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COMMONWEALTH OF AUSTRALIA

Quarantine Service.

SERVICE PUBLICATION NUMBER 6.

AUSTRALIA AND YELLOW FEVER

1. The Danger of the Introduction of Yellow Fever into Australia

BY J. H. L. CUMPSTON, M.D., D.P.H.,
DIRECTOR OF QUARANTINE.

2. Clinical Diagnosis of Yellow Fever

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3. Report of Survey of the Distribution of STEGOMYIA FASCIATA in the Ports of Queensland

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4. The Recorded Occurrence of STEGOMYIA FASCIATA in Australia and New Guinea

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Issued under the authority of the Minister for Trade and Customs.

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C.9197.

INTRODUCTION.

The opening of the Panama Canal has directed attention to the question of the possibility of the introduction of Yellow Fever into Australia.

It has been considered advisable to collect together the important information bearing on this subject so as to accurately assess the extent of the danger to Australia.

In March, 1914, the Minister for Trade and Customs sanctioned the expenditure necessary to conduct a survey of the coastal towns of Queensland, with the object of determining the distribution of the *Stegomyia fasciata* mosquito. This survey has been completed by Mr. Taylor, and the results are included in this volume.

In addition, Dr. Breinl, Director of the Australian Institute of Tropical Medicine, has, from his extensive personal knowledge of this disease, compiled a short clinical description for the benefit of Quarantine Officers who may be called upon to make a diagnosis.

J. H. L. CUMPSTON, M.D.,

1st October, 1915. Director of Quarantine.

THE DANGER OF THE INTRODUCTION OF YELLOW FEVER INTO AUSTRALIA,

BY

J. H. L. CUMPSTON, M.D., D.P.H.,

Director of Quarantine.

C.9197.—*a.*

THE DANGER OF THE INTRODUCTION OF YELLOW FEVER INTO AUSTRALIA.

From time to time various writers have drawn attention to the prospect of Australia becoming infected with yellow fever, and particularly has attention been drawn to the increase of this risk which will attend the opening of the Panama Canal for traffic.

Sir Patrick Manson (1) in 1903, discussed this subject as follows :—

> 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 ger erally 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 be through the tropics, and, for the most part, in atmospheric conditions favourable to yellow fever and the mosquito distributor. Furthermore, the route, instead of being something like 50 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.

During the discussion which followed the reading of the paper in which the above views were expressed, various leading scientific authorities, such as Dr. Strong (Director of the Biological Laboratory in Manila), Dr. Nuttall, Dr. Sambon, Dr. G. C. Low, and others, thoroughly endorsed this view of the danger to Asia and Australia.

Major S. P. James, the Secretary to the Sanitary Commissioner to the Government of India, was detailed by that Government in 1911 to proceed to Central America and report upon the conditions in that endemic area and in the principal seaports between that country and India. After considering the effect of the opening of the Panama Canal in the direction of shortening trade routes, Major James in his report (2) reviews the position as follows :—

> Distances, of course, are not the only factors to be considered in attempting to foretell future trade routes, but in the present case, the conclusions to which their study leads are supported by other considerations, and, on the whole, it seems clear that the spread of yellow fever to India, if such happens, will not be the result of direct trans-Pacific shipping to that country from, or through, the endemic area in Central and Southern America. If the same line of enquiry is now applied with regard to ports further east than India, it will be found that when we get beyond Singapore the conclusions are, with one important exception, the reverse of those arrived at regarding India ; in general, the distances to Japan, China, Australia, and the East Indies, will be much shorter by the new route than by the present one, and for this reason direct traffic to those countries through, and from, the endemic area may be expected. An examination of the columns of the tabular statement which refer to ports beyond Singapore will make this clear, and, in addition, it will be noted that by the new route Yokohama and Australia will be nearer to New York than to London.

It is now justifiable to sum up the conclusions resulting from the above line of enquiry, by saying that " the new danger to the East " is a direct danger as far only as Hong Kong, and that the spread of yellow fever to the Straits Settlements and to India, by the route which we have been considering, cannot result, except as a secondary event subsequent to, and consequent upon, the infection of ports in Japan, China, the East Indies or Australia. This opinion is, doubtless, held by all who have studied the subject, but I do not find that stress is laid upon it in the articles that I have read ; and it seems to me to be of material importance in connexion with the new danger to which India will be exposed.

The problem of immediate concern, therefore, is the possible spread of yellow fever, not to India, but to the other countries just named.

Dr. J. J. van Loghem (3) writing with special reference to the prospect of the invasion of the Dutch East Indies, emphasizes the same danger.

Dr. Elkington (4), in the annual report of the Commissioner of Public Health for Queensland, for 1913, states the position as follows :—

So far we have escaped yellow fever, but how long our immunity will continue after the Panama Canal opens and trade increases between our shores and the infected coastal centres of Western, South, and Central America, is open to grave doubt. We have the conveyor of yellow fever—the *Stegomyia fasciata* is one of our commonest domestic summer mosquitoes, and only infection is required to transform these household worries into veritable arrows of death. It is impossible for anyone to say when this infection will be introduced amongst us.

Dr. Anton Breinl (5) in the course of the Stewart Lectures on the Distribution and Spread of Diseases in the East, defines the position as follows :—

We are now on the eve of the opening of the Panama Canal. Ships coming from zones where yellow fever is endemic can travel, without leaving tropical waters, to China, India, and Australia. *Stegomyia fasciata*, the yellow fever carrying mosquito, has a very long life . . . . . Suppose, as an instance, that infected *Stegomyia* were introduced into North Queensland and were able to infect one person . . . . numbers of *Stegomyias*, which occur abundantly in Queensland, would have an opportunity to take up the virus, and after twelve days, the time required for the complete development of the parasite on the mosquito, more cases of an indefinite but fatal fever would crop up, and yellow fever would soon become established.

On the other hand, opinions have been expressed that there is no danger of the introduction of yellow fever into Australia.

Dr. Finckh (6) of Sydney, states this position as follows :—

As regards yellow fever, it is an interesting and, so far as we here in Australia are concerned, important fact, that a yellow fever patient can only infect the *Stegomyia* mosquito during the first three days of the illness, and a mosquito thus infected cannot transmit the disease to another human being before the twelfth day after such infection. In these data lies our protection from yellow fever.

Lalor and Stewart (7), in discussing the probability of the introduction of yellow fever into Burmah, considered that adequate precautions could, by vigorously conducted mosquito campaign, be taken against this danger.

In view of the fact that the Panama Canal has now been opened for general traffic, it is clearly important that the extent of the danger to which Australia is exposed, should be determined, and the details of any possible methods of introduction defined, in order that the measures taken shall be justified by, and based upon, known facts and rational deductions therefrom.

The necessity for obtaining exact knowledge on as many phases of this question as possible, has for some time been recognised, and, in 1913, the Minister for Customs instructed that arrangements be made with the Australian Institute of Tropical Medicine, Townsville, whereby the Entomologist

attached to the Institute (Mr. F. H. Taylor), should be detailed to make a *Stegomyia* survey of the principal Queensland coastal towns—the expense being borne by the Quarantine Service. This survey is completed for the whole of the coastal portion of Queensland, and the result will be discussed in this report. Other information has been collected from various sources and enough is obtainable to permit of the whole problem, so far as Australia is concerned, being discussed.

In such an enquiry, clearly the first point to be established is the present geographical distribution of yellow fever. A knowledge of the countries which are at present infected, and of the extent to which the disease is being, or may be, kept sufficiently under control in these countries to prevent the spread of infection, are essential items of information.

COUNTRIES INFECTED.

* Table I. is taken mainly from a bulletin of the United States Public Health Service, entitled *Quarantine Procedure* (8), and gives the number of cases of yellow fever recorded in any part of the world during the five years, 1909–1913.

The map facing page 34 shows the same information with the countries from which yellow fever has been reported, shown in colour.

The countries shown may be grouped to the best advantage as follows :—

A—The Pacific Coast of Central and South America.

B—The countries of Central America, the countries abutting on the Gulf of Mexico, and the Caribbean Sea, including the West Indies and the countries on the Atlantic coast of South America.

C—West coast of Africa.

D—East Africa.

E—Great Britain, France, Portugal, Hawaii.

These are shown in separate maps which indicate in more detail the infected localities.

Group E can be disposed of first, as these cases were mostly transient introductions brought by vessels to the countries concerned, and kept under control, so that the infection was, with few exceptions, confined to narrow limits, and rapidly terminated.

The grouping of the other countries brings out one fact of fundamental importance.

Groups A, C, and D, may have direct communication with Australia without the necessity for the vessels to pass through the Panama Canal, whereas any vessel coming from countries in Group B might or might not pass through the Panama Canal.

The information given shows the very extensive distribution of yellow fever, particularly on the American continent, and the number of foci towards which attention must be directed during this review.

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* Information from other sources has been included, the reference in each case being given.

IS THE DISEASE ENTIRELY UNDER CONTROL IN THE COUNTRIES WHERE IT EXISTS?

It will be obvious that, even though yellow fever be present, or even prevalent, in any country, there would be a minimum of danger to outside countries if in that country such precautions were taken continuously and consistently as would effectually prevent the spread of the disease within the country, or the infection of ships lying in its ports. If it can be shown that each of the countries in Table I. is actually taking such effective precautions, then the apprehension felt in Australia would be to a great extent unwarranted, but if, on the contrary, it appears that the countries are not taking the necessary precautions, then it will become self evident that the protection of Australia must be sought in other directions. The various prophylactic measures which may be regarded as comprising the effective precautions here referred to may be summarized as follow :—

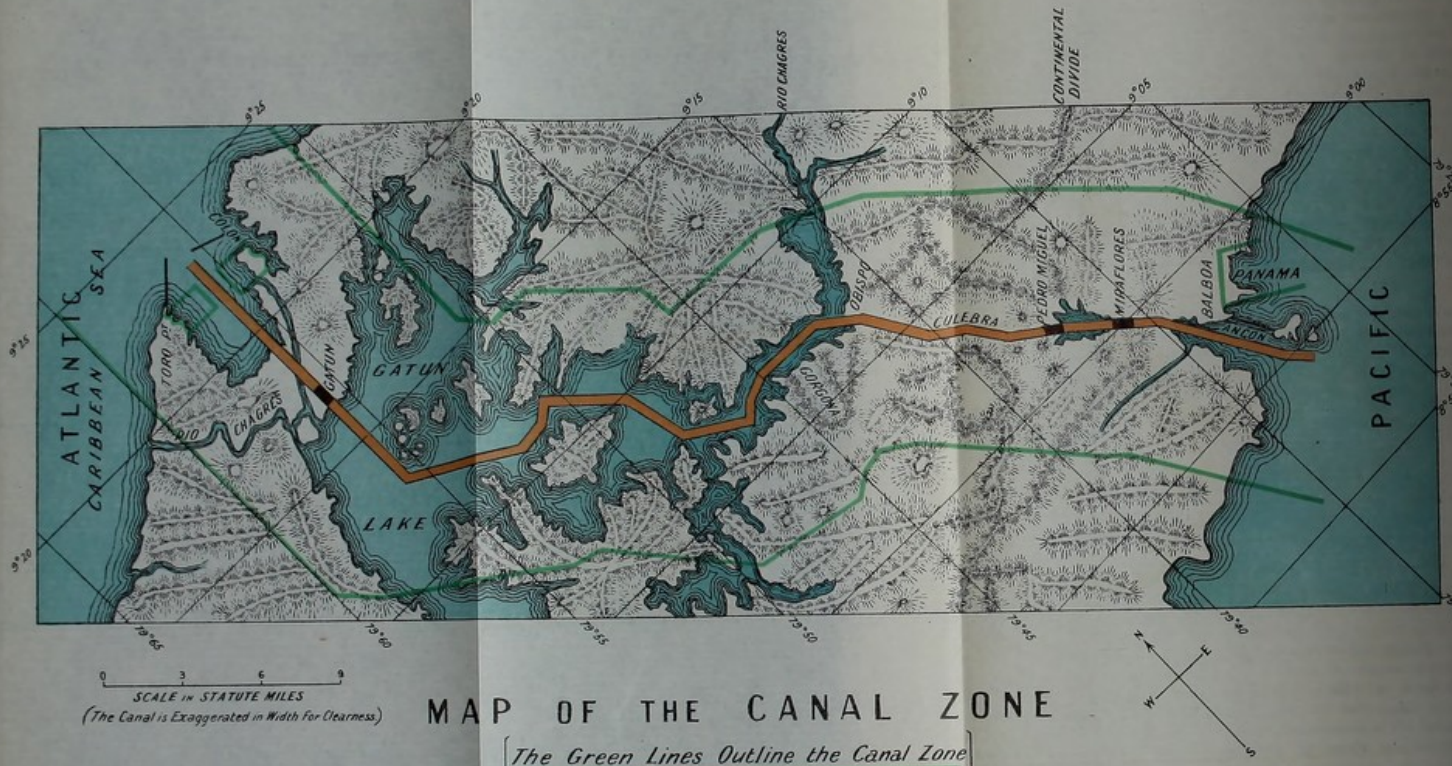
(1) A complete scheme of notification of cases, or suspected cases, of yellow fever, so designed and so enforced that immediately it occurs every case, without any exception, is brought under notice.

(2) Such provision of hospital accommodation and such administrative machinery as will ensure *immediate and absolute isolation of every case and suspected case of yellow fever.* The natural history of the disease being what it is, the isolation may be accomplished by preventing the access of mosquitoes.

(3) Effective measures for the destruction, or reduction to negligible numbers, of mosquitoes which carry, or may carry, yellow fever within a wide radius of any infected area, and similar destruction within a wide radius of every port whether known to be infected or not. In this connexion the destruction implies also the adoption of such methods as will effectually prevent the breeding of any casual mosquito which may give access to the area.

Such is an ideally complete scheme, but this perfection may in practice not be necessary or practicable. As was pointed out by Sir Ronald Ross, a certain degree of concentration of mosquito population, and of human sources of infection over a given area, are necessary before malaria would become endemic, so in the question now under discussion, commerce (communication) with other countries, might conceivably be accepted as safe if it were known that the number of cases was very small, or more especially if it were known that the degree of concentration of the *Stegomyia fasciata* mosquito was very limited, and that, by careful and continuous oversight, any great increase in the mosquito population was rendered impossible.

What, then, are the conditions in the countries where yellow fever exists ?



MAP OF THE CANAL ZONE

The Green Lines Outline the Canal Zone

From "Report on Health Conditions at Panama," by Prof. H. B. Allen.
1913.

Group A.

COUNTRIES ON THE PACIFIC COAST OF CENTRAL AND SOUTH AMERICA.

These countries, with their principal ports, are as follow :—

Mexico	Mazatlan.
	Manzanello.
	Acapulco.
	Salina Cruz.
Guatamala	Guatamala.
San Salvador	San Salvador.
Nicaragua	Managua.
Costa Rica	Punta Arenas.
Panama	Panama.
Canal Zone	Ancon.
Colombia	Tumaco.
Ecuador	Guayaquil.
Peru	Callao.
Chile	Iquique.
	Antofagasta.
	Valparaiso.

Canal Zone.

The Canal zone is American territory, with the exception of the cities of Panama and Colon, which still remain under the Republic of Panama, but the authorities of the United States have jurisdiction in all that relates to health conditions in these two towns. The American towns within the zone are Ancon and Cristobal.

Major James (9) who was an independent observer, whose experience justifies complete acceptance of his views, states in his report :—

> Complete freedom from yellow fever, and almost complete freedom from *Stegomyia* mosquitoes, is the outstanding character of the present condition of Ancon and Cristobal, and it appeared to me very improbable that, *if present arrangements are maintained*, these towns would ever again be infected with yellow fever. . . . . On the whole I conclude that these towns are uni nfectable. (p. 18.)

It is very noteworthy that Major James expresses this opinion despite the fact that he was able to catch several adult *Stegomyia fasciata* in his bedroom at the hotel in Ancon. This opinion accords with the views of Sir Ronald Ross, which have been given below, to the effect that a certain concentration of mosquito population is essential.

Many other competent observers have also expressed their satisfaction with the measures taken within the Canal zone.

Dr. Seidelin (10), for example, states :—

> I . . . . . was fortunate in having a very good opportunity of seeing the sanitary arrangements on the Panama Canal zone. I also had the opportunity of discussing sanitary matters with Colonel Gorgas, Dr. Perry, and other officers of the Health Department, and was much impressed by the thoroughly well-established organization.

The Quarantine Regulations adopted for the protection of the Canal zone itself are very stringent. They are contained in the Panama Canal Executive Office Circular of 8th January, 1915 (No. 626) (*vide* page 34), and

in protecting the Canal zone itself, the enforcement of these regulations necessarily, to a certain extent, protects all countries to which any vessel travels after passing through the Canal.

The number of recorded cases in the Canal zone bear sufficient testimony to the efficiency of the measures taken. They are as follow :—

TABLE II.

Year.	Number of Cases.
1900	62
1901	2
1902	112
1903	116
1904	20
1905	159
1906	1
1907	1
1908	—
1909	2
1910	2
1911	—
1912	3

The nine cases since 1905 have all been *imported* cases.

With reference to the native cities of Panama and Colon, Major James states (11) :—

As regards the effect of the measures in these cities, there is no doubt, in my opinion, that endemic yellow fever has been stamped out, and that the *Stegomyia* mosquito has been so effectively controlled as to minimize the risk that an epidemic would occur if undiscovered cases of the disease were reported. At the same time, it must be remembered that it is still possible to collect *Stegomyia* larvæ even in the dry season, and for this reason it is the case that the continuance of the satisfactory condition above recorded is dependent entirely on a continuance of the present very efficient arrangements for regular inspection and destruction of breeding places.

Table II. shows that 480 cases of yellow fever occurred within the Canal zone in the years 1900–1912, but the testimony of many independent observers is unanimously to the effect that the Canal zone itself does not offer to the outside world any danger, and that no case of yellow fever within the zone is at all likely to be a source of infection for any ship leaving the zone ports, or passing through the Canal.

The quarantine measures applied to every vessel arriving at the Canal ports will be dealt with at a later stage.

ECUADOR.

According to Major James (12)—

The available records of the occurrence of yellow fever refer only to Guayaquil (which is the principal seaport) and neighbouring places along the railway, and they are not, I think, sufficiently accurate to be given in detail. They show, however, that the disease has been endemic for a long time, and that, while cases occur as a rule in every month of the year, the disease is most prevalent during the rainy months from December to April. . . . . At the time of my visit, in April, mosquitoes were exceedingly prevalent, *Cellia albimana* and *Stegomyia fasciata* being particularly abundant. . . . . I had an opportunity of studying the sanitary organization at work in the city, and the measures that are being taken in the attempt to eradicate plague and yellow fever. What is being done is, doubtless, as much as can be accomplished with the money and means available, but the conditions of the city are exceedingly favourable to the breeding of mosquitoes and to the spread of yellow fever.

The arrangements by which an attempt is made to prevent the spread of yellow fever to the Canal zone by ships visiting the port have already been described, but those arrangements do not apply to ships trading with the ports of other countries than the United States, and such ships usually lie in the river opposite the wharves, and frequently become infected.

It is known that in the past the official reports on yellow fever in Guayaquil have not indicated the full incidence of the disease, but the following figures, incomplete though they may be, will serve to show the persistence of fatal yellow fever in this notorious seaport (13) (*vide* Annual Report of the Local Government Board of England, 1913–1914, page 157) :—

Year.	Number of Deaths.
1905	116
1906	275
1907	120
1908	103
1909	228
1910	113
1911	102
1912	166*

The menace to American shipping offered by this port was so great that the U.S.A. Government made strong representations to the Government of Ecuador, and the latter Government requested the despatch of a trained officer to supervise the necessary sanitary reforms. Colonel Gorgas was detailed for this duty, but, so far, no information as to results obtained is available.

So far as Australia is concerned, no further information than that contained in the last paragraph of the extract from Major James' report is required.

Mexico.

The bulletin of the Yellow Fever Bureau points out (14) that in four places in Mexico (including the port of Mazanillo) within eight months, yellow fever was contracted, and that in no one of these places was yellow fever believed to be present. A severe outbreak occurred also in Yucatan between August, 1911, and April, 1912, and, as Seidelin points out in his report upon this epidemic (15), the earlier cases were undiagnosed, and "in all probability the whole State of Yucatan should be equally so considered. . . . . Yellow fever infection has been present in a more or less active state for years, or probably for centuries, in the entire Yucatan peninsula." With reference to the Merida locality, Dr. Seidelin says—"I feel certain that a complete and repeated survey should show that all houses, with very few exceptions, are infected with mosquitoes, and mosquitoes are in Merida, in at least 80 per cent. of cases, *Stegomyia*."

That there is no reason for assuming that the conditions in the Pacific ports of Mexico are any different from the above, which reveal clearly the lack of any reliable system of notification, and abundance of mosquitoes, is evidenced by the case of the steamer *Hong Kong Maru* which, as will be discussed later, carried yellow fever from a Mexican port to Honolulu, and there infected one local officer.

Chile.

In January, 1912, one case of yellow fever was landed at Tocopilla from a vessel, and placed in hospital. In February cases appeared amongst the patients in the hospital. The disease spread to the entire city. Up to 30th April 570 cases were known to have occurred. On 7th May yellow fever was reported at five localities in the neighbourhood. On 25th April

* 11 months only.

the port was officially declared to be infected with yellow fever. *Stegomyia* mosquitoes were found to be present. This epidemic shows absolute lack of official control, and evident abundance of *Stegomyia* mosquitoes (16) (17).

Surgeon-General Blue, who was deputed by the United States Government to report upon the conditions in Chile, states (18) in respect of Valparaiso—

> There is no properly constituted Board of Health and no reliable certification of deaths. . . . . The *asistencia publica*, which performs some of the functions of a Board of Health, is not properly supported, and is always in need of funds and sympathetic encouragement.

And of Chile, generally, he says—

> The central authority exercises only an advisory function in the Republic. . . . . The Consejo Departmental de Higiene, a body similar in some respects to a State Health Board, does not possess jurisdiction over municipal authorities, however, and is in evidence only in time of epidemics.

It should be mentioned that no case has been reported at Tocopilla since June, 1912. The experience in other countries offers, however, a warning against accepting these facts as sufficient evidence of the complete disappearance of all disease.

Concerning the other countries on the Pacific coast, no exact information has been obtained, but the conditions known to exist in Mexico, Ecuador, and Chile render it impossible to place any reliance whatever upon the administration in these places as affording any protection to other countries. And it is almost certain that vessels will, at times, call at more than one port on the American coast *en route* to Australia, the whole of the Pacific littoral from Mexico to Chile (with the exception of Panama town) must be treated as definitely dangerous, and as offering through their internal sanitation absolutely no diminution of the risk.

Group B.

THE COUNTRIES ABUTTING ON THE GULF OF MEXICO, THE CARIBBEAN SEA AND THOSE ON THE ATLANTIC COAST OF SOUTH AMERICA.

These countries are—

United States,
Mexico,
Central American Republics,
Cuba,
Jamaica,
Hayti and San Domingo,
Bahamas,
Porto Rico,
Leeward and Windward Islands,
Venezuela,
Guiana,
Brazil,
Argentine Republic.

A map showing this area in a large scale is here reproduced.

The places indicated in red are those from which Yellow Fever has been reported since 1909.

United States.

The principal centre on the southern coast of the United States is New Orleans. This city experienced a severe outbreak of yellow fever in 1905, when 3,403 cases and 437 deaths occurred. This epidemic, according to Major James (19), "brought to light the exceedingly primitive and dangerous condition of the city and provided a much needed stimulus to sanitary effort and progress. Since its occurrence, improvement has been more or less continuous, but the problem is very complex, and at the time of my visit in April, 1912, it appeared to me that its difficulties had been by no means entirely overcome . . . . . Among a population of this kind conditions are favorable for the concealment of the disease, and any interference for sanitary purposes is usually much resented . . . . . I have no knowledge of the plan adopted in 1911, and as regards 1912, I was informed that, owing to lack of funds, no campaign against mosquitoes was being carried on . . . . . the President of the Louisiana State Board of Health, the British Consul-General, and other officials, informed me that during the summer months they are exceedingly prevalent and troublesome. The common species were said to be *Anopheles maculipennis*, *Stegomyia fasciata*, and various culicines. . . . . One cannot but regard with anxiety the cessation of the special measures."

It is evident from these remarks that two at least of the postulates are not satisfied—complete notification of cases, and absence of the carrier mosquito. And if this be the case in a well organized community in the United States of America, a less satisfactory condition in other places should cause no surprise.

British Honduras.

The colonial surgeon reported in 1910 that marked progress in anti-mosquito operations had been made. Low-level areas and swamps had been filled in by a sand suction dredger, and rigorous measures were taken against all unscreened water receptacles.

So far as is known no outbreak of yellow fever has occurred in British Honduras since 1906, when about 100 cases came under observation (20).

Central American Countries.

During 1913, Surgeon J. H. White was deputed by the Surgeon-General of the United States Public Health Service to visit these countries and report upon the menace offered by them in respect of yellow fever to the United States. This report concludes (21) :—"These ports fall naturally into two classes—(1) those above Cape Gracias, which need constant watching and for which an acting assistant-surgeon has been kept on duty every year, and (2) those below Cape Gracias, which, by reason of being five days' sail from New Orleans, as well as in superior sanitary condition, offer little or no menace to the United States coast." The report closes with the expression of opinion, based upon eight years' familiarity with this coast, "that the greatest risk of infection by far is *viâ* the Guatemalan railroad and not by sea, and that the infection of one of these northern fruit ports may, and probably will, result in the infection of all, and, therefore, that it would be well to watch them all the year round."

The Local Government Board report deals in a general way with these Republics, as follows (22) :—

It is probable that yellow fever is endemic in all these Republics of Central America, but that it smoulders on among the native population in a mild form without attracting much attention, such illness being diagnosed as malaria or something other than yellow fever.

Cuba.

So far as the city of Habana is concerned, the precautions taken would appear to be very satisfactory. The following is a quotation from the Annual Report of the Surgeon-General, United States Public Health Service, for 1910 (page 133) :—

Since 16th September, 1908, no case of yellow fever has been reported in the city of Habana ; but, on account of the possibility of a re-appearance of the disease, the Cuban Health authorities have been very watchful, causing all cases of fever in non-immunes to be seen by the Commission for the Diagnosis of Infectious Diseases, which consists of six physicians of large experience in the diagnosis of yellow fever.

That the other aspects of yellow fever prevention work are not neglected is evidenced by the information contained in a paper read by Professor Aristides Agramonte at the International Congress of Medicine in Buda Pesth, 1909, in which he details the methods employed to keep Cuba generally free from yellow fever, and these appear to be complete enough to justify the acceptance of Cuba as a country at present free from any risk to Australia or other countries.

In this same paper (23) Professor Agramonte speaks very scathingly of the conditions of sanitary administration in both the Southern States of America and the Central American Republics :—

I cannot refrain from calling the attention of my hearers to the superiority of our organization when compared with that of our neighbouring countries, including Mexico and the United States. The latter, and more especially the States bordering on the Gulf of Mexico, depend almost exclusively upon quarantine measures to prevent the introduction of yellow fever ; their towns are overrun by *Stegomyia* mosquitoes ; the city of New Orleans in Louisiana, which depends for its water supply upon the use of cisterns in every house, has failed to keep them all properly covered, and mosquitoes are to-day nearly as plentiful as before the dreadful epidemic of 1905. The non-immune population is widely disseminated and in the hands of private practitioners, who will fail to recognise the first cases, or will hide them, as they did in the memorable summer of 1905. The same may be said of the other Southern States, whose bugbear is yellow fever, and whose protective mainstay is quarantine, the least useful measure which may be implanted in any country for its defence against said infection.

Jamaica and Trinidad.

The former of these countries has experienced a continued series of cases of " vomiting sickness " which excited the suspicion that they might be cases of yellow fever. These were specially investigated by Dr. H. Seidelin in 1913 (24), and were inquired into by Surgeon White of the United States Public Health Service in the same year (25), and both concluded that this disease was not yellow fever. Seidelin, however, states definitely that he discovered one case of yellow fever amongst the natives, though the diagnosis in this case was vigorously combated by Dr. Guiteras, of Cuba (26), and Dr. Angus MacDonald.

Dr. MacDonald (27) points out that yellow fever is absent in typical form from Kingston, where there must be thousands of susceptibles resident, and where thousands more migrant susceptibles yearly still get bitten by *Stegomyia* is suggestive of, at any rate, extremely limited endemicity.

Dr. Seidelin adopts somewhat the same view. He states (l.c., page 97) —"That outbreaks of yellow fever do not occur in Jamaica, though the disease may exist amongst the natives, is easily explained, I believe, by the relative freedom from mosquitoes which the larger towns enjoy."

In Trinidad the position is not so well defined. Evidently the disease appears in this island, for Seidelin observes (28)—"The re-appearance of yellow fever in Surinam a few years ago, and quite recently in Trinidad, also illustrates the 'occult' endemicity of yellow fever."

Dr. David Thomson (29) in a Report upon Sanitation in the Tropics, states in respect of Trinidad—"There are practically no men employed on anti-mosquito work, except in Port of Spain, where *Stegomyia* reduction against yellow fever is persistently, and more or less successfully, pursued."

The position in respect of Jamaica and Trinidad* may, then, be summarized by saying that these islands do not at present offer a risk, but there is the prospect, albeit an indefinite one, that they may at some time become dangerous foci.

Hayti, San Domingo, and other West Indian Islands.

Dr. Mapleton stated in a letter to the *British Medical Journal* (30), that he had held the belief for twenty-four years that yellow fever was endemic in St. Kitts.

Martinique.

In 1908, a Commission investigated yellow fever in Martinique, and stated emphatically in their report that it was endemic in the colony. It is claimed that since then vigorous measures have been taken, but inasmuch as the "usual number" of endemic cases occurred during 1912, it would appear that there is still a definite danger of transmission of the disease from this island (31).

The Yellow Fever Bureau Bulletin (32), in a leading article, sums up the position as follows:—

> With regard to the West Indies there is a widespread feeling of uncertainty. Many of the islands are regarded with suspicion by their neighbours, and this uneasiness is increased by the lack of a reliable system of mutual notification. The neighbouring countries on the continent, the Central American and Republics, are either regarded with suspicion, or definitely considered infected, but only from Venezuela are cases regularly reported. Occasionally some information is published otherwise than in official reports, and conveys a somewhat different impression. This is illustrated by a recent paper by Martinez (*Journal of Tropical Medical Hygiene*, London, 1st April, 1913, abstracted in this Bulletin, page 364), in which yellow fever is stated to be endemic in Colombia; but, from Colombia, only two cases of yellow fever have been reported during the last three years—one in 1911, and one in 1912. Even official reports from one and the same place, but received from different sources, occasionally differ, as illustrated in the case of the figures for Caracas, Venezuela, for 1911 (93 cases, with 27 deaths, as compiled from the Public Health Reports, Washington, and 172 cases, with 107 deaths, according to the official Annual Report from Caracas).
>
> The discrepancy between the number of reported cases and that which might reasonably be expected to occur in endemic areas may, of course, depend, in some few cases, on actual concealment of the facts, even fatal and typical cases of yellow fever being reported under other headings. But there is no doubt that the chief reason, which in the majority of instances fully explains the discrepancy, is the prevalence of mild and atypical cases. The severity of yellow fever varies exceedingly, the mortality amongst natives in endemic areas being, as a rule, very low . . . . It would be of great importance if a series of investigations could be undertaken in the West Indies, similar to those in West Africa.

* In December, 1913, an outbreak of ten cases occurred at Brighton La-Brea, Trinidad. The origin of this outbreak is obscure. (Rev. Applied Entomology, June, 1915, p. 83).

While, therefore, this uncertainty remains as to the actual distribution of cases of yellow fever, it is obvious that one of the postulates demanded as necessary to a sense of security regarding the probability of any country acting as a source of infection for other countries must remain unsatisfied, so far as the West Indian islands are concerned. At the same time it must not be forgotten that precautions are taken at many of these West Indian ports, which greatly minimize the risk of translation of the disease.

Brazil.

The table already given shows that there have been five countries principally infected with yellow fever during the years 1909–1913, viz., Brazil, Chile, Ecuador, Mexico, Venezuela. The notifications from Brazil come only from the ports, the reason for this being that American consuls are stationed at the ports, and it is considered to be very definitely to the interest of the American Health Service to be kept accurately informed of the health conditions in these places. In Rio Janeiro, the amount of yellow fever appears to have been considerably reduced, mainly through the efforts of Dr. Oswaldo Cruz. Dr. Thomas, however, writing of Manaos, in 1910, describes the conditions in that town. His remarks have been summarized as follows (33) :—

> Manaos is at the present time one of the principal foci of yellow fever. In many respects the same conditions are prevailing as in so many other tropical cities, where accumulation of filth and stagnant water are abundant. In fact, the *Stegomyia* house index is reported as being 98 per cent. . . . . the hospitals are good, but insufficient for the number of patients . . . . the foreigners are much at fault for not notifying the cases before it is too late for an efficient prophylaxis and treatment to be instituted. It will be difficult to rid Manaos from *Stegomyia* and yellow fever, but the difficulties should not be nearly so great as they were at Rio Janeiro.

At Para, in 1911, the authorities were spending £9,000 to £10,000 per month to eradicate yellow fever and *Stegomyia*. Manaos, it is stated, "is waiting to see the result of the Para work" (34).

The figures showing the effect of the measures in Rio Janeiro are as follow (page 152) :—

1890 ..	.. 719	1902 ..	.. 984
1891 ..	.. 4,456	1903 ..	.. 584
1892 ..	.. 4,312	1904 ..	.. 48
1893 ..	.. 825	1905 ..	.. 289
1894 ..	.. 4,852	1906 ..	.. 42
1895 ..	.. 818	1907 ..	.. 39
1896 ..	.. 2,929	1908 ..	.. 4
1897 ..	.. 159	1909 ..	.. ..
1898 ..	.. 1,078	1910 ..	.. ..
1899 ..	.. 731	1911 ..	.. 2 } both
1900 ..	.. 344	1912 ..	.. 3 } imported.
1901 ..	.. 299		

It is very regettable, however, that "there is recent evidence during 1913 of a slackening in the yellow fever campaign in Rio Janeiro, the ostensible reason for this being retrenchment, with consequent withholding of the necessary funds by the municipality from the Public Health Department of the city. The men employed as the "anti-mosquito brigade,"

it is stated, had not received their pay for some months, with the result that a number of them had deserted their posts and obtained other employment. There seems, therefore, to be some danger of a recrudescence of yellow fever in Rio Janeiro as a result of the slackening of the vigorous campaign which had previously proved so successful.

The two towns of Para and Manaos offer a very instructive contrast which is well shown in the Annual Report of the Medical Officer to the Local Government Board (35). In Manaos "all the conditions necessary for fostering the *Stegomyia* mosquito are present in Manaos, and little is done to improve the state of the town." In Para, on the other hand, "organized measures were begun in 1910 for the suppression of the conditions which have favoured the breeding of the *Stegomyia* mosquito, and as a result there seems to have been a considerable diminution in the number of yellow fever cases reported during 1912. The figures are shown in parallel column thus :—

Year.	Manaos.	Para.
1904	56 ..	98
1905	157 ..	183
1906	117 ..	149
1907	170 ..	166
1908	117 ..	213
1909	61 ..	140
1910	173 ..	358
1911	210 ..	49
1912	96 ..	3

Bahia is still to be regarded as a focus of infection, the following cases having been reported :—

1908	26
1909	237
1910	18
1911	5
1912	8

British and French Guiana.

Dr. Thomson (36) states :—

There is no yellow fever in British Guiana, but *Stegomyia* are very abundant in Georgetown, so that if the disease was introduced a serious epidemic might easily result. Dr. Wise has found that 58·3 per cent. of the premises in Georgetown are breeding mosquitoes, the great majority of these being *Stegomyia fasciata*.

Cases of yellow fever were reported in 1909 in French Guiana (37).

Venezuela.

The Annual Report of the Surgeon-General of the United States Public Health Service for 1913, contains a report from Surgeon Stewart upon the conditions in certain Venezuelan towns :—

The outlook for improved sanitary conditions, not only in Caracas and in its port, the town of La Guaira, and in the nearest western port, Puerto Cabello . . . . has proved true in every particular. Considerable improvement has taken place not only in the eradication of yellow fever and plague from these cities, but also in the sanitary measures employed in them all, by which such eradication has taken place. . . . The same sanitary conditions (as regards freedom from quarantinable diseases) existing in La Guaira and in Puerto Cabello do not obtain in the port of Maracaibo. Advices from the consul there, and from medical men, point to the fact that yellow fever is endemic.

Notwithstanding the measures taken, there were four cases of yellow fever in Caracas in 1813 and eight cases (all fatal) in La Guaira. In Caracas, during 1912, there were 172 cases reported, and during 1912, 58 cases.

As a contrast to the satisfactory report given above by the United States authorities, the Local Government Board report discusses the situation as follows (38) :—

> The sanitary circumstances and administration of many Venezuelan towns leave much to be desired, and conditions are present which favour the multiplication of domestic mosquitoes, including the transmitting agent of yellow fever.

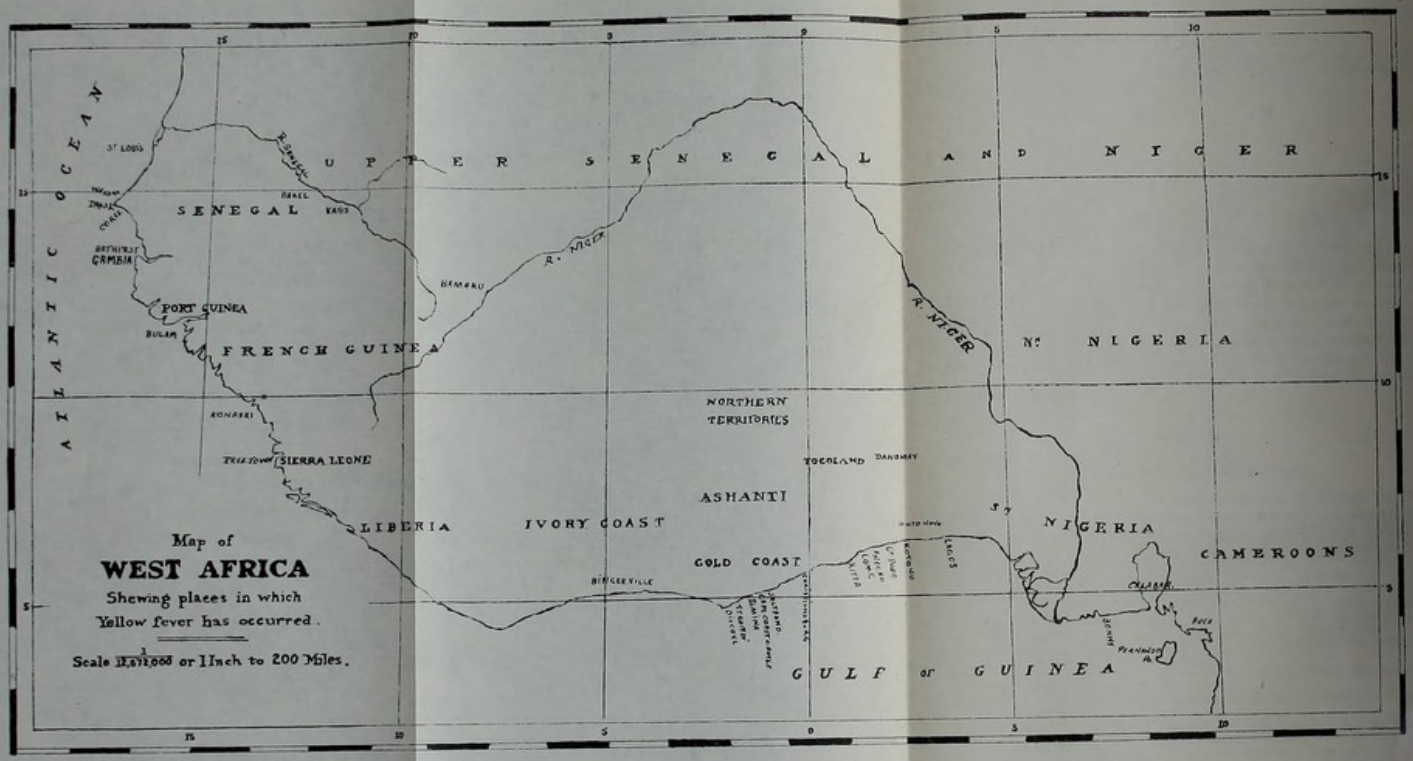
It will be seen from the facts above given that while in the West Indian Islands the precautions being taken are sufficient to greatly minimize the risk of these islands acting as sources of infection, yet the risk is by no means entirely eliminated, and the prospect of large epidemic outbreaks, with their attendant dangers, has always to be borne in mind. While the position is so far satisfactory for the islands, the same cannot be said of the mainland of South America. Venezuela, Guiana, and Brazil must be treated as definitely dangerous countries, even in spite of the great work that has already been done in some of the larger ports. This work has undoubtedly, in such ports as Rio Janeiro and La Guaira, diminished the danger, but no clean country can accept the results as sufficient to justify them in relaxing precautions against these ports.

Groups C and D.

West Coast of Africa and East Africa.

The accompanying map, which has been taken from Sir Rubert Boyce's work on "Yellow Fever and its Prevention," shows the places in West Africa from which yellow fever has been reported up to 1910, and the following summary from the same work (39) expresses the position very concisely :—

> I think I have brought forward sufficient evidence, based upon accurate records, clinical and historical, written by men of admitted ability and experience in yellow fever, to conclusively prove that yellow fever has been of far more frequent occurrence than is usually supposed on the West Coast. That, in fact, it has appeared annually over a very large number of years, practically, as my figures show, for the last 100 years.
>
> A few gaps of a few years have occurred, such as between 1852 and 1858, 1868 and 1872, 1873 and 1878, 1878 and 1883, 1884 and 1890.
>
> But from 1890 to the present date, I am of opinion from the present data which I have examined, that there is an unbroken line.
>
> During the whole 100 years there is no large interval which would make it reasonable to suppose that yellow fever had completely died out on the coast.
>
> In my opinion this evidence is so strong that we are obliged to assume that the disease is endemic upon the West African coast for at least the last 100 years.
>
> The question now, therefore, arises, by whom has the virus been kept up ?
>
> In the first place, we know positively that the transmitting agent, the *Stegomyia*, is present in overwhelming quantity. It only remains to prove how a continuous source of infection has been maintained.
>
> To those who would adopt the theory of importation, it would mean a continuous importation from, say, the West Indies, Central or South America, and there is no history of such importation.



From "Yellow Fever and its Prevention."—Boyce.

Therefore, in my opinion, the most reasonable explanation is the one which has proved correct in the West Indies, Central and South America; and is adopted by the most recent English, French, and German investigators in yellow fever, namely, that the disease exists amongst the natives in a mild form; in other words, that it is endemic.

A little consideration will show that the whites have not been the source of the continuous infection for the reason that the total number of whites on the whole West African coast has never been large enough to admit of continuous keeping up of the virus; the whites are in the very small minority.

Therefore, precisely as in the case of the sister disease, malaria, the continuous or endemic source of infection is the comparatively dense native population of the West Coast.

The evidence which I have brought forward also conclusively points both in English, French, and German colonies, to a vast amount of *mistaken diagnosis*. Yellow fever was not suspected in its mild form, and it was not found out, it was only discovered when fatal cases made their appearance; and, as my evidence shows, these cases were as often as not mistaken for other diseases. These same mistakes in diagnosis have occurred over and over again in yellow fever countries, especially in the commencement.

I therefore conclude from the evidence that a comparatively large number of deaths and mild cases have occurred from yellow fever in the past, and which have been attributed to malaria, chiefly the "bilious remittent fever." Most authorities upon yellow fever are agreed that in a very large number of instances, "bilious remittent fever" is another name for yellow fever.

It must be recollected that it is only in this year that effective sulphur fumigation of the infected *Stegomyia* has been attempted on the West Coast after outbreaks.

Therefore, infected *Stegomyia* were left in the past to live on and to carry infection into a succeeding year.

Finally—

(1) The historical record of outbreaks and sporadic cases, as recorded above;

(2) Mistaken diagnosis; and

(3) The absence of any destruction of infected *Stegomyia* in the past, is evidence overwhelmingly in favour of the disease being endemic on the coast and of its having been repeatedly mistaken for other diseases or entirely overlooked.

Years in which Yellow Fever has Appeared in Sporadic or Epidemic Form in West Africa.

(*Note.*—These figures are based upon documents, official reports, and published memoranda, carefully examined by the author.)

1807	1826	..	..	..	1894
1809	1827	1844	..	1878	1895
..	1828	1845	1862	..	1896
..	1829	1846	1863	..	1897
1812	1830	1847	1864	..	1898
..	..	..	1865	..	1899
1814	..	..	1866	1883	1900
..	..	1850	1867	1884	1901
1816	..	..	1868	..	1902
1817	1835	1852	..	..	1903
1818	1836	..	..	..	1904
1819	1837	..	..	..	1905
1820	1838	..	1872	..	1906
1821	1839	1856	1873	1890	..
1822	1840	..	..	1891	1908
1823	1841	1858	..	..	1909
1824	1842	1859	..	1893	1910
1825					

East Africa.

In a review in the Yellow Fever Bureau Bulletin (40) of a paper on "Yellow Fever in the Soudan," by G. Hudellet, the reviewer makes the following remarks :—

> The author comes, therefore, to the conclusion that the yellow fever virus was present on the spot ; the question of the endemicity of yellow fever in the region of the Soudan traversed by railways being no longer doubted by most observers.

In the Bulletin of Entomological Research (41), it is stated that *Stegomyia fasciata* occurs in various localities in the Soudan, and that it is very abundant in all the coast towns of British Somaliland. In the table already given, cases of yellow fever are reported from three centres in British East Africa, viz., Kisumu, Mombasa, Nairobi—two of these being ports.

Sufficient information has now been given concerning those countries where yellow fever exists to show that it would be fatal to assume that in any of those countries such precautions are taken continuously and consistently as would effectually prevent the infection of ships lying within the ports. In some of the countries some such precautions are taken, but in considering the danger to Australia, any assumption that such precautions are in themselves sufficient guarantee of protection to Australia would be unjustifiable.

There remain, therefore, for consideration, the exact extent and nature of this danger ; the measures to be adopted to neutralize it ; and, during this consideration, it is necessary to bear in mind two facts—(1) that most epidemics commence with a series of mild cases, and that the diagnosis of these cases is generally mistaken, so that the presence of yellow fever is not suspected until the disease has become firmly established ; (2) that, although all countries which have signed the Paris Convention have undertaken to notify to other countries the occurrence of cases of yellow fever, yet in practice this notification is often not given, and when it is given it is usually delayed until long after the diagnosis has been definitely confirmed.

Before any assessment of the risk can be undertaken, it is necessary to obtain a well-defined picture of the mode of spread of the disease.

It has now been well established that yellow fever will not spread in the absence of mosquitoes. In order that any person may become infected with yellow fever, it is essential that he be bitten by a mosquito which has previously fed from a person suffering from yellow fever. It has been proved that a particular mosquito—the *Stegomyia fasciata*—will transmit yellow fever, and this species is the only one which has been proved to transmit the disease. It has not, however, been proved that this mosquito is the only one which will convey the disease, and it must be considered

as possible that certain other allied species of mosquito will so act until the contrary has been proved. The Yellow Fever Bureau Bulletin directs attention to this aspect, as follows (42) :—

> In view of the fact that *Stegomyia fasciata* has never been proved to be the only mosquito capable of transmitting yellow fever, it would be very interesting to know whether yellow fever cases are ever observed where *Stegomyia fasciata* cannot be found, and whether in such cases other mosquitoes, especially other species of *Stegomyia*, are found.

The transmission of infection by the *Stegomyia* (or other) mosquito is not, however, a haphazard one, but is subject to certain limiting factors. For example, in the present state of knowledge on the subject, it must be stated that the person already ill with yellow fever must be bitten by the mosquito during the first three days of his illness, in order that the mosquito may be a source of danger to others. In other words, numerous susceptible mosquitoes may bite a yellow fever patient after the first three days of the illness without becoming able to infect any other person.

It has been said that this is the present state of knowledge on the subject, and the same must be said regarding the widely accepted idea that a mosquito after sucking blood from a person suffering from yellow fever does not become infective for another person until twelve days have elapsed. This must be accepted at the present time, but it may become necessary to modify this idea later on. The position in this regard is reviewed by Seidelin (43) :—

> That yellow fever is transmitted in nature by no other means than by mosquitoes has never been proved, but is extremely probable in view of our knowledge of protozoal diseases.
>
> The yellow fever germ is supposed to undergo a development in the mosquito of twelve days' duration. This is made probable by the negative results of experiment in which a period of less than twelve days had elapsed after the mosquito had sucked blood from an infected patient, until it was allowed to bite a non-immune individual. This theory corresponds well with the observations of Carter and others on the extrinsic incubation period, and is likely to be correct, but cannot be considered conclusively proved, as the negative experiments referred to were not numerous and, on the other hand, there is a comparatively large number of negative results in cases in which all conditions for obtaining positive results were fulfilled.
>
> Yellow fever blood is considered infectious during the first three days of the disease only, but on very scanty evidence, as I have previously pointed out. My argument has been objected to, but not shown to be erroneous, and I must again assert emphatically that we here have to do with a theory which is without adequate foundation. The negative experiments of the Army Commission prove nothing in this respect. In Carroll's table of twenty-two cases, with *thirty-two* negative inoculations, we find *two* inoculations only in which the patient bitten was in a later period than the third day, whilst the interval allowed in the mosquito was more than twelve days (thirteen and fourteen respectively). In ten inoculations, both conditions for favorable results were fulfilled (patient bitten during first three days of disease, and intervening period in mosquito twelve days or more). In the remaining 20 inoculations the interval in the mosquito was less than twelve days, which circumstance alone would explain the negative result. It really surprises me that anybody can take this table as an argument in favour of the three days' infectiousness.
>
> The responsibility for this dogma rests with Marchoux and Simond, and theirs should be the honour for having enunciated it, should it finally prove to be correct, but proved it they have not. I have, in a former paper, analyzed the four experiments which sustain their argument, and shall not go into details here. All four experiments are with infection of blood or filtered serum, and in only one was the infected individual proved, by subsequent mosquito inoculation, susceptible to yellow fever. The experiments are, therefore, both very few and of very relative value. Never has a dogma in medicine been established on evidence poorer than this.

Taking the facts as they are known at present, then, it appears that a mosquito may become infected at a port—Guayaquil, for example—and that mosquito will not become dangerous until twelve days have elapsed.

Assuming that it then bites another person on the vessel and infects that person, there will be an incubation period of several days before that person becomes infective, and at the lapse of that period he will remain infective to mosquitoes for three days only. If there be no mosquitoes on board, or if this patient be not bitten during those three days, then all further danger might appear to have ceased.

In these facts Finckh finds the safety of Australia. But there are several cogent objections to this presumption of safety. In the first place, there is no reliable information as to the duration of infectivity in the mosquito.

The United States Army Commission established the fact that infected mosquitoes may remain infective for as long as 57 days, and also showed that infected *Stegomyia* have survived for 71 days. There is, however, no maximum limit of infectivity yet established.

Van Loghem states (44) that "*Stegomyia fasciata* can remain infective very long after having bitten a yellow fever patient."

It is certain that the *Stegomyia* mosquito can remain alive for prolonged periods. Breinl has kept *Stegomyia* alive in Townsville (Queensland) for a period of five months (45).

It must, therefore, be concluded that the *Stegomyia* can remain alive throughout the whole journey from the most remote yellow fever centre to Australia, and that, in the absence of any knowledge to the contrary, it *may* remain infective for the whole of that period, even without producing any case of yellow fever on board. Finckh assumes that this production of a case on the vessel would be sufficient danger signal to protect Australia, but this is clearly not so. Instances of transmission of yellow fever by vessels will presently be considered, but it may be opportune to repeat here a remark from a leading article in the Yellow Fever Bureau Bulletin (46) :—

> It disproves again, as other examples have done before, the assertion which has been made by various authors, that a ship is not dangerous, and should not be considered infected, unless yellow fever cases have occurred on board.

Quite apart from this direct danger, it is not inconceivable, and any quarantine officer will readily believe it possible, that the case on board may not be accurately diagnosed by the ship's surgeon or master, and the presence of another infectible mosquito will start the twelve-day cycle afresh, making a total of 12 + 6 + 12 days from the port of departure. A series of cases will aggravate the danger, and it appears to be definitely acceptable that any vessel coming from a yellow fever focus, and keeping within 37° N. and 37° S. all the way, offers a potential danger to Australia.

Can this conclusion, which has been arrived at on theoretical grounds, be supported by the experience of vessels in the past. The following are instances of transmission of yellow fever :—

S.S. *Hong-Kong Maru.*—On 23rd October, 1910, the Japanese steamer *Hong-Kong Maru*, on her way from South American and Mexican ports to Japan, arrived at Honolulu, and on examination by the quarantine staff a sick Chinese passenger was declared to have yellow fever. The steamer ultimately proceeded to Japan, having had no communication with the shore, other than to receive supplies, during which time a guard was on board. The guard was itself segregated on shore for safety, but, on 27th October,

it transpired that one of their number, a Hawaiian, had broken quarantine and had been found outside ill, with what was diagnosed as yellow fever. All possible precautions to prevent spread were taken ; the patient recovered, and no further case occurred.

In the course of the campaign the yellow fever mosquito (*Stegomyia fasciata*) was found in various districts in and near Honolulu, confirming the previous discovery. The *Stegomyia scutellaris* was also found to exist in various places.

After discussing the above details, Major James makes the following deductions (47) :—

> If the facts are as stated, their explanation may be that the infected mosquito which had got on board at Manzanillo (Mexico), and caused one case during the ten or eleven days required for the voyage to Honolulu, had bitten the second man while he was assisting in the operations of fumigation. The occurrence indicates that Honolulu is in danger from the importation of infected mosquitoes as well as of patients, and since December, 1910, all vessels from places where mosquitoes are known to be prevalent have been fumigated before being permitted to enter the port.

U.S.S. *Yorktown*.—The United States Navy vessel *Yorktown* arrived on 7th January, 1912, at Guayaquil, Ecuador. The ship was anchored at a considerable distance from the shore and nobody was allowed on shore, except on official business. On 15th January the Commander developed yellow fever, and died on 24th January. Subsequently, seven other cases amongst the crew developed, five of whom had been ashore, but the other two had not left the ship. The Surgeon-General of the United States Navy, in commenting upon this outbreak and the insanitary conditions at Guayaquil, says :—" It can not be doubted but that a situation which constitutes a grave menace to the welfare of this nation and the shipping of the world, demands, and will receive, adequate consideration by the countries immediately concerned." The special interest of this outbreak is that members of the crew who had not left the ship were attacked, although the vessel was anchored some considerable distance from the shore.

Sailing Ship *Harriett*.—This vessel left Havana on the 11th June, 1862, and arrived at Havre on the 24th July, 1862, thus being 44 days at sea. Four days after leaving Havana a case of yellow fever appeared on board. This case must have been infected ashore ; nineteen days after the first case four others appeared, and twelve days after this second group of cases two more appeared. It is evident that infected mosquitoes were on board and capable of infecting persons as late as 32 days after leaving Havana, and it is very probable that mosquitoes capable of infecting the shore population were still on board on arrival at Havre—44 days after leaving Havana.

Ship-of-War *La Caravane*.—On the 18th May, 1856, the ship-of-war *La Caravane* left Havana, and within the next three days five cases of yellow fever occurred, all obviously infected ashore. On 26th May a fresh series began, consisting of 45 cases, the last of which appeared on 7th June. No cases then occurred until 20th June, when another case occurred. The vessel arrived at Brest on 22nd June, and thereafter three cases occurred, the last of which occurred on 26th June. In this case, again, infecting mosquitoes were certainly present on board until 20th June (if six days'

incubation in man be accepted), *i.e*, two days before arrival at Brest, and 34 days after leaving Havana. In both these instances the vessels were sailing ships occupying prolonged periods in warm latitudes.

As an interesting contrast, two vessels may be quoted, namely, the *La Plata* and the *Ville de Paris*, both steamers.

The *La Plata* left St. Thomas on the 4th November, 1882, and on the following day a case of yellow fever appeared. On the 9th November, four more cases appeared, all of which must have been infected ashore. No further cases occurred until the arrival of the vessel in England on the 18th November.

The *Ville de Paris* left Havana on the 9th June, 1889, and on the 16th June a case of yellow fever occurred. This case must also have been infected ashore. No other cases occurred on this vessel before its arrival at St. Nazaire on the 26th June.

The contrast here is very noticeable, in that the steamers making a rapid voyage and coming quickly into latitudes in which the *Stegomyia fasciata* would probably have been killed by the comparatively lower temperatures, prevented the occurrence of further cases, so that only those persons who were infected before embarkation on the ship developed yellow fever.

Another aspect of the question is illustrated by two vessels, *La Navarre* and *Ville de Paris*.

The *La Navarre* left Vera Cruz on the 12th October, 1889, and on the 20th and 21st, three cases of yellow fever developed, and another on the 26th. The vessel arrived at St. Nazaire on the 29th.

The *Ville de Paris* left Fort de France on the 20th May, 1881, and on the 1st, 2nd, and 3rd June, five cases of yellow fever occurred.

It is clear that no one of the cases on either of these vessels was infected ashore, but the interesting point is that of the nine cases, eight were members of the engine-room staff, illustrating the fact that, though the mosquitoes would be killed by lower temperatures in other parts of the ship, they would survive in the warmer regions of the engine-room.

The *La France*.—In 1908, the steamer *La France* left Martinique on 11th September, and arrived at St. Nazaire on 24th September—thirteen days after leaving Martinique. No case of yellow fever occurred on board, but as soon as the discharge of cargo commenced, an outbreak of yellow fever occurred. Eleven persons were attacked, of whom seven died. Nine of the eleven were members of the crew; one, a resident of St. Nazaire, who worked on the ship in port; and one a sailor in a ship moored close by. In this case it is clear that the vessel carried infected mosquitoes all the way to France.

The *Anne Marie* sailed from Havana on 13th June, 1861. On 1st July, 1861, 18 days after her departure from Havana, two seamen fell ill, and died on the fifth day of their illness 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 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. Shor ly 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. 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.

What deductions can be drawn from the above incidents concerning the danger to Australia. It has been shown in the case of the s.s. *Yorktown* that affected mosquitoes can gain access to a ship anchored a considerable distance off the shore. That mosquitoes can remain alive on board ship for considerable periods has been abundantly shown. Sir Rubert Boyce says (48) :—

> A consideration of the mode in which yellow fever is carried, shows that it is *par excellence* a disease especially suitable for transport by ships, especially by the sailing ships common in the fifteenth and sixteenth centuries.
>
> The history of yellow fever shows that it was as a matter of fact, one of the most frequent of the diseases common to ships in those centuries ; so common that "ship's fever" or "yellow jack" were the familiar names for yellow fever.
>
> Moreover, because yellow fever was of such frequent occurrence on ships when far out at sea, a few medical men to-day reason that the disease cannot be mosquito-carried, but must be due to some miasm arising from waterlogged ballast or special cargoes, or from the bilge. As a matter of fact, we know that the *Stegomyia calopus* is very frequently found on ships, and that it can be transported alive with great ease over long distances. Given a ship which has to remain against a wharf, or alongside of which lighters come off from the shore to discharge and load, it has been proved that the *Stegomyia*, in common with other mosquitoes, readily enters the ship. It is for this very reason that ships trading with mosquito-breeding ports are now being screened, and that the officers usually sleep under mosquito nets.
>
> Careful and systematic search has been made of the holds, engine-room, galley, sleeping and living quarters of the crew and officers of ships arriving from mosquito coasts, and the *Stegomyia* has been repeatedly found. Eighty-two vessels coming from ports infected with *Stegomyia* were subjected to careful examination, and in spite of the fact that the voyage had lasted from thirteen to twenty days, the *Stegomyia* was found

by Dr. Grubbs in three cases ; Dr. King, of St. Lucia, also found living *Stegomyia* in ships coming from Barbados in 1909 ; Dr. Durham on ships trading on the Amazon. I met with a similar instance in the case of a steamer which sailed from Belize in 1906.

Therefore, it is beyond dispute that living *Stegomyia* may be carried great distances oversea by means of ships. In the old days of sailing ships there was, however, another factor which made it a matter of certainty that ships trading in the tropics not only could transport *Stegomyia*, but also *breed* them during the voyage.

That infected mosquitoes can infect man 57 days after becoming themselves infected was experimentally shown by the United States Army Commission on Yellow Fever in 1901 (49). The same authority states that the incubation period varied from two days to six days, and it is stated that there is some reason for believing that this period may, exceptionally perhaps, be prolonged to eight or ten days (51).

The limits of variation of this period in the experimental cases produced by blood injection were from one day fifteen hours to twelve days eighteen hours (l.c., page 18). Agramonte, on the other hand, doubts the reliability of observations which fix the period of incubation at more than six days, and states that it never exceeds this period (50). In the same article, Agramonte records a case in which a *Stegomyia* was known to have lived for 154 days. Although many French writers adopt the possible maximum incubation period in man as thirteen days (Chantemesse, 51), on the results obtained by the French Yellow Fever Expedition to Brazil, yet Marchoux—a member of this Expedition—fixes the period for practical purposes as six days (52). It appears justifiable then to take as a reasonable basis that an infected mosquito may infect another human after 57 days, that this second human may not become a source of infection for another six days, and that he will remain as a source of infection for three days longer, *i.e.*, a total of 66 days from an infected port is a possible range for the transmission of infection. If, however, a member of the ship's company be bitten on shore in an infected port by an infected mosquito shortly before embarking, and a non-infected mosquito be on board and be carried alive throughout the journey, the infected human may not become infective for six days, and may not infect the mosquito on board for another three days, making the effective range of infection a 78 days' journey.

CAN SUCH A JOURNEY MENACE AUSTRALIA ?

During the two years ending 30th September, 1914, there arrived at Sydney or Newcastle the following vessels :—

From	Chile	74
,,	Ecuador	4
,,	Mexico	16
,,	Peru	4
,,	Brazil	48

The average duration of the voyage was as follows :—

From	Chile ..	47 days ..	39 vessels under 40 days ; 8 vessels 30 days or under.
,,	Ecuador ..	53 ,,	
,,	Mexico ..	68 ,,	
,,	Peru ..	56 ,,	

The 48 vessels from Brazil all came direct either *viâ* Cape of Good Hope or Cape Horn, and the shortest journey was 30 days. This was a single vessel; no other being less than 50 days.

Many of the vessels which arrived were sailing ships which, as experience has shown, offer special facilities for the conveyance of *Stegomyia* mosquitoes, and it is obvious that if vessels can reach Sydney from Chile in 30 days or less, they can reach Sydney from Ecuador, Mexico, and Peru, also in less than the 78 days of potential danger.

Actually Carter has reported six instances in which yellow fever appeared respectively on the 64th, 68th, 12th, 11th, and 38th days after the ship had left the infected area (53).

The distance from Panama to Sydney, which is the greatest distance to be covered between Sydney and an endemic focus of yellow fever, is 7,692 miles, and a steamer averaging 10 knots an hour will cover the distance in 28 days.

It must clearly be concluded that the eastern coast of Australia is well within direct striking distance of yellow fever from all endemic areas of yellow fever on the Pacific coast of America, as, potentially, an infected mosquito could be ashore for six weeks and infect any person bitten within that time.

The position then is clearly defined so far as ports west of the Panama Canal are concerned. What is the position with regard to ports east of the Canal, and from which Australia will be approached *viâ* the Canal?

The Quarantine Regulations brought into operation on 8th January, 1915, for the sanitary control of vessels passing through the Canal, are very complete. Such of the regulations as concern the subject now under discussion are quoted on page 34.

It will be seen that any vessel arriving at a Canal port already infected with yellow fever will be dealt with thoroughly, or in such a way as to render the vessel reasonably safe for ports to which the vessel may subsequently travel. There wil in such cases remain still an element of risk, and this risk while not large is yet great enough to demand attention.

Vessels on which no case of disease has shown itself, but which have come from a port infected with yellow fever, have either to show that they have carried out the necessary precautionary measures at that port, or else to be dealt with as follows:—After careful medical inspection all persons are to be quarantined until the expiry of six days from the last exposure to infection, and the vessel thoroughly fumigated for the destruction of mosquitoes.

Vessels, after the above treatment, then pass through the Canal in quarantine, and the regulations prescribing the conduct of vessels so passing through the Canal in quarantine are quoted in detail.

Finally, in the case of vessels which have had actually cases of yellow fever on board, a statement of the facts or of the treatment to which the vessel has been subjected, is to be written out and sent, under sealed cover, addressed to the Health Officer of the port of destination.

Provided the prescribed measures are efficiently carried out, and the record of the United States Public Health Service is sufficient to engender

confidence that such will be the case, then, it would appear that a great deal will be done to remove the risk to other countries from vessels travelling from yellow fever infected countries to Australia *viâ* the Canal.

Some risk will, however, remain, and both the western and eastern coasts of Central and South America must, so long as they remain infected with yellow fever, be regarded as potentially dangerous to Australia. The actual extent to which this danger has been affected by the opening of the Panama Canal cannot be assessed until considerable experience has been gained; but while the risk persists it is evident that precautions must still be maintained in Australia.

There is, however, another danger. Many of the steamers from America to Australia will call at Tahiti, Samoa, or Fiji, and most of the steamers from the Canal to Asia will call at Honolulu. The danger of infecting Honolulu has already been evidenced by the case of the *Hong-Kong Maru*, and while the alertness of the Public Health Service at Honolulu prevented any spread of infection, it is not improbable that the disease may gain a footing there. Even if it does, however, the United States Public Health Service may, with reasonable safety, be relied upon to prevent its spread to other countries; but it is more than doubtful whether the same confidence can be felt in respect of Samoa, Tahiti, or Fiji.

The prospect of the invasion of Asia by yellow fever, and the consequent danger to Australia, is sufficiently self-evident, and arrests attention so immediately as to require no special emphasis.

The distances in respect of the places referred to is as follows:—

Suva to Brisbane	1,521 miles.
Suva to Sydney	1,743 ,,
Tahiti to Sydney	3,250 ,,
Samoa to Brisbane	2,135 ,,
Samoa to Sydney	2,357 ,,
Tahiti to Salina Crus (Mexico)	3,824 ,,
Honolulu to Suva	2,736 ,,
Samoa to Honolulu	2,251 ,,
Panama to Honolulu	4,692 ,,
Panama to Suva	6,290 ,,
Panama to Wellington	6,500 ,,
Panama to Sydney, *viâ* Suva	8,000 ,,
Panama to Sydney, *viâ* Wellington	7,700 ,,

These figures are enough to show that either Honolulu, Samoa, Fiji, or Tahiti, might be infected, and might in turn infect Australia or any part of Eastern Asia.

The experience of Tocopilla (Chile), as above related, makes it quite clear that a single case landed on shore from a vessel is sufficient to start a wide-spread epidemic on shore. In this instance, 570 cases, with 179 deaths, were reported.

An interesting illustration of the spread of yellow fever on board a vessel is the case of the barque *Alcyon*. This vessel arrived at Fremantle on the

24th May, 1915, from Capetown, and reported that cases of sickness had occurred on board, which had been diagnosed by the Quarantine Officer at Capetown as being cases of yellow fever.

The history of the vessel was as follows :—

She sailed from Fredrikstad, Norway, on the 21st February, 1914, with a crew of nineteen men all told, and the following is a statement of her subsequent movements :—

Arrived Pernambuco, 6th May, 1914 ; left 9th July, 1914.
Arrived Barbados, 28th July, 1914 ; left 30th July, 1914.
Arrived Boco Grande, 24th August, 1914 ; left 9th October, 1914.
Arrived Bahia, 23rd December, 1914 ; left 21st January, 1915.
Arrived Capetown, 14th March, 1915 ; left 30th March, 1915.
Arrived Fremantle, 24th May, 1915.

On the 31st January, that is, ten days after leaving Bahia, four of the crew fell ill, and others of the crew became ill in the following succession :—

2nd	February	1 case.
4th	,,	2 cases.
6th	,,	1 case.
11th	,,	3 cases.
12th	,,	4 cases.
14th	,,	1 case.
15th	,,	1 case.

A total of seventeen cases, of which three died.

The symptoms, as described by the master, were as follows :—Patient wakes up with headache, followed by pains in stomach, diarrhoea, giddiness, weakness in legs, inability to take food, feeling generally bad, tongue whitish, temperature remains normal till near end. Few hours before death foaming at mouth. Mouth opened with difficulty to give medicine day or two before death. Abdomen and thighs of yellow colour. After death, eyes yellow. Large purple patches on neck, shoulders, and upper portion of body.

Dr. Thomas, Port Health Officer, Capetown, decided that the cases were yellow fever, and suitable measures were taken at that port, the vessel being thoroughly fumigated with Clayton gas. No further cases occurred between Capetown and Fremantle, and a thorough examination of the vessel at the latter port failed to reveal any indication of either adult mosquitoes or breeding places of mosquitoes.

From the date of the occurrence of the cases, it would appear that infected mosquitoes were carried on board for some considerable distance, and such event offers an illustration of what may happen at any time on a vessel coming from America direct to the Australian coast.

That outbreaks of mosquito-borne disease are not only possible in Australia, but actually have occurred with disastrous results, is evidenced by the fact that there was a severe epidemic of what was known as " Bilious Remittent Fever " in Burketown, Northern Queensland, in 1864. This disease was considered by the residents to be yellow fever, and was brought from Java by a sailing ship. The total number of residents was 76, and of these 50

died from this fever. The disease was, probably, malaria; but, whatever its exact nature, it was evidently a mosquito-borne disease, and resulted in a very serious mortality amongst a small community (54).

That the conditions in the tropical portions of Australia are still favorable for the spread of mosquito-borne disease may be concluded from the evidence submitted by Dr. Breinl in his Report upon Diseases of the Northern Territory, which reads as follows (55) :—

> One of the diseases most prevalent in the Northern Territory, appearing in more or less severe epidemics, in certain years, causing severe debility and heavy mortality, is malaria. The number of cases treated in the hospital since 1908—the diagnosis of which are based on the finding of the parasites in the blood, and, in addition, the death statistics during these years—prove this statement. A glance at the figures for malaria in the hospital statistics shows the rise of an epidemic, commencing in 1905 with one case, reaching a maximum in 1909 of 44 cases—34·10 per cent. of the total number of cases treated, this being in recent years the most severe epidemic in the Northern Territory. Again, in 1910, an outbreak of malignant malaria occurred in Kidston, North Queensland, where, out of a population of about 400, there occurred 120 cases, with 24 deaths.

These epidemics occurred in sparsely populated communities. The effect of the introduction of yellow fever into a community such as Brisbane, would be appalling. Dr. Nuttall gives instances which are very striking (56) :—

> 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 36,000 people died in Havana in less than 50 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.

If any further evidence of the fact that yellow fever may be transplanted from its endemic foci to countries previously uninfected were required, it could be supplied by the occurrence of epidemics in Europe, as follows :—

1857	..	Oporto	.. 18,000 cases, with 5,632 deaths.
1819	..	Cadiz	.. 4,800 cases.
1821	..	Barcelona	.. 21,483 cases. The following quotation is taken from Augustin's *History of Yellow Fever* (page 517) :—" The epidemic of 1821 was appalling, and has gone into history as one of the most murderous on record. The population of Barcelona in 1821 was 150,000. When the true nature of the 'mysterious disorder' which was causing wide-spread anxiety to the inhabitants of the ancient city became known, 80,000 fled precipitately to all points of the compass. Of the 70,000 who remained, nearly every one was attacked, and between 16,000 and 20,000 died, according to the estimates of various authorities."
			Barcelona reported 2,510 cases as late as 1870.

The evidence submitted makes it clear, therefore, that the transmission of an infected *Stegomyia* mosquito from a yellow fever country to Australia, is not only a possibility, but constitutes a distinct danger. This conclusion

is in no way affected by the resolution of the International Sanitary Convention of 1912, which states that "there is not recorded any undoubted instance of the transport of yellow fever over a great distance by a vessel on board of which there has not occurred during the voyage any 'sanitary incident' justifying the suspicion of the existence of yellow fever."

It may be true that yellow fever has not been carried over a long distance without betraying its presence by the infection of some member of the crew, but while this may be a factor of safety, yet it would not justify any relaxation of precautions, if only for the reason that records of the occurrence during the voyage, supplied by the ships officials are rarely, if ever, reliable.

Moreover, the possibility of infected mosquitoes being carried with cargo, and only released when the hatches are taken off, is one which must be borne in mind.

One other item of information requires to be known, namely, whether the special mosquito concerned (the *Stegomyia fasciata*), is present in the regions under consideration.

The report of Mr. F. H. Taylor upon his survey of Northern Queensland, which is printed as portion of this publication, makes it clear that the *Stegomyia* is very abundant in Normanton, Thursday Island, Cooktown, Cairns, Innisfail, is fairly prevalent in Townsville, and is not common in Burketown and Halifax. Mr. Taylor sums up with the statement that "the occurrence of *Stegomyia fasciata* has been demonstrated in all the towns visited."

Similarly, the second portion of the investigation, which covered that section of the coast line between Townsville and Brisbane, showed that *Stegomyia* was breeding abundantly in Bowen, Mackay, Rockhampton, Gladstone, Bundaberg, Maryborough, Gympie, and Brisbane.

It has been demonstrated, therefore, that the Queensland coast is, with regard to yellow fever, in a highly receptive condition.

Dr. Elkington, Chief Quarantine Officer in Queensland, describes the conditions in Brisbane as follow (57) :—

> During 1911 and 1912, I had 1,832 house tanks examined about Brisbane, and 679 of them were found to be breeding the *Stegomyia* mosquito.

Again, he says (58) :—

> Investigations were also made by the Northern staff concerning mosquito infestation in Townsville. Over 90 per cent. of water tanks were thus found to be unprotected, or insufficiently protected . . . . of 773 premises inspected the larvæ of *Stegomyia fasciata* were found in 98, and in 107 of these premises adults of *Stegomyia fasciata* were found. The adaptability of *Stegomyia fasciata* in finding new breeding places is illustrated by the discovery of larvæ in fire-sprinkler tanks 120 feet above street level in Brisbane. Two years ago I found the same species breeding in the sump-pit of a mine at Charters Towers, over 2,000 feet below the surface, and biting vigorously in the electrically-lit plat.

Mr. Taylor has also been good enough to supply a statement of the recorded prevalence of *Stegomyia* in Australia, and his statement is also given as an appendix to his principal report in this volume.

There can, therefore, be no possible doubt that *Stegomyia* mosquitoes are sufficiently prevalent in the principal coastal towns of Queensland to permit of the rapid spread of yellow fever if it were introduced, and that they are also present in Grafton and Newcastle in New South Wales.

The next point of interest in the distribution of *Stegomyia* in the surrounding countries from which yellow fever might be "relay"-ed into Australia.

These may be briefly indicated as follows :—

Japan	According to James (59), no special investigation has been made to determine the presence or absence of *Stegomyia* mosquito.
Shanghai	Presence of *Stegomyia* doubtful (60).
Hong Kong	In mosquito survey carried out between July and December, 1913, two distinct centres of *Stegomyia fasciata* have been found widely separated from each other in the city of Victoria (61). "The search for *Stegomyia fasicata* has given considerable trouble, but the most recent results show that it not only exists, but is also much more prevalent than might be thought" (75).
Tong King	*Stegomyia fasciata* numerous (73).
Burma	The *Stegomyia fasciata* is very common in Burma (62).
Singapore	*Stegomyia fasciata* and *scutellaris* are exceedingly abundant (63).
Ceylon	*Stegomyia fasciata* prevalent in Ceylon, especially so in Galle (64).
Java	Doctor Van Loghen found that *Stegomyia* is of frequent occurrence in places along the coast of Dutch East India, and also at a considerable height (700 metres) above sea level (65).
Manila	The *Stegomyia fasciata* is to be found abundantly throughout the Philippine Islands; and one may always obtain readily, in a few minutes, a number from any of the dwelling-houses in Manila (66). "The *Stegomyia fasciata* has been greatly reduced in numbers during the past few years, but when these efforts are slightly relaxed they soon reappear in large numbers" (74).
Samoa	*Stegomyia fasciata* is found in Samoa (67).
Fiji	Bahr states that "seven species of mosquito were collected in Fiji, and the four species most commonly encountered were *Stegomyia pseudo-scutellaris*, *Stegomyia fasciata*, *Culex fatigans*, and *Culex jepsoni*" (68).
Gilbert and Ellice Islands	The *Stegomyia* mosquito is common throughout the islands (69).

New Guinea.. ..	Dr. Bagelaar states that Fak Fak is swarming with *Stegomyia* (69).
	New Guinea generally, Theobald (*vide* page 91).
	Samarai, Port Moresby (Breinl), Lakekamu (Giblin).
Tahiti	Information not available.
New Caledonia ..	Information not available.
Federated Malay States Sumatra .. .. British North Borneo .. Kelantan .. .. Straits Settlements .. Indo-China	In all of these countries near the sea coast both *Stegomyia fasciata*, the known carrier of yellow fever, and *S. scutellaris* are found in abundance, but, inland, only the latter species as a rule. In Kuala Lumpur, an inland town, *S. fasciata* is, comparatively speaking, a rare mosquito (71).

It is clear, therefore, that the principal ports in close proximity to Australia, and from which Australia receives a great volume of shipping, are potential foci of yellow fever, requiring only the introduction of the disease. Concerning the care exercised by the sanitary authorities at these ports, there is not sufficient information in some cases. Manila, Singapore, and the principal Japanese ports may be considered as being under careful control. James' testimony may be accepted as sufficient evidence that the control at Hong Kong is unsatisfactory; and, of the other places, there is not sufficient information to justify any judgment.

CONCLUSION.

How, then, may the position of Australia be summed up?

The greatest danger at present is from the endemic foci on the Pacific coast of America. The opening of the Panama Canal will bring other foci within range of Australia, but the greater distance of these foci from Australia, and the care that will be exercised by the United States authorities over vessels passing through the Canal zone combined also with the local control exercised by the authorities in those countries from which trade to Australia will be most probable, will, to a certain extent, reduce the risk.

The possibility that yellow fever may be carried to Australia direct from these endemic foci must be recognised, and this danger is sufficiently real to justify all precautionary measures against vessels arriving in Australia from these places. A greater danger, however, exists by reason of the prospect of one of the ports adjacent to Australia becoming infected and acting as a relay station for Australia.

The prevalence in large numbers of *Stegomyia* in the northern ports of the eastern coast of Australia permit of the rapid spread of the disease if introduced, and one of the serious aspects of the question is that epidemics of yellow fever frequently commence with a series of mild cases, the nature of which may be overlooked.

The fact that the trade with Queensland and America has already increased, and shows signs of still further increase, combined with the ascertained fact of the great prevalence of *Stegomyia* in that State, point to the obvious necessity of doing all that can be done to anticipate or prevent any possible outbreak. It is obvious that if the *Stegomyia* population in any port were to be reduced to a vanishing point, as has been done in the Panama Canal zone, nothing need be feared even if cases were actually introduced, but *per contra*, so long as the mosquito population is allowed to remain unchecked, any undetected introduction of the disease is a potential starting point for a serious epidemic.

The loss of life, and the dislocation of commerce and shipping that would result from the occurrence of an epidemic of yellow fever might easily become a very serious matter, and notwithstanding the utmost care given by the Quarantine Service, an infected mosquito might escape and be sufficient to commence such an epidemic.

In view of all these facts the proposal put forward by James that there should be an Intelligence Officer, trained in sanitary administration, stationed at Panama, to act as an outpost for Australia and Asia, is worthy of the warmest support. The work of this officer is outlined by James as follows (72) :—

"In practice he would be attached for duty to the British Consulate at Panama, and his work would chiefly be that of an intelligence officer in the endemic area. By acting in co-operation with the consular and sanitary officers of the United States, by visiting suspicious places and by making a special study of the local and trans-Pacific shipping, he would quickly become aware of any new circumstances which threatened the safety of the East. He would, of course, keep a continuous record of the shipping from the endemic area to the East, and would ascertain the risk of infection to those ships. He might, as a rule, report his transactions monthly, but he would also be empowered to cable at any time to the quarantine officers in Eastern ports such information as would enable them to take adequate precautions against any threatened danger."

In addition to this officer, it would become advisable that the New Zealand and Commonwealth authorities should combine and station an officer in Samoa or Tahiti, should it appear as time goes on that vessels coming to Australia or New Zealand, from America, are making these places regular ports of call.

The most important aspect of the yellow fever question, so far as Australia is concerned, is that all steps should be taken to reduce the local mosquito population. Australia is, at the present time, in precisely the condition ironically described by Agramonte in referring to the American States. He says that—

"These depend almost exclusively upon quarantine measures to prevent the introduction of yellow fever. The bugbear of the Southern States of America is yellow fever, and their protective mainstay is quarantine, the least useful measure which may be implanted in any country for its defence against this infection.

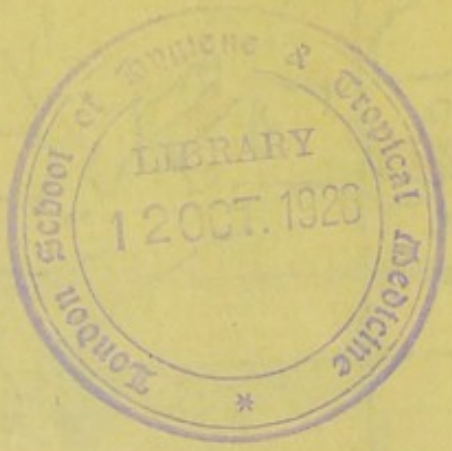
This is a very undesirable condition of affairs, and no sort of security will be possible until the greatest possible reduction of *Stegomyia* mosquitoes in the coastal districts, and provision of effective means for limiting introduced infection, render the spread of yellow fever impossible.

It does not require a particularly lively imagination to visualize the effect of the introduction of yellow fever into a city like Brisbane, where the

The Countries coloured with uniformly red colour are those in which Yellow Fever is endemic.

The Countries with red hatching are those in which Yellow Fever has occurred epidemically.

The places marked green are those places adjacent to Australia in which the presence of Stegomyia Fascista has been determined.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Stegomyia mosquitoes are numerous. The disease is generally difficult to diagnose with certainty, particularly in its earliest stage, and this is the stage when it is infectious.

The mosquito which is responsible for its spread is one of the most elusive and persistent of all domestic mosquitoes, and its control *especially under conditions of emergency and panic* correspondingly difficult.

The persons attacked would suffer an exceeding rapid, harrowing, and repulsive illness, and the mortality would probably be from 30 to 40 per cent. of those attacked. (In some epidemics the mortality has been nearly 90 per cent.)

The suffering and loss of life would be appalling. Add to this the general panic, the difficulty of creating an organization without preparation, and the extreme measures of restriction that would need to be imposed to prevent infected mosquitoes leaving Brisbane for Sydney, Townsville, or other places, and no effort is required to complete the details of the picture.

Two appendices are attached, viz., the Resolutions of the International Sanitary Convention of 1912, and the Regulations in force for the quarantine control of vessels arriving at and passing through the Panama Canal.

APPENDICES.

APPENDIX A.

RESOLUTIONS OF THE INTERNATIONAL SANITARY CONVENTION OF PARIS (1912) ON THE SUBJECT OF YELLOW FEVER.

TRANSLATION.

(*Procés Verbaux, page* 729.)

Yellow fever is spread by the transmission of the virus of yellow fever from the sick man to the healthy man, by the intermediary of the *Stegomyia calopus*.

In countries where *Stegomyia calopus* is not found, yellow fever never develops into an epidemic.

In countries where *Stegomyia* is found, yellow fever may be introduced by—

(*a*) persons attacked with, or passing through the period of incubation of, the disease;

(*b*) by infected *Stegomyia*.

The period of incubation for yellow fever does not exceed six days. The sick person can be considered as infective only during the first four days of his illness.

During the first four days of his illness the patient should be protected from mosquitoes.

Stegomyia infected ports provided with a rational sanitary organization against yellow fever have nothing to fear from the introduction of persons who are attacked with or in the incubation stage of yellow fever. The principles of such an organization are to-day well established, and instances of their satisfactory application are numerous.

There are no recorded observations which justify a definite statement that merchandise comprising foodstuffs, plays a part in the transport of *Stegomyia fasciata* to a distance.

Ships which frequent ports infected with yellow fever can receive and carry infected *Stegomyia*.

There is not recorded any undoubted instance of the transport of yellow fever over a great distance, by a vessel on board of which there has not occurred during the voyage any "sanitary incident" justifying the suspicion of the existence of yellow fever.

Vessels that visit countries where yellow fever exists should be equipped in such manner as to prevent possible the existence of *Stegomyia fasciata*. In a general way, all measures intended to free vessels from *Stegomyia* should be considered also, as diminishing the chances of diffusion of yellow fever.

Stegomyia on board vessels can, in practice, be destroyed by sulphuration.

APPENDIX B.

REGULATIONS IN FORCE FOR THE QUARANTINE CONTROL OF VESSELS ARRIVING AT AND PASSING THROUGH THE PANAMA CANAL.

Section 5.—Inspection is required of—

(*a*) All vessels from ports in which cholera, yellow fever, or plague in men or rodents prevails, or at which small-pox or typhus fever prevails in epidemic form and at which a medical officer is detailed.

Reg. 9.—At ports where yellow fever prevails, precautions should be taken to prevent the introduction of mosquitoes (*Stegomyia*) on board the vessel. Water tanks, water buckets, and other collections of water about the vessel should be guarded in such a manner as they shall not become breeding places for mosquitoes. The vessel should lie at an anchorage where it will be impossible for *Stegomyia* to gain access to it from the shore. If the vessel lies at an anchorage which, in the opinion of the inspecting officer, renders it liable to the access of mosquitoes, fumigation should be carried out to destroy the mosquitoes that may have come on board, so that the quarantine or the *personnel* of the vessel could be counted from this date or that of sailing.

For the purpose of these regulations, six days shall be considered as the period of incubation of yellow fever.

A vessel aboard which a case of yellow fever has occurred at any time during the voyage shall be treated as follows :—

(*a*) Careful visual and thermometer inspection of all persons.

(*b*) The sick are to be immediately disembarked, protected by netting against the access of *Stegomyia* mosquitoes, and transferred to a place of isolation.

(*c*) If the history of the case of sickness shows, in the opinion of the quarantine officer, that the infection was acquired on board from an infected ship, the *personnel* on such ship should be disembarked if possible, and subjected to an observation of six days, dating from the day of last possible exposure.

(*d*) If the history of the case of sickness shows, in the opinion of the quarantine officer, that the infection was contracted on shore before embarkation, and a period of ten days has not elapsed since the development of the case of yellow fever, the *personnel* of such vessel need not be detained after the completion of the fumigation of the vessel.

(*e*) Persons under observation presenting an elevation of temperature above 37·6 C. shall be isolated in a screened compartment.

(*f*) The ship shall be moored at least 200 metres from the inhabited shore.

(*g*) The ship shall be fumigated for the destruction of mosquitoes before the discharge of cargo, if possible.

A vessel which has lain in such proximity to the shore of a port infected or suspected as to render it liable to the access of *Stegomyia* mosquitoes, is to be subjected to the measures which are indicated in (*a*), (*c*), and (*g*) of the preceding section.

All persons who can prove their immunity to yellow fever to the satisfaction of the quarantine authorities, or who have not been exposed to possible infection of yellow fever, may be permitted to land at once.

For the destruction of mosquitoes there shall be a complete and simultaneous fumigation of all parts of the vessel by sulphur dioxide gas, 2 per cent. volume gas, two hours' exposure. Where sulphur is liable to injure articles, pyrethrum powder, camphophenol, or other approved culicides, may be used instead.

Vessels arriving under the following conditions shall be placed in quarantine :—

(*a*) With a quarantinable disease on board, or having had such a disease on board during the voyage.

(*b*) Any vessel which the quarantine officer considers infected with quarantinable disease.

(*c*) Vessels arriving from infected ports in which the regulations prescribed to be observed in foreign ports have not been carried out.

(*d*) In the case of vessels arriving from infected ports without sickness on board, the *personnel* shall be detained under observation at quarantine to complete the period of incubation of the disease against which quarantine is directed.

Vessels entering the port for the purpose of passing through the Canal without discharge of cargo or disembarking passengers at the ports of Balboa or Cristobal, or the ports of Panama or Colon in the Republic of Panama, will be given pratique to proceed without detention, provided the special regulations prescribed for observation in foreign ports have been carried out, and no disease of a quarantinable nature has occurred during the voyage.

Such vessels from ports infected with quarantinable disease arriving within the period of incubation of such disease or diseases shall be passed through the Canal "in quarantine."

Vessels entering the port for the purpose of passing through the Canal without discharge of cargo or disembarking passengers at the ports of Balboa or Cristobal, or the ports of Panama or Colon in the Republic of Panama, arriving from ports affected with quarantinable disease, and in which the special regulations prescribed for observation in foreign ports have not been carried out, may be passed through the Canal "in quarantine" after necessary measures of disinfection, &c., have been taken. Such vessels, however, as have not completed the quarantine period since leaving the last infected port, in addition to disinfection, may be detained in quarantine a sufficient length of time to cover the period of incubation of the disease in question before being allowed passage through the Canal.

Vessels entering the port for passage through the Canal that have on board cases of quarantinable disease, or that have had such during the voyage, may be allowed to proceed to the port of destination after the measures provided by the quarantine regulations have been carried out. In such case the vessel should proceed through the Canal "in quarantine."

In case the vessel coming under the previous section, a statement of the nature of the disease removed at quarantine, and the measures of disinfection carried out, shall be communicated to the health officer of the next port to which the vessel is going ; a sealed letter attached to the bill of health, and forming a part of the ship's papers, should be addressed to the health officer of the port of destination, and the pratique granted the vessel shall have a notation of the facts entered thereon.

SPECIAL REGULATIONS FOR PASSAGE THROUGH THE PANAMA CANAL "IN QUARANTINE."

Permission for passage through the Canal "in quarantine" shall only be granted with the approval of the Chief Health Officer.

A quarantine officer and one or more sanitary guards, or one or more sanitary guards when in the judgment of the Chief Quarantine Officer such will be sufficient, shall board the vessel for passage "in quarantine" and accompany her through the Canal. Their duty shall be to prevent unauthorized communication and see to the proper execution of the prescribed sanitary and quarantine regulations, during the passage through the Canal.

All embarkations, landings, and transhipments of passengers or cargo are forbidden during the passage through the Canal between the terminal ports.

Vessels passing through "in quarantine" shall make the trip from port to port without putting into dock. In case of being compelled to put into dock the necessary operations shall be performed by the *personnel* on board, all communication with the employees of the Panama Canal being avoided.

When ships are conveyed through the Canal "in quarantine," the trip shall be made in the daytime only, when practicable.

If it is necessary to stop in the Canal the vessel should anchor in Gatun Lake, not less than 200 metres from the shore. If it is absolutely necessary to tie up at a wharf or at the lock walls, special precautions, as prescribed by the Chief Quarantine Officer, shall be taken to prevent the passage of persons or things to or from the vessel.

Vessels passing through "in quarantine" are forbidden to approach the wharves or piers in the terminal ports.

When it is absolutely necessary for vessels passing through "in quarantine" to take on coal in the terminal ports, the coaling shall be done under the supervision of the quarantine authorities. If the coaling is done at night, the place where the coaling is done should be brilliantly illuminated by electric lights.

The pilots, quarantine officers, sanitary guards, or other agents of the Panama Canal will be subject to provisions under the heading "General Requirements at Quarantine."

War vessels passing through "in quarantine" may not be required to take on board quarantine officer and sanitary guards provided certificate is issued by the senior medical officer on board and countersigned by the commanding officer, that the quarantine regulations have been and will be complied with.

Nevertheless, the quarantine authorities shall have the right to place their agents on board whenever they deem it necessary.

COUNTRIES IN WHICH YELLOW FEVER HAS BEEN REPORTED DURING 1909–13.

	1909.	1910.	1911.	1912.	1913.	1914.
Barbados—						
General	78	..	2	..	..	..
Bridgetown	11	..	..	1	..	..
Speightstown	1	..	..	..	..	..
Brazil—						
Bahia	266	19	14	1	69	60
Ceara	..	..	2	6	1	..
Manaos	36	324	166	77	33	..
Para	177	263	195	2	..	..
Pernambuco	18	1	2	41	44	3
Rio de Janeiro	1	..	1	4	4	2
British East Africa—						
Kisumu	..	..	..	..	2	..
Mombasa	..	..	..	..	25	..
Nairobi	..	..	..	..	1	..
British Gold Coast—						
Axim	..	..	..	..	..	..
Saw Mills	..	..	..	..	..	..
Sekondi	..	8	..	..	..	..
Canal Zone—						
Ancon	..	1	..	..	..	..
Culebra Island	1	1	..	2	..	..
Panama	..	..	..	1	..	..
Chile—						
Sabanilla	..	..	1	..	..	..
Tocopilla	..	..	..	1,072	..	..
Colombia—						
Cartagena	1	..	..	..	1	..
Costa Rica—						
Limon	..	1	..	..	..	..
Cuba—						
Habana	1	..	..	..	1	..
San Luis	2	..	..	..	..	..
Curacoa	1	..	..	..	..	1
Dutch Guiana—						
Paramaribo	32	..	..	..	..	..
French Guiana—						
St. Jean de Maroni	..	..	..	..	..	19

COUNTRIES IN WHICH YELLOW FEVER HAS BEEN REPORTED DURING 1909–13—*continued.*

	1909.	1910.	1911.	1912.	1913.	1914.
Ecuador—						
Guayaquil	235	282	254	246	215	33
San Antonio hacienda	..	..	1	..	..	..
Esmeraldas	..	..	..	..	..	2
Milagro	..	..	..	..	..	6
Navangito	..	..	..	..	..	3
Gambia—						
Bathurst	..	5	..	..	..	..
Great Britain—						
Liverpool	..	1	..	1	..	..
Gold Coast—						
Accra	..	..	..	..	..	1
Ayinam	..	..	..	..	..	4
Bole	..	..	..	..	..	1
Quittah	..	..	..	..	..	3
Salt Pond	..	..	..	..	..	4
Hawaii—						
Honolulu	..	1	2	..	..	..
Honduras—						
Puerto Cortez	..	..	..	..	..	..
Ivory Coast—						
Grand Bassam	..	..	3	..	..	..
Martinique—						
Fort de France	5	..	..	..	..	..
Mexico—						
Campeche	..	10	..	..	27	..
Carmen	..	..	..	2	..	..
Frontera	..	..	1	10	..	..
Merida	34	1	45	67	2	5
Puerto Mexico	..	..	..	2	2	..
Salina Cruz	..	..	1	7	..	..
San Juan Bautista	..	..	..	48	..	..
Tabasco	..	..	..	2	..	..
Vera Cruz	14	..	..	..	..	..
Yucatan	..	..	..	73	..	..
Progreso	..	..	..	..	..	1
Peru—						
Callao	..	1	..	..	..	..
Iquitos	..	..	..	43	..	..
Portugal—						
Lisbon	2	8	..	..	..	..
Sierra Leone—						
Freetown	..	8	..	..	..	..
Boia	..	..	..	..	..	1
Southern Nigeria—						
Forcados	..	..	..	..	1	..
Lagos	..	..	..	..	1	3
Wari	..	..	..	..	..	1
Onitsha	..	..	..	..	..	1
Trinidad—						
Brighton	..	..	..	..	3	1
Port of Spain	1	4	..	..	..	..
Labrea	..	..	..	..	..	1
Venezuela—						
Caracas	3	12	104	45	15	4
La Guaira	..	8	1	7	..	1
Macuto	..	..	..	3	..	..
Valencia	..	3	..	..	..	..
Maracaibo	..	..	..	..	..	1
West Indies—						
St. Vincent	..	..	..	1	..	..

NOTE.—The figures for 1914 are not to be taken as complete.

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THE DIAGNOSIS OF YELLOW FEVER,

BY

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THE DIAGNOSIS OF YELLOW FEVER.

Yellow fever has one feature in common with the greater number of specific fevers, namely, the difficulty of diagnosis of early cases. This diagnosis is sometimes even impossible, especially in milder cases which occur at the commencement of an outbreak. These mild cases may pass as indigestion or influenza, and it is only some time later, when the severe cases appear, that the correct diagnosis is made. In the severe cases jaundice and black vomiting are, as a rule, pronounced, and renal symptoms are well developed.

It is generally recognised that the clinical aspect of cases of yellow fever occurring in an endemic area show considerable variation, depending on the age of the patient, the length of residence in the infected area, and the interval which elapses between the onset of the disease and the time the disease is recognised as such and treatment begun.

Young children born and reared in an endemic area are, like most children living in the tropics, subject to repeated irregular febrile attacks, several of which are probably due to infections with yellow fever virus. Similarly, a newly arrived adult may have, in the course of a year or so, several mild attacks of a short indefinite fever, which pass off, and which may, as in children, be in reality mild attacks of yellow fever, which confer an active immunity. This assumption is strengthened by the observation that newcomers to an endemic area, who survive the first year, are not likely to contract a serious attack of yellow fever.

The clinical features of yellow fever are, in many respects, characteristic. The onset of the disease is nearly always sudden; the patient may go to bed at night feeling perfectly well, waking a few hours later feeling decidedly ill. He has frontal headache, pains in his lumbar region, slight rigors, and is inclined to vomit. These symptoms increase in severity during the first few hours, the temperature rises somewhat, and the thermometer may record 100 or 101 degrees in the mouth. Simultaneously, the pulse rate increases to 90 or 100; the pulse is hard and bounding, and the respiration is slightly accelerated. The eyes are bright and shiny, and a certain amount of photophobia may be noticeable. The skin is moist and congested, especially that of the head and the shoulders. The mucous membranes of the eye and mouth are congested, the tongue is coated in the centre and slightly congested around the edges. The urine is scanty and concentrated. During this stage the case resembles in most respects the onset of any acute fever.

During the first 24 hours, these symptoms become more marked, and the patient begins to look much worse. The congestion of the skin increases and especially the face and chest are of dark reddish appearance, resembling in colour the early stages of a sun-burn, and early observers, as Bérenger-Féraud (1891), attached great diagnostic importance to the erythema of the scrotum and the labia majora.

The congestion of the mucous membranes increases still further, the lids are swollen, the eyes half closed and bloodshot, the gums are sore and, even in the earliest cases, small capillary injection is noted about the teeth in the same position where the lead line appears in lead poisoning. The mucous membrane of the cheek is injected, and on the floor of the mouth, around the attachment of the tongue, minute red spots are seen. *This condition of the mouth is hardly ever seen in any other fever and is rarely absent in cases of yellow fever, and can, therefore, be regarded as pathognomonic.*

As the fever progresses, the headache becomes more severe, especially in the frontal and supraorbital region. The pains in the loins are excruciating, the epigastrium is tender, and even the slightest pressure can hardly be endured. There is an unquenchable thirst, which is not relieved by the intake of large quantities of fluid. The vomiting, which is hardly ever absent during the onset of the disease, usually ceases now, unless there has been some gastritis previously.

At this stage the patient complains of sleeplessness, but he is still in full possession of his senses and feels tired and weary. The temperature then rises gradually, the pulse, between 100 and 120, is still full and bounding, the respiration is slightly increased.

As a rule, about 36 hours after the onset of the fever, the temperature has reached its maximum, which may lie between 102 and 106, according to the severity of the case, and symptoms are well pronounced. The pains in the back and epigastrium and the headache are very severe, the thirst is still present, the skin has become dry, the vomiting has completely abated, and albumen is still absent from the urine.

The pulse rate begins to become lower by the end of the second day, simultaneously with a remission in temperature. At the same time the congestion of the skin becomes less marked, the mucous membranes resume a normal tinge, the headache and the pains in the loin are less severe; in short, the patient is much better, but albumen has begun to appear in the urine, gradually increasing in amount.

This fall of temperature may continue for the next 24 hours, and may be accompanied by heavy sweating. The pulse rate is still increased, but the pulse becomes irregular and loses its tone. Jaundice usually becomes well marked at this stage.

In a mild case, general improvement will set in from this point and progress steadily; the temperature may be normal on the fourth or fifth day, whereas the pulse is still somewhat irregular and soft on account of myocarditis.

In other cases, however, the fall of temperature is more gradual, the amount of albumen in the urine increases, bleeding from the nose and the gums may be noticeable, and even these symptoms may abate after a shorter or longer interval, when the patient enters the convalescent stage.

In severe cases, the fall of temperature persists for a comparatively short time only, for about 10 to 20 hours. The patient during this time seems much improved. He is quiet, sleeps, and, in many cases, will even ask for food. This improvement, however, is only temporary and deceptive. Soon the body temperature rises again to 105 or more, and now the so-called Faget's sign, which is so characteristic of yellow fever, is observed, namely, the pulse rate does not increase in correspondence

with the temperature, but may even decrease. Now the dreaded picture of yellow fever in its severest form begins to develop suddenly. The patient becomes restless and uneasy, the mucous membranes are livid, whilst the congestion of the skin is diminished. The tenderness in the epigastrium re-appears, the liver is exceedingly tender on pressure. The amount of urine is diminished, and the quantity of albumen increased. Vomiting sets in again, and the vomit is typical, as it contains dark specks resembling coffee grounds, consisting of clotted blood ; and, suddenly, without any premonitory sign, a large quantity of blackish fluid may be brought up. The skin, icteric at first, becomes of a dark yellowish hue, and large hæmorrhages from the bowels, gums, ears, or uterus may occur. Small petichiæ in the skin are quite common.

With the development of these symptoms the general condition becomes worse ; the tongue is furred and dry, the lips are cracked, and even the slightest pressure on the skin may lead to subcutaneous hæmorrhages, as is frequently observed in hæmophilics ; the patient is then delirious, tossing from one side of the bed to the other, and calling out in his agony. The bowels move repeatedly, the stools being tarry and offensive. At this stage the albumen in the urine may be still greater in amount and complete anuria may set in.

The temperature may remain high, but generally falls to subnormal, whilst the pulse is irregular, running and soft, showing 80–100 beats to the minute.

The mucous membranes now become pale, due to the internal hæmorrhage. The vomiting becomes intensified, the number of motions increase, and the patient has become comatose, losing control of his sphincters, and death takes place within a few hours.

To sum up the words of Boyce :—" Yellow fever may be described as a continuous fever of one paroxysm, lasting more than 27 hours. The onset is sudden and accompanied by violent headaches, pains over the eye, eyeballs tender to pressure, violent pains in the back (*coup de barre*), epigastric tenderness, anorexia, nausea, and vomiting."

Morbid Anatomy and Histology.

For the description of the gross anatomical and histological changes nothing can be added to Boyce's excellent and complete account.* According to him—

> The appearances of the grosser and finer lesions in yellow fever are characteristic, as characteristic as the symptoms in a well marked severe case of yellow fever. Should there be any doubt about the diagnosis of yellow fever during life, there ought to be no doubt after making a *post-mortem* examination.
>
> The naked eye appearance of the body and viscera are such as cannot readily be mistaken for any other disease.
>
> The skin is yellow, often appearing much more yellow than during life ; there are large livid patches, especially in dependent parts, but not limited to them ; subcutaneous ecchymoses are frequently present ; there may be also evidence of oozing of blood from the nose, mouth, conjunctiva, or anus.
>
> On making an incision into the body, there is no sign of wasting ; the body is often well nourished, abundant subcutaneous fat, stained yellow ; the muscles appear normal. This simply means that the fever is, as a rule, so acute that there is no time for degeneration re-actions to set in. The first visceral system to be carefully examined should be :—
>
> *The Alimentary Tract.*—This system invariably exhibits some degree of congestion, very frequently the congestion is intense, especially in the stomach.

*Boyce. *Yellow Fever and its Prevention*, London, 1911.

It has frequently been observed that, although no black vomit may have taken place during life, yet after death the stomach may contain a large quantity of it. This fact was noted by Dr. Chichester in the 1900 yellow fever outbreak at Bathurst in West Africa, and has been many times recorded by other observers.

The gastric mucous membrane has a purple or hæmorrhagic appearance, most marked, according to some observers, towards the cardiac end. There is invariably present in the stomach some black vomit, or mucus, or watery serous fluid ("white vomit") tinged with blood.

The *intestines* usually contain dark, tarry material. According to Blair's table of 97 *post-mortem* findings, the œsophagus, towards the cardiac end, is deeply congested. In one of the autopsies which I made in New Orleans in 1905, I observed the same cardiac congestion. In Blair's table, the stomach contained black vomit in 79 cases out of 97, and in all cases it was congested. The œsophagus was congested in a very large proportion of the cases. The duodenum, the small and large intestines were congested in about one-third or more of the total cases; in many instances the contents were tarry.

Enlargement and congestion of the mesenteric lymphatic glands has been observed, but more usually they appear normal. Durham and Myers have described an enlargement of the lymphatic glands in a considerable proportion of their cases. After the alimentary tract, in importance, comes the liver.

The liver is invariably altered in colour; most frequently it presents some shade of yellow, usually boxwood colour, but shades like bath-brick, tan, ochreous brown, deep yellow, pale yellow, reddish yellow, are frequently recorded; the fact being that there is some shade of yellow with, in addition, some degree of congestion; the latter may be so pronounced that the liver looks like a yellow "nutmeg liver." Most observers agree that the term boxwood covers most accurately the shade of yellow which is most frequently seen. It is not a bright yellow such as is sometimes seen in jaundice. The neck of the gall bladder may be congested.

The kidneys show some degree of congestion. They may be pale, fatty, or fibroid; but, in addition, the vessels are, as a rule, congested, especially in the pyramidal region. The bladder should be examined for the presence of urine. For if it were not possible to test the urine during life for the presence of albumin, the opportunity should be taken to do so, if any urine happens to be found in the bladder.

Vascular System.—The noticeable feature in connexion with the vascular system is the general congestion of the vessels. The heart is very often flabby; but, on the other hand, it may present remarkably little change.

Brain and Spinal Cord.—I found the brain intensely congested in one of my autopsies, and the condition has been often found.

Lungs.—As a rule, there is no fluid in the pleural cavities; they are usually dry. There may, however, be considerable congestion of the lower lobes of the lung.

Spleen.—The spleen is, as a rule, not noticeably altered; it is usually normal in size.

The naked eye changes, therefore, point to the concentration of the pathological changes in the vessels, stomach, intestines, liver, and kidneys.

Microscopic Anatomy.

Liver.—In my experiences, the microscopic appearances are very constant, but they are not peculiar to yellow fever. Closely identical changes may be seen in cases of phosphorus poisoning, and in other diseases accompanied by rapid degeneration of the liver substance. The degeneration changes are most marked in the hepatic zone of the liver lobule. The capillaries in this zone are congested, exactly as in the nutmeg liver of venous congestion the liver cells between the capillaries have a dislocated, disorganized appearance, with complete loss of their outlines.

The cell substance has often a very characteristic vacuolated or sponge-like appearance and stained with osmic acid, it is found to be loaded with fat droplets, some very minute. The cell is, in fact, reduced to a fatty spongework around the nucleus. In these cases, the appearance of the cells more closely resembles that seen in phosphorus poisoning than in any other disease with which I have had practical acquaintance.

There is slight but distinct change in the portal zone of the lobule; there also appears evidence of cell proliferation, and there is slight leucocytic infiltration. But these changes are by no means so pronounced as in acute yellow atrophy, at least, in my experience. The mucous membrane of the gall bladder on section may show considerable injection of the capillaries.

Kidneys.—The capillaries in the region of the straight and collecting tubules may be considerably dilated and filled with blood-clot, and there may be evidence of capillary congestion throughout the kidney and in the glomeruli. The congestion is, however, most marked in the pyramidal portion of the kidney. In the parenchyma, I have

frequently observed dilatation* of Bowman's capsule, and often the presence of a coagulum inside the capsule. The epithelium of the convoluted tubes is vacuolated and contains fat droplets, and the cell substance is granular and the contours of the cells are ill-defined. The appearance of the cells is very similar to that seen in phosphorus poisoning.

In the tubules hyaline casts are very common, in my experience, and this fact has also been observed by Otto and Neumann, Durham, and other observers. Some of the casts may contain granular material and red corpuscles. There is an absence of leucocytic infiltration. The microscopic appearances are not those found in cases of blackwater fever, where the collecting tubules contain pigment.

Stomach.—The microscopic appearance of the wall of the stomach corroborates the naked-eye appearance, and simply shows dilation of the capillary loops.

Lungs.—Microscopic sections show only evidence of congestion ; there is no leucocytic infiltration.

Brain.—Apart from the congestion of the vessels, I have not observed any changes in the grey substance of the brain.

DIFFERENTIAL DIAGNOSIS.

It has been stated previously that the diagnosis of a typical severe case of yellow fever does not offer any difficulties, and it is only the mild and sporadic case which puzzles even the experienced. This is borne out by Carroll's remark—" That their experiments show that genuine yellow fever may be so mild in character that no man, no matter how extensive his experience may have been, would dare to diagnose it as such unless he knew the disease to be prevailing at the time."

The history of nearly all outbreaks in countries where yellow fever has been imported show that the first cases either passed unnoticed or were wrongly diagnosed, until the occurrence of a severe case put the diagnosis beyond doubt.

Of the diseases which resemble yellow fever clinically in one or other aspect, malaria, blackwater fever, and dengue may be mentioned.

1. *Malaria.*—Anybody with medical experience in tropical countries knows that the diagnosis " malaria " is only too often made in error in cases where the clinical diagnosis is not confirmed by microscopical blood examination.

Benign tertian can easily be differentiated from yellow fever. It hardly ever shows the acute onset ; the course of the fever is typical, intermittent, and either microscopical examination of the blood or the result of the administration of quinine confirms the diagnosis.

In malignant tertian malaria on the other hand, the course of the fever is somewhat irregular, the symptoms are somewhat severe and indefinite, and the parasites are often so scanty in the blood that they can only be found after a prolonged and painstaking search.

In this form of malaria, the febrile paroxysm lasts, as a rule, from 27 to 36 hours. Soon after the initial rise to 103 or 104, a remission of a degree or so often occurs, lasting from eight to ten hours, followed by a second rise ; but the fever, even in the severest case, is of a remittent type.

The pernicious cases which resemble yellow fever more closely often show pains and lassitude during the two days preceding the cold stage. The skin is dry, and assumes a yellowish tinge. The headache is very severe ; there are pains in every part of the body, the tongue is coated, and diarrhœa is often present. Vomiting is rarely absent ; the liver and spleen are tender on palpation, as also is the epigastrium.

* Durham lays stress upon the dilation of the capsules, and considers that the suppression of urine is probably due to blockage of the tubules by casts.

The differential diagnosis between malaria and yellow fever should however, not offer great difficulties. Enlargement of the spleen, not observed in uncomplicated cases of yellow fever, is very frequent in malaria, the pulse rate is nearly always high, rising with the temperature, but the most important diagnostic feature is the finding of the malarial parasites in the blood, or the presence of pigmented leucocytes and the increased mononuclear leucocytosis.

2. *Blackwater Fever* resembles yellow fever in many of its clinical features. Blackwater fever may set in without any premonitory signs or with a feeling of malaise for one or two days previously. As a rule, the attack commences with a rigor, the temperature rising to 103 to 105 degrees. The headache is severe, pains in the lumbar regions are well marked, the tongue is coated, and the patient complains of thirst. Severe vomiting is the rule. Shortly after the onset of the fever, the mucous membranes show icteric discolouration.

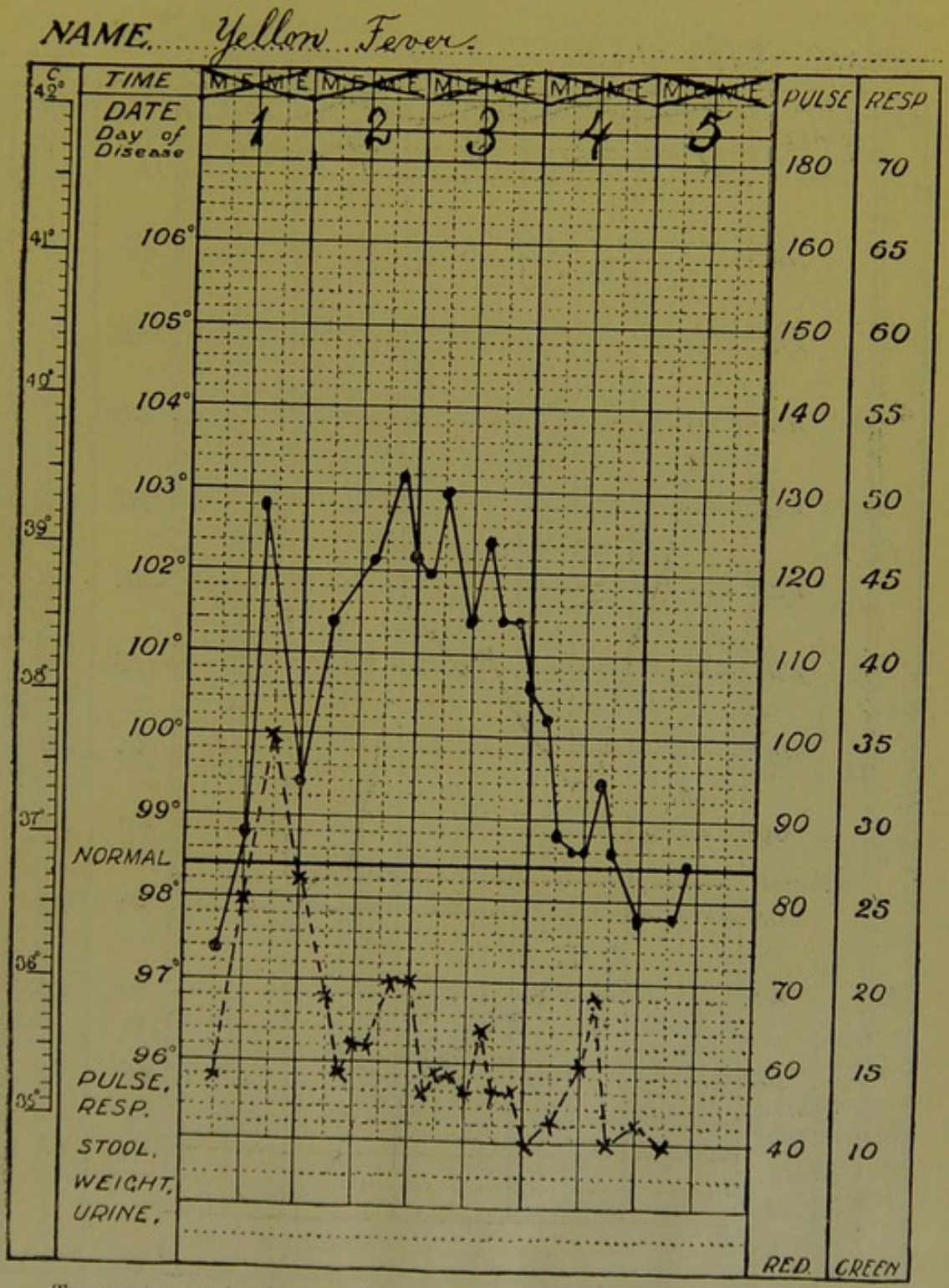
Some hours later the temperature abates, with profuse perspiration.

For the differential diagnosis it is necessary to remember that cases of blackwater fever usually give a history of repeated attacks of malaria. Blackwater fever is characterized by hæmoglobinæmia, followed by hæmoglobinuria. The colour of the urine resembles that of porter, and red blood corpuscles and albumen are rarely found. In yellow fever, on the other hand, the urine contains albumen and red blood corpuscles. In blackwater fever, jaundice appears shortly after the rise in temperature, whereas in yellow fever it develops later. In the former disease the patient vomits more or less changed blood, whereas in the latter the vomit consists mostly of pure bile. Faget's sign is never present in blackwater fever.

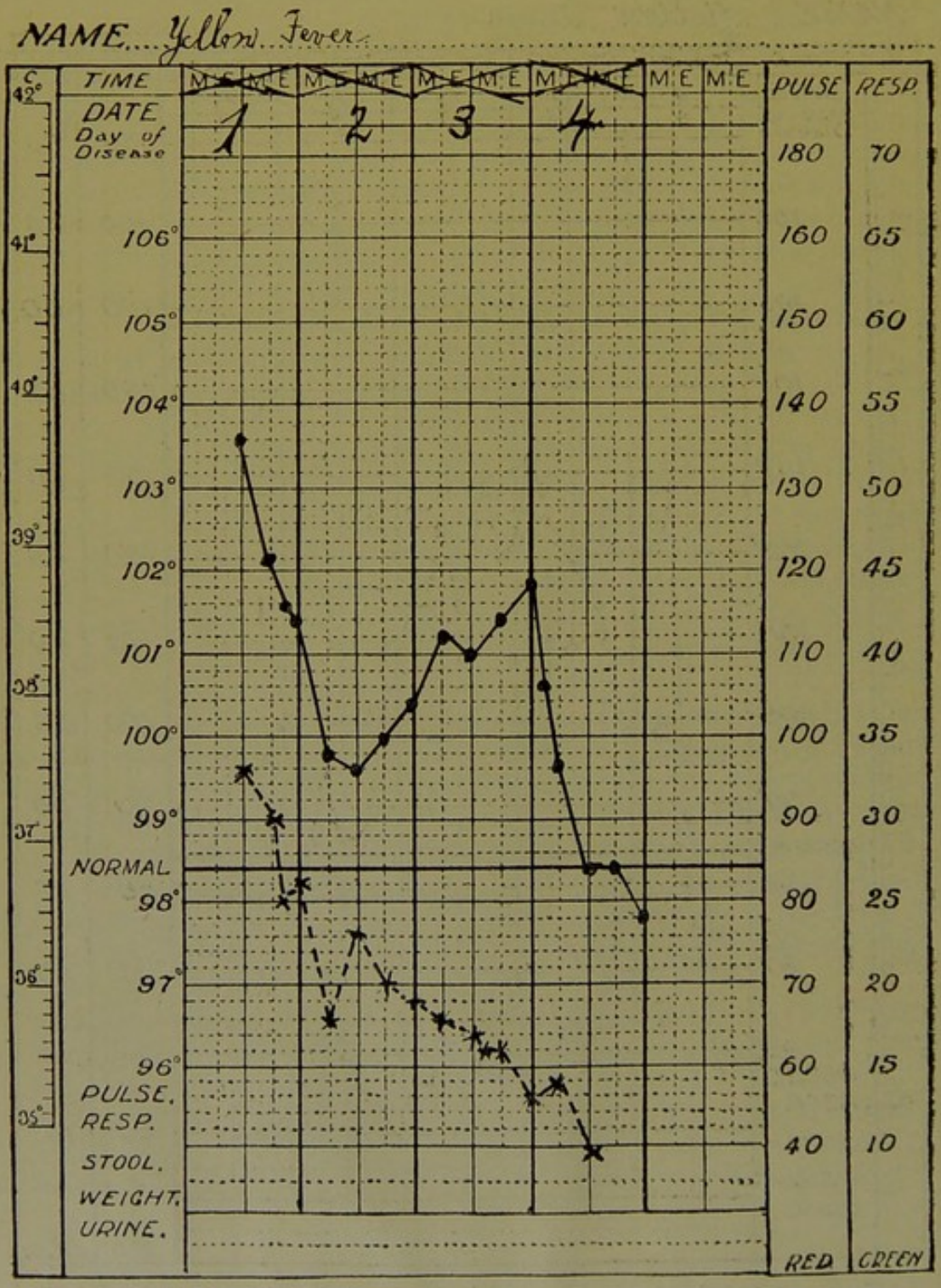
3. *Dengue Fever.*—It is beyond doubt that dengue fever resembles, in many of its manifestations, mild cases of yellow fever. The onset of dengue is always sudden, the temperature rising in a few hours to 103 degrees or higher, the frontal headache is severe, there are excruciating pains in every part of the body and vomiting may occur, the face is flushed, the eyes injected; all these being symptoms which may be present in cases of yellow fever. In dengue, however, albumen is hardly ever present in the urine; the lymph glands, especially in the axilla, are nearly always enlarged, and the pulse rate corresponds to the temperature.

The blood in dengue fever shows a leucopenia, whereas in yellow fever hypoleucocytosis is well marked in the severer cases only, much less pronounced in the milder form.

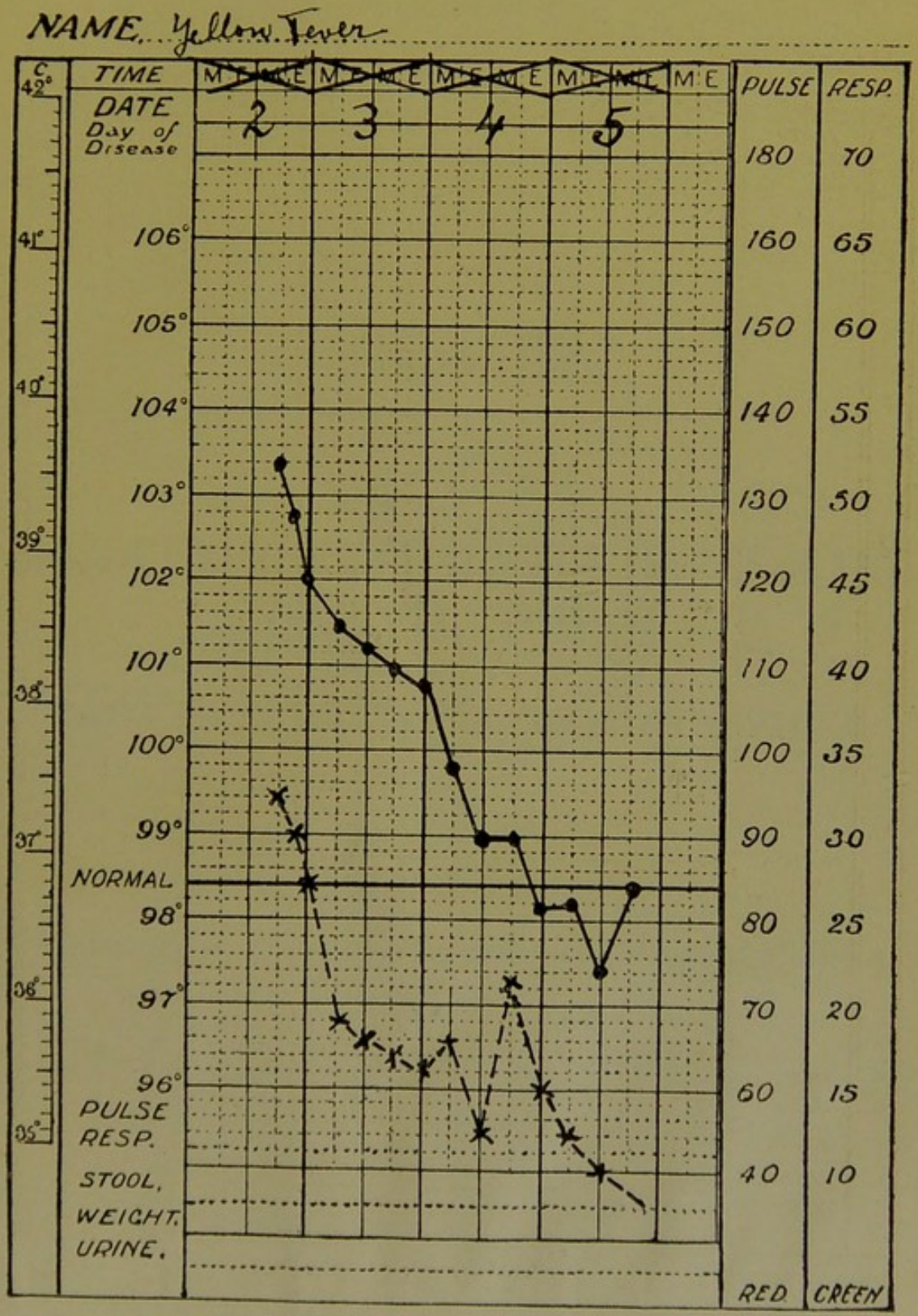
Epidemic jaundice, or Weil's disease, resembles yellow fever in its sudden onset, lumbar pains, vomiting, high temperature, slow pulse, and jaundice; the black vomit and albuminuria are, however, always absent.



Temperature and pulse curve (dotted lower curve) from an experimental case of infection by the *Stegomyia*. There is an early remission in the temperature curve on the second day. The pulse falls from the end of the first day, and does not follow the temperature. (After Guiteras.)



Temperature and pulse curves in the "remitting type." The remission occurs in this case at end of first day. Note the divergence of the pulse. (Guiteras.)



Temperature and pulse curves of the mild or abortive type (acclimatising or inflammatory fever, &c.) (Guiteras.)

REPORT

OF

MOSQUITO SURVEY OF THE QUEENSLAND COASTAL TOWNS.

PART I.—BURKETOWN TO TOWNSVILLE.

BY

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MOSQUITO SURVEY OF THE QUEENSLAND COASTAL TOWNS.

At the instigation of the Department of Quarantine, a journey was undertaken to the ports of Northern Queensland, in order to investigate the occurrence and distribution of *Stegomyia fasciata*. Opportunity was taken to map out the occurrence of mosquitoes, other than *Stegomyia fasciata*, as a first step towards a complete mosquito survey of Queensland.

This mosquito survey was suggested and financed by the Department of Quarantine, since the knowledge of the occurrence and prevalence of disease-carrying mosquitoes was considered of great practical importance. The extent and quality of measures to be taken against the introduction of insect-carried diseases, non-existent in Northern Australia, depend solely on the occurrence of biting insects acting as intermediary hosts.

I left Townsville on the 20th June, and proceeded direct to Burketown, arriving there on the 27th *idem*. After a short stay in Burketown, I proceeded by coach to Normanton, remaining there until 17th July. Thursday Island was then visited, where I remained till the 10th August, owing to the irregular steamer service connecting with Cooktown.

The distribution of mosquitoes in Cooktown was then mapped out. From there, Innisfail was reached on the 9th September. I returned to Townsville by way of Halifax on 23rd September.

I wish to express my indebtedness to Dr. Warren (Burketown), Dr. Taylor (Normanton), Drs. Wassell and Markwell (Thursday Island), Dr. Kortum (Cooktown), Drs. Knowles, Clarke, Baxter-Tyrie, and Mr. R. A. Tills (Cairns), and Dr. Willis (Innisfail), for their kind interest and help.

Habits of Stegomyia fasciata.

Stegomyia fasciata, the intermediary host of yellow fever, is essentially a domestic mosquito, and occurs only in the neighbourhood of houses, where it breeds in the water tanks and in many other receptacles containing standing water.

Specific Characters of Stegomyia fasciata.

The *Stegomyia fasciata* is easily differentiated from other species by the white lyre-shaped pattern on its thorax, and by the white banding of its legs. The vicious blood-sucking habits of this mosquito have given it the appropriate popular name of "tiger mosquito."

The females, as with other species of mosquitoes, only suck blood and attack man mainly in the day time. Their numbers are subject to seasonal changes. It is a tropical mosquito, weather conditions greatly influencing its activity and breeding habits, but the eggs can withstand low temperatures. Boyce, in his Report on Yellow Fever Prophylaxis in New Orleans says :—

" . . . . they (the eggs) are very resistant and have been kept in a dry state for periods varying between ten and twenty days, and freezing does not destroy their fertility. The eggs are, therefore, a ready means

of tiding over the cold weather." Each female lays between 20 and 70 very small, black, cigar-shaped eggs (about one-twenty-fifth of an inch in length). They are laid singly, and are easily distinguished from the raft-shaped masses of eggs of *Culex fatigans*.

The eggs develop into larvæ under favorable conditions in from ten hours to three days. The larval period usually lasts from six to eight days, though they may remain in this state for a longer period under unfavorable conditions of temperature and lack of adequate food. The pupal stage is of short duration and, as a rule, lasts about 24 hours, after which the adult and fully developed mosquito emerges.

The larvæ are easily distinguished by their greyish white body and black syphon from those of *Culex fatigans*, which are brown in colour. They are very active, sensitive, and quickly disappear on the slightest disturbance from the surface of the water.

Microscopically, the larvæ of *Stegomyia fasciata* are distinguished from other larvæ by the shape and form of the teeth on the respiratory syphon, the comb of teeth on the eighth abdominal segment, and the form of the labial plate.

The larvæ of *Stegomyia fasciata* and *Culex fatigans* are often found breeding in the same water tanks, especially when the tank is without any covering.

Method of Examination.

In order to examine the house tanks for the *Stegomyia fasciata* larvæ, the "screen" on the top of the tank was removed and, after the shaking of the tank and the water had subsided, a careful search was made for the larvæ which, when present, could be easily seen just below the surface of the water. Now and again adults flew away when the covering of the tank was removed.

Mosquito larvæ were often found in bedroom water jugs and earthenware safety stands in which the legs of tables, meat safes, ice chests, &c., rest for protection against invasion by the ubiquitous brown ant (*Pheidole sp.*).

Similar methods were adopted to discover the presence of the larvæ and adults of *Culex fatigans*.

Anopheles larvæ were found in waterpools at the edges of swamps and creeks and, according to Bancroft (1), are able to "live in salt water as well as in running fresh and stagnant waters; but they are to be found about habitations in small collections of water."

These larvæ can be easily differentiated from the others since they lie with the long axis of their bodies parallel to the surface of the water and when viewed from the side, the respiratory apparatus and the palmate hairs upon the dorsal surface of the abdomen are seen to pierce the surface. The absence of a respiratory syphon is a further distinguishing character.

The adult *Nyssorhynchus annulipes* has a brown back and abdomen, with a creamy clothing; the legs are brown with numerous bands, the wings are dark with numerous creamy patches, giving it a mottled appearance.

Moreover, the resting position of the Anopheles is also characteristic, since they generally settle with their head and body at right angles to the object on which they are resting.

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(1) *Annals of the Queensland Museum*, No. 8.

The following pages contain the results of the investigation as to the occurrence and distribution of mosquitoes in the coastal towns of North Queensland.

BURKETOWN.

Burketown is situated 30 miles inland from the mouth of the Albert River on its left bank, and is about 1,500 miles from Brisbane, with a population to the district of 265 (Census 1911).

The country immediately surrounding Burketown is flat and almost devoid of trees, but further inland it gradually becomes covered with belts of stunted gum and other trees.

There is a small creek near the centre of the town, draining into the river, which contains stagnant water in the dry season.

There are several swamps close to the river, but they are not in the immediate vicinity of the town.

During the wet season, heavy rains flood the country, rendering the coach route to Normanton impassable for vehicular traffic.

The general type of dwelling-house is constructed of galvanized iron, with or without verandahs. Only here and there are wooden houses with verandahs to the front and back.

The domestic water supply is contained in rain water tanks of galvanized iron, which have the usual sieve-like covering to the man-hole; the bottom of which is perforated with a number of nail holes, large enough to give adult mosquitoes access to the water. The artesian bore in the town, with a depth of 2,304 feet, has a daily flow of about 100,000 gallons, but this supply is not used for domestic purposes.

The garbage depôt is a considerable distance from the town, and, with the exception of a small collection of tins near the creek, there is no other refuse in the town. Mosquito larvæ and pupæ were breeding in these tins, and belonged to *Culex fatigans* and *Culex sitiens*.

There is a pronounced seasonal variation in the number of mosquitoes during the dry and wet seasons. During the months of the wet season they abound, but they are not so numerous in the dry season. This observation applies equally to the house mosquito, as well as to the bush mosquito.

The adult *Stegomyia fasciata* was not common in Burketown at the time of my visit. Larvæ were, however, seen on several occasions in the water tanks and in the water contained in other receptacles, such as disused tins, flower vases, and bedroom water jugs.

The adult mosquitoes of *Culex fatigans* were found in houses, particularly in bedrooms, and a large number of them, besides numerous larvæ and pupæ, were contained in an old, disused, and open house tank. The larvæ were also found in some of the house tanks and in the collection of tins near the creek.

The anopheline mosquito, *Nyssorhynchus annulipes*, is not a common species in the town, which is probably due to the fact that their nearest breeding-ground is some distance away. The larvæ were found in small numbers in the shallow water along the edges of the swamps on the side of the river away from the town.

The following mosquitoes were collected in the neighbourhood of Burketown :—*Culex sitiens*, Wied ; *Culicelsa vigilax*, Skuse ; and *Stegomyia* species, probably new to science.

Nyssorhynchus annulipes was seen in scanty numbers on the overland journey to Normanton at Punchbowl Station, where the coach stopped on the night of the first day. On the second day both *Culex sitiens* and *C. occidentalis* were encountered at the coach change at Armstrong Station. *Nyssorhynchus annulipes* was also seen sheltering in an outhouse at Magoura Station, which is about 20 miles from Normanton.

NORMANTON.

Normanton is situated on the left bank of the Norman River, some 60 miles from its mouth and about 1,382 miles from Brisbane.

The population of the district as given by the Census of 1911 is 541 souls.

The town is built on lightly raised ground, which slopes to the bed of a creek which contains running water during the rainy season, but dries up to a continuous chain of water holes during the dry season. On the opposite side of the town is an extensive swamp, which partially drains into the river. The land in the immediate vicinity of the town is bare of trees, but beyond this it is covered with a stunted growth of scrub.

The majority of the dwelling houses are built of timber with verandahs to the front and back. The houses of the coloured population are built of galvanized iron, and are generally without verandahs.

The inhabitants are using for domestic purposes rain water exclusively, collected in galvanized iron tanks. The water from the artesian bore, situated near the Public Hall, is not used for household purposes, and runs to waste.

The town is exceptionally free from collections of garbage, only one small lot of tins being found in the town.

The *Stegomyia fasciata* mosquito was found ubiquitous, abounding throughout the town, and is well known to the residents on account of its prevalence. In one establishment, for example, they were present in clouds round the counter, where they were breeding in great numbers in a trough containing standing water, which was used for domestic purposes.

The larvæ were found abundantly in the house tanks, bedroom water jugs, and other receptacles containing standing water.

Culex fatigans does not occur to the same extent as *Stegomyia fasciata*. This species breeds in the open tanks and kerosene tins about houses, and also in small numbers in some of the water-holes in the proximity of dwellings.

The anopheline, *Nyssorhynchus annulipes*, is more frequently found than the previous species, and is present in the houses in varying numbers, as many as 30 specimens were found on one occasion in a single room.

They breed principally in close proximity to the Chinese quarters, in the chain of water-holes which only partially dry up during the dry season. The larvæ were present in large numbers in the stagnant water in these holes, which were generally muddy. In many cases the mosquitoes were found sheltering in the long grass around these water-holes.

The seasonal prevalence of mosquitoes is very marked, according to local information. The consensus of opinion is that they are exceedingly abundant during the summer, whilst they are by no means so common during the winter.

Of the other mosquitoes in Normanton, two species were breeding in large numbers close to the town, namely, the "Scotch grey" (*Mucidus alternans*), and a species of *Culex*, which has not hitherto been described. The former was commonly found at all hours of the day resting amongst the grass near the water-holes, and was readily captured, the males being the more sluggish of the two sexes. The *Culex* was very abundant in the larval stage, and was apparently undergoing hibernation. The duration of the pupal stage was from five to seven days. Adult mosquitoes of this species were rare.

THURSDAY ISLAND.

Thursday Island is a small and hilly island in the Torres Strait group, a few miles distant from Cape York, and about 1,500 miles from Brisbane.

The north-eastern portion of the island is covered with light scrub, the north-western end being bare in parts with dense patches of scrub here and there.

The settlement is situated along the entire length of the southern side of the island. The last census gave the population as 1,418 souls. The white population, consisting of about 400 souls; the remainder consisting of Malays, Japanese, Chinese, and other coloured races.

The dwelling houses of the white population are built of timber. The majority of the coloured population live in galvanized iron houses, containing two or three rooms, with or without verandahs. Most of these houses do not have glass windows, but only shutters of the same type as used in the east.

The only water supply at present is rain water collected during the wet season in galvanized iron tanks which, especially in the Japanese quarters, are frequently defective.

The Queensland Government is building a large concrete storage tank, which will be capable of impounding a large quantity of rain water to supply the town.

No steps have been taken, up to the present, to render the water tanks mosquito proof in the settlement. Many tanks were without any covering to the man-holes, and in some instances were entirely open. In many of the Japanese houses water is kept for daily use in calcium carbide drums and kerosene tins without covers.

The municipal garbage depôt is situated in the gap between the two hills on the northern side of the island, and contains innumerable empty tins and other rubbish which is periodically burnt.

In spite of this procedure, many of the tins escape destruction, and offer suitable conditions for breeding mosquitoes. Many old, disused, and partly broken-up water tanks are found in this locality, which are still capable of holding water.

The seasonal variation of mosquitoes is well marked. During the summer they are said to be very troublesome, but in the winter months they are not so commonly found.

Stegomyia fasciata is abundant, and occurs in great numbers inside the houses. A complete inspection of the water tanks, carbide drums, and kerosene tins was made in the Japanese quarter. With the exception of three tanks out of about 100, *Stegomyia fasciata* larvæ were found in great numbers.

In several instances the larvæ of *Stegomyia fasciata* were present in kerosene tins containing the water for daily use, since the tins were never completely emptied before being refilled.

Culex fatigans is a less common mosquito than *Stegomyia fasciata*. The larvæ were found in small numbers where the tanks were entirely open. On two occasions *Culex fatigans* larvæ were found in open wells situated near houses; one about 8 feet deep contained only about 1 foot of water, which was swarming with the larvæ. In the other, only a comparatively small number of larvæ were found, which was probably due to the fact that water boatmen (*Notonectidæ*) were present.

Neither larvæ nor adults of *Nyssorhynchus annulipes* were encountered, which was due to the absence of swamps and other water-holes on the island.

COOKTOWN.

Cooktown, situated at the mouth of the Endeavour River, is about 1,050 miles from Brisbane and 260 from Townsville.

The population of the district, according to the last census, was 1,257 souls.

The country in the district is very hilly, and is covered with dense scrub. The land on the western side of the town adjoining the railway line, is low-lying and swampy, with many small and scattered collections of water, where the larvæ of *Culex sitiens* and *C. viligax* occurred in large numbers.

The dwelling houses are constructed of timber, either with verandahs to the front and back only, or are surrounded on all sides. The Chinese quarters, adjacent to the railway station, are built of galvanized iron, without verandahs.

Rainwater is collected for domestic purposes in galvanized iron tanks, which are not mosquito-proof.

Larvæ of *Stegomyia fasciata* were found in the water tanks in large numbers. On one occasion several hundreds of larvæ and pupæ were found in two flower vases. An examination of domestic utensils, containing standing water, showed a similar condition. The adult mosquito also occurs in considerable numbers both by day and night.

Culex fatigans is also a common mosquito, and breeds in kerosene tins, water tanks, and calcium carbide drums. The adult mosquito was found commonly in living rooms in houses.

Nyssorhynchus annulipes was not found in the town in either the adult or larval stages, although the adults occur in the scrub around the town.

Amongst other mosquitoes the following were also found:—*Culex sitiens*, Wied; *C. vigilax*, Skuse; *Chrysoconops acer*, Walker; *Pseudoskusea similis*, Theobald; and *P. basalis*, Taylor.

CAIRNS.

Cairns is a seaport situated on Trinity Bay, distant about 1,000 miles from Brisbane and 160 miles from Townsville.

The Cairns Inlet extends for a considerable distance inland, with many ramifications, its shores being covered with mangrove flats, which form excellent breeding places for mosquitoes. There is an extensive swamp, which originates at the foreshore and extends into the residential portion of the town. A second swamp, upon which part of the town is built, is situated across the Babinda tram line, and is approximately of the same area as the former. A third extensive swamp, with a depth of several feet of water, is situated on the northern side of the General Hospital.

In the near distance the land gradually begins to ascend to a background of high hills, densely covered with timber, and which surround the town on three sides.

The water supply is of two sources, rain water collected in galvanized iron tanks, and a town supply obtained from the tableland ; the latter is mainly used by the householders.

The water tanks, with few exceptions, are not mosquito proof, the " screens " in use being of the general type used throughout the north.

The dwellings are built of timber, with verandahs to the front and back ; only a few being of the bungalow type.

The last census of the district gave the population as 5,193 souls.

There are two municipal garbage depôts. One is situated in the town behind the general hospital, and is the dumping ground for disused tins. The second depôt is on the outskirts of the town, adjacent to the road leading to Hambledon, and is on the edge of a swamp. This is the principal depôt and consists of innumerable tins. Now and again an unsuccessful attempt is made to destroy these tins by burning the garbage, but the heat given off by the fire is insufficient to accomplish this.

Both depôts are breeding *Culex sitiens*, *C. vigilax*, *C. fatigans*, and *Nyssorhynchus annulipes*.

Stegomyia fasciata is a prevalent species in Cairns. The adult mosquito is generally distributed over the whole town. The larvæ were found breeding together with *Culex fatigans* in house tanks and kerosene tins. The larvæ were also found on one occasion breeding in inverted clam shells in the town.

Both adults and larvæ were found at the Kamerunga State nursery, where they were breeding in the water tanks and troughs.

The *Culex fatigans* mosquito is more prevalent than *Stegomyia fasciata*, and is very abundant in all parts of the town. The larvæ and egg rafts were found breeding mainly in the house tanks and in the disused tins at the garbage depôts. They occurred in large numbers in this latter locality.

In addition to *Nyssorhynchus annulipes*, which was found breeding in all the swamps in the vicinity of the town in fairly large numbers, the following mosquitoes also occurred :—*Myzorhynchus barbirostris* var. *bancrofti*, *Culex sitiens*, *Culex vigilax*, *Tæniorhynchus uniformis*, *Pseudoskusea similis*, and a variety of *Macleaya tremula* also occurred.

INNISFAIL.

Innisfail is situated on a ridge at the confluence of the north and south branches of the Johnstone River, a few miles from its mouth. It is about 870 miles from Brisbane and 120 from Townsville.

The surrounding district is composed of rich flats and undulating country, which extend to the Bellenden Kerr Mountains, which are about 20 miles from the township. The district is entirely given over to the cultivation of sugar cane.

The low-lying country is very swampy, owing to the fact that the yearly rainfall is exceptionally heavy. The country near the river is subject to periodical floods during the wet season. There is a permanent swamp of considerable size behind the town on the edge of the scrub, which is breeding large numbers of mosquitoes.

The houses are for the most part built of timber, with verandahs to the back and front.

The population of Innisfail and district was, according to the census of 1911, 1,230 souls.

The household water supply is rain water collected in galvanized iron tanks, which are not mosquito proof, the screens on the tanks being of the general type used in the north.

There is a large collection of old disused tins situated upon a block of land alongside a creek, which runs through a portion of the Chinese quarter, emptying itself into the south arm of the Johnstone River. No attempt is made to destroy these tins, which are the means of breeding large numbers of mosquitoes.

The conditions governing the prevalence of mosquitoes are well suited to the breeding of large numbers of mosquitoes, especially during the summer. The Innisfail district is one of the wettest in North Queensland, having an average rainfall of about 140 inches per year, so that mosquitoes may always find an abundance of water in which to lay their eggs. The high average temperature of the district is also a favorable factor for the rapid development of the mosquito larvæ.

Stegomyia fasciata is a common mosquito, the larvæ being commonly found in the house tanks.

Culex fatigans is also a common mosquito, the adults being found frequently in the houses. The larvæ breed in the house tanks and also in the collection of disused tins on the banks of the creek.

The mosquito fauna of this district will, probably, prove very interesting as it possesses forms analogous to those of Papua. One species, *Hodgesia triangulata*, originally described from Papua, was found, and a species of *Stegomyia* occurs, which is closely related to one from New Guinea. Other mosquitoes found were :—*Culex sitiens*, *Culex vigilax*, *Scutomyia notoscripta*, *Tæniorhynchus uniformis*, *Finlaya poicilia*, and a species of *Pseudoskusea*.

Nyssorhynchus annulipes was not found either in the town or in the adjoining scrub.

HALIFAX.

The township of Halifax, situated on the southern side of the Lower Herbert River, is about 800 miles from Brisbane and 60 miles from Townsville.

The surrounding country is very flat, and is entirely given over to the cultivation of sugar cane, the district supporting two sugar mills.

Between Lucinda Point and the township is a very extensive mangrove swamp, which becomes flooded in the wet season.

Halifax is a small township, consisting of very few houses, and is mainly composed of shops, the post-office, public school, and three hotels.

The population of the district is very scattered and, according to the census of 1911, comprised 459 souls.

The water supply of the town is derived from two sources, the chief supply coming from underground wells; the second source is rain water, which is stored in galvanized iron tanks.

Stegomyia fasciata is not a common species in Halifax, the larvæ were only found on occasions in water tanks, bedroom jugs, and, once, in a bucket of standing water at a Chinese store.

Culex fatigans is, on the other hand, an exceedingly common mosquito, and was found in large numbers indoors and in outhouses at the Chinese shops, where large numbers of larvæ were found in the drains leading from the underground wells, and also in buckets containing standing water.

Nyssorhynchus annulipes is a comparatively common mosquito in the bush on the banks of the river. The chief breeding ground in the vicinity of the town is a water-hole alongside the Ingham-road. The larvæ are present in considerable numbers in this locality. The adult mosquito was not found in houses.

The seasonal variation of mosquitoes is well marked during the summer and winter. They are said to be exceedingly abundant during the summer, but in the winter they are not nearly so common.

The following mosquitoes were also found in Halifax:—*Myzorhynchus barbirostris* var. *bancrofti*, *Culex sitiens*, *Culex vigilax*, *Tæniorhynchus uniformis*, *Finlaya poicilia*, *Chrysoconops acer*, and *Pseudoskusea* species.

TOWNSVILLE.

Townsville is a municipal seaport town, situated on the shores of Cleveland Bay, about 750 miles from Brisbane.

A considerable portion of the town is built on the slopes of Castle Hill and one of its spurs. The business quarter is for the most part built on made ground which is, at most, a few feet above high-water level. Part of the remaining portion of the town is flat and low-lying, containing numerous and, in some cases extensive swampy areas, especially during the wet season.

There is also a chain of hills, the highest being Mount Elliott, which take their rise near Stewart's Creek, and extend away in a southerly direction. These hills are well wooded, but the surrounding country between them and the town is low-lying and poorly covered with stunted scrub.

The majority of houses are built of timber, and are similar in detail to those in other northern towns.

The population, according to the census of 1911, was 13,678 souls; but since that time it has steadily increased both from natural sources and from immigration.

The water supply is derived from two sources; one the town supply, which is pumped from the Hubert Wells some distance from the town; the second being the galvanized iron tank system which is to be found in a large percentage of houses.

The municipal garbage depôts are in the town; one being in South Townsville on some swampy ground across Ross Creek. The site of the second is in Flinders-street west, where the council is building up the street with garbage, which is mainly composed of disused tins. Both of these depôts form an excellent breeding ground for mosquitoes.

The seasonal prevalence of mosquitoes during the dry and wet seasons is well defined. They are commonly found in large numbers throughout the town during the wet season. They are also exceedingly abundant in the scrub country at this season. During the winter, however, their presence is much less noticeable.

The mosquito survey of Townsville was conducted during the latter part of 1912, and the early part of 1913. The present local conditions are identical in all essentials with that period.

Through the courtesy of Dr. Booth-Clarkson, then Government Medical Inspector of North Queensland, and with the assistance of the Health Inspectors—Messrs. Cottle, Wright, and Wiseman—I was enabled to make an extensive investigation into the spread and distribution, not only of *Stegomyia fasciata*, but also of all mosquitoes which frequent house properties at that period of the year.

It is probable that the numbers of larval infections of tanks is small as the greater part of the investigations were carried out during the wet season when the water tanks are more or less continuously overflowing from incessant rains, which fall at this period. There is little doubt that, in many instances, the evidence of larvæ being present were unavailable on account of this fact.

The town was divided into blocks for convenience of working, and the results tabulated both for larvæ and adult mosquitoes.

Stegomyia fasciata was found in the larval state in 8 per cent., and in the adult stage in 18 per cent. of the rain water tanks, barrels, &c., and houses in north ward. In the east ward the percentage was much less, being only 4 per cent. for larvæ and 3 per cent. for adults. West ward proved to be more heavily infested with *Stegomyia* larvæ, the percentage being 17 per cent., whilst the percentage of adults was less (12 per cent.) than in north ward. The percentages of larval and adult forms found in South Townsville were 12 per cent. for larval and 13 per cent. for adult infection. The total number of tanks examined in the town was 477.

Culex fatigans was found to be a commoner species than *Stegomyia fasciata*. The larvæ were found in 9 per cent. of the breeding places examined, and the adults in 16 per cent. The east ward was not so heavily infested, the larvæ being found in 3 per cent., and the adults in 10 per cent. of the breeding grounds examined. West End again showed a heavy percentage of infection, the larvæ being found in 13 per cent. and the adults in 24 per cent. of the places examined. In South Townsville the percentage for larvæ and adults were 12 per cent. and 18 per cent. respectively.

Nyssorhynchus annulipes was not a common mosquito in the north ward, as it was found but twice; in one case on the edge of a swamp, and a second time in a drain. In west ward they were met with on eight occasions; in a creek, which is fed by the water from Castle Hill in the wet season, and in tins at the garbage depôt.

Culex tigripes was also found breeding in barrels both in the north and west wards. *Culex sitiens* and *Culicelsa vigilax* were also found to be breeding in barrels and drains on house properties.

There is a considerable variety of mosquitoes in Townsville, 26 different kinds having been found to date, the majority of which have been taken in and about houses.

The following is a list of the mosquitoes, with the exception of *Stegomyia fasciata* and *Culex fatigans*, which have been found in Townsville :—

Anopheles (*Myzorhynchus*) *barbirostris*. var. *bancrofti*, Giles.
Anopheles (*Nyssorhynchus*) *annulipes*, Walker.
Mucidus alternans, Westwood.
Calomyia priestleyi, Taylor.
Scutomyia notoscripta, Skuse.
Aedimorphus australis, Taylor.
Pseudohowardina linealis, Taylor.
Culicada annulata, Taylor.
Culicada squamosa, Taylor.
Leucomyia annulata, Taylor.
Leucomyia annulirostris, Taylor.
Culicelsa abdominalis, Taylor.
Culicelsa fuscus, Taylor.
Culicelsa paludis, Taylor.
Culicelsa simplex, Taylor.
Culicelsa vigilax, Skuse.
Culex sitiens, Wiedemann.
Culex tigripes, G. et C..
Chrysoconops acer (Walker).
Taeniorhynchus uniformis, Theobald.
Finlaya poicilia, Theobald.
Aedeomyia venustipes (Skuse).
Dixomyia elegans, Taylor.
Uranotænia albescens, Taylor.
Uranotænia propria, Taylor.
Anisocheleomyia nivipes, Theobald.

SUMMARY.

A mosquito survey, with especial reference to *Stegomyia fasciata*, has been made in the principal coastal towns of North Queensland.

The occurrence of *Stegomyia fasciata* and *Culex fatigans* has been demonstrated in all the towns visited.

Nyssorhynchus annulipes was found in all these places, with the exception of Thursday Island and Innisfail.

Special attention was paid to other mosquitoes, and a list of species taken is appended under each town.

EXPLANATION OF PLATES.

Fig. 1. Normanton.—Showing chain of water-holes.

Fig. 2. Thursday Island.—Showing the system of water tanks, and on the right-hand side the retaining wall of well.

Fig. 3. Thursday Island.—Showing empty disused tanks in the foreground.

Fig. 4. Thursday Island.—The garbage depôt, showing empty disused tins which afford breeding-places for mosquitoes in the wet season.

Fig. 5. Cairns.—Brackish swamp a few hundred yards from the shore, in which larvæ of *Culicelsa vigilax* were found.

Fig. 6. Cairns.—The outskirts of the town, showing an extensive swamp.

Fig. 7. Cairns.—The garbage depôt, situated in close proximity to the town.

Fig. 8. The same, showing Anopheles breeding pools.

Fig. 9. Innisfail.—Disused tins in which the larvæ of *Culex fatigans* were found.

Fig. 10. Halifax.—A stagnant water-hole on the edge of the town, where *Nyssorhynchus annulipes* and *Culicelsa vigilax* were breeding.

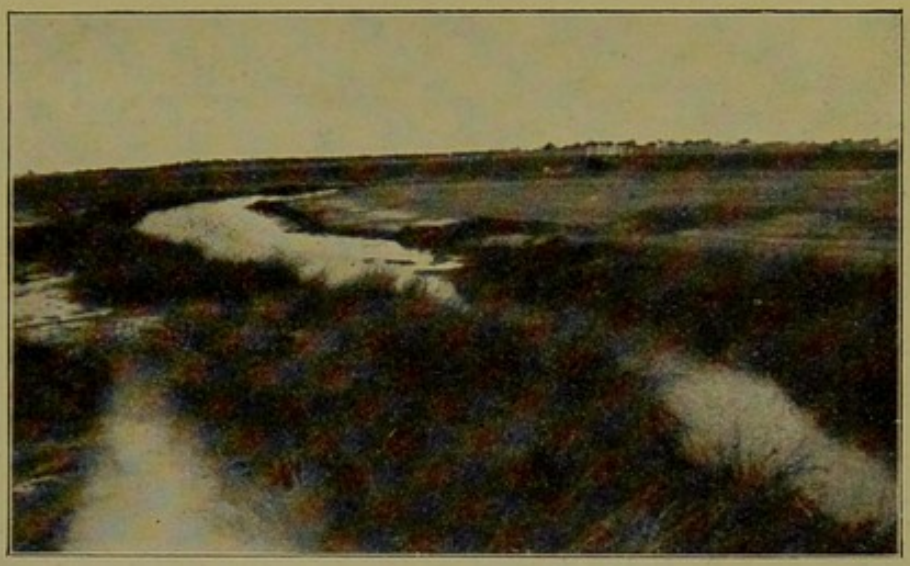

FIG. 1.—NORMANTON.

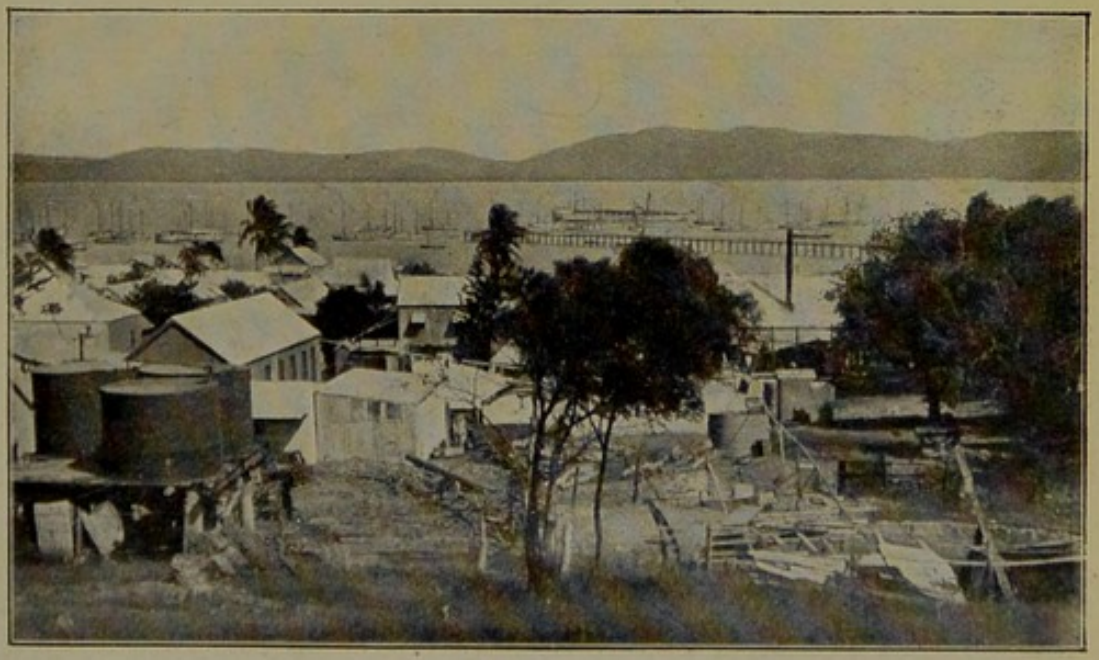

FIG. 2.—THURSDAY ISLAND.

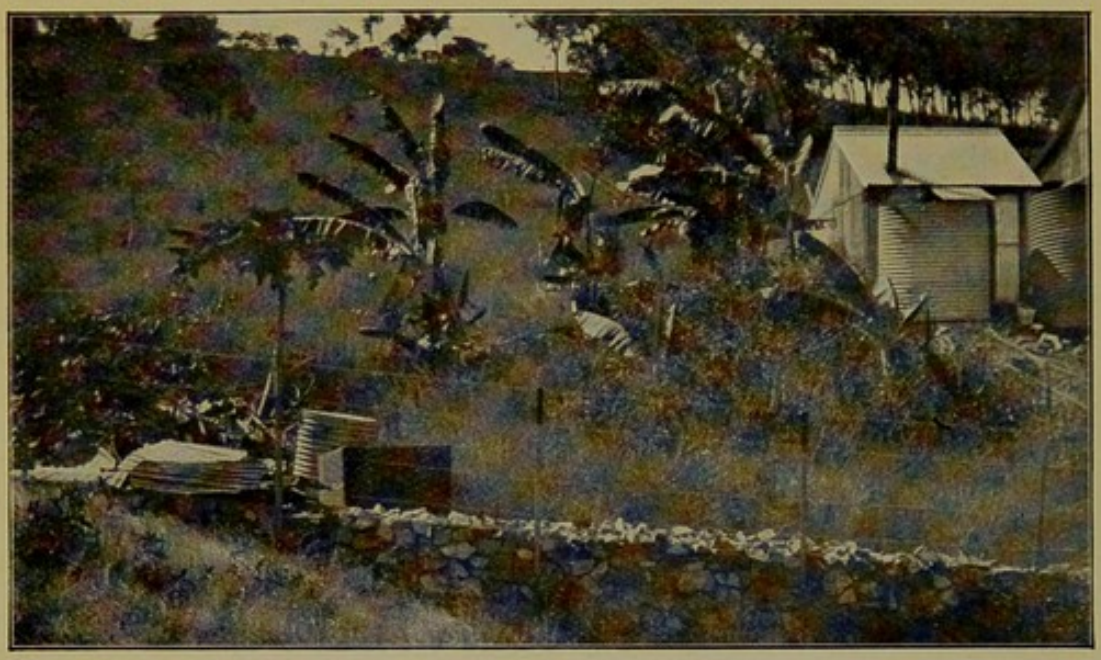

Fig. 3.—Thursday Island.

Fig. 4.—Thursday Island.

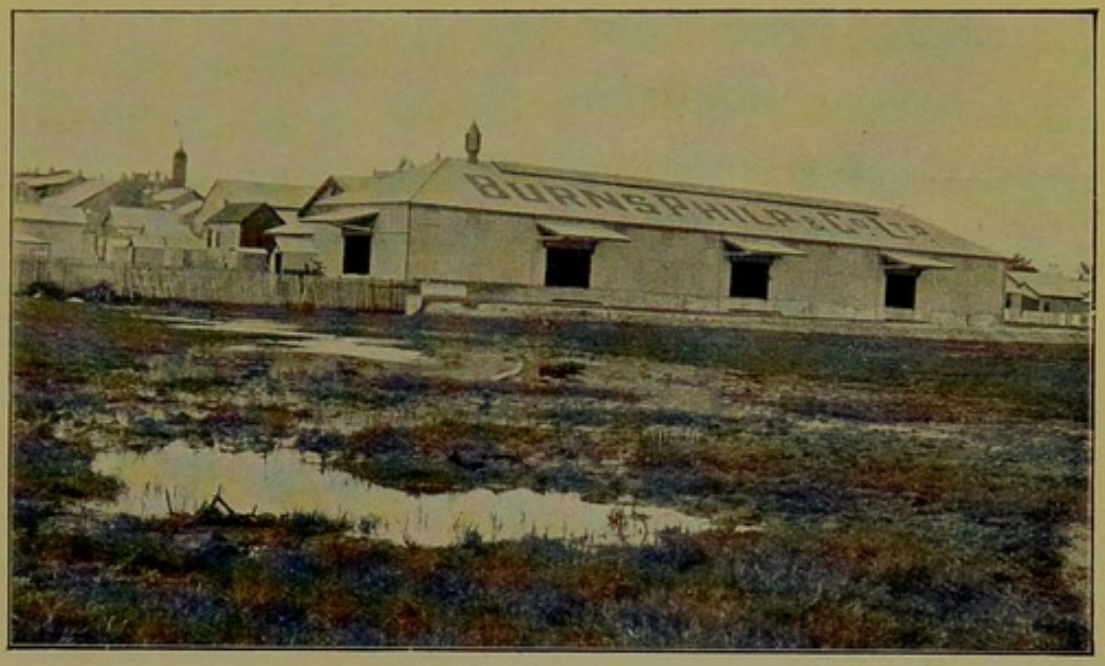

Fig. 5.—Cairns.

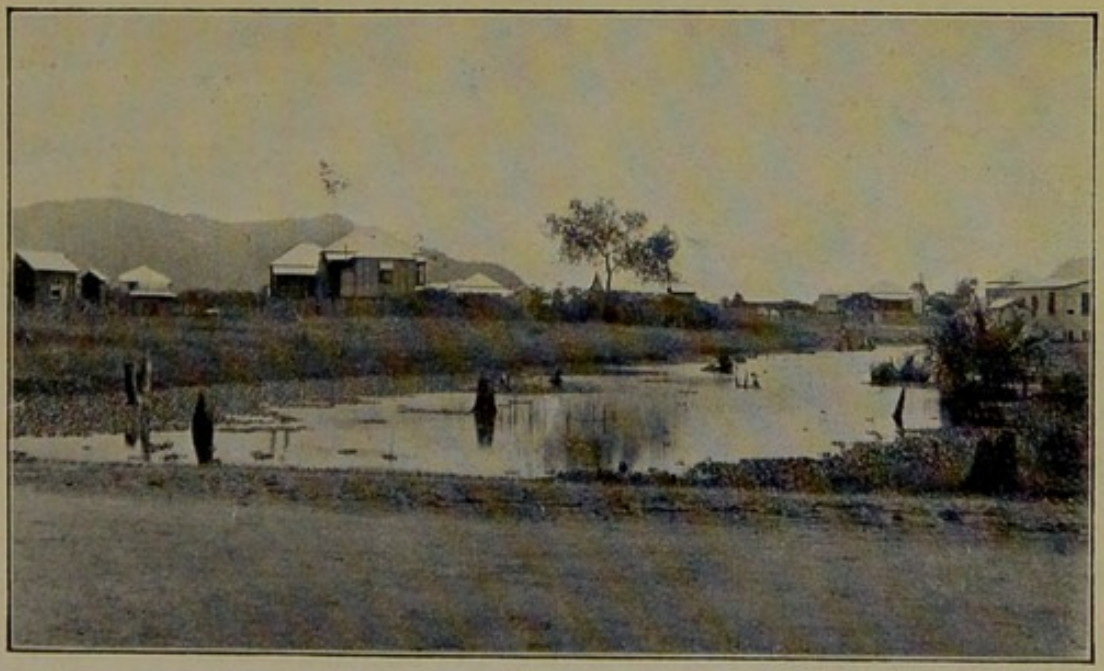

Fig. 6.—Cairns.

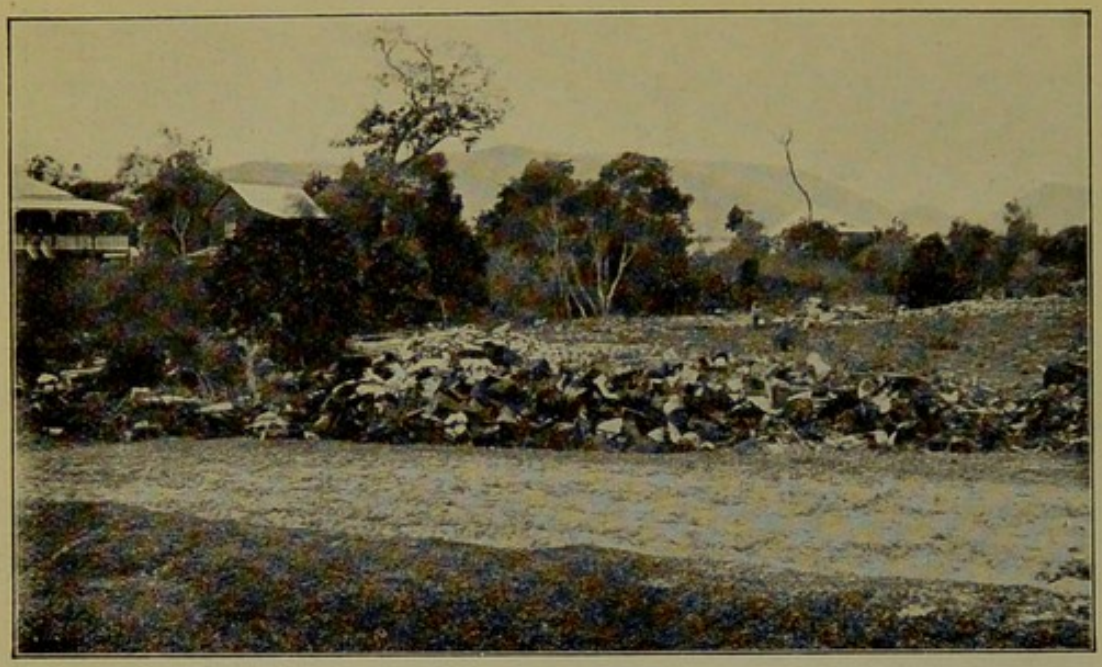

FIG. 7.—CAIRNS.

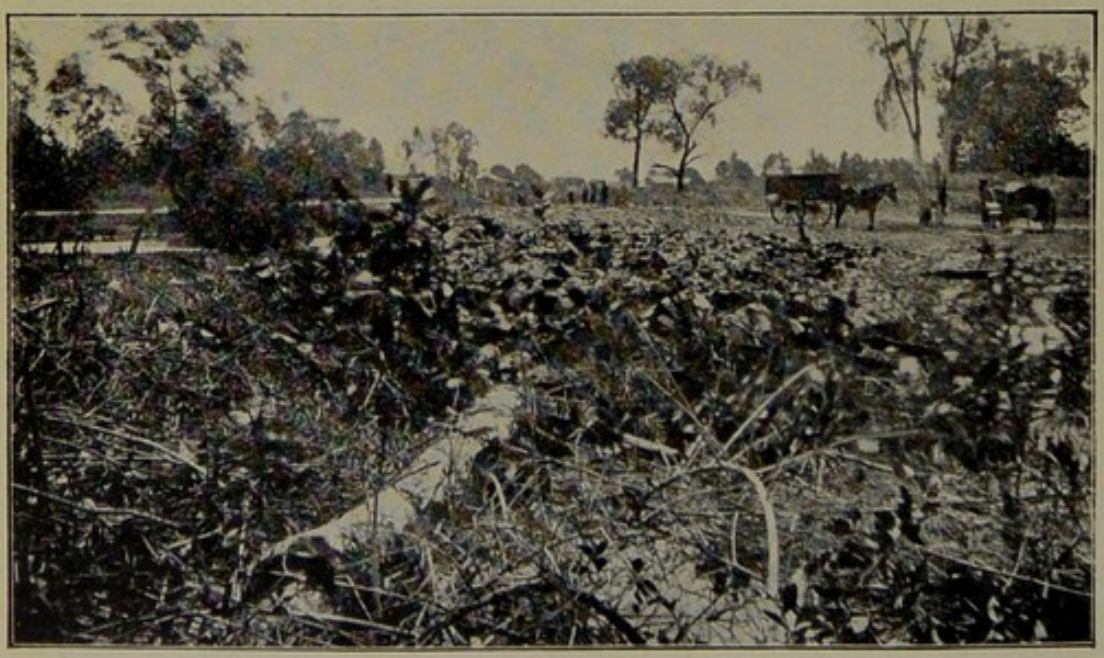

FIG. 8.—CAIRNS.

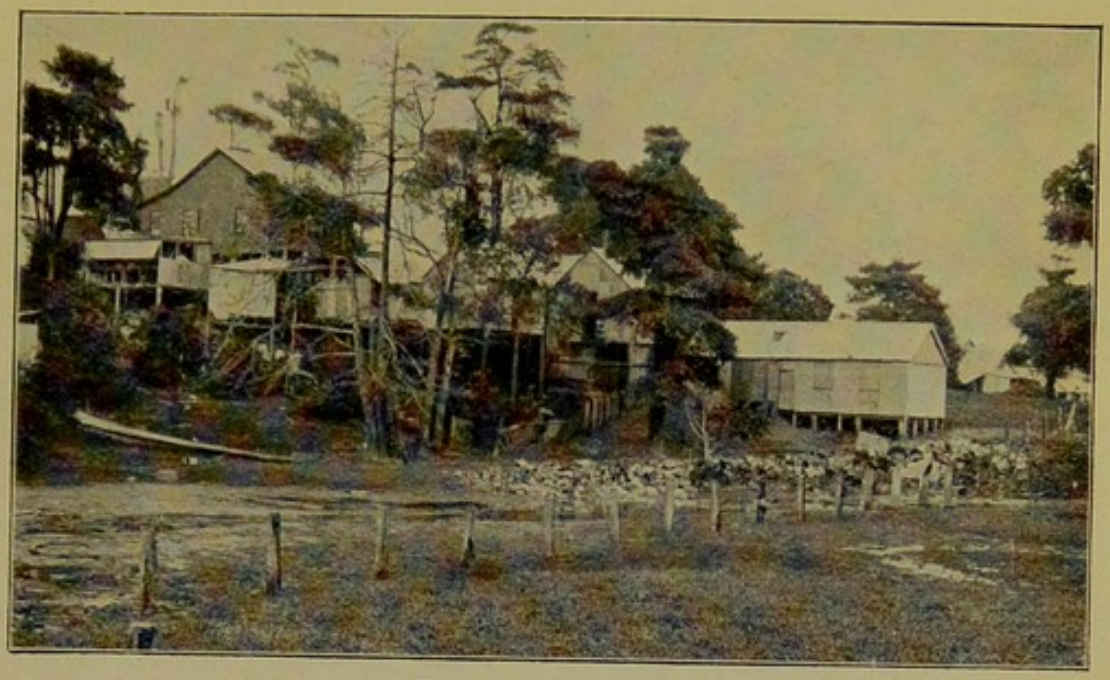

Fig. 9.—Innisfail.

Fig. 10.—Halifax.

REPORT

OF

MOSQUITO SURVEY OF THE COASTAL TOWNS OF QUEENSLAND.

PART II.—BRISBANE TO TOWNSVILLE,

BY

F. H. TAYLOR.

CONTENTS.

MOSQUITO SURVEY OF THE COASTAL TOWNS OF QUEENSLAND.

Part II.

During the months of January to March, 1915, the ports of Queensland, situated between Townsville and Brisbane, were visited in order to investigate the occurrence, distribution, and prevalence of *Stegomyia fasciata* (Fabr.) and other mosquitoes; this being a continuation of the mosquito survey of the coastal towns of North Queensland.

I left Townsville on the 11th January for Brisbane, where I arrived on the 14th, and thence proceeded to Gympie, remaining there till 29th January. Maryborough was next visited. From there I proceeded to Bundaberg, remaining until the 9th February. Afterwards Gladstone and Rockhampton were examined, and I arrived on 25th February at Mackay. On the 6th March, I left for Bowen, where I remained until the 12th, before returning to Townsville.

During my stay in the various towns I received every courtesy and help, and I am especially indebted to Dr. J. E. Thomson, Acting Commissioner of Public Health, Brisbane, for permission to examine the results of the mosquito survey carried out by the Department in and around Brisbane; to Mr. Cooling, for preparing a map of Brisbane; to Dr. Cuppaidge and Mr. E. E. Walker (Gympie); Dr. Cairns Penny and Mr. Parkinson, P.M. (Maryborough); in Rockhampton, to Inspector G. Wiseman, of the Health Department, Mr. G. Stevenson, Inspector Public Works, the Town Clerk, and the Curator of the Botanical Gardens; and in Mackay, to Drs. W. Hoare and Williams, and the Mayor and Town Clerk, for their interest and help.

Method of Examination.

In order to ascertain the presence of mosquito larvæ in the rain-water tanks, the "screen" from the man-hole was removed, and a scoop—a white enamelled kitchen ladle, 4½ inches in diameter and 2 inches deep, fitted with a telescopic handle—was gently lowered into the water and slowly raised again. The larvæ were thus captured and brought to the surface for identification. In cases where the "screens" were soldered down, it was sometimes possible to detect the presence of larvæ by striking a smart blow on the top of the tank, and thus driving the larvæ to the bottom, when they were found in the water drawn off from the tap.

A similar method was adopted in the examination of water barrels, street gully traps, water-courses, garbage depôts, &c.

Mosquito Breeding Places.

Generally speaking, mosquito breeding places may be conveniently divided into (1) natural, and (2) artificial, breeding grounds.

(1) Natural breeding places comprise creeks, stagnant waters, such as swamps and rain-water pools, plants, such as bananas, cocoanut trees, and sugar cane.

Larvæ are seldom found in running water, but still water along the banks of creeks offers opportunities for breeding purposes; pools in rocky creek-beds, left by the drying up of the creek, form excellent situations for the propagation of mosquitoes. Swamps, both fresh and salt water, often contain mosquito larvæ in numbers.

(2) Artificial grounds may be classed as rain-water tanks, underground wells, water barrels, roof gutters, old tins in garbage depôts, street gully-traps, dams, cess-pits, sewers, borrow pits, hollow trees, cut ends of bamboos, &c., in short, any place which may act as a receptacle for stagnant water.

Of such places, the most important are rain-water tanks, roof gutters, water barrels, and old tins. It is in these places that the larvæ of *Stegomyia fasciata* are found.

It is noteworthy that the larvæ of this species are found mainly in water receptacles which are covered, and they seem to avoid breeding in places exposed to the direct light of the sun. Thus they differ in their breeding habits from *Culex fatigans*, which are almost universally found in water collections to which the sun's direct rays have free access.

Maps of the towns visited are appended, showing the localities where mosquitoes were found.

The number of water tanks and other receptacles infected with mosquito larvæ are shown in tables, together with the number of larvæ of *Stegomyia fasciata* (Fabr.), *Culex fatigans*, Wied., and *Nyssorhynchus annulipes* (Walker), contained in a scoopful of water, and the number of occasions on which adults were encountered.

A fourth table gives a list of the various other species of mosquitoes found in the towns visited.

BRISBANE.

The city of Brisbane is situated on the River Brisbane, about 20 miles from its mouth. The population of the city and metropolitan area, according to the census of 1911, was 139,480.

The following details concerning the city of Brisbane are taken from Inspector L. E. Cooling's report, published in the Annual Report of the Commissioner of Public Health for the year 1913 :—

The mosquito breeding places in Brisbane are primarily divided into two classes, viz. :—

1. Natural waters.
2. Artificial waters.

The former may be divided into—

(*a*) Polluted waters.
(*b*) Pure waters.

In considering the former, it is very necessary to note that all water-courses in their natural state about Brisbane contain at least one kind of our indigenous larvivorous fish. These fish, under natural conditions, play a very important role in mosquito reduction, not so much against the typical foul-water breeder, *Culex fatigans*, but as against *Anophelinæ*.

The members of this sub-family, *Anophelinæ*, are universally known to be clean water breeders.* They breed in small puddles of rain water, especially water standing amongst grassy situations. If these waters are made uninhabitable for fish by sewage contamination, as in the case of sewers and septic tanks discharging into them, it tends to promote the propagation of *Culex fatigans*, Wied.

* This is not always the case, as I have found the larvæ of *Nyssorhynchus annulipes* on several occasions breeding in *muddy* water.

b) This includes mainly salt water. Typical breeding places exist about Brisbane River and its tributaries. In numerous places about their banks, tracts of low, flat land are subject to frequent flooding by our spring tides. Water is left on these stretches of land to stagnate after ebb tide. As the water evaporates more and more, these form in their basins a series of small ponds and puddles, in which green algæ grow and which serve as ideal breeding places for *Culicelsa vigilax* (Skuse).

(2) This comprises collections of water in artificial receptacles, viz., tanks, roof gutters, rubbish tips, and other innumerable places directly about habitations.

Cooling further states that—"By far the most prevalent mosquito in Brisbane is *Culex fatigans*, Wied., commonly known as the "house mosquito," the female of which is capable of transmitting the parasite of *filariasis*.

Culex fatigans is a most troublesome species; its breeding places are seldom found far from the abode of man, and they are thus classified as follows, in range of importance :—

1. Natural water-courses into which sewers and septic tanks discharge.
2. Septic tanks and cesspools.
3. Liquid manure barrels.
4. Street gully traps.
5. Rubbish bins containing water.
6. Old tins, &c., about neglected yards.

This mosquito may, therefore, be taken as the typical foul-water breeder.

Street gully traps are amongst the most important breeding places of *Culex fatigans*, and, consequently, they have necessitated the services of two men permanently employed throughout the summer months for their weekly petrolization. Throughout last summer, 2,070 street gully traps were kept under control.

It is a very common sight to see numerous egg rafts of *Culex fatigans* floating on the oily surface of water in street gullies; and, moreover, I have often observed that they have hatched into actively motile larvæ in spite of the remaining thin film of oil.

Liquid manure barrels are also prolific breeding places for *Culex fatigans*.

The breeding of *Culex fatigans* is very much reduced in the winter months, though it cannot be said that cold will check its growth to any great extent. It still propagates in sewerage collections, the larval life being considerably prolonged, usually extending over a fortnight. In view of this fact, we resorted to a fortnightly petrolization of its breeding places. During last year (1912) it was found that *Culex fatigans* passed the winter months both in the larval and the imago stages. They were so numerous in several districts as to render it almost impossible to sleep without nets.

Given abundant supply of sewerage collections, it matters not how cold it is, *Culex fatigans* will always be found.

Stegomyia fasciata (Fabr.), a second species of mosquito infesting houses, is very prevalent, and it, too, is essentially a domestic insect, never breeding away from habitations. This is the dreaded yellow fever carrier, commonly known as "the tiger mosquito."

Stegomyia fasciata is diurnal in its habits, and an extremely annoying insect. It breeds most abundantly in rain-water tanks, water in sagged portions of roof guttering, saucers under legs of safes, ornamental shells, garden barrels, and very frequently in tin cans, &c., about houses. Any small collection of water in an artificial receptacle is liable to be utilized as a breeding place for this pest. I have found larvæ in water other than artificial receptacles.

In the city *Stegomyia* larvæ have been found at an altitude of 120 feet above street level, in a cistern used as a fire sprinkler. Of sixteen fire sprinklers examined in the city about half have been found to be breeding larvæ of *Stegomyia fasciata*.

Stegomyia fasciata has been found to travel a distance of 5 chains. This has been demonstrated by the fact of a house being built at the above distance away from the nearest *Stegomyia* breeding place. It was found that seven months afterwards the new tank had begun to act as a breeding place for larvæ of this species.

On one occasion, after a long spell of dry weather, the roof gutters of a shingle-roofed church were found half full of water, and breeding innumerable *Stegomyia fasciata* larvæ. On another occasion *Stegomyia* larvæ were found breeding in a South African plant, *Dracæna hookeriana*.

There is no doubt that in Brisbane *Stegomyia fasciata* bridges the winter in the larval stage. During my inspections last winter (1912) I had opportunity to prove this, and larvæ were found to breed in tanks and other collections suited for *Stegomyia* breeding. It must, however, be said that the breeding was very slow.

Culicelsa vigilax (Skuse).—A third species of mosquito, is the cause of much annoyance in gardens and about shrubberies, but, fortunately, is seldom found frequenting the interior of houses. This is locally known as the "black bush" or "salt-water" mosquito.

Though this mosquito is of the sylvan variety, it is extremely annoying to man; but, so far, fortunately it is not known to play any part in the dissemination of disease.

Salt marshes about the river are subject to frequent renewal at spring tides; it is here that *Culicelsa vigilax* is found in enormous numbers. The places where these marshes are known to exist are at Mayne, Hamilton, Windsor, New Farm, and Norman Creek.

The breeding of the *Culicelsa vigilax* seems to be greatly affected by cold. The winter months are survived by a few stray females, and also by a small batch of larvæ.

Other Species.—Other species exist about Brisbane, but they are not in sufficient numbers to constitute a nuisance. These are *Mucidus alternans* (Westwood), or our "Scotch Grey," or locally known about Hexham swamps in New South Wales as "Hexham Grey"; *Culex sitiens*, Wied., *Culicelsa annulirostris* (Skuse); and *Culicada vittiger* (Skuse). The two former are found in company with *Culicelsa vigilax*, while the latter has only lately been found to breed in small temporary collections of rain water.

Anophelinæ are never plentiful, and on only one occasion has *Myzorhynchus bancrofti* (Giles), been found in a house. So scarce is this species that the larvæ have never been seen, and only a few females may be found occasionally in scrub country.

Larvæ of *Nyssorhynchus annulipes* (Walker), are found in moderate numbers in fresh water pools collecting after rain, and it seems not unlikely that they would propagate in our fresh water creeks if it were not for the presence of fish. The latter constitute the reason for the relatively small number of *Anophelinæ*.

Culex fatigans, *Stegomyia fasciata*, and *Culicelsa vigilax*, have really been the cause of the greatest mosquito nuisance in and around Brisbane.

As previously mentioned, temporary collections of water are in no way connected with the breeding of *Anophelinæ*. This has already been explained by the breeding habits of our *Culicinæ*. If clean water would remain as permanent marshes, and, at the same time not contain any larvivorous enemies, then it seems likely that we would be well represented by members of the sub-family *Anophelinæ*; but, as it fortunately happens that our clean waters are either temporary, for short periods only, or permanent, it does not give *Anophelinæ* time to breed in the former; and, again, even if the water does stagnate long enough, there are no *Anophelinæ* to inhabit it. With reference to the permanent waters, these are protected against mosquito breeding by the presence of fish.

GYMPIE.

Gympie, situated on the Mary River, is 106 miles from Brisbane and 61 miles from Maryborough by train.

The town and its environments are very hilly, and the gullies in between the hills afford an excellent outlet for all surface drainage into the Mary River. The surrounding country is of a similar nature, and is covered in many places with virgin scrub.

The estimated population of the town is about 9,000, who are mainly dependant for their livelihood upon mining, dairy farming, and timber getting.

The garbage depôt, situated off River-road, is not of an extensive nature, but contains a fairly large number of partially destroyed, disused tins, holding rain water which, in some instances, contained the larvæ of both *Stegomyia fasciata* and *Culex fatigans*, the former species predominating.

The water supply is of two sources—a town supply from the Mary River, heavily infected with plant organisms; and rain water, contained in rain-water tanks. This latter is in more general use on account of its purity.

Examination of House Tanks.

An examination of rain-water tanks in scattered parts of the town, revealed the presence of *Stegomyia fasciata* in comparatively large numbers.

The water tanks were found in every instance imperfectly protected against mosquitoes. They were covered by a rough screen or filter made of galvanized iron, generally funnel-shaped, loosely fitting, and perforated by large nail holes through which mosquitoes could readily pass. This screen acts as a filter to keep out eaves washed down from the roof.

Altogether fifteen rain-water tanks were examined, all of which were found to harbour larvæ pupæ or adults of *Stegomyia fasciata* in varying numbers. The adult mosquito was found on nine occasions.

Table 1 shows the number of tanks examined and the number of larvæ found. On the average, each tank contained three larvæ to a scoop.

In addition to the examination of the water tanks for the presence of *Stegomyia fasciata*, several dwelling-houses in Mary-street were visited, to ascertain whether adult mosquitoes were present.

Ten houses and one office building were searched, and with the exception of one house, adult *Stegomyia* were found in every case, most numerous in one house which was exceptionally dark.

Culex fatigans, Wied.—Larvæ and adults of *Culex fatigans* were found on four occasions. A considerable number of larvæ and egg-rafts of this mosquito were noted on one occasion in company with *Stegomyia fasciata*. Another time ten egg-rafts and about 30 larvæ were encountered in a horse-trough. Larvæ and adults were also found at the garbage depôt situated in close proximity to the town. Adults were found in one house in spite of the absence of stagnant water in the vicinity.

Larvæ were found in an old water tank on a mining property on the way to Nashville, a suburb of Gympie, as well as in Nash's Gully, at the intersection of River-road.

The scarcity of *Culex fatigans* in Gympie is probably due to the excellent natural drainage afforded by the hilly nature of the district, which prevents the accumulation of stagnant water-pools.

Nyssorhynchus annulipes (Walker)—The larvæ of *Nyssorhynchus annulipes* were found twice in shallow water around the edge of water-holes on the property of No. 4 North Phœnix mine. There they were present in comparatively large numbers, as many as ten were collected in a scoopful of water. Larvæ of this species were not found in deeper water.

Summary.

In Gympie, *Stegomyia fasciata* were found in large numbers in and around the majority of the houses examined, and were discovered breeding in every house tank examined.

Culex fatigans was less frequently encountered, breeding in collections of water open to light, such as horse troughs, old disused water tanks, and in Nash's Gully.

Nyssorhynchus annulipes was only encountered on two occasions in its larval stage, in shallow water on the North Phœnix mine.

MARYBOROUGH.

Maryborough is on the Mary River, 167 miles from Brisbane by train, and 180 miles by water. It is situated on comparatively level country with a few small hills in the distance.

The land has been cleared of trees for a considerable distance from the town, which is spread over a wide area, and has an estimated population of 13,000 inhabitants.

The main occupations of the population are farming, timber getting, and engineering. Maryborough possesses large engineering and railway workshops.

In addition to the town water supply, which comes from a distance of 9 miles, there are numerous rain-water tanks. The majority of the tanks could not be examined for the presence of larvæ owing to the fact that they were raised several feet above the ground, and many of them had their screens soldered down. The examination, therefore, was mostly limited to the older tanks from which the screens could be removed. These screens were made of galvanized iron, perforated with nail holes large enough to permit of the entrance of mosquitoes.

Altogether nineteen rain-water tanks were examined for the presence of the larvæ of *Stegomyia fasciata*, in various portions of the town, in every instance with a positive result. Sixteen of them also harboured the adult mosquito. The average number of larvæ found to a scoopful of water was 2·8 per tank.

The details of this examination are given in Table 1, and the exact localities where larvæ were found are shown on the sketch map of the town.

In addition to the water tanks, six water barrels in a bush house in Queen's Park contained larvæ of *Stegomyia fasciata*. One barrel harboured them in the proportion of one larvæ to a scoopful of water; two contained three larvæ; one four larvæ; one nine larvæ; and one had 25 larvæ to a scoopful. Thus, the average number of larvæ per scoop per barrel was 7·5.

Culex fatigans, Wiedemann.—*Culex fatigans* was of more common occurrence here than in Gympie, as there was a considerable amount of surface-water lying in the street water-tables, and in a gully which drained away the refuse water from houses in Queen-street. The larvæ were found in water barrels, one of which was heavily infected, 20 larvæ were counted to a scoopful of water. It was also found six times in street water-tables.

Two breeding places call for particular mention, the water-tables in that part of Ann-street between Richmond-lane and Marsh-street, and in John-street. In the former, this mosquito was found breeding in enormous numbers, as many as 100 larvæ being counted to a single scoopful of water. The other, which was about 2 feet wide, contained stagnant water for the whole distance between Churchhill and Woodstock streets, and was covered in places with green slime. Larvæ were present in numbers varying from four to twenty to a scoopful of water, and of egg-rafts from three to twelve were counted to a square foot of water.

Nyssorhynchus annulipes (Walker), was apparently absent from the neighbourhood of the town as the larvæ were not found in any of the water-tables or in the lagoon in the reserve off Gayndah-road, near Cheapside-street.

Both *Culex sitiens* Wied., and *Culicelsa vigilax* (Skuse), were found in large numbers sheltering in the trees and bushes on the banks of a tidal creek in Queen's Park, the most likely breeding place being a small pond enclosed by wire netting. Two small water-holes and a large lagoon situated

in the reserve on the Gyndah-road, between Cheapside and Neptune-streets, were searched for mosquito larvæ. None were found in the lagoon, but small numbers were seen in the water-holes. Adults of both species sheltered in the grass on the edges of these water-holes.

The garbage depôt is situated on the outskirts of the town, at the end of John-street, about a quarter of a mile distant from the nearest dwelling. It is of considerable size and contains a great number of empty tins, most of them still capable of holding water. Although at the time of inspection none of the tins contained water on account of the dry weather, they afford an excellent breeding ground for mosquitoes during the rainy season.

SUMMARY.

1. In Maryborough, *Stegomyia fasciata* was found in every rain-water tank examined in various parts of the town, as well as in a number of water barrels in a bush-house in Queen's Park.

2. Larvæ of *Culex fatigans* occurred in large numbers in several of the street water-tables and drains situated in the main parts of the town, and in water barrels in the vicinity of houses.

3. *Nyssorhynchus annulipes* was not found in the neighbourhood of the town.

4. *Culex sitiens* and *Culicelsa vigilax* sheltered in the trees and bushes along the creek in Queen's Park. Larvæ of these species occurred in small water-holes on the reserve on the Gayndah-road.

BUNDABERG.

Bundaberg is situated on the Burnett River, 217 miles from Brisbane by train, and 272 miles by water, and the district has a population of about 17,000.

It is the centre of a large sugar-growing district, extending for several miles.

In addition to a town water supply, most of the houses possess rain-water tanks, which are, on the whole, in a good state of repair. Many of the tanks are raised 10 or 12 feet above the ground, and a thorough examination of these tanks is practically impossible. The screens of the tanks examined were of the same pattern as previously described, and were perforated with large nail holes, thus affording no protection against the breeding of mosquitoes.

Unfortunately, the heavy cyclonic rain which fell during my stay in this town, greatly handicapped the work, since many possible breeding grounds were flooded and washed out by the incessant rain. As an example may be pointed out the small areas of swampy land on the town side of Salt Water Creek adjacent to Woondooma and George streets. These swamps are noted breeding grounds for mosquitoes, but at the time of my visit not a single larvæ or egg-raft could be found, since the stagnant water of the pools had overflowed into the creek. For the same reason the garbage depôt of the town was not visited.

Stegomyia fasciata (Fabr.).—Nineteen rain-water tanks in different parts of the town were examined for the presence of *Stegomyia fasciata* larvæ. In every case these larvæ were discovered, and on nine occasions the adult mosquito was found.

In addition, one water barrel contained these larvæ in the proportion of six larvæ to a scoopful of water.

The details of the examination of the rain-water tanks are given in Table 1, and the exact localities where larvæ were found are shown on the sketch map of the town.

Culex fatigans, Wiedemann.—*Culex fatigans* was found on one occasion only in a water barrel on the property at the intersection of Bourbong and Targo streets, in the number of three to a scoopful, but no adults were seen. The absence of *Culex fatigans* from the street gutters and other favorable breeding grounds is readily explained by the heavy rain.

SUMMARY.

1. A conclusive mosquito survey in Bundaberg was made impossible by the heavy rain, especially as regards *Culex fatigans*.

2. *Stegomyia fasciata* was found breeding in every tank examined, as well as in one water barrel.

GLADSTONE.

Gladstone, situated on Port Curtis, is 382 miles by train and 372 miles by water from Brisbane. The greater part of the town is built upon hilly ground, and the surrounding district is hilly and well covered with timber. The gullies in the hills form natural water-courses during the wet season. The fore-shores of Port Curtis are black mud flats, covered for several miles with dense growths of mangroves. A broad stretch of ground between the northern and western portions of the town lies below sea level and forms a tidal flat.

The estimated population of the town is about 1,000, and of the district about 5,000, and their principal means of livelihood is cattle and horse raising and dairying.

Rain-water tanks of the same nature as previously described are in general use throughout the town. The garbage depôt is situated near some mangrove flats, about 2 miles from the town and about ½ mile from the nearest dwelling. It covers a large area of ground and contains a number of old tins. In no instance were larvæ of any species of mosquito found in the tins, which, however, was probably due to the continued heavy rain which had fallen during the past few days.

Stegomyia fasciata (Fabr.).—Eighteen water tanks were examined in various parts of the town, and all were infected with the larvæ. No adults were seen in any of the water tanks, probably on account of the recent heavy rains.

Table 1 shows the number of water tanks examined and the number of larvæ found to a scoopful of water; the localities are indicated on the sketch map of the town.

On one occasion larvæ were found in water contained in a large tin in the back yard of a house, there being four larvæ to a scoop. Adults of this species were found in numbers in two houses.

Culex fatigans, Wiedemann.—*Culex fatigans* was only rarely met with, in all probability for the same reason as stated in Bundaberg, the heavy rains. It was found in one locality only, in old kerosene tins on vacant land adjoining the tennis court. One tin had ten larvæ to a scoopful of water, a second 25, and a third 48.

No *Nyssorhynchus annulipes* were seen in the neighbourhood of this town.

Adults of *Culex sitiens*, Wied., and *Culicelsa vigilax* (Skuse) were found in and around the town, although I was unable to discover their breeding places.

SUMMARY.

1. *Stegomyia fasciata* was found breeding in every house tank examined, and in a disused tin in a back yard. Adults were discovered in two houses.

2. *Culex fatigans* was comparatively scarce on account of the heavy rain flooding out their breeding places.

3. *Nyssorhynchus annulipes* was not seen, whilst adults of *Culex sitiens* and *Culicelsa vigilax* were encountered.

ROCKHAMPTON.

Rockhampton is situated on the Fitzroy River, about 396 miles by train and 472 miles by water from Brisbane. The Fitzroy River is navigable for ships of a tonnage of 12,000 tons almost as far as the town wharfs. The estimated population of the city is 20,000, which relies on the export of products from the back country, including meat, hides, minerals, &c.

Part of the city and much of the surrounding country is low lying and under water in wet weather. These low-lying parts act as breeding grounds for several species of mosquitoes, chiefly *Nyssorhynchus annulipes, Culicada vittiger, Culex sitiens*, and *Culicelsa vigilax*.

Besides the city water supply derived from lagoons about 2 miles from the Botanical Gardens, practically every house possesses a rain-water tank, which is, as a rule, kept in good repair. The "screens" are of a similar nature to those seen in the other towns, viz., funnel-shaped and perforated with large nail holes.

The garbage depôt is situated on the banks of the Fitzroy River, off Lion Creek-road, about 3 miles from the post-office, and contains a very large collection of old rusty tins, of which only a small number contained water. In four instances larvæ of *Culex fatigans* were found in the tins, 5, 7, 15, and 4 respectively to a scoop. The nearest dwelling to the depôt is about half-a-mile distant.

The lagoon from which the water supply for the railway is derived is situated on the Port Curtis-road, about 4 miles from the town, and is of considerable size. The larvæ of *Mucidus alternans* were found in small numbers along its banks—one larvæ to a scoop.

Stegomyia fasciata (Fabr.).—Forty-one rain-water tanks were examined in various parts of the town. All of them harboured the larvæ of *Stegomyia fasciata*, whilst adults were present in seven. The average number of larvæ found to a scoopful of water was 3·3.

Table 1 gives the number of rain-water tanks examined and the number of larvæ found to a scoop. The sketch map of the city shows the localities where the larvæ were found.

Culex fatigans, Wiedemann.—*Culex fatigans* is very prevalent throughout the city of Rockhampton. The principal breeding places are the street gully traps through which the storm and house water passes on its way to the main drains and river.

The heavy rain which fell during my stay in this city flooded many of the drains and gully-traps, washing out the mosquito egg-rafts and larvæ.

Larvæ were encountered in three disused oil drums, a water trough, the basin of a memorial fountain, and a disused water tank. Adult mosquitoes were captured on eight occasions.

Table 2 shows the number of receptacles examined, together with the number of larvæ found to a scoop. The localities where larvæ were found are indicated on the accompanying sketch map.

Nyssorhynchus annulipes (Walker).—Larvæ of *Nyssorhynchus annulipes* were seen on three different occasions, once in two small collections of water on a vacant allotment of land in the city, a second time in a dam, and a third time in a lagoon. Adults were captured on one occasion in the Botanical Gardens.

Of *Anophelinæ*, adult specimens of *Myssorhynchus barbirostris* var. *bancrofti* (Giles) occurred in numbers, but no larvæ were found in the Botanical Gardens in the water-holes.

Culicada vittiger (Skuse) was found in large numbers in the Botanical Gardens. Some larvæ, probably of the same species, which were collected, died before reaching maturity.

Only one adult of *Mucidus alternans* (Westw.), the "Scotch Gray," was captured. Larvæ were only seen in the lagoon from which the water supply for the railway is obtained.

Plants in the Rockhampton Botanical Gardens, capable of retaining water between their fronds, were searched in vain for mosquito larvæ. The recent heavy rain had, in all probability, washed out all the larvæ. The open tanks and the casks in the fern houses were apparently free from mosquito larvæ.

There is a comparatively large swampy area between Wood and Arthur streets, where *Culicelsa vigilax* breeds in large numbers.

Larvæ of *Culex sitiens* were found in two localities, in the lagoon near the Botanical Gardens, and in the dam on some vacant land off Wandal-street.

A single specimen of another species, *Pseudoskusea linealis*, Taylor, was found at the garbage depôt.

NORTH ROCKHAMPTON.

The town is situated on the opposite side of the Fitzroy River to Rockhampton, and is a suburb of the city, with an estimated population of about 3,000. Most of the township is built on low-lying and flat ground. An extensive swamp is situated on both sides of Bridge-street, adjoining the public school, and in this *Nyssorhynchus annulipes* breeds in small numbers, the proportion of larvæ present being one to a scoop. There is a second swamp in Ross-street, off Bridge-street, where these *Anophelines* are present in similar numbers.

Culicelsa vigilax was found breeding in three swamps, one situated in Bridge-street, three larvæ to a scoop; one in Ross-street, two larvæ to a scoop; and one in Edward-street, three and four larvæ to a scoop.

From information collected, it seems that mosquitoes are numerous in this part of the town, especially during the wet season, when the low-lying ground on which the town is built, is covered with water.

The water supply consists entirely of rain water collected in tanks. These tanks are generally insufficiently screened, the screens being of the same type as in other towns.

Stegomyia fasciata (Fabr.).—Thirty-nine rain-water tanks were examined for the presence of *Stegomyia fasciata* larvæ, which were present in every one. The average number of larvæ found to a scoop of water was 5·1.

Table 1 gives details of the examination of the tanks and the positions where the larvæ were found are indicated on the sketch map.

Culex fatigans, Wiedemann.—Larvæ of *Culex fatigans* were found on two occasions only, once in four water barrels in a back yard, and in one rain-water tank. The scarcity of this mosquito was probably due to the recent heavy rain.

Summary.

1. *Stegomyia fasciata* was found breeding in every tank examined in Rockhampton.

2. *Culex fatigans* was prevalent throughout the city, breeding in large numbers in drains and gully traps and other collections of stagnant water. Their number was comparatively small in North Rockhampton, on account of local conditions.

3. Larvæ of *Nyssorhynchus annulipes* were only found on two occasions in the city.

4. *Culicelsa vigilax* was found breeding in large numbers in the swamps.

5. A number of other species were found breeding in the Botanical Gardens and in the lagoons in the neighbourhood of the town.

MACKAY.

Mackay is situated on the Pioneer River, 540 miles from Brisbane by water. The town is built on flat country and is swampy during the wet season. Along the banks of the river and of Alligator Creek are extensive mangrove swamps, which afford shelter and breeding facilities for mosquitoes, particularly *Culex sitiens* and *Culicelsa vigilax*.

The estimated population of the town is 5,000, and the district, according to the last census, has about 12,000 inhabitants.

There are two sources of water supply, the town supply and a rain-water tank system. It is noteworthy that the town water supply is almost exclusively used for domestic purposes, and the water from the tanks is only occasionally used. As a result the tanks in most instances are neglected, some not having even a screen to the manhole.

The garbage depôt is situated on the banks of Alligator Creek off Nebo-street, closely adjoining the town. It is the dumping ground for old tins of all descriptions, many of which are capable of holding water.

Stegomyia fasciata (Fabr.).—Forty rain-water tanks were examined for the presence of *Stegomyia fasciata*. All these tanks harboured larvæ and adults were present in thirteen.

Table 1 indicates the number of tanks examined and the number of larvæ found to a scoop. The localities where the larvæ were found are indicated in the sketch map of the town.

Culex fatigans, Wiedemann.—Twenty-nine street gully traps were found to harbour larvæ of *Culex fatigans* in comparatively large numbers, the average number of larvæ to a scoop being 18·6.

In addition, egg-rafts were found in six street gully traps, three of which had twenty rafts and three had ten.

Only once were larvæ found in a street water-table, and once in a water barrel, where egg-rafts and adults were also present.

Larvæ of *Culex fatigans* were found in five old tins at the garbage depôt.

Table 2 shows the number of receptacles containing larvæ and the numbers found to a scoop. The sketch map shows the localities.

Nyssorhynchus annulipes (Walker).—Larvæ of *Nyssorhynchus annulipes* were found on six occasions, three times in street water-tables, twice in water-holes situated in Shakespeare and Goldsmith streets, and in a swamp adjoining Alfred and Goldsmith streets. In no case were they numerous, never more than two being counted to a scoop.

Larvæ of *Mucidus alternans* (Westw.) were found once in a street gully trap.

Adult *Culex sitiens*, Wied., and *Culicelsa vigilax* (Skuse) were present in Mackay. Larvæ of the latter occurred in small numbers in a small swamp off Goldsmith-street. Both species were breeding in a swamp across the Pioneer River, opposite the town.

Summary.

1. *Stegomyia* was found breeding in tanks throughout the town.
2. *Culex fatigans* bred in numbers in the drains and gully-traps in the streets and in old tins at the garbage depôt.
3. *Nyssorhynchus annulipes* was found six times in its larval stage in street water-tables of the town, in water-holes, and in swamps in close proximity to the town.

BOWEN.

Bowen is built on hilly country on Port Denison, and is 645 miles from Brisbane by steamer. The estimated population is about 1,600. There are three sources of water supply, a town supply, a rain-water tank system, and a number of wells filled by rain water from the roofs. The town supply is derived from the River Don about 2 miles distant.

Bowen possesses two garbage depôts, one situated in the scrub at the east end of William-street, and the other on the sanitary reserve on the banks of Doherty Creek. Both depôts were visited and found free from mosquito larvæ, on account of the dry weather. There are dense mangrove swamps on both sides of Saltwater and Doherty Creeks, the former skirting the town on the eastern, the latter on the western side, and two swamps adjoining the town on the eastern side, which form lagoons during the rainy season.

Stegomyia fasciata (Fabr.).—Seventy-eight rain-water tanks were examined for larvæ of *Stegomyia fasciata*. In every instance they were found, whilst adult mosquitoes were present in 29. Larvæ were also found five times in water barrels. The average number of larvæ to a scoop was 2·1.

Table 1 shows the number of rain-water tanks and other receptacles examined, with the number of larvæ found to a scoop, whilst the localities are indicated on the sketch map of the town.

Culex fatigans, Wiedemann.—Only a few breeding places of *Culex fatigans* were discovered in Bowen, because dry weather had prevailed for some time, and there were no suitable breeding grounds for this mosquito. The adult mosquito was only found once.

The larvæ were found on three occasions in open water tanks, and on a fourth occasion in a water barrel.

Culex vigilax (Skuse) was the only other mosquito met with, in small numbers, in the scrub round the lagoon near Hay-street.

No larvæ were seen, as the lagoon was quite dry.

Summary.

1. Larvæ of *Stegomyia fasciata* were found in every house tank examined (78), and five times in water barrels.
2. *Culex fatigans* were comparatively rare owing to local conditions.
3. *Culicelsa vigilax* bred in small numbers in the scrub around the lagoon.

Table 1.

Showing the number of tanks infected with *Stegomyia fasciata* (Fabr.), and the number of larvæ found to a scoopful of water in each tank.

Gympie.

No. of tanks in which *Stegomyia fasciata* was found ..	2	3	3	1	1	1
No. of larvæ found to a scoop	1	2	3	5	10	13

Average, 3·0.
No. of occasions on which adults were found, 9.

Maryborough.

No. of tanks in which *Stegomyia fasciata* was found ..	7	3	5	2	2	1
No. of larvæ found to a scoop	1	2	3	4	5	7

Average, 2·8.
No. of occasions on which adults were found, 16.

Bundaberg.

No. of tanks in which *Stegomyia fasciata* was found ..	9	4	3	1	1	1
No. of larvæ found to a scoop	1	2	3	4	5	6

Average, 2·1.
No. of occasions on which adults were found, 9.

Gladstone.

No. of tanks in which *Stegomyia fasciata* was found ..	7	3	3	3	2
No. of larvæ found to a scoop	1	2	3	4	5

Average, 2·4.
No. of occasions on which adults were found, nil.

Rockhampton.

No. of tanks in which *Stegomyia fasciata* was found	23	3	7	2	3	3	1	1	1	1
No. of larvæ found to a scoop ..	1	2	3	4	5	6	7	8	10	16

Average, 3·3.
No. of occasions on which adults were found, 7.

North Rockhampton.

No. of tanks in which *Stegomyia fasciata* was found	8	1	7	6	2	1	5	2	6	1
No. of larvæ found to a scoop ..	1	2	3	4	5	6	7	9	10	15

Average, 5·1.
No. of occasions on which adults were found, 1.

Mackay.

No. of tanks in which *Stegomyia fasciata* was found	21	8	3	4	2	1	1
No. of larvæ found to a scoop	1	2	3	4	5	6	10

Average, 2·5.
No. of occasions on which adults were found, 13.

Bowen.

No. of tanks in which *Stegomyia fasciata* was found ..	47	5	9	12	2	3
No. of larvæ found to a scoop	1	2	3	4	5	8

Average, 2·1.
No. of occasions on which adults were found, 29.

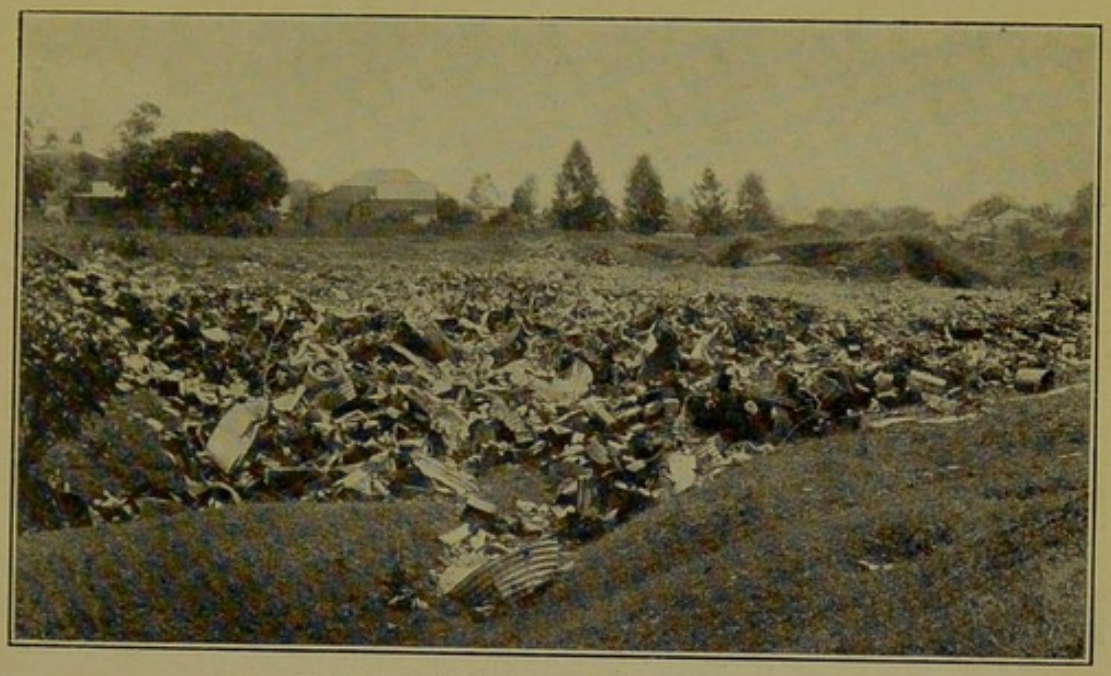

Fig. 1.—The Garbage Depot, Gympie.
A breeding-place of *Stegomyia fasciata* and *Culex fatigans*.

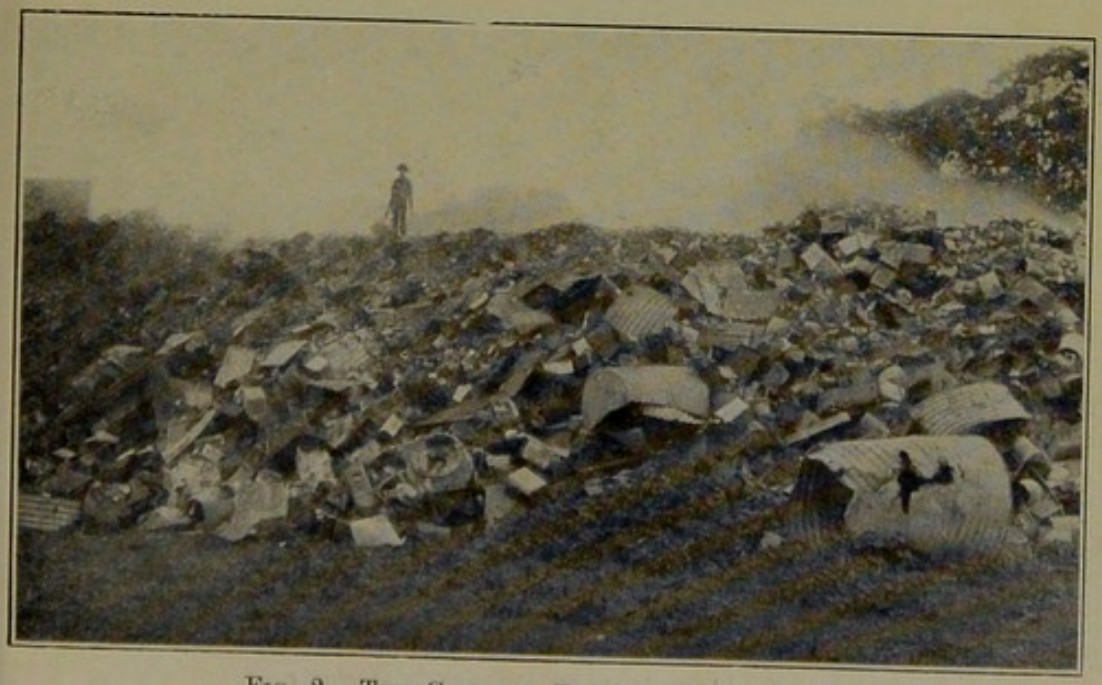

Fig. 2.—The Garbage Depot, Maryborough.

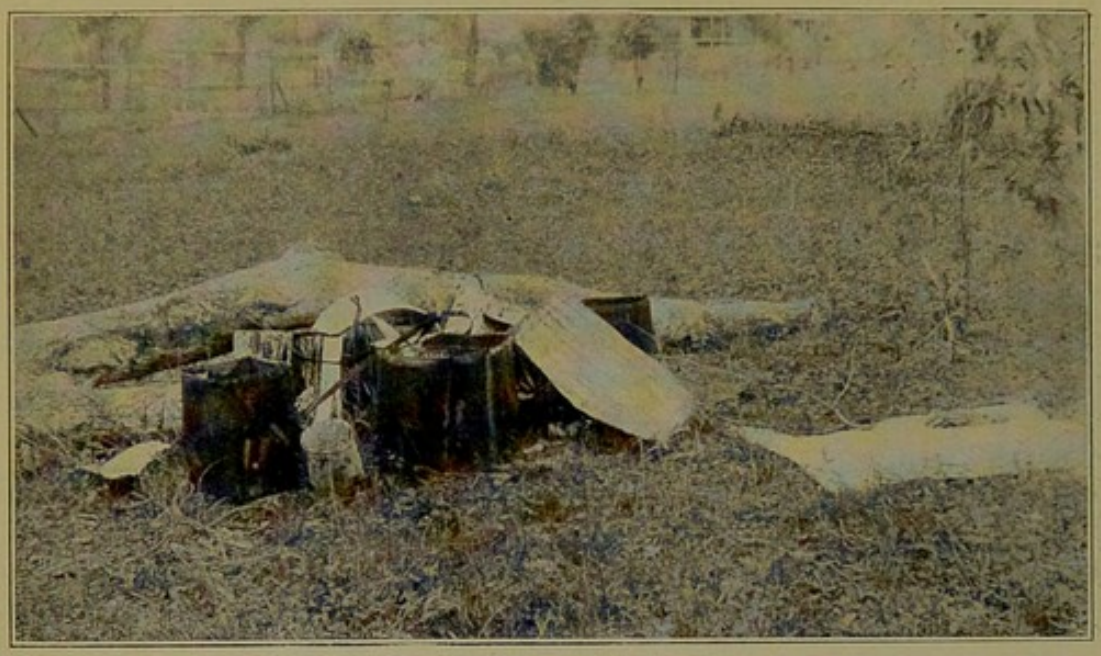

FIG. 3.—GLADSTONE.
Old tins in which larvæ of *Culex fatigans* were found.

FIG. 4.—THE GARBAGE DEPOT, GLADSTONE.

FIG. 5.—ROCKHAMPTON.
The Garbage Depot, where larvæ of *Culex fatigans* were found.

FIG. 6.—ROCKHAMPTON.
A dam in which larvæ of *Nyssorhynchus annulipes* and *Culex sitiens* were found.

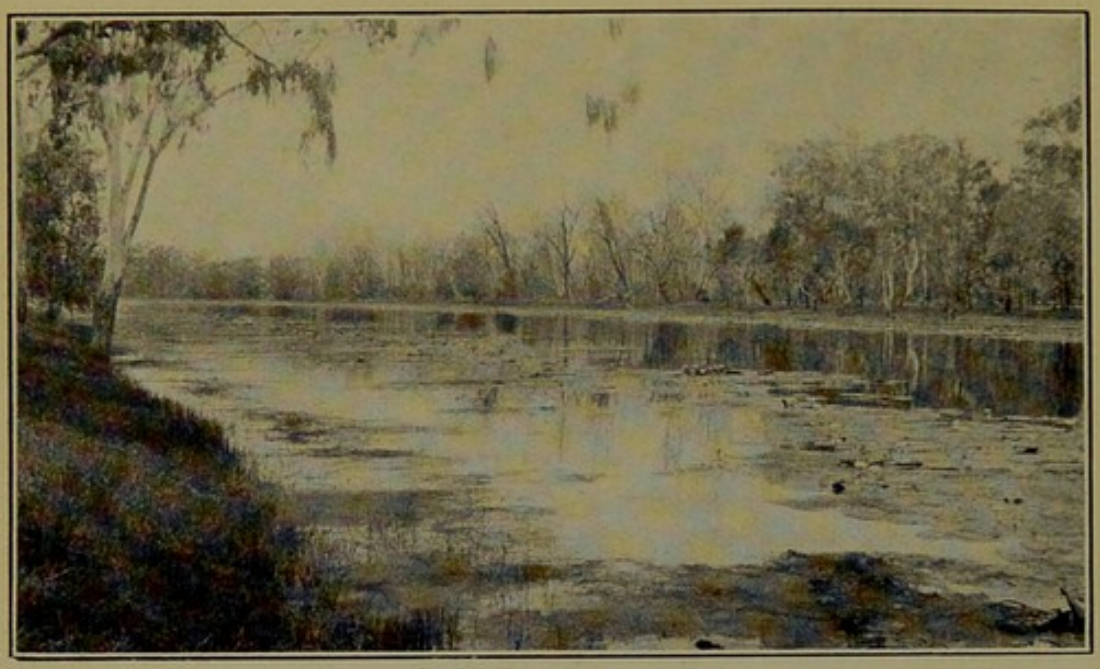

FIG. 7.—ROCKHAMPTON.
The Railway water supply lagoon, in which larvæ of *Mucidus alternans* were found.

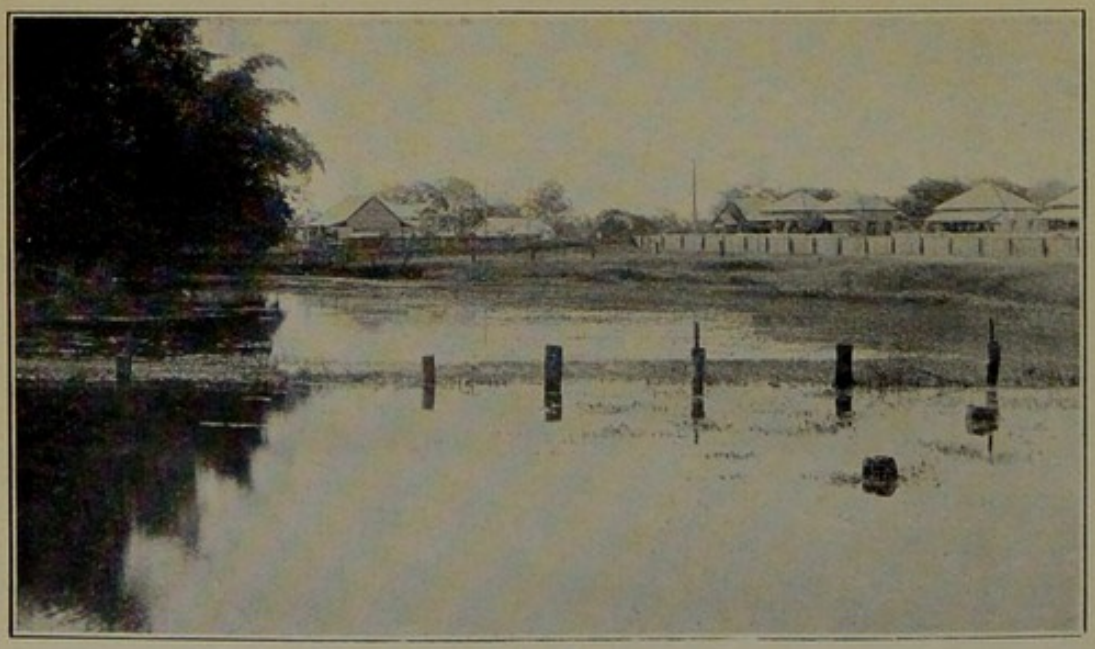

FIG. 8.—NORTH ROCKHAMPTON.
A swamp adjoining the State School, in which larvæ of *Nyssorhynchus annulipes* and *Culicelsa vigilax* were found.

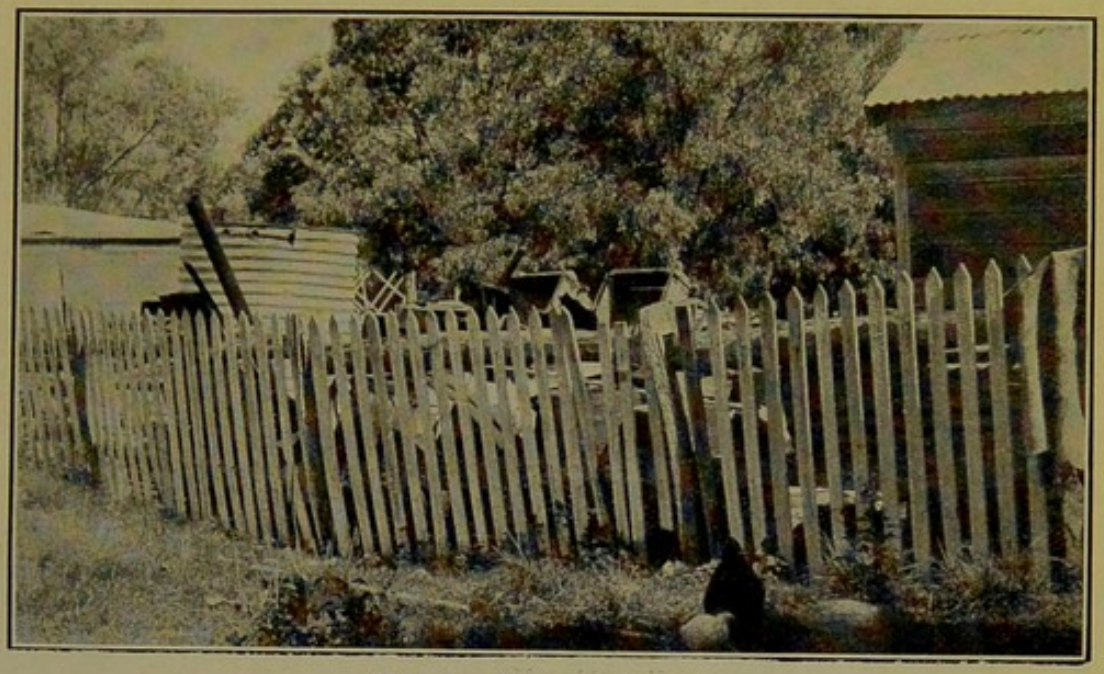

FIG. 9.—NORTH ROCKHAMPTON.

A back yard containing water barrels and an old tank, in which larvæ of *Culex fatigans* were found.

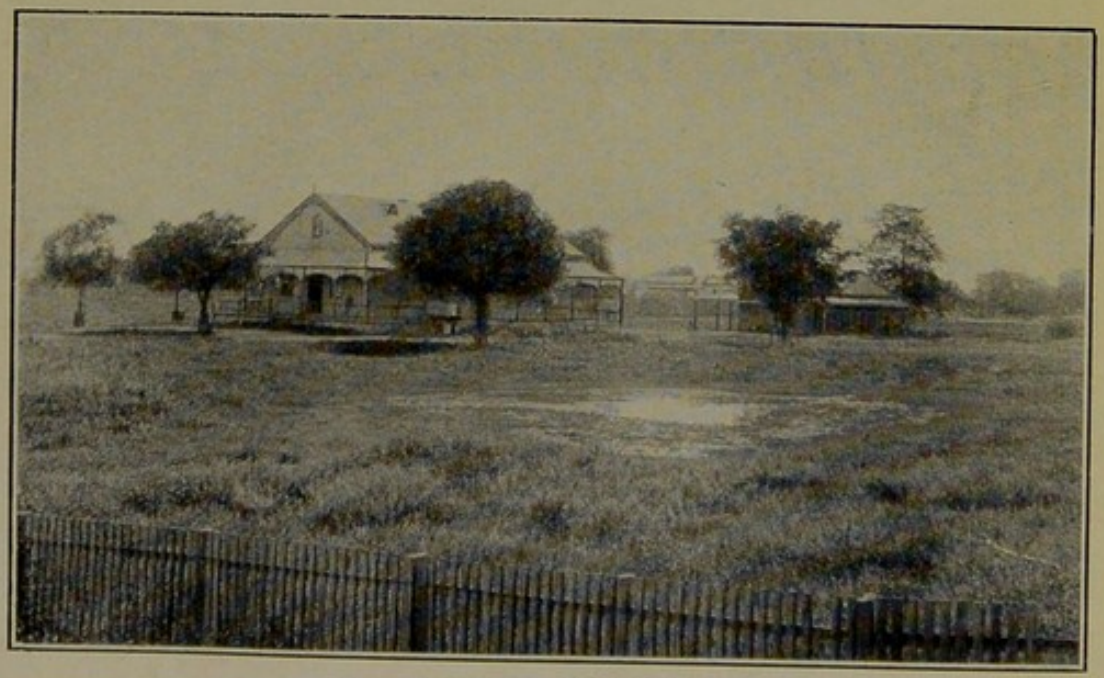

FIG. 10.—NORTH ROCKHAMPTON.

Municipal property with swamp breeding *Culicelsa vigilax*. *Stegomyia fasciata* and *Culex fatigans* were present in the water tanks.

FIG. 11.—MACKAY.

The Garbage Depôt. *Culex fatigans* larvæ were found here.

FIG. 12.—MACKAY.

A pond on private property in Goldsmith-street, in which larvæ of *Nyssorhynchus annulipes* were found.

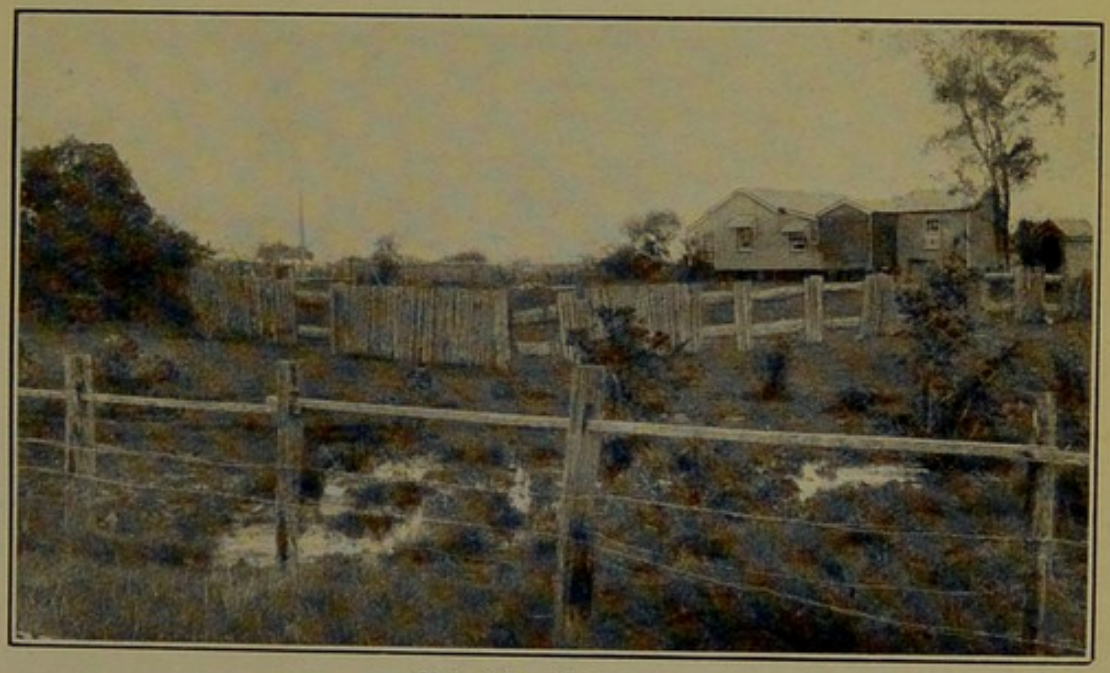

FIG. 13.—MACKAY.

A shallow swamp adjoining the Park. *Nyssorhynchus annulipes* and *Culicelsa vigilax* larvæ were found here.

Table 2.

Showing the number of water barrels, drains, &c., infected with *Culex fatigans*, Wied., and the number of larvæ found to a scoopful of water in each receptacle.

Gympie.

No. of receptacles in which *Culex fatigans* was found	2	1	2	2	3	1
No. of larvæ found to a scoop	3	5	7	13	27	30

Average, 14·7.
No. of occasions on which adults were found, 1.

Maryborough.

No. of water barrels in which *Culex fatigans* was found					1	1
No. of larvæ found to a scoop					5	20
No. of street gutters where *Culex fatigans* was found	1	2	1	1	1	
No. of larvæ found to a scoop	3	4	12	16	100	

Average, 20·5.
No. of occasions on which adults were found, nil.

Bundaberg.

No. of water barrels in which *Culex fatigans* was found						1
No. of larvæ found to a scoop						3

Average, 0·0.
No. of occasions on which adults were found, nil.

Gladstone.

No. of disused tins in which *Culex fatigans* was found					1	1	1
No. of larvæ found to a scoop					10	25	48

Average, 27·6.
No. of occasions on which adults were found, nil.

Rockhampton.

No. of drain traps where *Culex fatigans* was found	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3
No. of larvæ found to a scoop	6	14	16	18	28	39	54	60	97	10	12	15	17	20	25	80	100	4	5	9	3

Average, 27·0.
No. of occasions on which adults were found 8.

No. of water barrels and other receptacles	4	2	1	1	1	1
No. of larvæ to a scoop	10	4	2	5	7	15

Average, 7·7.
No. of occasions on which adults were found, nil.

North Rockhampton.

No. of water barrels, &c., where *Culex fatigans* was found	1	1	1	1	1
No. of larvæ found to a scoop	1	4	7	10	15

Average, 7·4.
No. of occasions on which adults were found, nil.

Mackay.

No. of drains and traps where *Culex fatigans* was found	1	2	4	4	2	3	1	1	3	2	3	2	1	2	2	1	1
No. of larvæ found to a scoop	1	4	5	7	9	10	11	12	15	16	17	19	20	30	48	50	54

Average, 16·4.
No. of occasions on which adults were found, 11.

Bowen.

No. of tanks and water barrels where *Culex fatigans* was found	2	2
No. of larvæ found to a scoop	1	3

Average, 1·7.
No. of occasions on which adults were found, 1.

Table 3.

Showing the presence or apparent absence of *Nyssorhynchus annulipes* (Walker).

Gympie	Two waterholes in which the larvæ were present in numbers varying from six to ten to a scoopful of water.
Maryborough ..	The presence of adults or larvæ was not detected in this town.
Bundaberg	The presence of adults or larvæ was not detected in this town.
Gladstone	The presence of adults or larvæ was not detected in this town.
Rockhampton ..	The larvæ were found on four occasions in water-holes in numbers varying from one to four larvæ to a scoopful of water. Adults were found in the Botanical Gardens.
North Rockhampton ..	Larvæ were found on three occasions in swamps in small numbers, one larvæ to a scoopful of water. Adults were not seen.
Mackay	Larvæ were found on six occasions, three times in street water tables, twice in water-holes, and once in a swamp. Adult were not observed.
Bowen	The presence of adults or larvæ was not detected in this town.

Table 4.

Showing the species of mosquitoes found other than *Stegomyia fasciata*, Fabr., *Culex fatigans*, Wied., and *Nyssorhynchus annulipes*, Walker.

Town.	*Anopheles corethroides*, Theob.	*Pyretophorus atratipes* (Skuse).	*Myzorhynchus barbirostris* V.d.W. var. *bancrofti*, Giles.	*Tozorhynchites speciosa*, Skuse.	*Mucidus alternans* (Westw.).	*Stegomyia punctolateralis*, Theob.	*Pseudoskusea multiplex*, Theob.	*Scutomyia notoscripta* (Skuse).	*Pseudohowardina linealis*, Taylor.	*Grabhamia theobaldi*, Taylor.	*Culicada vittiger* (Skuse).	*Culicelsa alboannulata* (Macq.).	*Culicelsa vigilax* (Skuse).	*Culex sitiens*, Wied.	*Culex tigripes*, G. and C.	*Culex occidentalis*, Skuse.	*Taeniorhynchus uniformis*, Theob.	*Chrysoconops acer* (Walker).	*Finlaya poicilia*, Theob.
Brisbane ..	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Gympie ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Maryborough ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bundaberg ..	..	..	..	..	..	..	..	..	×	..	..	..	..	..	..	..	..	..	..
Gladstone ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Rockhampton ..	..	..	×	..	×	..	..	..	..	..	×	..	×	×	×	..	..	..	..
North Rockhampton ..	..	..	..	..	..	..	..	..	..	..	..	..	×	..	..	..	..	..	..
Mackay ..	..	..	..	..	×	..	..	..	..	..	..	..	×	×	..	..	..	..	..
Bowen ..	..	..	..	..	..	..	..	..	..	..	..	..	×	..	..	..	..	..	..

Note.—The Brisbane localities are taken from Mr. Cooling's report in the Annual Report of the Commissioner of Public Health, June, 1914.

THE RECORDED OCCURRENCE OF STEGOMYIA FASCIATA, FABR., AND S. SCUTELLARIS (WALKER) IN AUSTRALIA AND NEW GUINEA.

By Frank H. Taylor, F.E.S.

(From the *Australian Institute of Tropical Medicine.*)

Only a few disconnected observations regarding the distribution of mosquitoes in Australia have been recorded. No organized mosquito survey has yet been attempted, hence our knowledge of the distribution of *Stegomyia fasciata* is very limited.

Skuse (1) described it under the name of *Culex bancrofti* from specimens sent to him by Drs. J. and T. L. Bancroft, which were taken in Brisbane.

Theobald (2) recorded it from Queensland and Victoria without giving definite localities; in the former case from specimens sent by Dr. T. L. Bancroft, in the latter the specimens were sent by Mr. C. French. He also recorded it from New Guinea generally. Specimens have been taken by Dr. Breinl at Samarai, in the Eastern Division, Port Moresby, in the Central Division, and the Lakekamu goldfields (Dr. Giblin), in the Gulf Division.

Taylor (3) recorded it from Port Darwin, Northern Territory of Australia, where it was found by Drs. Breinl and C. L. Strangman to be common. Dr. Breinl was unable to find it at the Pine Creek Settlement in 1911, although local conditions were suitable.

Summers (4) also records it from Port Darwin on specimens sent to the London School of Tropical Medicine by Dr. C. L. Strangman.

Taylor (5) found it to be a prevalent species at Cooktown and Somerset, North Queensland, and Thursday, Darnley, Murray, Stephens, Yorke, Yam, and Mulgrave Islands in the Torres Straits, North Queensland.

The absence of *Stegomyia fasciata* from Saibai and Boigu Islands, of the same group, can only be attributed to the fact that the natives bring their daily water supply from wells which are situated some considerable distance from their villages.

Advantage of a short stay on Thursday Island, during May, 1912, was taken to make a mosquito survey of the Japanese quarter, which contains some 2,000 souls, where it was found that *Stegomyia fasciata* was breeding in very considerable numbers in all the water tanks and other collections of water. It may be reasonably assumed from this finding that the white settlement and remaining Asiatic quarters are similarly infected.

Elkington (6) says:—"The adaptability of *Stegomyia fasciata* in finding new breeding places is illustrated by the discovery of larvæ in fire-sprinkler tanks 120 feet above street level. Two years ago I found the same species breeding in the sump-pit of a mine at Charters Towers over 2,000 feet below the surface, and biting vigorously in the electrically-lit plat."

We have, besides the above records, collected *Stegomyia fasciata* at Cairns, Townsville, Ching Do (situated 30 miles from Townsville in the Houghton River district, where it has been recently introduced), and Brisbane.

Specimens collected by Wild at Cunnamulla, a town in Southern-central Queensland, are contained in the Queensland Museum collections.

Dr. Hamilton Kenny sent us a small collection of mosquitoes from Gayndah, amongst which specimens of *Stegomyia fasciata* were noted.

Dr. T. L. Bancroft recently informed us *in litt.* that it was a very common species at Eidsvold, a town in the Burnet River district.

We have also received numerous specimens of *Stegomyia fasciata* from Inspector C. M. Cato, who was attached to the State Health Office at Townsville, from Ravenswood, Proserpine, Mackay, Eton, and Merinda, where he informed us it had become very common.

Dr. J. Booth-Clarkson recently presented a collection of mosquitoes from Ayr to the Institute. Most of the specimens proved to be *Stegomyia fasciata.*

A partial survey of Townsville was conducted, during the early part of this year, in conjunction with the local State Health inspectors, when it was found that *Stegomyia fasciata* was present in approximately 62 per cent. of the houses inspected. This percentage is in all probability a low one, as it is most probable that in many cases the larvæ had been washed out of the tanks by their continual overflowing, since the survey was conducted mainly in the wet season.

These results could very probably be applied to a large majority of towns in Queensland, as Townsville seems very similar in this respect to other towns which we have visited.

Dr. J. Burton Cleland, of the Bureau of Microbiology, Sydney, New South Wales, has informed us that he has collected *Stegomyia fasciata* at Grafton on the north coast of New South Wales, and that Dr. Dick has taken it at Newcastle, 100 miles from Sydney.

We have, to date, no information concerning its distribution in Victoria, South Australia, and Western Australia.

It remains still undetected in Tasmania, though we have received several fine collections of mosquitoes from Mr. F. M. Littler, taken in the neighbourhood of Launceston and on the West Coast.

Stegomyia scutellaris (Walker)* would appear to be a comparatively uncommon mosquito in Australia. It has, up to now, not been found on the mainland, and we know it from but one locality in New Guinea, the Lakekamu goldfields in the Gulf Division of Papua. A closely related, but very distinct species, *Stegomyia pseudo-scutellaris* (Theobald), would appear to be much more widely distributed.

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* Since the above was written *Stegomyia scutellaris*, (Walker), has been found by Mr. G. F. Hill, Government Entomologist at Darwin, Northern Territory, where, he states, it is a day-biting species.
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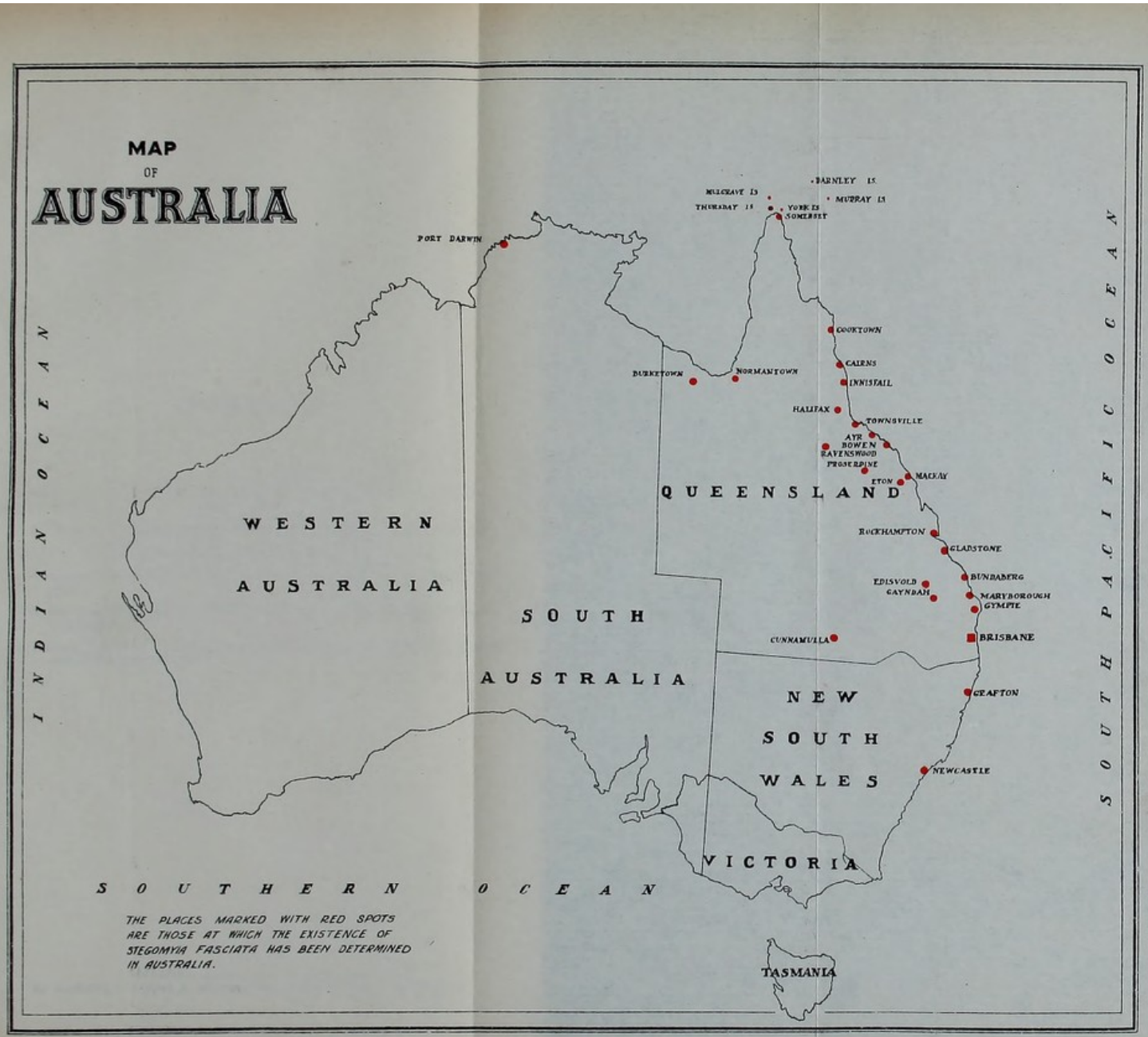
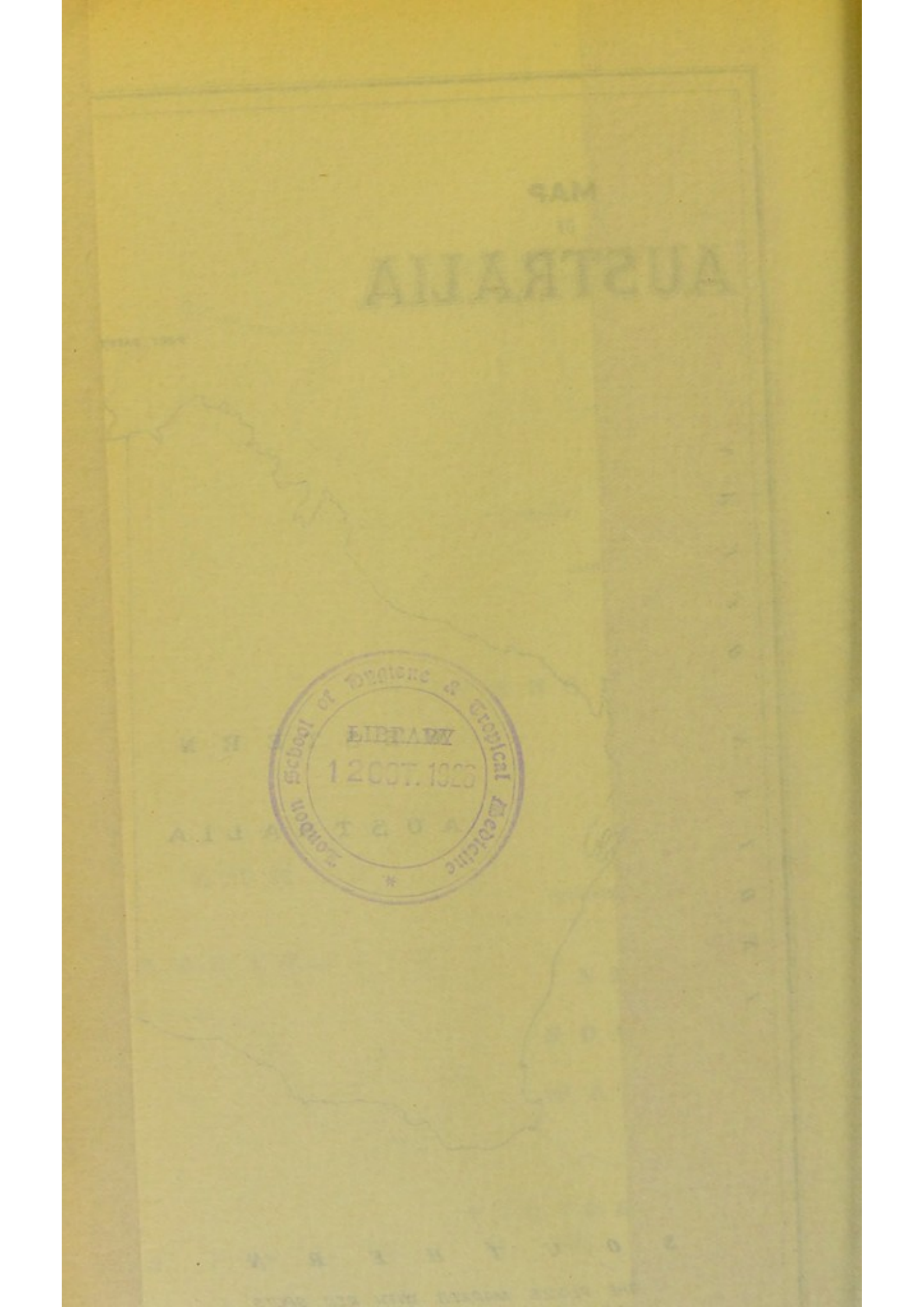

MAP
OF
AUSTRALIA
INDIAN OCEAN
SOUTH PACIFIC OCEAN
SOUTHERN OCEAN
WESTERN AUSTRALIA
SOUTH AUSTRALIA
QUEENSLAND
NEW SOUTH WALES
VICTORIA
TASMANIA
PORT DARWIN
MULGRAVE IS
THURSDAY IS
BARNLEY IS
MURRAY IS
YORK IS
SOMERSET
COOKTOWN
CAIRNS
INNISFAIL
BURKETOWN
NORMANTOWN
HALIFAX
TOWNSVILLE
AYR
BOWEN
RAVENSWOOD
PROSERPINE
ETON
MACKAY
ROCKHAMPTON
GLADSTONE
BUNBABERG
EDISVOLD
GAYNDAH
MARYBOROUGH
GYMPIE
BRISBANE
CUNNAMULLA
GRAFTON
NEWCASTLE
THE PLACES MARKED WITH RED SPOTS ARE THOSE AT WHICH THE EXISTENCE OF STEGOMYIA FASCIATA HAS BEEN DETERMINED IN AUSTRALIA.



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