HISTORY OF MALARIA IN AUSTRALIA.

It is interesting to speculate on the question as to whether Malaria was established in Australia prior to white settlement. All the other continents of the globe at the end of the 18th Century had large areas which were malarious and it would seem remarkable for Australia to escape the stigma; nevertheless, it is highly probable that malaria at this period was absent in Australia, or if present, existed only to a degree brought about by occasional infections from the East Indies and their subsequent dying out. To what factors then did this country owe its immunity? The answer cannot be found in either of the two factors of climate or anopheline population: both these are favourable in many localities. It is in the third factor of human population that we must seek for the explanation of Australia's freedom from malaria.

The population factor has throughout Australia's history been almost invariably unfavourable to the spread of malaria. Prior to white settlement the habits, culture, and social organization of the aboriginals accounted for this fact. The aboriginals were few in numbers, they had no fixed abodes. They were not tillers of the soil, but hunters and fishermen. They wandered over large areas of country where, speaking generally, native game was comparatively scarce and difficult to kill or capture with the rather primitive weapons used by the blacks. The consequence of this was that they had to shift camp very frequently and it was therefore only rarely that their stay in camp was sufficiently long for the development of the parasite in the body of the insect. It was generally many months before they returned to the same camp. On rare occasions it is said that aboriginals in the North of Australia did make more permanent camps in the wet season, but these camps were left as soon as the rains began to lighten.

The wet season however is a very unfavourable time for the spread of malaria in Northern Australia, the majority of cases occurring between May and September (17), (11). No doubt the continual flushing out

of breeding places prevented mosquito breeding on a large scale during this season. Whatever the cause, there seems but little doubt that the Australian aboriginals did not, when living in their wild state, suffer from malaria and did not act as a reservoir for the virus of the disease. This freedom from disease was not the result of natural immunity for once the aboriginal abandoned his old customs and came to live with, and work for, the white man he began to contract the disease and to act as a reservoir for the virus. The disease then spread to new corners to the big cattle stations and mining fields, on which the aboriginals were employed. (17), (18), (19), (20), (21), (23). Several small foci of infestion have been discovered in the aboriginals from time to time, e.g. at the Palm Islands (3), and Melville Island. (18), (22).

We must now briefly discuss the present distribution of malaria in and relating to Australia. The malarious area of the Austral Pacific Zone is very definitely bounded by the 160th meridian of E. longitude and the 20° of S.latitude. West and South of these two lines the Austral Pacific Zone is quite free from malaria except for an occasional case in Australia. The lack of endemicity S.of the 20° of S.latitude is explained on a climatic basis largely, but immunity E. of 160° E. longitude is due to the absence of suitable mosquitoes. The importance of keeping these islands free from anophelines and preventing the rise of a fresh factor favouring depopulation in this area will be realised.

N. of 20° S.latitude, and W. of 160° E.longitude, the situation is very different. New Guinea, the Solomon Islands and the New Hebrides are all heavily infected. Australia is but lightly infected and the reason for this comparative immunity will be discussed later.

In Australia at the present time malaria is confined to a small area in Northwest Australia, to two areas in the Northern Territory and to two areas in Queensland. In the tropical North-west of Australia the infection is, as it also is in Queensland and the Northern Territory, almost solely confined to cattlemen and miners.

The men working the large cattle stations and the miners often live under very primitive conditions. Food and lodgings are poor, and contact with natives is close and frequent.

In the Northern Territory we find malaria on the two water sheds i.e. in the rivers running into the Timor sea and in those running into the Gulf of Carpentaria. Here exist cattle stations along the banks of these rivers, where primitive living conditions exist. Miners perhaps recently from New Guinea and with chronic malaria constantly visit such areas; drovers, with mobs of cattle, each year travel from the Northern Territory and even Queensland right across the continent to Wyndham and Derby. All these conditions are favourable to the spread of malaria and the scarcity of cases of the disease must be attributed rather to the sparseness of the population than to anything man has done to prevent the disease.

In Queensland malaria exists in the Gulf country, where similar conditions exist to those encountered in the Northern Territory and North-west Australia. North of Cairns there is an area where occasional cases still arise. In this area there are several aboriginal Mission Stations, where large numbers of aboriginals are congregated. It is known that malaria has existed in the past among these aboriginals. (4), (13).

The first reference that can be found to malaria in Australia, is that by Jackson (53). Jackson states that the hospital at Moreton Bay (now Brisbane) opened in 1825. In the year December 1827 to December 1828 there were 956 admitted, and of these 27 were for intermittent fever and 161 are recorded under the name "febris". Other cases than malaria were no doubt included under the name intermittent fever. In 1832, in the month of January there were in the same settlement, 127 cases of intermittent fever, mainly from Brisbane and Eagle Farm (4 miles from Brisbane). In all, for the year 1832 there were 665 cases of intermittent fever recorded of which four died. In October 1832 the population of the settlement consisted of 858 men and 59 women and 66 children of whom 782 were convicts; the remainder mostly belonged to the 17th regiment. It is not likely that the convicts brought the malaria to Moreton Bay. It seems much more

likely that it was introduced by some of the officers or men of the regiment. In this connection Lieutenant Breton remarks that Captain C.of the 17th regiment is responsible for the following statement.- "I am,however,far from thinking our present place of abode unhealthy,although fever and ague have of late been rather prevalent; but these were not known when first I came here,and probably may not always continue to annoy us. It is strange that during the last very hot weather,when these complaints were most prevalent,the soldiers suffered more than the convicts; but such a circumstance never occurred before nor since" (78).

While it would seem that malaria was present at Moreton Bay in 1828 and 1832,it would appear that it did not exist at Raffles Bay in the Northern Territory at least in endemic form. Dr.T.B.Wilson (77) mentions that Dr.R.M.Davis in his Annual Medical Report from June 1828 to June 1829 states "Nothing in the form of epidemic or contagious disease has been observed. The greater proportion of the diseases which have occurred are to be attributed to the want of a due quantity of vegetable food.....The people,although generally complaining of not possessing as much bodily strength as heretofore, look more healthy than can be at first imagined. The health of some men,delicate on arrival here,has much improved.....No deaths have occurred within the year.....Although in the summer months the atmosphere is very hot,and at times oppressive,few cases of fever or other acute disease at that period prevailed,even among those men who were obliged to be much exposed to the sun's influence..... Captain Laws also supports the healthiness of this part,stating that the principal disease appears to have been scurvy,which they suffered from soon after their arrival.....".

In another place it is interesting to note that Dr.Wilson (p.72) mentions the arrival of the "Amity" at Raffles Bay on the 31st June 1829 and that two men from her died from fever on July 2nd. This fever was acquired at Coupang (Timor) and was most probably malaria. If suitable anopheline vectors were present at Raffles Bay,they must, as early as this in the 19th century,have had the chance of becoming disease carriers.

HISTORY OF MALARIA IN AUSTRALIA.

(To be inserted as three paragraphs in the middle of page 5.)

In 1864 Doherty (92) states that a trading vessel from Batavia called the "Jackmel Packet" introduced yellow fever into Burketown. This town had only been founded in 1861.

Charlton states (93) that in Burketown in 1864 an epidemic introduced by a Malay trader broke out. It was characterized by jaundice and in some cases by black vomit. The death roll assumed alarming proportions. The population fled to the present site of Normanton.

It seems highly probable that since yellow fever has never occurred at Batavia, or in the east in general, that this disease was really bilious remittent fever.

We have a number of references that the presence of these two cases did not lead to the disease then becoming endemic in the Northern Territory.

Sir George Grey stated that in 1837 and 1838 malaria did not exist in the neighbourhood of Prince Regent River, North-west Australia (79). Baron von Mueller is responsible for stating that malaria was absent from the Northern Territory and North-west Australia in 1855 and 1856. (80).

Sturt is the first to make mention of malaria in Northern Australia. He says that Leichardt when endeavouring to cross Australia from East to West was forced to turn back because his party had contracted the ague. (81). In this case it is much more likely that the party became infected on the Queensland coast and that the stress, strain, and hardship of an explorer's life precipitated attacks of fever after a certain period.

Cleland cites the fact that one of MacKinley's men was sick with a touch of fever and ague in August 1862, near Bowen, North Queensland. (82).

The first medical description of malaria is given by J.A. White in 1867. White states that the population in the Gulf country suffered from three fevers; the first being the well known intermittent, the second being remittent of all grades of severity, and the third contagious and continued. The latter White states is typhoid which was introduced by a small vessel, the "Margaret and Mary", and which caused many deaths in the Gulf area. The intermittent fever of course was malaria. The remittent type is of great interest. White gives the symptoms as follows: Very sudden onset 11 a.m. to 2 or 3 p.m. with dizziness, slight chills and flushes, wandering pains in extremities, fixed pain in the back and epigastrum, with an agonizing pain in the frontal and supraorbital region. Nausea exists and towards evening a quantity (generally small) of dark yellow, acrid, intensely bitter fluid having a foul odour is discharged from the stomach. Pulse generally 100 full and strong. Tongue lateral margin purplish, but covered with whitish or slightly yellow fur. The patient is delirious and generally unable to sleep. Towards 2 or 3 a.m. the symptoms abate,

but do not disappear. Another paroxysm commences at about 10 a.m. The second is generally the most severe and the fifth, in cases of recovery, the mildest and last. The treatment given consisted of a purge and 6 grs. of quinine every 4 hours.

Each paroxysm consists of a hot stage, which may or may not be preceded by rigors or chilliness; sweating sometimes does and sometimes does not occur after the hot stage (6).

This description reads very like subtertian malaria, and if so, is interesting in view of the statement commonly made that subtertian did not exist in Australia, till introduced by returning miners from New Guinea.

Right through the early history of medicine in Australia, the application of popular names instead of scientific, has led to confusion: "Gulf Fever" a popular term in the old days was malaria (60), but the position is most confusing as regards the term "Colonial Fever". Colonial fever would seem to have been mainly enteric. It also included a large number of cases of bacterial dysentery. In 1869 Dr. Martin (5) agreed that "Colonial Fever" was essentially enteric fever, variously modified. He also stated that malaria was unknown at that period in Victoria. Some practitioners at this time regarded colonial fever as a form of typhus. Others when dealing with malaria called it colonial fever. Thus Andrews (62), said that in 1874 at Albury on the Murray, colonial fever was really malaria. They never failed to yield quickly to large doses of quinine, though some of them relapsed next year.

Hirsch states that in Australia from 1859 to 1866 in 6736 soldiers, there were 31 cases of malaria.
From 1867 to 1869 in 4491 soldiers there were 25 cases (84).

We have seen that the Northern Territory was free in 1855 to 1856 and that in 1869 the Gulf area was well infected.
In 1889 Wood (10) states that malaria was very prevalent in Darwin in 1879-1880.

From 1880 to 1890 malaria reached its height as far as Australia was concerned. It was endemic through a large part of Queensland, the Northern Territory and North West Australia. In addition frequent little local epidemics occurred.

The factors responsible for this prevalence were largely concerned with mining activity. This was a period of great activity in opening up new fields in Queensland and the Northern Territory. In addition miners were returning from the very malarious goldfields of New Guinea. Thus Holmes (18) & (19) states malaria was very prevalent on the Pine Creek goldfield and railway construction work in the Northern Territory in 1879-1883. Holmes also states that the aboriginals at Melville Is. had suffered from subtertian outbreaks with considerable mortality.(18).

During the opening up of the goldfields in the Northern Territory in 1879-1883, in 1879, 61 out of 166 deaths were due to malaria; in 1880, 61 out of 154 and in 1881, 51 out of 130. (19).
There was no doctor in this area till 1885.

In 1884 Jee stated that malaria was formerly present in the Torres Straits Is. (69).

In 1885 Browne stated that practically the whole population of Charters Towers went down with malaria. There were no deaths. This was most probably not malaria at all, but dengue; more weight is lent to the diagnosis of dengue insomuch as Rockhampton had in this very year a severe epidemic of dengue. (57), (86).

In this decade (1880-90) malaria was frequently seen in Townsville according to Ahearne (56). It occurred at Hughenden in 1886-1890 when 26 per cent. of all cases admitted to hospital were malaria. It is interesting to note that whereas the type was formerly frankly intermittent by 1890 it had changed to remittent.(Hunt) (59). This change probably indicated a change from tertian to subtertian.

In 1888, Heydon (13) states that malaria was very prevalent at Yarrabah and Cairns.

In 1889, Dyson (11) says it occurred at Normanton, the Palmer goldfields, Croydon, the Johnstone River and Cairns. Indeed wherever virgin country was being turned over.

In the decade 1890-1900 a change for the better occurred. Hunt (7) shows that it was definitely on the decline at Hughenden where percentage of admissions to hospital for malaria were as follows:-

1887	35.2%
1888	30.1%
1889	20.9%
1890	15.06%
1891	19.1%
1892	8.5%

Other areas reflected the same trend. Ahearne (56) says the disease was rare in Townsville in 1890 though previously frequent. Jefferis Turner (58) in 1890 said that in 15 months in Brisbane he had only seen three cases in children and that one of these came from the North. In 1900 malaria was still fairly common in Cairns according to O'Brien, but in 1905-1908 there was none.(55).

In the Northern Territory the position from 1890-1900, while it had improved somewhat,did not do so to the same extent as in Queensland. The number of deaths due to fever in the Northern Territory for 40 years in a population varying between 3000 to 4000 of mixed races,white and coloured, was 412.

1871	-	1879	61	1887	4	1895	3	1903	6
1872	1	1880	61	1888	5	1896	7	1904	8
1873	13	1881	51	1889	6	1897	8	1905	-
1874	7	1882	9	1890	6	1898	5	1906	-
1875	15	1883	23	1891	-	1899	6	1907	7
1876	3	1884	4	1892	2	1900	9	1908	16
1877	1	1885	3	1893	3	1901	6	1909	18
1878	7	1886	2	1894	5	1902	6	1910	18

The admission book at the Darwin Hospital gives the following figures for malaria:-

		Total Admissions.			Total Admissions.			Total Admissions.
1897	18	77	1902	1	65	1907	12	114
1898	8	80	1903	2	50	1908	23	136
1899	6	68	1904	12	89	1909	44	129
1900	5	65	1905	1	74	1910	27	165
1901	1	59	1906	6	113			

This gives a total of 166 for 14 years. These figures are from Breinl (15) and (16).

The high figures for the years 1908, 1909 and 1910 were again accounted for by mining activity. A payable tinfield was discovered at Umbrawarra Creek 10 miles from Pine Creek,in 1909. Miners were attracted from Queensland,New Guinea and Western Australia,and malaria very quickly broke out. The type was subtertian. Living conditions were bad and men camped right on the banks of the creek. Numerous large square holes on each side of the creek were excavated by miners searching for alluvial tin. The miners worked up to their hips in water a large part of the time. (17).

The decade 1901-1910,despite the fact that a number of soldiers returned from the South African War with malaria,saw another change for the better,at least in Queensland,though in the Northern Territoryas mentioned above,the opening up of the Umbrawarra tinfield

Malaria was still bad in North-west Australia at Wyndham in 1903 according to Belgrave (63) and was on the authority of O'Brien (55) still occurring along the North Queensland coast in 1905-8, while in 1910 it was occurring again near Cairns, but benign in type (72).

A very bad epidemic occurred in Queensland in 1911, and Elkington (67) reports on this outbreak as follows.- "The outbreak occurred at Kidston on the Kimsleigh goldfield North Queensland. The population was 400. Two miners from New Guinea with subtertian infection inoculated the local mosquitoes. Before the outbreak subsided in this population of 400, there were 120 cases with 24 deaths.

Breinl reported in 1910 that a few cases were still occurring in Cairns, Cooktown and the Gulf country. The type was benign tertian except for a few malignant tertians from New Guinea. (32).

In the decade 1911-1920, in the opening half, improvement still continued, but in the later period a large number of soldiers infected with malaria returned from New Guinea, Palestine and other malarious war areas. According to the figures given later (on page 10) this had very little influence on the total number of deaths recorded for the Commonwealth; it did, however, because of the relapses, reflect itself in the statistics of those States which insisted on the notification of malaria as an infectious disease.

Thus Western Australia

	Cases of Malaria notified.	Remarks.
1913	41	None in South of State.
1914	19	" " " " "
1915	2	
1917	13	
1918	8	
1919	686	680 military cases.
1920	57	16 from Wyndham.
1921	39	(20 from Wyndham. (6 from Derby. (2 from Broome.
1922	41	(22 from Wyndham. (5 from Broome.
1923	23	)
1924	29	) Mainly imported or
1925	26	) from the North.
1926	18	)

The notifications are back to pre-war numbers again now.

The danger to Australia of these returning soldiers was realized and a Conference in Sydney drew up resolutions for the protection of Australia.(47). These resolutions in brief were as follows.-

1. Returning soldiers from New Guinea infected with malaria to disembark at Townsville for treatment.
2. The collection of invalided and discharged soldiers who have suffered from malaria, in one place for treatment.
3. Military pay to continue during treatment.
4. The treatment, officially recommended, to be used.

On June 3, 1916, the first three of these resolutions were put into effect.(48).

In addition to these measures the Commonwealth Government ordered a Survey of the Murray River Irrigation Areas. This was carried out by Taylor, October 1916 to January 1917. Despite rather unfavourable weather conditions, he found anophelines breeding in most of the areas visited and in those areas where they were not found, conditions were such that it was almost certain that had a more favourable time for a visit been chosen, such mosquitoes would have been discovered.(83).

In the last decade 1921-1929, it may be said that malaria has reached a figure so low that the deaths attributed to malaria, about 5 per million at present, are not likely to be permanently reduced. This statement is made because it must be recognised that in areas where malaria does occur, there is a definite tendency to label fatal and unclassified fevers as malaria. The fairly constant malaria level is revealed by the deaths attributed to malaria in the last 23 years.(76).

Year.	Deaths.	Year.	Deaths.	Year.	Deaths.	Year	Deaths.
1905	55	1911	19	1917	49	1923	21
1906	38	1912	17	1918	41	1924	2[illegible]
1907	42	1913	24	1919	34	1925	35
1908	52	1914	22	1920	19	1926	25
1909	59	1915	30	1921	43	1927	29
1910	55	1916	50	1922	21		

The increased deaths in 1916, 1917 and 1918 due to returned soldiers will be noted.

Queensland is almost free from malaria now. Northern Territory and North-west Australia still provide cases, but not so frequently as formerly.

The Australasian Medical Congress held in Brisbane in 1920, passed a resolution asking that the activities of the Australian Hookworm Campaign be extended to include a survey of Australia for malaria and filaria.(71).

The Australian Hookworm Campaign was financed by the Commonwealth Government of Australia, the International Health Board, and the Government of that particular State of the Commonwealth in which the Hookworm Campaign was working.

Work on this survey commenced in August, 1922. The results are given in the table below. (4).

Area.	MALARIA. Number Examined.	Number Infected.	Percentage Infected.
West Australia	111	0	0
Northern Territory	273	4	1.5
Northern Rivers.N.S.W.	145	0	0
Brisbane - Southport.	3194	3	0.1
Nambour - Maryborough.	273	1	0.4
Rockhampton District.	226	0	0.0
Mackay District.	834	0	0.0
Bowen - Townsville.	1168	10	0.8
Ingham - Innisfail.	183	0	0.0
Cairns.	1600	25	1.6
N. . Queensland.	654	1	0.1
S.W. Queensland.	361	0	0.0
	9022	44	0.5

The value of such an investigation is open to question. Chronic carriers may only at times have parasites in the peripheral circulation in demonstrable numbers. Again malaria may be seasonable and only be prevalent at one period of the year. The evaluation of malaria in any country is always a difficult matter. Notification is seldom satisfactory. All States but one in Australia have now instituted compulsory notification, but in the last 20 years there have been at least ten alterations in the number of States notifying malaria; at times only one State has demanded it; in one year all

States did so. When malaria is mild a medical practitioner is not sent for. Many malaria attacks occur in Australia in areas remote from medical attention. Again the large sale of tonics containing quinine which occurs in malarious areas, tends to masque the effect of that disease in the community.

Most of the cases of malaria in Australia are imported ones from Papua, New Guinea, New Hebrides, and the Solomon Islands. It must be remembered that Australia does a large trade with these infected areas and that white people working in these islands are largely recruited from Australia. Again, an increasing number of people in India and the Straits Settlements, not having time or not desiring to take long leave in England, make a short holiday trip to Australia or New Zealand. In cold weather such persons not infrequently suffer from malaria relapses.

From time to time isolated cases have arisen in other parts of Australia than those ordinarily regarded as malarious. Thus in New South Wales, Jamieson reported a case contracted at Gosford in 1915,(49) Evans reported a case contracted at Wyong in 1919,(54) Clayton and Utz reported a case contracted near Wagga in 1921,(52) and Coney reported a case contracted at Sydney in 1926.(70).

In West Australia, Baldwin reports a case arising at Maylands near Perth in 1920. (88).

There is much work to be done in connection with the insect carriers of the disease in Australia. The anopheles represented in Australia are as follows.- A.annulipes, A.annulipes var amictus, A.bancrofti, A.punctulatus, A.punctulatus var moluccensis, A.atratipes, A.stigmaticus.

There is no scientific proof as to the efficiency of any but two of these varieties.(87). Heydon (14) has shown that in New Guinea A.punctulatus and A.punctulatus var moluccensis are efficient carriers. From recent private correspondence it would appear that malaria used therapeutically has been conveyed by A.annulipes. At the present time the Tropical Institute at Townsville is investigating as to whether A.bancrofti can act as an efficient carrier, as previously suggested by Maplestone.(3).

The distribution of A.annulipes extends throughout the continent and this variety occurs in large numbers and can convey the disease. To what factor or factors does Australia then owe her immunity from malaria? We have the vector, we have had large influxes of infected persons into areas where the vector not only existed, but where meteorological conditions were favourable for the spread of the disease. So far was the spread of malaria favoured by man, that in tropical areas soldier settlements were formed, thus providing a maximum concentration of malarial gametes for the infection of mosquitoes. Despite this, there were no epidemics.

Ross (90) discusses the factors necessary for the spread of the disease. These concern largely the number of anophelines, the number of human beings, the number of human beings with malaria, and the character of the human population. He also discusses the question of the slow change in the malaria state of large areas and instances the increase in Mauritius and the disappearance in England. To these might be now added the recent spread in Barbadoes, a locality believed immune on account of the fish which inhabit the fresh waters of its area.

Ross discusses the factors suggested for the disappearance of malaria from England namely.-

i. Reduction of anophelines by drainage.

ii. Reduction of population by emigration.

iii. Use of quinine.

He believes that the first factor is all important and the last, in part important. He also suggests that the general use of glass windows in the last century, may have had something to do with the decline of the disease.

We have seen in Australia that there is no suitable native population to act as a reservoir of virus. We must also recognise that the population in general is sparse in those areas reputed to be malarious, but it is not considered that these two factors are sufficient to account for the absence of the disease. We have had on many occasions a congregation of human carriers, a sufficiency of suitable mosquitoes and meteorological conditions suitable for the

spread of the disease; yet the latter has spread on some occasions and not spread on others. A more careful consideration of the data reveals the fact that, malaria has spread when conditions for the white population have been primitive, where hardship is rife, where sanitation is poor, and where work is heavy. Thus we have had outbreaks on mining fields and on cattle stations. In the latter localities, no doubt the factor of a native reservoir of infection must also be conceded. On the other hand where conditions have been better, in soldier settlements and sugar growing areas, malaria has died out. It does not seem to be due to any lack of numbers in the anopheline population. No deliberate attempt has been made in the direction of drainage for mosquitoes and farm drainage in general is not well advanced. It would seem that in Australia the all important factor is the economic and hygienic status of the people. It is interesting to speculate as to whether this is due to increased bodily resistance, to less opportunity for mosquitoes biting, or to some difference in the time of appearance or the absolute numbers of malarial gametes in the blood. There is however, nothing at present to guide one in choosing the factor or factors concerned in this relative immunity. One other factor deserves consideration and that is, in agricultural areas there are many domestic animals. Recent work seems to show that anophelines often prefer such a blood supply, thus diverting the insects attention from man.

It is interesting to note that in other parts of the world the importance of the economic factor has been recognised. Thus Marchoux (91) compares two rural areas in the Rhine Valley. In both malaria was formerly a scourge and in both A.maculipennis is abundant at the present day. In one, however, Les Dombes, malaria no longer exists. In this district the peasantry were formerly sunk in extreme poverty, underfed and overworked. Drainage of more than half the area of the anopheline breeding grounds during the first half of the nineteenth century produced little effect on malaria. During the latter half of the century, however, the conditions of the peasantry vastly improved; they were no longer overworked, underfed, and oppressed by care; the number of cattle increased. Coincident with these changes malaria decreased and finally disappeared,

although some of the drained breeding grounds have been restored. In the second district, La Camargue, although A.maculipennis is less abundant than in Les Dombes, malaria is still prevalent; but here the labour is miserably lodged and badly fed.

Seeing that the mosquitoes are still prevalent in both these areas, it is in the economic factor we must seek our explanation of the phenomena above. Drainage leads to better land, to more animals, to better houses, and a higher economic status.

Minor factors which have influenced the decline of malaria in Australia are the dying out of the aborigines, and the White Australia policy leading to the deportation of the kanaka workers in the Queensland sugar-cane fields and to the non-admission of further coloured labourers, but of supreme importance has been the high economic standard of living enjoyed by most workers in the Tropical and Subtropical areas.

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REPORT OF INVESTIGATION INTO MALARIA AND FILARIASIS IN CAIRNS AND ELSEWHERE.

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REMARKS ON MALARIA.

It seems clear that the prevalence of endemic malaria on the North Queensland coast has declined very much, and is possibly on its way to gradual disappearance.

If Anopheles annulipes or amictus are suitable vectors, the decline in many localities at any rate cannot be attributed to any scarcity in the insect. If, however, as has been maintained to be probable by Maplestone, Anopheles bancrofti is the main vector , then a decline in the numbers of this mosquito such as appears to have occurred in some places, may be a factor.

As regards the town of Cairns itself, however, even Anopheles annulipes appears now not to be very plentiful, a result, no doubt, due to the abolition in recent years of many of the swampy patches.

A more probable explanation of the history of malaria on the North Queensland coast than any lack of suitable vectors is, perhaps to be sought in other epidemiological factors, such as the standard of life of the white population. Kanaka labour began to be brought to these districts not long after the middle of the nineteenth century,and continued to be imported until after the year 1900 (apparently until 1904). The district from which these boys were brought (New Hebrides, Solomons, Bismarck Archipelago) are malarious, so that a fresh supply of persons infectious to mosquitoes was always being kept up, since although adult natives of such places may seldom have severe attacks of malaria, their blood is liable from time to time to contain gametocytes, and, moreover, definite bouts of fever may be brought on by change of climate, or adverse conditions. This necessarily would involve the infection of a certain number of Australians with the disease, assuming that suitable vectors existed. It would not necessarily follow, however, that the disease would continue to spread, or even to maintain itself indefinitely after the importation of infectious persons ceased. On the contrary, if the conditions in North Queensland are unfavourable, the course of events to be expected would be a gradual decline of the disease in an irregular fashion and with temporary local recrudescences and small epidemics, until a low level of average endemicity, or even total disappearance was reached. Ross has discussed from a mathematical point of view the epidemiology of malaria in a self-contained community. If conditions are such that the number of new infections is smaller than that of recoveries, the malaria rate of the population will gradually decline until a level of equilibrium is reached at some definite average malaria rate which may be zero or above it. But even if conditions are such that no malaria can eventually survive the importation of a few fresh carriers from outside will always be liable to cause a greater or less number of infections; small epidemics which, in their turn, die out. In the early years of the war, many soldiers from New Guinea were coming in with malaria.

Although the abundance of suitable vectors is undoubtedly a main factor in determining whether malaria can spread or survive in a country, it is not the only one. In parts of Cambridgeshire, where malaria has gradually died out, it is a much more simple matter to catch a large supply of anophelines (known to be suitable vector) than it was, for instance, in Rabaul, when malaria was fairly prevalent there. One difference between the two places is that, in New Guinea, there is a native population with a low standard of life, living in huts, not using nets, and not taking

quinine. Such a population to act as a reservoir seems to be one of the most important factors in a permanently malarious country. It may consist of a coloured race, or of a white peasantry with a low standard of life. There appear to be few countries inhabited solely by a white population, most of which has reached a fairly high standard of life, in which malaria is not declining or already gone. In Italy, Russia, Greece, and the Balkan countries, there are peasantries at a low level; in France, England, the Netherlands, and Australia the disease has vanished, or is diminishing. In some parts, at least, of the southern States of America where the disease prevails, there is a considerable population of negroes and of poor whites.

An interesting paper by Marchoux is noteworthy in this connexion. Two rural districts in the basin of the Rhone are compared. In both tracts, malaria was formerly a scourge, and in both Anopheles maculipennis is abundant at the present day. In one of the regions, however, Les Dombes, malaria is now only a memory. In this district, the peasantry were formerly sunk in extreme poverty, underfed, and overworked. Drainage of more than half the area of anopheles' breeding places, during the first half of the nineteenth century, produced little effect on the malaria. During the latter half of the century, however, the condition of the peasantry vastly improved; they were no longer overworked, underfed, and oppressed by care; the number of cattle increased. Coincident with these changes, malaria decreased and finally disappeared, although some of the drained breeding ponds have now been restored. In the second tract considered, La Camargue, although Anopheles maculipennis is less abundant than in Les Dombes, malaria is still prevalent; but here the labour is miserably lodged and badly fed. The author concludes that "it is to general well-being that the disappearance of Paludism in Les Dombes is due " (causing increased resistance to the disease), not to measures of drainage, nor even to better housing.

It is suggested, then, that the important factors in Queensland which have led to a decline in malaria are, firstly, the cessation of any noteworthy immigration of persons containing, or liable to develop, gametocytes in their blood; secondly, the decrease in numbers, partly as a result of the White Australia policy, of a coloured population living under inferior conditions; and thirdly, the comparatively high standard of life of the white inhabitants.

It is of interest to note that, in the early days (before about 1860), the aborigines of the far north were said by travellers of the time to be free from malaria, which appeared later sometimes in virulent form as small settled communities arose, and intercourse with Pacific Islanders and Malays increased. The fact, if it be one, seems rather surprising, since some intercourse with islanders and Malays is believed to have existed from far earlier times. The nomadic habits of aborigines may possibly be the explanation.

Some, at least, of the ways in which a high standard of living tends to reduce the malaria rate, can be understood. Modern houses are less attractive to anophelines than hovels; abundance of good food increases the resistance, and accelerates the recovery rate. In Queensland, we have, in addition, the general use of mosquito nets, probably a very important factor in diminishing the number of bites, even though the nets be usually defective, and not universally used. The common use of quinine mixtures in Queensland has also to be remembered.

A factor to which much attention has been given of recent years in other parts of the world is an abundance of live stock preferred by the anophelines to man. It is a factor which probably becomes of greater importance as improvement takes place in the lighting, ventilation, and cleanliness of the human habitations. I do not know how far the habits of Anopheles annulipes make it probable that this may be a factor of importance in Australia.

Malaria is certainly still to be found in some parts of Australia, for instance, in some of the stations on the Gulf of Carpentaria. It may possibly prove that the aboriginal camps in these places are the strongholds of the disease, in spite of some reports that aborigines do not suffer from malaria. But probably even in these regions the disease is not very prevalent. The only cases of malaria admitted to Townsville Hospital during the last two years have been from New Guinea.

But thanks are due to the staff of the Yarrabah Mission Station for their hospitality, courtesy, and the trouble they took to give us every assistance; also to the medical practitioners of Cairns, Port Douglas, and Innisfail for their considerate helpfulness.

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MALARIA.

The enquiries made before the trip had led to the hope that Yarrabah Mission Station might provide cases of malaria and prove suitable for experimental work with Anopheles and further that the Cairns neighbourhood was the most likely locality in Queensland in which to find malaria apart from some places on the Gulf.

On arrival in Cairns the local medical practitioners were interviewed. Dr.Clarke who sees all the sick from Yarrabah said that there used to be malaria there,but that he had seen no case for some time. On arrival at the Mission Station the staff all expressed the opinion that malaria still existed but that it was formerly more prevalent. All the cases of fever suspected to be possibly malaria which occurred during the stay were examined and a number of other children and adults were examined. No case of malaria,of enlarged spleen,or of parasites in the blood was found and it became clear that the place is now free from malaria or very nearly so. Probably some existed in former times but the fact that old aborigines who had lived there all their lives showed no splenic enlargement suggests that it was never extremely prevalent. Anopheles were very abundant and in the immediate neighbourhood of the native huts. Anopheles bancrofti was not found.

As regards Cairns itself careful and full enquiries were made from the local medical practitioners and all cases of suspected malaria,a number of which they kindly brought to notice,were examined. The conclusion was reached that there was at the time no malaria or hardly any in Cairns. This was the opinion of some of the local doctors; Dr. Langan for instance believes that there has been none since 1922 (except occasional cases from New Guinea) when a small epidemic occurred. This epidemic occurred mainly in the months of April and May 1922 and practically all the cases were confined to the locality bounded by Bunda and Dutton Sts. on the North East,Severin St.on the South West,Mulgrave St.on the North West,and Kenny & Comport Sts.on the South East. Malay Town was not involved. The bulk of the cases were in the two blocks extending North West from the Railway line between Bunda and Draper Streets/

Swamps (some of them since abolished) were situated in this locality (see map in Breinl and Taylor's report).

Others of the local doctors believe that malaria still occurs to some extent and diagnose it fairly often,but in my opinion mistakenly. The position is complicated by the view prevalent among some of the older residents of the district that almost every fever is malaria and by the general practice of prescribing a mixture containing quinine for most febrile cases,thus obscuring the diagnosis. "Koch's mixture" a febrifuge containing quinine,the prescription of a medical man in Cairns in the days when malaria was common is still popular and supplied by the druggists.

There is general agreement among the doctors in Cairns that cases of pyrexia during the puerperium such as would be regarded with concern down South are frequently of benign character in Cairns and amenable to quinine,and there is a theory that they are malarial relapses. Only one such case could be examined; no parasites could be found.

The existing records of Cairns District Hospital go back to 1886. No clinical details survive however except the diagnoses. Some considerable time was spent in extracting all fevers from these records as it was hoped that when they had been plotted and studied interesting light might be thrown on the incidence of malaria. This idea had finally to be abandoned however in the absence of any sufficient guide as to what was probably meant by the different names given to fevers by different doctors and by the same doctors at different times. These names included "fever","Malaria","coastal fever" (Mossman fever) "dengue", climatic fever","continued climatic fever","intermittent fever" "remittent fever", "ague" and several others. Fevers other than malaria,particularly coastal fever and dengue,are of course very prevalent in some seasons in Cairns. The last epidemic of malaria (of 1922) for instance was recorded entirely as "fever". In another instance diagnoses of numerous cases of malaria changed suddenly to dengue with a change of doctors.

However these records contained abundant conclusive evidence that in earlier days true malaria was quite prevalent. It was noted that at a time railway construction was going on,in 1888 and neighbouring years,such entries as "malarial cachexia and enlarged spleen" "tertian ague" and other diagnoses which left no doubt as to the nature of the disease were particularly common. Many of these cases were white labourers from the various Railway Construction Camps and tunnels. In later years malaria is known to have been quite prevalent when Dr.Breinl and Mr.Taylor carried out their survey - the report of this was published in 1918 but Mr.Taylor informs me that the work was done and the blood specimens taken in the month of July 1917. The doctors who have resided long in the North,such as Dr.Clarke of Cairns, are also unanimous that malaria was formerly much more common.

As nothing further of value seemed obtainable at Yarrabah or Cairns it was decided to visit the Daintree River where cases of "fever" were reported to be prevalent and were believed by some to be malaria. On arrival at Port Douglas Dr.Burton was interviewed. He said he did not think that there was any malaria. On arrival at Mossman aborigines many of them from the Daintree were examined for splenic enlargement and through the courtesy of Dr.Burton some of the fever cases from the Daintree were seen. No evidence of malaria was found and it was decided that it was useless to proceed further. Cooktown from all reports was a less likely field than even the Cairns district. A rumour was heard of "fever" at Lockhart Mission Station,between Cooktown and Cape Yorke and a wire sent to the Bishop of Carpentaria concerning it as a private launch was proceeding up the coast by which it might have been possible to visit the place. The reply to the wire however was against the supposition that the fever was malaria.

After returning to Cairns Innisfail was visited and Dr.Craig interviewed there and the hospital records abstracted. It was evident that this District too is now free from malaria,as was the opinion of Dr.Craig who said he had seen none in seven years. But here again the hospital records showed prevalence of the disease in earlier days. It was here that the only surviving full histories,with blood examinations for parasites,were found; they were a few by Dr.Pridham in 1907/8. Several of these histories recorded splenic enlargement and the presence of malaria parasites,in white residents of the immediate neighbourhood of Innisfail.

The following is a summary of the malaria examinations carried out during the trip. No enlarged spleens nor malarial parasites were found.-

Aboriginal and half-caste girls; dormitory Yarrabah ages 2 to 15 years.	46 splenic examinations
Aboriginal and half-caste boys; dormitory Yarrabah. ages 7 to 16 years	39 " "
Aboriginal and half-caste children; village huts Yarrabah. ages 3 months to 11 years	80 " "
From the same children	45 blood examinations for parasites.
Adult male aborigines natives of Yarrabah where they had lived all their lives	3 splenic examinations.
Adult male aborigines and half-caste; living in village huts at Yarrabah from various parts of North Queensland.	61 " "
Aboriginal children and men at villages of Umbingi and Budda badoo about four and six miles respectively from Yarrabah.	23 " "
Fever cases at Yarrabah.	6 blood examinations.
Examinations of white patients in Cairns and Cairns Hospital and at Mossman suspected to be suffering from Malaria	13 including blood examinations in all cases.
Aboriginal camp at Mossman, inmates mostly from neighbouring districts including Daintree River	15 splenic examinations (10 men and 5 children)
Drumsira aboriginal camp near Mossman.	30 splenic examinations (18 men and 12 children)

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standard of life in which malaria is not declining or already gone. In Italy,Russia,Greece,and the Balkan countries there are peasantries at a low level - in France,England, the Netherlands,and Australia the disease has vanished or is diminishing. In some parts at least of the Southern States of America where the disease prevails there is a considerable population of negroes and of poor whites.

It is suggested then that the important factors in Queensland which have led to a decline in malaria are firstly the cessation of any noteworthy immigration of persons containing or liable to develop gametocytes in their blood, secondly the decrease in numbers partly as a result of the White Australia Policy of a coloured population living under inferior conditions,and thirdly the comparatively high standard of life of the white inhabitants.

It is of interest to note that in the early days (before about 1860) the aborigines of the far North were said by travellers of the time to be free from malaria,which appeared later sometimes in virulent form as small settled communities arose and intercourse with Pacific Islanders and Malays increased. The fact if it be one seems rather surprising since some intercourse with Islanders and Malays is believed to have existed from far earlier times. The nomadic habits of aborigines may possibly be the explanation.

Some at least of the ways in which a high standard of living tends to reduce the malaria rate can be understood; modern houses are less attractive to Anophelines than hovels; abundance of good food increases the resistance and accelerates the recovery rate; in Queensland we have in addition the general use of mosquito nets,probably a very important factor in diminishing the number of bites,even though the nets be usually defective and not universally used. The common use of quinine mixtures in Queensland has also to be remembered.

A factor to which much attention has been given of recent years in other parts of the world is an abundance of live stock perferred by the anophelines to man.
It is a factor which probably becomes of greater importance as improvement takes place in the lighting ventilation and cleanliness of the human habitations. I do not know how far the habits of Anopheles annulipes make it probable that this may be a factor of importance in Australia.

Malaria is certainly still to be found in some parts of Australia for instance in some of the Stations on the Gulf of Carpentaria. It may possibly prove that the aboriginal camps in these places are the strongholds of the disease,in spite of some reports that aborigines do not suffer from malaria. But probably even in these regions the disease is not very prevalent. The only cases of malaria admitted to Townsville hospital during the last two years have been from New Guinea.

It was suggested in the letter already referred to that a trip should be made to one of the stations on the Gulf in order to prosecute the work on malarial vectors. I should like to supplement the remarks then made by the following. The Gulf station will probably not be suitable for work on Filariasis,so that if the work on this condition be considered more important than that on malaria it would be better to do it in Townsville or Brisbane,instead of going North. (The Gulf is not accessible during the N.W. season so that a trip there would occupy almost the whole period from the end of my leave to the date of the next course; it is not possible to conduct any exacting research while the course is on with the staff available to me at present).

Further there are possibilities of incomplete success in the malaria work even in a station on the Gulf where malaria does occur if the incidence of the disease there is but low. In that case it might be impossible to find wild infected anophelines which is the only satisfactory way of incriminating any species of Anopheles as the actually important vector; the infection of laboratory specimens is not so satisfactory and may often throw no light on the relative importance of two species under natural conditions.

At Cairns an epidemic of "Coastal fever" (Moeseman fever) from a district where there was a construction camp in the bush ~~xxxxx~~ was just ending as I arrived. I was able to see several cases in hospital and took blood films and also aspirated an enlarged lymphatic gland and made smears. Nothing was discovered.

In the event of a trip to the Gulf being decided on I hope it will be possible for Mr.Taylor to be one of the party. His cooperation on the last trip was most valuable in every way and is bound to be still more so in the far North as would also be his collections of mosquitoes and other parasites.

The A/Director,
A.I.T.M.
TOWNSVILLE.

APPENDIX.

The remarks as to the comparative scarcity of filariasis in North Queensland should be restricted to parts of the East coast of North Queensland. The survey of the Hookworm Campaign showed a fairly high incidence on the West coast of the Cape York peninsula.

The Hookworm Campaign surveys in 1923 found 18 cases of malarial parasites in 554 persons in Cairns and 3 cases in 66 aborigines at Yarrabah. Although the remark is made in a report of the Hookworm Campaign that their figures in the Cairns district were lower than expected they seem to me to indicate a considerable amount of malaria at that date considering the classes of persons examined. No such rate exists at present.

87.

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4 3rd June 7

MEMORANDUM:-

I have to report in connection with the research into the distribution of Malaria and Filaria recently undertaken by Dr.G.H.Heydon and myself as follows,in regard to the distribution of Culex fatigans Wied., and Aedes (Stegomyia) argenteus (Poiret):-

Cairns: Culex fatigans,Wied., was found to be an abundant species in the two hotels, The Strand and The Pacific,also a boarding house situated on the Esplanade in which I stayed while there.

Aedes (Stegomyia) argenteus (Poiret) also is an abundant species in Cairns,being found abundantly in the same situations as above noted for C.fatigans.

Irvinebank: Dr.Derrick has recently sent me bred specimens of Aedes (Stegomyia) argenteus from this town.

Yarrabah Mission Station: Culex fatigans,Wied., was found here but during our visit was not an abundant species. Three adult specimens were captured at Oombingi Settlement (part of the Mission,about three miles distant from Yarrabah) in native huts. These specimens may have been stragglers from Yarrabah as no breeding places were observed.

Larvae of this species (adults bred out) were found in puddles under the bathroom at the Superintendent's residence. Surface drains,which are entirely lacking and which could easily be constructed as the ground surface has a good fall,would I consider destroy the potential breeding place of this mosquito.

Aedes (Stegomyia) argenteus (Poiret) is entirely absent and should remain so as there are no water tanks,casks etc. on the settlement.

The water supply is by a system of pipes,the water being obtained from a dam supplied by a spring about a quarter of a mile from the settlement.

Kuranda: Culex fatigans was found here but it was by no means common.

Aedes (Stegomyia) argenteus is apparently absent. I saw no specimens in the hotel where I stayed neither did I find any evidence of them at Mr. W.P.Dodd's residence where I spent the Sunday afternoon of the week end I spent at Kuranda.

Port Douglas: We were only here three hours from 10.30 a.m. to 1.30 p.m. on our way to Mossman during which time I was unable to find any evidence of either Culex fatigans or Aedes (Stegomyia) argenteus.

Mossman: Culex fatigans was taken here in scanty numbers in the hotel.

Aedes (Stegomyia) argenteus was a common and irritative species, especially annoying at night-time.

Mount Molloy: Culex fatigans was present in fairly large numbers in my room at the hotel here.

Aedes (Stegomyia) argenteus was common here being exceedingly irritating to me when engaged in mounting my daily "catch" of mosquitoes.

Innisfail: Culex fatigans is an abundant species in this locality.

Aedes (Stegomyia) argenteus is likewise an abundant species in Innisfail.

Berner Creek: Neither Culex fatigans nor Aedes (Stegomyia) argenteus are in this locality, which is about 14 miles from Innisfail on the Nerada line and one of the most interesting localities I have ever collected in.

Tully: Culex fatigans was found sparingly here but Aedes (Stegomyia) argenteus could not be found though carefully searched for in the hotel where I stayed.

Ingham: Culex fatigans was scarce here on the occasion of my visit.

Aedes (Stegomyia) argenteus though looked for in four rooms of the hotel, its presence was not revealed though several hours were spent hunting for it.

The apparent absence of this species from Ingham is difficult to explain since the town is an old established one. I should say that the species is most probably present and that the very heavy rains which had recently been experienced may have reduced the species to a minimum for the time being.

Since our return to headquarters I have received Aedes (Stegomyia) argenteus (Peiret) and Anopheles annulipes Walker, from Dr. Derrick at Irvinebank.

I have noticed on several occasions when travelling in the Brisbane-Cairns mail train, that Culex fatigans was generally to be found in the lavatory of the cars in which I travelled. This circumstance has not, as far as I am aware, been recorded for Australian trains, though it is a well established fact in other parts of the world that trains play an important part in the spread of mosquitoes.

The enquiry into the spread of Malaria and Filaria by Dr. Heydon and myself has been very productive in the large number of other mosquitoes, either taken as adults or bred out from their immature stages.

Some of the species of mosquitoes found are of considerable interest zoologically in that the known range is greatly extended, particularly that of Aedimorphus alboscutellatus (Theob.) which was recorded by myself in 1915 on a specimen taken by Hill at Doctor's Gully, N. Australia, has now been extended to several localities in Queensland viz.- Tully, Innisfail District, Cairns, Mount Molloy and Mossman. In addition to this extension of distribution, I was very fortunate in finding the male sex of this species which has never before been taken in Australia.

Another outstanding species is represented by two female specimens - one from Tully and the other taken at Berner Creek, Innisfail District. It possesses the identical head and thoracic markings of Aedes (Stegomyia) variegatus (Dol.) but is most probably a species of Finlaya and almost certainly a new species.

The following is a provisional list of the mosquitoes collected:-

Anopheles annulipes, Walker. Innisfail; Cairns.

Anopheles bancrofti, Giles. Mount Molloy.

Uranotaenia sp. Mount Molloy.

Hodgesia sp. Tully; Innisfail.

Rachionotomyia quasiornata (Taylor). Tully; Innisfail; Cairns Kuranda; Mt.Molloy; Mossman.

Rachionotomyia atripes (Skuse). Tully; Innisfail; Cairns; Kuranda.

Taeniorhynchus (Coquillettidia) xanthogaster, Edw. Innisfail.

Mucidus alternans (Westw.). Mossman.

Aedes (Aedimorphus) albosecutellatus (Theob.). Tully; Innisfail District; Cairns; Mt.Molloy; Mossman.

Aedes (Ochlerotatus) vigilax (Skuse). Cairns; Kuranda. This species has become known as the "Salt-Marsh Mosquito" or "Black Bush-Mosquito"; the former name is somewhat erroneous as this species is more often found in fresh water swamps and other collections of fresh water than in salt, or brackish water according to my observations which extend over a long period.

Aedes (Finlaya) notoscripta (Skuse). Innisfail; Cairns, Mt. Molloy; Mossman.

Aedes (Finlaya ?) australiensis (Theob.). Innisfail.

Aedes (Pseudoskusea). Two species. Tully; Cairns; Mt. Molloy; Mossman.

Lutzia halifaxi (Theob.). Innisfail; Cairns; Mossman.

Culex squamosus (Taylor). Innisfail; Cairns; Mt.Molloy; Mossman.

Culex bitaeniorhynchus? Giles. Cairns.

Culex sitiens? Wied. Innisfail; Cairns; Mt.Molloy.

Culex (Lophoceratomyia). Two species. Tully; Innisfail; Cairns; Kuranda; Mt.Molloy; Mossman.

Culex sp. Innisfail; Cairns. This is doubtfully referred to Culex (Culiciomyia) pullus, Theob., for the present. This latter species was originally described from New Guinea until I recorded it from the Innisfail District on specimens bred by me when on leave in September 1926.

Anopheles bancrofti,Giles,appears to have disappeared,or on the other hand,has become very greatly diminished in numbers in the City of Cairns since July 1917 (when Dr.Breinl and I carried out our enquiry into the incidence of Malaria there - vide Aust.Med. Jnl., Aug.10th,1918). This anopheline,at that time,was a moderately common spedies being taken not infrequently on the wing whilst its larvae were found in numbers in certain swamps within the city area,notably in the vicinity of the General Hospital. Since that date a considerable amount of reclamation of swamps has taken place so much so that the abovementioned swamp has been filled in and built upon. Other swamps in which Anopheline larvae were then (1917) found are in the course of reclamation.

Anopheles annulipes,Walker,which breeds in small collections of water,hoof holes of animals etc. as well as in swamps is also much less common in Cairns at the present time than formerly (1917),probably due in a measure to the same contributory causes as for A.bancrofti.

It seems probable that as time goes on the breeding of A.bancrofti and possibly that of A.annulipes may entirely cease actually within the city area.

There are in addition to the species listed above about twelve species of mosquitoes which for the present remain undetermined. They all belong to the tribe Culicini subfamily Culicinae. It is possible that not a few of them may be new species though it is difficult to say until their relationship with New Guinea and Dutch Indies species is worked out.

Other blood-sucking Diptera - exclusive of the Culicidae - are represented by the following species:-

Family Simulidae.

Simulium sp. Innisfail District. Probably a new species.

Family Tabanidae.

Tabanus doddi, Taylor. Cairns.

Tabanus strangmani, Ricards. Cairns.

Silvius australis, Ricardo. Cairns.

Family Muscidae.

Stomoxys calcitrans, Linn. Cairns.

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