Table III.—Mosquito Inoculations Performed by Prof. J. Guiteras at Las Animas Experimental Station, Havana, 1901.

No.	Name.	Inoculation.	Mosquitoes.	Contamination.	Result.	Incubation.
1	Gross	(a) 22 February	1	13/? iii.	0	
		(b) 17 March	1	17/(No. 2), ii.	0	
		(c) 14 April	1	15/vm., ii.	0	
		(d) 2 June	3	19/vm., ii.	0	
2	Vergara	23 February	1	26/(4, Table IV.), i.	Alb. y-f.	3 days 10 hours.
3	Quintillan	8 March	1	9/vm., iv.	0	
4	Maas	(a) 17 March	1	17/(No. 2), ii.	0	
		(b) 25 March	1	25/(No. 2), ii.	0	
		(c) 16 May	3	6/m., ii.	0	
		(d) 27 May	1	18/m., ii.	0	
		(e) 4 June	4	26/m., ii.	0	
		(f) 15 August	2 Alv.	24/hg., iii.	Fatal Hg.	3 days 21 hours.
5	Martinez	26 March	1	25/m., ii.	0	
6	Represas	(a) 17 March	1	18/m., ii.	0	
		(b) 31 March	1	25/m., ii.	0	
		(c) 8 August	4 Alv.	19/hg., iii.	Severe hg.	3 days 3 hours.
7	Santiso	(a) 30 April	1	21/m., ii.	0	
		(b) 16 May	2	7/m., ii.	0	
		(c) 2 June	3	20/vm., ii.	0	
8	Carro	(a) 25 April	1	25/m., ii.	0	
		(b) 24 May	4	15/m., ii.	0	
		(c) 8 August	4 Alv.	19/hg., iii.	Fatal hg.	4 days 5 hours.
9	Taylor	(a) 1 May	3	9/m., ii.	0	
		(b) 8 May	3	17/m., ii.	0	
		(c) 15 May	2	23/m., ii.	0	
		(d) 29 May	3	20/m., ii.	0	
		(e) 7 June	4	24/m., ii.	0	
		(f) 7 August	5	20/m., ii.	0	
		(g) 13 August	1 Alv.	24/hg., iii.	Alb. y-f.	3 days 14 hours.
10	Vazquez	31 May	4	22/m., ii.	0	
11	Campa	(a) 31 July	4	5/Hg., iii.	0	
		(b) 9 August	3 Alv.	20/hg., iii.	Fatal Hg.	5 days 3 hours.
12	Martin	(a) 4 August	4	17/m., ii.	0	
		(b) 13 August	2 Alv.	24/hg., iii.	0	
13	Varela	(a) 4 August	4	17/m., ii.	0	
		(b) 14 August	3 Alv.	24/hg., iii.	Severe y-f.	5 days 21 hours.
14	Holmes	(a) 7 August	1	14/hg., iii.	0	
		(b) 8 August	1	15/hg., iii.	0	
15	Migues	10 August	2	22/m., ii.	0	
16	Thomlison	10 August	2	22/hg., iii.	0	
17	Dominguez	10 August	4	15/Hg., iii.	0	
18	Alonso	24 August	2 Alv.	34/hg., iii.	Severe hg.	3 days.
19	Vicente	24 August	2 Alv.	36/hg., iii.	0	
20	Semil	17 November	1	57/(13, Table II.), ii.	Alb. y-f.	4 days 2 hours.
21	Rivero	(a) 17 November	1	26/(No. 1, Table VI.), ?	0	
		(b) 19 December	1	23/(No. 20, Table III.), iv.	0	
22	Kirby-Smith	28 November	1	3/(No. 20, Table III.), iv.	0	
23	Lopez	(a) 28 November	1	3/(No. 20, Table III.), iv.	0	
		(b) 15 December)	1	16/(No. 20, Table III), iv.	0	

Table IV.—Experimental Yellow Fever Produced by the Army Board with the Injection of Blood from Yellow-Fever Patients, 1901.

No.	Name.	Injection.	Quantity.	Source.	Attack.	Incubation.
1	W. J.	January 4th, 1901	2.0 c.c.	(m., y-f), ii.	January 8th: Alb.	3 days 22 hours.
2	W. O.	January 8th	1.5 c.c.	(No. 1, T. IV.), i.	January 11th: m. y-f.	2½ days.
3	W. F.	January 22d	.5 c.c.	(f. Hg.), ii.	January 24th: s. Alb.	1 day 19 hours.
4	J. H. A.	January 25th	1.5 c.c.	(No. 3, T. IV.), ii.	January 28th: Alb.	3 days 8 hours.
5 ?	J. M. B.	October 22d	1.5 c.c.	(No. 1, T. VI.), iv.	October 23d ?	24 hours.

Case 5 received an injection of filtered serum on the 15th and another of fresh blood on the 22d; opinions being divided as to which of the two injections was the successful one, the case has been recorded with a query, both in this table and in the following one (No. 3 ? T. V.).

nine persons to whom they were afterward applied seven were attacked with severe yellow fever, and three of them proved fatal. A mosquito which had been fed from the arm of Dr. Guiteras' first experimental case (No. 2, Table III.) gave a negative result when applied after seventeen days, and again eight days later, with twenty-five days of contamination, to Miss Maas (No. 4, *a* and *b*, Table III.), who died three months later from the bites of two of the Alvarez mosquitoes (No. 4, *f*, Table III.). Another mosquito which had bitten the patient upon whom Dr. Carroll had experimented with unheated defibrinated blood (No. 1, Table VI.), was applied, twenty-six days after biting this patient, to a non-immune (No. 21 *a*, Table III.) with a completely negative result. Finally, three mosquitoes which had bitten Dr. Guiteras' last successfully inoculated patient (No. 20, Table III.) three days and five hours after the first onset of the fever, were applied at the end of three, sixteen, and twenty-three days respectively to three non-immunes (No. 22, 23 *a* and *b*, 21 *b*), and the result was negative in all three. These results evidently prove that not all the Stegomyia mosquitoes that bite genuine yellow-fever patients become infected, even when all the conditions set down by the Army Board are complied with. This had already been inferred by Dr. Reed after witnessing an instance in which the simultaneous bites of twelve mosquitoes which had bitten a mild experimental case (No. 8, Table II.) failed to transmit the disease to a person considered non-immune, although the injection of 2 c.c. of blood drawn from the same patient had produced a characteristic attack in another non-immune (No. 1, Table IV.). The only hypothesis which affords a satisfactory explanation of these apparent anomalies seems to be that many of the natural or experimental cases of genuine yellow fever, but principally among those of a mild type, are due to the introduction of a limited number of germs which, having taken root, as it were, in some undetermined region of the body, establish a localized infection; and that the general symptoms of yellow fever which follow are elicited by the soluble toxins

conveyed through the blood circulation. Under these circumstances mosquitoes fed from the germ-free peripheral blood would not become infected, while a direct injection of the blood itself, saturated with toxins, might produce a purely toxæmic attack of yellow fever insusceptible of further reproduction.

The importance of this hypothesis will be better appreciated after one has gone over the interesting and highly instructive experiments which were performed by the Army Board with blood freshly drawn from the general circulation of yellow-fever patients on the first or second day of their attack.

Their first series consisted in injecting subcutaneously from 0.5 to 2 c.c. of blood drawn from a vein in the arm of a yellow-fever patient. They have reported five successful experiments of this kind (Table IV.), but the fifth, as will be explained farther on, belongs more properly to their other experiments with filtered blood serum (Table V.), and has for that reason been included in both tables, with a query appended to each.

The conclusions of the Army Board regarding their blood inoculations were expressed in the following terms: "First, that the parasite is present in the blood—at least during the early stages of the disease; secondly, that the passage through an intermediate host is not essential in the life cycle of the parasite. Thus yellow fever is analogous to the malarial fevers in that it may be produced either by the bite of a certain species of mosquito or by injection of blood taken from the general circulation." (*American Medicine*, July 6th, 1901, p. 16.)

Another very important investigation was carried out by the Army Board with blood drawn from a vein at the bend of the elbow of a mild experimental case (No. 14, Table II.). This blood, amounting to 65 c.c., was placed in a sterile test tube and set aside during five and one-half hours in the refrigerator. At the end of that time 19 c.c. of the supernatant, slightly blood-stained serum was pipetted off into another sterile tube, and after diluting it with an equal quantity of sterilized distilled water, it was filtered through a Berkefeld filter, previously tested and sterilized. Ten and a half hours after the blood had been drawn from the patient, 3 c.c. of the filtrate, corresponding to 1.5 undiluted serum, was injected into two American non-immunes (Nos. 1 and 2, Table V.). Both fell sick, after an incubation of a little over four days, with a mild attack of yellow fever. One showed a trace of albumin on the fourth day, but the other had none at all during his entire illness. The latter was, in fact, a type of what I have elsewhere termed the non-albuminuric abortive form. Three and a half hours after the inoculations of these two Americans, a third one (No. 3, Table V.) was likewise injected with the same quantity of the filtered serum, which by that time had been kept fourteen hours in the refrigerator. This inoculation was thought to have been a failure, as no reaction had been observed at the end of the seventh day, and the same subject was again utilized for another experiment. He was injected, at the commencement of the eighth day since his previous injection with filtered serum, with 1.5 c.c. of blood freshly drawn from the arm of the first American (No. 1, Table V.) on the fourth day of the attack. The object of this blood injection had been to ascertain whether the experimental attack in No. 1 (Table V.) should be attributed to soluble toxins contained in the filtered serum, in which case the second injection must be expected to give a negative result, or to the presence of ultra-microscopic germs which had passed through the Berkefeld filter, and which, having multiplied after being inoculated, would enable the disease to be reproduced through the injection of the patient's blood. This well-conceived experiment was, however, deprived of its significance by the circumstance that, not having at hand a fresh non-immune, it was performed upon a subject who might still be under the influence of a previous experiment. In point of fact, exactly eight days after this third American had received the injection with filtered serum, and just twenty-four hours after his injection with the fresh blood (No. 3, Table V., and No. 5, Table IV.), he was attacked with a mild form of yellow fever, showing a trace of albumin on the fourth day. The question as to which of the two injections had been the successful one rests, therefore, on the greater probabilities of an incubation period of eight days rather than of one of twenty-four hours. The experimenters decide in favor of the latter, but I cannot agree with them on that decision, for there is no reliable precedent for such a brief incubation as twenty-four hours in the records of either natural or experimental cases, while there are examples of both kinds regarding an incubation of eight days. Dr. Carter, in his valuable paper on that subject (New York *Medical Record*, March 9th, 1901, p. 366), gives the particulars about four members of a family who at different hours of the same day had gone from a non-infected house where they lived to an infected one at a short distance from their home, and they were all taken sick with yellow fever in the course of the eighth or ninth day after that visit, while a fifth member of the family who had not accompanied the others in their visit to the infected house, only took the disease several weeks later. As an experimental case in point, I can quote the only one (No. 9, Table I.) of my one hundred and two inoculated subjects about whose isolation from other sources of infection I had a reliable guarantee. With regard to the mosquito which I had used, it was not a home-bred insect, so that I have not the same certainty that it might not have bitten a yellow-fever patient before it was caught; but at any rate, I do know that the only source of infection to which the person had been exposed was the bite of my infected mosquito. He was bitten on the 17th of August, 1883 (hour not recorded), and was taken sick on

Table V.—Experimental Yellow Fever with Injection of 1.5 c.c. of Filtered Blood Serum from Case (No. 14, Table II.) IV.

No.	Name.	Injection.	Time *in vitro*.	Attack.	Incubation.
1	P. H.	October 15th.	10½ hours.	m., y-f., tr., alb.	4 days 4 hours.
2	W. C.	October 15th.	10½ hours.	abort., y-f., no alb.	4 days 1 hour.
3 (?)	J. M. B.	October 15th.	14 hours.	vm., y-f., tr., alb.	8 days.

Note.—Case 3, see note to Table IV.

Table VI.—Comparison Between Unheated Blood and the same Blood after having been Heated to 55° C., During Ten Minutes, when Injected into Non-immunes.

No.	Name.	Injection.	Source.	Quantity.	Condition.	Result.
1	(Control) M. G. M.	October 15th.	(14 Table II.) iv.	0.75 c.c.	Unheated.	m., y-f., tr., Alb., October 20th.
2	Sp. A. C.	October 15th.	(14 Table II.) iv.	1.5 c.c.	Heated.	0.
3	Sp. R. F. M.	October 15th.	(14 Table II.) iv.	1.5 c.c.	Heated.	0.
4	Sp. S. O.	October 15th.	(14 Table II.) iv.	1.5 c.c.	Heated.	0.

the 26th at 11:45 A.M., with a characteristic attack of non-albuminuric yellow fever, only a doubtful trace of albumin having been obtained in the night of the fourth day. There were hawking up of bloody phlegms, bleeding from the gums on pressure, yellowness, and the spontaneous defervescence on the seventh day, and his immunity was subsequently proved by more than twelve years of residence in Havana. In this experimental case, therefore, the incubation was between eight and nine days.

Until some more decisive experimental proof can be given, I must therefore adhere to my belief that the pathogenic effects which followed the injection of filtered blood serum in the experiments by the Army Board were due to the soluble toxins contained in that serum rather than to the hypothetical ultra-microscopic germ invoked by the experimenters. I believe, furthermore, that those experiments confirm my opinion about my own experimental cases (see Table I.), and that some of the pathogenic effects, which were observed after a few of my inoculations with recently contaminated mosquitoes, may have been due to the direct inoculation of human germs which had been retained upon the setæ of the insect's sting; these germs having found an appropriate nesting-place in some region of the body of the inoculated person and producing through their toxins mild non-infectious attacks of yellow fever, such as I have mentioned in connection with Dr. Guiteras' experiments at Las Animas.

While the inoculations with filtered serum were being carried on by the Army Board, the residual blood which had remained in the test tube after the supernatant serum had been pipetted off was mixed with 19 c.c. of sterilized distilled water and beaten up with a sterilized egg-beater, to remove most of the fibrin. This mixture may be supposed to have differed from the original 65 c.c. of blood, in that it would be poorer in soluble toxins by the quantity contained in the 19 c.c. of supernatant serum which had been pipetted off, but richer in living germs, for these would naturally gravitate, together with the red globules, to the bottom of the test tube. Fifteen and a half hours had elapsed since the blood had been drawn from the patient (five and a half in the refrigerator and ten at room temperatures) when they injected 0.75 c.c. of the above mixture into a non-immune Spaniard who was attacked, at the end of five days and two hours, with a mild but characteristic yellow fever showing a trace of albumin on the fourth day. In the mean time another portion of the same blood mixture was subjected during ten minutes to a heat of 55° C., and of this heated portion, after it had been cooled down, 1.5 c.c. were injected into three non-immune Americans, with a completely negative result, "no rise of temperature nor other symptoms of ill-health having followed the injection."

The outcome of these important experiments seems to be that the yellow-fever germ is killed by ten minutes' exposure to 55° C., but is not entirely deprived of its virulence by exposure to the cold of a refrigerator (presumably between 40° and 50° F.) during five and a half hours, nor by being kept *in vitro* fifteen and a half hours after having been drawn from the human subject. The soluble toxins contained in the filtered serum, on the other hand, appear to lose some of their virulence when kept beyond ten hours in the refrigerator; but nothing is known about their susceptibility to heat.

The original finding of the Army Board that through the bites of the insect variously named Culex mosquito Desv., Culex fasciatus Fab., Stegomyia fasciata Theo., experimental attacks of yellow fever can be produced almost at will has now, therefore, been established beyond the possibility of a doubt. But the Board had yet another task to fulfil, namely, to show that the disease is not also transmitted by any of the other modes of contagion which had formerly been invoked. For this purpose they instituted two very convincing experiments. One consisted in partitioning a room, by means of mosquito-proof wire netting, into two compartments, so that a certain number of contaminated mosquitoes which had been introduced into one of the compartments could be seen from the other side of the screen, but could not cross the barrier. A non-immune was then introduced on three occasions on two successive days into the compartment with the contaminated insects, while at the same hours two other non-immunes occupied the compartment on the other side of the screen. At the end of three days and twenty-three hours from his first visit to the mosquito compartment the first of these non-immunes was taken sick with a characteristic attack of yellow fever, while neither of the two who had been in the mosquito-proof compartment experienced the slightest inconvenience.

The other experiment consisted in accumulating in a mosquito-proof building constructed *ad hoc* all sorts of garments, bedding, rags, and refuse which had been soiled or used by yellow-fever patients or by their discharges, under the worst imaginable conditions, and allowing three non-immunes not only to enter that building, but to handle the objects, and to unpack them out of the boxes in which they had been preserved, to sleep in the soiled beds, etc., during twenty successive days. This performance was again gone through by two other couples of non-immunes during the two following periods of twenty days, and yet none of the seven who were thus exposed suffered the slightest disturbance in their health.

In order to try whether the local influence had contributed to these negative results, Major J. Ross, United States Navy, as director of Las Animas Hospital, repeated the same experiment some months later at this hospital, and the results were equally negative.

The universal conviction which has now been reached as to the fact that the mosquito does transmit yellow fever has given rise to the suggestion that other blood-sucking insects should also be able to do so. That this is not the case must be directly inferred from the circumstance that most of the blood-sucking insects, apart from the Stegomyia fasciata (Culex mosquito Desv.), are common to localities where yellow fever is transmissible, and to others where it is not transmitted from the sick to the healthy. In point of fact the difficulty in the study of yellow-fever etiology has not been to find an agent which should transmit the disease indiscriminately, but, on the contrary, to account for the fact that the disease has a very limited geographical distribution, and that its propagation is markedly affected by local conditions which are not known to affect in an equal degree any other blood-sucking insect but the Culex mosquito.

Deductions from the Experimental Facts that have been Recorded.—1. Only two ways are known by which yellow fever can be experimentally transmitted from a yellow-fever patient to a non-immune: one is through the bites of Stegomyia mosquitoes which have previously bitten a well-marked case of yellow fever within the first days of his attack, and which have been kept at summer temperatures (80° to 82° F.); and the other through the injection of blood or blood serum collected from a yellow-fever patient, also within the first days of his attack. In nature, only the first of these processes can occur.

2. Other modes of infection through fomites, both while fresh and after having been kept during several months, have proved ineffectual as a means of reproducing the disease.

3. While severe cases o. yellow fever appear, as a rule, to be infectious for yellow-fever mosquitoes that have been kept at summer temperatures, not a few of the mild cases seem to be incapable of infecting those insects, even when the injection of blood collected from the same patient does occasion a mild attack.

4. The occurrence of attacks of yellow fever which cannot infect mosquitoes suggests a localized infection in some undetermined region of the body, within the boundaries of which the germs remain confined. The general symptoms would then be due to the soluble toxins conveyed through the general circulation, so that an injection of this sterile blood, saturated with toxins, might yet develop a purely toxæmic attack insusceptible of further reproduction, while mosquitoes fed with the same blood would not become infected.

5. Non-infectious forms might follow the bites of recently contaminated mosquitoes, when the live germs retained upon the setæ of the insect's sting are deposited in the wound inflicted with its next bite, and find an appropriate nesting place in which a local infection may be originated.

6. The more acute course observed in the experimental cases produced with the blood injection, as compared with those resulting from the bites of moquitoes, may be due to the fact that with the former not only the live germ, but also the soluble toxins are injected, while the mosquito bite cannot be expected to convey any of the human toxins.

7. Table VI. shows that the yellow-fever germ is killed by ten minutes' exposure to a heat of 55° C., but not by exposure to low temperatures in a refrigerator during five and a half hours, nor by being preserved in vitro during fifteen hours. Table V., on the other hand, suggests that the soluble toxins lose some of their virulence when they have been kept in vitro beyond ten hours at temperatures between 40° and 50° F. (in a refrigerator).

8. The immunity acquired by foreigners after long residence in yellow-fever countries, without ever having suffered an attack of the disease, is probably due to repeated inoculations with recently contaminated mosquitoes, such as I have recorded in Table I.

Distinctive Features and Habits of the Yellow-Fever Mosquito.—The yellow-fever mosquito is the regular day mosquito by which all the houses in Havana are infested during the summer season, and even during winter some are habitually seen flying about and ready to bite whenever the temperature rises above 75° F. It remains hidden or asleep during the night hours unless disturbed in its rest by the admission of artificial light; but is wide awake, on the contrary, from daybreak till night-time. They are more abundant, however, at some hours than at others.

The yellow-fever mosquito has been included among a group of gnats variously named by their discoverers and some of which present more or less marked differential characters, but having in common the peculiar scale arrangement upon the nape and scutellum that characterizes Theobald's new Stegomyia fasciata species. Without calling into question the scientific grounds for this classification, it may be doubted whether all the members of the group possess the faculty of reproducing yellow fever, inasmuch as the regular habitat of yellow fever is confined to the intertropical zone of the Atlantic ocean, while the geographical distribution of the entire Stegomyia fasciata species is said to extend over almost all the lowlands of the tropical and intertropical belt around the globe. The only variety of that species which has so far proved capable of transmitting yellow fever was named Culex mosquito by Robineau Devoidy and agrees in all respects with Ficalbi's description of his Culex elegans. The characters by which, as a tyro entomologist, I was able to differentiate it from the night mosquito of Havana, and also from another day mosquito which occasionally makes its appearance in the same city, were the following ones: Its graceful form and agility of movements; dark gray, sometimes almost black color of its body with silver or snow-white ornamentation; white rings around the five last joints of its hind-legs—three upon those of the middle legs, and two upon the front ones; ventral segments of the abdominal rings of a dirty white; sides of the abdomen presenting a double row of white dots; sides of the thorax ornamented with several white patches of irregular outline; front view of the thorax from above presents a combination of white lines figuring a two-stringed lyre, the two parallel lines corresponding to the strings having at times a slight golden tinge; the face presents three white spots forming between them a symmetrical triangle pointing downward; the proboscis is uniformly black, but when the white tips of the palps (in the female) are resting on the upper part of the sheath, they may be mistaken for markings on the proboscis. The shortness of the wings in the yellow-fever mosquito struck me as a very convenient differential feature; when closed they leave the last segment of the body uncovered; in the night mosquito (C. pungens or pipiens?) they are just long enough to cover the posterior end of the body; while in the other day mosquito referred to above, and which resembles the night mosquito in many respects, the wings when closed project beyond the posterior end of the body. The yellow-fever mosquito has a peculiar way of laying its ova, not in the shape of a neat boatlet, like the night mosquito, nor in an irregular lump like the other day mosquito, but singly, in rows, or irregularly disposed upon the surface of the water or upon the walls of the receptacle above the water-line.

With the yellow-fever mosquito, as with the generality of gnats, it is only the female that bites and sucks blood. It disappears from view when the temperature falls below 70° F., hiding, in a state of semi-hibernation, in dark corners, behind presses or book-shelves, etc., but comes out again, anxious to bite, when the temperature rises to between 70° F. and 80° F. The shortest interval between two successive bites, when the insect has had a full meal of blood, is forty-eight hours in the hot season, but when the temperature is cool the interval may extend to five or six days. Ovulation is to a great extent regulated by the opportunities which the insect has had of biting and sucking blood. As a rule, it does not bite before having been fecundated; one fecundation proves, however, sufficient for all the ova that are to be laid by a female. All the ova are not laid in one batch, but at different intervals, a new feed of blood being apparently necessary for every new batch. The natural longevity of the female insect varies considerably under different circumstances, and even when several are caged together some may be short-lived, while others attain an old age. Probably the circumstance of not being allowed to bite, so that all their ova cannot be laid, may tend to prolong the term of their lives. In the condition of semi-hibernation which is produced by a temperature of 40° to 50° F., Dr. Guiteras informs me that he has had under observation Stegomyia mosquitoes which have reached the age of two and a half months, without any food and with no other water supply but the droplets condensed upon the walls of the cage. A contaminated mosquito which had never been allowed to bite after its contamination lived at room temperatures upon sugar and with a provision of water, five months (from August to December, 1902). In their natural condition, however, even without taking into consideration their numerous exposures to violent death, I imagine that the yellow-fever mosquito seldom lives beyond forty or fifty days in the summer season. They have, moreover, many natural enemies, some of which attack them in the larval stage, as do the larvæ of the Psorophora, and others also as a winged insect. The yellow-fever mosquito is killed by temperatures above 40° C.

For a more technical account of the Stegomyia fasciata the reader must be referred to Prof. H. B. Ward's article on *Mosquitoes in Relation to Human Pathology* in Volume V. of this HANDBOOK.

PROPAGATION OF YELLOW FEVER.

A recognition of the fact that yellow fever can be transmitted in nature only through the agency of the contaminated Stegomyia mosquito leads to the following conclusions:

When a case of undoubted yellow fever originates in a locality known to have been free from the disease during a certain length of time, including several months of summer temperatures, in a person who has not absented himself from the locality during the last ten or fifteen days previous to his illness, one of three events must be supposed to have happened.

1. If in the locality considered the Stegomyia mosquito does not exist, one or more mosquitoes of that species having had opportunities for biting yellow-fever patients must in some way have been introduced and had access to the first person attacked with the disease. The incrim-

inated insect must have become infected since at least ten or twelve days, but possibly as far back as several months, before biting the new case on hand, and the latter was probably bitten by the contaminated mosquito between three and nine days before he was taken sick.

2. If the yellow-fever mosquito is a normal dweller in the locality which we are considering, there is a possibility that an unrecognized yellow-fever patient, within the first days of his illness (perhaps a passenger in a railway train stopping a few moments in the city station, on a ferry, or in any other conveyance) may have been bitten incidentally by one of the local Stegomyia mosquitoes, so that after the lapse of a couple of weeks cases of yellow fever may begin to develop in the locality.

3. Contaminated mosquitoes may be introduced with an immature contamination, so that the first non-immunes who happen to be bitten by them will not take the disease while, a few days later, every non-immune who is bitten by the same insects will be likely to be attacked with yellow fever within the week following the bite.

Manner in which Contaminated Mosquitoes may be Conveyed from One Place to Another.—The most obvious modes of conveyance include the casual imprisonment of contaminated insects inside of trunks, boxes, parcels, etc., and it sometimes happens that a mosquito is entrapped under a hat at the moment when it is actually biting the wearer's head. Within certain variable limits of time, in accordance with what has been said regarding the longevity of the yellow-fever mosquito, the contaminated insect may be restored to liberty when the trunk or the box comes to be opened, or the first time the wearer of the hat uncovers his head; and thus the foundation for an epidemic may be laid. The mosquito, as a rule, does not fly away to any distance from the dwelling where it has established itself; but it may wander away the length of one or two blocks in pursuit of a victim or when driven from its quarters by obnoxious fumes such as are developed in disinfecting a house or a room, if the retreat of the infected insects has not been cut off. With its short wings the yellow-fever mosquito is incapable of supporting itself in the air when a strong wind is blowing. Under these circumstances, if carried away by the wind from the deck of a ship, or from the shore, it might strive to save itself from drowning by alighting upon some floating object, which, drifting with the current, would perhaps land the insect at a greater distance than it could have reached flying. Vessels trading with ports in the yellow-fever zone are apt to be boarded by the Stegomyia mosquito, and new broods of that species may be developed in the water casks or barrels, or in accidental collections of stagnant fresh water in any part of the ship. Fruit vessels or those laden with sugar must be particularly attractive to these insects. Thus it is evident that without any actual imprisonment the Stegomyia may make its temporary or permanent home in vessels as well as in public conveyances, railway carriages, freight cars laden with fruit, etc., when the local conditions are favorable. In the presence of so many sources of danger it must, therefore, be recognized that our only chance of actually controlling the propagation of yellow fever lies in our ability to carry out the following precepts:

1. To protect yellow-fever patients from the bites of mosquitoes.

2. To prevent the escape of any of the mosquitoes that have bitten a yellow-fever patient before adequate measures can be taken for their destruction.

3. To prevent the access of non-immunes to localities in which contaminated mosquitoes may still be alive.

The fact that by satisfying these conditions the propagation of yellow fever can be absolutely controlled has been fully demonstrated by Major W. C. Gorgas while he was at the head of the Sanitary Department of Havana, and by our subsequent experience in the same city, showing that non-immunes run no risk of becoming infected by staying in the presence of imported cases of the disease, when both the patient and the non-immunes are effectually protected against the bites of the yellow-fever mosquito.

Charles J. Finlay.

YELLOW FEVER: SYMPTOMATOLOGY AND TREATMENT. See The Appendix.

YELLOW SPRINGS.—Greene County, Ohio. Hotel.

Access.—Yellow Springs is a station on the Little Miami Railroad, seventy-four miles northeast of Cincinnati (Walton).

The springs are pleasantly situated on the banks of the Little Miami River. The surrounding country is undulating, and attractive drives lead in all directions. The springs yield about six hundred and sixty gallons of water per hour. An analysis by Messrs. Wayne and Locke resulted as follows: One United States gallon contains (solids): Calcium carbonate, gr. 19.57; calcium sulphate, gr. 1.35; sodium chloride, gr. 0.15; magnesium chloride, gr. 0.17; calcium chloride, gr. 1.54; iron oxide, gr. 0.39. Total, 23.17 grains.

The water possesses mild diuretic and tonic properties.

James K. Crook.

YELLOW SULPHUR SPRINGS. — Montgomery County, Virginia.

Post-Office.—Yellow Sulphur Springs. Hotels and cottages.

Access.—Via Norfolk and Western Railroad to Christianburg depot, thence three and one-half miles by stage to springs.

This resort is located near the summit of the Alleghany Mountains, at an elevation of 2,000 feet above the sea. We find here the usual beautiful scenery and charming climate characteristic of the Alleghany resort. Four miles north of the springs is the village of Blacksburg, the location of the Virginia Agricultural and Mechanical College and the State Experimental Station. The Montgomery White Sulphur Springs are also within a distance of only four miles. The Alleghany Springs are fifteen miles, and the wonderful Mountain Lake and Bald Knob eighteen miles distant. A large new hotel, having sixty-four bed-chambers, a handsome ball-room, a large and well-ventilated dining-room, numerous bath-rooms, etc., are among the recent improvements. The lawn and pleasure grounds are shaded by magnificent forest trees, whose dense foliage makes a delightful and luxurious shelter in warm weather. The Yellow Sulphur Springs yield one hundred and eighty gallons of water per hour. This water, which has a temperature of 55° F., is transparent and very palatable. Baths of this water are always to be had at any desired temperature. The following analysis of the water is taken from the United States Dispensatory for 1880, p. 1832:

One United States gallon contains (solids): Calcium carbonate, gr. 8.64; magnesium carbonate, gr. 1.38; iron carbonate, gr. 0.62; free carbonic acid, gr. 4.68; calcium sulphate, gr. 63.30; magnesium sulphate gr. 21.09; aluminum sulphate, gr. 3.18; potassium sulphate, gr. 0.11; sodium sulphate, gr. 0.75; calcium phosphate, gr. 0.01; magnesium phosphate, gr. 0. 01; potassium chloride, gr. 0.09; sodium chloride, gr. 0.08; organic matter, gr. 3.73; and traces of iron protoxide. Total, 107.67 grains.

The title to the designation "sulphur" water is not made clear by this analysis, yet it shows a valuable combination of mineral ingredients. The water should possess antacid, diuretic, and laxative properties. It contains sufficient iron to give it a tonic influence and enough free carbonic acid to impart a pleasant sparkle and to endow it with a grateful sedative action on the stomach. The water has been found, on continued use, to brace up and give tone to the muscular system and to allay chronic and subacute inflammation of the gastro-intestinal mucous membrane, thus regulating the secretory function, tranquillizing the nervous system, and tending to promote sound and refreshing sleep. It is highly recommended in chronic disorders of the female generative organs, especially in amenorrhœa, in dysmenorrhœa of certain forms, and in leucorrhœa. It also acts as a valuable restorative in general debility and in convalescence from acute prostrating diseases. The baths are recommended for rheumatism and chronic squamous skin affections.

James K. Crook.

YELLOWSTONE NATIONAL PARK SPRINGS.—The great Yellowstone Park is undoubtedly destined to become prominent as a health resort. Within its limits are contained upward of two thousand springs, many of which have been found to be highly mineralized as well as thermal. We present the following table of reactions, etc., of thirty-four of these springs, geysers, and streams, which we have compiled from analyses made in 1883, 1884, and 1885 by Messrs. Frank Austin Gooch and James Edward Whitfield*:

Springs and Geysers of the Yellowstone National Park.

	Temperature °F.†	Reaction.	Solid contents per U. S. gallon.‡
			Grains.
Cleopatra Spring	159.80	Alkaline	121.64
Orange Spring	145.40	"	101.54
Hot River	136.40	"	113.10
Soda Bath Spring	64.40	"	......
Fearless Geyser	191.40	Neutral	95.02
Pearl Geyser	187.20	"	......
Constant Geyser	197.60	Acid	94.44
Coral Spring	163.40	"	111.35
Echinus Spring	195.80	"	48.38
Schlammkessel	195.80	"	98.52
Fountain Geyser	179.60	Alkaline	81.03
Great Fountain Geyser	179.60 to 199.80	"	76.37
Hygeia Spring	109.40	"	68.79
Madison Spring	140.00	"	76.95
Excelsior Spring	197.60	"	85.70
Old Faithful Geyser	189.20 to 191.40	"	81.03
Splendid Geyser	199.80	"	95.02
Giantless Geyser	199.80	"	82.20
Bee-hive Geyser	199.80	"	70.54
Grotto Geyser	199.80	"	82.78
Turban and Grand Geysers	195.80	"	81.03
Artemisia Geyser	192.02	"	86.28
Taurus Geyser	197.60	"	74.62
Asta Geyser	187.20	"	39.05
Bench Spring	191.40	Slightly acid	27.40
Chrome Spring	197.60	Neutral	166.32
Alum Creek	......	Acid	71.12
Mush-pot Spring	185.00	"	64.13
Devil's Ink Pot	197.60	"	197.05
Firehole River at Marshalls	44.40	Alkaline	24.26
Gardiner River above Hot River	44.40	......	12.24
Water Supply at Mammoth Hot Springs	......	......	15.74
Soda Springs	42.80	Acid	48.90
Yellowstone Lake	......	......	99.11

† Converted from degrees centigrade.
‡ Converted from grams per kilograms.

Most of these waters, it will be seen, are not only highly thermal, but are quite heavily mineralized, the solid contents ranging from 12.24 to 197.05 grains per gallon. These mineral ingredients consist chiefly of calcium, sodium, potassium, lithium, magnesium, silicon dioxide, sulphur trioxide, carbon dioxide, chlorine, and basic oxygen. The chemists also discovered the following ingredients in small quantities or traces: Titanium, arsenic, iron, bromine, aluminum, manganese, barium, strontium, rubidium, cæsium, ammonium, hydrogen sulphide, boron, phosphoric and hydrochloric acids. The various combinations of these elements and bases have not been fully determined, but the waters may in general terms be classed as calcic, alkaline, silicious, saline, and sulphureted. It may be stated that the waters for the above examinations were collected during the months of July, August, September, and October, and the thermometric records represent as a rule the summer temperatures. It is probable that the waters of the hot springs show little variation in temperature at the fountains during the year. We present in full the analysis of the Fountain Geyser, which may be regarded as fairly representative of the group. The hypothetical combinations have been worked out for the author by E. E. Smith, M.D., Ph.D., of New York.

Fountain Geyser (Yellowstone National Park). One United States gallon contains (solids):* Sodium chloride, gr. 30.47; potassium chloride, gr. 2.09; sodium bromide, gr. 0.03; lithium bicarbonate, gr. 1.98; sodium bicarbonate, gr. 22.46; magnesium bicarbonate, gr. 0.35; calcium bicarbonate, gr. 0.33; iron bicarbonate, gr. 0.035; potassium sulphate, gr. 2.48; sodium phosphate, gr. 0.01; sodium tetraborate, gr. 1.16; sodium arseniate, gr. 0.20; alumina, gr. 0.96; silica, gr. 19.33; and a trace of manganese bicarbonate. Total, 81.885 grains. The water also contains free carbonic acid and a trace of sulphureted hydrogen.

This analysis presents a fairly strong alkaline-saline water. It possesses useful properties as an antacid, diuretic, and aperient. In addition, it contains an appreciable quantity of arsenic, and in continued dosage should speedily produce the physiological effects of that drug. The water of La Bourboule, in France, which contains but slightly more arsenic than this geyser, has long been celebrated in the treatment of skin diseases, notably in eczema and the other rheumides. The Yellowstone waters will no doubt in time be found to possess equal virtue in these affections. At the present time the waters are used for bathing only at the Fountain Geyser Hotel. At this resort the waters are conducted into the hotel building, which is supplied with an excellent system of bath-rooms. The thermal waters of the park will probably come into high repute, in the near future, in the treatment of gout, rheumatism, and syphilitic affections. Some of the springs contain a considerable proportion of sulphureted hydrogen, while free hydrochloric acid is found in several others. We may expect that all of these different waters will at some future time render useful service in practical therapeutics. We are informed that intensely hot weather is practically unknown in the park. Following is a temperature table of the summer and early autumn months, made during a recent season:

	Sunrise.	Midday.	Sunset.	Mean.
July	55° F.	77° F.	69° F.	67° F.
August	50	79	66	65
September	41	66	58	55
October	41	57	52	50

Visitors to the park should be amply prepared for cool weather, no matter what the season may be.

James K. Crook.

YERBA SANTA.—(*Eriodictyon*, U. S. P.; "Consumptive's weed," "Mountain balm," etc.) The dried leaves of *Eriodictyon Californicum* (H. et A.) Greene (fam. *Hydrophyllaceæ*). A very pretty evergreen shrub, growing on the western side of the United States and in northern Mexico, in gregarious clumps and patches in barren soils and among rocks. The drug is thus described: Usually much broken; blade narrowed into a very short and broad petiole, 5–12 cm. (2–5 in.) long and rarely exceeding 3 cm. (1¼ in.) in breadth, oblong-lanceolate, gradually tapering to an acutish point, most irregularly serrate- or crenate-dentate, thick and brittle, or flexible in a damp and warm atmosphere, the margins more or less incurved; upper surface yellowish-green, more or less resinous, smooth, the veins somewhat impressed; lower surface whitish or yellowish-white, with finely and conspicuously reticulate dark veins, densely but very shortly tomentose; odor somewhat aromatic, strongly balsamic if heated in the closed hand; taste balsamic, sweetish, somewhat tea-like.

The principal constituent of this drug is its ten to

* Bulletin 47 of the United States Geological Survey, 1888.

* The combinations, as estimated by the original analysts, have recently come under our observation. The result does not materially differ from those given above. It is probable that the proportion of sodium arseniate is somewhat over-estimated.