# Report of an Investigation in Regards to Prevalance of Stegomyia and Other Mosquitoes in Karachi

Vol. XX

(1913)

Dr. K. S. Mhaskar

# REPORT

OF AN

# INVESTIGATION IN REGARD TO THE PREVALENCE

OF

# "STEGOMYIA" AND OTHER MOSQUITOES IN KARACHI,

AND THE

# MEASURES NECESSARY FOR THEIR CONTROL.

BY

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1913.

BOMBAY:
PRINTED AT THE GOVERNMENT CENTRAL PRESS.
1913

No. 26 of 1913.

From

DR. K. S. MHASKAR, M.A., B.Sc., M.D., D. P. H.,
D. T. M. & H.,
Special Officer in charge of Stegomyia Survey, Karáchi.

To

THE SURGEON-GENERAL WITH THE GOVERNMENT
OF BOMBAY,
Bombay.

Through The Principal Medical Officer, Sind District, Karáchi.

*Civil Hospital, Karáchi, 20th February 1913.*

Sir,

In presenting this report on "Investigation into the prevalence of Stegomyia and other Mosquitoes in the Port of Karáchi and the measures necessary for their control," I wish to express my sincere thanks due to Dr. E. D. Shroff, M. R. C. S., D. P. H., for his kindness in placing his sanitary inspectors at my disposal from time to time, a favour which greatly facilitated the work, and also for the directions and help which have been of the greatest assistance.

The information given in Chapters I and II has been derived from Government Resolutions, Sind Gazetteer, the Municipal administration report and the annual report of the trade of Sind. But most useful of all has been Dr. Bentley's report on Malaria in Bombay on which the outlines of this report were based, as also the information obtained at the Malaria Conference, Madras, November 1912.

I have the honour to be,
Sir,
Your most obedient servant,
K. S. MHASKAR,
M.D., D. P. H.,
Special Officer in charge Stegomyia Survey.

*Letter No. 1762, dated 18th April 1913, from the Director, Bombay Bacteriological Laboratory, Parel, Bombay, to the Personal Assistant to the Surgeon-General with the Government of Bombay.*

With reference to your memorandum No. B/4192, dated 26th March 1913, I have the honour to submit the following remarks:—

2. I have read with very great interest Dr. Mhaskar's report on the Stegomyia Survey of Karáchi; in my opinion Dr. Mhaskar has done the work entrusted to him with care and promptness.

3. The first five chapters of the report require no further remarks from me, dealing, as they do, with observed facts, so that I pass on to the 5th chapter which is concerned with preventive measures.

4. Dr. Mhaskar does well in referring in Section I of this chapter to the comparative simplicity of a campaign against mosquitoes in a place like Karáchi when compared with other places in India. He points out that most of the breeding places of mosquitoes in Karáchi are artificial; there are no water-courses, the rainfall is negligible, the soil is sandy and porous, the heat of the sun is great so that pools of water dry quickly. But in contrast to these natural advantages he draws vivid picture of the poverty, ignorance and carelessness of the people. He aptly closes this section by referring to the improvements which have been affected in the water-supply of the town within recent years and the still greater need for further improvement, especially for a more abundant and continuous water-supply, so as to enable the people to dispense with the use of gharras and wells which he had found were the most common breeding places of mosquitoes and which were used and continued to exist only because of the intermittent water-supply.

5. In Section II of this chapter he discusses the measures which are required to prevent multiplication of mosquitoes. These measures aim for the most part at the restriction, removal and protection of collections of water in which mosquito larvae are found. He classes these collections of water into temporary and permanent collections. Under the latter head he deals with wells, cisterns, garden and other tanks, fountains, tubs, etc., and in certain localities marshy ground:—

A.—He proposes in the future to restrict as far as possible these permanent breeding places and he expects to effect this—

(1) by prohibiting the construction of open wells;

(2) by prohibiting the erection of cisterns except in special cases when they must be of approved pattern;

(3) by restricting the use of garden tubs by imposing a license for their use.

B.—With regard to the action which can be taken to remove existing permanent collections of water, Dr. Mhaskar makes the following suggestions:—

(1) *Wells.*—All foul and disused wells should be filled up and those that must be used should be permanently covered with reinforced concrete and a pump attached. If the owner cannot be persuaded or compelled to protect his well in this way he should be made to stock it with fish and keep the well clean.

(2) *Cisterns.*—In many cases these must be reconstructed and fixed in more accessible positions for inspection. In all cases where they must be used they should be properly protected from mosquitoes.

(3) *Garden tanks* should be licensed and subject to periodical inspection and cleaning.

C.—Dr. Mhaskar then passes on to consider the temporary breeding places of mosquitoes and he points out that the outstanding difficulty is the insufficient water-supply to every house and the consequent necessity for storing water in receptacles which vary in character according to the means of the inhabitants. To remedy these defects he recommends :—

(1) that an adequate supply of water should be available for every household;

(2) that periodical inspection should be made to ensure that water is not collected and stored in receptacles in such circumstances that mosquito larvae can develop in it;

(3) that the breeding of mosquitoes on any premises should be regarded as an offence subject to penalty;

(4) that a few mosquito breeding places should be selected and established under proper supervision and control to test the efficiency of anti-mosquito measures and to prevent mosquitoes taking to unusual breeding places.

6. In the next chapter Dr. Mhaskar considers the strength and cost of the staff to carry out his very excellent recommendations. He offers three schemes costing approximately one lákh, half a lákh and quarter of a lákh of rupees per annum. He thinks that for an expenditure of nearly a lákh of rupees per annum it would be possible to keep down all mosquitos in Karáchi. For half that sum he thinks it would be possible to control the breeding places of Stegomyia mosquitoes, while the third scheme, costing about quarter of a lákh of rupees per annum, would only allow of the inspection and control of breeding places of mosquitoes which are situated outside of houses.

7. The expenditure proposed for these three schemes is so very different that it is essential to consider which scheme, if any, should be adopted from the point of view of (1) necessity, (2) expediency.

8. Let me first consider the necessity for adopting one or any of the schemes. The present enquiry was undertaken owing to the possible importation of Yellow Fever into Karáchi when the Panama Canal is opened. It is well to point out that Major S. P. James has visited Panama and other places with the object of studying the conditions which may lead to the introduction of Yellow Fever into India when the Panama Canal is opened; his report is at present under the consideration of the Government of India and until this report has been published the necessity for taking precautions other than those which already exist against the possible importation of this disease into Karáchi does not immediately arise. But mosquitoes are responsible for the spread of other diseases than Yellow Fever and Dr. Mhaskar's more expensive scheme aims at the destruction and control of all mosquitoes including the anopheles which spread malaria. The table given on page 15 of the report however shows that fevers account for only one-third as many deaths as are attributed to plague, so that the urgency or necessity of measures against malaria in Karáchi is less than the need for measures to combat the plague.

9. Passing on to consider the expediency for adopting one or Dr. Mhaskar's schemes, it is well to point out that the total expenditure Health Department amounts to Rs. 73,488 per annum, so that if either of Dr. Mhaskar's larger schemes were adopted, the expenditure on this department would be doubled, a proposal, which, I think, hardly requires consideration especially in view of the remarks I have made above regarding the necessity for the adoption of any measures against Yellow Fever and Malaria when Plague at present causes more than three times as many deaths.

10. I am of opinion that the attention and money of the Karáchi Municipality should be concentrated on effecting improvements in the water-supply, drainage and housing of the inhabitants of the town, that meanwhile measures should be taken to prohibit the construction of new open wells or the erection of cisterns, fountains, etc., disused wells should be filled up and arrangements made to supply pipe water at those places where wells are at present used so that these may be closed.

11. Every endeavour should be made to instruct the people how mosquitoes live and have their being and how they are responsible for the spread of disease.

12. The staff proposed in Dr. Mhaskar's third scheme seems to me sufficient for the present needs of the Municipality bearing in mind their financial resources and the necessity for considerable expenditure in connection with measures mentioned above. This proposed additional staff should be amalgamated with the present staff of the Health Department and the duties of the various officers re-arranged so as to include among their other duties the periodical inspection of houses, wells, etc., with the object of detecting and removing mosquito breeding places and the instruction of the inhabitants in the life history of mosquitoes.

13. Although not relative to the present inquiry, I think it is necessary to draw attention to the large number of deaths which occur each year from plague in Karáchi and to suggest that measures to combat this disease are called for more urgently than for any other disease; it seems that familiarity with plague has bred some contempt for it.

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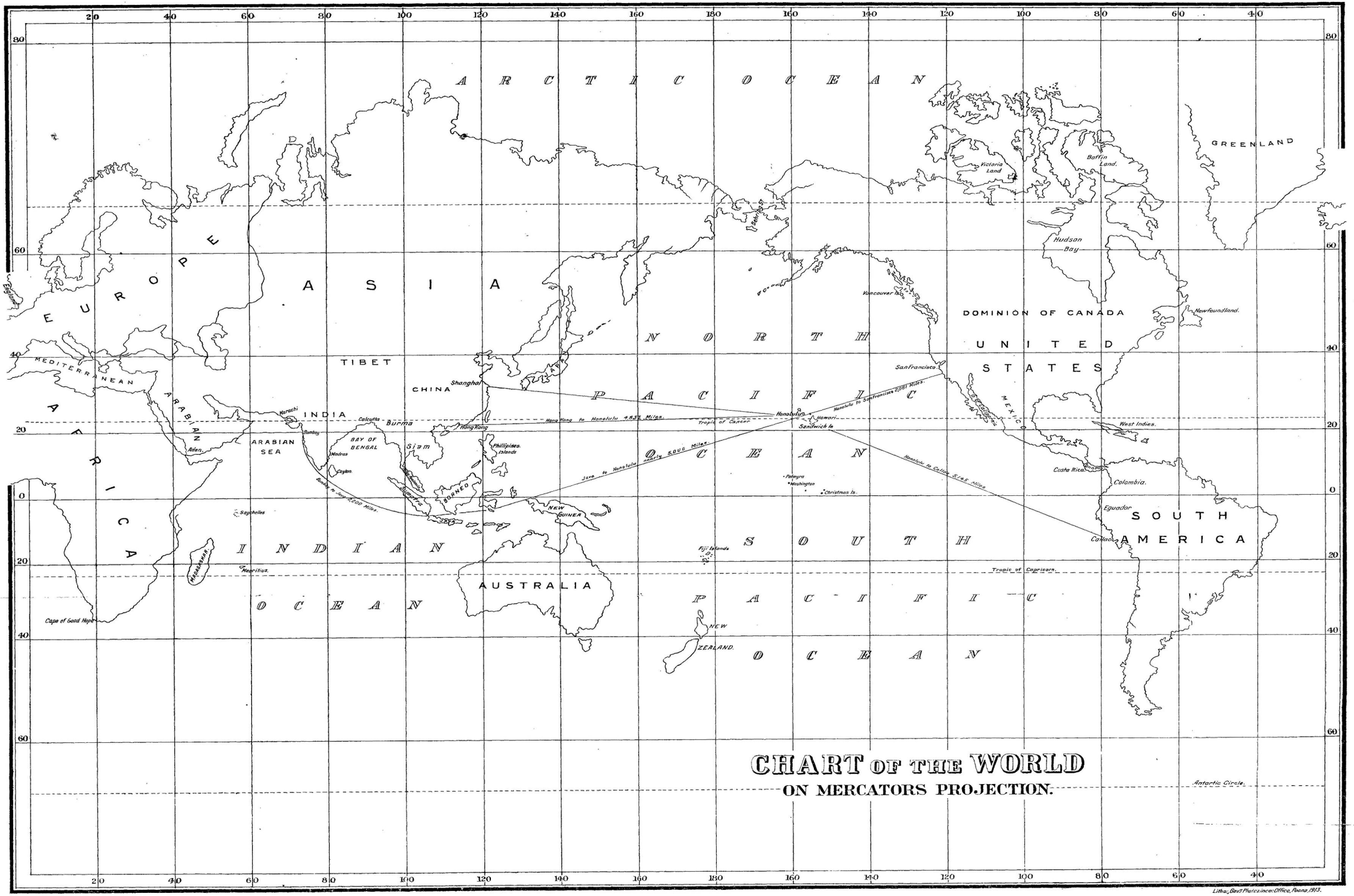



# CHART OF THE WORLD

## ON MERCATORS PROJECTION.

Litho. Govt. Photo-zinco-Office, Poona. 1913.

# CHAPTER I.

## Yellow Fever—India's Future Danger.

Section 1.

1. The Malaria Conference held in Bombay on November 10th and 17th, 1911, resolved that:—

"In view of the possibility of the importation of Yellow Fever in India, the Conference suggests the advisibility of a careful Stegomyia Survey and the education of the public in the matter of the destruction of domestic mosquitoes."

In accordance with this resolution the enquiry was started in Karáchi, as well as in other important ports of India having a large Eastern trade,—to prevent the Yellow Fever from getting an entrance through them.

2. Major E. F. Gordon Tucker, I. M. S., in a paper "Yellow Fever—India's Future Danger" read before the British Medical Association in June 1910 brought it prominently to notice, that the presence of *Stegomyia Fasciata* in a sea-port with trade communications with the East is a very serious matter. The essential facts in the epidemiology of Yellow Fever are, that it is a disease of sea-ports and especially affects shipping, by means of which it is conveyed to temperate climates at a great distance from the endemic areas. It affects the low-lying and insanitary areas of cities. It is a disease of warm climates, and latitude 22° North and South of the Equator roughly covers its area of maximum intensity—the key to the whole problem of epidemiology being the extra-corporeal host of the virus—Stegomyia Fasciata:—

"Considering 'the gross roads of the Pacific' of the future, Honolulu is the centre of the hemisphere which includes American continents, Japan, China and Malay Peninsula, Australia and New Zealand; and it is the central point of the direct route between Panama and Hongkong. It is hard to prognosticate as regards the direct trade between the endemic ports of Yellow Fever and India. India has of late been importing large quantities of sugar, which may in time come from Jamaica.

"The species *S. Fasciata* is widely distributed in the regions with which we are particularly concerned. As regards India, we have two of the three factors which permit Yellow Fever epidemics—(1) The *S. Fasciata* in abundance and (2) a complete non-immune population. The incubation period of Yellow Fever extends from 36 hours to 4 or 5 days. Another 3 days must be added to this when the diagnosis is doubtful. A case of Yellow Fever on a tramp steamer escaping detection will infect the Stegomyia on board, in whom the virus takes another 12 to 14 days to mature. So that in a period of 17 days, when the ordinary tramp steamer is approaching the Hawaiian group of islands, the virus will have matured in the mosquitoes and these can infect for 50 days after ingesting the virus. The *S. Fasciata* can make herself at home on steamers preferring warm spots such as cook's galley and engine room or in the hold containing cargoes of sugar. Efficient inspection at Hanolulu will no doubt be a great protection to Hongkong and Shanghai; but the trade for Borneo and the adjacent islands and Malay Straits may utilize ports of call rather near the Equator, such as Christmas Island, where the inspection may not be so efficient."

## Yellow Fever.

Section 2.

1. An acute specific, very fatal febrile disease, occurring within a peculiarly limited geographical area and is characterised by a definite course consisting of an initial stage of a Sthenic nature rapidly followed by such evidences of blood destruction, as black vomit, albuminuria, and jaundice.

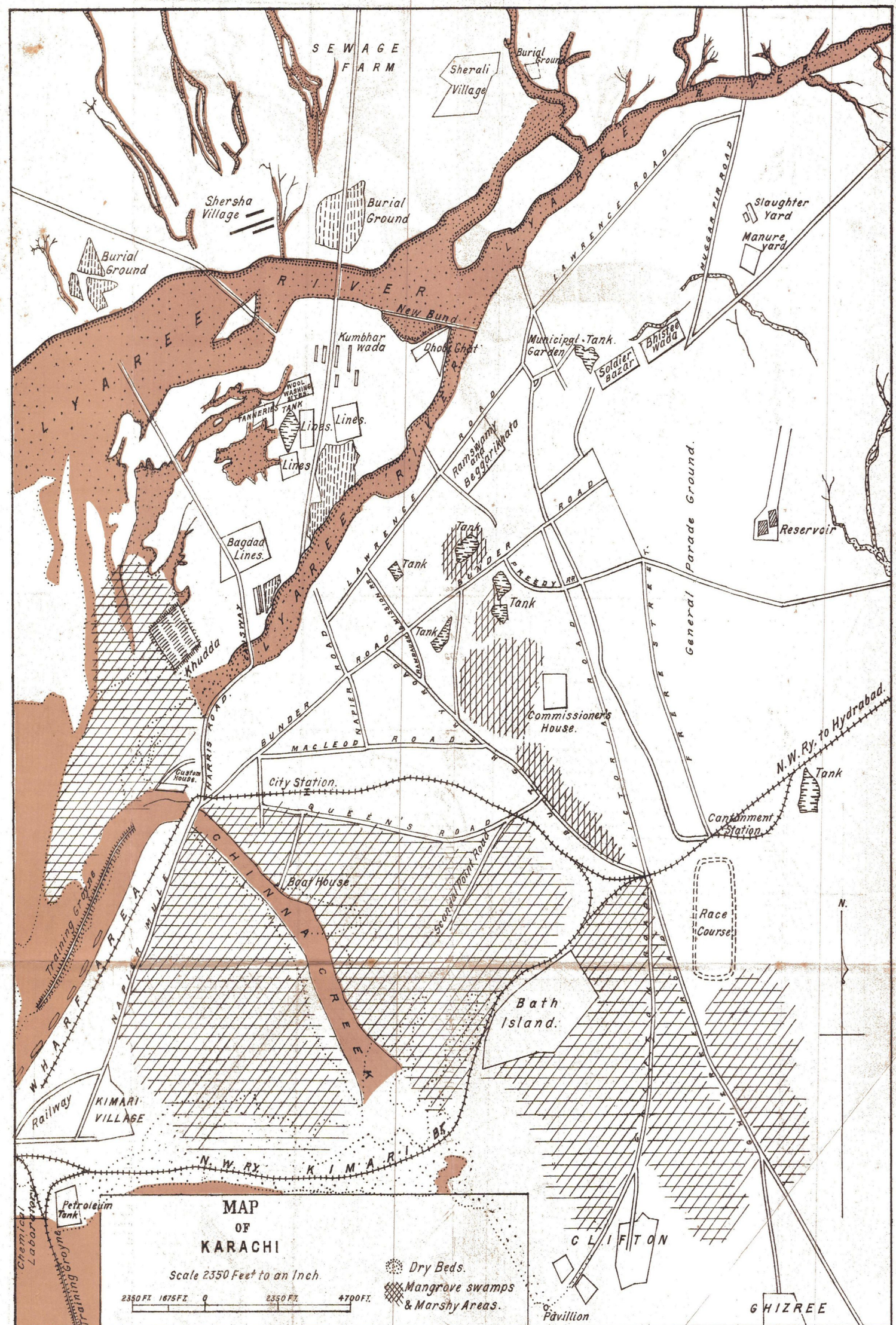
2. *Geographical Distribution.*—Its geographical range is most restricted. Its centre is in the West Indies whence it spreads north to the United States and Mexico, south to Brazil, west to Central America and across the Isthmus of Panama to the Pacific Coast, along which it extends north to the Gulf of California and south to Peru. It has frequently been imported into Portugal and Spain and once into Italy, and cases have occurred in sea-port towns of France and England—Brest and Swansea as also in Mauritius, Marseilles and Gibralter.

3. *Epidemiology.*—Atmospheric temperature has a definite influence, requiring for its development in the intermediate host—*S. Fasciata*—a temperature of over 75° F., in which alone it flourishes and is active. Dampness favours it. Its favourable haunts are the sea-coast towns, the banks of rivers and flat delta country, rarely extending inwards; and when it does, it follows the lines of communication, *e. g.* railways, canals, etc.

4. *The incubation period* averages 3 to 5 days and has an extreme limit of 13 days. Occasionally the virus remains in the ship from the time she left port, infecting the crew several weeks after the ship has been at sea—thus giving a mistaken idea of a long incubation period.

5. *The Germ.*—The Yellow Fever patient is dangerous to his neighbours, only during the first 3 days of disease; after this he ceases to confer infection. One phase of the germ as it exists in blood is ultramicroscopic. The *S. Fasciata* acts as the intermediate host and is capable of giving the infection to non-immunes at any time subsequent to the 12th day of their Yellow Fever blood meal, and they retain their infective power for at least 57 days. The mosquito itself is capable of surviving for five months or over, after getting a feed of blood.

6. It has been noted that the *S. Fasciata* must first have a feed of blood before they lay their eggs and that the virus is capable of being passed on to the next generation by means of its eggs. Also that before the first egg-laying *S. Fasciata* is both diurnal and nocturnal but subsequently she is strictly *nocturnal*. Therefore a *S. Fasciata* biting during the day does not convey Yellow Fever. *S. Fasciata* is a good traveller (Gorgas) and an infected mosquito shipped by accident would suffice to set the whole tropical section of Eastern hemisphere—ablaze.




Litho: Govt: Photozinco Office, Poona, 1913.

# Press Note.

Civilized States have a big problem to solve which arises in no small measure from the very fact of their civilization. They have to devise means, so far as is humanly possible, whereby the weaklings of the community, who in ruder societies would stand little chance of ever growing up into men and women, may become physically fit and efficient citizens. Much can be and is done by private effort, but the modern State has found that legislative action is also essential. Of this factory legislation is perhaps the most obvious example. It is no doubt a debateable question within what limits Government intervention is proper, but without going as far as the more advanced eugenic societies demand, the modern State can do much that is unexceptionable by putting into practice the maxim that prevention is better than cure. Physical culture has now almost reached the position of an exact science; it need entail no expense of money and little of time, and should prove of immense value to the physique of any nation that instructs its younger members in its theory and practice. In India in particular, where education is largely under Government control and where the importance of a *mens sana in corpore sano* is not so generally recognized as in England, there appears to be a great future for physical culture.

2. In this connection it is interesting to note that in his report surveying the progress of education during the quinquennial period from 1907-08 to 1911-12, issued a year ago, the Director of Public Instruction drew the attention of Government to the fact that such drill as had been practised in the great majority of schools was, with few exceptions useless. The main reasons of its inefficiency were that the exercises were not well thought out, graduated or progressive, and that the teacher seldom had any training or enthusiasm and regarded drill as something to be perfunctorily performed for an hour once or twice a week. Naturally the pupils also found drill meaningless and uninteresting, and the lesson not infrequently degenerated into a lethargic and apathetic parody of Swedish or other systems of drill. The Director's conclusions were that salvation was to be looked for in the devotion of greater attention in the training colleges, both secondary and primary, to the study of some rational system of physical culture, carefully adapted to Indian conditions.

3. With this view Government were in entire agreement, and decided to put the Director's recommendations into effect at an early date. An opportunity soon occurred, and in August last Mr. P. Wren, a member of the Indian Educational Service, who had been studying the question of physical culture for some time, was deputed on special duty for the preparation of a manual of drill exercises and the instruction of a class in such exercises. The class was to consist of one assistant master from each Government high and middle school in the Presidency proper and one master from Sind.

4. The class assembled at Poona on 6th October and lasted a fortnight. It was attended by 27 Government teachers, 7 inspecting officers, and 4 teachers from aided schools, and was visited by others engaged or interested in education. The results were eminently satisfactory. The class, apathetic and somewhat sceptical at first, soon grew interested and finished, as Mr. Wren believes, keen converts. The work done was both practical and theoretical. Lectures were given on physiology, personal hygiene, the theory of muscular development, organic health and general physical culture; demonstrations were made of exercises designed to develop and strengthen specific organs and muscles, and the class was instructed in the correct performance of selected exercises for junior and senior boys and for short daily courses as well as for longer courses.

5. The main tenets of the new scheme of physical culture are that exercise should be for health and not for big muscles, and that it should be for a few minutes every day rather than for a longer period once or twice a week. Mr. Wren strongly emphasized the theory that the health and strength of the heart, lungs, and digestive apparatus must inevitably precede the health and strength of the muscles. In other words, before any individual can be at once strong, healthy and muscular, he must have healthy respiration, digestion, circulation and perspiration. Thus a good course of physical culture was shown to

include, first, breathing exercises for the lungs, abdominal exercises for the stomach, liver, bowels, etc., and rubbing exercises for the circulation and skin, and, second, exercises designed for the development of all the large exterior muscles.

6. Mr. Wren accordingly taught the class a series of such exercises for boys of the sixth and seventh standards, a simpler and shorter series for boys of the fourth and fifth standards, and a still simpler and shorter series for smaller boys. When the class had learnt these and could perform them satisfactorily, Mr. Wren selected from each series a short course that could be performed in a few minutes during the morning and afternoon sessions, preferably in the compound or verandah, but if necessary in the class-room.

7. Mr. Wren is concluding a teacher's book on physical culture to embody the principles and schemes of exercise sketched above, and it will soon be published by Messrs. Longmans Green and Company in their "Practical Education Series." Mr. Wren has no doubt that such of the deputed teachers as are capable, intelligent and enthusiastic, will be able to organise the system in their schools before the book appears, while those who cannot do this will at least be able correctly to interpret the exercise plates and letter-press to their colleagues, and prevent any misconception as to the performance of a movement.

8. If this experiment proves a success—and there appears to be no reason why it should not—we may hope before long to find the dry bones of drill vivified into a live and rational physical culture. The schools scattered over the length and breadth of the country will form a connected series of centres whereat the youth of the nation will develop simultaneously their mental and physical endowments. The results may not become visible in our time, but Government are confident that a valuable reform, that will bear fruit in the future in the shape of health and a greater immunity from disease, has been initiated quietly and unostentatiously but none the less effectively.

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No. 3845.

EDUCATIONAL DEPARTMENT.

Bombay Castle, 27th December, 1913.

Forwarded to—

The Commissioner in Sind,
The Commissioner, N. D.,
The Commissioner, C. D.,
The Commissioner, S. D.,
The Director of Public Instruction,
All Collectors, including the Collectors in Sind and the Deputy Commissioner, Upper Sind Frontier,
The Editors' Tables and Editors of Newspapers,
The Oriental Translator to Government,
The Separate Department (for the reading room for the Members of the Legislative Council),
The Non-official Members of the Legislative Council,
All Registered Libraries.

J. L. RIEU,
Secretary to Government.

## CHAPTER II.

### Brief Description of Karachi.

Section 1.

1. *Karáchi* the capital and the chief city of the province of Sind is situated nearly at the apex of the Arabian Sea in 24°·27′ N. Latitude and 66°·58′ E. Longitude. It is the third in importance of all the sea-ports of British India and is the natural outlet of the trade for Sind and Punjáb. It is the sea-board terminus of the great railway system of the North-West, as far as Peshawar in the north and round to Delhi in the east. The present importance of the port is due to its being the nearest point of disembarkation, being 200 miles nearer to Aden than Bombay, and may in future become the point of junction of the main lines of railway to Europe.

2. *Physical aspects.*—The area within municipal limits comprises nearly 74 square miles and includes large areas of waste and dry lands and rocky grounds, absolutely useless, and covered at certain seasons only by water. The aspect of the surrounding district is hilly excepting that bordering on the sea. Ranges of hills, lofty and barren, are found running from north to south with deep wide valleys between. After heavy falls of rain these afford good pasturage.

The area of Karáchi, *quâ* town, is much more limited, being only 5 square miles, and is in the shape of a triangle with its apex at the Custom House and the base formed by a line from the Cantonment Station to the Government gardens. Kiamari, with its long line of wharves, forms an entirely separate district, separated from the mainland by a narrow creek (the China creek), the village being two miles away from the city. Manora, Baba and Bhit are islands facing the long line of wharves and have constant communication with the mainland across the basin. On the north and the west a shallow breakwater spreads out, through which runs the one river "Lyari" and a number of creeks connected with it. When heavy rain falls in the hills, the river flows with water; but this occurs only for a few days of the year and generally it is perfectly dry. The creeks are fringed with mangrove bushes, and drain the marshy ground and mud flats which are covered with water at high tide. The tidal waters of the creek have a scouring effect, and some of the mangrove swamps are almost entirely submerged twice a day.

3. *Hydrography.*—The canals of the district are all in the Indus Delta which extends from Ghizri to Ghar, 125 miles distant. The supply of water to the city is obtained from two wells on the Malir river 16 miles away, and is thence conducted by conduits into a distributing reservoir. The tanks in the city are all filled up. There are 271 wells in the city, none being found in the Civil Lines and at Kiamari which is the harbour proper. There are 230 wells in the Lyari division which is a suburban village extending beyond the Lyari river.

4. The town is not much above the mean sea-level, the greater part of it being from 5 to 7 feet above that level, while the Civil Lines are from 10 to 30 feet upwards. The marshy areas to the west of these and beyond Queen's Road are low-lying waste lands where the sea-water rushes in at spring tides and forms shallow pools.

5. *The vegetation* is characteristic of a rainless climate, dry atmosphere and a sandy soil impregnated with salts. Babul and milkbush are only seen and there are no jungles round about. There is little natural undergrowth. A great portion of the land on the east side—the Garden quarter—is under cultivation, a majority of them being market gardens.

Section 2.

1. *Climatic data.*—The climate of Karáchi resembles more nearly that of Bombay, in temperature, humidity and equability. The average mean annual temperature is 77·5° F.,

January being the coldest with an average mean temperature of 65·9° F., and June the warmest with an average of 87·6° F. The months from April to October show a mean maximum temperature of 89° F. and the months from November to March a mean maximum of 75° F. (Table 1—page 30).

2. *The rainfall* is slight and precarious and is not confined to the usual monsoon season of Bombay, *viz.*, June to October, but often happens in December and January. Nor is it ever a one long downpour. Excluding the last two abnormal years, the average annual rainfall varies from 5 to 7 inches. The rainfall being slight, only two seasons can be said to exist. The months of December and January are characterised by strong dust storms.

The following table shows the annual rainfall for the last 11 years :—

| Year. | Number of rainy days. | Inches. | Year. | Number of rainy days. | Inches. |
|---|---|---|---|---|---|
| 1902 ... | 10 | 10·99 | 1908 ... | 7 | 6·46 |
| 1903 ... | 8 | 4·58 | 1909 ... | 8 | 7·09 |
| 1904 ... | 7 | 4·62 | 1910 ... | 10 | 12·63 |
| 1905 ... | 9 | 3·31 | 1911 ... | 10 | 4·94 |
| 1906 ... | 10 | 6·92 | 1912 ... | 3 | 3·17 |
| 1907 ... | 10 | 7·75 | | | |

An important work was carried out in the diversion of the main branch of the Lyari river, a stream which, though dry for a great part of the year, at times descends with an extraordinary velocity and volume. Some portion rushes into the town and remains for a fortnight after in pools till it dries.

3. *Humidity, etc.*—The atmosphere is generally dry from November to March, when the lowest relative humidity of 56 occurs in December. During November, December and January it remains fairly uniform till it reaches its maximum of 84 in July, when the monsoon winds begin blowing. The south-west winds prevail during 8 months of the year and this added to the low situation of the town and stagnant pools in the break-waters that surround it, make the climate humid and moist. The wind blows from west-south-west and its maximum velocity of 21 miles per hour is attained in June or July. By November the direction changes to North-East and then to North-West. The roads in the town lead straight from the harbour, and there are also very large open areas. The houses are mostly two-floored. All these combine to make the wind acutely felt in almost all parts of the town. (Tables 2 and 3).

Section 3.

1. *Population.*—The population of Karáchi according to the census of 1911 is 159,270, including 11,394 souls residing in Cantonment limits, showing an increase of 43,863 over that of 1901. This large number is very unevenly distributed over different areas. 27,810 are located in the small area of 217·24 acres between Bunder Road, Napier Road and Lyari River; the density of the population being 128·02 per acre. The Lyari quarter accounts for another 32,000 on an acreage of 919; the density being 34·79 per acre. The next two in point of congestion are the Runchore with 17,000 and Garden Quarter with 12,000. That is 3/5th of the total population is located in that portion of old Karáchi beyond Bunder Road. Kiamari and the Harbour account for only 8,000.

2. Karáchi, fifth in 1901 and fourth now among the towns of the Presidency, has increased 38 per cent. in spite of plague which has claimed nearly 25,000 victims. There are 39 industrial enterprises in the city, employing a total of 4,000 artisans. The most important are the Port Trust Engineering and the Tramway Company's shops. There are 5 metal working establishments, 8 grain mills, 3 quarries, 3 tanneries, besides a few printing presses, bulk oil companies, coach building and thread factories and one bone mill. The

city's phenomenal growth, much in excess of any other city in the province, is due to its activity as the outlet for the Punjab and Sind harvests, and the growth of its ocean-borne trade. (Tables IV and V.)

1. *The Maritime Trade of the Province of Sind.*—The trade dealt with in the attached figures is the sea-borne trade of the Chief Port of Karáchi with the foreign countries.

Section 4.

The total value of imports for the year ending 31st March 1912 rose to 1,671 lákhs, an increase of more than 18 per cent. on the year immediately preceding. Molasses, metals, kerosine oil, yarns and piece-goods account for the principal increases. The total imports in the articles of food and drink amounted to 317 lákhs, out of which *sugar* alone account for 256 lákhs, the following being the countries from whence it was imported :—Java, Mauritius, Austria, United Kingdom, Persia, Germany, Egypt and Hongkong.

The foreign export rose at the same time to 2,495 lákhs, showing an increase of over 9 per cent. on the preceding year. The principal increases occur under grain, cotton and hides. The total exports in articles of food and drink amounted to 1,520 lákhs.

Statement showing in tabular form the sea-borne foreign trade of Sind for the five years 1907-08 to 1911-12 :—

| | 1907-08. | 1908-09. | 1909-10. | 1910-11. | 1911-12. |
|---|---|---|---|---|---|
| | Rs. | Rs. | Rs. | Rs. | Rs. |
| Total imports in lákhs ... | 1,290 | 1,594 | 1,341 | 1,419 | 1,671 |
| Total exports in lákhs ... | 1,825 | 869 | 2,241 | 2,251 | 2,495 |

2. The amount of foreign shipping entering this port during 1911-12 was 960,000 tons representing 567 vessels and that clearing was 1,100,000 tons representing 607 vessels. Among the steamers which entered this port were in addition to the large number of British ones—German, Austrian, Norwegian, Greek, Swedish, etc.

3. The total trade with the East amounts to 223 lákhs, Java leading an easy first. The following countries also contribute :—The Malay Straits, Australia, Hongkong and China, Japan, Borneo, Phillipines, Pacific Coast of the United States of America and Mexico.

The coasting trade carried on by native sailing crafts is not negligible and includes most of the ports on the west coast of India.

1. *Municipal Administration.*—The Municipality is constituted under the Bombay Act of 1901. At the head of the Municipal Administration of the city is the Municipal Corporation and its managing committee. The Corporation is composed of 36, made up of 24 elected and 12 nominated Councillors. During the year 4 were officials and 32 non-officials or 11 Europeans and 25 Indians.

Section 5.

With the Corporation lies the power of the purse, and under the Act it is incumbent upon it to provide for the execution and maintenance of drainage, water-works, conservancy, reclamation of unhealthy localities, birth and death registration, measures for checking and preventing the spread of disease, maintenance and regulation of markets and slaughter-houses, and has powers to control public streets, primary schools, vaccination, public hospitals and dispensaries.

The entire executive is vested in the Chief Officer, who is also the Chief Engineer, and under him are the Engineer and the Health Officer. The revenue of the Corporation is obtained from a tax on houses, lands, town duties and octroi dues, wheel-tax, conservancy and water-rates vaccination fees.

The total income for 1911-12 was Rs. 16,33,109, the incidence of taxation being Rs. 5-9-11 and the incidence of income Rs. 11-10-0. The total expenditure in the same period was Rs. 18,59,314-10-0.

2. *Sanitation.*—The Public Health Department of the city is under the control of the Health Officer assisted by one Chief Inspector and four Sanitary Inspectors. For administrative purposes the city is divided into four divisions, one in charge of each Inspector. They are responsible both for conservancy and sanitary works in their respective divisions. Each of them are in turn assisted by Sub-Inspectors in charge of scavenging and halalcore service.

The Inspector is a man of experience only and no qualifications. During the previous year, three coolies and one mukadum under an Inspector were told off to abolish or disinfect the breeding places of mosquitoes in Civil Lines and Frere town, with questionable results. The cantonment has a separate mosquito brigade.

The following is the staff engaged for the work in the city :—

| | |
|---|---|
| 1 Chief Inspector. | 27 Mukadums. |
| 4 Inspectors. | 5 Trip checkers. |
| 8 Sub-Inspectors in charge of scavenging. | 226 Halalcores. |
| 6 Sub-Inspectors in charge of halalcore. | 270 Sweepers, coolies, etc. |

During the year 1911-12 Rs. 73,488 were spent in Public Health Department, Rs. 29,125 on hospitals and dispensaries, and Rs. 10,482 on plague and cholera precautions.

3. *Water-supply.*—The water-supply is excellent in quality, but insufficient in quantity. The outlying quarters are practically dependent on wells for their water-supply. The wells at Málir and Dumelotte provide the required supply at Karáchi. The domestic consumption of water per head works out at 14·4 gallons per day. In some places where the supply is good it is about 20 gallons per day, but in other places it does not exceed 5 gallons. The pressure is very low, necessitating the use of hand-pumps and cisterns in certain houses, while the rest, store it as they can in small receptacles. Most of the houses have a public stand-pipe in common, from which they have to fetch it, and the flow from these pipes is often intermittent. The capital expenditure incurred so far has been Rs. 18,54,880.

4. *Drainage.*—The whole of the city, except the Civil Lines, Kiamári and the Lyári suburb, is drained on Shone's ejector system and gravitating drains. There are 13 of these ejectors at work. The quantity of the sewage is dealt with at the sewage-farm, two and half miles from the city and gives good satisfaction. The Civil Lines and Kiamári are supplied with catch-water pits, one or more for each house, from which the foul water is regularly carted away. The Lyári cannot even boast of these, and the waste water is somehow let out of the house and allowed to dry. The drainage system has not been extended to out-lying quarters, because of the great distances from house to house. The capital expenditure on drainage works amounts to Rs. 18,76,790.

1. *Vital statistics.*—The following table gives the recorded number of deaths against recorded plague mortality, male and female deaths, and the death-rate of each :—

Section 6.

| Year. | Total plague mortality. | Total number of deaths. | Death-rate per 1,000. | Total number of male deaths. | Male population. | Death-rate per 1,000. | Female deaths. | Female population. |
|---|---|---|---|---|---|---|---|---|
| 1906-07 ... ... | 2,385 | 6,283 | 57·83 | 3,355 | 62,779 | 54·07 | 2,888 | 45,865 |
| 1907-08 ... ... | 2,380 | 5,425 | 49·93 | 2,905 | ... | 46·27 | 2,520 | ... |
| 1908-09 ... ... | 2,547 | 5,946 | 54·72 | 3,287 | ... | 52·35 | 2,659 | ... |
| 1909-10 ... ... | 2,069 | 5,168 | 47·56 | 2,863 | ... | 45·60 | 2,305 | ... |
| 1910-11 ... ... | 1,681 | 5,316 | 35·94 | 2,985 | 88,056 | 33·33 | 2,591 | 59,320 |
| 1911-12 ... ... | 2,768 | 6,588 | 54·55 | 3,638 | ... | 41·31 | 2,950 | ... |

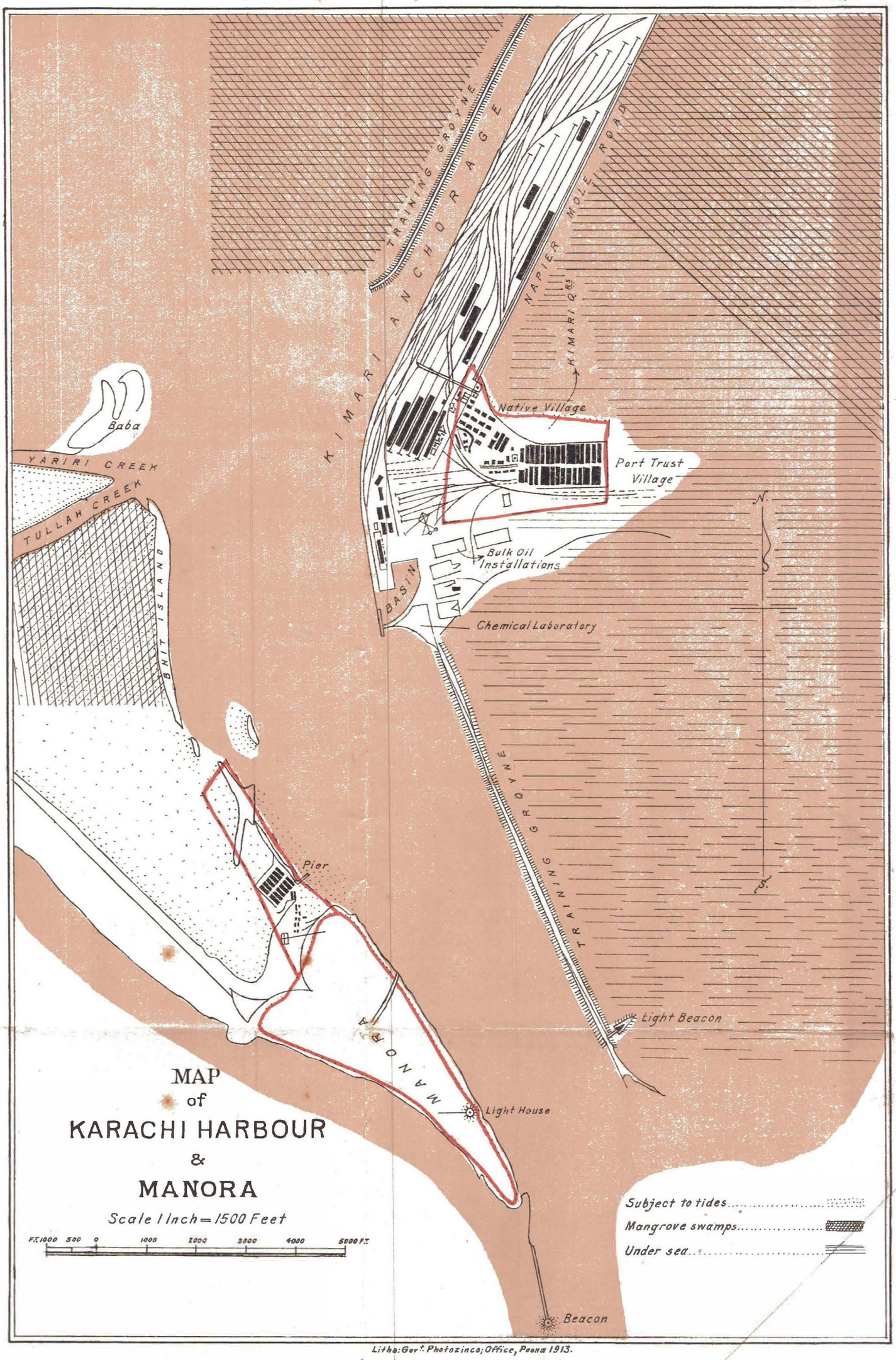
Deducting the recorded plague mortality from the total number of deaths, the true death-rate is 24·58 per mille for 1910-11 and 26·83 for 1911-12.

The following return gives the total deaths recorded under different headings with the calculated death-rate against each :—

| Causes of death. | 1911-12. | | 1910-11. | | 1909-10. | |
|---|---|---|---|---|---|---|
| | Number of deaths. | Death-rate per mille. | Number of deaths. | Death-rate per mille. | Number of deaths. | Death-rate per mille. |
| Fever ... | 628 | 5·64 | 668 | 4·51 | 696 | 6·40 |
| Small-pox ... | 11 | 0·07 | 24 | 0·16 | 12 | 0·11 |
| Cholera ... | 9 | 0·06 | 38 | 0·35 | ... | ... |
| Accidents ... | 31 | 2·20 | 23 | 0·15 | 20 | 0·18 |
| Stomach and bowel complaints ... | 123 | 0·83 | 83 | 0·56 | 88 | 0·80 |
| Plague ... | 2,768 | 18·71 | 1,681 | 11·86 | 2,069 | 19·04 |
| Other causes ... | 2,818 | 19·05 | 2,799 | 18·92 | 2,283 | 21·01 |

The total number of births (exclusive of still-born) recorded in 1910-11 was 6,553 and the birth-rate is 52·89 per mille. The infant mortality for the same period being 225 per 1,000 infants born :—

| Year. | Number of births. | Birth-rate per 1,000 of census population. | Census population. |
|---|---|---|---|
| 1906-07 ... ... | 5,432 | 49·99 | 108,654 |
| 1907-08 ... ... | 6,070 | 55,87 | ... |
| 1908-09 ... ... | 6,336 | 58·13 | ... |
| 1909-10 ... ... | 6,083 | 55·99 | ... |
| 1910-11 ... ... | 6,553 | 44·31 | 147,876 |
| 1911-12 ... ... | 6,279 | 42·46 | ... |




# MAP
of
# KARACHI HARBOUR
&
# MANORA

Scale 1 Inch = 1500 Feet

Litho: Gov.t Photozinco; Office, Poona 1913.

## CHAPTER III.

### The Mosquitoes of Karachi.

The present survey was started about the 27th of August 1912 and includes a period of nearly six months. The order of examination was—The Civil Lines and Frere Town, Cantonment limits, Kiamári and Harbour, Manora, Baba and Bhit islands; then all the portion to the north of Bunder Road and last of all to the south of it. There were no rains during the period. The investigation included the survey of all the Culicid Fauna, but for purposes of this report, that of Stegomyia Fasciata (S. F.) will be treated separately.

*The method of investigation* was to examine all possible collections of water for larvæ and hatch them out in the Laboratory. A net of muslin was always used and passed round the edges of a tank; or the contents of a gharra were emptied through it, and the washing of the inverted net was followed as a routine measure. For wells a similar net was let down by means of a rope.

Section 1.

*Breeding places.*—A detailed consideration of all the breeding places met with during the survey, indicated that the vast majority of them are artificial, and differ with the class of people residing in the locality.

1. *The Harbour and Kiamári*—The railway occupies a good deal of space on Kiamári and in connection with these there are a number of offices, godowns and bulk-oil installations. There are no docks, but a long line of wharves extends from one end to the other. The whole of the area is 1¼ square miles. A village built on model lines by the Port Trust forms a small part only of Kiamári.

(*a*) Of the permanent breeding places—there were masonry tanks for garden and other purposes, stand-pipes and the drains from these; and in the village 4 cattle troughs and cess pits to every house, imperfectly covered by wooden boards. There are no wells; excluding the cess pits and drains there are not more than 125 of these. Along the line of wharves and in harbour limits, the total number of permanent breeding places is 17, excluding the big tanks in connection with the steam power-house. Disused troughs, tinpots and holes in the machinery in the harbour were all dry.

I.—S. Fasciata were found in none of these except in six wooden tubs which are semi-permanent fixtures.

II.—Anophelines in three garden tanks and the water-logged areas about them.

III.—Culex found only in cess pits and 2 cattle troughs.

(*b*) Of the temporary breeding places are the gharras, *i. e.* earthern drinking water-pots, antiformicas and tubs.

I.—S. Fasciata were found in 30 per cent. of the houses in the village.

2. Manora differs from the above. There are 7 wells about 12 feet deep which contain brackish water; 4 tanks of 30 feet diameter hold the telegraph cables, and though cleaned every eight days, were still found to harbour larvæ of A. Rossi. The water-supply is limited, and is brought over from across the harbour and stored in mosquito-proof cisterns. There are no garden tanks and the cess pits were free from any kind of larvæ:—

I.—S. Fasciata found only in gharras of four bungalows on the south side while the servants' quarter on the north side showed them as usual.

II.—Anophelines—in 3 wells and 4 telegraph tanks.

III.—Culex in few cess pits on the south side.

3. *Baba and Bhit Islands* are fishing places. There are no permanent breeding places here, except the west shore which is an extensive mangrove swamp affected by the tide twice a day.

I.—S. Fasciata found in gharras.

II and III.—Anophelines and Culex, *nil.*

4. *Shipping.*—The native barges on the native jetty and Ghas Bunder are of three kinds:—(1) those plying on the coast of Sind are light in structure and have a small tub or two for their water-supply; (2) those that ply between the adjacent coast-ports of Cutch and Mandvi and Veraval are somewhat heavily built and carry small casks sufficient to carry a supply for 8 days at the most; (3) are vessels coming from over long distances, *i. e.* Málabár, Ceylon and Persian Gulf; these carry well-like wooden casks over 12 feet deep and had a narrow opening on top with a very badly fitting cover. The water carried in these was taken up at the initial port of call.

I.—S. Fasciata were found in (1) but with difficulty in some of those of (2), while all attempts to examine those of (3) were futile, because of the nature of the cask and the small hole on top.

The bilge water in not one, showed any kind of larvæ. This water was very foul from being mixed up with all kinds of stuff, and often emitted a hydrogen-sulphide odour.

III.—Culex, *nil.*

No other species of Stegomyia was found.

The city has been divided into 22 quarters for the purposes of the Municipality. For the better elucidation of the breeding places and further to facilitate the work of prevention, I have grouped the several quarters into three parts A, B and C. Each of these has several characters in common and stand out as distinct types from the rest (*vide.* Table IV-A).

*Group A.*

| | |
|---|---|
| 1. The Civil Lines. | 5. Rambaugh. |
| 2. Frere Town, etc. | 6 Preedy. |
| 3. Railway and Queen's Road. | 7. Garden. |
| 4. Serai. | 8. Ghizree. |

*Group B.*

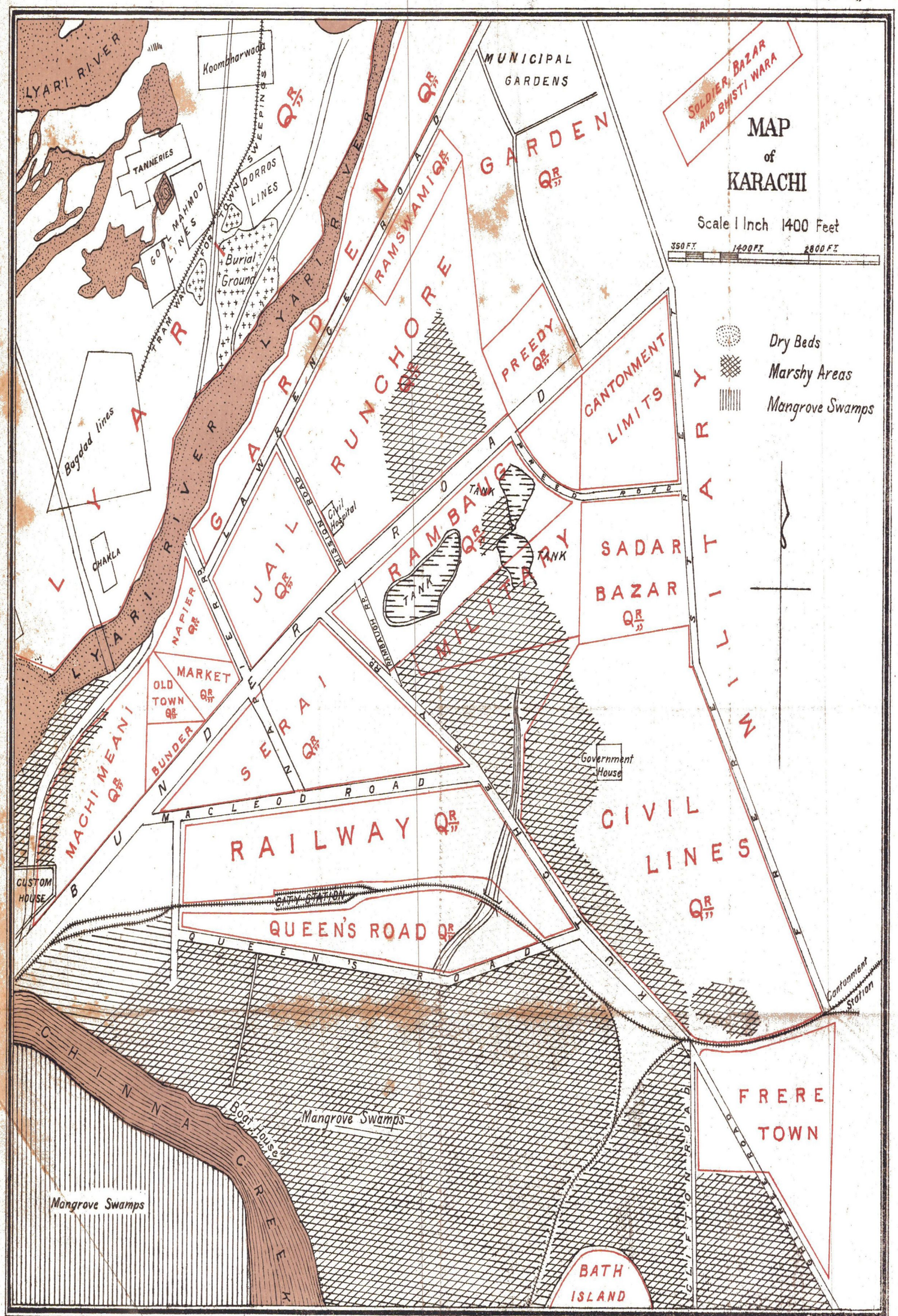
| | |
|---|---|
| 9. Old Town. | 14. Runchore. |
| 10. Napier. | 15. Ramswami. |
| 11. Market. | 16. Soldier Bazar. |
| 12. Bunder. | 17. Sadar Bazar. |
| 13. Jail. | |

*Group C.*

| | |
|---|---|
| 18. Lyári. | 21. Manora, Baba and Bhit. |
| 19. Machi Meani. | 22. Shamspir, etc. |
| 20. Kiamári. | |

*Group A* is characterised by well-to-do residents having houses with gardens and big compounds, out-houses and stables.

5. In the European quarter, *i. e.*, the Civil Lines, Frere Town Railway and Queen's Road as also the portion included within Cantonment limits, masonry garden tanks and mud channels or brick-work channels from these to various parts of the garden and catch water pits by far predominate. There are no wells and no municipal drainage. There is an extensive area of low marshy land near the road to Clifton, and another to the west of the Commissioner's compound; these are very sparsely covered with low bushes and weeds and show incrustation of salt on the surface. The effect of the spring-tides is felt here; the water stagnates and the puddles, which are shaded by weeds, etc., harboured numerous larvæ of anopholines in September. Latterly they were




Litho: Govt. Photozinco: Office, Poona. 1913.

found entirely free of these. There are only 31 cisterns to which the water is pumped up, 2 floral fountains and 3 cattle troughs and 553 garden tanks.

I.—S. Fasciata were found in only 4 garden tanks. These were near the out-houses, were small and shaded and had slimy walls and the water in them almost clear and very little disturbed. S. Fasciata were found in none else.

II.—Anophelines were found in over 60 garden tanks and tubs and in garden drains (which are not counted) of about 40 houses; in both the fountains, in 2 manure tanks, and disused cess pit (A. Stephensi). In the marshes they were found in 4 places, well-shaded by weeds.

III.—Culex in 20 per cent. of the cess pits and in some garden tanks and water-logged areas in gardens and stable runnings.

(*b*) In addition to these permanent breeding places, the following are the temporary ones:—gharras, antiformicas (*i. e.*, shallow vessels, containing water placed under tables, etc., to prevent ants from ascending) flower pots, tubs, soda cooling chatties, exhaust the whole list.

I.—S. Fasciata were found in connection with 30 per cent. of the houses—the out-houses as well as the main building contributing equally. They formed as it were the index of the negligence of the servants.

II and III.—Anophelines and Culex, *nil.*

The whole of the foreshore south of the Queen's Road is marshy and covered by mangrove swamps—an area of about 2 square miles. The effect of spring tides only is felt which leaves shallow pools in its midst. The nearest house is a quarter of a mile away. Except one small place near the boat house, which showed A. Stephensi, Rossi and Culex, the whole area was free of any for the last three months. The temperature of the water never went above 30°c. One railway drain opening in this area was infested nearly in all its course.

6. Rambagh and Preedy are reproductions on a smaller scale of the Civil Lines, and the nature of the permanent as well as temporary breeding places is much the same. There are 14 wells of which 2 showed both Culex and Anopheles and 10 Culex alone. Most of these wells are brackish and no S. Fasciata were found in these.

I.—S. Fasciata were found in 10 per cent. of the houses in gharras and antiformicas.

II.—Anophelines in 16 garden tanks and drains.

III.—Culex as usual.

The Serai quarter is almost wholly composed of big godowns each of them with an extensive court-yard and a small block for offices and out-houses. There are 8 wells, all of which showed Culex.

I.—S. Fasciata were found in 4 per cent. of the houses.

7. The garden quater is intermediate in character between the Civil Lines and old town. There are big court-yards to several of the houses which are converted into cattle-yards, and further eastward into gardens. The wells here number 146 and are mostly brackish. Garden tanks, cisterns, cattle troughs and fountains form the permanent breeding places. The cattle-yards are very badly kept, the ground is soaked with urine and dung; no good care is taken to remove these, thus causing an abominable stench and a pest of flies.

8. All the quarters in group B can be considered as a whole. Portions of it are densely crowded; there are no gardens except the Municipal ones. The water-supply is generous to most of the houses though those of the poor have, as usual, a stand-pipe in common to a number of houses. The area is well drained and some houses have water-closets in them and the cisterns of galvanized iron on top, to which the water is pumped. The cisterns serve to

water for the closets. None of them were found to be used for drinking purposes. The covers to these were almost always bad and the water in them dirty. The wells to the number of 77 in this part are unevenly distributed, a majority of them being on the Garden quarter side and Runchore. They are narrow, deep and dark, are badly situated and badly kept. Nearly a half of these are in mosques or temples. Most of the wells are brackish and are used for washing and for animals.

*The total number* of breeding places added to those of Garden quarter are—223 wells, 1,386 garden tanks and masonry tanks, in mosques used for religious purposes, 128 cisterns, 71 cattle troughs and 74 floral fountains, 9 manure tanks :—

i. *S. Fasciata* found in 11 wells, of which 4 are brackish, 2 in a cowshed and 2 of tubs placed one on top of another. These are all small and shallow.

7 Garden tanks, 8 garden drains, 2 of which were far away from the house, were surrounded by bushes and were water-logged.

1 Floral fountains, 3 cattle-troughs, 15 cess pits, 7 of which were connected with the kitchen and 2 in out of use houses.

ii. *Anophelines* in 27 wells, 87 garden tanks, 36 garden drains, 4 fountains, no cattle troughs and 2 manure tanks, 5 catch-water pits (*A. Stephensi*).

iii. *Culex* were uniformly distributed in every other house.

(*b*) Of the temporary breeding places are the Gharras, tubs, wooden and iron antiformicas, soda cooling chatties, etc :—

i. *S. Fasciata* were found in 4 per cent. of the houses.

ii. *Anophelines* nil.

iii. *Culex* almost negligible.

9. The Lyari suburb extends beyond the river Lyari and has almost wholly a working class population. There is no drainage and in most cases not even catch-water pits; the dirty water is allowed to flow out somehow and dry in the open spaces between houses. The houses are mere huts and sheds, the water supply is very limited and residents rely mostly on wells—268 in number; They are brackish, kutcha built, and sometimes so shallow that the sides were formed of tubs, two or three of which were placed one on top of another, with the bottoms knocked off. The sewage easily gains access to these and the water is in many cases exceedingly foul. There are in addition 37 large masonry water-tanks of a cubic capacity off about 15 cubit feet and are used for the storage of drinking water etc., as a common supply to several houses. The covers are wooden boards and in all cases very badly fitted.

i. *S. Fasciata* found in 6 wells, 2 were built of tubs and 4 kutcha; all were brackish.

ii. *Anophelines* in 28 water tanks, *i. e.*, over 60 per cent., and in the bed of the river Lyari where the tide water has access to it.

iii. *Culex* in about 180 wells which were all foul and brackish, as also in some cesspits and in the bed of Lyari.

(*b*) Of the temporary breeding places are the Gharras only.

i. *S. Fasciata* found in 40 per cent. of the houses. (The wells of the tanneries and wool-washing are not included in this list.)

*SUMMARY.*—(*a*) Summarising the total number of breeding places, Section 2. the following conclusions are arrived at :—

i. *S. Fasciata.*—Out of the total of 461 wells, excluding those of tanneries and wool washing company's, 17 were infected, *i. e.*, about 4 per cent. The wells had no points of similarity; they were of all sizes and depths, 4 were absolutely brackish and 6 contaminated

by filth and sewage from cattleyards and not more than 20 yds. away from the nearest house, which in every case showed larvae of the same, either in gharras or tubs. Of the 2,273 garden tanks only 11 were infected. The water in all of them was discoloured by decaying vegetable matter, but was in no case foul. Also of the total 116 cattle troughs and 80 floral fountains only 3 were infected.

(*b*) Of the temporary breeding places, gharras, especially those which were too big to be handled by one person, showed them. Tubs come next in order of number, but it must be remembered that these are infinitely less than the number of gharras. They were also found in 3 iron tubs only; also in soda cooling chatties etc., and fire buckets.

(*c*) The *S. Fasciata* larvae were found almost always by themselves. In 26 cases they found in association with *C. Fatigans* or *C. Concolor*, once with *A. Rossi* and four times with *A. Stephensi*.

ii. *Anophelines.*—(*a*) *A. Stephensi* have a distribution co-extensive with that of *A. Rossi* and their total number of breeding places is extremely limited. These will be considered together, as in many cases they overlap. Out of 461 wells they were found in 34, *i. e.*, about 8 per cent.; some of these were brackish and those at Manora are like seawater and contained *Rossi*. In 189 garden tanks etc., out of 2,273, *i. e.*, in 9 per cent. in 4 garden tubs and in 6 out of 80 fountains and none in cattle troughs. The garden drains are not counted in this list as when found in one place they could be picked up throughout the whole length. They were found in five catch water pits and curiously enough in two very foul decomposing manure tanks. They were absent from nearly the whole of the marshy area and mangrove swamps except in one place whrere there was back-water, and in the railway drain they could be picked up in myriads. Taking their distribution as a whole they are not found in more than 8 per cent. of the total number of possible breeding places, the actual number in which they were found being a little less than 275.

(*b*) They were not found in any of the temporary breeding places.

iii. *Culex.*—The larvae are found in the cesspits and drains in enormous numbers, breeding readily in foul water, and a stinking decomposing mass and faecal contamination are no debar. They were found in sweet and brackish well waters and also in the sea-water in marshes and mangrove swamps.

Out of the total of 513 wells including those of tanneries, 217, *i. e.*, 45%, were infested; in 20% of the garden and the other tanks; in nearly all cattle troughs and public fountains of the city and in some of the cisterns on tops of houses, especially those in Lyari. Others of their breeding places are garden tubs and drains, manure tanks, stable runnings, fire buckets, pools of water near stand-pipes, cattle yards, etc.

(*c*) They were 26 times in association with *S. Fasciata*, 22 times with *A. Stephensi* and 27 times with *A. Rossi*.

## B. Distribution by Locality.

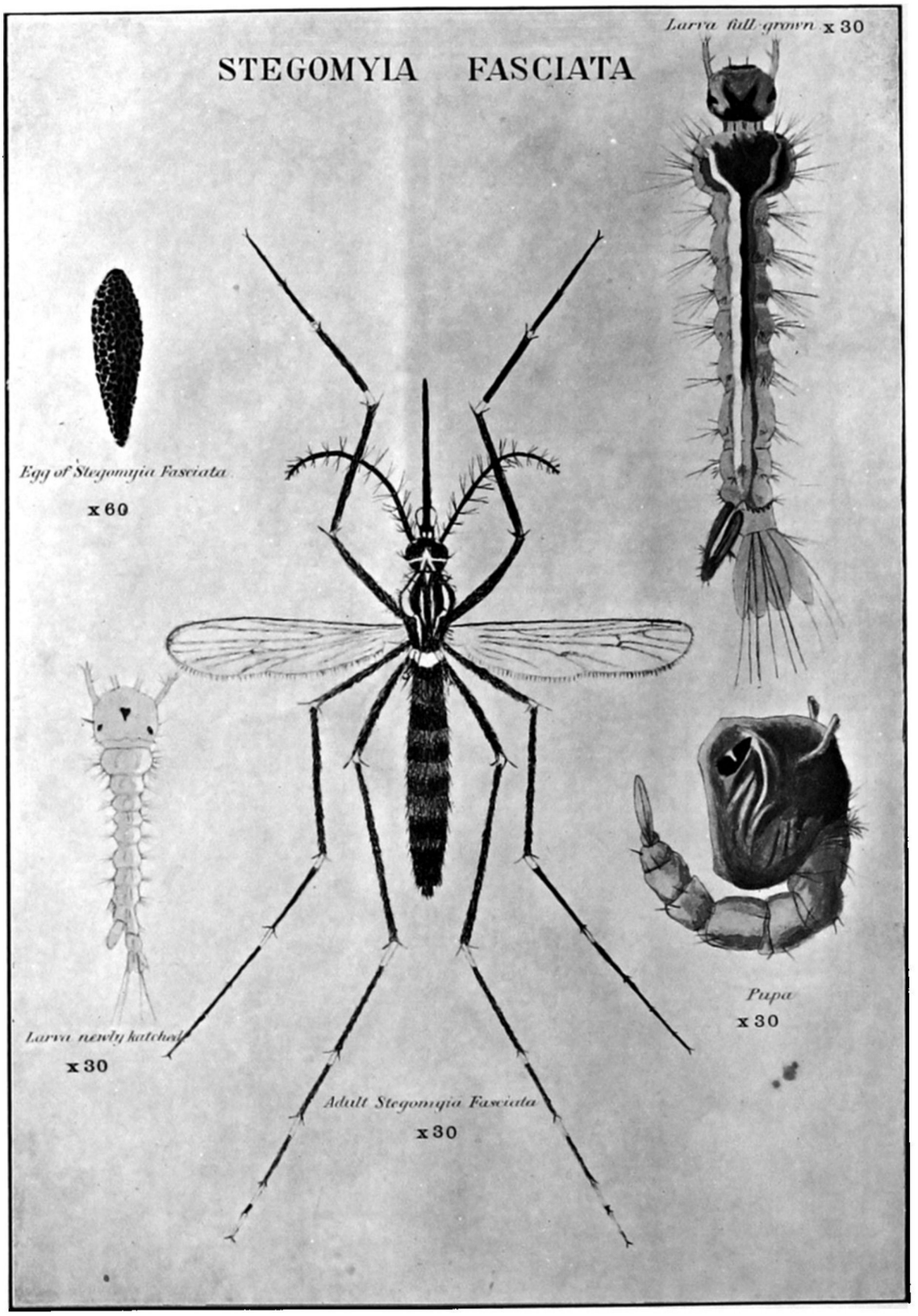
i. *S. Fasciata.*—An analyses of all the above shows that as things are at present, the Lyari and Civil Lines are most infested. The Garden quarter, Kiamari old town, etc., of group B and Rambagh and Serai come next in order of descending preponderence, but the first two are by far the worst. Their prevalence is an index of the negligence of people.

ii. *Anophelines.*—The Garden quarter is the most infested, then come the Civil Lines, Manora and Lyari. The rest show a specimen here and there. Those houses which have water-logged gardens, like the Madrasah in Serai, can be said to be their exclusive haunts.

iii. The *Culex* has a universal distribution, but the Lyari is the worst. The *Culex* and the flies are equal pests of Karáchi.

The following table gives the percentage distribution of each of the three in different localities. The percentages are deduced from the ratio of the actual number of breeding places to the possible ones of each class.

| | | i. S. Fasciata. | ii. Anophelines. | iii. Culex. |
|---|---|---|---|---|
| Group A. | Civil Lines and Frere town ... | ... 30% | 15% | 20% |
| | Rambagh, Preedy and Serai ... | ... 10% | 6% | 20% |
| Group B. | Garden, Lyari ... ... | ... 4% | 11% | 20% |
| Group C. | Machi Meani ... ... | ... 40% | 9% | 20% |
| | Kiamari and Harbour ... | ... 30% | 3% | 40% |


STEGOMYIA FASCIATA
Larva full-grown x 30
Egg of Stegomyia Fasciata
x 60
Larva newly hatched
x 30
Adult Stegomyia Fasciata
x 30
Pupa
x 30

## CHAPTER IV.

### THE MOSQUITOES OF KARACHI—*continued.*

*The Mosquitoes of Karachi.*—The Culicid Fauna of Karachi is very limited. The different species met with are:—

Section 1.

*Culicines.*

Stegomyiata Fasciata
Culex Fatigans
Culex Concolor
Culex Taeniorhynchus
Theobaldia Spathiapalpis.

*Anophelines.*

Nyssomyzomyia Rossi
Neocellia Stephensi
Cellia Pulcherima.

By far the commonest is *Culex Fatigans* and was found everywhere. The *S. Fasciata* came in next in extent of distribution, and each of these were severally proportionate to the permanent and temporary breeding places of the locality respectively.

*Stegomyia Fasciata.*

1. The genus *Stegomyia* is characterised by the head and scuttellum being entirely clothed with flat scales. *S. Fasciata* is the only species found in Karáchi. It is essentially a domestic mosquito living and breeding in the immediate neighbourhood of houses. It adapts itself readily to all sorts of conditions, provided the water is stagnant. It is pre-eminently a chatty breeding mosquito here, even clean and new chatties with clean water being sometimes found full of them. It cannot possibly be the odour of baked moist earth that attracts them most, because in Kumbarwadda, *i.e.*, the potter's quarter, where chatties are baked or made, their larval and adult population differed in no respect from any other similar quarter, and perhaps it was less still. It does not breed by preference in dirty or foul water, but can adapt itself readily under necessity to all sorts and conditions of life, *e.g.*, wells, garden tanks, tubs smeared with coal tar, cess-pits, etc. Their presence in cess-pits can only be accounted for by their being transferred from an original receptacle, as when this cess-pit water was bottled, they died either from development of foul gases or a thick film of fungus on surface of water.

Section 2.

2. *Larvae.*—The larvae are somewhat elongate with rudimentary antennae and a short stout syphon. They are of a creamy white colour and darken later to a pale brown tinge, when they are about to change into pupae. The intestinal canal can always be made out by the naked eye as a dark line in the body. Their movements are sluggish and wriggling, and they pass a greater part of their time in browsing at the bottom. At the surface they hang limp down almost vertical, or go round and round the receptacle by wormlike movements. The size of the larva differs according to the quantity and nature of food available, and the greater of it there was, they became plump and opaque white, suggesting almost a fungus growth on their body. I am inclined to believe that they live entirely on dead organic matter—vegetable or animal—and were never observed to touch unicellular living organisms running even near their mouth-brushes. Active Vorticella were often seen living and attached to a part of their body. No definite period can be assigned to the length of their larval life. In the Laboratory when abundant food was supplied they turned into Nymphae on the 9th day at the earliest (from the time of the hatching of eggs) to the 15th. They were observed to moult twice. Under conditions found outside, the shortest time has been two weeks and the longest nine weeks; and that, while some of the same breed, attained maturity earlier, that of others was considerably retarded. Another thing noticed was that the size of the larva in no way limited that of the adult Imago—small mosquitoes hatching out of even big larvae and *vice versa*.

3. *The Nymphae* are not so dark as those of *C. Fatigans*; the trumpets are expanded and broadly triangular in shape. They hatch out within 2 to 4 days invariably and never more.

4. *The Imago* varies in size from 2·5 to 4 m.m., the smaller size predominating. Their colour for a day or two of their emergence is bright red on the thorax, with white bright lines. Of these there are two median parallel pale lines, and two curved silvery ones, one on each side and a small line in front between the two median ones. The legs are banded and on account of their striped appearance they are known as tiger mosquitoes. The colour gradually darkens to reddish brown, though it is never so dark as it is in Bombay. They bite viciously during the day from 11 a.m. to 3 p.m., and the bite is very irritating. I have never found *S. Fasciata* to become a nocturnal feeder after its first blood meal. Dark clothing attracts them most. Adult *S Fasciata* were almost always caught inside the houses and out-houses, but never outside or in gardens. The males are more delicate in structure and smaller in size and from any particular sample more males than females hatched out.

5. *The eggs* are ovoid, pointed at one end and rounded at the other, and are surrounded by a series of little air chambers. They adhere to the sides of the vessel or to the material on which they are laid, and are difficult to remove.

6. *Life History.*—The following points in their life history were noted. Three series of cage experiments on isolated couples were done; (the cages used were 1 cubit feet in size, were made of wooden frames with fine cloth gauze stuck all round. They were well protected from spiders or ants. The mosquitoes were fed on black raisins, and a dish of water with pieces of pith floating was kept in).

In the 1st series, where no feed of blood was given, no egg-laying was ever seen, though mating was often noticed.

In the 2nd series, the couples were fed on blood on the first day of their emergence, and subsequent feeds were given ten days after the last batch of eggs was laid. This period was allowed to elapse in order to observe whether one feed of blood was sufficient for the egg-laying function for all their life. Copulation was not seen earlier than on the third day, and on the sixth day or later, the first batch of eggs was laid, the number of eggs varying from 24 to 44; in a few cases a second and a third batch of 8 to 12 eggs was laid in two or three days more. Similar results were noted after the 2nd and 3rd feed of blood; but the female never outlived the 3rd egg-laying period, the maximum number of eggs laid during the lifetime of one female being 64.

In the 3rd series, it was attempted to give the female frequent feeds of blood. In the majority of cases she refused to bite and the results in no way differed from that of the second series.

The males died off earlier than the females, 12 days being the maximum period of their lifetime. New males were always supplied. The female lived from four to five weeks.

The eggs were laid singly during the night time and some of them immediately sank though an almost perfect rim of floats could be seen around them. 25 per cent. of them hatched out during the first 24 hours; but even after three days 20 per cent. still remained unhatched. These unhatched eggs, after remaining in water for a fortnight, were dried and a few days later were placed under suitable conditions for hatching. Out of these only a few hatched out at different times during these three months, but the others, 8 per cent., are still just the same. Whether they are unfertilized eggs, or some form of resistent eggs, I cannot say. Another batch of eggs, which were dried soon after being laid, were after three months placed under suitable conditions and these hatched out with the above reservations.

No statement can be made as regards the seasonal variation of *S. Fasciata* in the same locality, nor of their prevalence in different parts of the city at any one particular period.

7. *Stegomyia Scuttalaris.*—An attempt was made to find out whether any of this species exist in Karáchi through escaping detection. Hollow test-tubes like bamboo stumps full of water were placed in different parts of the city. No *scuttalaris* were caught in two months. But a new species, not met with so far, bred in a few of them. This was identified as *Theobaldia Spathiapalpis.*

Section 3.

1. *Culex Fatigans.*—Swarms of the adult mosquitoes haunt many of the houses in the city and they were exclusively caught when *Anophelines* or *Stegomyia* were looked for. Drains, gutter-traps, cess-pits are mainly responsible for them.

2. *Culex Concolor* have a distribution like that of *C. Fatigans* and were always found in association with the same. Their breeding places number about 8 per cent. of those of *C. Fatigans* and are mostly wells.

3. *Culex Taeniorhynchies* was found only once in salt water of a marsh along with *A. Rossi.*

4. *Theobaldia Spathiapalpis* was found in bamboo traps set as mentioned above.

5. *Anopheles Stephensi.*—Its breeding grounds are about 2/3rd of the total for *Anophelines.* It was found under all conditions living quite happily and did not die in sampled bottles. As may be seen from the analysis, it was found in sweet as well as brackish water and in the back waters of the sea; in garden tanks but specially in the garden drains and water-logged areas; in very foul manure pits. It is impossible to give an opinion as regards their choice of breeding place.

6. *A. Rossi.*—Nothing unusual noted.

7. *Cellia Pulcherima* was found only once in a big garden tank.

8. *Desvoidea* were not met with.

9. *Phlebotomus.*—The sand fly was found everywhere and is a great pest at Manora.

10. *Chironomus* are found everywhere in clean water, *e. g.*, garden tanks, cattle troughs, etc.

*The Natural Enemies of Mosquitoes.*

Section 4.

The water-boatman, belonging to the order Notonectidae, is very often found in tanks and under experimental conditions they devour both *Culcines* and *Anophelines.* But in tanks, live larvae could always be caught. Minute water bugs, dark grey in colour and 1/16th of an inch in length, were found in wells and tanks and keeping down the number of larvae. The larvae of May-flies—*Ephemerae*—are also very destructive. It is doubtful though whether even a large number of these will serve to keep a breeding place free of larvae. Fish, unknown, were found in three big tanks and one well. In spite of all attempts no larvae could be found in these.

An attempt was made to experiment on local small sea-water fish, but they invariably died before a satisfactory conclusion as regards their feeding on larvae, could be arrived at. They are awaiting identification, and if from their habits in other places, they are of the right kind, it will be possible later to experiment on them.

## CHAPTER V.

### Preventive Measures.

Section 1. Karáchi is a small place as compared with other places where mosquito destruction is carried on successfully. All the breeding places are artificial, and not natural. There are no water-courses, pools, etc., and the marshy area can be entirely ignored as it exceptionally harbours larvae; and with the expansion of the city it is sure to be reclaimed in future and thus cease to be a menace. The rainfall is negligible in quantity and the adventitious breeding places can be easily kept under control. There do not, therefore, appear any great physical obstacles in the way of mosquito destruction. To add to the facilities in overcoming the same, are the sandy porous soil and the heat of the sun. All collections of water, artificial or natural, dry quickly because of the sandy nature of the soil.

*Summary of the economic conditions, customs of the people, etc.*—The greater part of the population is concentrated in the northern half of the town. Most of them are poor, and are attracted here by work from distant parts, *e. g.*, Deccan, Konkan, Cutch and Gujarát ports, etc. They live in chawls or lines closely built together with only one living room to serve for a good many of the people. The rooms are dirty and often full of smoke and where there are no women in the house the place is very unclean. Each of these houses has a courtyard of its own which is utilized for keeping animals of all kinds, and thus instead of the courtyard being a luxury, it becomes an abominable nuisance.

*Water-supply.*—On referring to old maps we find that there are twice or thrice as many wells as there are now but they are all filled up. As to who took the initiative and why they were filled up could not be ascertained. Perhaps it was the pipe water-supply that did away with the necessity and the present wells too are in a rotten condition because of disuse. Every house is not provided with tap water, the pressure is low and the supply intermittent, and the water in many cases has to be brought over from across the road. Big gharras are used to store the water and a fresh supply is added everyday without removing the remnants of the previous day. The first and paramount necessity, therefore, of the city is to increase the water-supply to such an extent as to enable every householder to dispense with the use of gharras and the wells.

Section 2. The measures required for the prevention and destruction of these breeding places fall into two classes :—

Those for—

I. Permanent breeding places.

II. Temporary breeding places.

These shall again be discussed under two heads—

A. General measures.

B. Special measures.

I. In the survey it has been shown that the commonest permanent breeding places are—

1. Open wells.

2. Open and imperfectly closed house cisterns.

3. Garden and other tanks, fountains, tubs, etc.

4. In certain localities special places exist in the marshy areas and the backwaters in mangrove swamps from the sea.

The first step of a general measure for controlling these, must be a strict limitation of their number and no increase of their potential breeding places must be allowed. At the present time wells are dug open or improperly closed, cisterns are erected, fountains and tanks constructed, garden and other tubs multiplied, without let or hindrance. The danger is great and the community must be protected from further risk by stringent regulations. The existing

places must be registered and a license obtained for keeping them. Even a nominal fee will have a deterrent effect.—

i. The construction of new open wells must be strictly prohibited.

ii. The erection of new cisterns must also be strictly prohibited, and these should be made to conform to a given standard of safety as regards protection from mosquitoes.

iii. The use of garden tanks and tubs should be subject to regulation and their multiplication should be restricted.

Having taken steps to restrict these, it will be possible to set about the reduction of those already in existence :—

i. Wells.—The protection of these is an important measure. The subsoil level of the water is very near the surface and not much trouble is required to dig a new one; all the wells are open and most of them kutcha built, *i. e.*, the brick and concrete work extends to a depth of few feet only, the result being that the earth work at the bottom crumbles away making the whole structure unsafe; and worse still, it allows an easy contamination from surface drainage; and the water in some cases is so foul that even fish will find it difficult to live in them. 60 per cent. of the wells breed larvae, and 2 per cent. those of Stegomyia. From very few wells is water taken for drinking purposes and religious ceremonials, and the great majority of them are used for purposes of washing, bathing, and for animals. 62 of the total of 513 wells are never used and the owners are willing to close them. An increased water-supply and laying on of taps to every house will easily do away with this nuisance and dispense with the necessity of storing water in gharras—

A. Owners should be obliged to register the wells and protect them in any of the following ways and allow a periodical inspection.

B. (i) They can be filled up and permanently closed (all foul and sewage contaminated wells must be closed).

(ii) They can be completely covered with stone or brick work, or enforced concrete, with no opening except that for the pump to be used for drawing water (the depth of no well will preclude the use of a hand-pump).

(iii) They may be similarly covered, and a small opening left, which is fitted with trap door and stocked with suitable fish. The trap door should have iron gauze with 20 meshes to the inch and be provided with a padlock. These should be allowed only in cases after personal inquiries.

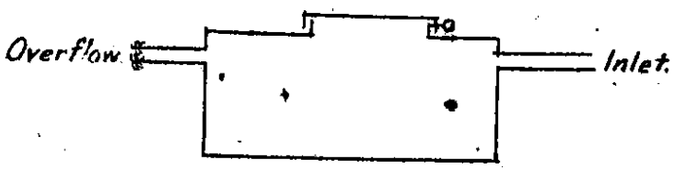
(iv) Or if a well cannot be concreted, it should be similarly stocked with a sufficient number of fish and kept always free from weeds and floating matter.

If in spite of these precautions the well cannot be kept free, *e.g.*, from the neglect of the residents, steps should be taken to close the well.

2. Cisterns.—These are at present badly constructed and badly situated They are sometimes on top of houses, and are fouled by dust and excreta of birds, etc., or in cramped places as under stairs where rats, cockroaches, etc., have an easy access to them; most of the residents think that the lid is superfluous. Those that were exposed to the sun, were mostly free from larvae because of the heating of the water :—

A. A license and a periodical inspection.

B. i Perfect fitting trap doors and the open end of the over-flow pipe should be covered with gauze.




ii Thorough cleaning every 10 days.

iii They should, whenever possible, be built exposed to the sun.

3. Garden tanks.—These should be erected according to the necessities of a garden and not the comfort of the "mali". They should not be sunk in the ground, and the water tap in connection with them must always be inspected and show no leakage. They should be built of bricks and concrete, and plastered all round and should have an opening at the bottom to clear out all possible traces of water and thus allow of thorough scouring. Fish for these cannot be advised, nor a wire-meshed netting, as this will soon get damaged. Putting kerosine on top is no good too, as the wind carries it all to one corner, and forms blebs leaving a greater part open, in which larvæ do live and thrive. Whenever there are more than two such in a garden they should be periodically dried in the sun every 8 days. Fountains may be stocked with fish of a suitable kind.

The general measures for garden tanks, fountains, cattle troughs, etc., are :—

A. A license and periodical inspection.

B. Cleaning and occasional drying.

The plot of ground around these should be always kept dry and never be allowed to get water-logged. These wells and tanks can be rendered innocuous at little expense and should remain so.

Garden drains.—Of these there should be always as few as possible and all should be brick-built and well levelled to allow no pools of water in their course. They should not pass close to a house. The pernicious habit of allowing a constant flow of water to pass through them and soak plots at leisure must be steadily discouraged. They should be thoroughly swept out and allowed to dry (most of these water-logged areas breed *Anophelines*).

Garden tubs should be periodically emptied and scoured.

Drains and gully traps should be inspected every 8 days and the traps pesterined.

II When we come to consider the temporary breeding p laces, the outstanding difficulty is the insufficient supply of water to every house, and the consequent necessity of storing it in receptacles according to the means of the tenant. Gharras, tubs, soda-cooling chatties, flower pots, antiformicas, fire-buckets, etc., must all be emptied out in the presence of the inspecting staff. Large sizes should be steadily discouraged. Disinfectants cannot be used.

A. i Supplying taps to every house.

ii Periodical inspection every 10 days.

iii The breeding of larvæ on the premises must be dealt with as an "offence" and should entail a penalty.

iv Erecting and keeping under control experimental breeding grounds.

All collection of waste water, round stand-pipes and in hollows of masonary works of tanks, and around the mouth of wells, should be carefully inspected and promptly filled up. Solid surface drains should be constructed to carry off all waste water.

The killing of the residual adult mosquito appears an entirely unnecessary measure, provided that a locality far and round is kept constantly under control. If necessary, as in holds of ships, sulphur should be burnt in a closed space—1½ lb. to every 1,000 cubit feet of space.

Special traps :—It must be remarked that it will not be sufficient only to inspect and cleanse the temporary breeding places of *S. Fasciata*. There are millions of adult mosquitoes existing, and as soon as their favourite haunts are abolished they will seek other suitable locations and in the absence of these, such unusual places (in Karáchi) as wells and garden tanks, cess-pits, etc. This being the case it will certainly follow that any well, etc., in the neighbourhood if not already infected will speedily become so. Starting, therefore, with the premise that the present temporary breeding places are well under control, a special catch-place, as a tub full of water, should be prepared for them. These should be located in every group of 50 or 100 houses. They are in no case to be touched but for the emptying and cleansing of them every eight days. These will serve to attract the flying adults and induce them to lay their eggs therein.

*Fish.*—There appears to be every reason to believe that fish of the right kind can successfully be employed in protecting wells, tanks, fountains, etc. :—

Section 3.

(i) the number of fish to be employed should be proportional to the amount of the surface of water to be protected.

(ii) the water should be kept free from weeds, floating matter, etc., which afford protection to larvæ.

The local fish are awaiting identification.

*Larvacides.*—No experiments were made locally but the following can be recommended :—

1. Kerosine is most effective than pesterine and a mixture of the two in equal parts is more efficient. Pesterine is cheap, and its colour shows when applied. These should be applied as a spray and the "Success Sprayer" works well.

2. Dr. Bentley's modification of Gorgas' Larvacide :—

| | | | |
|---|---|---|---|
| Carbolic acid, crude . | ... | ... | 100 gals. |
| Resin ... | ... | ... | 330 lbs. |
| Solution of caustic soda | ... | ... | (100 lbs. of the soda in solution.) |

The resulting preparation when cold is a thick dark brown mass of paste. This is heated up and diluted with three parts of water and is used as a stock emulsion :—

Emulsion 1—1,000 kills S. F. Larvæ in 8 minutes (one teaspoonful to a gallon).
Emulsion 1—5,000 „ „ 20 minutes.

It is found to have more action on larvæ than pupae and nearly mature larvae pupate rapidly on coming in contact with it. So that it is a good plan to combine kerosine or pesterine with it in equal parts. Half ounce to 1 square yard.

Improved drainage will not in any way affect the prevalence of *Stegomyia* or *Anophelines*. There is great danger, however, that if proper precautions are not taken it will still further increase the number of *Culicines*.

It is a most significant fact that during the investigation, no difficulty was experienced in any part of the city in dealing with uneducated and poor people. Whenever the important fact of the presence of larvae in their drinking water is brought home to them, they are extremely careful not to let it occur again, and though most of them are both illiterate and ignorant, they are not so apathetic. They accept without question the wholesome advice given. Many of the householders are willing to have the wells closed, and as regards temples and mosques, a satisfactory solution can be easily arranged by consultation with the leading citizen. Religious and caste prejudices will not interfere. I was always received with friendliness and though the presence of a Government official naturally creates some alarm, still with a little patience and coaxing, work can be more satisfactorily done, than with a show of authority.

## CHAPTER VI.

### The Cost of Mosquito Prevention in Karachi.

Section 1.

It is necessary to go into the question of the cost of efficient mosquito work in Karáchi in some detail, in order to get an idea of the staff and organisation required for such work. It is possible to deal with this question in three different ways:—

*Scheme I.*—The prevention and destruction of mosquitoes of all species.

*Scheme II.*—The prevention and destruction of *Stegomyia* only, throughout the city—(a relative extermination of these is worth attempting.)

*Scheme III.*—The prevention and destruction of Anopheline mosquitoes.

At the census of 1911 there were 31,000 occupied houses and here the term house has not such a wide significance as it has in Bombay. This number is used as a basis on which is estimated the cost of a scheme. For the purposes of a working basis, the different quarters are grouped according to the character of houses in each locality—see table IV-A and IV B.

Before any of these schemes can be carried out it is necessary to have a thorough careful inspection of all the premises, occupied or unoccupied, at intervals of not less than 8 days, by a trained Inspector. In addition to this house inspection, the Inspectors will have to examine the immediate surroundings of each, in order that no other likely place escapes attention. The status of the Sub-Inspectors must also be considered. A trained cooly is as good as any one, for the mere discovery of the mosquito larvae, but they can never be used as Inspectors. There is the same difficulty in the use of men of a superior stamp, *i.e.*, "Mukadums". Power of entry to private houses can not be delegated to men below the standing of a Sub-Inspector.

In other places where mosquito prevention is carried on, not more than 25 houses are allocated to one Sub-Inspector. In these schemes a higher number has been assigned deliberately for the following reasons:—

1. The system of numbering the houses is different.

2. The total possible number of breeding places is much less, on account of less rainfall and sandy soil.

3. Personal experience.—I could examine all the houses in the outdoor work of 3 to 4 hours; an equal time can with justification be added to carry out the preventive measures.

*Scheme I.*—Inspection every 8 days should be decided on.

*Group A* comprises 6,668 houses; one Sub-Inspector can readily examine 30 houses a day; *i.e.*, 200 houses per week. 30 Sub-Inspectors will therefore be required.

*Group B* 13,861 houses. One Sub-Inspector can examine 40 houses a day, *i.e.*, 280 per week. 50 Sub-Inspectors will be required.

*Group C* 10,900 houses. 75 houses on a liberal average can be examined, *i.e.*, 525 houses per week. 20 Sub-Inspectors will be required.

That is, a total number of 100 Sub-Inspectors will be required for the whole of Karáchi. Each of these will require two coolies to help them and carry the appliances and material required for discovering and destroying mosquito larvæ; it necessitates an extra staff of 200 coolies. Again it would be necessary, to have proper control of the subordinate staff, that the superior inspecting staff must be increased. An Inspector cannot supervise the work of more than

10 Sub-Inspectors as this would allow him to devote two or three working days a month for the work of each individual Sub-Inspector in his charge. 10 Inspectors will thus be required.

It has been found that there are about 500 wells in the city and over 60 per cent. of these are mosquito breeding places. 80 of these are absolutely useless and never used by anybody. In addition to these there are an equal number which the owners will permit to be closed with a little persuasion. There thus remain 350 wells to be absolutely dealt with. These will require inspection and periodical cleaning. They also need to be stocked with larvae-destroying fish. For this purpose special gangs of men under a good Mukadum must be employed for periodical cleaning at least once in two months. A gang of four men and one Mukadum can cleanse efficiently 30 wells a week on an average, as the majority of the wells are too shallow. That is, two such gangs will be enough all the year round.

The great amount of routine work rendered necessary by the adoption of such a scheme would require proper control and co-ordination, and this can only be done by placing one responsible officer in sole charge of anti-mosquito measures. This officer should be an Assistant to the Health Officer and would require to be specially trained or to have had special experience. It would soon be found that the effect of more constant inspection will necessitate an increase in the number of men employed in cleansing the city, and for the work of filling in and levelling small pools and hollows, and abolishing minor breeding places, an increased number of coolies, Mukadums, bullocks, etc., will be required.

(The following figures have been arrived at in consultation with the Health Officer, Karáchi.)

The total staff then comes to:—

| | | | | | |
|---|---|---|---|---|---|
| 100 Sub-Inspectors at Rs. 20, each per month | ... | ... | ... | Rs. | 24,000 |
| 200 Coolies at Rs. 12 | „ | ... | ... | „ | 28,800 |
| 10 Inspectors at Rs. 75 | „ | ... | ... | „ | 9,000 |
| 2 Well-cleansing gangs of 4 men and 1 Mukadum each | | | ... | „ | 1,500 |
| Health Officer at Rs. 350; 2 clerks at Rs. 60 each and 2 peons at Rs. 12 each, etc. | ... | ... | ... | „ | 6,500 |
| Material Larvacides, etc. | ... | ... | ... | „ | 10,000 |
| Increased cleansing work | ... | ... | ... | „ | 5,000 |
| | | | Total | ... Rs. | 84,800 |

or in rough figures Rs. 90,000 per year will be required.

*Scheme II.*—It is perfectly possible to rid the city of *Stegomyia* alone. It is not necessary to undertake such careful work as detailed in Scheme I. The inspection will be chiefly limited to temporary breeding places (mentioned in chapter III) and of the permanent ones—wells and garden tanks very near the houses. Against this has to be set down the fact that every house must be visited. The life-cycle of *Stegomyia* larvæ teaches us that an inspection every 10 days will leave an ample margin. All things considered the amount of work to be done will be lessened by about half. Allowing a third more of the houses to be inspected by each Sub-Inspector and insisting on a ten days' instead of a weekly interval, we have for Scheme II:—

| | | | | |
|---|---|---|---|---|
| Group A—400 houses every | 10 days | ... | 15 | Sub-Inspectors. |
| Group B—560 „ | „ 10 „ | ... | 25 | „ |
| Group C—1,050 „ | „ 10 „ | ... | 10 | „ |

The total staff on the same calculation comes to:—

| | | | | | |
|---|---|---|---|---|---|
| 50 Sub-Inspectors | ... | ... | ... | Rs. | 12,000 |
| 100 coolies | ... | ... | ... | „ | 14,000 |
| 5 Inspectors | ... | ... | ... | „ | 4,500 |
| 2 well cleansing gangs | .. | ... | ... | „ | 1,500 |
| Head Office establishment | ... | ... | ... | „ | 6,500 |
| Material, Larvicides, etc. | ... | ... | ... | „ | 5,000 |
| Increased cleansing work | ... | ... | ... | „ | 5,000 |
| | | | Total | Rs. | 48,900 |

or in rough figures Rs. 50,000 per year.

*Scheme III.*—This is the simplest of the three. The work will be limited for the inspection of the wells, garden tanks, and garden drains, cisterns, floral fountains and cattle-troughs. The prevention of mosquitoes in marshy areas involves the consideration of reclamation, etc., quite beyond the scope of this paper. All the above permanent breeding places are not more than 4,000 in all and leaving the wells out of consideration for a time, there are only 3,500 places to be dealt with on the whole. Now, it often happens that 3 or 4 of these are included in the compound of one house. But the distances which the working gang must go over in one day, shall also have to be considered. With a wide and a liberal margin, therefore, 30 such places—*not houses*—can be inspected and cleansed in one day and with an average inspection every 8 days, 15 Sub-Inspectors can do the work easily. The well-cleansing and fish-stocking gangs shall have to be retained, as also the charges on disinfectants. In the case of this particular anti-malaria campaign the Health Officer in charge will be burdened with the extra task of a periodical spleen census in different areas and the careful collection of returns from hospitals and dispensaries, corrected, whenever necessary, by microscopical observations.

The total then comes to :—

| | | |
|---|---|---|
| 15 Sub-Inspectors | ... | Rs. 3,600 |
| 1 Inspector | ... | „ 900 |
| 30 coolies | ... | „ 4,320 |
| 2 well-cleansing gangs | ... | „ 1,500 |
| Material larvacides, etc. | ... | „ 5,000 |
| Increased cleansing work | ... | „ 5,000 |
| Head Office establishment | ... | „ 6,500 |
| | Total | Rs. 26,820 |

or in rough figures Rs. 26,000 per year.

Section 2.

For the success of the operations detailed in these schemes, the area should be divided into sections of 1,000 houses each. Each of these sections should be divided into beats for each Sub-Inspector. Wholetime men must be employed to make a determined and constant attack on mosquitoes. All possible breeding places must be noted, as also every place where larvæ are found. A diary must be kept of the places visited and the whole staff must be clearly given to understand that their sole duty is to prevent mosquitoes breeding in their charge. Failure to prevent the breeding must be immediately reported. The whole staff should be regularly coached up in the routine work and in the method of inspecting wells, etc.; and distinguishing between *Anophelines*, *Culex* and *Stegomyia*. Each Sub-Inspector should be supplied with a ring-net, sauce pan, spoon, bottle, etc., and a card (like the one used in Bombay) should be filled in and returned to the officer to take further steps.

*Public Health Department.*

_____Quarter_____ Section_____Street.

House No._____ Name of owner_____

Class of occupier_____

Type of closet_____

Position of cistern_____ Larvæ present _____

Position of well_____ Do._____

Date of 1st inspection _____

Date of 2nd inspection_____

Date of action _____

Result of action taken_____

Subsequent inspection and remarks_____

Name of Inspector _____

All unused wells should be filled in as soon as possible. Those that are required for use should be covered and arrangements made for suitably raising the water by a hand-pump. Special traps, as detailed in Chapter V, should be set. All breeding places should be styled as a Dangerous Nuisance. The

stable and cattle yards should be paved and drained or totally abolished. All tins and rubbish should be removed to prevent an accidental filling of these with water. Privy pits should be kerosined and barrels screened.

Private individuals should be encouraged to do much by not allowing to remain near their houses any accumulations of water, by preventing its waste and overflow, and by seeing that all tanks and cisterns on their premises are closed properly or are larvæ free. No details should be left to the discretion of the servants. For this purpose it is necessary to distribute pamphlets to householders, etc., describing the various precautions against breeding mosquitoes. Education in sanitary ideas is essential before an attempt can be made to start anti-mosquito measures, and knowledge must be diffused steadily until it is shared by officials and non-officials alike.

## CHAPTER VII.

### Final Conclusions.

It has been shown in the previous chapters that there is real danger of Yellow Fever to India from increased trade communications with the East, and Karáchi will be one of the portals of its admittance if precautions are not taken in time—first because of its situation and rising importance as a maritime port, secondly from the universal and unchecked distribution of *Stegomyia Fasciata*, and thirdly the non-immunity of the population. It is desirable, and is perfectly possible, to control the second factor and exterminate the *S. Fasciata* or at least to so limit its dissemination that it will cease to be a potential danger. In the previous chapters has been discussed the prevalance of only one species—*S. Fasciata*—its distribution in the harbour and the city, a consideration of their breeding places and the factors which will influence them, and it has been clearly shown that in the absence of an ample water-supply, each house is a possible focus of infection.

It is necessary to point out that the harbour is so well isolated from the city that even if it is decided to draw the cordon of mosquito prevention round the harbour alone instead of the whole city, it is perfectly possible to prevent the yellow fever from finding a permanent foothold.

The measures suggested are practicable though requiring constant attention to minute details and much arduous work. Mosquito prevention, in order to be successful, must be carried on indefinitely and without relaxation. The cost of the scheme is not prohibitive and when considered with figures for other ports, stands a favourable comparison.

The whole responsibility of the measures must rest on the authority in charge, and not on the residents who can learn nothing and their reliance on measures will engender a false sense of security. The ultimate success will be ensured by co-operation with the public, *i. e.*, more by explaining to them than forcing them to do a thing blindly. As far as natural difficulties are concerned the problem is an easy one, and the more rapidly they are encountered over a whole area, the more certain will be their complete success.

# APPENDICES.

## TABLE 1.

*Mean Maximum and mean Minimum Temperature—monthly averages taken in Karáchi for five years 1908—1912.*

| Months. | 1912. | | 1911. | | 1910. | | 1909. | | 1908. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. |
| January ... ... | 77·3 | 61·1 | 72·3 | 57·4 | 74·8 | 57·5 | 73·5 | 55·7 | 77·1 | 55·3 |
| February ... ... | 80·7 | 63·2 | 77·5 | 61·6 | 80·0 | 62·5 | 78·9 | 60·5 | 80·5 | 56·6 |
| March ... ... | 84·0 | 66·5 | 79·0 | 66·6 | 81·7 | 66·5 | 83·7 | 66·7 | 85·6 | 63·8 |
| April ... ... | 86·2 | 75·6 | 84·3 | 72·6 | 85·8 | 72·8 | 85·8 | 74·5 | 90·2 | 73·3 |
| May ... ... | 89·1 | 79·0 | 87·9 | 78·4 | 86·7 | 77·0 | 91·2 | 76·4 | 94·2 | 77·7 |
| June ... ... | 91·8 | 83·6 | 88·5 | 80·6 | 90·8 | 81·5 | 91·0 | 83·1 | 95·0 | 82·6 |
| July ... ... | 89·6 | 82·1 | 86·6 | 79·3 | 87·5 | 80·2 | 88·6 | 80·4 | 88·8 | 79·8 |
| August ... ... | 87·8 | 79·5 | 85·1 | 77·8 | 85·8 | 77·3 | 83·4 | 75·2 | 85·8 | 77·6 |
| September ... ... | 86·1 | 75·7 | 85·3 | 77·0 | 85·0 | 75·6 | 86·1 | 75·2 | 85·7 | 75·6 |
| October ... ... | 88·3 | 73·0 | 85·4 | 73·4 | 86·3 | 72·1 | 86·5 | 73·3 | 85·4 | 72·2 |
| November ... ... | 84·7 | 66·0 | 83·2 | 65·0 | 84·5 | 66·2 | 85·3 | 70·2 | 83·0 | 85·1 |
| December ... .. | 78·9 | 59·6 | 78·8 | 58·9 | 77·9 | 59·1 | 77·6 | 60·5 | 78·8 | 59·5 |

## TABLE 2.

*Vapour tension mean and Humidity mean at 8 a.m.—monthly averages for five years 1908—1912.*

| Months. | 1912. | | 1911. | | 1910. | | 1909. | | 1908. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Vapour. | Humidity. | Vapour. | Humidity. | Vapour. | Humidity. | Vapour. | Humidity. | Vapour. | Humidity. |
| January ... ... | ·399 | 65 | ·334 | 62 | ·337 | 61 | ·333 | 63 | ·369 | 72 |
| February ... ... | ·455 | 66 | ·465 | 73 | ·441 | 68 | ·384 | 61 | ·370 | 63 |
| March ... ... | ·509 | 64 | ·564 | 76 | ·538 | 68 | ·525 | 66 | ·552 | 66 |
| April ... ... ... ... | ·838 | 82 | ·736 | 80 | ·697 | 73 | ·759 | 78 | ·725 | 70 |
| May ... ... | ·930 | 81 | ·877 | 81 | ·891 | 86 | ·774 | 68 | ·848 | 72 |
| June ... ... | ·980 | 77 | ·946 | 84 | ·965 | 80 | ·981 | 80 | 1·004 | 77 |
| July ... ... | ·975 | 82 | ·873 | 82 | ·920 | 82 | ·934 | 84 | ·989 | 88 |
| August ... ... | ·893 | 82 | ·839 | 83 | ·865 | 86 | ·815 | 88 | ·899 | 88 |
| September ... ... | ·820 | 81 | ·833 | 83 | ·795 | 82 | ·781 | 80 | ·821 | 83 |
| October ... ... | ·719 | 74 | ·764 | 81 | ·728 | 79 | ·747 | 79 | ·798 | 76 |
| November ... ... | ·463 | 59 | ·454 | 59 | ·494 | 66 | ·636 | 73 | ·541 | 73 |
| December ... ... | ·333 | 56 | ·291 | 50 | ·344 | 57 | ·341 | 60 | ·363 | 62 |

## TABLE 3.

*Monthly averages of rainfall from 1908 to 1912 and monthly averages of wind in 1912.*

| Months. | Rainfall 1908—1912. | | | | | | | | | | Wind 1912. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1912. | | 1911. | | 1910. | | 1909. | | 1908. | | | | | | |
| | Rainfall in inches. | No. of rainy days. | Rainfall in inches. | No. of rainy days. | Rainfall in inches. | No. of rainy days. | Rainfall in inches. | No. of rainy days. | Rainfall in inches. | No. of rainy days. | Components of the wind. | Nature of wind. | Maximum No. of miles in one day of the month. | Minimum No. of miles in one day of the month. | Mean velocity in miles per hour derived from 24 hourly observations. |
| January ... ... | ... | ... | 0·50 | 2 | 0·37 | 1 | 0·68 | 2 | 0·85 | 2 | S.W. ; N.E. ... | Light breeze ... | 590 | 119 | 9·9 |
| February ... ... | ... | ... | 0·02 | ... | ... | ... | 0·01 | ... | ... | ... | S.W. ; N.W. ... | Light to moderate ... | 612 | 146 | 13·0 |
| March ... ... | ... | ... | 3·88 | 6 | ... | ... | ... | ... | ... | ... | W.N.W. ... | Moderate ... | 614 | 157 | 13·3 |
| April ... ... | — | ... | ... | ... | ... | ... | ... | ... | ... | ... | W.S.W. ... | Moderate and strong | 632 | 264 | 15·7 |
| May ... ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | W.S.W. ... | Do. ... | 602 | 235 | 17·1 |
| June ... ... | ... | ... | ... | ... | 2·29 | 2 | ... | ... | ... | ... | S.W. ... | Do. ... | 674 | 277 | 20·9 |
| July ... ... | 2·77 | 2 | ... | ... | 3·14 | 3 | 5·03 | 3 | 5·11 | 4 | W.S.W. ... | Do. ... | 690 | 321 | 20·2 |
| August ... ... | 0·38 | 1 | 0·09 | ... | 1·73 | 3 | 0·63 | 1 | 0·49 | 1 | W.S. ... | Do. ... | 736 | 193 | 19·2 |
| September ... ... | 0·02 | ... | 0·12 | 1 | ... | ... | 0·02 | ... | 0·01 | ... | W.S.W. by W.N. | Do. ... | 609 | 160 | 16·1 |
| October ... ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | N.N.E. ; N.N.W. | Light ... | 339 | 160 | 9·8 |
| November ... ... | ... | ... | 0·28 | 1 | ... | ... | ... | ... | ... | ... | N.E. ... | Do. ... | 512 | 134 | 7·8 |
| December ... ... | ... | ... | ... | ... | 0·10 | ... | 0·72 | 2 | ... | ... | N.E. ... | Do. ... | 524 | 53 | 9·5 |
| | | | | | | | | | | | | | | | 14·4 |

# TABLE 4-A.

*Census of 1911.*

| Group. | Quarter. | Area in acres. | Number of occupied houses. | Total number of persons. | | | Density per acre. |
|---|---|---|---|---|---|---|---|
| | | | | Male. | Female. | Total. | |
| A | 1. Civil Lines ... ... ... | 505·96 | 252 | 1,563 | 795 | 2,358 | 4·66 |
| | 2. Frere Town bath Island and Clifton. | 254·82 | 260 | 843 | 529 | 1,302 | 5·38 |
| | 3. Railway and Queen's Road... | 258·96 | 34 | 166 | 58 | 225 | 0·86 |
| | 4. Serai ... ... ... ... | 172·17 | 1,653 | 5,055 | 2,605 | 7,660 | 44·48 |
| | 5. Rambagh ... ... ... | 161·15 | 1,348 | 3,664 | 2,250 | 5,914 | 36·68 |
| | 6. Preedy ... ... ... | 64·69 | 347 | 765 | 526 | 1,291 | 19·99 |
| | 7. Garden quarter ... ... | 940·30 | 2,711 | 7,259 | 5,345 | 12,601 | 13·41 |
| | 8. Ghizri, etc. ... ... ... | 156·10 | 63 | 218 | 183 | 401 | 2·56 |
| B | 9. Old Town ... ... ... | 32·83 | 1,235 | 2,450 | 2,078 | 4,528 | 137·95 |
| | 10. Napier ... ... ... | 45·80 | 1,987 | 5,611 | 4,315 | 9,926 | 216·55 |
| | 11. Market ... ... ... | 37·88 | 963 | 3,169 | 2,409 | 5,578 | 168·94 |
| | 12. Bunder ... ... ... | 30·25 | 291 | 1,203 | 292 | 1,495 | 49·42 |
| | 13. Jail ... ... ... ... | 91·83 | 1,459 | 3,698 | 2,571 | 6,269 | 68·25 |
| | 14. Runchore ... ... ... | 204·54 | 4,559 | 10,519 | 6,731 | 17,250 | 84·34 |
| | 15. Ramswami and Begarikhatta. | 66·56 | 1,252 | 2,332 | 1,736 | 4,068 | 61·11 |
| | 16. Soldier Bazar ... ... | 44·98 | 346 | 654 | 487 | 1,141 | 25·36 |
| | 17. Sadar Bazar ... ... ... | 126·26 | 1,769 | 5,310 | 3,580 | 8,890 | 74·12 |
| C | 18. Lyari... ... ... ... | 918·27 | 7,118 | 17,378 | 14,571 | 31,949 | 34·79 |
| | 19. Machimiani ... ... ... | 70·48 | 1,265 | 3,521 | 2,762 | 6,283 | 89·14 |
| | 20. Kiamari ... ... ... | 172·17 | 1,220 | 3,566 | 1,961 | 5,527 | 32·11 |
| | 21. Manora, Baba bhit ... ... | 24·37 | 121 | 411 | 330 | 741 | 30·40 |
| | 22. Maurypur and Shawapir and scattered hamlets. | 84·93 | 1,180 | 2,674 | 2,371 | 5,045 | 59·40 |
| | Total ... | 4,465·30 | 31,433 | 82,026 | 58,485 | 140,511 | ... |
| | Add that of Railway limits ... | ... | ... | 3,841 | 1,283 | 5,124 | ... |
| | Harbour ... ... ... ... | ... | ... | 2,148 | 69 | 2,217 | ... |
| | Cantonment—Military charge ... | ... | ... | 4,680 | 954 | 5,634 | ... |
| | Cantonment „ ... | ... | ... | 3,529 | 2,231 | 5,760 | ... |
| | Grand Total .. | ... | ... | 96,265 | 63,005 | 159,270 | ... |

## TABLE 4-B.

*Total Number according to Groups.*

| Groups. | Area in acres. | Number of occupied houses. | Total Population. | Density per acre. |
|---|---|---|---|---|
| Group A (1 to 8) ... | 2,514·15 | 6,668 | 31,821 | 12·25 |
| Group B (9 to 17) ... | 680 93 | 13,861 | 59,145 | 88·33 |
| Group C (18 to 22) ... | 1,270 22 | 10,904 | 49,545 | 39·05 |
| Total ... | 4,465 30 | 31,433 | 140,511 | ..... |

## TABLE 5.

*Population according to race in 1911.*

| Names. | Males. | Females. | Total. |
|---|---|---|---|
| Mahomedans ... ... ... | 38,996 | 31,548 | 70,544 |
| Hindus ... ... ... | 38,582 | 23,846 | 62,428 |
| Christians ... ... ... | 2,434 | 1,524 | 3,958 |
| Parsis ... ... ... | 981 | 931 | 1,912 |
| Jains ... ... ... | 434 | 213 | 647 |
| Others ... ... ... | 599 | 423 | 1,022 |

## TABLE 6.

| Causes of death. | 1911-1912. | | 1910-1911. | | 1909-1910. | |
|---|---|---|---|---|---|---|
| | Number of deaths. | Death rate per 1,000. | Number of deaths. | Death rate per 1,000 | Number of deaths. | Death rate per 1,000 |
| Fever ... ... | 828 | 5·64 | 668 | 4·51 | 696 | 6·40 |
| Small-pox ... ... | 11 | 0·07 | 24 | 0·16 | 12 | 0·11 |
| Cholera ... ... | 9 | 0·06 | 38 | 0·35 | ... | 0·00 |
| Accidents ... .. | 31 | 2·20 | 23 | 0·15 | 20 | 0·18 |
| Stomach and Bowel complaints... | 123 | 0·83 | 83 | 0·56 | 88 | 0·18 |
| Plague ... ... ... | 2,768 | 18·71 | 1,681 | 11·36 | 2,069 | 19·04 |
| Other causes ... ... | 2,818 | 19·05 | 2,799 | 18·92 | 2,283 | 21·01 |

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