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A CHRONIC DEFICIENCY OF (1) CALCIUM, (2) VITAMIN C, AND (3) BOTH CALCIUM AND VITAMIN C IN MONKEYS

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The pathologic condition induced by excluding as completely as possible certain dietary essentials from animals is frequently very striking. It should be recognized, however, that such experiments represent artificial conditions to which the animal or man is rarely, if ever, exposed under natural conditions. It was decided, therefore, in the experiments herein reported, to observe the effect in monkeys of a chronic or partial deficiency of (1) calcium, (2) vitamin C, and (3) both calcium and vitamin C. The mouth lesions in these animals are separately reported by Fraser and Topping, and the histopathology by Tomlinson. These subjects are made the basis of two concurrent reports.

Selection and grouping of animals.—Thirty monkeys were placed in individual screen-bottom cages and preliminary observations made for symptoms of disease. This included a record of the temperature daily except Sunday for 5 weeks, one stool culture, a weekly weight record, and two complete blood counts on each animal. Following such initial observations, 24 monkeys in good condition were selected and divided into groups, being equalized as evenly as possible, taking into account age as estimated from the teeth (1), sex, and weight.

Four monkeys received control diet 516 composed of natural foods; 8 animals received control diet 517 composed of processed foods with calcium in the salt mixture and appropriately supplemented with vitamin C; 4 animals received diet 518 which was deficient in calcium; 4 animals were given diet 519 containing inadequate supplements of vitamin C; and 4 animals were placed on a regime of chronic deficiency respecting both calcium and vitamin C as provided by diet 520.

One monkey receiving control diet 517 consistently refused his food and was discontinued after 22 days. Another monkey on the calcium and vitamin C deficient diet developed acute pulmonary tuberculosis and was killed after 21 days. Each of these was replaced by a monkey from the stock colony in good condition. Except for these two animals, no substitutions or additions were made to the experimental group.

Diets served monkeys.—The composition of the above diets and their method of preparation are presented in table 1.

Salt mixture A is a modification of Hubbel, Mendel, and Wakeman (3). One kg. of this salt mixture contains the following ingredients with a ratio as specified: calcium carbonate 474, manganous sulfate, anhydrous, 0 76, potassium iodide 0.17, sodium fluoride 0.22, cupric sulfate 1.95, magnesium carbonate 54, magnesium sulfate 34.9, sodium chloride 149, potassium chloride 242, and ferric citrate 43.

¹ From the Division of Chemotherapy, National Institute of Health.

TABLE 1.—Composition and preparation of diets

| Nutrients | Diet number | | | | |
|--|---|-------------------------|-----------------------------------|---|---|
| | 516 ¹ Control | 517 Control (gm.) | 518 Ca defi- cient (gm.) | 519 Vitamin C defi- cient (gm.) | 520 Ca and vitamin C defi- cient (gm.) |
| Graham flour ² | Composed of the fol- lowing natural foods: Whole milk, Irish po- tatoes, lettuce, eggs, whole-wheat bread, bananas, carrots, and cabbage. | 15 | 15 | 15 | 15 |
| Corn meal ² | | 50 | 50 | 50 | 50 |
| Sucrose..... | | 8.95 | 8.95 | 8.95 | 8.95 |
| Cottonseed oil ² | | 5 | 5 | 5 | 5 |
| Butterfat, dehydrated..... | | 1 | 1 | 1 | 1 |
| Liver, dried ³ | | 7 | 7 | 7 | 7 |
| Cassia, leached..... | | 10 | 10 | 10 | 10 |
| Liver extract 343 Lilly..... | | 0.1 | 0.1 | 0.1 | 0.1 |
| Cod liver oil..... | | 2 | 2 | 2 | 2 |
| Salt mixture A, with CaCO ₃ ⁴ | | 0.95 | | 0.95 | |
| Salt mixture B, without CaCO ₃ ⁴ | | | 0.5 | | 0.5 |
| Average supplement vitamin C daily..... | | mg. None | mg. 30 | mg. 30 | mg. 1.96 mg. or less |

¹ The composition and schedule for monkey diet 516 is the same as that of 495A used in other experiments previously reported (2), except that 2 additional eggs were given each monkey each week and 300 ml. instead of 250 ml. of milk were provided daily.

² These items are stirred into water in a double boiler of enamelware and cooked for 1½ hours. Then the other ingredients are well stirred in; the completed diet is dried for 3 hours and fed *ad libitum*.

³ The pork liver was cooked in a double boiler for 30 minutes and then air- and oven-dried. For a period of 31 days, from Dec. 15, 1939, to Jan. 15, 1940, the liver received the additional treatment of autoclaving for 1½ hours.

Salt mixture B is identical with salt mixture A except that the calcium carbonate has been omitted.

Diets 517 and 518 were supplemented with 30 mg. of vitamin C given 5 days a week and 60 mg. 1 day a week. Animals which received diets 519 and 520 received daily or intermittent allowances of small amounts of vitamin C as shown in table 2. All supplements of vitamin C were given by intramuscular injection.

TABLE 2.—Vitamin C schedule of each monkey with chronic vitamin C deficiency or chronic vitamin C plus chronic calcium deficiency

| May 17 to Aug. 7, 1939 | Aug. 7 to Dec. 13, 1939 ¹ | Dec. 13 to Jan. 11, 1940 | Jan. 12, 1940 | Jan. 26 to Apr. 19, 1940, each animal received 3 or 6 mg. dose for symptoms | | Total vitamin C each monkey | |
|---|--|-----------------------------------|--|---|-------------------------------|-----------------------------|---------------------|
| | | | | Monkey No. | Total mg. of 3 or 6 mg. doses | | Days on ex-periment | Total C in mg. |
| Each monkey received 3 mg. of vitamin C for 5 days and 6 mg. for 1 day each week, a total of 243 mg. for this period. | Each monkey received 3 mg. 3 times a week, a total of 165 mg. for this period. | No monkey received any vitamin C. | Four animals 473, 400, 475, and 477 each received 30 mg. | ² 461 | 63 | 340 | 471 |
| | | | | ² 473 | 51 | 336 | 489 |
| | | | | ² 459 | 33 | 335 | 441 |
| | | | | ² 400 | 39 | 337 | 477 |
| | | | | ² 471 | 48 | 335 | 456 |
| | | | | ² 475 | 45 | 334 | 483 |
| | | | | ² 475 | 33 | 333 | 473 |
| | | | | ² 477 | 48 | 341 | 486 |

¹ Monkey 479 was given 30 mg. of vitamin C on Nov. 18, 1939, by mistake as the animal showed no symptoms of deficiency.

² Vitamin C deficient.

³ Vitamin C plus calcium deficient.

Calcium deficient diets 518 and 520, by chemical analysis prior to cooking, contained 10.2 mg. of calcium per 100 gm. of ration and the calcium control diet 517 contained 190 mg. of calcium per 100 gm. of ration. The amount of each basal ingredient, except for the salt mixture, is identical for diets 517, 518, 519, and 520. The basal constituents of each of these diets contain 380 mg. of phosphorus per 100 gm. No phosphorus was added to either salt mixture, hence the amount of phosphorus in each of these diets is comparable.

Concurrent check assays of monkey diets in rats and guinea pigs.—Three separate groups of rats composed of 40, 20, and 10 animals, ranging in age from 21 to 25 days and including males and females, were used to test diets 517 and 518 as served to monkeys. They were observed for rate of growth, symptoms, ability to reproduce, and success in lactation. Rats on control diet 517 grew well and were successful in reproduction and lactation. Rats on calcium deficient diet 518 showed symptoms of loss of weight, depilation, irritability, muscular weakness, and paralysis of hind legs. Many of these animals died by the tenth week of the experiment.

Twenty-four guinea pigs were used to test for the presence of vitamin C in the dried liver by comparing it with dried liver from the same lot which was autoclaved for 1½ hours. There was no vitamin C in the liver by biological tests and none was found by titrating the extracted liver with 2-6 dichlorophenol-indophenol.

Since the monkeys received autoclaved liver for 31 days, 20 additional rats were used to test the effect of this change in the basal diet. There was no difference noted in rats by such a change in the liver preparation. (There was also no evidence that the substitution of autoclaved liver affected the monkeys.)

Clinical course of animals.—In planning the experiment it was considered desirable to maintain the animals in a chronic phase of depletion and then observe their response to therapy of minimum doses. The four calcium deficient monkeys on diet 518 showed no conspicuous clinical symptoms for 11 months. Consequently no calcium therapy was given to any animal. Of the 8 animals on a low calcium intake, either alone or associated with vitamin C deficiency, 6 were sacrificed after 11 months on the diet and 2 calcium deficient animals were continued for 7 additional months on the same diet.

Except for 1 animal, the 8 animals which received the low allowance of vitamin C either alone or in combination with a low calcium intake showed no conspicuous symptoms of vitamin C depletion from May 17, 1939, to December 13, 1939. In order to induce characteristic symptoms of scurvy, all supplements of vitamin C were discontinued for these 8 animals beginning December 13, 1939. After varying intervals without vitamin C, all of these monkeys manifested typical symptoms of vitamin C depletion.

The individual weight curves of monkeys in each of the groups are shown in figure 1. It is noted that many animals distributed in all groups, except those receiving a stock diet, manifested a precipitous drop in weight about 10 weeks after the experimental diets started. This was caused in each instance by an acute attack of bloody diarrhea of undetermined etiology from which all the animals apparently made a complete recovery.

Determinations of the hemoglobin content and red and white blood cell counts were made at intervals of about 5 weeks. Blood was withdrawn for these counts between 1:00 and 2:30 p. m., prior to feeding the animals. The hemoglobin content was ascertained by

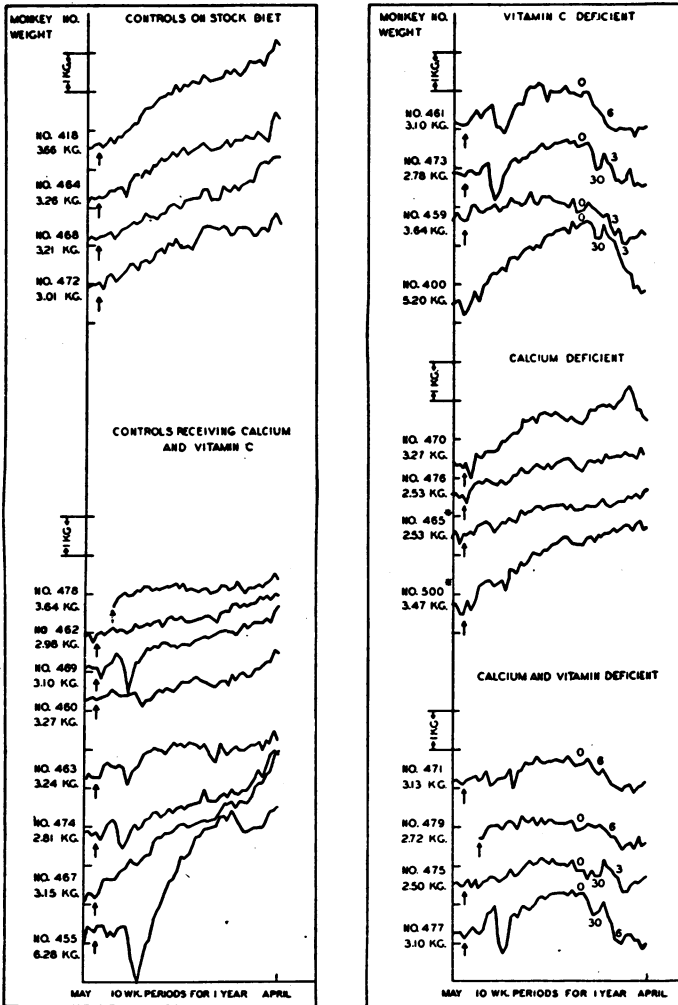


FIGURE 1.—Weight curves.

↑=Start of experimental diet.

0=Vitamin C supplements to basal diet were discontinued.

30=30 mg. of vitamin C were given intramuscularly.

3 or 6=Started 3 and 6 mg. doses of vitamin C for treating advanced symptoms of deficiency.

*=These 2 animals were continued for an additional 7 months on calcium deficient diet.

the Newcomer method. The hemoglobin of monkey 459 which received the vitamin C deficient diet declined from 15.2 to 6.4 gm. per 100 cc. of blood during the 333 days of depletion. Monkey 473 on the same regime showed a decrease of from 14.3 to 8.6 gm. and monkey 477, on a combined deficiency of vitamin C and calcium,

showed a decrease of from 16.7 to 8.4 gm. in a similar period. No other animals showed a significant reduction of hemoglobin content.

There was a tendency for the 8 animals on a vitamin C deficiency diet, either alone or combined with a calcium deficiency, to show lower white blood cell counts than comparable controls or animals ingesting natural foods. The average white blood cell count of the 8 vitamin C deficient animals at the beginning of the experiment was 16,600 and 11 months later it was 12,800.

There was no evidence that any of the deficiencies tested significantly reduced the red blood cell count.

TABLE 3.—Calcium content of femurs and blood serum determinations of calcium, total protein, albumin, globulin ratio and nonprotein nitrogen ¹

| Diet No. | Diet deficiency | Monkey No. | Age, mos. ⁴ | Percent calcium in femurs based on ² — | | | Blood serum content of— | | | |
|--------------|--------------------------------------|--------------------|------------------------|---|------------------------|---------------|-------------------------------|-----------------------|-------------------------|-------|
| | | | | Volume cleaned bone ³ | Weight ether ext. bone | Weight of ash | Ca. mg., ³ percent | Protein, gm., percent | Albumin globulin, ratio | N P N |
| 516 | None (stock diet)..... | { 464 | 35 | 20.1 | 22.3 | 38.4 | 11.2 | 7.57 | 2.24 | 48 |
| | | { 472 | 33 | 20.8 | 22.9 | 38.5 | 12.9 | 7.25 | 2.08 | 30 |
| | Average..... | | | 20.5 | 22.6 | 38.5 | 12.1 | 7.41 | 2.16 | 39 |
| 517 | None (controls)..... | { 478 | 38 | 20.8 | 21.8 | 38.0 | (⁵) | | | |
| | | { 469 | 27 | 18.7 | 22.1 | 38.1 | 12.2 | 8.22 | 2.20 | 47 |
| | | { 463 | 38 | 21.2 | 22.4 | 38.1 | 13.4 | 8.25 | 2.09 | 52 |
| | | { 455 | 43 | 23.8 | 22.9 | 38.5 | 13.3 | 7.65 | 2.14 | 36 |
| Average..... | | | 21.1 | 22.3 | 38.2 | 13.0 | 8.04 | 2.14 | 45 | |
| 518 | Calcium deficient..... | { ⁶ 470 | 37 | 16.6 | 20.5 | 37.5 | 7.6 | 8.75 | 1.50 | 34 |
| | | { ⁶ 476 | 27 | 10.5 | 18.3 | 38.2 | 9.1 | 7.85 | 1.97 | 37 |
| | | { ⁶ 465 | 33 | 9.9 | 17.8 | 37.6 | 5.0 | | | |
| | | { ⁶ 500 | 37 | 7.5 | 15.2 | 37.1 | 5.5 | | | |
| Average..... | | | 11.1 | 18.0 | 37.6 | 6.8 | 8.30 | 1.74 | 36 | |
| 519 | Vitamin C deficient..... | { 461 | 35 | 14.5 | 22.0 | 38.0 | 11.6 | 7.16 | .74 | 43 |
| | | { 473 | 27 | 12.5 | 21.1 | 38.0 | 12.7 | 6.50 | .90 | 53 |
| | | { 459 | 49 | 20.0 | 22.8 | 38.4 | 11.8 | 8.02 | .74 | 58 |
| | | { 400 | 47 | 19.9 | 24.1 | 38.3 | 12.4 | 6.67 | 1.37 | 56 |
| Average..... | | | 16.7 | 22.5 | 38.2 | 12.1 | 7.19 | .94 | 53 | |
| 520 | Calcium and vitamin C deficient..... | { 471 | 40 | 12.4 | 21.5 | 38.2 | 12.6 | 6.80 | 2.06 | 51 |
| | | { 479 | 26 | 10.4 | 20.8 | 37.7 | 11.1 | 7.66 | 1.21 | 37 |
| | | { 475 | 32 | 12.4 | 20.3 | 37.2 | 11.8 | 8.02 | .74 | 58 |
| | | { 477 | 27 | 8.4 | 18.5 | 37.2 | | | | |
| Average..... | | | 10.9 | 20.3 | 37.6 | 11.8 | 7.49 | 1.34 | 49 | |

¹ The calcium determinations of the femurs were made by Norman Sharpless under the direction of Lawrence T. Fairhall, principal industrial toxicologist of the National Institute of Health.

The blood serum determinations were made in the Biochemical Laboratory, University of Virginia, through the courtesy of Prof. Alfred Chanutin.

² Calcium of the bone was determined volumetrically as the oxalate (Sutton, F.: Volumetric Analysis, 12th ed., J. & A. Churchill, Ltd., London, 1935. P. 201).

³ Calcium of the serum was determined according to Halverson and Bergeim as given in Peters and Van Slyke.

⁴ All values listed in this table were ascertained when the animal was sacrificed at the conclusion of the experiment. The age in months, however, represents the estimated age at the start of the experiment.

⁵ 11 months on calcium deficient diet.

⁶ 18 months on calcium deficient diet.

⁷ A space with no values in it indicates that no determinations were made on that animal.

The calcium content of one femur from each animal examined is shown in table 3. It should be noted that the percentage of calcium based on the volume of the cleaned bone brings out the most striking differences between the groups and corresponds most satisfactorily

with the clinical course of the animal, röntgenograms of each skeleton, and the post-mortem appearance of the bones. A very marked depletion of bone calcium content occurred in the monkeys on a chronic calcium deficiency and a chronic calcium associated with a chronic vitamin C deficiency regime. There is a considerable depletion of bone calcium in the case of young monkeys in the vitamin C deficient group but not in the case of older animals in this same group.

The blood serum calcium mg. percent is shown in table 3 and it is noted that there is no appreciable reduction for any group except the chronic calcium deficient animals (4). Values of 5.0 and 5.5 mg. percent were obtained on two calcium deficient animals on this regime for 18 months. It is noteworthy that when the calcium deficiency was associated with a concurrent vitamin C deficiency there was no evidence of a lowering of blood serum calcium content. In the combined deficiency of calcium and vitamin C, a normal level of blood serum calcium persisted despite an extensive depletion of calcium content of the bone.

Table 3 demonstrates that none of the deficient animals suffered a significant reduction of total protein in the blood serum, even though they showed a considerable curtailment of food intake. There was, however, a significant reduction in the serum albumin content and an increase in the serum globulin fraction, resulting in reversal of the albumin to globulin ratio, particularly in the case of vitamin C deficiency.

The animals on the calcium deficiency regime displayed no symptoms for 10 months. Shortly after this, monkey 470 showed a moderately rapid decline in weight.

Monkey 465 continued on the calcium deficient regime for 488 days before manifesting a decline in weight, and for 521 days before showing symptoms of mild diarrhea, some increase in irritability, reduced activity, muscle atrophy and loss of muscle tone.

Monkey 500 continued on the calcium deficient regime for 432 days before showing a decline in weight. At this time he displayed symptoms of irritability, 1 month later anorexia, and, after 475 days, a considerable weakness of the hind legs. At the conclusion of 543 days on the calcium deficient diet he would scream and shriek when being caught in the net and would "tremble all over" while receiving an intramuscular injection of vitamin C. He was unable to walk well and would move about slowly on his rump using his arms and legs in the sitting position for locomotion. There was considerable atrophy of muscles, together with loss of muscle tone. The fur was stringy but did not pull out. His condition remained the same until he was sacrificed after 551 days on the experimental diet. The first definite symptom in this monkey was weakness of the hind legs which appeared after a year on the deficient diet.

It should be stated that monkeys 465 and 500 were transferred from Washington, D. C., to Wilson Dam, Ala., at the conclusion of 1 year. Temporarily after this they showed symptoms of decreased activity from which they recovered in a few days.

In the monkeys on a chronic deficiency of (a) vitamin C, and (b) chronic deficiency of calcium and vitamin C, there was a noteworthy delay in the onset of symptoms of vitamin C deficiency, except for one large monkey, number 400, on a vitamin C deficient diet. Monkeys were classified as having clinical scurvy if they had two or more symptoms of this disease which progressed and did not heal spontaneously. Monkey 400 weighed 5.2 kg. at the beginning of the experimental diet on May 17. He gained weight rapidly, obtaining a maximum of 7.64 kg. on December 27. After 1 month on a vitamin C intake of 3 mg. per day, this large, rapidly growing animal began to show a definite gingivitis. One week later the gingivitis was associated with hemorrhage. Since this condition persisted or progressed, together with other symptoms, until the monkey was treated with vitamin C, the condition should be considered as scurvy which began about 5 weeks after the start of the experimental diet.

The three other animals on diet 519, which provides a low vitamin C intake, developed scurvy 21, 21, and 44 days after the cessation of vitamin C supplements.

The four animals on diet 520, which is deficient in both calcium and vitamin C, developed scurvy after 21, 29, 29, and 44 days following the discontinuance of vitamin C supplements.

The outstanding symptoms of the vitamin C deficient monkeys may be reviewed briefly. The animals developed hemorrhagic gingivitis, hemorrhage about the eyes including retrobulbar hemorrhage, loss of weight, dryness of skin, and rough appearance of the fur, which shed readily and in many animals could be pulled out by the handful. The young animals showed extensive bone and joint pathology with complete obliteration of the epiphyseal line by impaction of the epiphysis on the diaphysis with ankylosis of the knee joint in many animals. These bony changes crippled them greatly and none of the younger animals could walk when symptoms advanced. There was progressive muscular atrophy and loss of muscle tone in all vitamin C deficient animals. There was no evidence of aggravation of vitamin C deficiency by superimposing a calcium deficiency upon it. In fact, the incipient symptoms of vitamin C deficiency appeared to be delayed in the animals suffering from vitamin C and calcium deficiency combined.

DISCUSSION

For the purpose of orientation it may be stated that the life span of the *Macacus rhesus* monkey approximates ten times that of the rat

(5) and one-third that of man (1). Hence 11 months on a low intake of calcium and vitamin C could be interpolated to approximately 33 months in the life cycle of man, and the 18 months during which two animals remained on the extremely low calcium intake would be analogous to $4\frac{1}{2}$ years in the case of man. It should be remembered that these monkeys from the point of view of chronological age of man were from $6\frac{1}{2}$ to 12 years old when they started the experiment and that 22 of them were observed for approximately 3 man-years or during a rapid growth phase which included the period of puberty in many instances.

In this connection it is interesting to observe that Boelter and Greenberg (6) noted a decline in the weight curve of young rats receiving approximately 10 mg. of calcium per 100 gm. of diet after about 49 days. Interpolated to monkey days this is equivalent to 490 days and is consistent with the results herein reported. Boelter and Greenberg (7) observed that the calcium content of the blood serum of the rat decreased to around 5 mg. per 100 cc. after about 8 weeks. Theoretically comparable findings should occur in the monkey after about 560 days. Actually two monkeys after 547 days on a low calcium diet showed values of 5 and 5.5 mg. per 100 cc. of blood. Values definitely higher than these were observed at the conclusion of 330 days in two other animals. In agreement with Boelter and Greenberg's (6) observations in rats, monkeys showed no tetany despite low blood calcium content, and the hemoglobin content was not affected by calcium deprivation. Rats on parallel calcium deficient diets likewise showed as their outstanding symptoms, weakness, muscle atrophy, loss of activity and, finally, paralysis of the hind legs. Gross hemorrhage of the internal organs was not observed in the case of calcium deficient monkeys or rats such as is described by Aron and Sebauer (8), Martin (9), and Boelter and Greenberg (6) in dogs and rats.

Respecting vitamin C all the animals on this chronic deficiency regime very uniformly resisted weight loss until they had been on the diet for an average of 224 days (fig. 1). Apparently definite weight loss was not precipitated until vitamin C supplements had been discontinued entirely. It would appear from the data on vitamin C supplements, computed from table 1, that an average dose of 1.96 mg. per day for 208 days was sufficient to protect 7 growing monkeys weighing 3.64 kg. or less from typical symptoms of scurvy under the conditions of this experiment. These animals then developed scurvy after a minimum of 21 days and a maximum of 44 days or an average of 28 days when vitamin C supplements were discontinued. One monkey (400), weighing 5.2 kg., developed

symptoms of scurvy but nevertheless maintained a rapid rate of growth on an average of 1.96 mg. per day for a period of 208 days.

SUMMARY

The influence of a chronic deficiency of calcium, vitamin C, and a combined deficiency of these dietary components has been studied in young monkeys.

Symptoms of calcium depletion appear after about 1 year on a diet containing 10.2 mg. per 100 gm. of diet. They consist of loss of weight, weakness, muscular atrophy, irritability, decreased activity, and a paralysis of the hind legs developed in one animal. The bones of all monkeys on a calcium deficient diet showed a very low calcium content. The bones of two young monkeys on a vitamin C deficient diet showed a low calcium content as compared with two older animals in the same group.

The conspicuous symptoms of chronic vitamin C depletion observed in the monkeys of this experiment are: Anorexia, loss of weight, loss of hair, hemorrhage of the gingiva and other tissues, inability to walk because of extensive joint hemorrhage, and finally ankylosis of knee joints.

There was no evidence that a chronic deficiency of both calcium and vitamin C influenced the course of these animals other than what might be anticipated from an addition of their individual effects.

ACKNOWLEDGMENT

The writer is indebted to the Health and Safety Department of the Tennessee Valley Authority for laboratory facilities during a portion of this investigation.

REFERENCES

- (1) Hartmann, Carl G., and Straus, W. L.: *The Anatomy of the Rhesus Monkey*. Williams and Wilkins, Baltimore, 1933.
- (2) Topping, N. H., and Fraser, H. F.: Mouth lesions associated with dietary deficiencies in monkeys. *Pub. Health. Rep.*, **54**: 416 (1939).
- (3) Hubbel, R. B., Mendel, L. B., and Wakeman, A. J.: New salt mixture for use in experimental diets. *J. Nutrition*, **14**: 273 (1937).
- (4) Todhunter, E. N., and Brewer, W.: The ascorbic acid, phosphatase and calcium contents of the blood of guinea pigs with varying degrees of scurvy. *Am. J. Physiol.*, **130**: 310 (1940).
- (5) Donaldson, Henry H.: *The Rat*. 2nd ed.; Westar Institute, Philadelphia, 1924.
- (6) Boelter, M. D. D., and Greenberg, D. M.: Severe calcium deficiency in growing rats. I. Symptoms and pathology. *J. Nutrition*, **21**: 61 (1941).
- (7) Boelter, M. D. D., and Greenberg, D. M.: Severe calcium deficiency in growing rats. II. Changes in chemical composition. *J. Nutrition*, **21**: 75 (1941).
- (8) Aron, Hans, and Sebauer, Robert: Untersuchungen über die Bedeutung der Kalksalze für den wachsenden Organismus. *Biochem. Ztschr.*, **8**: 1-28 (1908).
- (9) Martin, G. J.: A calcium deficiency syndrome produced in growing animals. *Growth*, **1**: 175 (1937).

MOUTH LESIONS IN MONKEYS ASSOCIATED WITH A CHRONIC DEFICIENCY OF (1) CALCIUM, (2) VITAMIN C, AND (3) BOTH CALCIUM AND VITAMIN C^{1,2}

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Fraser³ has described in detail the experimental diets and clinical course of 24 monkeys which were placed on control diets, a chronic deficiency of calcium, vitamin C, and a deficiency of both calcium and vitamin C. Tomlinson⁴ is reporting the histopathology in these animals. This includes microscopic sections of the mandible, maxilla, teeth, gingiva, and associated tissues.

The purpose of this paper is to present in detail observations made on the mouths of these 24 monkeys. Twenty-two animals were maintained for 11 months on complete control diets and diets partially deficient in calcium or vitamin C, as well as diets deficient in both of these dietary essentials. Since none of the animals in the calcium deficient group showed any symptoms after 11 months on this regime, 2 of them, Nos. 465 and 500, were continued for an additional 7 months on this diet.

The individual protocol of each monkey is presented in table 1.

Photographs were taken of the mouths of all the monkeys before the experimental diets were begun, after 239 days on the various diets, and directly following the sacrifice of each animal. These photographs were carefully reviewed in evaluating the clinical progression of the lesions, and particularly in weighing the severity of lesions at death.

Since it is impracticable to publish the series of photographs for each animal, typical examples have been selected of the mouths of two normal animals following 11 months on the control diet and other pictures demonstrating additional types of lesions (as listed in table 1) observed at death. These photographs are presented in figures 1 to 6, inclusive, and illustrate the descriptive terms employed.

¹ From the Division of Chemotherapy and the Division of Infectious Diseases, National Institute of Health.

² N. H. Topping and H. F. Fraser (Pub. Health Rep. 54: 416 (1939)) and T. H. Tomlinson (Pub. Health Rep. 54: 431 (1939)) have presented the symptomatology and histopathology of mouth lesions in monkeys acutely deprived of vitamins A, C, D, nicotinic acid, and riboflavin. The former report summarized the pertinent literature respecting gingivitis, periodontal disease, stomatitis, and noma in both experimental animals and man.

³ The preceding article of this issue.

⁴ This report will be published in the PUBLIC HEALTH REPORTS, Vol. 57, No. 17 (July 3, 1941).

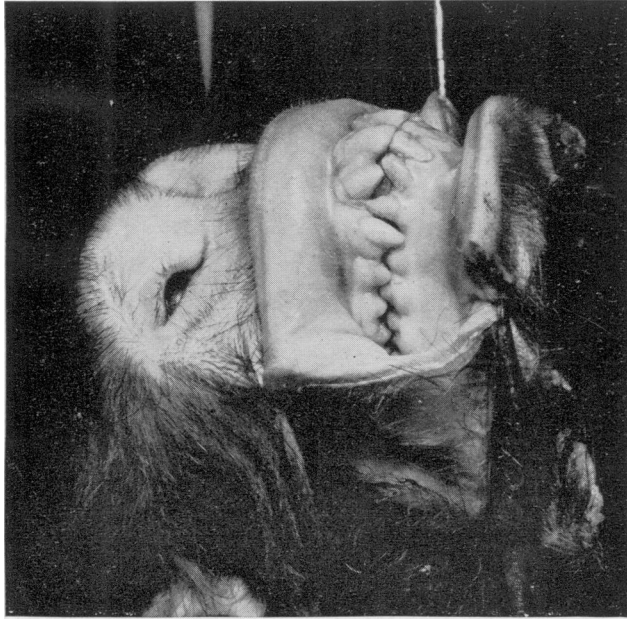


FIGURE 1.—Post-mortem photograph of monkey 463, illustrating normal gingiva and mucosa (control diet 517).

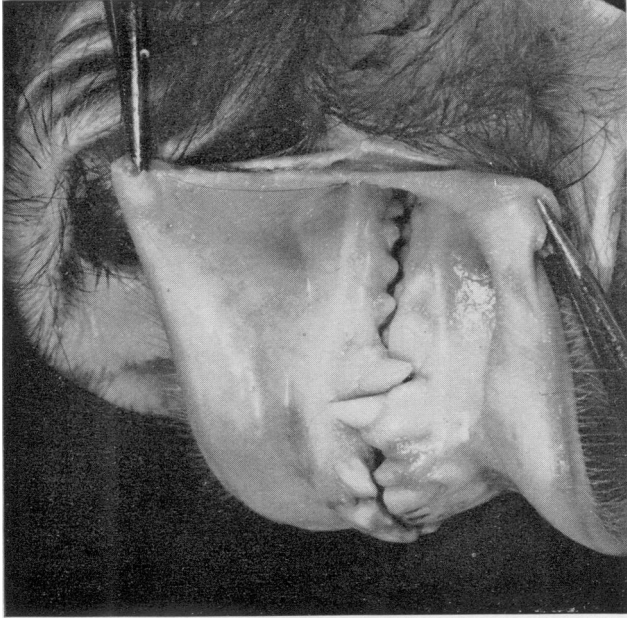


FIGURE 2.—Post-mortem photograph of monkey 455, illustrating normal gingiva and mucosa (control diet 517).

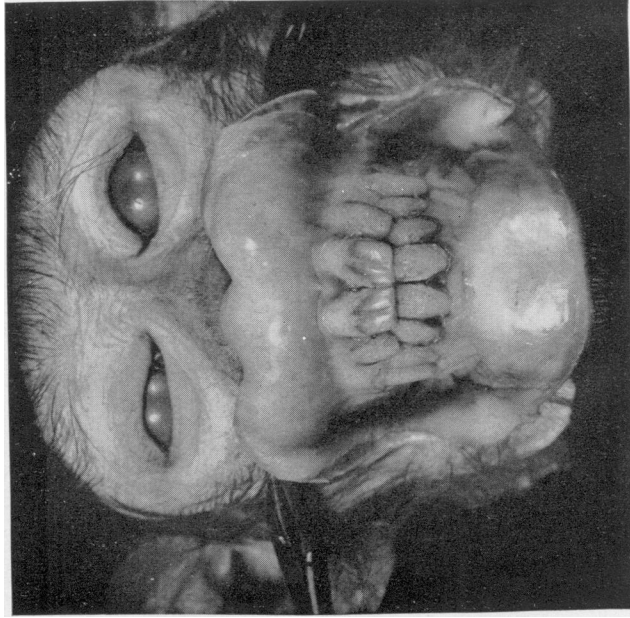


FIGURE 3.—Post-mortem photograph of monkey 459, illustrating 3+ inflammation, 4+ localized recession, 3+ deposit of food and debris, 3+ hemorrhagic gingivitis, 4+ necrosis of interdental papillae, and 3+ necrotic gingivitis (vitamin C deficient diet).

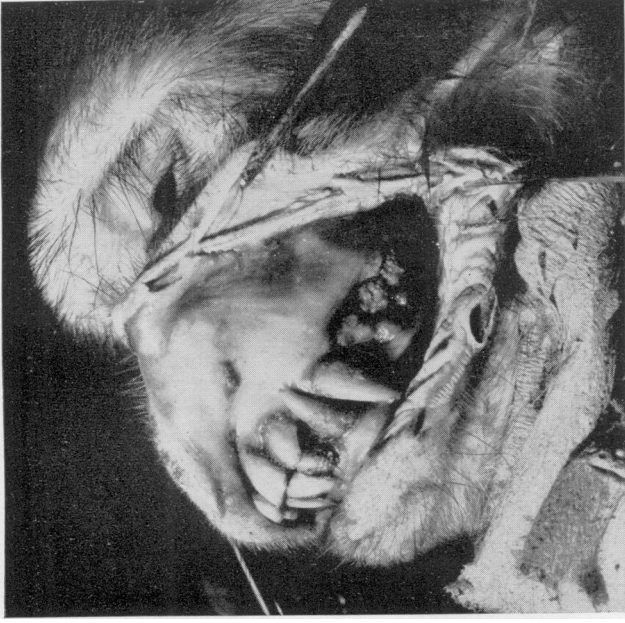


FIGURE 4.—Post-mortem photograph of monkey 400, illustrating 4+ inflammation, 4+ localized recession, 4+ deposit of food and debris, 4+ hemorrhagic gingivitis, 4+ necrosis of interdental papillae, and 4+ necrotic gingivitis (vitamin C deficient diet).

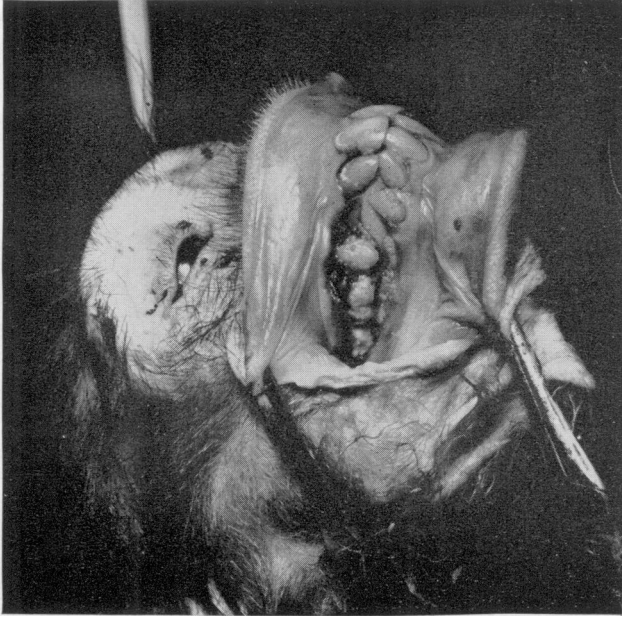


FIGURE 5.—Post-mortem photograph of monkey 461, illustrating 4+ inflammation, 4+ localized recession, 3+ deposit of food and debris, 4+ hemorrhagic gingivitis, 4+ necrosis of interdental papillae, and 4+ necrotic gingivitis (vitamin C deficient diet).



FIGURE 6.—Post-mortem photograph of monkey 477, illustrating 2+ inflammation, 2+ localized recession, 1+ deposit of food and debris, 2+ hemorrhagic gingivitis, 2+ necrosis of interdental papillae, and 1+ necrotic gingivitis (calcium deficient and vitamin C deficient diet).

TABLE 1.—*Summarization of pertinent data*

| Diet number | Vitamin or mineral deficiency | Monkey number | Sex | Estimated age in months at beginning of experiment | Numbers of days before mouth lesions developed | Description of mouth lesions when first noted | Progress of lesions and response to treatment | Description of mouth lesions at termination of experiments † | | | | | | |
|-------------|-------------------------------|---------------|-----|--|--|---|---|--|---------------------|-----------------------------|------------------------|----------------------------------|---------------------|---|
| | | | | | | | | Inflammation | Localized recession | Deposits of food and debris | Hemorrhagic gingivitis | Necrosis of interdental papillae | Neurotic gingivitis | |
| 1516 | None (controls) | 418 | 0 | 39 | 0 | None | None | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | 464 | 0 | 35 | 216 | Unabsorbed tooth root associated with small draining sinus. | Recovery in 14 days | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | 468 | 0 | 40 | 0 | None | None | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | 472 | 0 | 33 | 0 | do | do | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | 478 | 0 | 38 | 1 | Repeated trauma with hemorrhage of gums from capping with net. | do | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | 462 | 0 | 39 | 0 | None | do | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | 466 | 0 | 27 | 0 | do | do | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | 460 | 0 | 32 | 0 | do | do | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | 463 | 0 | 38 | 15 | Slight localized gingivitis at start of experimental diet period. | Gingivitis and hemorrhage. After loss of deciduous teeth in affected areas all symptoms subsided. | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 474 | 0 | 27 | 139 | Slight gingivitis and debris accumulation about left upper second molar. | Moderate gingivitis with some hemorrhage which localized to upper second molar area. | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 2617 | None (controls) | 467 | 0 | 35 | 0 | None | None | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | 465 | 0 | 43 | 0 | do | do | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | 470 | 0 | 37 | 1 | Trauma upper premolar area bilaterally. | Injected upper premolar area and some collection of debris—subsided. | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | 476 | 0 | 27 | 176 | Abscess of gum at site of deciduous tooth which failed to shed. | Recovery | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | 465 | 0 | 33 | 543 | Moderate redness of gingival margin and 2+ accumulation of food and debris. | Redness of gingiva generalized with hemorrhage | 1 | 1 | 2 | 1 | 0 | 0 | 0 |
| 618 | Calcium deficient | 500 | 0 | 37 | 0 | None | None | 0 | 0 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | |

† See footnote at end of table.

TABLE 1.—*Summarization of pertinent data—Continued*

| Diet number | Vitamin or mineral deficiency | Monkey number | Sex | Estimated age in months at beginning of experiment | Numbers of days before mouth lesions developed | Description of mouth lesions when first noted | Progress of lesions and response to treatment | Description of mouth lesions at termination of experiments: | | | | | |
|-------------|-------------------------------|---------------|-----|--|--|--|--|---|---------------------|-----------------------------|------------------------|----------------------------------|---------------------|
| | | | | | | | | Inflammation | Localized recession | Deposits of food and debris | Hemorrhagic gingivitis | Necrosis of interdental papillae | Necrotic gingivitis |
| | | 461 | 0 | 35 | 20 | Very slight gingivitis and accumulation of debris in left upper molar area at start of experimental diet period. | | 4 | 4 | 3 | 4 | 4 | 4 |
| | | 473 | 0 | 27 | 27 | Very slight gingivitis with tendency to hemorrhage. | Progressive with remissions.—Gums finally projected as large flaps of spongy bleeding hemorrhagic tissue which separated at attachment. Moderately foul mouth odor. Moderate improvement to 3 mg. of vitamin C and repeated relapse following cessation of therapy. | 3 | 2 | 2 | 3 | 2 | 3 |
| 519 | Vitamin C deficient. | 459 | 0 | 49 | 48 | Very slight gingivitis about central and lateral incisors. | Redness gingivitis, some hemorrhage, after stopping vitamin C on Dec. 13, 1939; some separation of gingival attachment with impaction of food and debris in these gingival pockets. Foul mouth odor. Definite improvement after 30 mg. of vitamin C; repeated relapse following cessation of therapy. | 3 | 4 | 3 | 3 | 4 | 3 |
| | | 400 | 0 | 47 | 27 | Collection of debris and a faint line of redness at gingival margin. | Early symptoms subsided and did not recur until completely deprived of vitamin C, then animal developed extensive redness, swelling, inflammation, hemorrhage, and retraction of gums from gingival attachment. Foul mouth odor. Some reduction of symptoms following 3 or 6 mg. of vitamin C. | 4 | 4 | 4 | 4 | 4 | 4 |
| | | | | | | | Rapidly progressive redness, generalized gingivitis, hemorrhage, accumulation of food and debris about all teeth, separation of gingival attachment, gradual loss of gingival tissue by necrosis and foul odor of mouth. Definite reduction of inflammation and hemorrhage following 30 mg. of vitamin C. No evidence of repair or replacement of necrotic tissue following therapy. | | | | | | |

| | | | | | | | | | | |
|-----|---|----|-----|--|--|---|---|---|---|---|
| 471 | 0 | 40 | 231 | Gums show reddish purple discoloration and slight hemorrhage. | No definite gingivitis for 231 days or 3 weeks after vitamin C supplements were stopped entirely, then gums developed a moderate degree of redness, gingivitis, and hemorrhage with localized separation of gingival detachment. Gradually progressive redness, hemorrhage, soft and spongy gums, gradual loss of interdental papillae and separation of gingival attachment, accumulation of food and debris. Some improvement after 3 or 6 mg. of vitamin C; repeated relapse following cessation of therapy. First lesions subsided after 3 weeks and did not recur for 4 months. Then showed inflammation, hemorrhage, partial loss of interdental papillae and some separation of gingival attachment. Very definite improvement of all symptoms after 30 mg. of vitamin C except no replacement of necrotic interdental papillae. Chronic course on 3 or 6 mg. of vitamin C which was given as symptoms developed. | 2 | 1 | 1 | 1 | 1 |
| 479 | 0 | 26 | 208 | Localized redness and accumulation of food and debris. | No definite symptoms for 238 days or 4 weeks after vitamin C supplements were stopped entirely. Then localized redness and hemorrhage which completely subsided after giving 30 mg. of vitamin C. Gums very resistant to depletion of vitamin C. Chronic course on 3 or 6 mg. of vitamin C as symptoms developed. | 4 | 4 | 3 | 4 | 4 |
| 475 | 0 | 32 | 63 | Redness with slight tendency to hemorrhage at gingival margin. | No definite symptoms for 238 days or 4 weeks after vitamin C supplements were stopped entirely. Then localized redness and hemorrhage which completely subsided after giving 30 mg. of vitamin C. Gums very resistant to depletion of vitamin C. Chronic course on 3 or 6 mg. of vitamin C as symptoms developed. | 2 | 3 | 2 | 0 | 2 |
| 477 | 0 | 27 | 238 | Slight redness and localized hemorrhage. | No definite symptoms for 238 days or 4 weeks after vitamin C supplements were stopped entirely. Then localized redness and hemorrhage which completely subsided after giving 30 mg. of vitamin C. Gums very resistant to depletion of vitamin C. Chronic course on 3 or 6 mg. of vitamin C as symptoms developed. | 2 | 2 | 1 | 2 | 2 |

220 Calcium and vitamin C deficient.

¹ Diet 516 is composed of natural foods.

² Diet 517 is composed of processed foods low in calcium and containing no vitamin C. It is supplemented by calcium in the salt mixture and intramuscular injections of vitamin C.

³ 0=none, 1=slight, 2=mild, 3=moderate, 4=severe.

DISCUSSION OF TABLE

General.—Observing table 1 as a whole it is at once obvious that the 12 control animals on stock diet 519 and control diet 517 showed no evidence of gingivitis or periodontal disease except for a localized process in one monkey. Likewise, 3 out of 4 animals on the calcium deficient diet revealed no indication that this deficiency had adversely affected their mouth tissues. One animal after 15 months on the calcium deficient regime developed gingivitis which progressed gradually but the lesions were not extensive even after 18 months on this diet. In contrast to the above animals, all of those on the vitamin C deficient diet, either alone or combined with a calcium deficiency, manifested extensive lesions of the mouth.

It should be noted in table 1 that there was a considerable delay in the initial appearance of mouth lesions in the animals on the combined deficiency of calcium and vitamin C as compared with those on a vitamin C deficient diet only. In addition, the mouth pathology after 11 months appeared to be more extensive in the group on a vitamin C deficient diet as compared with those on a combined deficiency of vitamin C and calcium.

Influence of vitamin C therapy.—Four monkeys, Nos. 473, 400, 475, and 477, developed relatively advanced symptoms of gingivitis and periodontal disease after all supplements of vitamin C were discontinued from their diet. Each was then given 30 mg. of vitamin C by intramuscular injection. In each instance there was a dramatic improvement of such symptoms as gingivitis with hemorrhage, accumulation of food and debris, and a foul mouth odor. There was, however, no replacement of necrotic interdental papilla, and if there had been a separation of the gingival tissue from its attachment, creating pockets, there was little or no tendency for these to be corrected by therapy.

Small doses of 3 or 6 mg. of vitamin C would consistently improve the general condition of the animal as well as the mouth lesions, but in every instance there would be a prompt relapse following cessation of therapy.

If gingival scurvy lesions in monkeys have advanced only to the stage of inflammation and hemorrhage, specific therapy will generally arrest the condition promptly and restore normal tissues. But if the lesions advance to the stage of necrosis, many changes occur in the gingiva and periodontal tissue which do not respond to therapy and should be considered irreversible in this respect.⁵

⁵ The observations in this experiment regarding therapy of vitamin C in monkeys confirm those made by Topping and Fraser in a preliminary experiment using 8 animals.

SUMMARY AND CONCLUSIONS

1. *Macacus rhesus* monkeys maintained for 11 months on a stock diet of natural foods and on a control diet of processed foods showed little or no evidence of gingivitis or periodontal disease.

2. Only one out of four comparable animals maintained on a calcium deficient diet showed a tendency toward these diseases.

3. Monkeys chronically depleted of vitamin C or chronically depleted of both vitamin C and calcium developed extensive lesions of the gingiva and periodontal tissues. If this proceeded only to the stage of inflammation and hemorrhage of the gingiva, vitamin C therapy caused prompt arrest of symptoms and restoration of the tissues to normal. A continuation, however, of the condition to the stage of necrosis of the gingiva induced many lesions which did not respond to vitamin C therapy and were, therefore, irreversible in this respect.

4. There was no evidence from these experiments that a combination of chronic calcium and vitamin C depletion provoked any mouth symptoms which could not have been caused by vitamin C deprivation alone.

NATIONAL HEALTH SURVEY
LIST OF PUBLICATIONS—CORRECTION

In the list of publications presenting the reports of studies undertaken by the National Health Survey, published in the **PUBLIC HEALTH REPORTS** for May 29, 1942, pages 834-841, the following reports were inadvertently omitted under the heading "General Illness Findings," on page 834:

The National Health Survey—Some general findings as to disease, accidents, and impairments in urban areas. Rollo H. Britten, Selwyn D. Collins, and James S. Fitzgerald. *Pub. Health Rep.*, 55:444-470 (1940). Reprint No. 2143.¹

The prevalence of disabling illness among male and female workers and housewives
David E. Hailman. *Pub. Health Bull.* No. 260, 1941.¹

INCIDENCE OF HOSPITALIZATION, MAY 1942

Through the cooperation of the Hospital Service Plan Commission of the American Hospital Association, data on hospital admissions among about 8,000,000 members of Blue Cross Hospital Service Plans are presented monthly. These plans provide prepaid hospital service and it is believed that the admission rate per 1,000 reflects rather accurately the prevalence of serious illness among

¹ Obtainable from U. S. Public Health Service, Bethesda, Md., as long as supply is available (order by number where possible).

the members. The data cover about 60 hospital service plans scattered throughout the country, mostly in large cities.

| Item | May | |
|---|-------------|-------------|
| | 1942 | 1941 |
| 1. Number of plans supplying data..... | 61 | 45 |
| 2. Number of persons eligible for hospital care..... | 7, 885, 482 | 5, 137, 943 |
| 3. Number of persons admitted for hospital care..... | 67, 846 | 44, 929 |
| 4. Incidence per 1,000 persons, annual rate, during current month (daily rate x 365)..... | 101. 2 | 102. 9 |
| 5. Simple average of annual rates for the 12 months ended May 30..... | 108. 9 | ..... |

DEATHS DURING WEEK ENDED JUNE 13, 1942

[From the Weekly Mortality Index, issued by the Bureau of the Census, Department of Commerce]

| | Week ended June 13, 1942 | Correspond- ing weekly 1941 |
|---|-----------------------------|-----------------------------------|
| Data from 86 large cities of the United States: | | |
| Total deaths..... | 7, 974 | 7, 690 |
| Average for 3 prior years..... | 7, 681 | ..... |
| Total deaths, first 23 weeks of year..... | 190, 992 | 202, 603 |
| Deaths per 1,000 population, first 23 weeks of year, annual rate..... | 12. 3 | 12. 4 |
| Deaths under 1 year of age..... | 545 | 499 |
| Average for 3 prior years..... | 487 | ..... |
| Deaths under 1 year of age, first 23 weeks of year..... | 12, 755 | 11, 787 |
| Data from industrial insurance companies: | | |
| Policies in force..... | 64, 975, 834 | 64, 445, 165 |
| Number of death claims..... | 10, 861 | 11, 685 |
| Death claims per 1,000 policies in force, annual rate..... | 8. 7 | 9. 5 |
| Death claims per 1,000 policies, first 23 weeks of year, annual rate..... | 9. 9 | 10. 3 |

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

REPORTS FROM STATES FOR WEEK ENDED JUNE 20, 1942

Summary

For the country as a whole, the incidence of the common communicable diseases continues low, with only measles and meningococcus meningitis above the 5-year (1937-41) median expectancy. The cumulative death rate for 88 large cities in the United States to date this year is slightly below that for the corresponding period last year.

The number of cases of meningococcus meningitis declined during the current week from 75 to 64, with more than one-half of the cases (38) reported from the Middle and South Atlantic areas, which have been reporting the largest numbers of cases this year.

A total of 28 cases of smallpox was reported, as compared with 7 for the preceding week. Of the current total, 10 cases occurred in Illinois, of which 9 were in Cook County.¹

Of 435 cases of bacillary dysentery, 382 cases were reported in Texas, and of 57 cases of amebic dysentery, 44 occurred in that State. Virginia reported 101 of the total of 136 cases of unspecified dysentery.

Other reports for the current week include 1 case of anthrax each in New Jersey and Pennsylvania, 1 case of leprosy in Tennessee, 18 cases of Rocky Mountain spotted fever (7 in the northwestern States), 32 cases of tularemia, and 70 cases of endemic typhus fever, of which 30 were in Texas, 17 in Georgia, and 11 in Florida.

During May, 8 cases of psittacosis were reported in New York, of which 5 cases occurred in New York City.

The death rate for the current week for 88 large cities in the United States is 10.8 per 1,000 population, as compared with 11.3 for the preceding week and a 3-year (1939-41) average of 10.7. The cumulative rate to date (first 24 weeks), is 12.2, as compared with 12.4 for the corresponding period last year.

¹ See p. 980.

Telegraphic morbidity reports from State health officers for the week ended June 20, 1942, and comparison with corresponding week of 1941 and 5-year median

In these tables a zero indicates a definite report, while leaders imply that, although none were reported, cases may have occurred.

| Division and State | Diphtheria | | | Influenza | | | Measles | | | Meningitis, men ingococcus | | |
|--------------------------------|---------------------|---------------------|----------------------------|---------------------|---------------------|----------------------------|---------------------|---------------------|----------------------------|-------------------------------|---------------------|----------------------------|
| | Week ended— | | Me- dian 1937- 41 | Week ended— | | Me- dian 1937- 41 | Week ended— | | Me- dian 1937- 41 | Week ended— | | Me- dian 1937- 41 |
| | June 20, 1942 | June 21, 1941 | | June 20, 1942 | June 21, 1941 | | June 20, 1942 | June 21, 1941 | | June 20, 1942 | June 21, 1941 | |
| NEW ENG. | | | | | | | | | | | | |
| Maine..... | 1 | 0 | 0 | ----- | ----- | 54 | 111 | 81 | 0 | 0 | 0 | |
| New Hampshire..... | 0 | 0 | 0 | ----- | ----- | 8 | 3 | 33 | 0 | 0 | 0 | |
| Vermont..... | 0 | 0 | 0 | ----- | ----- | 171 | 47 | 47 | 0 | 0 | 0 | |
| Massachusetts..... | 0 | 3 | 2 | ----- | ----- | 851 | 759 | 759 | 2 | 4 | 1 | |
| Rhode Island..... | 3 | 0 | 0 | ----- | ----- | 130 | 1 | 26 | 1 | 0 | 0 | |
| Connecticut..... | 0 | 0 | 1 | ----- | 2 | 1 | 233 | 422 | 72 | 0 | 0 | |
| MID. ATL. | | | | | | | | | | | | |
| New York..... | 17 | 13 | 13 | ----- | 6 | 985 | 1,830 | 1,511 | 11 | 6 | 4 | |
| New Jersey..... | 0 | 4 | 8 | 2 | 2 | 3 | 529 | 966 | 787 | 6 | 1 | |
| Pennsylvania..... | 3 | 9 | 14 | 3 | ----- | 377 | 2,379 | 1,408 | 4 | 0 | 7 | |
| E. NO. CEN. | | | | | | | | | | | | |
| Ohio..... | 2 | 15 | 13 | 9 | 3 | 7 | 138 | 1,280 | 898 | 1 | 4 | |
| Indiana..... | 2 | 3 | 3 | 1 | 3 | 2 | 58 | 218 | 97 | 0 | 0 | |
| Illinois..... | 21 | 25 | 25 | 7 | 6 | 9 | 148 | 598 | 427 | 3 | 1 | |
| Michigan ¹ | 7 | 4 | 4 | ----- | ----- | 1 | 285 | 960 | 508 | 0 | 0 | |
| Wisconsin..... | 1 | 4 | 2 | 13 | 28 | 11 | 996 | 1,222 | 954 | 0 | 0 | |
| W. NO. CEN. | | | | | | | | | | | | |
| Minnesota..... | 0 | 0 | 1 | ----- | ----- | 1 | 496 | 16 | 65 | 0 | 0 | |
| Iowa..... | 0 | 1 | 2 | ----- | 1 | 1 | 159 | 128 | 126 | 0 | 0 | |
| Missouri..... | 1 | 1 | 5 | ----- | ----- | 2 | 67 | 238 | 50 | 3 | 1 | |
| North Dakota..... | 1 | 0 | 1 | ----- | 2 | 1 | 17 | 13 | 5 | 0 | 0 | |
| South Dakota..... | 0 | 1 | 0 | ----- | ----- | 1 | 28 | 2 | 3 | 0 | 0 | |
| Nebraska..... | 0 | 1 | 1 | ----- | ----- | 1 | 84 | 6 | 17 | 0 | 0 | |
| Kansas..... | 1 | 7 | 4 | ----- | ----- | 1 | 112 | 152 | 152 | 1 | 0 | |
| SO. ATL. | | | | | | | | | | | | |
| Delaware..... | 0 | 0 | 0 | ----- | ----- | 4 | 24 | 5 | 0 | 0 | 0 | |
| Maryland..... | 5 | 4 | 2 | 1 | 4 | 2 | 116 | 366 | 120 | 7 | 3 | |
| Dist. of Col..... | 1 | 1 | 1 | ----- | ----- | 47 | 111 | 93 | 0 | 1 | 1 | |
| Virginia..... | 3 | 8 | 7 | 75 | 16 | 16 | 93 | 528 | 298 | 6 | 2 | |
| West Virginia..... | 2 | 9 | 3 | 1 | 2 | 8 | 12 | 296 | 75 | 0 | 1 | |
| North Carolina..... | 4 | 7 | 7 | 1 | 1 | 1 | 251 | 719 | 288 | 2 | 1 | |
| South Carolina..... | 6 | 0 | 3 | 118 | 111 | 110 | 59 | 270 | 49 | 0 | 0 | |
| Georgia..... | 3 | 7 | 2 | 10 | 27 | 2 | 30 | 196 | 60 | 1 | 9 | |
| Florida..... | 3 | 2 | 6 | 1 | 9 | ----- | 80 | 50 | 32 | 1 | 1 | |
| E. SO. CEN. | | | | | | | | | | | | |
| Kentucky..... | 1 | 2 | 4 | ----- | ----- | 5 | 35 | 246 | 102 | 1 | 1 | |
| Tennessee..... | 1 | 3 | 3 | 10 | 15 | 15 | 62 | 178 | 161 | 1 | 0 | |
| Alabama..... | 1 | 1 | 5 | 40 | 9 | 8 | 44 | 89 | 76 | 2 | 0 | |
| Mississippi ¹ | 6 | 3 | 3 | ----- | ----- | ----- | ----- | ----- | 0 | 1 | 1 | |
| W. SO. CEN. | | | | | | | | | | | | |
| Arkansas..... | 3 | 2 | 3 | 5 | 7 | 8 | 37 | 156 | 31 | 0 | 0 | |
| Louisiana..... | 5 | 1 | 5 | 2 | 2 | 10 | 25 | 3 | 10 | 2 | 0 | |
| Oklahoma..... | 2 | 3 | 2 | 4 | 10 | 10 | 45 | 84 | 69 | 0 | 0 | |
| Texas..... | 21 | 23 | 26 | 168 | 273 | 138 | 327 | 303 | 303 | 4 | 2 | |
| MOUNTAIN | | | | | | | | | | | | |
| Montana..... | 1 | 1 | 0 | 1 | 1 | ----- | 70 | 9 | 49 | 1 | 0 | |
| Idaho..... | 0 | 0 | 0 | ----- | ----- | ----- | 12 | 8 | 18 | 0 | 0 | |
| Wyoming..... | 0 | 4 | 0 | 61 | ----- | ----- | 80 | 5 | 8 | 0 | 0 | |
| Colorado..... | 10 | 7 | 7 | 20 | 12 | 1 | 123 | 108 | 56 | 0 | 0 | |
| New Mexico..... | 0 | 1 | 2 | ----- | ----- | ----- | 8 | 82 | 62 | 0 | 0 | |
| Arizona..... | 1 | 2 | 2 | 24 | 47 | 21 | 38 | 81 | 16 | 0 | 0 | |
| Utah ¹ | 0 | 0 | 0 | ----- | 1 | ----- | 537 | 43 | 92 | 0 | 0 | |
| Nevada..... | 0 | 0 | ----- | ----- | ----- | ----- | 10 | 0 | ----- | 0 | 0 | |
| PACIFIC | | | | | | | | | | | | |
| Washington..... | 2 | 0 | 2 | ----- | ----- | ----- | 645 | 12 | 54 | 1 | 0 | |
| Oregon..... | 2 | 1 | 1 | 12 | 4 | 7 | 116 | 38 | 49 | 0 | 0 | |
| California..... | 11 | 13 | 21 | 40 | 842 | 110 | 3,648 | 477 | 477 | 3 | 2 | |
| Total..... | 154 | 196 | 217 | 630 | 1,440 | 641 | 12,480 | 15,851 | 9,210 | 64 | 45 | |
| 24 weeks..... | 6,051 | 6,093 | 9,773 | 77,306 | 483,897 | 156,636 | 435,636 | 781,146 | 322,064 | 1,855 | 1,144 | |

See footnotes at end of table.

Telegraphic morbidity reports from State health officers for the week ended June 20, 1942, and comparison with corresponding week of 1941 and 5-year median—Con.

| Division and State | Pollomyelitis | | | Scarlet fever | | | Smallpox | | | Typhoid and paratyphoid fever | | |
|---------------------|---------------|---------------|----------------|---------------|---------------|----------------|---------------|---------------|----------------|-------------------------------|---------------|----------------|
| | Week ended— | | Median 1937-41 | Week ended— | | Median 1937-41 | Week ended— | | Median 1937-41 | Week ended— | | Median 1937-41 |
| | June 20, 1942 | June 21, 1941 | | June 20, 1942 | June 21, 1941 | | June 20, 1942 | June 21, 1941 | | June 20, 1942 | June 21, 1941 | |
| NEW ENG. | | | | | | | | | | | | |
| Maine..... | 0 | 0 | 0 | 8 | 3 | 6 | 0 | 0 | 0 | 0 | 0 | 0 |
| New Hampshire..... | 0 | 0 | 0 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Vermont..... | 0 | 1 | 0 | 4 | 2 | 4 | 0 | 0 | 0 | 0 | 3 | 1 |
| Massachusetts..... | 0 | 0 | 1 | 162 | 139 | 137 | 0 | 0 | 0 | 2 | 4 | 1 |
| Rhode Island..... | 1 | 0 | 0 | 9 | 5 | 5 | 0 | 0 | 0 | 1 | 1 | 1 |
| Connecticut..... | 0 | 1 | 0 | 17 | 29 | 36 | 0 | 0 | 0 | 0 | 2 | 2 |
| MID. ATL. | | | | | | | | | | | | |
| New York..... | 3 | 0 | 2 | 137 | 316 | 328 | 0 | 0 | 0 | 5 | 11 | 9 |
| New Jersey..... | 3 | 1 | 0 | 66 | 132 | 101 | 0 | 0 | 0 | 0 | 2 | 0 |
| Pennsylvania..... | 2 | 1 | 1 | 121 | 172 | 172 | 0 | 0 | 0 | 9 | 7 | 8 |
| E. NO. CEN. | | | | | | | | | | | | |
| Ohio..... | 0 | 3 | 1 | 95 | 131 | 131 | 2 | 0 | 2 | 4 | 4 | 5 |
| Indiana..... | 0 | 0 | 0 | 17 | 24 | 46 | 5 | 0 | 4 | 0 | 4 | 3 |
| Illinois..... | 1 | 7 | 1 | 64 | 156 | 255 | 10 | 5 | 12 | 7 | 7 | 7 |
| Michigan..... | 0 | 1 | 1 | 129 | 242 | 242 | 0 | 0 | 1 | 0 | 4 | 4 |
| Wisconsin..... | 0 | 0 | 0 | 73 | 54 | 67 | 0 | 1 | 1 | 1 | 0 | 1 |
| W. NO. CEN. | | | | | | | | | | | | |
| Minnesota..... | 2 | 2 | 0 | 24 | 23 | 29 | 1 | 0 | 2 | 0 | 0 | 0 |
| Iowa..... | 0 | 0 | 0 | 14 | 14 | 40 | 1 | 2 | 12 | 2 | 2 | 2 |
| Missouri..... | 1 | 0 | 1 | 22 | 30 | 30 | 1 | 0 | 8 | 5 | 0 | 7 |
| North Dakota..... | 0 | 0 | 0 | 3 | 1 | 10 | 0 | 0 | 3 | 0 | 0 | 0 |
| South Dakota..... | 0 | 1 | 0 | 5 | 2 | 7 | 0 | 0 | 3 | 0 | 1 | 0 |
| Nebraska..... | 0 | 0 | 0 | 5 | 9 | 9 | 0 | 0 | 1 | 0 | 0 | 0 |
| Kansas..... | 1 | 0 | 0 | 26 | 18 | 25 | 2 | 0 | 5 | 1 | 0 | 2 |
| SO. ATL. | | | | | | | | | | | | |
| Delaware..... | 1 | 0 | 0 | 5 | 6 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Maryland..... | 1 | 0 | 0 | 13 | 29 | 19 | 0 | 0 | 0 | 1 | 0 | 2 |
| Dist. of Col..... | 0 | 0 | 0 | 2 | 6 | 6 | 0 | 0 | 0 | 1 | 0 | 0 |
| Virginia..... | 2 | 0 | 0 | 11 | 7 | 7 | 0 | 0 | 0 | 3 | 1 | 8 |
| West Virginia..... | 0 | 2 | 0 | 8 | 17 | 20 | 0 | 0 | 0 | 7 | 3 | 3 |
| North Carolina..... | 0 | 1 | 1 | 11 | 13 | 18 | 0 | 0 | 0 | 4 | 3 | 5 |
| South Carolina..... | 1 | 3 | 0 | 1 | 2 | 1 | 0 | 0 | 0 | 2 | 6 | 6 |
| Georgia..... | 1 | 9 | 1 | 5 | 8 | 6 | 0 | 0 | 0 | 12 | 15 | 17 |
| Florida..... | 1 | 15 | 0 | 1 | 4 | 4 | 0 | 0 | 0 | 0 | 2 | 2 |
| E. SO. CEN. | | | | | | | | | | | | |
| Kentucky..... | 2 | 1 | 1 | 23 | 42 | 24 | 0 | 3 | 2 | 2 | 3 | 9 |
| Tennessee..... | 0 | 0 | 0 | 17 | 15 | 15 | 2 | 2 | 0 | 3 | 9 | 10 |
| Alabama..... | 1 | 3 | 3 | 7 | 4 | 5 | 0 | 0 | 0 | 5 | 3 | 9 |
| Mississippi..... | 0 | 4 | 3 | 4 | 1 | 4 | 0 | 0 | 0 | 0 | 2 | 2 |
| W. SO. CEN. | | | | | | | | | | | | |
| Arkansas..... | 3 | 0 | 0 | 7 | 2 | 4 | 1 | 0 | 1 | 10 | 10 | 10 |
| Louisiana..... | 2 | 1 | 1 | 3 | 6 | 6 | 0 | 0 | 0 | 7 | 11 | 11 |
| Oklahoma..... | 0 | 1 | 1 | 2 | 3 | 8 | 1 | 0 | 1 | 3 | 4 | 11 |
| Texas..... | 2 | 2 | 2 | 18 | 14 | 23 | 1 | 0 | 5 | 16 | 12 | 28 |
| MOUNTAIN | | | | | | | | | | | | |
| Montana..... | 1 | 0 | 0 | 6 | 12 | 8 | 0 | 0 | 0 | 2 | 2 | 2 |
| Idaho..... | 0 | 0 | 0 | 0 | 1 | 6 | 0 | 1 | 1 | 0 | 1 | 1 |
| Wyoming..... | 0 | 1 | 0 | 7 | 4 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Colorado..... | 0 | 0 | 0 | 8 | 10 | 17 | 1 | 0 | 2 | 0 | 0 | 2 |
| New Mexico..... | 2 | 0 | 0 | 4 | 5 | 14 | 0 | 0 | 0 | 0 | 1 | 1 |
| Arizona..... | 0 | 1 | 0 | 5 | 3 | 3 | 0 | 2 | 0 | 0 | 3 | 3 |
| Utah..... | 2 | 0 | 0 | 8 | 2 | 12 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nevada..... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PACIFIC | | | | | | | | | | | | |
| Washington..... | 0 | 0 | 0 | 21 | 10 | 22 | 0 | 1 | 1 | 0 | 0 | 2 |
| Oregon..... | 0 | 0 | 0 | 1 | 7 | 12 | 0 | 1 | 2 | 0 | 1 | 1 |
| California..... | 2 | 7 | 7 | 73 | 112 | 112 | 0 | 1 | 14 | 3 | 6 | 7 |
| Total..... | 38 | 69 | 65 | 1,275 | 1,849 | 1,890 | 28 | 19 | 180 | 118 | 150 | 254 |
| 24 weeks..... | 514 | 592 | 592 | 82,084 | 82,726 | 107,943 | 542 | 1,044 | 7,078 | 2,057 | 2,182 | 3,069 |

See footnotes at end of table.

Telegraphic morbidity reports from State health officers for the week ended June 20, 1942—Continued

| Division and State | Whooping cough | | Week ended June 20, 1942 | | | | | | | | |
|--------------------------------|----------------|---------------|--------------------------|-----------|------------|--------------|----------------------------|----------|-------------------------|------------|---------------|
| | Week ended— | | An-thrax | Dysentery | | | En-ceph-alitis, infectious | Lep-rosy | Rocky Mt. spotted fever | Tula-remia | Ty-phus fever |
| | June 20, 1942 | June 21, 1941 | | Ame-bic | Bacil-lary | Un-specified | | | | | |
| NEW ENG. | | | | | | | | | | | |
| Maine..... | 22 | 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New Hampshire..... | 5 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Vermont..... | 78 | 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Massachusetts..... | 268 | 188 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rhode Island..... | 20 | 20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Connecticut..... | 102 | 49 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| MID. ATL. | | | | | | | | | | | |
| New York..... | 446 | 283 | 0 | 0 | 12 | 0 | 0 | 0 | 0 | 0 | 0 |
| New Jersey..... | 453 | 90 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Pennsylvania..... | 198 | 250 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| E. NO. CEN. | | | | | | | | | | | |
| Ohio..... | 172 | 330 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Indiana..... | 37 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Illinois..... | 232 | 102 | 0 | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 0 |
| Michigan ¹ | 169 | 0 | 0 | 1 | 4 | 0 | 1 | 0 | 0 | 0 | 0 |
| Wisconsin..... | 207 | 123 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| W. NO. CEN. | | | | | | | | | | | |
| Minnesota..... | 25 | 70 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Iowa..... | 12 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| Missouri..... | 8 | 12 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 |
| North Dakota..... | 2 | 16 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 |
| South Dakota..... | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nebraska..... | 11 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Kansas..... | 33 | 156 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| SO. ATL. | | | | | | | | | | | |
| Delaware..... | 1 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Maryland ² | 64 | 75 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 |
| Dist. of Col..... | 17 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Virginia..... | 97 | 103 | 0 | 0 | 0 | 101 | 0 | 0 | 1 | 0 | 0 |
| West Virginia..... | 18 | 55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| North Carolina..... | 168 | 155 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| South Carolina..... | 66 | 168 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Georgia..... | 29 | 23 | 0 | 2 | 16 | 0 | 0 | 0 | 0 | 0 | 17 |
| Florida..... | 11 | 10 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 11 |
| E. SO. CEN. | | | | | | | | | | | |
| Kentucky..... | 48 | 52 | 0 | 0 | 9 | 0 | 0 | 0 | 2 | 0 | 0 |
| Tennessee..... | 28 | 78 | 0 | 0 | 0 | 11 | 0 | 1 | 0 | 3 | 0 |
| Alabama..... | 53 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| Mississippi ³ | 0 | ..... | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 1 |
| W. SO. CEN. | | | | | | | | | | | |
| Arkansas..... | 17 | 51 | 0 | 1 | 2 | 0 | 0 | 0 | 6 | 0 | 0 |
| Louisiana..... | 9 | 16 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 4 | 0 |
| Oklahoma..... | 10 | 12 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| Texas..... | 201 | 361 | 0 | 44 | 382 | 0 | 3 | 0 | 0 | 1 | 30 |
| MOUNTAIN | | | | | | | | | | | |
| Montana..... | 16 | 31 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 6 | 0 |
| Idaho..... | 1 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Wyoming..... | 2 | 5 | 0 | 3 | 0 | 0 | 0 | 0 | 2 | 3 | 0 |
| Colorado..... | 25 | 162 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New Mexico..... | 18 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Arizona..... | 11 | 55 | 0 | 0 | 0 | 21 | 0 | 0 | 0 | 0 | 0 |
| Utah ⁴ | 28 | 87 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 |
| Nevada..... | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PACIFIC | | | | | | | | | | | |
| Washington..... | 40 | 61 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oregon..... | 29 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| California..... | 208 | 658 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total..... | 3,721 | 4,105 | 2 | 57 | 435 | 136 | 8 | 1 | 18 | 32 | 70 |
| 24 weeks..... | 91,802 | 111,93..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |

¹ New York City only.
² See p. 980.

³ Period ended earlier than Saturday.
⁴ Onset in January.

PLAGUE INFECTION IN THE UNITED STATES DURING
MARCH AND APRIL 1942

Extensive surveys by field units of the Public Health Service engaged in plague suppressive measures were begun in the western States early in March of this year. Especial attention will be directed to military reservations and air fields. The surveys will include the area between the Mexican and Canadian borders approximately between longitudes 100° and 124°. It is planned to survey all military reservations within that area and to institute control work where indicated, as well as around air fields at Spokane, Washington, and Boise, Idaho.

Four States now have field units engaged in collecting specimens of rodent tissue and ectoparasites, as follows: Oregon, 2; Washington, 1; Idaho, 1; and Montana, 1. The U. S. Public Health Service Laboratory in San Francisco examines all specimens submitted by these units.

The following delayed reports of plague infection found during March and April 1942 have recently been received:

CALIFORNIA

Lassen County: April 22, tissue from ground squirrel, *C. oregonus*, 9 miles southeast of Amedee; pool of 20 fleas from 19 ground squirrels, *C. townsendi*, same location.

Monterey County: Camp Hunter Liggett Military Reservation, King City, March 20, pool of 13 fleas from 7 mice, *Peromyscus truei*, near Bradley Road; March 21 pool, of 15 fleas from rabbit, *Sylvilagus bachmani*, near Bradley Road. April 28, tissue from ground squirrel, *C. beecheyi*, west of San Antonio River in Lugo Canyon; pool of 42 fleas from 14 wood rats, *Neotoma fuscipes*, in same locality; pool of 132 fleas from ground squirrel, *C. beecheyi*, in same locality.

San Luis Obispo County: April 24, pool of 198 fleas from 10 ground squirrels, *C. beecheyi*, ranch 3½ miles east of Santa Margarita.

Santa Barbara County: April 29, pool of 27 fleas from ground squirrel, *C. beecheyi*, Alamo Creek, 10 miles east of Santa Maria.

OREGON

Jackson County: March 21, pool of 77 fleas from 8 ground squirrels, *C. douglasii*, Little Butte Creek area 17-19 miles northeast of Medford. March 24, pool of 199 fleas from 17 ground squirrels, *C. douglasii*, Applegate Valley, 4 to 9 miles south of Ruch, on the Copper Road.

Josephine County: March 23 pool of 213 fleas from 12 ground squirrels, *C. douglasii*, Deer Creek Valley, 2½ to 4 miles east of Selma.

Klamath County: April 29, pool of fleas from ground squirrel, *C. oregonus*, Sprague River, 36 to 38 miles east of Klamath Falls, on Route No. 66.

Union County: April 30, pool of 35 fleas and 5 lice from ground squirrels, *C. oregonus*, and a pool of 20 fleas from ground squirrels, same species, from ranches 1 to 5 miles west of North Powder.

City reports for week ended June 6, 1942—Continued

| | Diphtheria cases | | Enecephalitis, infectious, cases | | Influenza | | Measles cases | Meningitis, meningococcus, cases | Pneumonia deaths | Pollomyelitis cases | Scarlet fever cases | Smallpox cases | Typhoid and paratyphoid fever cases | Whooping cough cases |
|---------------------------|------------------|--------|----------------------------------|--------|-----------|--------|---------------|----------------------------------|------------------|---------------------|---------------------|----------------|-------------------------------------|----------------------|
| | Cases | Deaths | Cases | Deaths | Cases | Deaths | | | | | | | | |
| Flint, Mich..... | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 6 | 0 | 2 | 0 | 0 | 0 | 5 |
| Fort Wayne, Ind..... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 3 |
| Frederick, Md..... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Galveston, Texas..... | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 10 |
| Grand Rapids, Mich..... | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 3 | 0 | 0 | 0 | 6 |
| Great Falls, Mont..... | 0 | 0 | 0 | 0 | 23 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 2 |
| Hartford, Conn..... | 0 | 0 | 0 | 0 | 64 | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 16 |
| Helena, Mont..... | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Houston, Texas..... | 1 | 0 | 0 | 0 | 12 | 0 | 7 | 0 | 7 | 0 | 0 | 0 | 3 | 1 |
| Indianapolis, Ind..... | 0 | 0 | 0 | 0 | 80 | 0 | 6 | 0 | 6 | 0 | 17 | 0 | 0 | 33 |
| Kansas City, Mo..... | 2 | 0 | 0 | 0 | 58 | 0 | 8 | 0 | 8 | 0 | 19 | 0 | 1 | 0 |
| Kenosha, Wis..... | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 14 |
| Little Rock, Ark..... | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Los Angeles, Calif..... | 6 | 0 | 1 | 0 | 417 | 1 | 11 | 0 | 11 | 0 | 17 | 0 | 0 | 20 |
| Lynchburg, Va..... | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 43 |
| Memphis, Tenn..... | 0 | 0 | 0 | 1 | 46 | 0 | 2 | 0 | 4 | 0 | 4 | 0 | 0 | 6 |
| Milwaukee, Wis..... | 0 | 0 | 0 | 0 | 446 | 0 | 2 | 0 | 2 | 0 | 25 | 0 | 0 | 63 |
| Minneapolis, Minn..... | 1 | 0 | 0 | 0 | 169 | 0 | 2 | 1 | 6 | 0 | 6 | 0 | 0 | 11 |
| Missoula, Mont..... | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Mobile, Ala..... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| Nashville, Tenn..... | 0 | 0 | 0 | 1 | 9 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 8 |
| Newark, N. J..... | 0 | 0 | 1 | 0 | 190 | 1 | 5 | 0 | 5 | 0 | 13 | 0 | 0 | 59 |
| New Haven, Conn..... | 0 | 0 | 0 | 0 | 36 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 8 |
| New Orleans, La..... | 0 | 0 | 1 | 0 | 28 | 0 | 0 | 12 | 2 | 3 | 0 | 0 | 2 | 2 |
| New York, N. Y..... | 8 | 0 | 9 | 1 | 124 | 13 | 39 | 0 | 39 | 0 | 151 | 0 | 2 | 184 |
| Omaha, Nebr..... | 0 | 0 | 0 | 0 | 53 | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 0 | 0 |
| Philadelphia, Pa..... | 2 | 0 | 0 | 0 | 43 | 3 | 21 | 0 | 21 | 0 | 112 | 0 | 2 | 134 |
| Pittsburgh, Pa..... | 1 | 0 | 0 | 0 | 11 | 1 | 5 | 0 | 5 | 0 | 11 | 0 | 1 | 15 |
| Portland, Me..... | 0 | 0 | 0 | 0 | 41 | 2 | 0 | 1 | 3 | 0 | 3 | 0 | 0 | 0 |
| Providence, R. I..... | 0 | 0 | 0 | 0 | 163 | 0 | 3 | 0 | 3 | 0 | 4 | 0 | 0 | 18 |
| Pueblo, Colo..... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Racine, Wis..... | 0 | 0 | 0 | 0 | 154 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 25 |
| Raleigh, N. C..... | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 6 |
| Reading, Pa..... | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 9 |
| Richmond, Va..... | 0 | 0 | 0 | 0 | 5 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| Roanoke, Va..... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rochester, N. Y..... | 0 | 0 | 1 | 0 | 8 | 1 | 4 | 0 | 4 | 0 | 4 | 0 | 0 | 5 |
| Sacramento, Calif..... | 2 | 1 | 0 | 0 | 34 | 0 | 2 | 0 | 2 | 0 | 5 | 0 | 0 | 29 |
| Saint Joseph, Mo..... | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Saint Louis, Mo..... | 0 | 0 | 1 | 0 | 49 | 0 | 7 | 0 | 7 | 0 | 15 | 0 | 3 | 5 |
| Saint Paul, Minn..... | 0 | 0 | 0 | 0 | 77 | 0 | 3 | 0 | 3 | 0 | 3 | 0 | 0 | 18 |
| Salt Lake City, Utah..... | 0 | 0 | 0 | 0 | 309 | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 1 | 7 |
| San Antonio, Tex..... | 0 | 0 | 0 | 0 | 9 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| San Francisco, Calif..... | 0 | 0 | 0 | 0 | 136 | 1 | 6 | 0 | 6 | 0 | 7 | 0 | 0 | 0 |
| Savannah, Ga..... | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| Seattle, Wash..... | 0 | 0 | 1 | 0 | 240 | 0 | 3 | 0 | 3 | 0 | 4 | 0 | 0 | 8 |
| Shreveport, La..... | 1 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| South Bend, Ind..... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 |
| Spokane, Wash..... | 0 | 0 | 0 | 0 | 91 | 0 | 1 | 0 | 1 | 0 | 3 | 0 | 0 | 2 |
| Springfield, Ill..... | 0 | 0 | 0 | 0 | 17 | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 0 | 0 |
| Springfield, Mass..... | 0 | 0 | 0 | 0 | 56 | 0 | 0 | 0 | 0 | 16 | 0 | 0 | 0 | 5 |
| Superior, Wis..... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Syracuse, N. Y..... | 0 | 0 | 0 | 0 | 500 | 1 | 2 | 0 | 2 | 0 | 4 | 0 | 0 | 24 |
| Tacoma, Wash..... | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 6 |
| Tampa, Fla..... | 0 | 0 | 0 | 0 | 12 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| Terre Haute, Ind..... | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| Topeka, Kans..... | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 5 |
| Trenton, N. J..... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 5 |
| Washington, D. C..... | 1 | 0 | 0 | 0 | 59 | 1 | 9 | 0 | 9 | 0 | 4 | 0 | 1 | 21 |
| Wheeling, W. Va..... | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Wichita, Kans..... | 0 | 0 | 0 | 0 | 63 | 0 | 2 | 0 | 2 | 0 | 5 | 0 | 0 | 5 |
| Wilmington, Del..... | 0 | 0 | 0 | 0 | 5 | 0 | 1 | 0 | 1 | 0 | 4 | 0 | 0 | 0 |
| Wilmington, N. C..... | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 1 | 0 | 0 | 11 |
| Winston-Salem, N. C..... | 0 | 0 | 0 | 0 | 7 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| Worcester, Mass..... | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 13 | 0 | 0 | 0 | 43 |

Anthrax.—Cases: Camden, 1.

Dysentery, amebic.—Cases: St. Louis, 1.

Dysentery, bacillary.—Cases: Los Angeles, 1; Springfield, 1.

Typhus fever.—Cases: New York, 2; Savannah, 2.

Rates (annual basis) per 100,000 population, for the group of 89 cities in the preceding table (estimated population, 1942, 33,831,758)

| Period | Diphtheria cases | Influenza | | Measles cases | Pneumonia deaths | Scarlet fever cases | Small-pox cases | Typhoid fever cases | Whooping cough cases |
|-----------------------------|------------------|-----------|--------|---------------------|------------------|---------------------|-----------------|---------------------|----------------------|
| | | Cases | Deaths | | | | | | |
| Week ended June 6, 1942.... | 9.09 | 5.55 | 1.85 | 723.15 | 44.06 | 143.49 | 0.00 | 3.24 | 199.90 |
| Average for week, 1937-41.. | 13.70 | 7.32 | 3.11 | ¹ 608.91 | 55.28 | 211.80 | 2.02 | 4.20 | 190.93 |

¹ Median.

TERRITORIES AND POSSESSIONS

Hawaii Territory

Plague (rodent).—A rat found on May 16, 1942, in Kapulena area and one rat found on May 19, 1942, in Paauhau area, Hamakua District, Island of Hawaii, T. H., have been proved positive for plague.

FOREIGN REPORTS

CANADA

Provinces—Communicable diseases—Week ended May 23, 1942.—During the week ended May 23, 1942, cases of certain communicable diseases were reported by the Dominion Bureau of Statistics of Canada as follows:

| Disease | Prince Edward Island | Nova Scotia | New Brunswick | Quebec | Ontario | Manitoba | Saskatchewan | Alberta | British Columbia | Total |
|----------------------------------|----------------------|-------------|---------------|--------|---------|----------|--------------|---------|------------------|-------|
| Cerebrospinal meningitis..... | | 1 | | 1 | 3 | 1 | | | 3 | 9 |
| Chickenpox..... | | 7 | | 124 | 258 | 14 | 14 | 2 | 108 | 527 |
| Diphtheria..... | | 19 | 2 | 23 | 2 | 8 | 5 | 3 | | 62 |
| German measles..... | | 1 | | 16 | 39 | 4 | 16 | 8 | 20 | 104 |
| Influenza..... | | 12 | | | 9 | 1 | | | 8 | 30 |
| Lethargic encephalitis..... | | | | | | 1 | | | | 1 |
| Measles..... | | 1 | | 336 | 170 | 131 | 27 | 10 | 34 | 709 |
| Mumps..... | | 33 | 3 | 108 | 361 | 64 | 189 | 30 | 319 | 1,107 |
| Pneumonia..... | | 2 | | | 12 | 2 | 2 | | | 9 |
| Poliomyelitis..... | | | | | | 2 | | | | 2 |
| Scarlet fever..... | 1 | 17 | 20 | 89 | 168 | 27 | 30 | 53 | 30 | 435 |
| Trachoma..... | | | | | | 1 | | | | 1 |
| Tuberculosis..... | 2 | 6 | 11 | 90 | 67 | | 3 | | 27 | 206 |
| Typhoid fever..... | | | | 31 | 3 | | 5 | | | 39 |
| Undulant fever..... | | | | | 1 | | | | | 1 |
| Whooping cough..... | | 1 | 2 | 157 | 78 | 2 | | 4 | 56 | 300 |
| Other communicable diseases..... | | 6 | | 4 | 277 | 30 | 4 | | 6 | 327 |

FRENCH WEST AFRICA

Cerebrospinal meningitis.—In 1941, there were 2,244 cases of cerebrospinal meningitis in French West Africa, with 606 deaths, of which 1,567 cases and 449 deaths occurred during the first quarter. During the first quarter of 1942, 1,047 cases and 354 deaths occurred.

Past experience shows that in French West Africa this disease makes its appearance in January and reaches a peak late in February or early in March. It is thus most prevalent during the dry season. The disease declines as the year advances, reaching a low during the third and fourth quarters. So far in 1942, the disease has been most prevalent in the French Sudan, Ivory Coast Colony, and Senegal.

NEW ZEALAND

Notifiable diseases—4 weeks ended March 23, 1942.—During the 4 weeks ended March 23, 1942, certain notifiable diseases were reported in New Zealand as follows:

| Disease | Cases | Deaths | Disease | Cases | Deaths |
|-------------------------------|-------|--------|----------------------|-------|--------|
| Cerebrospinal meningitis..... | 34 | 1 | Puerperal fever..... | 4 | |
| Diphtheria..... | 71 | 2 | Scarlet fever..... | 40 | |
| Dysentery (bacillary)..... | 14 | 1 | Tetanus..... | 1 | |
| Erysipelas..... | 27 | 2 | Trachoma..... | 1 | |
| Lead poisoning..... | 1 | | Tuberculosis..... | 154 | 41 |
| Ophthalmia neonatorum..... | 2 | | Typhoid fever..... | 30 | 1 |
| Poliomyelitis..... | 4 | | | | |

WORLD DISTRIBUTION OF CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER AND YELLOW FEVER

From medical officers of the Public Health Service, American consuls, International Office of Public Health, Pan American Sanitary Bureau, 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]

NOTE.—Since many of the figures in the following tables are from weekly reports, the accumulated totals are for approximate dates.

| Place | January-March 1942 | April 1942 | May 1942—week ended— | | | | |
|---------------------|--------------------|------------|----------------------|---|----|----|----|
| | | | 2 | 9 | 16 | 23 | 30 |
| ASIA | | | | | | | |
| Ceylon..... | C 31 | 30 | 3 | | | | |
| India..... | C 1,946 | 7,463 | | | | | |
| Calcutta..... | C 181 | 165 | | | | | |
| Chittagong..... | C 30 | 6 | | | | | |
| Rangoon..... | C 1 | | | | | | |
| India (French)..... | C 1 | | | | | | |

PLAGUE

[C indicates cases; P, present]

| | | | | | | | |
|---|-------|----|---|----|---|----|----|
| AFRICA | | | | | | | |
| Basutoland..... | C 7 | | | | | | |
| British East Africa: | | | | | | | |
| Kenya..... | C 308 | | | | | | |
| Nairobi..... | C 62 | | | | | | |
| Uganda..... | C 123 | | | | | | |
| Madagascar..... | C 64 | 14 | | | | | 16 |
| Morocco..... | C 113 | 26 | 8 | 17 | 8 | 35 | 25 |
| Union of South Africa..... | C 31 | 10 | | | | | |
| ASIA | | | | | | | |
| China ¹ | | | | | | | |
| India..... | C 385 | | | | | | |
| Indochina (French)..... | C 54 | 13 | | | | | 13 |
| Palestine: Haifa..... | C 4 | | | | | | |
| SOUTH AMERICA | | | | | | | |
| Argentina: Cordoba Province..... | C 7 | | | | | | |
| Brazil: | | | | | | | |
| Alagoas State..... | C 3 | | | | | | |
| Pernambuco State..... | C 6 | | | | | | |
| Chile: Valparaiso..... | C 1 | | | | | | |
| Peru: | | | | | | | |
| Ancash Department..... | C 6 | | | | | | |
| Lambayeque Department..... | C 3 | | | | | | |
| Libertad Department..... | C 6 | | | | | | |
| Salaverry—Plague infected rats..... | P | | | | | | |
| Lima Department..... | C 28 | 8 | | | | | |
| Piura Department..... | C 7 | 6 | | | | | |
| OCEANIA | | | | | | | |
| Hawaii Territory: Plague-infected rats..... | 16 | 1 | | | | | |

¹ For the month of May.

² Plague has been reported in China as follows: Chekiang Province, Apr. 1-10, 1942, 4 cases; Fukien Province, Jan. 1-Apr. 5, 1942, plague appeared in 11 localities; Hunan Province, week ended Apr. 18, 1942, 2 cases; Suiyuan Province, pneumonic plague appeared in epidemic form during the period Jan. 1-Apr. 4, in the northwestern area.

SMALLPOX

[C indicates cases]

| Place | January-March 1942 | April 1942 | May 1942—week ended— | | | | |
|--------------------------------------|--------------------|------------|----------------------|-----|----|-----|-----|
| | | | 2 | 9 | 16 | 23 | 30 |
| AFRICA | | | | | | | |
| Algeria..... | C 326 | 68 | | | | 156 | |
| Belgian Congo..... | C 249 | | | | | | |
| British East Africa: Tanganyika..... | C 3 | | | | | | |
| Dahomey..... | C 40 | 12 | | | | | |
| French Guinea..... | C 59 | 8 | | | | | |
| Ivory Coast..... | C 50 | | | | | | |
| Morocco..... | C 899 | 151 | 13 | 20 | 22 | 34 | 12 |
| Nigeria..... | C 537 | 335 | 88 | 104 | | | |
| Niger Territory..... | C 237 | 200 | | | | | |
| Senegal..... | C 9 | | | | | | |
| Tunisia..... | C 1 | | | | | | |
| Union of South Africa..... | C 464 | | | | | | |
| ASIA | | | | | | | |
| Ceylon..... | C 3 | 1 | | | | | |
| China..... | C 7 | | | | | | 1 |
| India..... | C 9,551 | 2,872 | | | | | |
| Indochina (French)..... | C 1,292 | 615 | | | | | 494 |
| Iran..... | C 28 | | | | | | |
| Iraq..... | C 164 | 12 | | | 7 | | |
| EUROPE | | | | | | | |
| France: | | | | | | | |
| Seine Department..... | C 41 | | 2 | | 1 | | |
| Unoccupied zone..... | C 13 | | | | | | |
| Portugal..... | C 24 | 3 | | | 6 | | |
| Spain..... | C 48 | 28 | 4 | | 6 | | |
| NORTH AMERICA | | | | | | | |
| Canada..... | C 1 | 1 | | | | | |
| Mexico..... | C 9 | | | | | | |
| SOUTH AMERICA | | | | | | | |
| British Guiana..... | C 1 | | | | | | |
| Colombia..... | C 126 | | | | | | |
| Venezuela (alastrim)..... | C 84 | | | | | | |

1 For the period May 1-20.

2 For the month of May.

TYPHUS FEVER

[C indicates cases; P, present]

| | | | | | | |
|---------------------------------|----------|-------|-------|-------|-------|--------|
| AFRICA | | | | | | |
| Algeria..... | C 16,329 | 7,009 | | | | 13,740 |
| Basutoland..... | C 15 | | | | | |
| British East Africa: Kenya..... | C 4 | | | | | |
| Egypt..... | C 7,654 | 1,953 | | | | |
| Ivory Coast..... | C 4 | | | | | |
| Morocco..... | C 9,179 | 5,783 | 1,119 | 1,021 | 1,001 | 1,050 |
| Niger Territory..... | C 1 | | | | | |
| Sierra Leone..... | C 1 | | | | | |
| Tunisia..... | C 7,303 | 2,797 | 721 | 485 | 580 | |
| Union of South Africa..... | C 362 | | | | | |
| ASIA | | | | | | |
| China..... | C 7 | | | | | |
| India..... | C 5 | 1 | | | | |
| Iran..... | C 129 | 131 | | | | |
| Iraq..... | C 6 | 8 | | 8 | | |
| Palestine..... | C 16 | 3 | | | | |
| Syria..... | C 22 | | | | | |
| EUROPE | | | | | | |
| Bulgaria..... | C 291 | 114 | 57 | 43 | | |
| Czechoslovakia..... | C 5 | | | | | |
| France: | | | | | | |
| Seine Department..... | C 1 | | | | | |
| Unoccupied zone..... | C 45 | 79 | | 2 | | 6 |
| Germany..... | C 85 | | | | | |
| Hungary..... | C 358 | 143 | 23 | | 35 | |
| Irish Free State..... | C 2 | 1 | | | | |

1 For the period May 1-20.

2 For 1 week.

TYPHUS FEVER—Continued

[C indicate cases; P, present]

| Place | January-March 1942 | April 1942 | May 1942—week ended— | | | | | |
|--|--------------------|------------|----------------------|-----|----|-----|----|-----|
| | | | 2 | 9 | 16 | 23 | 30 | |
| EUROPE—continued | | | | | | | | |
| Portugal..... | C | 1 | | | | | | |
| Rumania..... | C | 2,068 | 434 | 140 | 94 | 141 | 96 | 104 |
| Spain..... | C | 3,349 | 265 | 46 | 70 | | | |
| Canary Islands..... | C | 1 | | | | | | |
| Turkey..... | C | 193 | P | P | P | P | P | P |
| Union of Soviet Socialist Republics..... | C | 66 | | | | | | |
| NORTH AMERICA | | | | | | | | |
| Guatemala..... | C | 34 | 10 | | | | | |
| Jamaica..... | C | 10 | 4 | | | | | |
| Mexico..... | C | 197 | 2 | | | | | |
| Panama Canal Zone..... | C | 1 | | | | | | |
| Puerto Rico..... | C | 3 | | | | | | |
| SOUTH AMERICA | | | | | | | | |
| Chile..... | C | 16 | 7 | 6 | | | | |
| Ecuador..... | C | 14 | | | | | | |
| Venezuela..... | C | 7 | | | | | | |
| OCEANIA | | | | | | | | |
| Australia..... | C | 12 | 1 | | | | | |
| Hawaii Territory..... | C | 20 | 1 | | | 2 | | |

YELLOW FEVER

[C indicates cases; D, deaths]

| AFRICA | | | | | | |
|-----------------------------|---|----------------|---|----------------|--|--|
| Belgian Congo: Libenge..... | D | | 1 | | | |
| French West Africa..... | C | 1 | | | | |
| Gold Coast..... | C | 1 | | | | |
| Ivory Coasts..... | C | 1 | | 1 ¹ | | |
| Senegal. ² | C | | | | | |
| Sierra Leone: Freetown..... | C | 2 | | | | |
| Sudan (French)..... | D | 1 ¹ | | | | |
| Togo: Hohoe..... | C | 1 | | | | |
| SOUTH AMERICA ³ | | | | | | |
| Brazil: Acre Territory..... | D | 4 | | | | |
| Colombia: | | | | | | |
| Boyaca Department..... | D | 2 | | | | |
| Intendencia of Meta..... | D | 1 | | | | |
| Santander Department..... | D | 1 | | | | |

¹ Suspected.² According to information dated Feb. 9, 1942, 15 deaths from yellow fever among Europeans have occurred in Senegal.³ All yellow fever in South America is of the jungle type unless otherwise specified.