 1½ hours. Then the other ingredients are well stirred in and the final weight is brought to 2,400 grams with water (so that 1 gram represents 1 calorie). The mixture is served to the dog in suitable calorie portions.

<sup>2</sup> Commercial casein leached for a week in daily changes of acidulated water, after McCollum (15).

<sup>3</sup> After Osborne and Mendel (16).

TABLE 6.—Composition of cowpea diet No. 299<sup>1</sup>

[Total calories, 2,400]

Articles of diet	Quantity	Nutrients		
		Protein	Fat	Carbo- hydrate
	Grams	Grams	Grams	Grams
Cowpeas ( <i>Vigna sinensis</i> ).....	450	96.3	6.3	273.6
Casein (purified) <sup>2</sup> .....	60	53.2	.3	-----
Cornstarch.....	30	-----	-----	27.0
Cottonseed oil.....	45	-----	45.0	-----
Cod-liver oil.....	15	-----	15.0	-----
Salt mixture <sup>3</sup> .....	15	-----	-----	-----
Total nutrients.....	-----	149.5	66.6	300.6
Nutrients per 1,000 calories.....	-----	62.2	27.7	125.2

<sup>1</sup> The cowpeas (previously coarsely ground) and cornstarch are stirred into water and cooked about 1½ hours. Then the other ingredients are well stirred in and the final weight is brought to 2,400 grams with water (so that 1 gram represents 1 calorie). The mixture is served to the dog in suitable calorie portions.

<sup>2</sup> Commercial casein leached for a week in daily changes of acidulated water, after McCollum (15).

<sup>3</sup> After Osborne and Mendel (16).

TABLE 7.—Composition of soy-bean diet No. 110<sup>1</sup>

[Total calories, 2,260]

Articles of diet	Quantity	Nutrients		
		Protein	Fat	Carbo- hydrate
	Grams	Grams	Grams	Grams
Soy beans <sup>2</sup> .....	85	31.0	14.9	26.2
Cornmeal <sup>3</sup> .....	200	16.8	9.4	148.0
Wheat farina (Quaker brand).....	100	11.4	1.0	75.0
Rice (white).....	28	2.2	.0	22.1
Cowpeas ( <i>Vigna sinensis</i> ).....	14	3.0	2.0	8.5
Cornstarch.....	35	-----	-----	31.5
Cottonseed oil.....	42	-----	42.0	-----
Cod-liver oil.....	15	-----	15.0	-----
Sodium chloride.....	10	-----	-----	-----
Calcium carbonate.....	3	-----	-----	-----
Tomato juice (canned tomatoes).....	130	-----	-----	-----
Total nutrients.....	-----	64.4	84.3	311.3
Nutrients per 1,000 calories.....	-----	28.5	37.3	137.7

<sup>1</sup> The soy beans (previously coarsely ground) are soaked in water over night, then cooked 30 minutes, after which the maize meal, farina, rice, cowpeas (coarsely ground), cornstarch, and sodium chloride are stirred in and this mixture is cooked about 1½ hours, after which the other ingredients are well stirred in and the final weight is brought to 2,500 grams with water. This finished mixture is served to the dog in suitable calorie portions.

<sup>2</sup> Mammoth yellow variety.

<sup>3</sup> Whole maize meal, sifted as for human consumption.



TABLE 8.—*Composition of soy-bean diet No. 287<sup>1</sup>*

[Total calories, 2,400]

Articles of diet	Quantity	Nutrients		
		Protein	Fat	Carbo- hydrate
	Grams	Grams	Grams	Grams
Soy beans <sup>1</sup> .....	360	13.4	63.0	110.9
Cornstarch.....	224			202.0
Cod-liver oil.....	6		6.0	
Salt mixture <sup>2</sup> .....	15			
Total nutrients.....		131.4	69.0	312.9
Nutrients per 1,000 calories.....		54.8	28.8	130.4

<sup>1</sup> The soy beans are coarsely ground and soaked in water over night. The starch is then added and, with the soy beans, cooked about 2 hours. After this the other ingredients are well stirred in and the final weight is brought to 2,400 grams with water (so that 1 gram represents 1 calorie). The finished mixture is served to the dog in suitable calorie portions.

<sup>2</sup> The mammoth yellow variety.

<sup>3</sup> After Osborne and Mendel (16).

TABLE 9.—*Composition of cod-liver-oil diet No. 114<sup>1</sup> and of Milledgeville butterfat diet No. 115<sup>1</sup>*

[Total calories, 2,410]

Articles of diet	Quantity	Nutrients		
		Protein	Fat	Carbo- hydrate
	Grams	Grams	Grams	Grams
Cornmeal <sup>2</sup> .....	200	16.8	9.4	148.0
Wheat farina (Quaker brand).....	100	11.4	1.0	75.0
Rice, white.....	28	2.2		22.1
Cowpeas ( <i>Vigna sinensis</i> ).....	14	3.0	2.0	8.5
Cod-liver oil <sup>3</sup> (for diet No. 114).....	128		128.0	
Butterfat <sup>3</sup> (for diet No. 115).....				
Sodium chloride.....	10			
Calcium carbonate.....	3			
Tomato juice (canned tomatoes).....	130			
Total nutrients.....		33.4	140.4	253.6
Nutrients per 1,000 calories.....		13.8	58.3	105.2

<sup>1</sup> The maize meal, wheat farina, rice, cowpeas (previously coarsely ground), and sodium chloride are stirred into water and cooked about 1½ hours. Then the other ingredients are well stirred in and the total weight is brought to 2,000 grams with water. The finished mixture is served to the dog in suitable calorie portions.

<sup>2</sup> Whole white maize meal, sifted as for human consumption.

<sup>3</sup> For origin see text.

TABLE 10.—*Composition of Beltsville butter diet No. 115B<sup>1</sup>*

[Total calories, 2,415]

Articles of diet	Quantity	Nutrients		
		Protein	Fat	Carbo- hydrate
	Grams	Grams	Grams	Grams
Corn meal <sup>2</sup> .....	200	16.8	9.4	148.0
Wheat farina (Quaker brand).....	100	11.4	1.0	75.0
Rice, white.....	28	2.2		22.1
Cowpeas ( <i>Vigna sinensis</i> ).....	14	3.0	2.0	8.5
Beltsville butter <sup>3</sup> .....	160	1.6	128.0	
Sodium chloride.....	10			
Calcium carbonate.....	3			
Tomato juice (canned tomatoes).....	130			
Total nutrients.....		35.0	140.4	253.6
Nutrients per 1,000 calories.....		14.4	58.0	104.8

<sup>1</sup> The maize meal, wheat farina, rice, cowpeas (previously coarsely ground), and sodium chloride are stirred into water and cooked about 1½ hours. Then the other ingredients are well stirred in and the total weight is brought to 2,000 grams with water. The finished mixture is served to the dog in suitable calorie portions.

<sup>2</sup> Whole white maize meal, sifted as for human consumption.

<sup>3</sup> For origin see text.

TABLE 11.—*Composition of butterfat diets No. 180A<sup>1</sup>, No. 180B<sup>1</sup>, and No. 180C<sup>1</sup>*

[Total calories, 2,400]

Articles of diet	Quantity	Nutrients		
		Protein	Fat	Carbo-hydrate
	Grams	Grams	Grams	Grams
Corn meal <sup>2</sup> .....	300	25.4	14.1	222.0
Wheat germ (ether-extracted).....	25	7.3	-----	15.7
Casein (purified) <sup>3</sup> .....	32	23.0	-----	-----
Milledgeville butterfat (in diet No. 180A).....	115	-----	115.0	-----
Vermont butterfat (in diets No. 180B and No. 180C).....			-----	-----
Cod-liver oil.....	5	-----	5.0	-----
Salt mixture <sup>4</sup> .....	18	-----	-----	-----
Tomato juice (in diets No. 180A and No. 180B only).....	130	-----	-----	-----
Total nutrients.....	-----	60.7	134.1	237.7
Nutrients per 1,000 calories.....	-----	25.2	55.8	99.0

<sup>1</sup> The maize meal and wheat germ are stirred into water and cooked about 1½ hours. Then the other ingredients are well stirred in (omitting the tomato juice in the case of diet No. 180C) and the final weight is brought to 2,400 grams with water (so that 1 gram represents 1 calorie). The mixture is served to the dog in suitable calorie portions.

<sup>2</sup> Whole white maize meal sifted as for human consumption.

<sup>3</sup> Commercial casein leached for a week in daily changes of acidulated water, after McCollum (15).

<sup>4</sup> After Osborne and Mendel (16).

TABLE 12.—*Composition of cottonseed oil diet No. 302<sup>1</sup>*

[Total calories, 2,400]

Articles of diet	Quantity	Nutrients		
		Protein	Fat	Carbo-hydrate
	Grams	Grams	Grams	Grams
Corn meal <sup>2</sup> .....	310	23.3	13.0	204.0
Casein (purified) <sup>3</sup> .....	80	72.5	.5	-----
Cottonseed oil (Wesson oil).....	110	-----	110.0	-----
Cod-liver oil.....	10	-----	10.0	-----
Salt mixture <sup>4</sup> .....	21	-----	-----	-----
Total nutrients.....	-----	95.8	133.5	204.0
Nutrients per 1,000 calories.....	-----	39.9	55.6	85.0

<sup>1</sup> The maize meal and salt mixture are stirred into water and cooked 1½ hours. The other ingredients are then well stirred in and the final weight is brought to 2,400 grams with water (so that 1 gram represents 1 calorie). The mixture is served to the dog in suitable calorie portions.

<sup>2</sup> Whole white maize meal, not sifted.

<sup>3</sup> Commercial casein leached for a week in daily changes of acidulated water, after McCollum (15).

<sup>4</sup> After Osborne and Mendel (16).

TABLE 13.—*Composition of beef diets No. 196,<sup>1</sup> No. 196A,<sup>1</sup> and No. 196B<sup>2</sup>*

[Total calories, 2,400]

Articles of diet	Quantity	Nutrients		
		Protein	Fat	Carbo-hydrate
	Grams	Grams	Grams	Grams
Corn meal <sup>3</sup> .....	400	33.6	18.8	296.0
Cowpeas ( <i>Vigna sinensis</i> ).....	50	10.7	.7	30.4
Beef muscle: <sup>4</sup>				
Fresh for diet No. 196.....	233	52.3	6.8	-----
Dried for diets No. 196A and No. 196B.....	64			
Sucrose.....	32	-----	-----	32.0
Cottonseed oil.....	23	-----	23.0	-----
Cod-liver oil.....	15	-----	15.0	-----
Sodium chloride.....	10	-----	-----	-----
Calcium carbonate.....	3	-----	-----	-----
Total nutrients.....	-----	96.6	64.3	358.4
Nutrients per 1,000 calories.....	-----	40.2	26.7	149.3

<sup>1</sup> The maize meal, cowpeas (previously coarsely ground), and sodium chloride are stirred into water and cooked about 1½ hours. Then the other ingredients are well stirred in and the total weight is brought to 2,400 grams with water (so that 1 gram represents 1 calorie). This finished mixture is served to the dog in suitable calorie portions.

<sup>2</sup> In preparing diet No. 196B, the dried beef is cooked with the maize meal, cowpeas, and salt. In all other respects the preparation is as for diets No. 196 and No. 196A.

<sup>3</sup> Whole white maize meal sifted as for human consumption.

<sup>4</sup> Lean round steak. For preparation see text.

TABLE 14.—Composition of pork liver diet No. 292<sup>1</sup>

[Total calories, 2,400]

Articles of diet	Quantity	Nutrients		
		Protein	Fat	Carbo- hydrate
	Grams	Grams	Grams	Grams
Pork liver (dried) <sup>2</sup> .....	64	43.5	7.8	4.7
Corn meal <sup>3</sup> .....	400	33.6	18.8	296.0
Cowpeas ( <i>Vigna sinensis</i> ).....	50	10.7	.7	30.4
Casein (purified) <sup>4</sup> .....	10	8.9	.....	.....
Sucrose.....	25	.....	.....	25.0
Cottonseed oil.....	26	.....	26.0	.....
Cod-liver oil.....	12	.....	12.0	.....
Sodium chloride.....	10	.....	.....	.....
Calcium carbonate.....	3	.....	.....	.....
Total nutrients.....	.....	96.7	65.3	356.1
Nutrients per 1,000 calories.....	.....	40.2	27.2	148.3

<sup>1</sup> The dried pork liver, maize meal, cowpeas (coarsely ground), cottonseed oil, and sodium chloride are stirred into water and cooked about 1½ hours. Then the other ingredients are well stirred in and the final weight of the mixture is brought to 2,400 grams with water (so that 1 gram represents 1 calorie). This finished mixture is served to the dog in suitable calorie portions.

<sup>2</sup> For method of preparation see text.

<sup>3</sup> Whole white maize meal sifted as for human consumption.

<sup>4</sup> Commercial casein leached for a week in daily changes of acidulated water, after McCollum (15).

TABLE 15.—Composition of canned chum salmon diet No. 294<sup>1</sup>

[Total calories, 2,400]

Articles of diet	Quantity	Nutrients		
		Protein	Fat	Carbo- hydrate
	Grams	Grams	Grams	Grams
Canned chum salmon <sup>2</sup> .....	300	64.4	22.2	.....
Cornmeal <sup>3</sup> .....	400	33.6	18.8	296.0
Cowpeas ( <i>Vigna sinensis</i> ).....	50	10.7	.7	30.4
Sucrose.....	17	.....	.....	17.0
Cottonseed oil.....	12	.....	12.0	.....
Cod-liver oil.....	12	.....	12.0	.....
Sodium chloride.....	10	.....	.....	.....
Calcium carbonate.....	3	.....	.....	.....
Total nutrients.....	.....	108.7	65.7	343.4
Nutrients per 1,000 calories.....	.....	45.2	27.3	143.0

<sup>1</sup> The maize meal, cowpeas (coarsely ground), and sodium chloride are stirred into water and cooked about 1½ hours. The other ingredients are then well stirred in and the final weight is brought to 2,400 grams with water (so that 1 gram represents 1 calorie). This finished mixture is served to the dog in suitable calorie portions.

<sup>2</sup> The entire contents of the can are used.

<sup>3</sup> Whole white maize meal, sifted as for human consumption.

TABLE 16.—Composition of egg yolk diet No. 293B<sup>1</sup>

[Total calories, 2,400]

Articles of diet	Quantity	Nutrients		
		Protein	Fat	Carbo- hydrate
	Grams	Grams	Grams	Grams
Egg yolk (dried) <sup>2</sup> .....	100	33.9	60.9	.....
Corn meal <sup>3</sup> .....	400	33.6	18.8	296.0
Cowpeas ( <i>Vigna sinensis</i> ).....	50	10.7	.7	30.4
Casein (purified) <sup>4</sup> .....	15	13.3	.....	.....
Sodium chloride.....	10	.....	.....	.....
Calcium carbonate.....	3	.....	.....	.....
Total nutrients.....	.....	91.5	80.4	326.4
Nutrients per 1,000 calories.....	.....	38.1	33.5	136.0

<sup>1</sup> The dried egg yolk, maize meal, cowpeas (coarsely ground), and sodium chloride are stirred into water and cooked for about 1½ hours. Then the other ingredients are well stirred in and the final weight is brought to 2,400 grams with water (so that 1 gram represents 1 calorie). This food mixture is served to the dog in suitable calorie portions.

<sup>2</sup> For method of preparation see text.

<sup>3</sup> Whole white maize meal sifted as for human consumption.

<sup>4</sup> Commercial casein leached for a week in daily changes of acidulated water, after McCollum (15).

## PUBLIC HEALTH ENGINEERING ABSTRACTS

**German Developments in Refuse Disposal.** John H. D. Blanke. *The American City*, vol. 38, No. 2, February, 1928, pp. 87-89. (Abstract by J. B. Harrington.)

The developments of refuse disposal in Germany since 1893 are set forth briefly in this article. The shaft furnace in which heavy layers of refuse are burned was first developed at Hamburg. Other recent and successful developments are the removal of combustion residues by machinery, and, in 1925, the installation of fire-tube boilers in combination with the furnace unit. At the Hamburg plant, consisting of 12 furnace units, four of which are equipped with fire-tube boilers, one of the units was replaced with a furnace provided with a grate-residue remover and a vertical-tube boiler. Tests on this unit indicate that it will handle 80 tons of refuse per 24 hours, as compared to 30 tons per 24 hours for the old units. Further successful developments along this line are an increased grate area, a slack-forming zone of water-cooled iron surface covered with stone, the vibrating or oscillating blower, and the air heater. Combustion usually lasts about 20 minutes. The flue gases pass through the ashing chamber, where they are burned further, and then successively through a fire-tube boiler, a flue chamber with steam superheater, two horizontal flue-tube boilers, a second flue chamber, electric filter, and chimney. The by-products of the plants are 45 to 50 per cent slack; 1 per cent old iron, 0.7 per cent magnetic slack, 5 to 20 per cent flying ash, 0.55 to 3.3 pounds steam per pound of refuse, 353 to 530 cubic feet of hot water at 122° F. in one hour from one furnace unit.

**House Refuse Collection,** E. H. Radcliffe. *The Surveyor*, vol. 73, No. 1888, March 30, 1928, pp. 375-376. (Abstract by H. N. Old.)

In this paper, presented at a recent meeting of the Royal Sanitary Institute held at Taunton, the various methods of house storage of refuse are discussed. The ash pit is a requirement in some jurisdictions, although the more common types of tubs, buckets, and boxes are in general use. The evils of curb-side collection are given and coincide with similar conditions in the United States.

The desirability of the collection from the rear of the premises is stressed, despite the factor of additional cost of this service. The author advocates a system of collection somewhat identical with the trailer method used rather generally throughout this country in the larger communities.

Another method described is that of yard collection, but allowing the loaders, usually two men, to carry the containers to the curb while the van goes to the disposal ground. In this way much time is saved and the loaders can usually judge the number of premises they may serve while waiting for the return of the van to pick up the material lined up at the curb.

At Taunton the town is divided into 15 districts, and three electric vehicles and a 30-hundredweight "Morris lorry" are used for curb-side collection. The schedule for a week is given as example of the system and indicates that the collection of refuse and scavenging is taken care of by the same outfits by systematic apportionment of the time.

**Refuse Disposal as a Factor in National Economy.** F. D. Ogden. *The Journal of the Institution of Municipal and County Engineers*, vol. 54, No. 15, January 24, 1928, pp. 971-979. (Abstract by Harriet S. Ryan.)

Salvage operations properly conducted attain the object of definitely disposing, in a hygienic manner, of objectionable refuse, and, in addition, open up an appreciable source of revenue. Tipping and other insanitary methods of disposing of refuse are fast passing, giving place to the refuse destructor. Refuse is not actually destroyed, but merely changed in form so as to be rendered innocuous. It is the salvage of refuse so dealt with which has prompted the

writer to make these notes. He quotes the law relating to scavenging in general as set out in the public health act of 1875. He endeavors to encourage interest in the subject by means of examples of the various residuals it is possible to obtain from the average refuse of a town of 30,000 inhabitants.

Before embarking upon a salvaging scheme, it is necessary to institute tests to ascertain the average amount of the various components, which vary considerably according to locality, season, etc. The refuse is sorted and the salable material is sent to the necessary salvage plant, while all which should be burned is committed to the furnace. Every available particle of refuse is utilized.

In following the various materials to the respective salvage plants and indicating the possibilities of salvage, the writer reviews that aspect of scavenging dealing with the ultimate disposal of refuse in such a manner as to obviate some of this waste by its utilization, in changed form, for various purposes.

**Water Supply, Sewage Treatment, and Refuse Disposal in 1927.** H. B. Cleveland. *Public Works*, vol. 59, No. 1, January, 1928. pp. 14-18. (Abstract by R. J. Faust.)

*Refuse disposal.*—The trend has been almost wholly to construct incinerators rather than build reduction plants or develop hog farms.

The Buffalo, Los Angeles, Toledo, Birmingham, Philadelphia, and New York City incinerator installations have been the more recent notable plants. At Cleveland a reduction plant is being planned, and at Indianapolis the reduction plant started operation within the year.

**Treatment of Packing-Plant Wastes.** Frederick G. Nelson. *The Canadian Engineer*, vol. 53, No. 25, December 20, 1927, pp. 627-629. (Abstract by R. E. Thompson.)

A description of the activated sludge plant operated by the Iowa State College Engineering Experiment Station at the packing works of J. E. Decker & Son, Mason, Iowa, with an outline of operating experiences. The plant consists of a Dorco rotary screen, primary settling tank, two aeration tanks, secondary settling tank, and a sludge reeration tank. Both settling tanks are of the Dorr type, equipped with thickeners. The average hourly flow varied from 200-490 gallons per minute, dropping to 125 gallons per minute on Sundays. During periods of low flow, difficulties were experienced, due to the primary settling tanks becoming septic, this condition giving rise to disturbances in the purification process. With a sludge return of 50 gallons per minute, the theoretical detention period in the sludge reeration tank is five and one-half hours. This tank, which was installed after the plant had been in operation some time, has effected a great improvement. The short period of aeration has little effect, however, when the sludge is septic. Increasing sludge return to 150 gallons per minute by returning sludge directly to the aeration tank during low flow periods has been found to facilitate the building up of a large amount of sludge for use when the flow increases.

One of the most troublesome factors encountered has been the rising of sludge in the final settling tank. This occurs when the sludge is under or over aerated or slightly septic. Applying a continuous spray of water to the scum formed has been partially successful in causing the sludge to resettle. Carefully controlling the air supply is the best method of combating this condition.

On some days extreme foaming has occurred in the aeration tanks, the foam at times covering the tanks to a depth of 6 feet and the ground to depth of 1 to 4 feet for a distance of 50 feet. Foaming apparently occurs at certain intervals when the tanks are changing from an underaerated to a fully aerated condition. Probably the most effective remedy would be either the use of oil in the tanks or the application of a flat, horizontal spray of water which would tend to cut the foam.

To correct unequal distribution of air, the tanks were dewatered and cleaned. A heavy deposit of sand and organic matter was found on the entire bottom of the aeration tanks to a depth of 4-6 inches. The filtros plates were cleaned by scrubbing, soaking in hydrochloric acid (specific gravity 1.14), and finally washing with hot water applied through a nozzle under pressure. The method employed for testing the loss of head through the plates before replacing them is outlined.

Experiments have been carried out on dewatering the sludge with an American continuous filter. The primary sludge, which contains 6 per cent dry solids, when treated with 10 pounds of alum per 1,000 gallons, filters readily to 71 per cent moisture. A few determinations have indicated an erratic solid content in the activated sludge varying from 0.25 to 1.5 per cent. A mixture of 75 per cents activated and 25 per cent primary sludge treated with 5 pounds of alum per 1,000 gallons gave a cake with 75 per cent moisture or a little higher. A few tests with ferric chloride also gave good results, but the moisture content of the cake was somewhat higher. The mixture of sludges filters more rapidly than the ordinary sludge alone. It is not expected that the plant will be able to treat successfully the wastes during the approaching peak of the killing season.

**Water Pollution Control: Cannery Wastes.** Homer S. Murphy, J. M. Hepler, and E. F. Eldridge. A Compilation Covering Activities, Experimental Work and Cooperative Investigations as Conducted by the Department of Conservation, Department of Health and the Michigan Canners Association. 18 pages. (Abstract by D. S. Abell.)

The first section of this pamphlet mentions the history of experimental work on canning-factory waste. Previous work done in Michigan was summarized in the statement, "The biological process might be slower than the chemical treatment process, but past experiments indicate that it could be operated efficiently and at less expense." Since 1925 Michigan has had a law which makes it "the duty of the Department of Conservation; \* \* \* to guard against the pollution of lakes and streams within the State and to enforce all laws provided for that purpose with all authority granted by law and to foster and encourage the protecting and propagation of game and fish." Previous investigations at the following places are each reviewed: New Jersey, 1910; Washington, Ill., 1913; Fremont, Mich., Amelia, Ohio, 1916; Columbus, Ohio, Brockport, N. Y., and Poynette, Wis., 1916. Next follows a condensed report of the operation of the Michigan Canners Association experimental waste treatment plant located at the W. R. Roach & Co.'s plant at Kent City. Members of the association voted to assess themselves a sum of 0.2 of a cent per can based on the 1925 pack for the purpose of studying the problem. The plant consisted of fine screens, "which every canning plant should have," settling tanks, one of which could be used for digestion; and filter beds of different types. Sprinkling filters gave quite satisfactory results. The intermittent sand filters, however, showed a tendency to form a hard crust. Cinder filters will be abandoned. The small amount of sludge obtained indicates the possibility of supplanting the tanks with fine screens. A grit chamber may help. A portable plant is planned. It is hoped that after the next (1927) season definite recommendations can be made to the industry with reference to treatment of all canning wastes.

**Sprinkling Filter Planned for Expansion.** Henry R. Buck. *The American City*, vol. 38, No. 2, February, 1928, pp. 107-108. (Abstract by J. B. Harrington.)

Watertown, Conn., has an area of 18,750 acres; population of the town is 6,000, and of the district 2,000. The wastes to be treated are almost entirely of domestic nature. The plant is designed to handle 200,000 gallons per day, with an ultimate flow of 500,000 gallons. The tank with two units each 20 by 39

feet, 8 inches square, has been constructed. Each unit has an 8-inch sludge line. The total sludge capacity is 11,880 cubic feet, or 5.9 cubic feet per capita. Gas vents are a minimum width of 1 foot 6 inches, giving 30 per cent of the total area. Each tank has two flow chambers, with a minimum capacity of 9,750 gallons. The retention period when all chambers are in use is  $2\frac{1}{4}$  hours. Two grit chambers each 5 feet 2 inches by 2 feet 6 inches by 7 feet deep with removable racks, have been constructed at the end of the 20-inch line. The sludge bed was built in two sections, each with 2,175 square feet area. Two siphon chambers operating on 8.7-foot head have been provided. The sprinkling filters, only one of which has been constructed, are 110 feet by 75 feet 3 inches, with  $\frac{1}{8}$ -inch nozzles on 13-foot centers. During the winter months construction was carried on by the use of calcium chloride. The cost of the treatment plant was \$80,000, and the cost of 17,964 feet of sewer was \$75,000.

**The Administration of the Milk and Dairies Order, 1926.** W. O. Coates. *Journal Royal Sanitary Institute*, vol. 48, No. 8, February, 1928, pp. 462-469. (Abstract by H. A. Whittaker.)

This article gives a general discussion of the administration of the Milk and Dairies Order of England (passed in 1926) which regulates dairy premises and their supervision by the sanitary authority.

For purposes of administration, the author makes several divisions of the order as follows: (1) The two administrative authorities; (2) the administrative officers; i, e., the veterinary inspector, the medical officer of health, and the sanitary inspector. Divisions may be formed for grouping the duties of these authorities and officers; (3) the sanitary inspector being responsible for the administration of the greater portion of the order, this portion is divided to emphasize his varied duties, thus: (a) Office administration, (b) general routine dairy requirements, (c) special requirements applicable to cow keepers, (d) constructional requirements, (e) distributional routine requirements.

Only the topics contained under No. 3 are taken up in this paper. The author outlines the various requirements and gives a brief interpretation and discussion of each. Brief discussions of certain parts of the order by persons interested in its administration are appended to the article.

**Connecticut Standard Test for Dirt in Milk.** Friend Lee Mickle. *Connecticut Health Bulletin*, vol. 42, No. 2, February, 1928, pp. 27-30. (Abstract by W. H. Haskell.)-

The author points out that the standard disks prepared according to the Standard Methods of Milk Analysis of the American Public Health Association were found to be inadequate as a guide for Connecticut. Laboratory results from various State laboratories were not uniform with results of tests. Standard Methods is also criticized for not specifying certain specific apparatus to be used in making the test. It is also stated that the sizes of the particles of dirt on the different standards varied greatly, and that the kind of dirt used in different laboratories varied in color to a greater extent than had previously been thought possible. An additional photograph of disks has been adopted (in addition to photographs shown on page 33 of fifth edition of Standard Methods) showing 0.25, 0.50, 0.75, and 1 milligram of dirt per pint and the Wisconsin or Lorenz model of sediment tester chosen as the standard. The exact method of carrying out the adopted test is included in the article.

**The Purification of Contaminated Oysters in Natural Waters.** Charles Krumwiede, William H. Park, Georgia Cooper, Marie Grund, Charles Tyler, and Carolyn Rosenstein. *American Journal of Public Health*, vol. 18, No. 1, January, 1928, pp. 48-52. (Abstract by F. O. Almquist.)

An interesting article on the investigation of the cleansing effect of changing sea water on contaminated oysters. Two lots of freshly dredged oysters were

obtained, one lot from waters where the experiment was to be carried out and the other from distant waters. Each lot was equally divided, one batch of each lot being lightly contaminated and the other heavily contaminated. They were then placed in the natural water for the test. The area in which the tests were made was located near condemned oyster beds. The viability of *B. typhosus* in sea water was also determined.

From the tables compiled it was shown that *B. typhosus* survives roughly 2 to 3 weeks in oysters and 3 weeks in sea water.

It is believed that contaminated oysters transferred to new water would require for purification about the same time equal to the length of time of survival of *B. typhosus* in sea water. It is then concluded that an ordinance allowing the transfer of oysters from questionable to clean waters providing no dredging be allowed for four weeks after the transfer would give a good margin of safety.

**An Investigation into the Effect of Pasteurization on the Bovine Tubercle Bacillus in Naturally Infected Tuberculous Milks.** L. J. Meanwell. *The Journal of Hygiene*, vol. 26, No. 4, October, 1927, pp. 392-402. (Abstract by W. D. Tiedeman.)

Results obtained by other workers in studying the effect of Pasteurization upon the tubercle bacillus in milk, either naturally or artificially infected, are reviewed. The author points out that apparent differences may be due in part to a greater virulence of the organisms in naturally infected milk. He also considers the possibility of latent infections, and in his experimental work kept guinea pigs 100 days or more.

He Pasteurized separately, in special laboratory apparatus designed to heat every particle of the milk to a uniform and accurately determined temperature, the naturally infected milk from 3 cows known to be suffering from tuberculosis of the udder. The milk from cow No. 1 was abnormal in appearance, a flocculent mass separating out on standing. The milk from the other two cows was normal, although slightly darker in color at times.

The centrifugalized deposit and cream from Pasteurized, naturally infected milk was injected into guinea pigs with the following results: Two pigs out of 284 injected developed tuberculosis with milk treated at 145° F. for 30 minutes, 140° F. for 30 minutes, and 140° F. for 20 minutes, respectively, whereas 10 pigs out of 12 injected developed tuberculosis with milk treated at 138.8° F. for 20 minutes. Coagulated material collecting on the cooler in some of the experiments was ground up with saline and injected into guinea pigs with the following results: Two pigs out of 44 injected developed tuberculosis with material from milk treated at 145° F. for 30 minutes and at 140° F. for 20 minutes. None of the 6 pigs injected with this material from milk treated at 138.8° F. for 20 minutes developed tuberculosis.

The author mentions collecting control samples, but gives no results, leaving an open question as to the significance of the large number of negative results obtained with Pasteurized milk.

## DEATHS DURING WEEK ENDED MAY 26, 1928

*Summary of information received by telegraph from industrial insurance companies for the week ended May 26, 1928, and corresponding week of 1927. (From the Weekly Health Index, May 31, 1928, issued by the Bureau of the Census, Department of Commerce)*

	Week ended May 26, 1928	Corresponding week, 1927
Policies in force.....	71, 266, 788	67, 772, 503
Number of death claims.....	15, 183	11, 919
Death claims per 1,000 policies in force, annual rate	11. 1	9. 2



*Deaths from all causes in certain large cities of the United States during the week ended May 26, 1928, infant mortality, annual death rate, and comparison with corresponding week of 1927. (From the Weekly Health Index, May 31, 1928, issued by the Bureau of the Census, Department of Commerce)*

City	Week ended May 26, 1928		Annual death rate per 1,000 corresponding week 1927	Deaths under 1 year		Infant mortality rate, week ended May 26, 1928 <sup>2</sup>
	Total deaths	Death rate <sup>1</sup>		Week ended May 26, 1928	Corresponding week 1927	
Total (67 cities) .....	7,959	13.9	12.5	800	731	65
Akron .....	39			3	4	33
Albany <sup>3</sup> .....	37	16.1	11.3	5	4	102
Atlanta .....	72	14.8	15.7	7	5	
White .....	32		11.9	1	1	
Colored .....	40	( <sup>4</sup> )	24.7	6	4	
Baltimore <sup>3</sup> .....	218	13.7	11.7	26	18	83
White .....	159		10.1	19	10	76
Colored .....	59	( <sup>4</sup> )	21.2	7	8	110
Birmingham .....	82	19.3	14.6	10	8	86
White .....	37		12.2	1	4	14
Colored .....	45	( <sup>4</sup> )	18.5	9	4	203
Boston .....	250	16.4	13.4	38	38	105
Bridgeport .....	29			4	2	73
Buffalo .....	154	14.5	13.9	24	14	103
Cambridge .....	41	17.0	9.7	2	1	36
Camden .....	37	14.3	14.5	2	5	32
Canton .....	24	10.7	11.0	2	3	48
Chicago <sup>3</sup> .....	746	12.4	12.5	71	79	61
Cincinnati .....	160	20.2	13.8	18	8	109
Cleveland .....	240	12.4	9.9	16	20	43
Columbus .....	84	14.8	10.9	6	3	56
Dallas .....	46	11.1	13.6	5	10	
White .....	38		12.2	5	7	
Colored .....	8	( <sup>4</sup> )	22.8	0	3	
Denver .....	89	15.8	12.1	9	4	
Des Moines .....	38	13.1	11.6	2	1	33
Detroit .....	318	12.1	12.5	37	52	57
Duluth .....	32	14.3	11.4	2	1	47
El Paso .....	35	15.5	11.5	10	4	
Erie .....	34			4	3	82
Fall River <sup>3</sup> .....	38	14.8	13.4	0	5	0
Flint .....	33	11.6	10.6	8	5	102
Fort Worth .....	26	8.1	8.9	3	6	
White .....	19		8.7	1	5	
Colored .....	7	( <sup>4</sup> )	10.6	2	1	
Grand Rapids .....	27	8.6	11.6	0	6	0
Houston .....	63			12	6	
White .....	41			6	3	
Colored .....	22	( <sup>4</sup> )		6	3	
Indianapolis .....	96	13.1	12.7	9	4	69
White .....	82		12.2	7	4	61
Colored .....	14	( <sup>4</sup> )	16.3	2	0	121
Jersey City .....	92	14.8	10.4	10	7	75
Kansas City, Kans. ....	26	11.5	11.1	1	2	21
White .....	20		10.8	1	1	25
Colored .....	6	( <sup>4</sup> )	12.3	0	1	0
Kansas City, Mo. ....	100	13.4	16.1	9	17	64
Knoxville .....	38	18.9	15.3	5	5	109
White .....	32		10.4	5	2	121
Colored .....	6	( <sup>4</sup> )	51.3	0	3	0
Los Angeles .....	239			21	29	60
Lowell .....	44	20.9	12.3	5	2	105
Lynn .....	32	15.9	12.4	2	1	50
Memphis .....	73	20.1	17.2	9	4	105
White .....	40		13.1	7	3	131
Colored .....	33	( <sup>4</sup> )	24.7	2	1	63
Milwaukee .....	122	11.7	11.2	21	19	94
Minneapolis .....	92	10.6	10.8	13	7	78
Nashville .....	41	15.5	18.5	2	0	31
White .....	19		14.8	1	0	21
Colored .....	22	( <sup>4</sup> )	28.1	1	0	60
New Bedford .....	28	12.2	8.7	4	5	87

<sup>1</sup> Annual rate per 1,000 population.

<sup>2</sup> Deaths under 1 year per 1,000 births. Cities left blank are not in the registration area for births.

<sup>3</sup> Deaths for week ended Friday, May 25, 1928.

<sup>4</sup> In the cities for which deaths are shown by color, the colored population in 1920 constituted the following percentages of the total population: Atlanta, 31; Baltimore, 15; Birmingham, 39; Dallas, 15; Fort Worth, 14; Houston, 25; Indianapolis, 11; Kansas City, Kans., 14; Knoxville, 15; Memphis, 38; Nashville, 30; New Orleans, 26; Richmond, 32; Washington, D. C., 25.

*Deaths from all causes in certain large cities of the United States during the week ended May 26, 1928, infant mortality, annual death rate, and comparison with corresponding week of 1927. (From the Weekly Health Index, May 31, 1928, issued by the Bureau of the Census, Department of Commerce)—Continued*

City	Week ended May 26, 1928		Annual death rate per 1,000 corresponding week 1927	Deaths under 1 year		Infant mortality rate, week ended May 26 1923
	Total deaths	Death rate		Week ended May 26, 1928	Corresponding week 1927	
New Haven.....	48	13.4	13.8	3	3	42
New Orleans.....	168	20.5	21.6	17	18	82
White.....	93		17.9	11	11	80
Colored.....	75	( <sup>1</sup> )	32.1	6	7	87
New York.....	1,671	14.5	11.7	174	136	70
Bronx borough.....	201	11.0	9.4	21	14	63
Brooklyn borough.....	578	13.1	10.7	53	50	53
Manhattan borough.....	665	19.8	15.9	85	58	101
Queens borough.....	172	10.5	7.6	9	11	36
Richmond borough.....	55	19.1	12.4	6	3	108
Newark, N. J.....	114	12.6	10.6	7	13	36
Oakland.....	70	13.4	9.0	5	3	54
Oklahoma City.....	41			1	3	
Omaha.....	65	15.3	10.7	5	2	58
Paterson.....	30	10.8	14.1	4	4	69
Philadelphia.....	521	13.2	11.6	49	36	66
Pittsburgh.....	218	17.0	14.4	27	20	88
Portland, Oreg.....	79			3	10	32
Providence.....	79	14.4	12.6	7	5	61
Richmond.....	44	11.8	14.4	5	3	65
White.....	25		11.9	2	2	41
Colored.....	19	( <sup>1</sup> )	20.6	3	1	110
Rochester.....	85	13.5	14.0	5	13	41
St. Louis.....	228	14.1	13.5	13	10	43
St. Paul.....	55	11.4	12.9	6	8	57
Salt Lake City <sup>2</sup> .....	25	9.5	10.4	4	2	65
San Antonio.....	87	20.9	16.3	19	16	
San Diego.....	37	16.2	21.7	1	1	19
San Francisco.....	150	13.4	13.5	9	11	57
Schenectady.....	19	10.6	12.3	2	4	63
Somerville.....	29	14.8	8.7	2	2	69
Spokane.....	31	14.9	18.2	1	3	26
Springfield, Mass.....	45	15.7	9.6	4	3	63
Syracuse.....	52	13.6	12.4	3	2	36
Tacoma.....	16	7.6	9.2	1	0	26
Toledo.....	89	14.9	15.2	7	13	67
Trenton.....	56	21.1	10.7	8	2	136
Utica.....	25	12.5	14.6	0	4	0
Washington, D. C.....	144	13.6	11.3	10	10	57
White.....	102		9.9	5	5	41
Colored.....	42	( <sup>1</sup> )	15.3	5	5	92
Waterbury.....	20			2	3	58
Wilmington, Del.....	31	12.6	9.1	4	3	105
Worcester.....	68	18.0	17.9	3	4	36
Yonkers.....	23	9.9	8.3	0	1	0
Youngstown.....	25	7.5	9.8	2	3	27

<sup>1</sup> Deaths for week ended Friday, May 25, 1928.

<sup>2</sup> In the cities for which deaths are shown by color, the colored population in 1920 constituted the following percentages of the total population: Atlanta, 31; Baltimore, 15; Birmingham, 39; Dallas, 15; Fort Worth, 14; Houston, 23; Indianapolis, 11; Kansas City, Kans., 14; Knoxville, 15; Memphis, 33; Nashville, 30; New Orleans, 26; Richmond, 32; Washington, D. C., 25.

# PREVALENCE OF DISEASE

*No health department, State, or local, can effectively prevent or control disease without knowledge of when, where, and under what conditions cases are occurring*

## UNITED STATES

### CURRENT WEEKLY STATE REPORTS

These reports are preliminary and the figures are subject to change when later returns are received by the State health officers

Reports for Weeks Ended June 2, 1928, and June 4, 1927

Cases of certain communicable diseases reported by telegraph by State health officers for weeks ended June 2, 1928, and June 4, 1927

Division and State	Diphtheria		Influenza		Measles		Meningococcus meningitis	
	Week ended June 2, 1928	Week ended June 4, 1927	Week ended June 2, 1928	Week ended June 4, 1927	Week ended June 2, 1928	Week ended June 4, 1927	Week ended June 2, 1928	Week ended June 4, 1927
<b>New England States:</b>								
Maine.....	10	1	8	3	78	36	0	0
New Hampshire.....					11		0	
Vermont.....					53	77	0	0
Massachusetts.....	50	80	102	3	720	331	2	2
Rhode Island.....	5	10			217	1	0	0
Connecticut.....	27	26	13	4	351	44	3	0
<b>Middle Atlantic States:</b>								
New York.....	287	427	153	112	4,133	1,025	22	9
New Jersey.....	142	111	10	1	1,796	96	7	1
Pennsylvania.....	126	168			2,781	791	5	1
<b>East North Central States:</b>								
Ohio.....	111		87		1,210		6	
Indiana.....	23	23	15	8	477	174	0	0
Illinois.....	117	124	153	34	268	754	13	10
Michigan.....	46	74	25	7	974	215	7	3
Wisconsin.....	15	18	237	14	57	938	2	9
<b>West North Central States:</b>								
Minnesota.....	17	19		2	74	83	4	3
Iowa.....	4	14			9	124	1	0
Missouri.....	21	28	12		425	114	16	0
North Dakota.....	1	2	12		9	20	0	0
South Dakota.....	3	2			210	72	0	0
Nebraska.....	11	5	2		37	116	0	0
Kansas.....	11	4	2	10	116	597	2	0
<b>South Atlantic States:</b>								
Delaware.....	2	3			38	8	0	0
Maryland.....	39	53	9	14	429	22	1	0
District of Columbia.....	14	16	1	2	215	4	0	0
Virginia.....								
West Virginia.....	10	12	204	17	72	165	2	0
North Carolina.....	13	14			439	1,564	0	0
South Carolina.....	11	9	421	289	231	213	0	0
Georgia.....	3	10	47	34	104	129	2	1
Florida.....	6	11	5	4	175	66	0	0

<sup>1</sup>New York City only.

<sup>2</sup>Week ended Friday.

*Cases of certain communicable diseases reported by telegraph by State health officers  
for weeks ended June 2, 1928, and June 4, 1927—Continued*

Division and State	Diphtheria		Influenza		Measles		Meningococcus meningitis	
	Week ended June 2, 1928	Week ended June 4, 1927	Week ended June 2, 1928	Week ended June 4, 1927	Week ended June 2, 1928	Week ended June 4, 1927	Week ended June 2, 1928	Week ended June 4, 1927
<b>East South Central States:</b>								
Kentucky.....	7				130		0	
Tennessee.....	10	5	103	24	117	32	1	1
Alabama.....	9	24	108	15	262	263	0	1
Mississippi.....	8	6						1
<b>West South Central States:</b>								
Arkansas.....	4	2	147	7	167	72	1	0
Louisiana.....	14	11	15	13	108	99	1	0
Oklahoma <sup>1</sup> .....	9	9	89	45	167	245	0	0
Texas.....	17	16	78	27	246	125	0	0
<b>Mountain States:</b>								
Montana.....	2	3	3		34	16	4	1
Idaho.....	3	2			10	37	1	1
Wyoming.....	1	3			12	65	0	0
Colorado.....		12				264		0
New Mexico.....	2	5			59	78	0	0
Arizona.....	1	1			9	22	0	0
Utah <sup>1</sup> .....	2	11	10		1	26	0	1
<b>Pacific States:</b>								
Washington.....	16	8			67	344	1	4
Oregon.....	5	7	3	7	38	221	0	0
California.....	74	117	29	12	90	927	3	8

Division and State	Poliomyelitis		Scarlet fever		Smallpox		Typhoid fever	
	Week ended June 2, 1928	Week ended June 4, 1927	Week ended June 2, 1928	Week ended June 4, 1927	Week ended June 2, 1928	Week ended June 4, 1927	Week ended June 2, 1928	Week ended June 4, 1927
<b>New England States:</b>								
Maine.....	1	0	25	15	0	0	4	2
New Hampshire.....	0	1	2		0		0	
Vermont.....	0	0	9	16	0	0	0	0
Massachusetts.....	4	3	178	340	0	0	4	4
Rhode Island.....	0	0	24	13	0	0	0	0
Connecticut.....	1	0	42	68	1	0	0	0
<b>Middle Atlantic States:</b>								
New York.....	1	0	432	619	3	7	3	18
New Jersey.....	0	0	165	240	0	0	1	5
Pennsylvania.....	1	1	344	432	15	1	11	27
<b>East North Central States:</b>								
Ohio.....	2		207		23		5	
Indiana.....	0	0	70	136	87	181	1	5
Illinois.....	1	2	231	194	70	23	4	9
Michigan.....	1	0	156	258	44	31	8	6
Wisconsin.....	0	2	170	116	19	21	42	0
<b>West North Central States:</b>								
Minnesota.....	1	8	89	157	3	1	3	7
Iowa.....	0	0	49	32	44	0	0	1
Missouri.....	0	0	116	52	33	17	1	6
North Dakota.....	0	0	23	36	0	1	2	1
South Dakota.....	0	0	26	23	18	6	0	0
Nebraska.....	0	1	55	28	24	13	0	0
Kansas.....	0	0	75	43	73	29	1	2
<b>South Atlantic States:</b>								
Delaware.....	0	0	2	5	0	0	0	0
Maryland <sup>1</sup> .....	3	0	55	24	3	0	4	11
District of Columbia.....	0	0	45	10	0	2	2	1
Virginia.....						1		
West Virginia.....	0	0	20	26	17	26	7	15
North Carolina.....	1	0	37	10	40	27	8	24
South Carolina.....	0	2	7	3	1	12	39	73
Georgia.....	0	0	15	11	0	23	13	65
Florida.....	2	0	4	6	1	70	18	21
<b>East South Central States:</b>								
Kentucky.....	0		38		18		2	
Tennessee.....	0	0	11	9	23	9	11	22
Alabama.....	1	0	6	6	23	29	14	39
Mississippi.....	0	0	5	5	5	4	8	11

<sup>1</sup> Week ended Friday.<sup>2</sup> Exclusive of Tulsa.

*Cases of certain communicable diseases reported by telegraph by State health officers  
for weeks ended June 2, 1928, and June 4, 1927—Continued*

Division and State	Poliomyelitis		Scarlet fever		Smallpox		Typhoid fever	
	Week ended June 2, 1928	Week ended June 4, 1927	Week ended June 2, 1928	Week ended June 4, 1927	Week ended June 2, 1928	Week ended June 4, 1927	Week ended June 2, 1928	Week ended June 4, 1927
<b>West South Central States:</b>								
Arkansas.....	0	0	16	3	3	13	5	17
Louisiana.....	1	2	5	3	14	3	16	15
Oklahoma <sup>1</sup> .....	0	2	42	23	122	31	4	35
Texas.....	3	1	58	4	37	40	9	24
<b>Mountain States:</b>								
Montana.....	0	0	10	48	23	8	0	1
Idaho.....	0	0	4	0	4	10	1	1
Wyoming.....	0	0	12	19	1	3	7	0
Colorado.....	0	0	—	132	—	5	—	5
New Mexico.....	0	0	20	8	5	2	4	1
Arizona.....	0	4	0	0	5	0	3	2
Utah.....	0	0	10	13	1	4	1	0
<b>Pacific States:</b>								
Washington.....	2	1	22	51	21	36	2	4
Oregon.....	0	0	12	14	33	8	3	8
California.....	6	7	148	164	35	16	13	9

<sup>1</sup> Exclusive of Tulsa.

### SUMMARY OF MONTHLY REPORTS FROM STATES

The following summary of monthly State reports is published weekly and covers only those States from which reports are received during the current week:

State	Menin- gococ- cus menin- gitis	Diph- theria	Influ- enza	Ma- laria	Mea- sles	Pel- lagra	Polio- mye- litis	Scarlet fever	Small- pox	Ty- phoid fever
<i>April, 1928</i>										
Arkansas.....	2	14	1,088	124	1,310	77	0	64	48	11
California.....	19	363	146	↓	522	6	20	501	91	17
Colorado.....	29	52	7	—	502	—	2	390	34	2
Idaho.....	6	1	39	—	10	—	0	56	41	11
Indiana.....	1	81	182	—	1,670	—	0	399	515	7
Iowa.....	1	26	4	—	109	—	0	274	190	9
Kansas.....	7	29	24	—	554	—	1	730	347	8
Mississippi.....	2	55	7,191	4,536	7,405	1,029	2	48	35	50
North Carolina.....	1	116	—	—	8,032	—	3	97	0	10
Oklahoma <sup>1</sup> .....	10	67	2,564	82	1,621	20	4	204	482	26
Oregon.....	6	37	145	—	379	—	1	40	237	14
Rhode Island.....	0	44	14	—	1,297	—	0	188	0	0
South Carolina.....	0	74	2,575	541	2,609	398	2	34	41	40
South Dakota.....	4	8	120	—	202	—	1	161	46	4

<sup>1</sup> Exclusive of Oklahoma City and Tulsa.

<i>April, 1928</i>	Cases
<b>Chicken pox:</b>	
Arkansas.....	62
California.....	2,327
Colorado.....	298
Idaho.....	47
Indiana.....	271
Iowa.....	117
Kansas.....	438
Mississippi.....	852
North Carolina.....	517
Oklahoma <sup>1</sup> .....	65
Oregon.....	218
Rhode Island.....	30

<sup>1</sup> Exclusive of Oklahoma City and Tulsa.

<i>April, 1928—Continued</i>	Cases
<b>Chicken pox—Continued.</b>	
South Carolina.....	228
South Dakota.....	50
<b>Coccidiosis:</b>	
California.....	4
<b>Dengue:</b>	
Mississippi.....	4
South Carolina.....	4
<b>Dysentery:</b>	
California (amebic).....	7
California (bacillary).....	15
Iowa.....	12

## April, 1928—Continued

Dysentery—Continued.	Cases
Kansas (amebic).....	1
Mississippi (amebic).....	47
Mississippi (bacillary).....	268
Oklahoma <sup>1</sup> .....	9
German measles:	
California.....	1,450
Colorado.....	43
Kansas.....	29
North Carolina.....	36
Rhode Island.....	3
Hookworm disease:	
California.....	2
Mississippi.....	208
South Carolina.....	94
Impetigo contagiosa:	
Colorado.....	8
Iowa.....	2
Oregon.....	6
Leprosy:	
California.....	2
Colorado.....	1
Lethargic encephalitis:	
California.....	5
Colorado.....	1
Kansas.....	2
Oregon.....	2
Mastoiditis:	
Rhode Island.....	1
Mumps:	
Arkansas.....	141
California.....	1,403
Colorado.....	500
Idaho.....	47
Indiana.....	445
Iowa.....	247
Kansas.....	747
Mississippi.....	1,393
Oklahoma <sup>1</sup> .....	146
Oregon.....	84
Rhode Island.....	112
South Carolina.....	55
South Dakota.....	17
Ophthalmia neonatorum:	
Arkansas.....	2
California.....	1
Mississippi.....	11
Oregon.....	1
South Carolina.....	20
Paratyphoid fever:	
California.....	1
Oregon.....	1
South Carolina.....	4
Puerperal fever:	
Mississippi.....	36

<sup>1</sup> Exclusive of Oklahoma City and Tulsa.

## April, 1928—Continued

Rabies in animals:	Cases
California.....	61
Idaho.....	5
Mississippi.....	7
Rhode Island.....	11
South Carolina.....	10
Rocky Mounted spotted or tick fever:	
California.....	1
Idaho.....	8
Oregon.....	7
Scabies:	
Colorado.....	4
Oregon.....	11
Septic sore throat:	
Kansas.....	2
North Carolina.....	12
Oklahoma <sup>1</sup> .....	7
Oregon.....	11
Rhode Island.....	1
South Dakota.....	2
Tetanus:	
California.....	6
Colorado.....	1
Oklahoma <sup>1</sup> .....	1
Rhode Island.....	1
Trachoma:	
Arkansas.....	45
California.....	14
Mississippi.....	8
Oklahoma <sup>1</sup> .....	3
South Dakota.....	3
Trichinosis:	
California.....	3
Undulant (malta) fever:	
South Carolina.....	1
Vincent's angina:	
Colorado.....	2
Iowa.....	1
South Carolina.....	4
Whooping cough:	
Arkansas.....	65
California.....	1,200
Colorado.....	87
Idaho.....	12
Indiana.....	122
Iowa.....	26
Kansas.....	283
Mississippi.....	1,899
North Carolina.....	494
Oklahoma <sup>1</sup> .....	99
Oregon.....	19
Rhode Island.....	20
South Carolina.....	417
South Dakota.....	10

## ADMISSIONS TO HOSPITALS FOR THE INSANE, FEBRUARY, 1928

Reports for the month of February, 1928, showing new admissions to hospitals for the care and treatment of the insane have been received by the Public Health Service from 85 institutions located in 30 States, the District of Columbia, and the Territory of Hawaii.

Sixteen of these institutions were corporate or private. These hospitals reported a total of 118,122 patients on February 29, 1928, including those on parole.

The following table shows the numbers of new admissions for the month of February, 1928, by psychoses.

*First admissions to 85 hospitals for the insane, February, 1928*

Psychoses	Male	Female	Total
Traumatic psychoses	11	0	11
Senile psychoses	112	91	203
Psychoses with cerebral arteriosclerosis	68	35	103
General paralysis	140	28	168
Psychoses with cerebral syphilis	20	10	30
Psychoses with Huntington's chorea	0	4	4
Psychoses with other brain tumor	2	0	2
Psychoses with other brain or nervous disease	20	8	28
Alcoholic psychoses	68	3	71
Psychoses due to drugs and other exogenous toxins	6	3	9
Psychoses with pellagra	6	16	22
Psychoses with other somatic diseases	20	36	56
Manic-depressive psychoses	150	154	304
Involution melancholia	7	24	31
Dementia præcox (schizophrenia)	249	162	411
Paranoia and paranoid conditions	25	17	42
Epileptic psychoses	36	31	67
Psychoneuroses and neuroses	11	22	33
Psychoses with psychopathic personality	23	12	35
Psychoses with mental deficiency	43	29	72
Undiagnosed psychoses	61	55	116
Without psychosis	57	25	82
Total	1,135	765	1,900

Fifty-nine and seven-tenths per cent of the new admissions were males and 40.3 per cent were females, giving a ratio of 148 males per 100 females. The 85 institutions on February 29, 1928, had 62,496 male and 55,626 female patients, the ratio being 112 males per 100 females.

Undiagnosed psychoses constituted 6.1 per cent of the total admissions; dementia præcox, 21.6 per cent; manic-depressive psychoses, 16 per cent; senile psychoses, 10.7 per cent; general paralysis, 8.8 per cent; psychoses with cerebral arteriosclerosis, 5.4 per cent; and 4.3 per cent were recorded as without psychosis.

#### TYPHOID FEVER IN RUTLAND, VT.

The Secretary of the Department of Public Health of Vermont reports an epidemic of typhoid fever in the city of Rutland, Vt., from March 25 to April 14, 1928, which was traced to a healthy carrier employed in a dairy. There were 15 primary cases, 1 secondary case, and 3 deaths. The carrier was 63 years of age and gave a history of typhoid fever when about 15 years old. Eighteen years ago he developed cholecystitis and was operated upon with the removal of a number of gallstones. Since that time he has been apparently well.

## GENERAL CURRENT SUMMARY AND WEEKLY REPORTS FROM CITIES

The 101 cities reporting cases used in the following table are situated in all parts of the country and have an estimated aggregate population of more than 31,650,000. The estimated population of the 95 cities reporting deaths is more than 30,960,000. The estimated expectancy is based on the experience of the last nine years, excluding epidemics.

*Weeks ended May 19, 1928, and May 21, 1927*

	1928	1927	Estimated expectancy
<i>Cases reported</i>			
Diphtheria:			
42 States.....	1,251	1,573	
101 cities.....	828	1,034	844
Measles:			
41 States.....	17,939	12,625	
101 cities.....	8,152	3,692	
Poliomyelitis:			
43 States.....	20	28	
Scarlet fever:			
42 States.....	3,647	4,170	
101 cities.....	1,532	1,841	1,171
Smallpox:			
42 States.....	1,012	743	
101 cities.....	145	152	116
Typhoid fever:			
42 States.....	211	345	
101 cities.....	34	59	55
<i>Deaths reported</i>			
Influenza and pneumonia:			
95 cities.....	1,293	708	
Smallpox:			
95 cities.....	0	0	

*City reports for week ended May 19, 1928*

The "estimated expectancy" given for diphtheria, poliomyelitis, scarlet fever, smallpox, and typhoid fever is the result of an attempt to ascertain from previous occurrence the number of cases of the disease under consideration that may be expected to occur during a certain week in the absence of epidemics. It is based on reports to the Public Health Service during the past nine years. It is in most instances the median number of cases reported in the corresponding weeks of the preceding years. When the reports include several epidemics or when for other reasons the median is unsatisfactory, the epidemic periods are excluded and the estimated expectancy is the mean number of cases reported for the week during non-epidemic years.

If the reports have not been received for the full nine years, data are used for as many years as possible but no year earlier than 1919 is included. In obtaining the estimated expectancy, the figures are smoothed when necessary to avoid abrupt deviations from the usual trend. For some of the diseases given in the table the available data were not sufficient to make it practicable to compute the estimated expectancy.

Division, State, and city	Population, July 1, 1926, estimated	Chick- en pox, cases re- ported	Diphtheria		Influenza		Meas- les, cases re- ported	Mumps, cases re- ported	Pneu- monia, deaths re- ported
			Cases, esti- mated expect- ancy	Cases re- ported	Cases re- ported	Deaths re- ported			
NEW ENGLAND									
Maine: Portland.....	76, 400	13	1	0	1	0	4	6	1
New Hampshire: Concord.....	22, 546	0	0	0	0	0	1	0	2
Manchester.....	84, 000	0	1	0	0	0	3	0	2
Vermont: Barre.....	10, 008	0	0	0	0	0	0	0	0
Burlington.....	24, 089	0	1	0	0	0	0	0	1

<sup>1</sup> Estimated, July 1, 1925.



## City reports for week ended May 19, 1928—Continued

Division, State, and city	Population, July 1, 1926, estimated	Chicken pox, cases re-ported	Diphtheria		Influenza		Meas-les, cases re-ported	Mumps, cases re-ported	Pneu-monia, deaths re-ported
			Cases, esti-mated ex-pectancy	Cases re-ported	Cases re-ported	Deaths re-ported			
NEW ENGLAND—CON.									
Massachusetts:									
Boston.....	787,000	37	43	23	21	8	113	6	48
Fall River.....	131,000	0	3	3	1	1	1	1	2
Springfield.....	145,000	8	2	0	4	6	4	22	4
Worcester.....	193,000	7	3	2	0	0	21	16	2
Rhode Island:									
Pawtucket.....	71,000	4	0	1	0	0	16	15	2
Providence.....	275,000	0	7	7	0	1	222	1	5
Connecticut:									
Bridgeport.....	(?)	2	5	3	2	1	9	0	5
Hartford.....	164,000	3	5	8	1	0	33	9	9
New Haven.....	182,000	13	2	1	0	1	80	19	10
MIDDLE ATLANTIC									
New York:									
Buffalo.....	544,000	5	9	18	-----	0	25	25	16
New York.....	5,924,000	134	256	298	94	40	2,533	0	291
Rochester.....	321,000	2	10	2	1	1	89	35	12
Syracuse.....	185,000	20	5	2	-----	0	134	15	9
New Jersey:									
Camden.....	131,000	1	5	9	0	0	91	9	6
Newark.....	459,000	17	12	21	10	1	223	9	17
Trenton.....	134,000	2	3	1	0	0	17	3	3
Pennsylvania:									
Philadelphia.....	2,008,000	43	65	49	1	8	1,416	55	48
Pittsburgh.....	637,000	28	18	18	0	8	98	54	43
Reading.....	114,000	6	2	1	0	0	42	1	3
EAST NORTH CENTRAL									
Ohio:									
Cincinnati.....	411,000	3	7	7	0	3	26	0	17
Cleveland.....	960,000	50	21	29	15	6	96	61	32
Columbus.....	285,000	5	3	3	170	4	114	3	5
Toledo.....	295,000	10	4	2	6	6	159	4	5
Indiana:									
Fort Wayne.....	99,900	2	2	2	0	0	6	0	2
Indianapolis.....	367,000	23	4	3	0	3	150	66	18
South Bend.....	81,700	0	1	0	0	0	0	0	0
Terre Haute.....	71,900	3	0	0	0	0	1	0	4
Illinois:									
Chicago.....	3,048,000	68	74	59	45	18	38	40	166
Springfield.....	64,700	2	0	0	4	3	1	3	4
Michigan:									
Detroit.....	<sup>1</sup> 1,242,044	38	46	63	12	11	396	19	53
Flint.....	136,000	9	4	1	0	0	202	15	4
Grand Rapids.....	156,000	2	2	0	0	1	5	10	7
Wisconsin:									
Kenosha.....	52,700	13	1	0	2	0	0	0	0
Milwaukee.....	517,000	51	12	6	8	6	3	22	24
Racine.....	69,400	1	1	0	0	0	1	0	1
Superior.....	<sup>1</sup> 39,671	0	0	2	0	0	1	1	3
WEST NORTH CENTRAL									
Minnesota:									
Duluth.....	113,000	3	0	0	0	4	0	1	1
Minneapolis.....	434,000	36	15	10	0	3	61	119	11
St. Paul.....	248,000	13	12	2	0	1	3	17	10
Iowa:									
Davenport.....	<sup>1</sup> 52,469	1	0	0	0	-----	0	0	-----
Des Moines.....	146,000	0	2	0	0	-----	0	0	-----
Sioux City.....	78,000	2	1	0	0	-----	6	15	-----
Waterloo.....	36,900	10	0	1	0	-----	1	20	-----
Missouri:									
Kansas City.....	375,000	28	4	2	1	1	72	79	10
St. Joseph.....	78,400	1	0	0	0	0	0	2	3
St. Louis.....	830,000	28	38	31	0	0	370	18	-----
North Dakota:									
Fargo.....	<sup>1</sup> 26,403	0	0	0	0	0	0	2	0
Grand Forks.....	<sup>1</sup> 14,811	0	0	0	0	-----	0	0	-----

<sup>1</sup> Estimated, July 1, 1925<sup>2</sup> No estimate made.<sup>3</sup> Special census.

## City reports for week ended May 19, 1928—Continued

Division, State, and city	Population, July 1, 1926, estimated	Chick-en pox, cases re-ported	Diphtheria		Influenza		Meas-les, cases re-ported	Mumps, cases re-ported	Pneu-monia, deaths re-ported
			Cases, esti-mated expect-ancy	Cases re-ported	Cases re-ported	Deaths re-ported			
WEST NORTH CENTRAL—continued									
South Dakota:									
Aberdeen.....	<sup>1</sup> 15,036	0	0	0	0	-----	0	0	-----
Sioux Falls.....	<sup>1</sup> 30,127	0	1	1	0	-----	0	0	-----
Nebraska:									
Lincoln.....	62,000	9	1	1	0	0	0	11	0
Omaha.....	216,000	7	1	2	0	0	0	0	3
Kansas:									
Topeka.....	56,500	14	1	1	0	0	22	6	0
Wichita.....	92,500	26	1	0	0	0	38	1	5
SOUTH ATLANTIC									
Delaware:									
Wilmington.....	124,000	0	1	2	0	0	16	3	5
Maryland:									
Baltimore.....	808,000	79	21	30	3	7	408	56	30
Cumberland.....	<sup>1</sup> 33,741	1	0	0	1	0	11	0	2
Frederick.....	<sup>1</sup> 12,035	0	0	1	0	0	15	0	1
District of Columbia:									
Washington.....	528,000	10	12	12	2	2	234	0	13
Virginia:									
Lynchburg.....	<sup>1</sup> 38,493	6	0	0	0	0	27	4	4
Norfolk.....	174,000	1	0	1	0	0	14	7	2
Richmond.....	189,000	3	1	3	69	0	0	2	3
Roanoke.....	61,900	4	1	0	0	0	15	2	1
West Virginia:									
Charleston.....	50,700	0	0	1	0	0	1	0	1
Wheeling.....	<sup>1</sup> 56,208	10	1	0	2	0	7	2	6
North Carolina:									
Raleigh.....	<sup>1</sup> 30,371	1	0	0	0	0	21	0	3
Wilmington.....	37,700	2	0	0	0	0	1	0	0
Winston-Salem.....	71,800	3	0	0	0	0	12	10	1
South Carolina:									
Charleston.....	74,100	3	0	0	2	0	5	1	2
Columbia.....	41,800	15	1	0	0	0	0	14	0
Greenville.....	<sup>1</sup> 27,311	0	0	0	0	0	2	2	0
Georgia:									
Atlanta.....	( <sup>2</sup> )	14	1	8	7	0	29	9	7
Brunswick.....	<sup>1</sup> 16,809	0	0	0	0	0	0	1	0
Savannah.....	94,900	4	0	0	18	0	0	1	0
Florida:									
Miami.....	<sup>1</sup> 131,286	10	3	0	3	0	1	6	2
St. Petersburg.....	<sup>1</sup> 47,629	0	0	-----	0	0	-----	-----	0
Tampa.....	102,000	5	0	1	0	0	1	11	2
EAST SOUTH CENTRAL									
Kentucky:									
Covington.....	58,500	0	1	0	0	0	0	0	4
Louisville.....	311,000	3	3	1	2	1	110	6	12
Tennessee:									
Memphis.....	177,000	9	1	1	0	3	7	6	6
Nashville.....	137,000	4	0	0	0	2	23	2	5
Alabama:									
Birmingham.....	211,000	13	1	0	89	6	85	3	18
Mobile.....	66,800	1	0	1	0	0	7	0	1
Montgomery.....	47,000	5	0	1	2	-----	16	0	-----
WEST SOUTH CENTRAL									
Arkansas:									
Fort Smith.....	<sup>1</sup> 31,643	4	0	1	0	-----	2	1	-----
Little Rock.....	75,900	2	0	0	3	0	3	14	3
Louisiana:									
New Orleans.....	419,000	6	6	8	6	4	5	0	15
Shreveport.....	59,500	0	0	0	0	0	12	1	2
Oklahoma:									
Oklahoma City.....	( <sup>2</sup> )	0	0	2	5	1	5	2	1
Tulsa.....	133,000	17	1	0	0	-----	0	18	-----
Texas:									
Dallas.....	203,000	13	3	1	0	0	16	0	1
Forth Worth.....	150,000	8	1	3	1	2	5	0	2
Galveston.....	49,100	0	0	0	0	0	3	2	0
Houston.....	<sup>1</sup> 154,954	1	3	3	0	0	19	0	4
San Antonio.....	205,000	4	0	3	0	0	7	1	5

<sup>1</sup> Estimated, July 1, 1925.<sup>2</sup> No estimate made.<sup>3</sup> Special census.

## City reports for week ended May 19, 1928—Continued

Division, State, and city	Population, July 1, 1926, estimated	Chick- en pox, cases re- ported	Diphtheria		Influenza		Meas- les, cases re- ported	Mumps, cases re- ported	Pneu- monia, deaths re- ported
			Cases, esti- mated expect- ancy	Cases re- ported	Cases re- ported	Deaths re- ported			
MOUNTAIN									
Montana:									
Billings.....	<sup>1</sup> 17, 971	4	0	0	0	0	0	0	0
Great Falls.....	<sup>1</sup> 29, 883	11	1	0	0	0	4	0	1
Helena.....	<sup>1</sup> 12, 037	0	0	0	0	0	0	0	0
Missoula.....	<sup>1</sup> 12, 668	0	0	0	0	0	0	0	0
Idaho:									
Boise.....	<sup>1</sup> 23, 042	3	1	0	0	0	0	1	0
Colorado:									
Denver.....	285, 000	37	10	9	-----	1	97	46	8
Pueblo.....	43, 900	15	1	1	0	0	27	0	0
New Mexico:									
Albuquerque.....	<sup>1</sup> 21, 000	2	0	0	0	0	6	0	0
Utah:									
Salt Lake City.....	133, 000	22	3	1	0	2	2	1	2
Nevada:									
Reno.....	<sup>1</sup> 12, 665	0	0	0	0	0	0	0	0
PACIFIC									
Washington:									
Seattle.....	(?)	57	5	4	0	-----	51	5	-----
Spokane.....	109, 000	15	2	0	0	-----	0	0	-----
Tacoma.....	106, 000	8	1	1	0	0	9	46	1
Oregon:									
Portland.....	<sup>1</sup> 282, 383	20	5	2	0	0	12	5	4
California:									
Los Angeles.....	(?)	97	37	30	29	2	16	47	21
Sacramento.....	73, 400	22	2	0	0	0	9	6	3
San Francisco.....	567, 000	54	17	12	2	1	18	27	6

Division, State, and city	Scarlet fever		Smallpox			Tuber- culosis, deaths re- ported	Typhoid fever			Whoop- ing cough, cases re- ported	Deaths, all causes
	Cases, esti- mated expect- ancy	Cases re- ported	Cases, esti- mated expect- ancy	Cases re- ported	Deaths re- ported		Cases, esti- mated expect- ancy	Cases re- ported	Deaths re- ported		
NEW ENGLAND											
Maine:											
Portland .....	3	4	0	0	0	0	0	0	0	5	20
New Hampshire:											
Concord .....	1	0	0	0	0	1	0	0	0	0	9
Manchester .....	1	1	0	0	0	1	0	0	0	0	17
Vermont:											
Barre .....	0	0	0	0	0	0	0	0	0	0	3
Burlington .....	0	0	0	0	0	1	0	0	0	0	6
Massachusetts:											
Boston .....	62	67	0	0	0	19	1	1	0	25	273
Fall River .....	3	3	0	0	0	0	0	0	0	2	35
Springfield .....	6	9	0	0	0	2	0	0	0	5	54
Worcester .....	9	7	0	0	0	4	0	0	0	14	61
Rhode Island:											
Pawtucket .....	1	4	0	0	0	0	0	0	0	0	15
Providence .....	8	24	0	0	0	4	0	2	1	0	61
Connecticut:											
Bridgeport .....	10	4	0	0	0	5	0	0	0	4	49
Hartford .....	4	5	0	0	0	2	1	0	0	5	54
New Haven .....	6	0	0	0	0	0	0	0	0	22	49
MIDDLE ATLANTIC											
New York:											
Buffalo .....	19	32	0	0	0	7	1	0	0	31	158
New York .....	253	356	0	0	0	127	9	9	0	178	1, 784
Rochester .....	13	7	0	0	0	3	0	0	0	13	69
Syracuse .....	9	2	0	0	0	3	0	0	0	7	75

<sup>1</sup> Estimated, July 1, 1925.<sup>2</sup> No estimate made.

## City reports for week ended May 19, 1928—Continued

Division, State, and city	Scarlet fever		Smallpox			Tuber- culosis, deaths re-ported	Typhoid fever			Whoop- ing cough, cases re-ported	Deaths, all causes
	Cases, esti- mated expec- tancy	Cases re- ported	Cases, esti- mated expec- tancy	Cases re- ported	Deaths re- ported		Cases, esti- mated expec- tancy	Cases re- ported	Deaths re- ported		
MIDDLE ATLANTIC— continued											
New Jersey:											
Camden.....	6	3	0	0	0	0	0	0	1	0	35
Newark.....	24	30	0	0	0	13	0	0	0	27	103
Trenton.....	2	2	0	0	0	7	0	0	0	3	42
Pennsylvania:											
Philadelphia....	88	93	0	0	0	44	4	0	0	77	512
Pittsburgh.....	30	29	0	0	0	13	1	0	0	28	196
Reading.....	2	18	0	0	0	1	0	0	0	7	26
EAST NORTH CEN- TRAL											
Ohio:											
Cincinnati.....	17	53	2	3	0	6	1	0	0	8	146
Cleveland.....	35	20	0	0	0	22	2	1	1	40	224
Columbus.....	9	9	2	0	0	5	1	0	0	0	91
Toledo.....	12	2	3	0	0	7	0	0	0	9	81
Indiana:											
Fort Wayne....	3	3	3	0	0	3	0	0	0	0	25
Indianapolis....	9	19	13	12	0	5	0	1	0	5	108
South Bend....	3	0	1	0	0	0	0	0	0	0	0
Terre Haute....	3	1	0	0	0	1	0	0	0	0	18
Illinois:											
Chicago.....	111	90	2	5	0	51	3	0	0	79	859
Springfield....	3	14	0	0	0	1	1	1	0	3	23
Michigan:											
Detroit.....	86	142	1	6	0	41	2	0	1	87	343
Flint.....	5	10	1	8	0	2	0	0	0	7	27
Grand Rapids..	6	2	1	0	0	2	0	0	0	1	43
Wisconsin:											
Kenosha.....	3	1	1	0	0	0	0	0	0	2	4
Milwaukee.....	21	37	1	0	0	6	0	0	0	16	132
Racine.....	4	4	1	0	0	1	0	0	0	2	17
Superior.....	2	11	1	0	0	1	0	0	0	0	15
WEST NORTH CEN- TRAL											
Minnesota:											
Duluth.....	7	10	1	0	0	2	0	0	0	6	27
Minneapolis....	37	31	6	1	0	4	0	0	0	18	109
St. Paul.....	22	11	3	0	0	4	0	0	0	22	49
Iowa:											
Davenport.....	1	4	2	3	-----	-----	0	0	-----	0	-----
Des Moines.....	6	4	2	14	-----	-----	0	0	-----	0	34
Sioux City.....	2	0	2	0	-----	-----	0	0	-----	0	-----
Waterloo.....	1	3	1	0	-----	-----	0	0	-----	0	-----
Missouri:											
Kansas City....	9	29	1	13	0	1	1	0	0	11	15
St. Joseph.....	2	3	0	1	0	1	0	0	0	1	33
St. Louis.....	32	32	3	2	0	14	1	1	1	18	208
North Dakota:											
Fargo.....	1	0	0	0	0	0	0	0	0	6	9
Grand Forks....	0	3	0	0	-----	-----	0	0	-----	0	-----
South Dakota:											
Aberdeen.....	2	0	0	0	-----	-----	0	0	-----	0	-----
Sioux Falls....	3	4	1	0	-----	-----	0	0	-----	0	5
Nebraska:											
Lincoln.....	1	16	1	3	0	0	0	0	0	2	-----
Omaha.....	4	11	8	6	0	2	0	0	0	0	56
Kansas:											
Topeka.....	2	8	0	0	0	0	0	0	0	4	22
Wichita.....	4	5	1	10	0	1	0	0	0	5	26
SOUTH ATLANTIC											
Delaware:											
Wilmington....	4	5	0	0	0	0	0	0	0	0	30
Maryland:											
Baltimore.....	33	28	0	0	0	17	3	1	1	53	243
Cumberland....	0	0	0	0	0	0	0	0	0	0	12
Frederick.....	1	0	0	0	0	0	0	0	0	0	7
District of Col.:											
Washington....	20	43	1	0	0	10	1	0	0	11	146

## City reports for week ended May 19, 1928—Continued

Division, State, and city	Scarlet fever		Smallpox			Tuber- culosis, deaths re- ported	Typhoid fever			Whoop- ing cough, cases re- ported	Deaths, all causes
	Cases, esti- mated expect- ancy	Cases re- ported	Cases, esti- mated expect- ancy	Cases re- ported	Deaths re- ported		Cases, esti- mated expect- ancy	Cases re- ported	Deaths re- ported		
SOUTH ATLANTIC— continued											
Virginia:											
Lynchburg.....	1	0	0	0	0	2	1	0	0	7	17
Norfolk.....	1	3	0	1	0	2	0	1	0	0	0
Richmond.....	2	4	0	0	0	7	0	0	0	0	53
Roanoke.....	1	0	0	0	0	2	0	0	0	0	19
West Virginia:											
Charleston.....	1	1	1	1	0	1	0	0	0	0	16
Wheeling.....	1	0	0	0	0	0	1	0	0	0	23
North Carolina:											
Raleigh.....	0	4	0	6	0	0	0	0	0	3	13
Wilmington.....	0	0	1	1	0	0	0	0	0	3	11
Winston-Salem.....	1	0	4	0	0	3	0	0	0	0	16
South Carolina:											
Charleston.....	0	0	0	8	0	1	0	1	0	0	21
Columbia.....	0	3	1	0	0	0	1	0	0	3	7
Greenville.....	0	0	1	0	0	0	0	0	0	0	4
Georgia:											
Atlanta.....	3	20	7	0	0	6	1	0	0	2	58
Brunswick.....	0	0	1	0	0	0	0	0	0	0	5
Savannah.....	1	0	1	1	0	3	1	0	0	3	32
Florida:											
Miami.....	0	0	1	0	0	1	0	0	0	3	27
St. Petersburg.....	0	0	0	0	0	0	0	0	0	12	12
Tampa.....	0	0	0	0	0	1	1	1	0	3	19
EAST SOUTH CENTRAL											
Kentucky:											
Covington.....	1	5	0	0	0	1	0	0	0	0	22
Louisville.....	6	27	0	0	0	0	1	0	0	5	146
Tennessee:											
Memphis.....	5	2	3	2	0	5	1	2	0	9	66
Nashville.....	2	3	1	3	0	3	0	0	0	1	38
Alabama:											
Birmingham.....	2	0	6	1	0	7	2	1	0	3	83
Mobile.....	0	1	1	0	0	1	0	1	0	0	23
Montgomery.....	0	0	1	0	0	0	1	0	0	0	0
WEST SOUTH CENTRAL											
Arkansas:											
Fort Smith.....	0	1	0	0	0	0	0	0	0	4	1
Little Rock.....	0	28	1	0	0	2	1	0	0	0	0
Louisiana:											
New Orleans.....	4	4	1	1	0	10	2	0	0	8	165
Shreveport.....	0	1	1	9	0	1	0	0	0	0	29
Oklahoma:											
Oklahoma City.....	0	12	2	10	0	2	0	0	0	0	20
Tulsa.....	2	3	4	4	0	0	0	0	0	4	0
Texas:											
Dallas.....	2	18	3	1	0	3	1	0	0	22	39
Fort Worth.....	1	5	4	5	0	3	1	0	0	0	35
Galveston.....	0	0	0	0	0	1	0	0	0	0	11
Houston.....	1	2	1	3	0	2	1	1	0	0	55
San Antonio.....	0	0	0	1	0	9	1	0	0	0	66
MOUNTAIN											
Montana:											
Billings.....	1	0	0	0	0	0	0	0	0	2	5
Great Falls.....	1	3	1	0	0	0	0	0	0	1	5
Helena.....	1	0	0	1	0	0	0	0	0	0	1
Missoula.....	0	0	0	0	0	0	0	0	0	0	1
Idaho:											
Boise.....	0	0	1	0	0	0	0	0	0	0	5
Colorado:											
Denver.....	11	11	1	0	0	9	0	0	0	28	87
Pueblo.....	1	0	0	4	0	2	0	0	0	0	11
New Mexico:											
Albuquerque.....	0	2	0	0	0	3	0	0	0	0	9
Utah:											
Salt Lake City.....	2	1	1	10	0	1	0	0	0	17	26
Nevada:											
Reno.....	0	0	0	3	0	0	0	0	0	0	8

## City reports for week ended May 19, 1923—Continued

Division, State, and city	Scarlet fever		Smallpox			Tuber- culosis, deaths re- ported	Typhoid fever			Whoop- ing cough, cases re- ported	Deaths, all causes
	Cases, estimated expect- ancy	Cases re- ported	Cases, esti- mated expect- ancy	Cases re- ported	Deaths re- ported		Cases, esti- mated expect- ancy	Cases re- ported	Deaths re- ported		
PACIFIC											
Washington:											
Seattle.....	8	14	3	1	-----	-----	1	0	-----	2	-----
Spokane.....	5	3	5	10	-----	-----	0	0	-----	0	-----
Tacoma.....	2	1	3	3	0	0	1	0	0	2	16
Oregon:											
Portland.....	6	6	7	31	0	2	0	2	0	0	-----
California:											
Los Angeles....	27	13	7	3	0	25	1	0	0	63	259
Sacramento....	1	1	0	3	0	2	1	3	0	7	27
San Francisco..	15	24	1	1	0	12	1	6	0	7	158

Division, State, and city	Meningococcus meningitis		Lethargic encephalitis		Pellagra		Poliomyelitis (infantile paralysis)			
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases, estimated expectancy	Cases	Deaths	
<b>NEW ENGLAND</b>										
Connecticut:										
Bridgeport.....	1	1	0	0	0	0	0	0	0	0
<b>MIDDLE ATLANTIC</b>										
New York:										
New York.....	23	11	3	6	0	0	1	4	0	0
Syracuse.....	0	0	0	0	0	0	0	1	0	0
New Jersey:										
Newark.....	0	0	0	0	0	0	0	1	0	0
Pennsylvania:										
Philadelphia.....	1	0	2	1	0	0	1	0	0	0
Pittsburgh.....	4	1	0	0	0	0	0	0	0	0
<b>EAST NORTH CENTRAL</b>										
Ohio:										
Cleveland.....	5	2	0	0	0	0	0	0	0	0
Columbus.....	0	1	0	0	0	0	0	0	0	0
Toledo.....	2	1	0	0	0	0	0	0	0	0
Indiana:										
Indianapolis.....	0	3	0	0	0	0	0	0	0	0
Illinois:										
Chicago.....	17	3	0	0	0	0	0	0	0	0
Michigan:										
Detroit.....	2	0	2	0	0	0	1	0	0	0
Wisconsin:										
Milwaukee.....	1	1	0	0	0	0	0	0	0	0
<b>WEST NORTH CENTRAL</b>										
Minnesota:										
Minneapolis.....	1	0	0	0	0	0	0	0	0	0
St. Paul.....	0	1	0	0	0	0	0	0	0	0
Missouri:										
Kansas City.....	9	2	0	0	0	0	0	0	0	0
St. Louis.....	11	1	0	0	0	0	0	0	0	0
<b>SOUTH ATLANTIC</b>										
Maryland:										
Baltimore.....	0	0	1	0	0	0	0	0	0	0
District of Columbia:										
Washington.....	1	1	0	0	0	0	0	0	0	0
South Carolina:										
Charleston.....	0	0	0	0	0	1	0	0	0	0
Columbia.....	0	0	0	0	0	1	0	0	0	0

## City reports for week ended May 19, 1928—Continued

Division, State, and city	Meningococcus meningitis		Lethargic encephalitis		Pellagra		Poliomyelitis (infantile paralysis)		
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases, estimated expectancy	Cases	Deaths
<b>SOUTH ATLANTIC—continued</b>									
Georgia:									
Atlanta.....	0	0	0	0	1	0	0	0	0
Savannah <sup>1</sup> .....	0	0	0	0	2	1	0	0	0
Florida:									
Miami.....	0	0	0	0	2	0	6	0	0
Tampa.....	0	0	0	0	0	1	0	0	0
<b>EAST SOUTH CENTRAL</b>									
Alabama:									
Birmingham.....	0	0	1	0	0	0	0	0	0
Mobile.....	0	0	0	0	2	0	0	0	0
<b>WEST SOUTH CENTRAL</b>									
Arkansas:									
Fort Smith.....	2	1	0	0	0	0	0	0	0
Little Rock.....	0	0	0	0	0	3	0	0	0
Louisiana:									
New Orleans.....	1	0	0	0	3	2	0	0	0
Shreveport.....	0	0	0	0	0	1	0	0	0
Texas:									
Dallas.....	0	0	0	0	0	1	0	0	0
Fort Worth.....	0	0	0	0	0	1	0	0	0
Houston.....	0	0	0	0	1	1	0	0	0
<b>MOUNTAIN</b>									
Colorado:									
Denver.....	0	2	0	1	0	0	0	0	0
<b>PACIFIC</b>									
Washington:									
Tacoma.....	0	0	0	0	0	0	0	2	0
Oregon:									
Portland.....	0	0	0	0	0	0	0	0	1
California:									
Los Angeles.....	2	0	1	0	0	0	0	0	0
San Francisco.....	0	0	0	0	2	2	1	0	0

<sup>1</sup> Typhus fever: 1 case at Savannah, Ga.

The following table gives the rates per 100,000 population for 101 cities for the five-week period ended May 19, 1928, compared with those for a like period ended May 21, 1927. The population figures used in computing the rates are approximate estimates as of July 1, 1928 and 1927, respectively, authoritative figures for many of the cities not being available. The 101 cities reporting cases had estimated aggregate populations of approximately 31,657,000 in 1928 and 31,050,000 in 1927. The 95 cities reporting deaths had nearly 30,961,000 estimated population in 1928 and nearly 30,370,000 in 1927. The number of cities included in each group and the estimated aggregate populations are shown in a separate table below.

*Summary of weekly reports from cities, April 15 to May 19, 1928—Annual rates per 100,000 population compared with rates for the corresponding period of 1927<sup>1</sup>*

## DIPHTHERIA CASE RATES

	Week ended—									
	Apr. 21, 1928	Apr. 23, 1927	Apr. 28, 1928	Apr. 30, 1927	May 5, 1928	May 7, 1927	May 12, 1928	May 14, 1927	May 19, 1928	May 21, 1927
101 cities.....	137	179	123	171	123	183	121	174	137	174
New England.....	131	135	133	95	133	130	113	105	110	153
Middle Atlantic.....	204	270	172	242	170	272	177	282	204	267
East North Central.....	116	131	131	137	107	159	109	132	114	160
West North Central.....	80	141	84	158	78	131	55	135	95	105
South Atlantic.....	82	135	86	105	88	119	82	115	103	110
East South Central.....	40	30	45	76	40	76	35	81	20	35
West South Central.....	124	124	100	178	50	141	92	112	64	50
Mountain.....	80	188	133	99	80	152	71	99	97	108
Pacific.....	102	157	56	188	125	110	102	94	120	104

## MEASLES CASE RATES

101 cities.....	1,362	788	1,290	638	1,423	696	1,376	602	1,346	620
New England.....	1,743	295	1,593	323	1,322	270	1,120	346	1,159	416
Middle Atlantic.....	1,824	145	1,862	231	2,266	212	2,254	297	2,274	323
East North Central.....	817	797	723	637	794	564	788	450	680	492
West North Central.....	986	1,552	1,017	1,225	888	1,522	937	932	1,116	952
South Atlantic.....	2,353	1,589	1,767	1,017	2,109	1,577	1,704	1,545	1,436	1,537
East South Central.....	1,536	517	1,521	375	1,132	517	1,082	345	1,237	355
West South Central.....	380	1,249	396	922	392	877	336	567	268	620
Mountain.....	761	1,793	840	1,542	752	1,632	1,141	1,300	1,150	906
Pacific.....	393	2,103	386	1,528	266	1,601	327	1,259	263	1,215

## SCARLET FEVER CASE RATES

101 cities.....	264	362	266	339	258	360	253	340	253	309
New England.....	264	346	329	402	345	393	347	439	292	432
Middle Atlantic.....	287	528	312	446	303	540	285	474	279	415
East North Central.....	272	298	281	269	254	263	265	289	272	267
West North Central.....	288	342	275	333	218	271	242	319	279	289
South Atlantic.....	170	161	214	191	175	128	167	148	195	101
East South Central.....	200	167	209	193	304	183	155	152	190	132
West South Central.....	164	41	108	33	148	58	184	21	216	33
Mountain.....	212	932	203	950	274	1,004	115	726	133	986
Pacific.....	151	209	110	198	153	212	204	201	143	167

## SMALLPOX CASE RATES

101 cities.....	22	33	25	21	14	22	18	21	24	26
New England.....	0	0	0	0	0	0	0	0	0	0
Middle Atlantic.....	0	0	0	0	0	0	0	0	0	0
East North Central.....	31	29	23	33	15	23	20	20	22	37
West North Central.....	60	40	68	38	31	34	43	26	64	48
South Atlantic.....	12	65	33	18	14	36	21	38	32	36
East South Central.....	20	162	70	66	15	56	45	56	30	76
West South Central.....	8	95	28	25	36	33	8	58	60	17
Mountain.....	168	54	150	9	106	36	159	9	159	45
Pacific.....	59	97	43	65	31	73	36	91	54	71

<sup>1</sup> The figures given in this table are rates per 100,000 population, annual basis, and not the number of cases reported. Populations used are estimated as of July 1, 1928 and 1927, respectively.



*Summary of weekly reports from cities, April 15 to May 19, 1928—Annual rates per 100,000 population compared with rates for the corresponding period of 1927—Continued*

## TYPHOID FEVER CASE RATES

	Week ended—									
	Apr. 21, 1928	Apr. 23, 1927	Apr. 23, 1928	Apr. 30, 1927	May 5, 1928	May 7, 1927	May 12, 1928	May 14, 1927	May 19, 1928	May 21, 1927
101 cities.....	6	7	4	8	6	10	8	8	6	10
New England.....	7	0	5	5	2	2	5	5	7	5
Middle Atlantic.....	6	7	3	5	4	10	2	5	4	6
East North Central.....	3	3	2	6	3	7	3	3	2	5
West North Central.....	6	4	6	4	2	2	8	2	2	6
South Atlantic.....	9	11	7	16	18	18	19	9	7	13
East South Central.....	15	30	5	30	0	15	20	66	20	56
West South Central.....	20	12	24	12	28	37	16	25	4	45
Mountain.....	0	27	0	9	0	18	18	9	0	9
Pacific.....	3	10	0	18	15	3	31	10	23	10

## INFLUENZA DEATH RATES

95 cities.....	28	18	32	18	32	13	33	13	29	12
New England.....	7	12	14	7	21	5	16	14	41	14
Middle Atlantic.....	26	20	34	21	28	15	31	14	28	10
East North Central.....	28	11	35	10	36	7	43	10	36	12
West North Central.....	41	21	31	12	53	8	43	4	18	8
South Atlantic.....	16	22	30	29	21	16	9	25	16	11
East South Central.....	68	58	37	37	84	43	73	32	63	43
West South Central.....	45	30	37	47	25	13	37	13	16	25
Mountain.....	53	0	44	9	35	9	27	9	27	9
Pacific.....	14	10	17	21	7	21	17	7	10	0

## PNEUMONIA DEATH RATES

95 cities.....	198	159	196	143	206	131	210	123	189	110
New England.....	166	151	138	184	189	140	257	144	207	100
Middle Atlantic.....	242	199	246	168	264	166	267	151	218	119
East North Central.....	192	135	215	128	211	121	232	97	222	104
West North Central.....	155	124	90	56	128	68	120	70	88	58
South Atlantic.....	181	179	172	153	184	114	89	128	146	148
East South Central.....	235	160	178	133	214	149	193	128	240	112
West South Central.....	197	81	189	123	90	115	164	140	123	106
Mountain.....	106	161	106	188	159	99	133	54	97	63
Pacific.....	81	97	125	117	74	79	98	114	105	121

*Number of cities included in summary of weekly reports, and aggregate population of cities in each group, approximated as of July 1, 1928 and 1927, respectively*

Group of cities	Number of cities reporting cases	Number of cities reporting deaths	Aggregate population of cities reporting cases		Aggregate population of cities reporting deaths	
			1928	1927	1928	1927
Total.....	101	95	31,657,000	31,050,300	30,960,700	30,369,500
New England.....	12	12	2,274,400	2,242,700	2,274,400	2,242,700
Middle Atlantic.....	10	10	10,732,400	10,594,700	10,732,400	10,594,700
East North Central.....	16	16	7,991,400	7,820,700	7,991,400	7,820,700
West North Central.....	12	10	2,683,500	2,634,500	2,566,400	2,518,500
South Atlantic.....	21	21	2,981,900	2,890,700	2,981,900	2,890,700
East South Central.....	7	6	1,048,300	1,028,300	1,000,100	980,700
West South Central.....	8	7	1,307,600	1,260,700	1,274,100	1,227,800
Mountain.....	9	9	591,100	581,600	591,100	581,600
Pacific.....	6	4	2,046,400	1,996,400	1,548,900	1,512,100

# FOREIGN AND INSULAR

## THE FAR EAST

*Report for the week ended May 12, 1928.*—The following report for the week ended May 12, 1928, was transmitted by the Eastern Bureau of the Health Section of the Secretariat of the League of Nations, located at Singapore, to the headquarters at Geneva:

Plague, cholera, or smallpox was reported present in the following ports:

PLAGUE	SMALLPOX
<i>Aden Protectorate.</i> —Aden.	<i>Egypt.</i> —Alexandria.
<i>India.</i> —Bassein, Bombay, Rangoon.	<i>India.</i> —Bombay, Calcutta, Madras, Moulmein, Negapatam, Rangoon, Tuticorin, Vizagapatam.
CHOLERA	<i>French India.</i> —Pondicherry.
<i>India.</i> —Bassein, Calcutta, Moulmein, Vizagapatam.	<i>China.</i> —Canton, Shanghai, Hong Kong.
<i>Siam.</i> —Bangkok.	<i>Japan.</i> —Osaka.
<i>French Indo-China.</i> —Haiphong, Saigon.	<i>Kwantung.</i> —Dairen.
	<i>South Manchuria.</i> —Changchun, Yingkow.

Returns for the week ended May 12 were not received from Colombo, Ceylon; Samarinda, Dutch East India; nor Vladivostok, Union of Soviet Socialist Republics.

## CANADA

*Provinces—Communicable diseases—Week ended May 12, 1928.*—The Canadian Ministry of Health reports cases of certain communicable diseases from seven Provinces of Canada for the week ended May 12, 1928, as follows:

Disease	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	Total
Cerebrospinal meningitis.....				2				2
Influenza.....	23			11	4			38
Lethargic encephalitis.....				3				3
Poliomyelitis.....				1				1
Smallpox.....				15		12	13	40
Typhoid fever.....	1	1	19	9	1			31

*Quebec Province—Communicable diseases—Week ended May 19, 1928.*—The Bureau of Health of the Province of Quebec reports cases of certain communicable diseases for the week ended May 19, 1928, as follows:

Disease	Cases	Disease	Cases
Chicken pox.....	15	Scarlet fever.....	70
Diphtheria.....	30	Smallpox.....	25
German measles.....	4	Tuberculosis.....	43
Influenza.....	3	Typhoid fever.....	16
Measles.....	132	Whooping cough.....	11

## HAITI

*Epidemic meningitis—Improved conditions.*—Under date of May 26, 1928, the Island of Haiti was reported free from cerebrospinal meningitis, but on May 31 two cases were reported in the interior of the Island.

## PERU

*Lima—Mortality from all causes and from certain diseases—March, 1928.*—During the month of March, 1928, 567 deaths from all causes were reported at the city of Lima, Peru, including deaths from certain diseases as follows:

Disease	Deaths	Disease	Deaths
Cerebrospinal meningitis.....	14	Measles.....	6
Gastroenteritis.....	49	Pneumonia.....	10
Influenza.....	19	Tuberculosis.....	111
Malaria.....	26	Typhoid fever.....	8

Population: 200,000.

## SPAIN

*Mortality from all causes and from certain diseases—April-June, 1927.*—During the months of April, May, and June, 1927, total mortality from all causes was reported in Spain as follows: April, 1927, 32,241 deaths; May, 1927, 31,541 deaths; June, 1927, 34,419 deaths. Deaths from certain causes were reported as follows:

## DEATHS, APRIL TO JUNE, 1927

Disease	April	May	June
Bronchitis:			
Acute.....	1,930	1,351	1,015
Chronic.....	905	651	518
Cancer.....	1,082	1,191	1,279
Diarrhea and enteritis (under 2 years).....	1,816	3,586	7,348
Diphtheria.....	91	74	64
Heart disease.....	3,246	2,817	2,465
Influenza.....	530	288	157
Malaria.....	254	330	433
Nephritis.....	1,045	865	841
Pneumonia.....	832	709	515
Puerperal fever.....	115	94	97
Scarlet fever.....	29	55	37
Smallpox.....	2	1	4
Tuberculosis, pulmonary.....	2,472	2,352	2,135
Meningeal.....	244	284	261
Other forms.....	301	344	334
Typhoid fever.....	244	276	321
Typhus fever.....	1		
Whooping cough.....	68	82	88
All causes.....	32,241	31,541	34,419

Population: 22,390,162.

## UNION OF SOUTH AFRICA

*Cape Province—Natal—Typhus fever—April 8-14, 1928.*—During the week ended April 14, 1928, fresh outbreaks of typhus fever were reported in three districts of the Cape Province and in one district in the Province of Natal. One sporadic case was reported in a European at Durban, Natal, stated to have been imported.

*Month of March, 1928.*—During the month of March, 1928, 115 cases of typhus fever with 33 deaths were reported in the native population of the Union of South Africa, distributed according to Provinces as follows: Cape Province, cases, 107, deaths, 33; Natal, cases, 2; Orange Free State, cases, 4; Transvaal, cases, 2. In the European population in Natal 9 cases were reported.

#### VIRGIN ISLANDS

*Communicable diseases—April, 1928.*—During the month of April, 1928, communicable diseases were reported in the Virgin Islands of the United States as follows:

Disease and island	Cases	Remarks
St. Thomas and St. John:		
Gonorrhea.....	3	
Pellagra.....	1	
Syphilis.....	6	Secondary, 5.
Tetanus.....	1	
Whooping cough.....	9	
St. Croix:		
Gonococcus.....	1	
Syphilis.....	5	Secondary.
Uncinariasis.....	1	Necator americanus.

#### YUGOSLAVIA

*Communicable diseases—April, 1928.*—During the month of April, 1928, communicable diseases were reported in Yugoslavia as follows:

Disease	Cases	Deaths	Disease	Cases	Deaths
Anthrax.....	7	2	Measles.....	2,070	42
Cerebrospinal meningitis.....	15	7	Poliomyelitis.....	2	
Diphtheria.....	151	32	Scarlet fever.....	1,134	187
Dysentery.....	47	1	Tetanus.....	19	13
Leprosy.....	2	2	Typhus.....	10	2
Lethargic encephalitis.....	1	1	Typhoid fever.....	129	12

**CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER**

From medical officers of the Public Health Service, American consuls, health section of the League of Nations, and other sources. The reports contained in the following tables must not be considered as complete or final as regards either the list of countries included or the figures for the particular countries for which reports are given.

## CHOLERA

[C, indicates cases; D, deaths; P, present]

Place	Sept. 25, Oct. 22, 1927	Oct. 23- Nov. 19, 1927	Nov. Dec. 17, 1927	Dec. 18, 1927- Feb. 11, 1928	Week ended—											
					February, 1928		March, 1928						April, 1928			May, 1928
					18	25	3	10	17	24	31	7	14	21	28	
China:																
Amoy.....	16															
Canton.....	14	12	1													
Foochow.....	14	11	1													
Hong Kong.....	P															
Shanghai (settlement and concession)—	P															
Foreigners only.....	3															
Including natives.....	C															
Swatow.....	P	P														
Tientsin.....	P	P	1													
Dutch East Indies: Java—Batavia.....	2	P	3													
India.....	20, 160	18	25, 139	15, 377	12, 391	2, 865	3, 047	3, 250	4, 068	4, 546	5, 384	5, 856	5, 529			
Basseln.....	10, 371	12, 863	15, 026	8, 863	6, 750	1, 529	1, 686	1, 755	2, 312	2, 605	2, 931	3, 182	3, 159			
Bombay.....		2			1		1	1	1	1	1	1	1			
Calcutta.....	101	199	428	176	203	1		80	99	162	164	148	162	163	131	
Madras.....	64	138	281	125	112	35	42	63	101	94	122	114	112	111	97	105
Madras Presidency.....	8	2	7	1	4	2	3	11	7		7	1	2	5	5	5
Negapatam.....	2, 050	3, 073	3, 702	1, 864	4, 681	930	839	621	571	510	455	243	1	4	5	5
Rangoon.....	1, 055	1, 736	2, 104	984	2, 660	504	457	357	300	280	244	131				
	6	2	8	4	6	2	2	2	4	4	4	7	3	1	10	1
	5	5	6	3	2	8	4	4	2	2	2	3	6	5	6	1



## PLAGUE

[C indicates cases; D, deaths; P, present]

[illegible]





## PLAQUE—Continued

**Week ended—**

Place	Week ended—																			
	Sept.			Oct.		Nov.		Dec.		Jan.		Feb.		March, 1928		April, 1928			May, 1928	
	25- Oct. 1927	22, 19, 17, 14, 11, 8	1927	23- Nov. 19, 17, 14, 11, 8	20- Dec. 17, 14, 11, 8	1927	18	25	3	10	17	24	31	7	14	21	28	5	12	19
India.....	8,246 1,792	8 4 3		8,600 2,066	5,518 3,260 4		7,097 4,925 17 14 11 8	12,652 8,521 8 9	5,188 3,585 1 6	5,776 3,993 2 14 7 13	6,136 4,828 4 7 7	6,074 4,566 5 4 4	7,517 6,081 5 4 4	6,077 4,724 5 16 11	6,634 5,372 6 26 25	5,851 4,780 8 21 21	5	1	3	
Bassett.....																				
Bombay.....																				
Calcutta.....																				
Madras Presidency.....																				
Rangoon.....																				
Indo-China (see also table below):																				
Szechwan.....																				
Iraq.....																				
Baghdad.....																				
Dulaim Liwa.....																				
Kwanchow Wan (see table below):																				
Madagascar (see table below)																				
Mauritius (see table below)																				
Nigeria (see also table below):																				
Lagos.....																				
Peru (see table below)																				
Senegal (see also table below):																				
Baol.....	95	P	P																	
Cayor.....	40																			
Dakar.....	176	48																		
Lougla.....	88	28																		
Thies and vicinity.....	1																			
Siam.....	13	1	3	16	20	4	11	14	7	8	13	5	6	11						
Bangkok.....	9	2	2	11	12	10	4	10	12	6	9	10	5	4	3	1				
	2			1	2	1	1	1	1	2	3	1	7	7	2					

Place	July- Sep- tem- ber, 1927	Octo- ber- Decem- ber, 1927	Janu- ary, 1928	Feb- ruary, 1928	March, 1928	April, 1928	May, 1928	Place	July- Sep- tem- ber, 1927	Octo- ber- Decem- ber, 1927	Janu- ary, 1928	Feb- ruary, 1928	March, 1928	April, 1928	May, 1928
Straits Settlements: Singapore	C	1	1	1	1	1	1	Madagascar—Continued.							
Syria (see table below)	D	1	1	1	1	1	1	Italy Province	36	104	33	19			
Tunisia	D	1	1	1	1	1	1	Moromanga Province	41	94	29	17			
Turkey: Constantinople	C	1	1	2	1	1	1	Tananarive Province	12	83	19	23			
Union of South Africa:	D	1	1	1	1	1	1	Mauritius	211	408	135	123			
Cape Province	D	1	1	1	1	1	1	Nigeria (see also table above)	189	354	129	102			
Orange Free State	D	2	2	2	2	2	2	Peru	1	63	16	16			
Union of Soviet Socialist Republics:	D	2	2	2	2	2	2	Senegal (see also table above)	29	61	16	16			
Chita district	D	1	1	1	1	1	1	Callao	34	34	41	41	52		
Northern Caucasus	D	1	1	1	1	1	1	Lima	3	3	3	3	7		
Venezuela: State of Miranda—Tacata and	C	1	1	1	1	1	1	Syria: Beirut	3	3	3	3	5	8	81
Cua	C	1	1	1	1	1	1		2	2	2	2	13	4	40
On vessel:	C	1	1	1	1	1	1								
S. S. Cadwallen at La Plata, from Ro-	C	1	1	1	1	1	1								
sario, Argentina	C	1	1	1	1	1	1								
S. S. Aglios Gerasimos, at Vigo, Spain	C	1	1	1	1	1	1								

\* 8 cases of plague with 6 deaths were reported in Bengardane region, Tunisia, Mar. 17 to 27, 1923.

## PLAQUE RATS ON VESSELS

S. S. *Dryden* at Liverpool from La Plata River ports, January 20, 1928.

## SMALLPOX

[C indicates cases; D, deaths; P, present]

Place	Sept. 25- Oct. 22, 1927	Oct. Nov. 1927	Nov. Dec. 17, 1927	Dec. 18- 1927- Feb. 11, 1928	Week ended—												
					February, 1928				March, 1928				April, 1928				May, 1928
					18	25	3	10	17	24	31	7	14	21	28		
Algeria (see also table below)	683	661	170	129	71	30											
Algiers			3	9	15	5											
Oran	11	20	39	29	11	1											
Angola (see table below)						28	14	3									
Arabia: Aden						4	1										
Brazil (see also table below)			1	3	1	2	2										
Rio de Janeiro						1											
British East Africa (see also table below):																	
Kenya—Mombasa																	
Tanganyika			P	8	6												
British South Africa:																	
Northern Rhodesia	164	185	252	236	23	79	117	38	63		54	8	5				
Southern Rhodesia	11	64	62	31	23	5	32	2	3		9						
Canada:						2	4	P	3		1	2					
Alberta							1										
Calgary	23	10	10	11	27		3		7	7	20	7	13	4	2	3	
Edmonton																	
British Columbia: Vancouver	1	1	8	5	3	1	11	1	1	1	11	1	7	2		1	
Manitoba			4	8	26	2	1	3	4	2	5	6	4	11	6	1	
Winnipeg	7	19	7	11	1											6	
New Brunswick	2	3	2	2	2											4	
New Scotia:																7	
Halifax																1	
Ontario:	1																
Hamilton	96	264	347	212	243	40	51	36	20	19	35	20	9	6	18	8	
Kingston			2	1	1											15	
Kingston			1	1	1									2	1	1	







### SMALLPOX—Continued

[O indicates cases; D, deaths; P, present]

Place	Week ended—																											
	February, 1928				March, 1928				April, 1928				May, 1928															
	18		25		3		10		17		24		31		7		14		21		28		5		12		19	
Senegal (see also table below):																												
Dakar.....	O																											
Siam.....	O																											
Bangkok.....	O																											
Spain (see also table below):																												
Malaga.....	O																											
Seville.....	O																											
Vallencia.....	O																											
Strait Settlements; Singapore.....	O																											
Sudan (Anglo-Egyptian).....	O																											
Sudan (French) (see table below).	O																											
Switzerland.....	O																											
Syria (see table below).	O																											
Tunisia; Tunis.....	O																											
Union of South Africa:																												
Cape Province.....	O																											
Natal.....	O																											
Orange Free State.....	O																											
Transvaal.....	O																											
Union of Soviet Socialist Republics (see table below).	O																											
Upper Volta.....	O																											
Venezuela:																												
On vessel:																												
Maracaibo.....	D																											
S. S. Arendskerk at Singapore, from Amoy, China.	O																											
S. S. Tyllieboet at Hong Kong, from Shanghai.	O																											
S. S. Yarmouth at Kingston, Jamaica, from Habana, Cuba.	O																											





## TYPHUS FEVER

[C indicates cases; D, deaths; P, present]

[illegible]



## TYPHUS FEVER—Continued

[C indicates cases; D, deaths; P, present]

## YELLOW FEVER

[C indicates cases; D, deaths; P, present]

[illegible]

