The relation of the Panama Canal to the introduction of yellow fever into Asia : A paper read before the Epidemiological Society of London / by Dr. Patrick Manson, C.M.G., F.R.S., medical advisor to H.M. Colonial Office, ex-president of the Epidemiological Society.

THE RELATION OF THE PANAMA CANAL TO THE INTRODUCTION OF YELLOW FEVER INTO ASIA.

A PAPER

READ BEFORE THE EPIDEMIOLOGICAL SOCIETY OF LONDON.

BY

DR. PATRICK MANSON, C.M.G., F.R.S.,

MEDICAL ADVISER TO H.M. COLONIAL OFFICE, EX-PRESIDENT OF THE EPIDEMIOLOGICAL SOCIETY.

LONDON:

PRINTED AT THE BEDFORD PRESS, 20 & 21, BEDFORDBURY, W.C.

1903.

THE RELATION OF THE PANAMA CANAL TO THE INTRODUCTION OF YELLOW FEVER INTO ASIA.

A PAPER

READ BEFORE THE EPIDEMIOLOGICAL SOCIETY OF LONDON.

BY

DR. PATRICK MANSON, C.M.G., F.R.S.,

MEDICAL ADVISER TO H.M. COLONIAL OFFICE, EX-PRESIDENT OF THE EPIDEMIOLOGICAL SOCIETY.

LONDON:

PRINTED AT THE BEDFORD PRESS, 20 & 21, BEDFORDBURY, W.C.

1903.

THE RELATION OF THE PANAMA CANAL

TO THE

INTRODUCTION OF YELLOW FEVER INTO ASIA.

By DR. PATRICK MANSON, C.M.G., F.R.S., Medical Adviser to H.M. Colonial Office; Ex-President of the Epidemiological Society.

(*Read: February 25th*, 1903.)

THE influence of trade and travel routes on the diffusion of disease is a fascinating and important branch of epidemiology. But it is an extensive and intricate one, and I have no intention of attempting its discussion; at all events, in its wider bearings. My object on the present occasion is much more restricted: it is to elicit an expression of opinion on the part of the members of this Society on two specific points connected with the wider subject. These are: 1st, The risk of the introduction of Yellow Fever into Asia that will attend the making and working of the projected Central American Inter-Oceanic Canal; 2nd, The measures that should be taken to lessen the risk of such a calamity.

It seems to me, that the present is a suitable time to bring forward this matter; for it is a matter which, in my humble opinion, is not only one of importance, but also one of urgency. Providentially, recent discovery has given it a hopeful and practical aspect which, but a few years ago, it did not possess. Whereas, formerly, we knew little or nothing of the way in which Yellow Fever was conveyed, we now have a body of exact knowledge to guide us, and to work on. There can be no question about the urgency of the matter. The United States of America are pledged to carry through a Panama Canal. Their national pride is at stake. Their economic as well as their Naval interests would be so manifestly favoured by the success of this great undertaking that, apart from considerations of national ambition, we may be certain that every effort will be made to carry the scheme to a successful issue. Already, the purchase of the old workings has been agreed on. In a year or two, perhaps in a month or two, active opera-

tions will commence. Ship-load after ship-load of labour in the shape of Chinese, Japanese, or Indian coolies, will be landed at Panama, and steamers to supply the peculiar wants of the coolies will be plying backwards and forwards between Central America and the ports of Asia. So soon as the works begin, the risk that some of these steamers may convey Yellow Fever to Asia will begin. To put off sanitary measures, therefore, until the Canal is completed is, in my opinion, to incur a terrible risk. It might be too late then. The calamity I contemplate might have already fallen on the Asiatic world.

I firmly believe that, if direct and rapid marine communication between the present endemic area of Yellow Fever and Asia be permitted, and, if at the same time, efficient precautions against the conveyance of the Yellow Fever germ be not instituted, in a very short time there will be Yellow Fever in Asia. I also firmly believe that a properly devised and administered sanitary organisation could prevent such a catastrophe. We have the necessary knowledge; we need only apply it. It will be a standing reproach to the sanitarians and Governments of this generation if, knowing the risk, and knowing how to counteract it, Yellow Fever be allowed to get a footing in Asia; if, having the power to prevent this, they did not have the will or the wisdom to use this power.

That the introduction of the germ of Yellow Fever into Asia would be a disaster of the first magnitude cannot be doubted. We know what Yellow Fever did for Spain, for the United States, for Brazil, and for the Argentine. We know what it has done for the West Indies. We know that on more than one occasion it has wiped out French and English armies. We know the heavy toll it has levied on European, Chinese, and Indian life in Havana, in New Orleans, in Rio de Janeiro, and in many other cities in that part of the world. We know how the fear of it has taxed and dislocated commerce. It is hardly necessary to mention these things to this Society. If Yellow Fever has done so much mischief in the relatively restricted and not very densely populated endemic and epidemic area in America and Europe, how much more serious would its ravages be were it introduced into Asia and the island dependencies. There the germ would fall on an absolutely non-immune community, with numberless cities and densely populated areas, linked together by an active but unregulated commerce. It would spread from trade centre to trade centre. It would enjoy opportunities even more favourable than it

has ever encountered in America or South Europe; for the cities of Asia are larger, older, more densely populated, more insanitary; with inhabitants wedded to old customs and prejudiced against sanitary methods; passively, and sometimes actively, hostile to all sanitary and municipal reform. The dislocation of trade would be ruinous. Imagine what would happen if Yellow Fever broke out in distributing centres such as Zanzibar, Aden, Bombay, Calcutta, Colombo, Singapore, Batavia, Bankok, Saigon, Hong Kong, Shanghai, or Yokohama. Trade, in its wider sense, would stop. Our merchants, manufacturers, and shipowners, both at home and in Asia, would be ruined. And, if after a time, the initial epidemic outburst died down, there would still remain here and there throughout the tropical portion of the Eastern Hemisphere endemic centres of the disease—Oriental Rios and Havanas. These would be permanent threats to the rest of the Continent, necessitating permanent, and very irksome, and very expensive quarantine and isolation measures. To cholera, dysentery, and malaria, which already nearly everywhere threaten European life in the East, another and perhaps worse danger would be added.

I think in this matter the Epidemiological Society of Great Britain has a distinct duty, and, I would add, a very great opportunity. Just as this Society took a leading part in the fight against small-pox in Britain, so I conceive it might follow a similar course as regards Yellow Fever in Britain's Asiatic dependencies. It can influence public opinion. It can advise and influence the Government.

To proceed with the points I wish to bring forward for discussion:—

1. The risk of the introduction of Yellow Fever into Asia by the making and working of the Panama Canal.

I can imagine that some will set me down as an alarmist and busybody. I can imagine that some will say that, as Asia has enjoyed an absolute immunity from Yellow Fever during all these ages, this immunity will continue for our day at least, and therefore that there is no occasion to bother about it. To such I would answer that before Columbus's time, some Aztec or Inca, had he known about Europe and its diseases, might have said the same about small-pox, cholera, or plague. And so long as their continent was practically isolated from the Old World, as regards the Old World diseases these New World epidemiologists would have been right enough. But so soon as active communication with the Old World was established,

any *laissez aller* policy the Inca-Aztec sanitarian might have founded on this way of thinking would have been wrong. The Panama Canal will do for Asia, as regards Yellow Fever, exactly the same thing that Columbus did for America as regards European and Asiatic epidemic disease; this it will do if we remain Inca-Aztec sanitarians; if we do not recognise the danger and take measures accordingly.

Hitherto there has been no direct communication between the endemic haunts of Yellow Fever and Asia. It is quite true that there has existed for some decades an active communication between Western America and Asia; but this communication has been exclusively between points far to the north or far to the south of the Yellow Fever region, and therefore, in respect to this disease, free from risk. But with the opening of the Canal there will come a change; a huge and increasing commerce will pass through the Yellow Fever region direct to Asia. Hitherto the course of ships has been well to the north or well to the south of the Tropic belt, and generally in cold or temperate zones, in temperatures inimical to Yellow Fever and the distributor of Yellow Fever. But the new route—the direct route from Panama to Japan, China, Manila, the Straits Settlements, Java and Australia—will lie through the Tropics, and, for the most part, in atmospheric conditions favourable to Yellow Fever and its mosquito distributor. Furthermore, the route, instead of being something like fifty days, including transhipments, from Panama to Asia, will be reduced to three or four weeks and include no transhipments, and the coaling ports that will be established in the tropical parts of the Pacific will serve as convenient jumping-off places for the gradual advance of the germ.

That Yellow Fever can be successfully exported, so to speak, from the endemic area, is proved by the various epidemics that have ravaged the South of Europe. These imported epidemics prove that the germ can support a sea voyage, and that other places besides Tropical and Sub-tropical America supply the conditions necessary for its successful propagation. If these conditions are to be found in Europe, why not in Asia? Doubtless they are present in Asia; in fact, we know they are. The only conceivable reason why Yellow Fever has not appeared hitherto in Asia is the circumstance that the germ has never been introduced; and the reason why the germ has not been introduced is that hitherto there has been no direct, rapid, and all-tropic communication between Asia and Central

America. Epidemiologically, the opening of the Panama Canal will inaugurate a new area. The establishment of a great trade and travel route must always be a new factor in the diffusion of disease. It brings with it not only interchange of merchandise, but interchange of germs.

I take it that all are now agreed that the story of the Yellow Fever germ, as disclosed by the labours of Reed, Carroll, Lazear, Agramonte, and Guiteras is correct. We believe now—nay, we know now—that the germ is present in the blood of the patient in a communicable form only during the first three days of the fever; that it is removed from the human body by the *stegomyia* mosquito; that it undergoes a necessary metamorphosis in the body of this insect: a metamorphosis that takes some twelve to fourteen days to complete; that it is transferred to the bodies of non-immunes by the bite of the mosquito; that clinical evidence of the inoculated germ's presence is manifested in from three to five days after inoculation; that an infected mosquito retains its capacity to convey the germ for at least fifty-seven days from the time it bit a Yellow Fever patient. We know, further, that *fomites* have nothing whatever to do with the spread of Yellow Fever, and that our ideas of a few years ago were in this respect absolutely erroneous. There is no well-established fact that can be regarded as a reason for thinking that there is any other way by which, under natural conditions, the germ of Yellow Fever is conveyed than by the mosquito. We have no reason to suppose that the *stegomyia* mosquitoes of Asia, including *fasciata*, which abound there, would be inefficient as an intermediary of the germ. The European species has shown itself to be efficient. Why not the Asiatic?

If we apply this new-found knowledge, we will not only receive the explanation of the heretofore absence of Yellow Fever in Asia, but we will also be able to forecast the effect that changed conditions of communication, brought about by the Panama Canal, will have, or may have, on the future of Asia as regards this disease.

A steamer from Cuba, Rio de Janeiro, or other American port where Yellow Fever is raging, ships among her passengers a *stegomyia* mosquito that has recently made a meal off a Yellow Fever patient. The mosquito conceals herself, as is the habit of her kind, in some dark and quiet nook of the ship. From time to time, during the voyage, she feeds on fruit, sugar, rat, dog, fowl, or such

live-stock as chances to be on board. The ship passes through the Canal, and, in due course, arrives at Manila or Hongkong. Cargo is discharged, cabins, holds, store-rooms, live-stock pens are cleaned out, and the mosquito, being disturbed, takes flight, and reaches the shore. Presently, she has a meal off the blood of some native. With her saliva she injects into him some Yellow Fever germs. Three days later, the native falls sick. His disease is not recognised, and he is not isolated. Local *stegomyiae* feed on him, and then, a fortnight later, on other natives. The fat is now in the fire, and Yellow Fever begins in Asia. The physicians, not having seen the disease before, are some time in apprehending its nature. It is too late then. Hundreds have died or are ill. The mortality is great. Many of the inhabitants flee from the plague-stricken city. Some of them carry the germ with them. So the disease is spread from point, to point, and the epidemic rapidly attains unmanageable proportions. By degrees, the whole of Tropical Asia becomes involved, and we are in the presence of one of the worst and most deadly epidemics the world has known.

Or, there is Yellow Fever somewhere along the Panama Canal. A ship is passing through. An infected *stegomyia* from the shore comes on board. She feeds on one of the crew. Next day, the ship clears from Panama. Two days later, the bitten sailor has Yellow Fever. There are several, or perhaps many, *stegomyiae* in the ship. They feed on the patient. Fourteen days later, some of them bite another, or other, sailors. Three days later, these other sailors have Yellow Fever. There are now many infected *stegomyiae* on the ship. By this time she is near to Asia. The Captain, at his wit's end, puts into the first port he comes to for medical assistance. There is no quarantine or sanitary organisation at the port, and free communication with the shore is permitted. The infected *stegomyiae* fly ashore, and three days later an epidemic of Yellow Fever is in full swing.

But there are other ways by which the infection could be brought to Asia. I can imagine some scientist, more enthusiastic than prudent, deliberately carrying with him, for purposes of study or experiment, infected mosquitoes from America to Asia. Should one of these insects escape, it might very well start an epidemic, We know what has been done in this way with the plague bacillus, and what a narrow escape certain cities—Vienna, for example—had not so long ago.

I can even imagine some malignant Nero-like monster intentionally introducing an infected insect, and gloating over the result. Or I can imagine some wretch, with a perverted craving for fame, like that Erostratus who set fire to the Temple at Ephesus, letting loose in this way a bigger scourge to Asia than ever fire or sword have proved. But apart from risks of this sort, the repeated day-by-day recurrence of opportunities for infected *stegomyiae* being transported to Asia from America, must, if given uninterrupted play, sooner or later bring Yellow Fever to Asia.

It is not as if the Yellow Fever mosquito were a delicate insect, or one peculiar to America. *Stegomyia fasciata* is the most widely distributed and one of the most common of the tropical *Culicidae*. That is so probably because it is the best traveller of its kind, and, therefore, the best suited in this respect for the transport of the Yellow Fever germ. Its range is from Spain and Japan in the north to Natal and Australia in the south. The vitality of its eggs is not destroyed by prolonged (months) desiccation. They will hatch out in the dark, and its larvæ will live in the dark and in foul water. The insect itself is very adaptable in the matter of food, and can live at least two months on water alone (Theobald), and altogether, except as regards low temperatures, is a hardy insect.

I think I have said enough to show that my fears about Yellow Fever are not imaginary, and that it could very easily be carried to Asia, and that once introduced it could flourish there.

I pass now to the second point I propose for discussion, namely, the measures that should be taken to avert the introduction of Yellow Fever into Asia, *viâ* the Panama Canal.

It is manifest that quarantine directed against Yellow Fever *fomites* is useless and unnecessary. Reed and his colleagues proved that the *fomites* of Yellow Fever patients were as harmless as the *fomites* of malaria fever patients. They may be disregarded, therefore; the things to be guarded against are the Yellow Fever patient himself, and the Yellow Fever-infected mosquito.

Now, whatever may be the case as regards North and South America and the West India Islands, where the inter-port distances are relatively short—seldom in these days of steam exceeding, as regards duration of voyage, the combined incubation and infective periods of Yellow Fever, say ten days—it is quite different in this respect with the Trans-Pacific Panama-Asia voyage. This latter is a matter

of several weeks—a month or more. Therefore, quarantine measures directed against the danger from patients infected in America, however necessary they may be for the protection of American ports are quite unnecessary as regards Asiatic ports.

A man might be bitten by an infected *stegomyia* in Rio de Janeiro, go on board a fast steamer the same day, and reach New Orleans before he had ceased to be infective. Or a man might be bitten by an infected *stegomyia* in Havana, and land in New Orleans before he had shown any clinical evidence of a successful inoculation. But such a thing would be impossible in a case of Yellow Fever infection contracted in America and subsequently landed in Asia; the infectivity of such an individual would have disappeared weeks before he landed.

There is no danger, therefore, in shipping Yellow Fever at Panama, and no necessity for quarantine measures directed against Yellow Fever patients shipped for Asia, *on one condition*. This condition, however, is all-important. There must be no mosquito on board the ship in which the Yellow Fever patient travels; no mosquito to keep up and transmit infection, whether to fellow passengers or to the inhabitants of the Asiatic port of destination. Therefore, in dealing with the problem of the exclusion of Yellow Fever from Asia, the Yellow Fever patient may be ignored, provided the mosquito danger be adequately guarded against. And this insect must be regarded as the *crux* of the sanitary situation, whether there be Yellow Fever on board the ship she travels by or not. For, independently of Yellow Fever patients shipped in America, the mosquito may come on board already infected, either at the ports of departure or of call, or during the transit of the Canal. Such a mosquito might very well set up fever on board after the ship had cleared from Panama, at any time during the voyage to Asia, or after the arrival at the Asiatic terminus.

My idea, therefore, in attempting the protection of Asia from Yellow Fever is to disregard the Yellow Fever patient altogether, to have no quarantine, but to stringently enforce destruction of all mosquitoes, their eggs, and their larvæ in all ships, before these ships are allowed to clear from the Pacific end of the Canal, or from other ports on the Pacific side of the American Yellow Fever district. If this be effectually done, Yellow Fever will never appear in Asia.

To carry out this important sanitary measure an organisation and funds are necessary. To ensure its

efficiency, the organisation should be altogether independent of the local Canal functionaries; it must be liberally subsidised; its official head must be responsible to the Secretary of State in Washington, or other central authority, and his position should be such as to secure him freedom of action and freedom from interference by the local authority.

The funds might be provided by a special toll on ships using the Canal, or by a *pro rata* contribution from the Asiatic governments interested.

The chief of the sanitary staff must, of course, be an American citizen—such a man as Gorgas—possessed of ability, experience, energy, independence of character, and, above all, imbued with a thorough belief in the efficacy of anti-mosquito measures. The details of the staff might be selected from those nationalities whose ships are most likely to use the Canal.

That is, in rough outline, the scheme I have in my mind. The particular methods that would be employed to clear ships of mosquitoes can be easily devised after a little experience of the local conditions. I would suggest that every ship on arrival at the eastern end of the Canal be boarded by at least two sanitary officers, who, during the passage of the waterway, would clear her of mosquitoes. Before she puts to sea again at Panama, one or more inspecting officers should board her, and assure themselves that the work has been effectually carried out.

As a supplementary measure, I would suggest that the banks of the Canal, for at least half a mile back, and on both sides, should be cleared of jungle and mosquito pools.

The American people have always—and more especially of late years—shown themselves alive to the value of scientific discovery. They have been prompt, indeed usually the first, to apply it in practice. I have, therefore, very little doubt that the American Government will do all in its power, by anti-mosquito means, to render the making and working of the Canal as little dangerous to those engaged as possible. Not to mention humanitarian considerations, it is the interest of America to do so. But, apart from trade, America has little direct interest in Asia, and we have no right to expect that she will regard the health of the peoples of that Continent as specially in her keeping. It is otherwise with Great Britain. Our stake in Asia is an enormous one; our duty to our fellow subjects there is a very manifest one, and the duty of our rulers to guard our

military and commercial interests there is also a very manifest one. I would suggest, therefore, that Great Britain approach the United States of America, and that together they concert measures for the safeguarding of Asiatic countries against the introduction of Yellow Fever by the Panama Canal. Doubtless Japan, China, France, Siam, Holland, Germany and Australia, all of them directly interested in this matter, would willingly assist in any wise measures which might be devised to protect them or their Colonies from this worst of epidemic diseases.

The world owes an incalculable debt to the American Commission who discovered the bearing of the mosquito on the spread of Yellow Fever. This Commission has given the right cue to the prevention of this disease. Every one of the members of that Commission risked their lives in carrying out the necessary researches and experiments. One of them—Dr. Lazear—succumbed, a martyr, at his post. It must be a matter of profound regret to every one interested in the epidemiology of Yellow Fever that yet another—the leading spirit, as I understand—of this band of courageous workers should have died so soon after the completion of his notable labours, and before he had reaped the full measure of reward to which he was so justly entitled. Dr. Walter Reed did a great and beneficent work. We in England thoroughly appreciate this, and heartily sympathise with America in the loss she and the world has sustained by his premature death. The best tribute we can pay to his memory is at once to apply his discovery. Let us hope that the good he has done will not be interred with his bones, and that his countrymen and the rest of us will take care to push forward the great and beneficent measures his brilliant labours so clearly indicate.

I believe that within the next few years, and in great measure in consequence of the object-lesson this Panama business is about to afford, we will witness a profound revolution in tropical sanitation. The discovery of the part played by the mosquito in the diffusion of three of the most important tropical diseases, although admitted practically by all in an academic sort of fashion, has, so far, with one notable exception, not been applied in a practical and adequate way. Either from ignorance, or indolence, or indifference, or the dread of expense, or from hide-bound conservatism, the discovery has been nearly a barren one. There are not a few who oppose the new idea simply because it is new: because it has the impertinence to afford the explanation of what they had grown up to regard as a mystery

and inexplicable like other visitations of Providence, or because it has upset preconceived and erroneous ideas. There is another order of mind that seems to think that because the entire field of the relation of the mosquito to *filariasis*, malaria and Yellow Fever has not been exhaustively explored and worked out, practical action founded on the ascertained relationship should be delayed. Such a line of thought in any other department of human affairs would be deemed ridiculous. When our neighbour's house is on fire and our own is threatened, we do not wait to study the chemistry of combustion before we send for the fire-engine.

In urging elsewhere the line of action against Yellow Fever which I have advocated to-night, I have been met with the objection that, although these discoveries about the mosquito may be interesting, perhaps promising, they are still far too crude and incomplete for the country to put its money on. Let me call your attention to the Table on the following page, lately published by Gorgas.

Up to 1900, and yearly for one hundred and fifty years, Yellow Fever has claimed in Havana its annual toll of hundreds or thousands of victims; it has not missed one year. In 1900 Reed and his colleagues proved that the mosquito carried the germ. Gorgas promptly applied the discovery. These columns of cyphers are ample testimony, not only to his energy and ability, but to his wisdom. He did not wait till the whole story of the mosquito was worked out. He did not wait till someone should have proved, years hence, perhaps, a negative—that there is no other way by which infection is conveyed. He did not wait even till the germ itself was discovered; it is still unknown. It sufficed for him that Yellow Fever is conveyed by the mosquito. He acted on the ascertained fact, and thereby undoubtedly saved hundreds, if not thousands, of lives, and much treasure.

This is an object-lesson that must not—that cannot—be ignored. The struggle against malaria (which I feel sure the Americans will enter on with keenness and energy, and, I doubt not, with success), at the making of the Panama Canal will be another object-lesson in the application in a business way of scientific discovery, But we may not wait for this second object-lesson. The danger to Asia from Yellow Fever is imminent. Action must be taken at once. Why delay what Gorgas has proved, in so practical a manner, is not only easy of accomplishment, but all-sufficient?

Years.	1890 and 1891.	1891 and 1892.	1892 and 1893.	1903 and 1904.	1894 and 1895.	1895 and 1896.	1896 and 1897.	1897 and 1898.	1898 and 1899.	1899 and 1900.	1900 and 1901.	Average.	1901 and 1902.	1902.
April ...	13	5	8	8	4	6	14	71	1	2	0	12.00	0	0
May ...	23	7	7	23	16	10	27	88	4	0	2	18.81	0	0
June ...	38	41	13	69	31	16	46	174	3	1	8	40.00	0	0
July ...	67	66	27	118	77	88	116	168	16	2	30	70.45	1	0
August ...	60	66	67	100	73	120	262	102	16	13	49	84.36	2	0
September	33	65	70	68	76	135	166	56	34	18	52	70.27	2	0
October ...	22	48	54	46	40	102	240	42	26	25	74	66.27	0	0
November	15	24	52	28	23	35	244	26	13	18	54	48.36	0	0
December	9	17	33	11	29	20	147	8	13	22	20	29.90	0	0
January ...	10	15	15	7	15	10	69	7	1	8	7	14.90	0	0
February .	3	10	6	4	4	7	24	1	0	9	5	6.63	0	0
March ...	4	1	4	2	2	3	30	2	1	4	1	4.90	0	0
—	307	365	356	484	390	552	1385	745	128	122	302	466.90	5	0

To have a thin red band across the Isthmus of Panama, with the Canal in the middle of it, would gratify my patriotism. I am sorry the Panama Canal is not to be a British work. But I must confess that my regret is tempered by the knowledge that it is an American one: for I feel more confidence in American energy as regards

sanitary matters than in our own. We are too slow, too timid, too niggardly, too much afraid of failure, too unbusinesslike. I like the prompt and autocratic way in which the great democracy deals with these things. America, ever since her Colonial expansion began, only a few years ago, whether in Honolulu, or in Cuba, or in Manila, has shown an intelligence and practical appreciation of the benefits of medical and sanitary science, and an energy in these things to which we in England are not always accustomed. I cannot but feel, therefore, that in this matter of the Panama Canal the public interests are in the best hands. Still, this does not free us from our obligations to India, to Australia, and the East generally; and I trust that this Society will do something, by expressing its views freely, to strengthen the hands of Government; or, if necessary, to stimulate our Government to back up America in any measures that may be proposed or instituted with a view to keeping Yellow Fever out of Asia.

Discussion on Dr. Patrick Manson's Paper.

Dr. Strong (Director of the Biological Laboratory in Manilla) in a communication on "The Panama Canal and its Relation to the Introduction of Yellow Fever into our Eastern American Possessions," said that the question obviously, as Dr. Manson has fully explained this evening, is one of colossal importance to the Far East. In our American possessions, the Hawaian Islands, Guam, and the Philippines, we shall have to be continually on our guard against the importation of cases of Yellow Fever or of infected *stegomyia fasciata*. During the past year Yellow Fever has been frequently present in Panama, the proposed western terminus of the Canal. Thus, from April 22nd to May 12th, 1902, there were 8 cases and 6 deaths reported; while from July 1st, 1902, until the middle of January of this year, according to the Health Reports of the United States Marine Hospital Service, there have been 133 cases and 23 deaths of Yellow Fever in this city.

As has long been recognised, the disease often follows the lines of commercial maritime travel. Of the frequent introduction of the malady into hitherto uninfected regions by vessels, it is well known there are many instances. Good examples of the conveyance of the disease by ships over short distances may be seen in the infection of the ports

of the Southern United States and Mexico from the West Indies. Whether the Indian Islands were primarily infected from West Africa, or *vice versâ*, must still remain uncertain. The first accredited record of Yellow Fever in Spain is that of 1730, when the disease was imported into Cadiz by a ship from Central America. The introduction of the malady into Brazil in 1849 occurred, it is said, through an infected vessel from New Orleans which landed at Bahia. Before this time, according to some authorities, the disease was unknown in the latter place.

However, others claim that Yellow Fever was imported into Lisbon from Brazil as early as 1723, and that this was its first appearance in Europe. At any rate, since 1849 Yellow Fever has never been absent from Brazil. The introduction of the disease into Portugal from Brazil by vessels followed in 1850, 1851, and in 1856. Again, there occurred at Saint Nazaire, in 1861, the only important epidemic of Yellow Fever that ever broke out in France, and this also was due to infection from shipboard as follows :—

The ship, *Anne Marie*, sailed from Havana on June 13th. On July 1st, eighteen days after her departure from Havana, two seamen fell ill, and died on the fifth day of their illnesses, of Yellow Fever. The epidemic then spread throughout the crew, and nine of the total number of sixteen were attacked with the disease. The ship then entered the port of St. Nazaire twenty days after the last death, and ten days after the inception of the final case of suspicious illness. As no case of sickness had occurred during the last ten days, and as all were well at the time of arrival, the vessel and crew were not quarantined. The *Anne Marie* lay near the shore, and at her side were moored two other vessels. Her crew were disbanded, and the discharge of the cargo was entrusted to seventeen stevedores, all in good health. Shortly after ten of these sickened and died of Yellow Fever, while six people on the shore who had been in contact with the stevedores also fell ill of the disease. In addition, Yellow Fever broke out on board both of the vessels which had been lying near the *Anne Marie*, and from these ships others became secondarily infected. To make a long story short, the *Anne Marie* infected, primarily and secondarily, seven vessels with Yellow Fever. In all there were 40 cases and 23 deaths.

The epidemic in Italy, at Leghorn, in 1804, also owes its origin to a Spanish ship from Havana. During the

voyage to Cadiz, this ship had lost almost its entire crew from Yellow Fever. The crew was recruited at Cadiz, and eventually arrived after several stoppages at Leghorn, where no quarantine was imposed. Two sick men were taken off the vessel, and carried to an inn in the city. Both of them died a few days later; and, shortly after, twelve other persons at the inn were stricken with the disease. Suspicion was directed against the ship from Havana as the source of the trouble, and sanitary guards were stationed aboard. They also promptly took the fever. The malady extended gradually throughout the city of Leghorn. The figures of this epidemic are very conflicting, it having been variously estimated that from 700 to 1,900 people died of the disease. While the malady was not admitted to be Yellow Fever at the time (probably on account of commercial reasons), Palloni, who had witnessed and studied the epidemic, admitted seventeen years later that it had been really one of Yellow Fever.

I will not weary you with the recital of other instances in which epidemics of Yellow Fever have been carried directly by vessels from one port to another, and often over great distances. One need glance only for a moment at the map, and again at the statistics of the location of Yellow Fever cases in many seaport towns for the past year, to be again impressed by the relationship between maritime commerce and the disease. During the past year, among the cities on the eastern coast of the Western Continent, Port Limon, Progresso, Vera Cruz, Tuxpan, Tampico, Rio de Janeiro, Bahia, Manaos, Pernambuco, Para, and Paramaribo, and on the western, Panama and Guayaquil, have all been frequent sufferers from this scourge. It therefore does not seem improbable that unless extreme precautions are taken in regard to vessels passing from these regions and bound for ports in the far East, that infected ships, and even cases of Yellow Fever, will be conveyed from some of these cities to Honolulu, or even directly to Guam, Hong Kong, and the Philippine Islands. I would remind you that as late as 1865 a sailing vessel arrived at Swansea from Santiago de Cuba; Yellow Fever broke out on board while she was in port, and fifteen persons died. It is well known that it is of not very uncommon occurrence in Italian ports to have vessels arrive from South America with a history of Yellow Fever on board during the voyage. With these examples in view, does not the argument seem reasonable that the same thing might take place in Asiatic ports, owing to the

increased traffic from the endemically-infected regions directly to the East? The distance from Panama to Honolulu is 4,692 miles, which is somewhat shorter than from Bahia to Naples, viz., 4,488 miles, and considerably less than that from Rio de Janeiro to Naples, 5,188 miles. Mail steamers leaving Panama should reach Honolulu in from thirteen to fourteen days, or, without stopping, the Philippines in about twenty-eight or twenty-nine days. Vessels, even though leaving Panama with no cases of Yellow Fever on board, and reaching Honolulu with still no history of sickness *en route*, yet might obviously be agents of most serious infection to the Hawaian Islands: for if infected *stegomyia*, which had had recently bitten Yellow Fever cases, were taken on board the ship at Panama (as the late Dr. Walter Reed has shown), they would not be capable of conveying the disease until about twelve days later, which would be at the earliest time about that of the arrival of the ship in Honolulu. Stevedores from Honolulu, sent on board to unload cargo, might be bitten by such infected *stegomyia*, and could in time convey the disease later to others in the Hawaian Islands. The same might occur in Guam or in the Philippines; for even though ships should also arrive at these ports with no Yellow Fever on board, and no history of the disease *en route*, yet they might also still contain infected *stegomyia*, which, concealed in the hold, or in other places unfrequented by the passengers or crew, had not had the opportunity of feeding upon susceptible individuals during the voyage. H. R. Carter has reported six such instances. On these occasions, Yellow Fever appeared respectively on the 64th, 68th, 12th, 11th and 38th days after the ship left the infected area. As it has been shown that the *stegomyia* is capable of conveying the disease at least as late as fifty-seven days after biting, it would still be dangerous for many days after the arrival of the vessel in the Eastern port, either if it remained on board or escaped to the land.

The question of whether the *stegomyia fasciata* could be kept alive during a voyage of such duration is easily answered in the affirmative. Reed, however, pointed out that free access to water is necessary for the existence of this mosquito, and that when deprived of it, it dies in from five to six days. There are many instances of mosquitoes being carried great distances at sea, and the *stegomyia* is frequently found on board ships in tropical ports. Dr. Cummings, of the United States Marine Hospital Service, reported that a Spanish barque, sixty-five days from Rio de

Janeiro, arrived at the South Atlantic Quarantine Squadron carrying a veritable plague of mosquitoes, most all of which were the *stegomyia fasciata*. According to the captain's statement, the mosquitoes had been present on board the ship only forty-three days. In the water-tanks of this vessel great quantities of the larvæ were found, showing that the mosquitoes were propagating and multiplying on board. I have purposely cited at some length above two instances in which Yellow Fever was carried in vessels over great distances, and for long periods of time. In the first instance, the ship *Anne Marie* carried the infection from Havana to Saint Nazaire. It will be remembered that the vessel entered the port ten days after the last case of Yellow Fever, and that all on board were at the time well. The infections of the stevedores and others immediately following must have been from the infected *stegomyia* on board the vessel. The history of this epidemic has been carefully explained in this light by H. de Gousea, in *Le Bulletin Medical de Paris*, October 12th, 1901. While it may be argued that as Yellow Fever has been successfully kept out of Italy since 1883, no cases having been registered on shore since this date, even though cases of the disease frequently arrive at Italian ports, that probably the question of its exclusion from our coast cities in the Far East will be an equally simple one. We must remember, however, that evidently the climatic and hygienic conditions in Europe are not favourable for the development of this disease, and that, moreover, the ports I have particularly mentioned—viz., Honolulu, Guam, and the Philippine Islands—all lie within from 10 deg. to 22 deg. north latitude, while the Italian ports are almost all above 40 deg. north. Again, with a greatly increased maritime traffic between the endemic Yellow Fever ports and the East, the danger becomes multiplied manifold, and with each ship so *en route* is the risk further increased. Should, moreover, a case of Yellow Fever, or even infected *stegomyia*, reach Manila without quarantine, the chances would seem to be in favour of its not falling upon barren soil. Humidity and heat, which seem to be, perhaps, the ideal coefficients for the preservation of the disease, are always present in the Philippine ports. Also, the *stegomyia faciatus* is to be found abundantly throughout these islands, and one may always obtain readily, in a few minutes, a number from any of the dwelling-houses in Manila. Again, in the Philippine ports there will be no on-coming of cold weather to limit the spread of the epidemic, the factor which seems to have

been of most importance in the disappearance of the disease at various times hitherto in the United States. As the *stegomyia*, as well as the conditions favourable for its propagation and development, are to be found everywhere the year round, so an epidemic once started there with a people of perhaps no marked immunity to the disease, would probably only end when no further susceptible material existed.

But while it has seemed wise to emphasise the great importance to these, and its greater risk of infection with Yellow Fever upon the opening of the Panama Canal, in the light of recent results the matter has altogether not a dark side. For example, Wood and Gorgas, stimulated by the work of the late Walter Reed, have recently shown us that it is possible and practicable, by proper sanitation, to entirely stamp out Yellow Fever from its natural endemic home—from a place (Havana) of which, as Dr. Manson himself, writing in 1898, has said: "The disease is never absent." Having shown that this extermination of the malady is possible in such regions, why, then, should not the same be accomplished along the entire route of the Panama Canal? It does not seem too much to hope that this will be brought about, and that before the opening of the Canal there will be little danger of infection from its shores, or from its port of entrance or exit. The measures adopted in the main are to be those already employed by the sanitary brigades in Cuba. Obviously, however, this will not exclude infection from other Yellow Fever ports, such as, perhaps, in Brazil, the West Indies, and Mexico. Over vessels coming from these regions there must naturally be the greatest care exercised, both at the Canal and upon their arrival at the eastern city. The careful work of Dr. Reed has shown that the disease is not conveyed by clothing, sheets, blankets, etc., and that quarantine efforts directed against the transmission of the disease by *fomites* are unnecessary. Moreover, Reed pointed out that infected insects were not likely to be imported in boxes or in trunks, for the reason that when deprived of water the *stegomyia* dies within five or six days. Grubbs, working upon *culex pungens*, arrived at practically the same results, and concluded that these latter mosquitos would not live over six or eight days in trunks and boxes packed loosely with damp clothes. In blankets, etc., they lived a much shorter time, viz., not over two days; all the other carefully-obtained evidence in regard to the conveyance of the disease by baggage seems also to be negative.

In 13 cases of experimental Yellow Fever, Reed and the Army Commission showed that the incubation period varied from forty-one hours to five days and seventeen hours. This also agrees with the incubation period, as clinically observed in a large number of cases by various obervers. A quarantine of an individual beyond six days at any time would therefore be unnecessary.

As to the practical measures that should be adopted at the port of Manila, were the Panama Canal opened under the present existing conditions in regard to Yellow Fever in the West Indies, Mexico, Central and South America, perhaps the safest rule would be that all vessels for Manila arriving from Panama should be sent to the United States Quarantine Station at Marivales. There, all passengers going on shore should be placed at the station for five days in quarantine, and carefully protected from mosquitoes during this period: the great risk involved would perhaps warrant such extreme measures. This proceeding, I may add, is a perfectly practical one, and is scarcely any severer than the quarantine which all our passengers on transports have been compelled to undergo during the recent cholera epidemic. As for the ships themselves, after disinfection as complete as possible against mosquitoes, they should be then allowed to proceed on their way. Unfortunately, as experience has shown, it is not always practicable to destroy all mosquitoes on board, but by quarantine of the ship for a longer period nothing might be gained; and in other ports, nearer infected regions, if *stegomyia* which had recently bitten Yellow Fever cases were still left on board, no case of Yellow Fever would be likely to develop before twelve or fourteen days, and none might develop for a much longer period. In regard to ships which pass through the Canal, and which do not anchor within 200 fathoms of infected places, it seems no quarantine should be imposed. For while, in so far as I know, the exact distance which the *stegomyia* may fly, or be carried by the wind, has not been determined, that of 200 fathoms has practically proved to be a safe one.

I trust that the reiteration of these familiar facts which I have brought before you this evening has not been too tiresome. It has been thought advisable to put the matter in a simple light, in order that the layman may also thoroughly understand and appreciate its importance.

Dr. George H. F. Nuttall (Cambridge) said: It is difficult to add anything to the excellent and most sug-

gestive paper which Dr. Manson has read. His communication deserves serious consideration.

We are dealing with a broad biological problem, when studying the dissemination of disease. It is well known to biologists that a change in the geographical distribution of the *fauna* and *flora* of the world is rapidly taking place, chiefly through the agency of man; and that animals and plants introduced into foreign countries take their parasites with them. It has again and again been observed that indigenous forms may disappear in the presence of those which have been imported. Assuming even that the distribution of the genus *Stegomyia* were more restricted than appears from the maps of the world which Dr. Manson has shown us, there is every reason to suppose that these insects may become more disseminated, and thus, under favourable conditions, serve to maintain Yellow Fever elsewhere. We know that *Culicidae* may survive for weeks on ship-board, and consequently that they may be distributed to distant parts.

The increase of trade throughout the world, as also the rapid communication between ports, made possible by modern ships, greatly facilitates the dissemination of epidemic diseases and their causative agents. Formerly, such epidemic diseases as plague progressed slowly along the old caravan routes—now plague and cholera are scattered broadcast over the world through rapid steamer traffic. There is no reason to suppose that Yellow Fever and other diseases may not pursue the same course.

Those of us who have not been in countries which have suffered from the scourge of Yellow Fever have been thoroughly impressed with the enormous importance of the disease, not only with regard to its fatal effects on life, but also the disastrous influences it exerts on trade and commerce. To accomplish anything along the lines suggested by Dr. Manson, we must impress those in authority with the extent of the losses which might follow the introduction of Yellow Fever into Asia, with its teeming populations existing under conditions eminently favourable for the establishment of the disease in endemic form.

The cost of preventive measures would be infinitesimal, as compared to the financial losses which might follow their neglect. As *an example of the loss of life* due to Yellow Fever alone, in a single city, I would state that it has been estimated that thirty-six thousand people died in Havana in less than fifty years (ending 1900). As *an example of the financial losses* entailed by a single city

from one epidemic alone, I will state that the epidemic of 1878 cost the City of New Orleans a loss of over £2,000,000.

The extent of the losses amongst the Spanish troops in Cuba will probably never be known, but some conception thereof may be formed when I state that I was told the loss amounted to no less than 25 per cent. This was in 1892, when I visited Cuba, my informant being the physician in charge of the military hospital. One ward, set aside for the Yellow Fever season, was styled the "mortuary," the physician in charge thereof the "undertaker," in grim allusion to the fact that the patients who entered the ward rarely, if ever, left it again alive.

DR. SAMBON said: Dr. Manson deserves great praise for his momentous and stirring address. The danger of the wider spread of Yellow Fever is most imminent. Indeed, if I am well informed, its urgency is even greater than represented. The China Commercial Steamship Company, which was incorporated in Hong-Kong last November, will inaugurate on March 1st a service between China and Mexico. The company's steamers will carry both freight and passengers, and a monthly service will be maintained between Hong-Kong and the Mexican ports. Thus, quite independently of the opening of the Panama Canal, within a few days the Asiatic Coast will be in direct communication with one of the great endemic centres of Yellow Fever. A few weeks later, the annual epidemic will break out within the endemic stations of the disease, to become more or less threatening under the influence of the peculiar meteorological conditions of the year, and of other no less important shifts of the animate environment.

Some years ago, we should have been in a terrible plight. Now, although the primary causative agent of Yellow Fever is still unknown, possibly on account of its minuteness, or because it escapes detection within the *leucocytes* or other structures, yet the main epidemiological factors of the disease have been thoroughly worked out by our learned and brilliant American colleagues. The endless and hopeless disputation between contagionists and non-contagionists has at length given way to scientific research; and already we have a sufficient amount of exact knowledge on which to base a sound and efficient prophylaxis against Yellow Fever.

But, though we may well agree as to the means of combating an epidemic of Yellow Fever, I fear that some may

consider Dr. Manson's move as unnecessarily alarming. Only the other day, having mentioned the subject to a medical acquaintance of great influence and authority, I was reminded that Yellow Fever had been known to Europeans since the days of Columbus; that communications between Europe and America had been constantly increasing and improving during the last four centuries; but that the disease had not moved from its endemic region. Although its "germs" had been frequently imported into Europe and North America, Yellow Fever had not gained a foothold in either country; and, being essentially a coast-line disease, it could never become diffused like other exotic pestilences, such as cholera and plague.

The truth is that the distribution of Yellow Fever has slowly but steadily increased. It is only quite recently that the disease has become endemic on the Atlantic and Pacific coasts of South America, and now we see it spreading, by means of its propagating agent, from the coast to the interior, not only through river traffic, but along railways, and regardless of elevation.

Chiefly on account of great engineering changes in the large sea-ports of the Atlantic coast, the United States have been spared, of late years, those frightful epidemics of Yellow Fever which recurred so frequently in the latter part of the eighteenth century and the beginning of the nineteenth. On the other hand, the increasing commercial relations between the United States and Mexico, by reason of the marvellous development which has taken place in the latter country during the last two decades, and the consequent activity in railroad building, are opening up a new and far more dangerous route for the importation of the dread disease.

It is true that in most cases of importation abroad, Yellow Fever did not spread beyond the shipping and wharves, or, at any rate, did not extend beyond the precincts of the town into which it was imported; but we know also from various instances—both in the United States and in Europe—that, given certain conditions, it can spread very widely, and give rise to a deadliness unequalled by any other disease.

Recent advance in the etiology of disease has enabled us to grasp the principles of disease distribution. We know that diseases are always in some way or another caused by living organisms, and that, in many cases, these pathogenetic organisms are fostered and propagated by other living organisms. It is obvious, therefore, that the distribution of

diseases is governed by the same laws which govern all living organisms.

Like other species innocuous to man, so our pathogenetic organisms must have originated within narrow limits, and subsequently spread more widely. Of the spread of many diseases we have no record whatsover; of others we know that they have extended their geographical range considerably within recent times. I need but quote small-pox, scarlet fever, beri-beri, and the chigoe pest.

The present restricted range of certain diseases, and the fact that they have not spread out of their habitat for centuries, do not prove in the least that they are unable to spread more widely. In studying the distribution of insects and fungi injurious to agriculture (that is to say, the diseases of plants), we find numerous examples of species which, although repeatedly imported to certain countries for hundreds of years, have only quite recently established themselves in these countries.

It is not always easy to understand why a certain species will not spread, though frequently imported into a new country. Thus, we do not know why, amongst butterflies, the well-known Garden-white (*Pieris rapae*) should have spread far and wide in America, while the equally common and injurious Cabbage-white (*P. brassicae*) has never been found there. A similar example is offered by the *Filariidae*. While *Filaria bancrofti* has spread very widely throughout the tropical and sub-tropical world, *F. loa* has remained limited to small areas on the west coast of Africa; and, though frequently introduced with Negro slaves into the West Indies, has never become acclimatised in those islands.

At one time, these peculiarities of distribution were easily dismissed by the theory of an uncongenial climate. Now, we know that adaptation to a new country depends upon a number of complex ecological factors. I can do no better than quote Darwin's famous example, by which he showed that in a measure cats are responsible for the production of clover seed in this country, through the inter-relations of cats, field mice, and bumble-bees. Red clover would not grow in New Zealand until bumble-bees were introduced to fertilise its flowers; now it displaces the native grasses.

But whatever may be the obstacles to the establishment of foreign importations, it is undoubtedly true that our rapidly-increasing international trade is the most important factor in the spread of injurious insects, noxious weeds, and disease organisms. Every improvement in rapidity of

travel, and in safety of carriage of goods of all kinds increases the opportunities of accidental importations.

The commerce in living plants and nursery stock, which has of late years assumed considerable proportions, has afforded a new and most efficient means for the accidental transmission and subsequent establishment of numerous kinds of insects, acari, and fungi. It is by means of importations of this kind that many scale-insects (*Coccidae*), which have usually a rather restricted distribution, have become almost cosmopolitan. Fortunately, the enclosed hymenopterous parasites of these pests have spread almost equally with their hosts.

To take an example from the very region which now concerns us, I will mention the Mexican cotton-boll weevil, which, introduced quite recently in Texas cotton-fields, has proved a serious lesson to the planters of that State.

It is quite obvious that the establishment of a direct and rapid line of transit between Mexico and China will expose the Eurasian Continent to frequent importations of Yellow Fever; and you know full well that we have there the conditions best suited to the widespread and possible establishment of the disease: a wide distribution of the necessary intermediate host, and a non-immune, careless, ignorant, overcrowded, and unruly population.

Our knowledge of the distribution of *Stegomyia fasciata* is still very imperfect, but we know that this truly cosmopolitan mosquito is very prevalent in Southern China, Japan, Siam, India, and Malayia. Another mosquito of the same genus and of similar habits, S. *scutellaris*, is also very common and widely distributed in Asia. It is not unreasonable to surmise that the latter species may also prove a suitable host for the Yellow Fever parasite, since we know that various species of the genus *Anopheles* can subserve the propagation of the malaria parasites.

An outbreak of Yellow Fever in China would probably be followed by epidemics in Japan, Siam, India or Malayia; and from these countries the disease might well spread to Australia and, possibly, to Europe, along the Red Sea route of many a cholera epidemic.

The prophylaxis against Yellow Fever offers no great difficulty. The means of prevention, suggested by recent discoveries and the experience of a hundred epidemics, are simple, inexpensive, and efficient. But there is a difficulty—an almost insuperable difficulty—and that is the almost universal ignorance and unpardonable neglectfulness of those whose bounden duty it is to foresee any possible

danger and endeavour to avert it. Truly, the Ancients were right when they stated that epidemics were the chastisement of sin!

I trust that on this occasion the authorities will take warning, and thus avoid the horrors and humiliation of a Yellow Fever epidemic in Asia. That the risk is great no one can reasonably doubt; but, at the same time, we know for certain that it can be prevented. Anyhow, whatever may be the course of events, we can assert that physicians have done their duty; many have yielded their lives to save mankind from this fearful monster of the Western Hemisphere.

I will not waste any time in describing minutely the measures to be adopted in order to prevent or repress an outbreak of Yellow Fever. The cleansing of Havana is already more famous than that of the Stables of Augeas. The admirable measures adopted by Major Gorgas, of the United States Army, were based upon the recently-acquired knowledge that Yellow Fever is propagated by mosquitos, and by mosquitos only.

In order to prevent the further extension of Yellow Fever, the most important step is the extirpation of the disease from its endemic stations. So long as there is Yellow Fever in Central America, in South America, and in the West Indies, the United States and Eurasia will run the risk of its annual invasions. I think that Great Britain and the United States should co-operate for the enforcement of the measures necessary for the removal of this danger.

It should be the duty of Governments possessing threatened sea-ports to carry out such engineering changes, and other appropriate measures, as would tend to wipe out the offending mosquito.

All vessels leaving suspected districts should be thoroughly fumigated on departure, and again on arrival, whether Yellow Fever has broken out on board or not. The possibility of carrying mosquito larvae should be guarded against by frequent inspection of water-tanks.

Captains and officers of ships should be thoroughly acquainted with the *rôle* played by the mosquito, and with the measures necessary for the prevention of Yellow Fever. Any disregard or carelessness on their part should be heavily fined.

Any idea of establishing a quarantine should be unhesitatingly set aside. Quarantines hamper commerce, entail useless expenses, and encourage a fatal disposition

to conceal infection. The first practical requirement towards checking the spread of a disease lies in its prompt detection; therefore, notification should not entail any unnecessary inconvenience, and should be insisted upon with the utmost severity. Experience has proved again and again that the Yellow Fever patient, screened from the bite of mosquitos, is of no danger whatever to the community.

Gentlemen, twenty-four years ago Dr. Manson discovered that mosquitos were the intermediary hosts and propagators of filarial infection. Since that day, a new generation has sprung up. Those who have visited the Tropics know how fearfully this new generation has been visited by *Filaria bancrofti* and its attendant horror, *Elephantiasis*. Only consider how much wretchedness might have been avoided had Dr. Manson's discovery been acted upon!

Alas! even Erostratus has followers!

Dr. Low said: I have not very much to say on the subject under discussion; but from my own practical experience of the disease I can confirm the great danger of its introduction into new areas. Dr. Strong has given you many instances of its spread by mosquitos escaping from infected ships, and a similar instance to some of these has been investigated by myself in St. Lucia.

Ships and steamers had been in the habit of coming from Rio and other Yellow Fever ports in South America to coal at this island; and from one of these mosquitos escaped, and a white sergeant of police in the town was evidently bitten, and developed Yellow Fever. On the first day of his illness, when his premonitory symptoms were developing, he spent a portion of his time in the sergeant's mess on the Morne, the military station. More mosquitos bit him there, it must be assumed, became infected, and bit other people. Yellow Fever subsequently broke out amongst the troops. The prompt action of the military authorities in changing the troops to another site prevented a serious epidemic, and the mosquitos in the affected areas were killed by destroying their breeding grounds, and by fumigating them in the houses. The military authorities followed out the suggestions made and improved their areas permanently, but the town of Castries did not stir in the matter at all. The point I wish, however, to specially point out is, what practical steps are to be taken to stamp out mosquitos and so prevent the spread and the continual danger of the introduction of this disease. The scientific world is agreed on the point that the mosquito spreads

Yellow Fever, malaria, and filariasis; yet, even after this has been proved, what has the English Government done to take practical steps to prevent those diseases? I am sorry to say, practically nothing. Major Ross, with private funds, has tried to show what can be done in Sierra Leone, and the War Office has also been at work to perfect the military areas there; but it is unreasonable to expect enthusiasts to privately clean up and improve the sanitation of all the tropical towns in the world. While in St. Lucia I proposed a useful scheme to improve the sanitation of Castries, the main town, which is a standing disgrace to all sanitary laws; but the administrator was lukewarm on the subject, and nothing has been done. Again, in Barbados, I showed how easily mosquitos could be stamped out, and the enormous prevalence of filariasis diminished by simply passing a law about people keeping standing water in their houses. Though Sir Frederick Hodgson, the Governor, took the greatest interest in this scheme, and helped me in every way, what was the result? The local parliament decided not to pass the law, and the mosquito reigns supreme. It is this indolence and indifference in British Colonies that is so aggravating. Why should they not have a part of their annual income or grant set apart solely for the purpose of sanitation? Unless the Government take action in this matter of the Panama Canal, and the introduction of Yellow Fever into Asia, exactly the same thing will occur, namely: the matter will be treated with laziness and indifference; captains of ships will pooh-pooh the idea, not fumigate their ships, and after, when the disease has been introduced (that is, when it is too late), people will begin to talk about doing something. With the example of what Italy and America has done in regard to mosquito hygiene before us, it is nothing short of a disgrace that we should have done so little. The mosquito theory has passed away; it is now no longer a theory but an actual fact that they spread those diseases, and acting practically, not talking, is what is now required.

Dr. Edward Henderson (late of Shanghai, China) said: I have listened with much interest to Dr. Manson's able address, as I am sure we have all done, and to the interesting comments which have followed it from the various speakers. The danger pointed out—that of the introduction of Yellow Fever to Asia and the Far East—by the construction and opening up of the Panama Canal—is, so far as I am aware, not one which has

as yet attracted that degree of public attention which it should have done. That it is a real danger, and one which should receive immediate and serious attention, there can, however, be little doubt. The view taken of the position by Dr. Manson is by no means one founded on theoretical considerations—that would be a comparatively poor basis, and one on which few Governments would care to take any decided action. It rests, on the contrary, on well-ascertained facts, and on facts established in the surest way—the way of scientific experiment and accumulated experiences. We know the history of Yellow Fever, its malignancy, its highly contagious character, and its easy transport to a distance from its endemic area: and we also know the conditions which favour its rapid extension, and are essential to its endemic continuance. In addition to all this, we have, within the last few years, acquired the knowledge, thanks to the labour and devotion of American men of science in Cuba and elsewhere, that a special mosquito is the most active—possibly the sole—agent in its distribution.

I say, definitely, we have "acquired this knowledge," because the necessary investigations have been so carefully, so scientifically, and so completely carried out, that it seems to me impossible to doubt the accuracy of the results arrived at. With all this knowledge it would be strange indeed if we could regard with indifference the opening up of a new and greatly shortened trade route to Asia and the Far East, which will pass directly through the area in which Yellow Fever is endemic. Panama itself has been described as the hotbed of Yellow Fever, and in the West Indian islands, through which the route is continued eastwards, Yellow Fever is always more or less present.

I have myself been engaged in active practice in Shanghai for now over thirty years; and during that time, for over twenty years, I have held the position of Medical Adviser to the Municipal Council, which presides over the British division of the settlement. As the result of this extended experience, I am only too familiar with the disastrous consequences which follow when epidemic disease is introduced among the natives of a hot climate; and I cannot contemplate, without grave apprehension, the future of the Shanghai community should Yellow Fever ever be introduced there—a community in which foreigners and natives are, and must continue to be, intimately associated. The dirt and overcrowding which determine the virulence and extension of an epidemic, though possibly

absent in the foreign settlement itself, are never likely to be wanting in the closely-adjoining native city, while the temperature of the Shanghai summer would supply the only other requisite—sustained tropical heat. Quite possibly an outbreak of Yellow Fever in Shanghai might terminate as a single epidemic, for the climate of Shanghai is a sub-tropical one, and Yellow Fever is endemic only in the Tropics. I say an outbreak might terminate as a single epidemic, but think what that means in the case of Yellow Fever; it might mean the death of 10 per cent. of the whole inhabitants—it did mean that once in Philadelphia, when 4,000 died out of a population of 40,000. I have spoken of Shanghai because all my personal associations with China were centred there; but what of the thriving British colony of Hong Kong? Again a mixed community, where foreigners and natives are intimately associated, Hong Kong is in the Tropics, and Yellow Fever once introduced there would find all the conditions necessary for endemic continuance. It might fail to make a lodging in Hong Kong itself, but might easily do so among the natives in Canton or the surrounding district. What I have said of Shanghai and Hong Kong has, of course, a very wide application in the great and populous Empire of China.

Among the various precautionary measures to be taken to avert the possibility of such a calamity as the one we are now considering, the destruction of the special mosquito now known to be the active agent in the dissemination of Yellow Fever, should, as suggested by Dr. Manson, be made the principal object. The details are simple enough: such details as were carried out with the happiest result by the American Government in the city of Havana within the last three years; details differing in no essential particular from the arrangements made by Major Ross and his co-workers in dealing with malaria. Success will ultimately depend on the ability of the Government undertaking the task, to secure the services of a staff sufficient in numbers and intelligence to carry out the work thoroughly. And I am glad to leave the further discussion of these measures in abler hands than my own. Nothing must be left to chance in so important a matter—a matter which concerns the lives of thousands, and may one day seriously affect the vast trade interests represented in China and the Far East.

After a few remarks by Sir William Kynsey, C.M.G., late Principal Civil Medical Officer and Inspector-General of Hospitals in Ceylon,

DR. SIMPSON said, that Dr. Manson had very clearly set forth the dangers likely to follow the opening up of a new trade route by the construction of the Panama Canal. History showed that epidemic diseases followed trade routes. Taking plague as an example, this disease had not only followed the trade routes, but had died out in those countries in which it had prevailed where the trade routes were changed. For instance, the disappearance of plague in Europe, in the latter part of the seventeenth century, was due in a large measure to the change of trade routes brought about by the discovery of America and the West Indies, and the new sea route to India *viâ* the Cape. He agreed with Dr. Manson that quarantine, or for that matter any other precautionary measure to be applied at the terminal ports in the East, was not likely to be successful in keeping out Yellow Fever. China would never carry out any sanitary measure. Precautionary measures would have to be taken at the ports of departure. Who should be the authority to carry out these measures would be a matter for consideration. The question was an international one; more countries than America and Great Britain were concerned in the threatened danger. There were also the Dutch and the French, whose tropical colonies would be affected. It would therefore have to be considered from an international point of view.

INSPECTOR-GENERAL ALEXANDER TURNBULL, M.D., R.N., said: At the Edinburgh Meeting of the British Medical Association in 1898, I read a paper on "Insanitary Environment the Cause of the Spread of Yellow Fever." The exciting cause of this disease was not then apparent; the discovery of the part the mosquito plays in propagating the disease is of a later date.

My difficulty at first in accepting this now-established fact was the apparent occurrence, on October 7th, 1845, of Yellow Fever in a pilot, who had embarked in the *Eclair*, a Yellow Fever ship, at the Motherbank, on October 1st, and died on the 10th, at Sandgate, at the mouth of the Thames. It is, however, recorded that, in his case, "the head appeared to bear the onus of the illness." With the present accurate knowledge of the incubation stage of Yellow Fever, it may be concluded that this was not true Yellow Fever. "He was exceedingly alarmed from the first;" and, it may here be stated, that though two Yellow Fever patients were landed and died with suspicion of black vomit, in the Marine Infirmary, Wool-

wich, there was no extension of the disease to their attendants.

On January 15th, 1870, at Rio de Janeiro, I assisted in diagnosing a case of Yellow Fever, soon quickly fatal with black vomit, on board H.M.S. *Egmont*, in a close, unventilated dock; the ship was at once moved to a more open anchorage, and no further case occurred until the 30th.

In 1871, I was at Buenos Ayres on the outbreak of what proved a decimating epidemic of Yellow Fever in that city, spreading up the Parana and Paraguay rivers, in the towns on their banks, but having no extension to the open country adjoining of the same level—save in an exceptional case or two, possibly—though the sick moved to this new ground died as in the towns.

Rio de Janeiro, in the "Forties," was a sanatorium for West Coast of Africa ships' crews; ere long Yellow Fever was introduced there, and is now endemic. All these cases are explained by mosquito inoculation, amid insanitary environment.

The following authentic official particulars appear germane to the subject under consideration.

H.M.S. *Eclair* developed Yellow Fever amongst her crew in July, 1845, at Sierra Leone; in August she introduced it into Boa Vista; and, by December 22nd, two hundred and fifty natives had died of it; by March, 1846, the deaths numbered four hundred.

In 1865, a working party from H.M.S. *Bristol*, a fine, airy frigate, were employed on board a stationary storeship at Sierra Leone. Yellow Fever broke out among this party, on board the *Bristol*, viz., on their return to that ship; they were treated on her airy main deck, and no other cases resulted in the *Bristol*, unlike the *Eclair*, on board of which ship the disease increased all the way to England, the last fatality being in the case of a Lieutenant, who had been on board the ship from the onset of the fever, in close attendance on the sick; he was siezed on October 7th, at Sandgate, at the mouth of the Thames, nine days after reaching England.

The mosquito inoculation will account for his fever, in an ill-ventilated paddle-steam sloop, and the immunity of the *Bristol's* crew is explained by the sick being treated on her airy main deck.

A question, however, that arises in connection with these two Sierra Leone infected ships is, If Yellow Fever is now endemic at that tropical spot, and commerce affected thereby?

H.M.S. *Dauntless*, November, 1852, landed 62 cases of Yellow Fever at Barbadoes; they were treated "indiscriminately" with other patients in the military hospital.

H.M.S. *Highflyer*, December, 1852, sent 51 cases to the Naval Hospital at Port Royal, Jamaica, who were "mingled" with other sick there.

H.M.S. *Esk*, in November, 1853, landed 8 cases at Nassau, with black vomit.

In none of these three instances did the disease spread in the islands; though, in the *Dauntless*, it did in the ship anchored at Barbadoes.

There is no Yellow Fever in the River Plate or its affluents, the Parana and Paraguay, now, I believe.

At the conclusion of the discussion, a hearty vote of thanks was accorded to Dr. Manson for his valuable contribution, and it was resolved to forthwith print the paper and the discussion thereon.

It was also further resolved that a Committee, consisting of the President of the Society (Professor Corfield), Dr. Cantlie, Sir William Kynsey, C.M.G., Sir Francis Lovell, and Dr. Nuttall, should be appointed to consider and determine what action should be taken upon Dr. Manson's paper, and to report to the Society the result of their deliberations.

Note on the Genus "Stegomyia" (Theobald), and its Distribution.

By F. V. Theobald, Esq., M.A., F.E.S.

The genus *stegomyia* ranks next to *anopheles* and the related genera of *anophelina*, on account of the part it plays in the distribution of Yellow Fever. How many of the species in this genus may be implicated we do not at present know; at present a single species only seems to be held responsible. That species (*S. fasciata*), is one of the two commonest West Indian and South American *culicids*. Although *fasciata* is widely distributed in all tropical and sub-tropical countries, it does not occur in any numbers in certain parts, such as the Malay States, China, and in Africa. Where it does not occur in abundance it is nevertheless represented by closely-allied members of the genus, such as *scutellaris* in the Malay States, China, etc., and *Africana* and *argenteo punctata* and others in Africa. It is quite possible that the latter species and the common

Australian *notoscripta* might play the same *rôle* as *fasciata*, given a sufficient Yellow-Fever grazing ground. The genus seem to have a decided preference to the littoral. The genus was separated from *culex*, entirely on account of the scale structure of the head, thorax, and wings; and, as has been recently shown, there is as much structural difference in the larvæ of the two genera. In regard to the eggs (if records are correct) there are, however, discrepancies, for *fasciata* and *scutellaris* lay their eggs singly, but, according to Skuse, those of *notoscripta* are deposited in "rafts." Little is known, however, of the life-history of any members of this genus except in *fasciata*.

From information I have been able to collect they all seem to be vicious bloodsuckers, and this habit does not only seem to be confined to the females. The reports of the males being bloodsuckers requires further investigation, however. These insects bite both by day and night, and, in all, the bite alone is most annoying, irrespective of the insects possibly carrying Yellow Fever. It is in this genus that we find special predilection for settling, when at rest, on dark objects and clothing. They have been popularly known as "Tiger-mosquitoes," on account of their banded and striped appearance; but a glance at the synoptic Table will show that that name is misleading, as many members of the genus are unbanded or unstriped. They are, however, mostly small dark gnats, with white, silvery, or yellow lines, bands, or spots on the thorax and legs (*fasciata*, *sugens*, etc.), or they may be unadorned (*brevipalpis*, *nigricephalae*, etc.). The largest species is *cranipes* (4.8 to 5 in.), an aberrant form of a more general brown hue than the rest, and *grantii*, which is often as large; but both can at once be told by the flat head and scutellar scales. They mostly seem to be more or less connected with man, some being exclusively domestic, others only partially so.

Certain species (as *fasciata*, *scutellaris*, *notoscripta*, etc.) are found not only in houses, stables and sheds, but also on ships and trains, and are doubtless distributed with the *culex fatigans* in that manner.

Longevity of Adults and Eggs.—Through the kindness of Dr. Finlay I received, last year, some ova of *fasciata* from Cuba. They were sent dry in a tube, and were left for two months after arrival. As an experiment they were placed in some tepid water in my greenhouse, and all the fifty eggs hatched within twenty-four hours, and from these several adults hatched out. Further, these adults were

kept for two months without food of any kind, but with moisture, and at the end of that time, not having been supplied with water, they died during my absence from home.

Pairing of S. fasciata takes place in sunshine; the male invariably gets under the ♀, who may or may not carry him off and complete the process in the air. The males fertilise a large number of ♀'s, never tiring according to Dr. St. George Grey's observations.

The genus is certainly a remarkable one in many respects, but most of all in regard to the wide distribution of the type species, *S. fasciata*. The original home of this species is undoubtedly the West Indies and the north of South America, where it is most abundant, most vicious, and of greatest importance in regard to the part it plays in the dissemination of Yellow Fever. Fortunately, being an almost exclusive tub and pot breeder, it can be more easily dealt with than the various *Anophelina*, which have wider breeding grounds.

At present there are twenty-two species described: I have seen all but one of these (*signifer Coquillett*). Another new species, too broken to describe, was sent me by Dr. Sergent from Algeria, and one by Dr. Lutz from Brazil, that I have had the misfortune to mislay, so that there are known to really exist twenty-four species, all of which are easily identifiable on account of their striking thoracic and other ornamentation.

The known species may be easily distinguished by the following synoptic Table :—

SYNOPTIC TABLE OF *STEGOMYIA*.

A.—PROBOSCIS BANDED.

1. Thorax, with five silvery and yellow lines ... *Notoscripta*. Skuse.
2. Thorax unadorned; black, with yellow-golden scales ... *Periskelta*. Giles.

B.—PROBOSCIS UNBANDED.

(*a*) *Legs basally pale banded.*

β. Abdomen banded basally.

3. Thorax with momedian yellow lines and lateral silvery curved lines; ungus of ♀ serrated ... ... *Fasciata*. Fabr.
4. Thorax as in 3; ungus of ♀ simple ... ... *Signifer*. Coquill.
5. Thorax, with two short median pale lines in front, and a pale spot on each side of them ... ... *Nigeria*. Theob.
6. Thorax, with narrow median white line forked in front of scutellum, a fine curved lateral pair, and a short pure white one below on each side .. ... *Grantii*. Theob.

7. Thorax, with momedian yellow lines and two pale creamy lateral lines in front ... *Sexlineata*. Theob.
8. Thorax, with one silvery median line, and lateral curved lines ... ... *Scutellaris*. Wele.
9. Thorax, with five white spots ... ... *Sugens*. Wied.

ββ. Abdomen unbanded.

10. Thorax, with two pairs of lateral oblique silvery bars ... *Africana*. Theob.
11. Thorax, with a broad patch of white scales on each side in front, and a median pale line ... .. *Terrens*. Wele.

(aa) *Legs apically banded.*

12. Thorax, with two prominent and two pallid spots *Marshallii*. Theob.

(aaa) *Legs apically and basally banded.*

β. Abdomen with basal white bands.

13. Thorax, with median white line, a large lateral curved one, a small straight white one on each side of median line in front, and another on each side behind ... ... *Pseudo taeniatus*. Giles.

β. Abdomen unbanded, with white lateral spots.

14. Thorax, with round median white spot in front, two lateral white areas, median area prolonged downwards laterally ... ... *Gubernatoris*. Giles.

(aaaa) *Legs unbanded.*

β. Thorax adorned.

15. Thorax, with four brilliant white spots ... *Argenteo punctata*, Theob.
16. Thorax, with two pale spots and two median pale lines ... ... *Minuta*. Theob.
17. Thorax, with two dark spots ; head white *Albocephala*. Theob.
18. Thorax, with front half silvery ... ... *Nivea*. Ludlow.

ββ. Thorax unadorned.

19. Abdomen, with basal bands .. .. *Irritans*. Theob.
20. Abdomen, with apical pale bands ... *Crassipes*. V. d. Wulp.
21. Abdomen, with basal lateral white spots ... *Nigricephala*. Theob.
22. Abdomen unbanded ... ... *Brevipalpis*. Giles.

NOTES ON DISTRIBUTION OF SPECIES.

(In nearly all cases the species are found over a wide area around the locality given ; where otherwise, it is mentioned in each species.)

1. *Stegomyia notoscripta*. Skuse.

This species has, so far, only been found in Australia. Specimens have been sent from Queensland, where it seems to be abundant. It is also common in New South Wales, and has been also sent from Victoria and South Australia. It is a household form ; but Dr. Bancroft has found it biting in jungle. The *larvae* breed in water-butts. It is one of the common annoying *Culicids* of Australia. We may expect it to occur elsewhere.

2. *Stegomyia Nigeria.* Theobald.

A single specimen only has occurred. Taken at Bonny, West Africa. Evidently rare.

3. *Stegomyia Grantii.* Theobald.

So far only recorded from Sokotra, where it is abundant and very annoying.

4. *Stegomyia sexlineata.* Theobald.

A very marked species, so far represented by a single ♀ from Trinidad.

5. *Stegomyia scutellaris.* Walker.

A very abundant species in parts of India, Malay States, East Indies, China, Japan, etc. It bites very severely, and occurs in and around man's habitations. It will probably prove to be a Yellow Fever carrier. It has been sent frequently as *fasciata*, but can at once be told by the single silvery median thoracic line.

The following are its recorded localities :—

India.—Ceylon ; Madras ; Canara district, Goa ; Central Provinces ; Naini Tal.

Malay States, etc.—Selangor ; Penang ; Perak ; Singapore ; Siam.

China.—Hongkong ; Foo-chow ; Thaohyling.

East Indies.—Borneo ; Celebes ; Amboina, and British New Guinea.

Other Islands.—Seychelles ; Formosa ; Japan ; Fiji and Mauritius.

6. *Stegomyia fasciata.* Fabr.

The most widely-distributed member of the *genus.* Previously described under a variety of names. Essentially a domestic form, and bites with severity. The male, as well as the female, *said to bite.* This species is found in houses, tents, stables, ships, trains, etc. It is subject to considerable variation in size ; but the thoracic markings are constant, except in the variety *mosquito*, in which the two median pale lines on the thorax are almost or quite obliterated. It does not seem to occur further north or south of line 43 deg.

The following are its recorded localities :—

India.—Ceylon ; Travancore ; Madras ; Central Provinces ; Calcutta.

Malay States, etc.—Siam ; Perak. (Apparently rare, and represented by *scutellaris.*)

East Indies.—Celebes and New Guinea.

Palestine.—A few specimens recorded.

Japan.—A single specimen.

Australia.—Queensland ; New South Wales ; Victoria and South Australia. Known here as *Culex Bancroftii.* From the malarious uplands of Victoria it has ueen sent in numbers, but no *Anopheles.*

Africa.—Sierra Leone ; Lagos ; Nigeria; Gambia ; Senegambia ; Old Calabar ; Mashonaland ; Pretoria ; Durban ; Nairobi ; Zanzibar ; Port Said ; Zomba, British Central Africa generally. None have occurred in the large collections from Uganda.

North America.—Savannah ; Gecrgia, etc. Abundant in Southern parts of the States, and as far North as Atlantic coast at Virginia.

South America.—British Guiana ; British Honduras ; French Guiana ; Demerara ; Panama ; Brazil ; Argentine Republic.

West Indies.—In all the Islands.

Europe and Mediterranean Islands.—South Italy ; Spain ; Portugal ; common at Gibraltar ; Cyprus ; Crete.

Oceanic Islands.—Fiji ; Seychelles ; Mauritius ; Bermuda.

Stegomyia periskeleta. Giles.

The only locality known for this species is Shajahanpur, N.-W. Provinces, India. Evidently rare.

Stegomyia Africana. Theobald.

Fairly common in West Africa. Recorded from Sierra Leone; Lagos; Old Calabar; Zomba, and Mashonaland. (Evidently rare in the two latter places.)

Stegomyia sugens. Wiedemann.

Apparently rare, but widely distributed. Occurs in Sierra Leone; Mashonaland; Nubia, and Corsica.

Stegomyia argenteo punctata. Theobald.

Recorded only from Mashonaland.

Stegomyia minuta. Theobald.

A single specimen known only; from Mashonaland.

Stegomyia albocephala. Theobald.

A single male only known; from Gambia.

Stegomyia nivea. Ludlow.

Apparently limited to the Philippine Islands.

Stegomyia Marshallii. Theobald.

So far recorded only from Mashonaland and Gambia.

Stegomyia pseudo tereniata. Giles.

Occurs in the hills in India, up to 8,000 ft. Bakloh, Punjaub; Naini Tal (7,000 ft.); Himalayas (8,000 ft.)

Stegomyia gubernatoris. Giles.

Represented by a single female from Allahabad, India.

Stegomyia irritans. Theobald.

So far found only at Bonny, West Africa.

Stegomyia crassipes. Van der Wulp.

Burmah and the Indies. No recent records.

Stegomyia brevipalpis. Giles.

Found with *S. piperokeleta* at Shahjahanpur, N.-W. Provinces, India, only.

Stegomyia nigricephala. Theobald.

Recorded only from Bonny, West Africa.

Stegomyia terrens. Walker. South America.

The type only has been recorded.

It will thus be seen that, as far as we know at present, only three species are very abundant, namely, *fasciata*, *scutellaris*, and *notoscripta*. The only two species with a wide distribution are *fasciata* and *sugens*.

The *genus* does not occur, as far as we know, outside 43 deg., but we may expect it to occur anywhere within 43 deg. N. and 43 deg. S.

If, of course, *Calopus* (Meigen), is *fasciata* (Fabricius), then it has occurred in England; but I am extremely doubtful upon this point, so many errors have been made in identification and the confusion of synonomy.

The species that seem to be most important after *fasciata*, in regard to "Yellow Fever," are *scutellaris* and *notoscripta*, both of which, being very closely related to the *fasciata*, might prove to be carriers of the disease.