APPENDIX C.

CUBA.

(1) IS THE MOSQUITO THE ONLY AGENT THROUGH WHICH YELLOW FEVER IS TRANSMITTED?

By CHARLES J. FINLAY, M. D., chief sanitary officer of Cuba.

I have been requested by my Government to answer the question formulated for the section on yellow fever, in the programme of this convention: "Is the mosquito the only agent through which yellow fever is transmitted?" and I shall endeavor to do so by linking together the experience of former years with the discoveries of the present day. Taking for granted that all admit that the mosquito does transmit the disease, I suppose that the question will be considered duly answered if I can show that yellow fever is not transmitted, as was at one time believed, through fomites, nor, as has recently been suggested, by other blood-sucking insects besides the Stegomyia mosquito. As to the spontaneous generation of the yellow-fever infection, independently of a previous case of the disease, I consider that idea as obsolete, having long since been decided negatively by the most competent students of yellow-fever etiology.

The question of fomites as a means of propagating yellow fever is one about which conscientious observers had never been able to agree among themselves, and was the habitual battlefield upon which contagionists and anticontagionists waged their fiercest battles during the greater part of the last century. Some twenty years ago, however, the most experienced and clear-sighted epidemiologists in the United States, having at their disposal a vast amount of reliable data, came to the conclusion that the germ of yellow fever, as it is first discharged from the body of a yellow-fever patient, was innocuous, and that it only acquired virulent properties when it happened to find an appropriate medium or soil in which it might undergo some intermediate transformations. This ingenious theory was called the "nidus theory," and obtained very general acceptance in the United States, inasmuch as it appeared to meet some of the more obvious difficulties of the problem, while others soon proved to have been left untouched. It could never be ascertained what it was that constituted the favorable medium upon which the primary germ was supposed to acquire the property of reproducing the disease; no amount of disinfection applied to the inanimate surroundings of the patient, after the sick room had been vacated, having ever succeeded in stamping out the disease until the advent of a cold season or a scarcity of nonimmunes had brought about the spontaneous cessation of the epidemic. The truth of the matter, as we now understand it, is that the medium which was sought for is not an inanimate one, as had been supposed, but the body of a living insect provided with wings. After those
insects have contaminated themselves, no precautions having been taken to prevent their escape, some of them will have flown out of the sick room and dispersed, thus carrying with them the infectious germ, before the room or house has been disinfected. This was well exemplified in Habana, in 1900, in evident contrast with Major Gorgas’s subsequent success in 1901 and 1902.

A few instances are quoted of epidemic outbreaks which have apparently been traced to the opening of a trunk, package, or closet in which yellow-fever fomites were believed to have been preserved during such a period of time as no contaminated insect could have survived. I am not aware, however, that it has ever been proved that, at the time when the said trunks, closets, etc., had been thrown open, some infected mosquitoes or persons had not been introduced in the neighborhood by some other channel, or that mild unrecognized cases of yellow fever had not already occurred in the locality. As an offset to the above allegation, we have thousands of instances to show that, at a time when disinfection was never used, yellow-fever fomites, so called, have been, year after year, conveyed from the Habana yellow-fever hospitals to Spain, in the summer season, without propagating the disease, either during the trip or at the port of arrival.

There is also the significant fact to be considered that nonimmunes who become infected during their passage through Vera Cruz or Rio de Janeiro and develop an attack of yellow fever after their arrival at Mexico (City) or Petropolis, go through the same train of symptoms as if they had remained at the point of infection, but the nonimmunes who surround them run no risk of infection, while in Vera Cruz or Rio the risk would have been great. Yet there would be no imaginable reason why the same fomites should not have been produced within the sick room in the City of Mexico or in Petropolis as well as in Vera Cruz or Rio, so that the transmission of yellow fever at these ports can not be attributed to the fomites.

Finally, the crucial experiment has been tried by the Yellow Fever Military Commission, at Camp Columbia, in 1900, and also by Major Ross as director of Las Animas Hospital, in 1901, of subjecting non-immunes during consecutive days, to the emanations of a large amount of fomites of the worst kind, collected from fatal cases of yellow fever, and the result has always been completely negative.

After these experimental proofs and the collateral evidence that I have recalled, there can be no excuse for considering fomites as a factor in the propagation of yellow fever.

In order to demonstrate my second proposition, that the mosquito appears to be the only insect capable of transmitting the yellow-fever infection, I must first recall the manner in which the yellow-fever mosquito was discovered by me in 1880. This happened about the time when Bemiss, Stone, and other American yellow-fever experts had invented the “nidus theory” in order to account for the fact that the propagation of the disease, in places where the disease is transmissible, is not effected through direct contact with yellow-fever patients or their secretions, nor by inhaling the emanations from their bodies, nor by using contaminated food or beverages. I had, however, conceived a different solution of the problem. My own conclusion had been that the germ of yellow fever must be one which is pathogenic for human beings only when it is introduced by inoculation, and that the natural transmitter of the disease must be a blood-sucking insect,
peculiar to the yellow-fever zone and whose existence and functional activity should be incompatible with certain degrees of cold and with certain altitudinal limits as well as with other conditions which are known to control the spread of the disease. By searching for such an insect in Habana, I came across the Culex mosquito, Desv. (*Stegomyia fasicata*, Theo.) in which I had observed certain peculiarities in the manner of laying its ova and in its readiness to renew its bites whenever the digestion of a previous meal had been completed, both of which peculiarities seemed to differentiate it from the generality of gnats. Upon investigation, that particular mosquito was found to fulfill all the conditions which I had postulated in my theory, in a manner which was considered remarkable by several European experts when I published in the Archives de Médecine Navale. (Avril 1883, p. 308), the following table in which the climatic conditions of yellow fever were confronted with the vital conditions of the C. mosquito (*Stegomyia*):

**CLIMACTERIC CONDITIONS OF YELLOW FEVER.**

Temperatures at which yellow fever epidemics decline and cease at New Orleans. [*Dr. Barton's Report, 1854, Introduction, p. xiii.*]

- **Minimum:** 15.6° C.
- **Maximum:** 18.7° C.

Degree of cold which did not exclude a return of yellow fever on the *Plymouth* [see "Hygiene," Med. Reports Navy Department, Washington, 1879, p. 689].

- **Freezing point.** [4 experiments.] Below 0° C.

Degree of cold which proves effective for the permanent arrest of yellow fever. [*Laroche, II, p. 295.*]

- **Severe frosts.**

Artificial heat which proved effective in arresting yellow fever: Case of the *Regalia* [see Laroche, On Yellow Fever, II, p. 440].

- **Maximum:** 43° C.
- **Minimum:** 39° C.
- **Mean:** 41° C.

Altitudes up to which yellow fever has exceptionally been propagated:

- Madrid, 1878, 2,000 feet.
- New Castle [Jamaica], 4,000 feet.

- **Degrees of heat after which the Culex mosquito does not revive.**

Artificial rarefaction which seems to deprive it permanently of the power of stinging: 5,000 to 6,000 feet.

At that time it might have been objected that, until the germ of the disease was discovered, it would be impossible to determine whether the cessation of yellow-fever epidemics when the thermometer falls to 15° C. was due to the influence of that temperature upon the mosquito or to its action upon the infectious germ itself. This question seems, however, to have been resolved, incidentally, through one of the last experiments recorded by Drs. Reed and Carroll, although the sig-
nificance of the incident appears to have escaped the sagacity of the experimenters. I refer to the fact that 65 c. c. of blood which had been drawn from the vein of a yellow-fever patient, and kept during five and one-half hours in the refrigerator, was not thereby deprived of its virulence, the disease having been reproduced in several nonimmunes who were inoculated with it some hours later. Now, this blood after being kept five and one-half hours in the refrigerator must certainly have been cooled considerably below the temperature of 15° C., which is known to arrest the progress of yellow-fever epidemics in New Orleans, in Rio, and in Habana, and also to deprive the Stegomyia mosquito of the power of biting. We are therefore obliged to admit that the arrest of the epidemics of yellow fever, which occurs when the thermometer falls to 15° C., must be attributed to the fact that the Stegomyia is thereby deprived of the power of biting, and not to any loss of virulence experienced by the yellow-fever germ.

All doubts about the aptitude of the Stegomyia for transmitting yellow fever having now been finally dispelled by the experiments of the military yellow-fever commission of 1900, it is more than probable that the influence of altitude in making the disease intransmissible at heights of 5,000 feet, in the City of Mexico, for instance, may be also attributed to the fact that a highly rarefied atmosphere appears to interfere with the power of the Stegomyia to drive its sting into the flesh of its victims. This being so, it is logical to infer that any blood-sucking insect which is habitually found to exist and to exert its natural functions in a locality where it is positively known that yellow fever is never transmitted, such as Mexico, must, ipso facto, be excluded from consideration as a possible transmitter of the disease. I am not aware that the inhabitants of the City of Mexico, specially those of the lower class, are exempt from the annoyance of fleas, bedbugs, or other blood-sucking vermin, but I infer that probably they are not, because those insects can not be affected by atmospheric temperatures to any great extent, for they mostly live in touch with the warm body of their victims.

In support of this opinion I can also cite our recent experience in Habana, from which yellow fever has been stamped out by the adoption of measures which were only directed against mosquitoes and would have proved quite inadequate to control the entrance or the escape of fleas, bedbugs, etc.

The idea that any other blood-sucking insect should transmit the yellow fever infection in the same manner as does the Stegomyia fasciata, must have arisen, as was to be expected, from the important discovery made by Dr. Reed and his colleagues, in 1900, that the injection of yellow-fever blood to nonimmunes constitutes the surest way of reproducing the disease. But the proboscis of a living insect must not be assimilated to a surgical hypodermic syringe. It is highly probable that every insect, specially those which feed on human blood, must be provided by nature with buccal secretions which are germicidal for the generality of germs which may occur in the blood of the sick, lest some of them should prove fatal to the insect itself and annihilate the species. This may perhaps be one of the functions of the venom glands. In that case the power of transmitting yellow fever, as exhibited by the Stegomyia, should not be considered as an additional functional manifestation on the part of this insect, but on the contrary, as a deficiency in the germicidal power.
of its venom as compared with that which is displayed by the venom of other blood-sucking insects. The yellow-fever germ will thus pass unharmed into the stomach of the Stegomyia and continue therein the mosquito phase of its existence, while in the case of any other blood-sucking insect it would have been destroyed or inhibited by the venom. So long as the true germ of yellow fever remains unknown, this hypothesis can not be directly verified under the microscope; but the principle seems to be confirmed in the case of the malaria parasite, which passes unscathed through the buccal cavity of the Anopheles and continues to develop in the stomach of its host, while in the other species of gnats it reaches the stomach already doomed to degeneration and death.

Having thus presented what I consider to be a plausible explanation of the fact that only certain kinds of blood-sucking insects are capable of transmitting certain germs, and that some species of the same family of insects may exhibit that peculiarity while the other species do not, I have only to add that so far, no valid reason has been brought forward for supposing that any other insect but the mosquito is capable of transmitting yellow fever, nor even that any other species of mosquito but the Stegomyia fuscata is capable of doing so.

HABANA AS A MODEL CITY.

By Dr. Juan Guiteras.

Habana is the first among the large cities of the world to have instituted a systematic campaign against the mosquito as a prophylactic measure against malaria, yellow fever, and filariosis. The success attained with respect to yellow fever is one of the greatest triumphs of preventive medicine. We owe this practical application of the doctrine enunciated by Finlay to the conclusive demonstration made by the U. S. Army board, and to the well directed zeal of the American Government in Cuba through its representatives, General Wood and Major Gorgas.

The city of Habana, under the direction of the great founder of the mosquito doctrine, Dr. Finlay, now health officer of the island, has kept up and carried to perfection all the practical measures of prophylaxis that are based upon the said doctrine. In doing this, Dr. Finlay is carrying out the plan outlined by him since 1881, and presented again by himself, with all details, to the American Government of intervention immediately after the occupation of Habana.

The measure of success that has been thereby attained is such that we can not help but regard with apprehension the evidences of unwillingness to accept this doctrine as the sole basis upon which the prophylaxis against yellow fever should rest. We are in possession of a specific treatment for the prevention of this disease. No other epidemic disease can be so perfectly controlled, and a grave responsibility rests upon the leaders of medical opinion who fail to educate their people and to prepare them in the practice of the new methods.

We feel apprehensive in Habana because we know that the Southern States still continue to rely solely upon maritime quarantine for the