1. Introduction

COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF HEALTH.

REPORT ON MOSQUITO SURVEY OF THE BRISBANE METROPOLITAN AREA, 1923.

By

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May, 1923.

COOLING

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I. INTRODUCTION. (Mostly Historical).

Between February 27th and April 26th 1923, I was instructed to make, under the direction of the Director, Division of Tropical Hygiene, Commonwealth Department of Health, and in cooperation with the Hookworm Campaign, a survey of Brisbane and its contiguous areas in order to ascertain the conditions governing the prevalence of mosquitoes in the area as a whole, and to outline permanent measures for control. This survey was of particular interest by reason of the fact that in recent years several extensive breeding places have been either filled or drained and therefore rendered innocuous, and that even more recently, several "domestic" mosquito breeding places of a greater extent have come into existence further afield coincidently with the increase in the Brisbane population, and the centrifugal migration of the residential and business areas of the metropolis.

In 1912, Dr. J.S.C.Elkington, then State Commissioner of Public Health for Queensland, directed a preliminary survey to be made of Brisbane and suburbs, and the results of the investigation were used for large scale anti-mosquito work which was commenced a few months later. The writer was entrusted with the executive charge of this survey, of which the results were published in the Commissioner's report for 1913. At that period the area which was sufficiently settled upon to warrant the terms "residential areas" and "business areas", amount approximately to 30 square miles. Nowadays this area embraces some 63 square miles - excluding the outlying places of Wynnum, Manly, Sandgate, Cleveland, etc. In other words, the habitable site of Brisbane has expanded to twice its area in the course of a decade. This expansion has had a very far-reaching effect on the appearance and propagation of domestic mosquitos as will be seen later on, when the actual effects, qua mosquito-breeding, of a pipe-borne water-service in an unsewered area are considered.

In 1919, as an officer of the State Health Department (Queensland) I was instructed to make a re-survey of the metropolis in connection with mosquito work. Information resulting from this inquiry was embodied in a report submitted at the conclusion of the survey. In it, the effects of sewage-pollution of natural waters were stressed as well as the bad state of repair into which tanks and tank-screens installed as a result of the anti-mosquito operations of 1912-13, had fallen.

For the present survey a staff of six, including myself, was employed, four of whom were detailed for systematic house-to-house visitation in connection with tanks, and other domestic collections of water. The services of Miss M. Walker M.Sc., and two inspectors were made available by the Hookworm Campaign for investigation into mosquito-breeding in local swamps and other natural waters near at hand. With the exception of a few minor (natural) breeding places, the natural waters were seen by myself at one period or another. Certain tanneries and marshes which had been observed in previous years by myself, and which on account of pressure of work, could not actually have been personally observed in the time at our disposal during the present resurvey, were visited by Miss Walker so that the present conditions might be noted.

The outlying portions of Brisbane were investigated by myself but in the country lying between Nundah and the southern shores of Deception Bay - an area of approximately 80 square miles - difficulties of time available and transportation, did not permit either an exhaustive or final investigation of all breeding places of Aedes (Ochlerotatus) vigilax. It may however, be stated confidently that all the chief breeding places for A. vigilax within flight-range of Brisbane were located.

Inspection indoors was not carried out except in a few instances at the wish of the occupiers. It was generally the case in these - especially when the prevalence of domestic mosquitos was very marked - that the less obvious water-containers were solely or in part responsible for the abundance of mosquitoes; thus the water-insulators of the legs of food-safes, flower-pot saucers and so on, have, as in previous surveys, been actually observed to act as breeding places for Aedes aegypti (L.). Observations were made mainly on tanks, roofgutters and other external domestic collections of water; but time was not spent in vain attempts to secure larvae in unscreened tanks after apparently negative findings. Thus it is that

CONDITION OF 3422 PREMISES REGARDING MOSQUITO - BREEDING.

Particulars	Block													Total
	A	B	C	D	F	G	H	J	K	L	M	N	O	
No. of Premises visited	688	540	477	289	175	258	211	233	316	83	88	22	42	3422
Tanks-														
No. inspected	647	500	497	278	200	259	212	154	244	137	90	45	58	3321
No. effectively screened	409	294	244	121	103	139	61	19	91	37	27	21	16	1583
Percentage of Screened tanks to those inspected	63.21	58.8	49.09	43.52	51.50	53.66	28.77	12.33	37.28	27.00	30.00	46.6	27.58	
No. insufficiently screened	-	-	-	-	-	-	-	108	133	-	-	-	-	241
No. Unscreened	219	184	195	152	87	86	133	16	19	99	54	20	37	1289
† No. Dilapidated	19	22	58	5	10	34	38	11	21	1	9	4	5	238
Barrels	6	19	-	3	-	6	1	-	1	-	-	2	-	38
Roof Gutters	6	-	3	7	-	4	-	3	-	-	-	-	-	23
Garden Receptacles	-	-	3	8	-	-	-	-	-	-	-	-	-	11
Pools and Puddles	12	34	77	25	1	15	-	-	2	3	-	-	1	170
Tins & water holding rubbish	3	-	10	16	-	-	1	7	4	-	-	-	-	41
Gutters and channels	37	22	12	42	-	3	-	-	-	-	-	-	-	116
Wells	-	1	1	1	-	-	2	-	-	3	-	-	-	8

INDEX:

Block	Local Authority	Block	Local Authority.
A.	Windsor	H.	Coorparoo
B.	Toowong	J.	Brisbane.
C.	Stephens	K.	South Brisbane.
D.	Balmoral	L.	Yeerongpilly.
F.	Toombul	M.	Taringa
G.	Ithaca	N.	Belmont
		O.	Sherwood.

Areas compared with reference to the percentage of screened tanks to those inspected.

* This group includes those tanks which have been screened except overflow pipes or other openings into the tanks.

† Comprising those tanks with large gaping holes in the sides.

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the proportion of tanks in which larvae were actually found to those in which none were seen, does not form any index of the infestation by adult mosquitos. From observations conducted over a number of years, it is safe to conclude that all unscreened tanks in and about Brisbane constitute breeding places for *A. aegypti* at one time or another of the year.

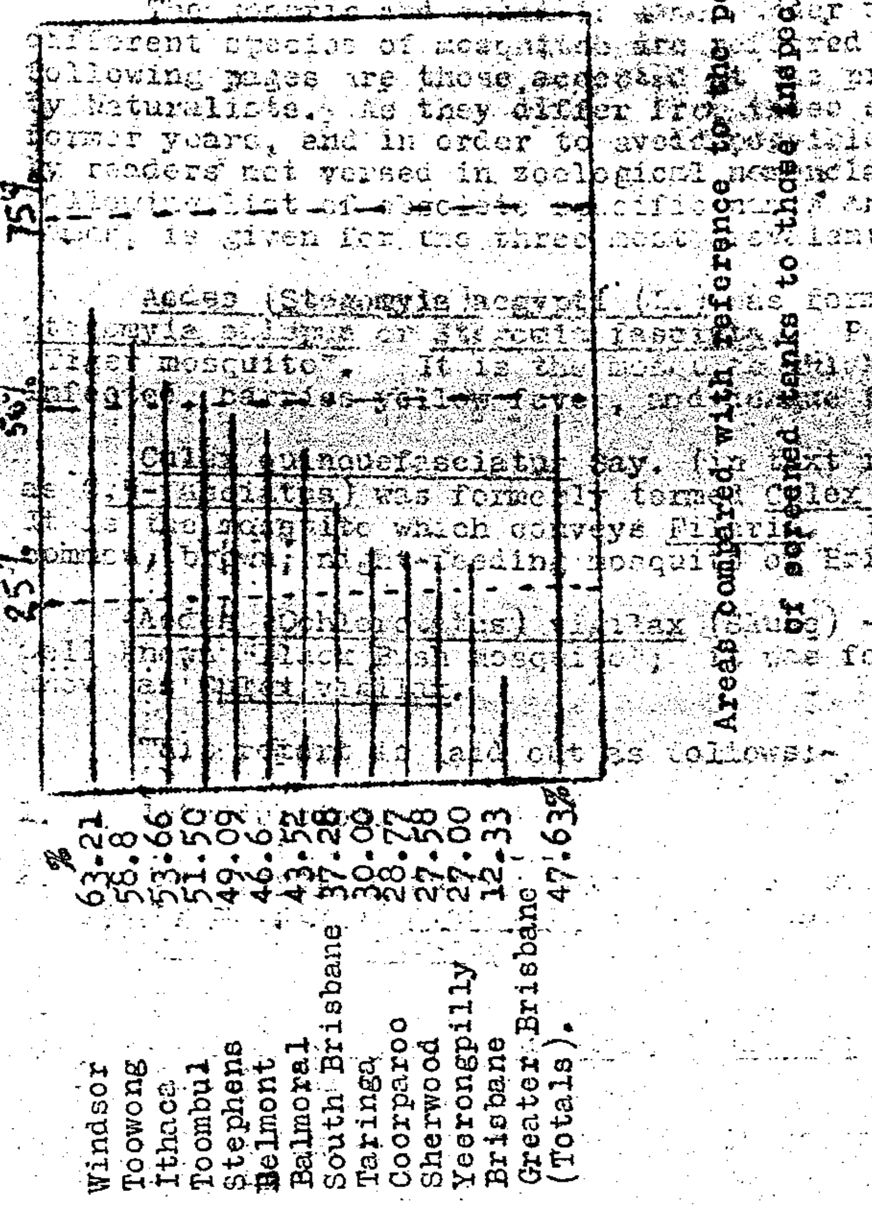
The generic and specific names under which the different species of mosquitoes are referred to in the following pages are those accepted at the present day by Naturalists. As they differ from those employed in former years, and in order to avoid possible confusion by readers not versed in zoological nomenclature, the [illegible] list of obsolete specific names and popular names is given for the three most prevalent species.

Aedes (Stegomyia) aegypti (L.) was formerly termed *Stegomyia calopus* or *Stegomyia fasciata*. Popular name, "Tiger mosquito". It is the mosquito which once [illegible] yellow fever, and dengue fever.

Culex quinquefasciatus Say. (in text referred to as *C. fatigans*) was formerly termed *Culex fatigans*. It is the mosquito which conveys *Filaria*. It is the common brown night-feeding mosquito of Brisbane.

Aedes (Ochlerotatus) vigilax (Skuse) - is the well known "Black Bush mosquito", was formerly known as *Culex vigilax*.

These are laid out as follows:-



Summary and Conclusions.

Suggested measures for control.

Block

that/

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Aedes (Ochlerotatus) vigilax (Skuse) - is the well known "Black Bush Mosquito"; it was formerly known as Culex vigilax.

This report is laid out as follows:-

1. Introduction.
2. The Stegomyia survey which located breeding-places mainly of A.aegypti and also in part, of Culex quinquefasciatus.
3. The Culicine survey which was made in connection with C.5-fasciatus, A.vigilax, C.sitiens and C.annulirostis.
4. The Anopheline survey, mainly in connection with A.annulipes.
5. Observations on the rarer species of Mosquitos.
6. List of breeding places, according to Local Government areas.
7. Summary and Conclusions.
8. Suggested Measures for control.

(3). THE CULICINE SURVEY.

Natural fresh waters artificially contaminated by sewer effluents and trade wastes are dealt with specially in Part 3 (Culicine Survey).

Natural salt marshes and pools are dealt with in Part 2 under separate headings for Brisbane and the immediately adjoining Local Authorities and for Outlying Areas respectively.

The breeding places have been discussed in relation to their magnitude and impertance rather than in relation to Local Government Areas, but a summary of breeding places according to Local Authorities' Areas is given in Part 6.

(2). HOUSE-TO-HOUSE SURVEY. (MAINLY STEGOMYIA)

The accompanying table shows the proportion of unscreened to screened tanks in each area as well as the number of inspections made. The proportion of tanks screened to those inspected is expressed graphically according to local Authority Areas. Bearing in mind that the growth of the Brisbane population has been attended with a corresponding growth in the number of residences and not by a species of compression into the existing houses, it will be readily understood that the residential areas about the periphery of Brisbane are those which will exhibit the newest houses (and also tanks) brought more or less up to the standards required by the Health Act and its Regulations. A rather high proportion of screened tanks, for example in the areas like Windsor, Toowong, Ithaca and Toombul, contrasts strongly with the older parts of Brisbane such as the city proper South Brisbane and the older parts of Coorparoo. Again, the number of garden receptacles in the better class of premises is in excess of that found on the premises of the poorer householder. The property owner who erects a house in a crowded neighbourhood on 16 square perches of land cannot obviously find room for a fernery or bush house which could otherwise be erected in a more sparsely populated district. This explains the contrast in this respect between the conditions found in places like Toowong and Windsor, and those of Brisbane and South Brisbane.

The case of Brisbane deserves special mention in connection with the low proportion of screened tanks. Almost without exception these tanks were screened during the anti-mosquito activities of 1912-1913 and the fact that only 12.33% of the entire number examined are now mosquito proof, is sufficient justification for urging a periodic re-inspection of tanks in connection with routine systematic inspection by the inspectors of Local Authorities.

(3). THE CULICINE SURVEY.

(A) POLLUTED WATERS.

The Victoria Park Water Course, Brisbane. This is a natural drainage basin which commences about the confines of two contiguous areas (Brisbane and Ithaca) and flows by a rather tortuous course through Brisbane, to fall into Breakfast Creek by means of the Sneyd Street sewer-invert. While in rainy weather this watercourse forms the drainage system for surface water collecting on the Brisbane side of the Ithaca area, in dry weather its waters are kept permanently replenished by household sewage by means of two sewer outfalls (from Ithaca) each discharging into an arm of the forked-headed watercourse at Normanby railway yards and Rochester St., (Ithaca). Throughout the summer weather the sewage in the Victoria Park watercourse is actually coloured as a dark mass by innumerable larvae of C.5-fasciatus which are seen to occur for a distance of about a mile or so down-stream. Except for a few of the non-larvivorous fishes (Mogurnda mogurnda var. adspersus = "Trout" the Gudgeon", and Carassiops compressus = "Carp Gudgeon") all fishes have been killed off by the sewage and the streamlet is too short to effect self-purification by the natural processes of sedimentation, oxidation etc. The ultimate disposal might be considered one of dilution into a tidal salt-water creek.

Measures are now being taken by the Brisbane and Ithaca Councils to sewer this watercourse. For success from the anti-mosquito viewpoint it will be essential that the whole course be so dealt with, and not a part only.

The Victoria Park watercourse has, for many years past, as is the case at present, continued to supply the residences of Gregory Terrace and Herston, and also the Hospitals, with an abundance of C.5-fasciatus. Its proximity to the General Hospital where cases of filariasis have congregated for years past may conceivably have an active influence on filarial endemicity.

Ithaca Creek, near Waterworks Road (Ithaca). At the point where Ithaca Creek crosses under Waterworks Road a sewer-outfall is to be found. A Chinese garden is located at the intersection (of creek and road) in which the back-waters stagnate, being partly cut off from the main stream by siltage. The sewage stagnation in the creek forms a very fruitful breeding ground for C.5-fasciatus and the "sewage-patch although limited in surface area must undoubtedly supply the neighbouring area with large numbers of nocturnal mosquitos. A few larvae of Lutzia halifaxi were also observed in the dilute sewage.

The edges of the polluted streamlet were in parts overgrown with aquatic vegetation. Some 600 yards lower down, just after Ithaca Creek discharges into Breakfast Creek the water is again contaminated by the discharge of -

The Murray Street Sewer (Ithaca). The water of Breakfast Creek being fresh (not salt) at this point, the effects of pollution were manifested in the large numbers of larvae and pupae of C.5-fasciatus with which the water abounded. As the sewer does not drain very many properties, there is a correspondingly small output of sewage, with the result that the destruction of fish life in the stream is not so severe as with the large sewer-outfalls. Breakfast Creek in this vicinity meanders for 900 or 1000 yards further and then passes the Kelvin Grove Wool scour, and Johnson's tannery, Kelvin Grove, at which point the water becomes salt owing to tidal influence.

The pollution of the lower part of Breakfast Creek by the discharge of several sewers may be entirely disregarded from the mosquito reduction standpoint, for the reason that the Creek in this part is subject to daily tidal floodings, and that the water is salty. But a small fresh water tributary flowing into Breakfast Creek in the vicinity of Newmarket (Windsor) is contaminated locally by the effluent from Mackler's Tannery, at Edmonstone and Creek Streets, Newmarket (Windsor). Culex 5-fasciatus was observed to be breeding very freely in the system of sewage disposal - i.e., in a concrete precipitation sump and in a couple of soakage pits on the bank of a small water-course hard by. The watercourse, through soakage from the pits, was also polluted and seen to contain innumerable larvae of C.5-fasciatus and a few of Lutzia halifaxi.

Toowong Park Watercourse (Toowong).- A Chinese garden in Issac St. marks the head of a watercourse and the approximate "outfall" of a concrete sewer-invert. By an earthen dam the mixture of water and sewage in a part of the watercourse is kept stagnant on the premises occupied by the Chinese garden. The natural fall of the land is in a south-easterly direction and after flowing through Toowong Park, the watercourse empties into a small tidal creek which latter discharges its waters into the Toowong Reach of the Brisbane River at Langsville Bridge. Quite an abundance of larvae of C.5-fasciatus was found in the polluted waters in the Chinamen's garden and Toowong Park. Moreover, the amount of aquatic vegetation was sufficient to render the flow of water and sewage very sluggish, especially in Toowong Park.

Thorpe Street Watercourse (Toowong). This watercourse originates in Toowong Cemetery and flows in an easterly or an east by southerly direction, to fall eventually into a branch of the small tidal creek to which allusion has just been made. Of recent years many houses have been erected on the slopes of this valley, and in consequence pollution of the watercourse by household sewage has been very decided. Its top waters about Thorpe Street Toowong constitute very fruitful breeding places for C.5-fasciatus especially where the "bed" expands into marshy or boggy tracts and where sewage finds its way into the water. As this watercourse runs in the vicinity of, and parallel with, Dixon Street it is drained by a concrete invert sewer to empty into the river.

Watercourse which intersects Baroona Road near Carrington Street, Rosalie (Ithaca). The head waters of this valley arise in Torwood (Toowong area) and Bardon (Ithaca) and immediately after crossing Baroona Road - the boundary between two contiguous local authority areas - pollution takes place by the effluent from the Carrington Street sewer on the Ithaca side of Baroona Road. At the point of contact of the sewer with the watercourse numerous larvae of C.5-fasciatus were observed. About 50 yards lower down stream the waters of this basin are received into a brick and concrete sewer which latter discharges into a tidal creek at Milton. The top-waters of this watercourse (in Toowong and Ithaca areas) are seen, occasionally, to breed Anopheles annulipes W. especially where the land becomes reedy and marshy.

Ekibin Watercourse (upper side of Burnett Swamp) (Stephens). The Ekibin Street sewer flows an easterly course to empty into the upper waters of Burnett "swamp" or watercourse. The sewer being a short one and the habitable drainage area small, the pollution is only confined to a very circumscribed portion of the watercourse. A pot-hole of sewage is to be seen immediately at the sewer-outfall at which place innumerable larvae of C.5-fasciatus and several of L.halifaxi were present. For about fifty (50) metres down stream the watercourse is overgrown with water - hyacinth and it is noted that the larvae of Culex annulirostris (= C.consimilis of Taylor) were present in rather large numbers. As the streamlet becomes more purified and more free from rank vegetation, mosquito-larvae are only found with the greatest difficulty and for many hundred yards down stream mosquito larvae cannot be observed - a condition resulting from the abundance of fish (Melanotaenia nigrans (Richardson) -- "the Crimson-spotted Sun-Fish") with

with [illegible] which the water abounds. In previous years before settlement had taken place at Eidbin and when water hyacinth had not attained a foothold, this streamlet flowed a natural course unaffected by sewage contamination and in consequence did not contribute to the breeding of domestic mosquitoes.

Ipswich Road Sewer Outfall (South Brisbane). The mouth of a sewer opens into the head of Kingfisher Creek in the vicinity of Walker Street, and Logan Road. When seen during the present survey a film of oil was observed to be floating on the surface of the slowly moving sewage, but previous experience of this district ranks this place as a chronic breeding place for C.5-fasciatus. There are grounds for believing that the presence of oil on this water did not represent anything in the nature of regular mosquito reduction measures, and mosquito breeding was found to be common in street gully-traps of South Brisbane.

Head of the Ipswich Road Sewer (South Brisbane). An inlet of this sewer in the vicinity of a railway culvert near the junction of Arthur Street and Ipswich Road marks the position of a small tract of polluted water in which numerous larvae of C.5-fasciatus were found. The sewage stagnates on railway property and by a few yards of sewering, the mouth of the railway culvert might be connected with the sewer inlet. This would exclude the possibility of future trouble in connection with mosquito breeding.

Paddock adjacent to Police Station on corner of Vulture Street and Main Street, (South Brisbane). This marks the site of a rubbish dump and polluted pond of water in which larvae of C.5-fasciatus were seen. A large amount of filling in is required here. In reality this place is the remains of an old stone quarry the excavations in which have gone down too far below datum level.

Wooloowin Sewer (Windsor). Within very recent years a very excellent piece of sewering was done through Wooloowin, and the work has been responsible for reducing in great measure, the myriads of nocturnal mosquitos (C.5-fasciatus) which had been regularly produced in the sewage polluted watercourse. The earth resulting from the sewer excavations might have been used to better advantage in the way of levelling off the bed of the old watercourse; a series of hillocks and depressions occurs in parts along the sewer-alignment, and the water collecting in a few of the hollows was observed to contain larvae of C.5-fascihtus. When the sewer reaches the bounadry of

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adjacent premises is taken by a concrete sewer's invert through the centre of Toombul where it ultimately empties into Cairn Brook in the vicinity of Kalinga Park. At the point of contact of the sewer with the Brook, a few mosquito larvae may be seen (C.5-fasciatus) but the body of water being large and the flow rather fast, self-purification is expedited.

Nundah Sewer (Toombul). Larvae of Culex fasciatus and C.annulioostris were found at the outfall of the sewer which opens in the vicinity of the Nundah Pineapple Preserving factory. At the mouth of the sewer, water stagnates in a short stretch of spade-cut channelling, the latter emptying into the upper end of the Serpentine Marsh. A few larvae of Anopheles (Nyssorhynchus) annulipes were found about the marshy and boggy edges of the swamp.

Swan Hill watercourse (Windsor). - Running a parallel course with, and between Lutwyche Road and Victoria Street, a slight depression exists. This depression, or watercourse, runs transversely through the yards of the premises facing Lutwyche Road and Victoria St., and besides receiving household sewage, forms the natural get-away for storm water towards Breakfast Creek. The bed of this watercourse is, moreover, overgrown with grass. Innumerable larvae of C.5-fasciatus were observed in the stagnant sewage in the bed of this watercourse.

An earth-cut channel through the premises would temporarily relieve the district of a great nuisance and certainly of numberless night flying mosquitoes.

Windsor Sewer (at Bell's paddock) (Windsor). - A sewer draining a portion of Windsor opens in the vicinity of Brown St. to enter the premises occupied by Bell. Bell's paddock occupies portion of the bed of a watercourse which crosses Lutwyche Road (near Windsor Station), flows in an approximately easterly direction, expands into a large marsh overgrown with hyacinth and other vegetation, and empties into Breakfast Creek near Campbell's timber yards. The upper end of this water-course being highly contaminated, breeds innumerable mosquitos (C.5-fasciatus). The place presents the decided disadvantage of being boggy in Bell's premises - a condition which intensifies the breeding of mosquitos in polluted waters. The periphery of the large marsh (lower down) was seen on examination to be free from mosquito larvae. Lower down-stream (Albion Flats) the watercourse again breeds C.5-fasciatus. For years past the Windsor Council has considered the advisability of draining this watercourse, but nothing definite has occurred. The mosquito nuisance could be alleviated temporarily by rough canalisation of the boggy portion of the marsh.

The Greenslopes-Coorparoo Watercourse (Green's Gully) (Coorparoo):- The upper waters of this streamlet have their origin about White's Hill and after flowing north-westwards for a distance of about 1800 metres, the watercourse becomes contaminated at intervals by the discharge of household drains along the banks. During the time of inspection which was in droughty weather the watercourse was simply a string of waterholes intercepted occasionally by marshes. For the most part the water abounded with fish, but at points where the vegetation became excessive in growth, larvae of Anopheles annulipes and Culex annulirostris were found by Miss Walker. At portions where the water was polluted, the fish were expelled and the larvae of C.5-fasciatus were found. Owing to the fact that the sewage is not excessive in quantity there are chances of local purification of the watercourse and rehabitation by fish until the next contaminated source is reached. By a tortuous route, Green's gully eventually reaches the tidal basin of Norman Creek by way of one of the latter's tributaries.

Memorial Park Sewer (Balmoral):- A sewer invert traverses Memorial Park in a southerly direction to discharge into Norman Creek - a tidal gutter. In the semi-stagnant sewage (due to siltage of the invert) larvae of C.5-fasciatus were noted.

Moynihan Street Watercourse (Hamilton):- This takes its origin on the eastern slopes from the watershed formed by Bartley's Hill and after traversing about 400 metres, by the circuitous paths of street water-channels, is polluted by the discharge of the Moynihan Street sewer - a short conduit running in an easterly direction along the northern side of the street. It was at the point of sewage-contact with the streamlet that many larvae of C.5-fasciatus were observed. The streamlet rapidly clears itself of gross contamination, for the quantity of sewage collected by the sewer is small. Lower down stream the water abounds with fish (Melanotaenia nigrans (R.) or "Crimson spotted Sun Fish") and it is only with the greatest difficulty that mosquito larvae may be found (A. (N.) annulipes).

McGregor's Waterhole: the Clayfield Clay Pit (Hamilton):- This small lake is bounded by Oriel Road, Bartley St. Russel St. and Denham St. It is in the remnants of a clay pit, and might be used as an illustration of the sanitary evils of clay-pit diggers, potters and brick makers in the way of making excavations below datum level. Bowser's quarry in Lutwyche Road Windsor is following in the same footsteps, and there is apparently no legislation to prevent such an extensive "borrowing" of earth and stone without any regard to draining or filling in with other material.

The Bartley Street sewer empties into one end of McGregor's waterhole and by reason of the rank grass about the edges of the lake a few square yards of stagnant sewage are left undisturbed to breed countless numbers of C.5-fasciatus. In certain parts of the lake which were not materially affected by sewage contamination, but which showed a luxuriant growth of aquatic vegetation, a few larvae of Anopheles (Nyssorhynchus) annulipes Walker, were observed. The main body of water is stocked with larvivorous fishes, (sp? M.nigrans) and in consequence no mosquito larvae could be found. The outfall of McGregor's waterhole is by a watercourse which flows by a more or less unhindered route and is unaffected by mosquito breeding.

Rubbish Dumps at Woodville Road, Hendra (Toombul).- At the foot of Woodville Road a slight depression exists. During the wet weather this place holds water, and the wandering of animals about the edges of the water makes the surroundingsground boggy. On one side of the small marsh, rubbish has in past years, been tipped, with the result that the putrescible portion thereof has been instrumental in effecting a slight contamination of the water. Larvae of C.5-fasciatus were found in moderate numbers. The natural fall of the land is towards the Serpentine Marshes and by a short length (about 100 metres) of canalisation the water might be drained away.

a. TANKERIES.

Hendra Watercourse (Toombul).- The watercourse which crosses Pring Street (between Gerler Road and Manson Road) was specially examined on account of a complaint about the prevalence of C.5-fasciatus in a house hard by. This watercourse flows in a north-easterly direction for about 800 metres to fall into the Serpentine Swamps. Although the streamlet flows through an inhabited area, vigilence seems to have been exercised with respect to sewage discharge into the water, for a close search did not reveal any source of pollution. In consequence no mosquito larvae could be observed and moreover, the water abounded with fish. Mention is here made of this watercourse as serving to illustrate the readiness with which natural waters are blamed for mosquitos that they do not produce.

Park in Lutwyche, near Wesley Street (Windsor) and a back water of Kedron near Lamington Avenue (Windsor). The former exists as a shallow depression while the latter takes the form of a shallow tributary of Kedron Brook. A few larvae of C.5-fasciatus were observed in these waters which were polluted by animals.

Several other smaller places will here be listed as acting as breeding places for C.5-fasciatus. They are as follows:-

(a) An earth cut gutter of sewage running a north Easterly direction from the juncture of Brisbane Street and Apollo Road, Bulimba, (Balmoral).

(b) A short sewer discharging into a small watercourse between Aberleigh Road and Hetherington St. Herston (Brisbane).

(c) Polluted water in Toowong Creek bed between Campbell and Alpha Streets, Toowong, (Toowong) due to household sewage. For the most part, this creek-bed was dry at the time of inspection and was only breeding mosquitos in that portion where the replenishment of its waters was rendered more or less independent of weather conditions by the discharge of household sewage.

(d) Sewer discharging into a tributary of Toowong Creek between Oxford Terrace and Swann Road, Taringa, (Taringa). Larvae were rather plentiful in the bed of the watercourse.

(e) Pool of water between Ryan's Road and Bryce St., Ironside (Taringa).

(f) A small watercourse (polluted by household sewage) running between Wylie Avenue and Marian Street, Greenslopes (Coorparoo).

a. TANNERIES.

Some ten years or so ago the position of tanneries on the peripheral portion of Brisbane was such that they did not materially interfere with the residential areas by reason of their distance from habitation. Nowadays the case is entirely altered with the result that tanneries are fast becoming nuclei of residential areas owing to the centrifugal "flow" of houses to these areas. Although certain tanneries have in past years acted (and still do) as sources for the constant supply of C.5-fasciatus, their situation beyond the ordinary range of flight of the mosquito in question was sufficient justification for considering them innocuous to "neighbouring" premises. At the present day, the populated areas of Stafford, Kedron, and Chermside (Kedron), have their principal sources of nocturnal domestic species of mosquitos centred on tanneries. A portion of Newmarket and Wilston (Windsor) is similarly affected.

Gibson's Tannery, Stafford (Kedron).- This establishment is situated on the north bank of Kedron Brook - a fresh water stream which gains access to the sea through the medium of the Serpentine Swamp. The site is more or less flat but forms the head of a small watercourse which eventually finds its way into the Brook. By an earthen dam which has been thrown across the outfall of the watercourse from a depression, a small lake is formed. This lake, into which the effluent from the tannery soak-pits is

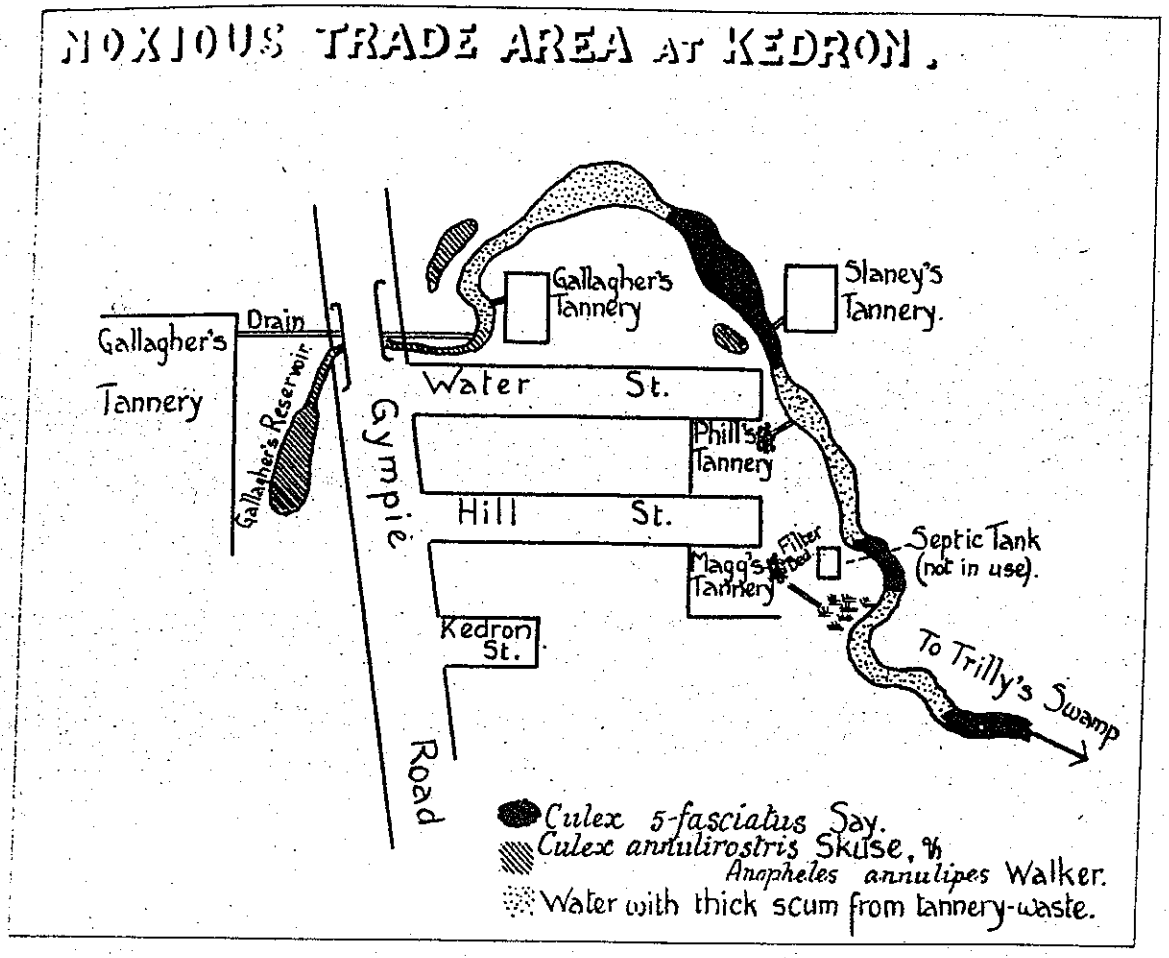
is/

received after preliminary treatment through bark beds, plays an anaerobic part in the treatment of the tannery sewage; but satisfactory treatment is not possible on account of the large volume of liquid to be dealt with (which necessitates broad-irrigation methods) and the small amount of available land. This sewage is kept dammed up for long periods and only tends to disappear by the slow process of soakage and evaporation. During flooding of the Brook in rainy weather a penstock valve is opened in the earthern dam and the body of sewage is released into Kedron Brook.

During the time of inspection, Kedron Brook flowed as a sluggish streamlet through an almost dry basin and the whole presented the aspect of a string of disconnected waterholes. No fouling of the Brook was noticed, but about the grassy edges of the pool of sewage on Gibson's premises innumerable larvae of C.5-fasciatus were observed. The whole condition, from the standpoint of mosquito work could be materially improved by cleaning the grassy edges - especially at the foot of the bark beds, and weekly petrolisation.

Gallagher's tannery, Stafford, (Kedron).- Situated hard by Gibson's premises is a smaller tannery, the effluent from which after passing through a small amount of bark, flows into a depression which meanders a couple of hundred yards to enter Kedron Brook. No larvae were observed in the sewage - a condition accounted for by its very raw and particularly thick nature. With the approach of rainy seasons, this hollow becomes waterlogged by diluted sewage and direct rainfall, with resultant mosquito breeding. Apart from a small amount of filtration through bark, there is no further attempt at purification of the tannery effluent. The land available for broad irrigation treatment is small in area.

Mackler's Tannery, Newmarket (Windsor).- This tannery is situated at the corner of Edmonstone and Creek Streets, Newmarket. The sewage disposal plant consists of a disused concrete "soak" and a couple of subsidiary earth-cut pits on the bank of a small watercourse. This watercourse in the vicinity of the tanning premises is fresh, but a few yards lower down-stream it is affected by the tides flowing up Breakfast Creek. The water of these pits was found to be swarming with larvae of C.5-fasciatus and also to contain a few larvae of Lutzia halifaxi. By slow seepage, sewage escapes from the last soakage pit to find its way into the watercourse, where larvae of C.5-fasciatus were also observed. As the water of this streamlet becomes salty, no mosquito larvae are to be seen. On the immediate upper side of the tannery the watercourse abounds with fish. (Melanotaenia nigrans (R) and Mogurnda mogurnda var. adspersus Cast.) The sewage disposal of this



[illegible] sufficient to cause the formation of a continuous scum.

tannery is too near the watercourse, being almost directly on the bank. No successful land treatment of sewage is therefore possible. In its present position the only measure recommended for dealing with mosquitos here is weekly petrolisation.

Tanneries at Kedron Park(Kedron).- These five tanneries owned respectively by Gallagher, Gallagher, Slaney, Phill, and Magg are situated on the banks of a small watercourse. It seems preferable to consider these tanneries collectively, rather than separately and the accompanying illustration shows their position with reference to the streamlet and to one another. The streamlet flows a rather tortuous course for about a mile, where reaching rather flat country, it expands into Trilly's swamp and eventually falls into Kedron Brook in the neighbourhood of Kalinga Park. Miss M.Walker, who re-visited this place states:-

"The conditions at the tanneries at Kedron Park offer a striking illustration of the effect of pollution on larvae of Culex 5-fasciatus and their power of withstanding it... Between Gallagher's main building and Gympie Road lies a waterhole (in reality the unpolluted and upper end of the watercourse) from which water for use in the tannery may be pumped. It contains a few fish, but around the grassy edges Culex annulirostris and Anopheles (Nyssorhynchus) annulipes may be found. A small stream proceeds from the northern end of this, then turns sharply to the right (eastwards) to cross Gympie Road under the bridge. In pools along its length A.(N.) annulipes may be found.

"Gallagher's premises possess a filtration plant but it is not used and the sewage goes directly into a drain which enters the stream just in front of the supplementary tannery, the sewage from the latter entering at almost the same point. The water is immediately rendered extremely foul and has a thick grey scum on it; no mosquito larvae are found in it at this point or for some distance further on as the stream progresses in a more or less northerly, and then easterly direction, and where the scum persists. Between the streamlet and Gympie Road there are one or two waterholes harbouring C.annulirostris and A.(N.) annulipes. The stream curves round in an easterly and south easterly direction and widens out at several points; the scum disappears and immediately larvae and pupae of C.5-fasciatus are found in great abundance although the water is still extremely foul - of a pea-soup consistency and vile odour. The larvae continue throughout the length of the stream, which was stagnant at the time of inspection, and are unaffected by the entry of the sewage from Salney's tannery which is not sufficient to cause the formation of a continuous scum.

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In front of Slancy's tannery is an isolated pool of clean water which contains fish and very few larvae, [A. (N.) annulipes]. The stream crosses the end of Water Street and then receives the sewage from Phill's tannery which is filtered through a clinker bed and a wattle bark bed. For some distance after its entrance, no larvae are to be found but shortly after the stream crosses the dividing fence to Lagg's property, they appear again in numbers and continue until the sewage from Lagg's tannery again causes a scum to appear. Lagg's possesses both filter beds and a septic tank, but neither was in use at the time of inspection. The sewage (from Lagg's property) is conveyed in an earthenware pipe from the corner of the tannery for some distance and then the latter ends abruptly and foul water trickles down (a rather steep inclination) in several small streams to enter the main watercourse. As noted above, the sewage again causes the disappearance of the larvae for a short distance, but they soon appear again and flourish unchecked as the stream sluggishly progresses towards Trilly's swamp.

All these tanneries are situated in too close proximity to the watercourse, and there is no land available between the tanneries and the streamlet for land-treatment of the sewage. Moreover, the tanneries as a whole are grouped too closely and the area nowadays is quite unsuited to the continuance of noxious trades.

Not only in this group of tanneries, but in the Brisbane tanneries generally, the idea has always been allowed to gain dominance that directly sewage reached a watercourse all obligations on the part of tanners ceased. The fact alone that they almost all stand on the banks of streamlets serves as an heirloom of this species of reckoning. There is a second objection which can be raised against the areas in which tanneries are situated; apart from the fact that at one time they were located in bush country quite isolated from habitation, namely that their location in relation to a large body of water is quite unsatisfactory. The two natural drainage systems of the present Brisbane tanneries are Kedron Brook and Breakfast Creek. Kedron Brook, in its entirety is a fresh water creek taking its origin in the Taylor Range, Enoggera, and flowing in an approximate easterly course to empty on to the southern shores of Bramble Bay - north of the mouth of the Brisbane. The mouth of Kedron Brook is intercepted from the sea beach by the Serpentine Creek - in reality the outfall of the Brook in question.

Breakfast Creek is fed by two mountain streams (also originating in the Taylor Range) Enoggera Creek, and Ithaca Creek which unite at Ithaca to form Breakfast Creek.

About 800 yards down-stream, Breakfast Creek becomes tidal, and is flodded by salt-water daily backing up from the Brisbane River.

Both these creeks are quite ill-adapted to receiving large volumes of industrial sewage, yet, for years past these drainage systems have been deprived of numberless shoals of mosquito-larvivorous fishes which would in a state of nature render the waters incapable of acting as a breeding place for domestic species of mosquitos.

b. STREET GULLY TRAPS.

Time was not spent in any exhaustive examination of street gully traps, for there is every reason from past experience, for believing that these breed mosquitos (C.5-fasciatus) almost without exception. During the present re-survey, approximately a dozen street gullies were examined in the area of each Local Authority, (Belmont, Sherwood and Kedron excepted, where sewers are rare or absent). Except in one area (Ithaca) which was examined shortly after heavy downfalls of rain, all showed the presence of mosquito larvae (C.5-fasciatus and sometimes L.halifaxi), in greater or lesser numbers. In the case of Ithaca, three out of twelve examined showed the presence of egg-rafts and young larvae of the species in question.

c. THE EFFECT OF CONSTRUCTIONAL WORKS ON THE BREEDING OF CULEX QUINQUEFASCIATUS.

The present excavations which are being made in connection with the Brisbane sewerage scheme play a very decided part in the formation of breeding places for mosquitos. In the tunnelling operations and the sinking of shafts large volumes of ground water must be raised to the surface and generally speaking, in the out-lying portions of Brisbane where visits by the street gutter chipping-party are rarely made, street gutters and vacant land become silted up with mud and overgrown with grass. The bogs so created constitute very favourable breeding places for C.5-fasciatus and the difficulty is certainly enhanced when wandering animals have access to these places.

Examples of these types of silted gutter breeding mosquitos are to be seen in Victoria Street (both sides) Swan Hill (Windsor) and Creek Street and Newmarket Road, Newmarket (Windsor).

B. NATURAL SALT MARSHES AND POOLS.

As this section will deal with the non-domestic forms -- mosquitos which, by their power of migration are capable of causing great discomfort in gardens and wooded localities in and about Brisbane, and thus rendering apparently ineffective the reduction measures against the strictly domestic species, certain coastal areas up to a number of miles from the centre of Brisbane were necessarily included in the general survey. Thus, besides an exhaustive examination of the inhabited areas of Brisbane, the coastal strip of country stretching from Reef point, Scarborough, to Cleveland Point, Cleveland, was examined for the purpose of plotting out the larger breeding grounds for Aedes vigilax. Roughly speaking the survey in connection with A. vigilax embraces a strip of coast 30 miles long, with an average width of 4 miles. This width attains its maximum at Brisbane, which is situated inland about 10 miles, or following the meanderings of the Brisbane River, some 15 miles above its mouth.

It is a notable physiographical feature of the Brisbane topography that about 18 miles from the mouth of the River the banks are generally high and the land being well graded does not allow of the formation of salt marshes. A glance at Map. No.1 will make this clear. A line drawn from One Tree Hill to White's Hill, practically divides the salt-marsh fringed River with its two main tributaries from the marsh free banks higher up. The marshes and watercourses which occur south of this line (with one exception where the salt marsh is almost on the borderline) are all fresh and abound with larvivorous fishes. If for convenience, we term this line the "vigilax borderline" then we might state that the habitable part of Brisbane south of (or on the up-stream side of) the vigilax border line, is in such a sparsely populated condition (at present only, be it noted) that sewage-polluted streamlets do not exist. Therefore, except for migratory flights of A.vigilax from without, almost all species of mosquitos, and certainly all domestic forms result from local breeding - i.e., household breeding.

In the present section Brisbane can only be discussed in relation to that portion on the down-stream side or northern side of the vigilax border line. On this side the banks, in certain parts, become very shallow, and the land about flat, so much so that spring tides encroach on quite a number of square miles of useless marsh land, to stagnate until a re-filling occurs, either by salt water or by rain. For the most part the beds of the Brisbane marshes are below datum level so that drainage by gravitation is impossible; where partial

drainage can be effected the labour is generally in vain on account of animals wandering over and destroying earth-cut invert-canals.

Map No.1 shows that the salt marshes are confined principally to the lower portions of the two chief tributaries - Breakfast Creek and Norman Creek, and to the smaller creeks such as Pashen Creek (Balmoral) Toowong Creek (Toowong) and a couple of other smaller, nameless ones.. It will be most practicable to consider salt marshes in relation to natural drainage systems, and to subdivide these according to Local Authorities within whose areas they lie.

The survey in connection with A.vigilax is divided here into two sections, the first of which deals with Brisbane and the immediately surrounding Local Government areas, and the second dealing with the more outlying portions of Toombul, Sandgate, Redcliffe, part of Caboolture, and Wynnum.

Section 1-Brisbane and adjoining Local Government Areas.

The Breakfast Creek System.-

(a) Windsor. Breakfast Creek skirts Swan Hill on the southern and western sides; as the land is very low lying in certain places along these two sides, the overflow of salt water from the Creek causes the formation of permanent or semi-permanent salt-marshes in which A.vigilax breeds profusely. Larvae of both A.vigilax and Culex sitiens Weide, were observed in plentiful numbers during the present survey.

A small salt marsh is also to be found about the salt water creek which empties into Breakfast Creek near the railway crossing over Breakfast Creek. This also is a fruitful breeding place for A. vigilax.

There is no other salt marsh belonging to the Breakfast Creek system in the area of Windsor.

(b) Hamilton. The south-western and southern boundaries of Hamilton are formed respectively by Breakfast Creek and the Brisbane River. As the north bank of the Brisbane River at Hamilton Reach is rather high and does not permit of the extensive inundation of land by salt water, the only portion of the Hamilton area of interest is that lying towards its south-western corner, or the mouth of Breakfast Creek. Crosby Park, Albion Park Race Course, and the Albion Flats (immediately to the western side of Albion Park Race Course) are low lying localities which must be ranked as salt-marsh land, and as breeding places for A.vigilax. The north-eastern corner of the Race Course is, by far, the most extensive breeding place in

respect of area. It is kept permanently filled by spring tidal waters backing up Cockley Street sewer. In previous years a large amount of filling has been accomplished in a brackish marsh which existed in the centre of this land, but no pains have been taken to level off the top of the filling-in material with the result that fresh water pools are found in the irregular depressions. In a couple of these, larvae of Aedes (Ochlerotatus) alboannulatus were observed.

The land comprising Albion Park Race Course is very flat and low-lying, but in spite of this condition the process of "borrowing" earth for levelling up the course is continually carried on in certain parts of the premises. The sinking of borrow-pits on race-courses is in evidence also at Doomben Park Race Course (Hamilton) and Kedron Park Race Course (Windsor) both of which are also situated in low lying land.

During a survey made in 1912, and for several years subsequent to that time, Crosby Park marked the situation of a large teatree marsh which, having been fed by a hill-streamlet from the western slopes of Bartley's Hill, and having had communication with Breakfast Creek (through the Grove and the Collingwood Streets sewers) presented the condition of a fresh marsh gradually merging into a salt marsh on the lower side. At the time of the present inspection (1923) almost the entire swamp has been reclaimed with the exception of a central canal to give easement to the flow of storm water from Bartley's Hill to the Creek, and also with the exception of a few small salt puddles in which larvae of A. vigilax were observed. In its present state, a moderate amount of levelling of the filling-in material is required, but this will probably be accomplished with the completion of the reclamation work.

The swamp land immediately surrounding Albion Park Race Course on its western side has been in recent years in great measure reclaimed. A small amount of filling work is still required (on private property) in Jane Street, while Jane Street requires raising above datum level. Both of these places, though small in extent, are notorious for the swarms of larvae that are produced in the salt marshes.

(c) Brisbane. Herston, Bowen Hills Sports Ground, and Mayne, fringe the right (southern) bank of Breakfast Creek. The marsh land at Herston is private property and contributes very freely to the propagation of A.vigilax. The work of filling and draining would not be extensive.

The old Sports Ground at Bowen Hills is occasionally flooded by salt water in which A.vigilax breeds; drainage by spade-cut channels is possible and was at one time adopted with success but, owing to lack of attention, siltage has occurred and the work thus rendered ineffective.

The Mayne breeding places take the form of railway borrow-pits and salt-swamp land. A great amount of swamp reclamation in the way of filling has been done by the Railway Department at Mayne but unfortunately the line of borrow-pits skirting the embankment on the eastern side of the North Coast and Sandgate Railway line has been overlooked. The filling of this line of borrow-pits in proportion to that which has already been accomplished, would be a very small job. It would remove an active breeding ground and deserves consideration by the Railway Department. During the present survey the water of these borrow-pits abounded with larvae of A. vigilax, and a few of Mucidus alternans Westwood.

The Norman Creek System.- The salt marshes bounding Norman Creek on its right (eastern) bank lie in the areas of Coorparoo and Balmoral. A small patch of salt water on its left bank occurs in the area of South Brisbane at Buranda.

(a) Coorparoo. The salt marshes in this area lie immediately about the banks of the Creek and of its tributary - Bridgewater Creek in the vicinity of Langland's Park and Coorparoo Racecourse respectively. There is also a small salt marsh at the foot of Rome Street fringing the southern bank of a small creek which empties into Norman Creek and which constitutes in part the boundary between the contiguous areas of Balmoral and Coorparoo. All these places are below datum level and require filling. Their waters were found to harbour larvae of A. vigilax.

On the immediate upper side of Burnett Swamp Bridge which is approximately situated on the "vigilax border line", Norman Creek is a fresh water creek and owing to its pollution by sewage coming from the area of South Brisbane, acts as a breeding place for C.5-fasciatus.

(b) Balmoral. The two principal swamps of the Norman Creek system occur at Norman Park in the vicinity of the foot of Moreton Street. These swamps are found in the "pocket" formed by the windings of Norman Creek, and also exist at the foot of a valley which traverses a south westerly course from Galloway's Hill. Except in the very rainy season, this valley remains dry and it is only as it expands at the foot of Moreton Street that it becomes of interest by reason of the large numbers of mosquitos (A.vigilax) which are hatched in its saline waters. The evil of mosquito-breeding here is very greatly aggravated

by the "paddy-melon" holes over the entire lower portion of the salt swamp. Each of these paddy-melon holes (which would present an average water-area of 40 square inches) is separated from its neighbours by dry ground of approximately similar area to the water surfaces. During the late Brisbane anti-mosquito operations, these swamps were almost wholly drained (or at least the water area was concentrated) by the cutting of a central invert canal and a series of laterals. The wandering of animals over the swamp and its drainage canals has in great measure ruined this system of drainage. Unless concrete or brick sewer-inverts are installed in a future system the area requires to be fenced against the ingress of animals.

Pashen Creek System.-
Pashen Creek is quite a short creek - no longer than a mile from source to mouth- rising in the Bulimba heights and flowing by a roughly westerly course to empty into the Brisbane River at Bulimba Reach. Its upland waters are fresh, and it is only after it traverses half its length that it reaches flat country whence there is a lateral spreading of its waters in delta-like formation. This place, which occurs at the foot of Memorial Park, Bulimba (Balmoral) is flooded by salt water backing up the Creek, and forms a very fruitful breeding place for A.vigilax.

Balmoral.- There are a couple of other smaller salt marshes in the area of Balmoral but these occur independently of the Pashen Creek drainage basin. They are located lower down stream and slightly more inland than the Apollo Candle Works. The marshes have immediate communication with the River at Hamilton Reach. As the land is rather low lying here, there is no permanent measure other than filling; but the water areas may be materially reduced by partial drainage.

Western Creek Drainage System.-
The upper waters of this creek are found on the slopes of Fernberg, Rutledge's Hill and Torwood and after flowing a north easterly course, the creek bends rather sharply to take a south easterly direction, reaching the Milton Reach of Brisbane River. Its course of late years has been somewhat modified by the construction of sewers and sewer-inverts along its alignment and it is only in the vicinity of the Southern and Western Railway that its banks are overflowed by salt water backing up the Creek. All the salt water part of this creek lodges in the area of Toowong.

At Milton, Western Creek has been straightened by the construction of a large concrete sewer-invert through which the daily tides ebb and flow. During spring tides the land about the invert is flooded and the marshes so formed stagnate for long periods and breed A.vigilax. A couple

of the marshes have, in late years been filled in, but the remaining ones - occurring about the Milton Tennis Courts and Sieman's Paddock were seen to be still acting as breeding places (A.vigilax and Mucidus alternans). In the neighbourhood of Kilroe Street, the creek is fed by a branch which flows from Auchenflower (Toowong) through Dunmore Park, in the form of a concrete invert. Dunmore Park is also flooded by salt water backing up the Creek (invert) during spring tides and forms a favourite breeding place for A.vigilax. A large part of Dunmore Park has lately been filled but, as with the other marshes surrounding the Western Creek system, much might be done by drainage. There is, moreover, an entire absence of weep-holes in the concrete inverts, which condition makes impossible the effective drainage of ground or seepage in immediate proximity to the concrete work. Thus certain places surrounding the inverts retain a sloppy and marshy character which could be obviated by instituting a few weep-holes in the sides of the inverts.

Toowong Creek Drainage System (Toowong).-
Toowong Creek originates on the eastern slopes of Mount Cootha (One Tree Hill) and flows as a fresh water streamlet through the area of Toowong until it meets the lower end of Alpha Street, whence its lower portion acts as a boundary between the adjacent areas of Toowong and Taringa. Where it commences to form the boundary (at the foot of Alpha Street) the water becomes salty and the creek-bed marshy with the result that a breeding place for A.vigilax is formed. Much might be done here to concentrate the water on a central canal and so give the water a free flow through the creek.

Immediately on the upper side of the stagnant salt water the Creek (which is fresh) is polluted and breeds C.5-fasciatus. This has already been discussed on page 12.

Toowong Creek is located about the vigilax border line and therefore forms the upstream limit of vigilax-producing places on the Brisbane River. This is the last place to be considered with reference to the survey against A.vigilax in Brisbane.

Section 2 - Outlying Areas.

The outlying salt marshes on the north side of the city will first be discussed, after which those to the south-east side will be considered. They will be taken roughly in order of their distance from Brisbane.

Land about Cabbage Tree Creek and Nundah Creek (near Sandgate).- It will be seen by the attached map that Cabbage Tree Creek arises about five miles to the west of Virginia and flows roughly in an easterly direction to empty into Bramble Bay at the south eastern corner of the town of Sandgate. During its course Cabbage Tree Creek drains the areas of Zillmere and Nudgee College, at which latter place the creek is affected by tides. Discharging its waters into the estuarine mouth of Cabbage Tree Creek, is another stream - Nundah Creek - which takes its origin in the gentle slopes of Virginia in the area of Kedron.

Nundah Creek swamp near Cribb's Island (Toombul).- Like the lower portion of Cabbage Tree Creek Nundah Creek has a delta-like formation at its mouth, with the result that the land about Nudgee Beach, Nudgee College, and Sandgate, are more or less permanently covered by stagnant salt marshes. The salt marshes on the right bank of Nundah Creek (Toombul) separate in part the so-called Cribb "Island" from the mainland. The place is to a great extent unapproachable on account of the oozy sand flats which surround the marshes; here and there, however, where the swamps were accessible, the water abounded with larvae of A.vigilax. A few larvae of C.sitiens and Mucidus alternans were also seen. Nudgee Orphanage is on the right of Nundah Creek, and it is only about the lower (or north eastern) portions of the field that the extensive marshes here alluded to are to be found.

Cabbage Tree Creek Swamps near Nudgee College (Kedron). Lodging between the two arms of the "Y" formed by the coalescence of Cabbage Tree and Nundah Creeks, is to be found a very flat and low tract of country on a great part of which the spring tidal waters encroach. This land constitutes a part of the district of Nudgee College, and occurs to the immediate east of Nudgee College Railway Station. A couple of silted up gutters give easement of the marshes into Cabbage Tree Creek and Nundah Creek. Aedes vigilax was observed to be breeding very freely in the swamps. The peripheral portions of the swamp are to a great extent, broken up into small pools and puddles, due to wandering animals and it was in such water collections that larvae noticeably abounded.

A couple of hundred yards to the west of Nudgee College Railway Station is another collection of salt water. A small tidal gutter connects this swamp with Cabbage Tree Creek- its outfall being in the immediate vicinity of the point where the Brisbane - Sandgate Road crosses Cabbage Tree Creek. The tidal gutter has a fairly good fall, but its flow, in parts, is rendered more or less sluggish by an abundance of swamp grass which fringes its edges. In the land near the upper portion of this gutter a few larvae of A.vigilax were found.

Cabbage Tree Creek Swamps at Sandgate (Sandgate).- About the left (or north) bank of Cabbage Tree Creek in the vicinity of the railway overbridge a small tract of low lying country covered by stagnant salt water was observed. To the east of Deagon Station (Sandgate) the peripheral waters of a salt marsh were also breeding A.vigilax. The waters of this marsh drain directly into Cabbage Tree Creek.

Bald Hills Creek (? Mosquito Creek) (Sandgate).- Bald Hills Creek arises in the district midway between Sandgate and Strathpine and meanders in a northerly direction to fall into the mouth of the North Pine River. A stagnant salt marsh fringes both banks of this creek and in innumerable salt pools about the edges of the main body larvae of A. vigilax were freely encountered. Time would not permit of any thorough investigation to this swamp, but it is apparently the case that a large part of it might be drained by a system of "crow's foot" invert channels. Adults of A.vigilax were an intolerable nuisance while walking through the wooded parts of the outskirts of the swamp. A few imagines of Aedes (Skusea) funerea were also observed.

North Pine River.- About the North Pine River in the vicinity of the railway bridge south of Petric, the banks were rather high, and the land well graded, except three small pools of salt-water about the railway bridge. No larvae were noticed. Towards the mouth the river appears to drain some salt marshy country but the investigation of this would require several days, and time available did not permit its completion.

Marsh about Hay's Inlet. (Shire of Caboolture, and Shire of Redcliffe).- On the Caboolture side of the Creek leading into Hay's Inlet are the head waters of an extencive salt marsh. The marsh is located on both sides of the Anzac Memorial Road (on the Brisbane - Redcliffe Road) and also on both sides of Hay's Inlet. The marsh was investigated at intervals for a course of about 4 miles in the direction of the creek-bed; and little or no variation in the conditions was found. The country is very flat and the nature of the marsh permanent. Larvae of A.vigilax were very freely encountered all over the swamp and the adults of this species were very numerous throughout the surrounding bush. The marsh is open to the access of cattle and horses.

This marsh, together with the Kippering, is perhaps the largest in the vicinity of Brisbane. The cost of drainage would certainly be great but it is certain that it contributes to a very large extent towards the large numbers of migrating forms of A.vigilax which occasionally manifest themselves along the habitable parts of the coast including Brisbane.

Drainage, (along with the protection of drains by fencing) is the only practical measure which might be recommended, and lifting of the drained waters by windmill or other form of power would probably be required in places, together with banking. After sweetening of the drained land, however, it is probable that a large area of rich soil would become available for agriculture or posturage.

The Kippering (Shire of Redcliffe).- The Kippering is a large swamp, some 4 miles long by one mile broad, bounding a portion of the southern shore of Deception Bay.

The approach to the swamp is protected by dense and more or less impenetrable Lantana and the swamp itself is difficult of access in parts by reason of treacherous boggy mud and innumerable grass-protected pot-holes. A sort of table-land bounds the southern margin of the swamp. This table-land is raised about 12 to 15 feet about the marsh and is quite dry, but it dips down very abruptly to the level of the marsh. All along its foot a fresh water boggy marsh is formed, apparently by seepage from the high ground. By the gradual mixing of the fresh waters and the salt, and intercepting the fresh from the salt water. In certain places, capes of dry land project into the marsh, and it was only along these routes that the salt water part of the marsh became approachable for investigation. There is a rank growth of swamp grass in the fresh part of the marsh with the result that innumerable boggy pools and puddles become obscured only a couple of yards away. It was in such places that larvae of Anopheles (Nyssorhynchus) annulipes Walker, were found. The permanency or semi-permanency of this fresh marsh is indicated by the abundance of Notonectidae ("water boatmen") and fresh water Crustacea with which the water abounded. The water is too shallow and grassy for fish. The Anopheline larvae referred to were seen in quite moderate numbers, on the average three or four being found to each ladle-full of water.

The salt part of this marsh -- which is by far the most extensive portion -- contained innumerable larvae of A.vigilax and each scoopful of the water taken at random about the edges would contain between two and three hundred larvae. The imagines of this species occurred in myriads as one disturbed their resting places in the grass and on the foliage of undergrowth; moreover, their vicious attacks rendered investigation quite a burden of discomfort

The seepage from the table-land about the southern borders of the Kippering should be dealt with by a circumvallatory drain. The method could be also extended as a series of concentric circumvallating invert channels until there was an easement of the waters on to the shore at Deception Bay. The task is certainly a big one, for not only is it very extensive but its location away from habitation and the difficulty of access, cause it to be very little known even to residents of the district. To an even

greater extent than the Hay's Inlet system of marshes, the Kippering presents possibilities for the reclamation of valuable soil for agricultural or pastoral purposes, with coincident removal of a vast mosquito-breeding area.

It is indisputable that the Kippering supplies Redcliffe, and in part Brisbane, with the migrating species of mosquitos, and especially A.vigilax.

Lytton Swamp (Wynnum).- This is the chief salt marsh in a south easterly direction from Brisbane. It occupies a rather extensive tract of land between Lytton and Hemmant, and in the number of mosquitos it breeds (A.vigilax) is surpassed perhaps only by Hay's Inlet marsh and the Kippering. The marsh is in the form of a horse-shoe, with two outlets into the lower part of Brisbane River. One of the outlets passes through the Military area at Lytton to a graded channel through the Quarantine area, while the other crosses the Lytton Road a couple of miles on the downstream side of Hemmant. The upper waters of this swamp are fresh and result from a natural basin dipping between Wynnum abd Lindum, but it is only when the water is influenced by spring tides that the breeding places for A.vigilax are formed. Of late years the Defence Department (on whose land part of the northern swamp-outfall exists) has thrown, across a portion of the swamp a road under which are a couple of culvert pipes at a slightly higher level than the permanent water surfaces of the swamp. This has partially dammed the water back on to the swamp. That portion of the northern outfall which passes through Quarantine land is quite innocuous in so far as mosquito breeding is concerned. The southern outfall of the swamp is a rather sluggish streamlet by reason of fallen timber and siltage in its course. Clearing of the swamp-out-falls would tend to lower the water in the swamp very materially. The lowering of the pipe drain on the military road would also form an essential part of the work. As has already been indicated with reference to the Hay's Inlet and Kippering swamp-systems, systematic drainage would probably result in the conversion of this great mosquito-breeding area into valuable land for agriculture and pasturage.

Cleveland.- A line of railway borrow-pits on the southern part of the Cleveland railway embankment was examined and found to be holding up salt water in which a few larvae of A.vigilax were seen. By cleaning and deepening the drain-outfall on to the foreshore, the drainage of the borrow-pits might be effected.

4. THE ANOPHELINE SURVEY.

Many permanent fresh waters were examined in and about Brisbane at a stage when the effects of a prolonged spell of dry weather had been manifested by the small amount of water which occurred in swamp-beds and watercourses. Usually during times of drought, when a creek may be reduced to a mere string of waterholes, there is an abundance of, or apparent increase in, the aquatic vegetation. Fish, for the most part, are found in the larger gully holes in the bed of the creek and it is from these "sanctuaries" that the streamlet, in times of restoration to normal conditions is restocked with larva-destroying fish.

Fresh water marshes and streamlets in a state of nature, in southern Queensland, do not breed domestic mosquitos by reason of the larvivorous fishes with which the waters abound. When however, the activities of the fishes are impaired through overgrowth of aquatic vegetation, one is generally successful in finding a few Anopheline larvae (Anopheles (Nyssorhynchus) annulipes), and the rarer forms of Culicini. It is only after streamlets become polluted by sewage that fish are killed, and domestic species of mosquitos are enabled to breed in such waters by the protection so given against their natural enemies.

The present survey has afforded a very favourable opportunity for observing the maximum amount of Anopheline development which follows during a protracted drought, when the natural waters must be overcrowded with aquatic vegetation due to the lack of flushing which would normally go on in the rainy season. It is particularly noticeable that water Hyacinth is shewing a decided increase of late years in certain parts of Brisbane. Cases in point are the Ekibin watercourse and the Fairfield swamps (Stephens), Chelmer Swamps (Sherwood), Bell's paddock and Windsor Watercourse (Windsor), certain parts of Kedron Brook and the Serpentine Swamp (Toombul), Nundah watercourse (Toombul) and the upper parts of Breakfast Creek (Ithaca), and of Pasman Creek (Balmoral). The growth of Hyacinth is generally sufficient to cut off all surface activities of the larvivorous fishes, and the result is that one may usually find a few larvae of A.(N.) annulipes in such waters. Ekibin watercourse not only shewed Anopheline larvae, but an abundance of larvae of C. annulirostris, Certain parts of Kedron Brook which shewed overgrowth of green Algae and aquatic grass, were also found to contain larvae of A. (N.) annulipes. As a matter of fact by close investigation of a much overgrown swamp or watercourse, it was possible to secure Anopheline larvae. It was rather noticeable, however, that a very great proportion of the number of larvae encountered were in the early stages of development, a fact suggesting that the natural restraining influences (fish, Notonectidae, etc.) were great.

No natural water collections were seen in such a state as to have really caused a nuisance in connection with Anopheline breeding, indeed the reverse condition was the case, and it is surprising after having thoroughly examined clean natural waters, to find in what meagre numbers mosquito-larvae as a whole could be found.

Those watercourses and swamps which were observed to contain unusual numbers of larvae of either A.(N.) annulipes or C.annulirostris or both, are marked green on the Spot Map (No.3) and shewn as square dots on Map No.1.

The Einbunpin Lagoon.- a fresh water lake at Sandgate - was examined but no mosquito larvae were seen. The main part of the larger lagoon (bounded on its western side by Southerden St.)also gave a negative finding, but on its southern end where a dam has been thrown across, thus cutting off a triangular piece of the swamp surrounded by three roads, larvae of A.(N.) annulipes and C.annulirostris were found. These swamps with the exception of the triangular southern portion of the larger swamp are well stocked with larvivorous fishes. Another freshwater lagoon, the largest of the three, is located on the outskirts of Sandgate, its southern bank being bounded by the Bald Hills Road. In certain marshy parts about the edges of a few larvae of A.(N.) annulipes were observed. The main portion of this lagoon is evidently well stocked with fish. A well defined edge or retaining wall to the largest lagoon would have the effect of producing a beauty spot for Sandgate and would enable the fish to do their work. The triangular part of the second largest swamp should either be filled or connected by a culvert under the road - with the main body of water so as to allow the access of fish to all parts.

5. OBSERVATIONS ON THE RARER SPECIES OF MOSQUITOS.

Several of the rarer species of mosquitos were noticed in certain parts of Brisbane during the present investigation.

At Kalinga Park a few adults of Aedes (Ochlerotatus) vittiger,Skuse, Taeniorhynchus (Coquillettidia)brevicellulus Theobald, and Taeniorhynchus (Mansonioides)uniformis (Theo.) were taken, biting, about foliage. Miss Walker succeeded in finding a larva of A.vittiger in a temporary rainwater pool - an interesting observation as making the third record of larval finding for this species. Aedes (Skusea) funerea was noticed on a couple of occasions biting about saltmarshes. Careful examination revealed the presence of no other Anopheline than A.(N.)annulipes Walker. The scarcity with which Anopheles (Myzorhynchus) bancrofti Giles, occurs,either in the larval or imago stage

is sufficient explanation for our failure to locate it. A few larvae of Aedes (Finlaya) notoscriptus were observed in the water of a couple of cavities in the hole of a Moreton Bay fig-tree. In a few street gully traps and sewer outfalls larvae of Lutzia halifaxi were found. The foregoing species of mosquitos never occur in such a degree as to constitute a nuisance, owing in great part, to the types of breeding places which they select. For all practical mosquito work, therefore, their presence might be disregarded.

6. LIST OF BREEDING PLACES ACCORDING TO LOCAL AUTHORITIES' AREAS.

BRISBANE.

Breeding places for Culex 5-fasciatus.

I. Victoria Park watercourse (p. 5).
II. Sewer outfall at Herston - discharging into a small watercourse between Aberleigh Road and Hetherington St. (p.12).
III. Street gully traps, generally distributed (p.16).

Breeding places for Aedes vigilax, Culex sitiens and Mucidus alternans.

IV. Salt marshes and pools at Herston, Bowen Hills, and Nayne (pp. 19 & 20).

Breeding places for Anopheles (Nyssorhynchus) annulipes.

V. Seepage water in Victoria Park at the foot of the Boys' Grammar School, and on northern side of railway embankment.

SOUTH BRISBANE.

Breeding places for Culex 5-fasciatus.-

I. Ipswich Road sewer outfall at head of kingfisher Creek (p.8).
II. Street gully traps (p.16).
III. Polluted pool on north side of police station (near Lain St. and Vulture Street East). (p.8).
IV. Watercourse at head of Ipswich Road Sewer at foot of Railway embankment near Arthur St. and Ipswich Road. (p.8.).

Breeding places for A.vigilax.

V. Small collections of salt water at end of Maynard St, Buranda, where the railway crosses Norman Creek.

WINDSOR.

Breeding places for C.5-fasciatus.-

I. Depressions along the Wooloowin sewer (pp. 8 & 9).
II. Pool in Park about Wesley and Bruce Sts. near Kedron Brook. (p.11).
III. Depressions and small watercourses in vicinity of preceding (p. 11).
IV. Windsor sewer at Bell's paddock. (p. 9).
V. Swan Hill polluted watercourse (p.9).
VI. Hackler's tannery (p.13).
VII. Silted gutters in Victoria St. Swan Hill (p.16).
VIII. Quagmire at Newmarket Road and Creek St. Newmarket.
IX. Street gully traps.

Breeding places for A.vigilax.
X. Land about Green Terrace and Garden St. near Breakfast Creek, Swan Hill (p.18).
XI. Land about Swan St. and Edgar St. Swan Hill. (p.18).
XII. Pools about a tidal gutter near Windsor Park.(p.18).

Breeding places for Anopheles (Nyssorhynchus)annulipes. and Culex annulirostris.
XIII. Depression near Fifth Avenue and Kedron Brook Road, Wilston.
XIV. Depression near Fifth Avenue and Sylvester St, Wilston.

HAMILTON.

Breeding places for C.5-fasciatus.
I. McGregor Waterhole; the Clayfield Clay pit (p.10).
II. Moynihan Street watercourse (p.10).
III. Street gully traps.

Breeding places for A.vigilax.
IV. Albion Park Racecourse (pp. 18-19).
V. Crosby Park (pp.18-9).
VI. Albion Flats (to immediate west of Racecourse)(pp.18-9)

Breeding places for Anopheles (Nyssorhynchus)annulipes.-
VII. Watercourse on upper side of Oriel Park. See under "Moynihan Street Watercourse" (p. 10).

ITHACA.

Breeding places for Culex 5-fasciatus.
I. Ithaca Creek and Waterworks Road (p.5).
II. Breakfast Creek at Murray Street (p.6).
III. Watercourse which intersects Baroona Road near Carrington St. Rosalie (p.7).
IV. Grass-choked and sewage-polluted water table in Ranley Grove St. Paddington.
V. Street gully traps.

Breeding places for A.vigilax - Nil.

TOOWONG

Breeding places for Culex 5-fasciatus.
1. Toowong Park Watercourse (p.6).
11. Thorpe St. Watercourse (p.7).
111. Polluted water in Toowong Creek bed between Campbell and Alpha Streets.
1V. Street gully traps.

Breeding places for A. vigilax
V. Salt swamps near Milton Tennis Courts, in Sieman's Paddock and Dunmore Park, (Auchenflower) (p.21)
V1. Marshy land about Toowong Creek near the foot of Alpha St. (p.22).

COORPAROO

Breeding places for C.5-fasciatus.-
1. The Greenslopes - Coorparoo watercourse (Green's Gully) (p.10).
11. Small watercourse running between Wylie Avenue and Marian St. Greenslopes (p. 12).
111. Langland's Park.

Breeding places for A. (N.) annulipes.-
V. Green's Gully, and watercourse through Greenslopes

BALMORAL.

Breeding places for C.5-fasciatus.
1. Memorial Park, Bulimba (p. 10).
11. Apollo Road " (p. 11).

Breeding places for A.vigilax.-
111. Land about Norman Creek, Norman Park (p.20).
1V. Pashen Creek swamp.(p.21)
V. Small salt swamps in vicinity of Apollo Candle Work. Bulimba (p. 21).

STEPHENS

Breeding places for C.5-fasciatus.-
1 Ekibin Watercourse, near Ekibin Street (p.7).

Breeding places for A.vigilax.- Nil.

Breeding places for A.(N.)annulipes & C.annulirostris.
11. Fairfield Swamps, and waterhole in Wilkins' paddock (p. 27).
111. Ekibin watercourse on the lower side of Ekibin Road (p. 27).

TOOMBUL.

Breeding places for C.5-fasciatus.-
1. Rubbish dump at Woodville Road Hendra (p.11).
11. Nundah sewer-outfall in vicinity of Nundah Pine-apple preserving factory (p. 9).

Breeding places for A.vigilax.-
111. Nundah Creek swamp near Cribb Island (p.23).

TARINGA

Breeding places for C.5-fasciatus .-
1. Sewer discharging into a tributary of Toorong Creek between Oxford Terrace and Swan Road (p.12).
11. Pool between Ryan's Road and Bryce St. Ironside (p. 12).

Breeding places for A.vigilax.- Nil

Breeding places for A.(N.) annulipes.-
111. Head of a watercourse near Brisbane St. and Cormody Road Ironside.

KEDRON.

Breeding places for C.5-fasciatus .-
1. Tanneries at Stafford and Kedron (pp.12-15).

Breeding places for A.vigilax.
11. Cabbage Tree Swamps near Nudgee College (p.23).

ENOGGERA, BELMONT, SHERWOOD AND YERONGPILLY.

These Local Authority Areas are grouped together here by reason that there are no mosquito breeding places (apart from the essentially household forms) of any consequence, to be considered at present. The areas are not sufficiently closely settled, nor do sewers of any importance yet exist whereby streamlets may become polluted - thus it is that swamps and watercourses, being found in their natural state in these areas abound with larvivorous fishes, and it was only with the greatest difficulty that larvae of A.(N.)annulipes could be found in the waters of these areas. The finding of a young Anopheline larva here and there along a few hundred yards of a natural stream - a young larva which would possibly never attain maturity but be killed off by natural enemies - does not warrant any serious consideration in a report of this description.

These areas being for the most part well raised above sea level do not contain salt swamps in which Aedes vigilax could breed. In respect of (a) settlement and the prevalence of C.5-fasciatus and (b) contour and the presence of A. vigilax, this group of areas contrasts very strongly with the preceding areas, which latter, in one way or another produce C.5-fasciatus by polluted waters and A. vigilax by salt swamps.

It is well to emphasise here the important fact that neither the physiographical position, nor the effect of settlement, has any influence in affording protection from the species which are essentially of domestic nature - to wit, A.(S.)aegypti and C.5-fasciatus. The former species is well distributed in these areas as a tank-breeding form, while the latter, when it occurs, is found breeding in artificial receptacles - usually other than tanks.

SANDGATE.

Breeding places for A.vigilax.-
I. Salt pools and swamps about the north bank of Cabbage Tree Creek (pp.).
II. Marsh about Bald Hills Creek. (p.).

Breeding places for A.(N.)annulipes.-
The two larger lagoons.(p.).

CABOOLTURE.

Breeding places for A.vigilax.-
Marsh about Hay's Inlet (p.).

REDCLIFFE.

Breeding places for A.vigilax and A.(N.)annulipes. -
The "Kippering" (p.).

WYNNUM.

Breeding places for A.vigilax.-
Lytton and Hemmant Swamp (p.).

CLEVELAND.

Breeding place for A.vigilax (p.).

7. SUMMARY AND CONCLUSIONS.

A. DISTRIBUTION OF SPECIES IN THE METROPOLITAN AREA.

I. Aedes (Stegomyia) aegypti (L.) is very commonly distributed throughout the Metropolis of Brisbane, its larvae being almost invariably found in rain-water tanks. Other places it selects for breeding are sagged and water-holding portions of roof guttering, garden water-barrels, water insulators of the legs of food-safes, bedroom water-jugs, and any other domestic collection of water in an artificial receptacle.

2. A.aegypti is almost always present in houses, without any regard to adverse meteorological conditions or the presence or absence of swamps. In the essentially business portions of the town, where rain water tanks have been banished in favour of the pipe-borne water service, A.aegypti is seldom noticed. When its presence is felt in the city proper, if there are no rain-water tanks near at hand, its larvae are found either in sagged and blocked roof-gutters, or other artificial receptacles.

3. In the bush (and uninhabited) country about Brisbane A.aegypti does not occur.

4. Culex quinquefasciatus Say, (C.fatigans) is also a close follower of man, but not to the same extent as A.aegypti, inasmuch as it is a community follower and does not necessarily follow isolated houses. In the Metropolitan district - and in Southern Queensland generally speaking - C.5-fasciatus shows a decided preference for breeding in foul rather than in clean waters. Thus it is extremely prevalent in a thickly populated area which is unsewered (or only partly sewered), rather than in the sparsely settled areas like Enoggera, Belmont, certain parts of Stephens shire, etc. Many individuals of this species occurring in houses are not bred on the premises but come from places further afield, (such as polluted water-courses etc.) where their larvae should be sought.

5. Aedes vigilax (Skuse), on account of its capacity for long migrations - either by independent flight, or carried on winds - its is a species which invades, at times to a greater or lesser extent, all parts of Brisbane, and is well-recognised as the "Black bush-mosquito" by all Brisbane dwellers. When migrant forms occur, their presence during times of anti-mosquito operations is liable to prejudice people against the efficiency of reduction measures directed against the disease-bearing and therefore essentially domestic, species of mosquitoes. A.vigilax is found breeding very freely throughout the warm months of the year in the salt pools and marshes in and about Brisbane.

6. During the months of February and March the larvae of Culex sitiens Wiedemann, and Mucidus alternans (Westwood) (the "Scotch Grey") are seen occupying the same breeding places as A.vigilax. Towards the early part of April their larvae are only found with difficulty.

7. Although the larvae of Anopheles (Nyssorhynchus) annulipes Walker, are not difficult to find in waters stocked with dense growths of vegetation, imagines of this species are very seldom seen in the Metropolitan area.

8. Larvae of the rarer forms are sometimes or rarely found; such as <u>Aedes (Ochlerotatus) alboannulatus</u> and <u>Aedes (Ochlerotatus) vittiger</u>. A few imagines of <u>Taeniorhynchus (Coquillettidia) brevicellulus Theo.</u> <u>Taeniorhynchus (Mansonioides) uniformis</u>, Theo., and <u>Aedes (Skusea) funerea</u> were noticed during the present re-survey in scrub country about Kedron Brook and Nundah marshes. Mosquitoes of these species are characterised by the rarity with which they are seen and their sylvan nature; their numbers never attain to the extent of a nuisance. Occasionally in houses situated in wooded localities the larvae of <u>Aedes (Finlaya) notoscriptus</u> may be observed in tree cavities, or water barrels in ferneries. A specimen of <u>Rachisoura atripes</u> was noticed once in a suburb of Brisbane.

B. CONDITIONS INFLUENCING THE BREEDING AND DISTRIBUTION OF SPECIES, IN THE METROPOLITAN AREA.

I. <u>Tanks.</u> <u>A.aegypti</u> is to a very great extent, dependent for its propagation upon tanks. Large numbers of tanks which were made mosquito proof during the 1912-13 anti-mosquito work in Brisbane are now ineffective against the breeding of this mosquito in them. The screens on the manholes have become choked and broken or dislodged, and for the most part overflow-pipe screens do not exist. There is no kind of screen, whether flap-valve or gauze, which does not require at one time or another, attention on the part of the householder. In the city, dust chokes the meshes, while on the out-skirts falling leaves from overhanging trees block the screen. A hooded (dust proof) cover over the screen, though reducing the deposit of dust, becomes a nuisance which is only detected after a long time. In a few cases where either the manhole or overflow (or both) were effectively screened, large gaping holes were seen in the sides of the tanks. There seems to be an erroneous conception on the part of some plumbers and householders that, be a tank in ever so dilapidated condition, so long as rain water is strained through a piece of gauze in its passage into the tank the "ideal" is attained.

In a few instances gauze was observed which showed on measurement 17 meshes and 18 meshes respectively, on the two sides of an inch square of the gauze (the two measurements made at right angles), instead of being "not coarser than eighteen meshes to the inch each way" as is provided by paragraph 4 (1), Part II, of the <u>State Mosquito Prevention and Destruction Regulations</u>. One type of patent mosquito proof screen - the principle of which is a pipe which dips into the manhole obliquely and the end of which is closed by a swinging flap on an inclined plane - was seen to be ineffective by reason of the distorted and gaping inlet pipe.

The iron hinges had rusted and made the flap valve fast which apparently resulted in the pipe being forced by hydraulic action. Flap-valves should invariably have brass hinges to prevent rusting. No galvanizing process can be relied on for the purpose.

2. Roof gutters. As the survey was conducted in a period of drought, no roof-gutters were actually observed to be holding water, but many likely places were noted. Sagging gutters are caused by failure of the supports, and not infrequently gutters are laid with insufficient fall. Leaves dropping from overhanging trees result in the blocking of down pipes and thus damming water in the gutters. To remedy this there is no necessity whatever to destroy ornamental or valued trees in Brisbane gardens, but actually overhanging branches should be trimmed away, and roof gutters examined and cleared at regular intervals. The accumulation of dust and air-borne rubbish in gutters renders this latter measure necessary in any case, and sparrows' nests are often found in gutters or down pipes in dry weather.

3. Other Water Containers. In certain areas it will be noticed from the attached graphs and figures that there is a preponderance of garden-receptacles over other areas. A similar variation also exists as regards tanks. This condition is not so fortuitous as would at first seem; for in a crowded area where the poorer types of houses are to be found, houses which are built on a 16 square perch allotment, there is hardly room for such out-buildings as ferneries and bush houses. In consequence we do not expect to find many garden water-barrels or other such accessory sources of rain water supply. Again, the proportion of unscreened to screened tanks in these overcrowded and older parts of Brisbane is greater than that found in newer and more sparsely populated districts, where the better class of house prevails. While the presence or absence of garden receptacles forms a fairly good index of the type of locality, the prevalence of A.aegypti traceable to other breeding places must be regarded as a fortuity. For instance plagues of A.aegypti have resulted from neglected ant-stoppers under safes, both in the poorer and well-to-do classes of houses. The less obvious breeding places are sometimes overlooked. Thus in an investigation of a house and its environs - the owner of which complained of mosquitos which he asserted "came from a gully hole near by" - the water-seal of a disused acetylene gas generator and other receptacles were found to contain the cause of the invasion in the form of numerous eggs and larvae of A.aegypti. The plague of mosquitos complained of was obviously due to A.aegypti bred on the premises; investigation of the accused gully hole showed that it formed part of a watercourse, all of which abounded with larvivorous fishesm and that it was free of larvae.

4. Polluted Waters. Where these are present in an area there is always a superabundance of C.5-fasciatus. Polluted waters in the Metropolitan area generally occur as a result of sewers and drains discharging into small streams and gully holes, and are not found except in rather closely settled localities. In Sherwood, Belmont, Enoggera, Yeerongpilly and certain parts of Stephens, by reason of a sparse population per acre, contaminated watercourses are, as yet, absent.

Where people rely solely upon rain water collected in tanks for domestic supplies, watercourse pollution can seldom take place owing to the fact that the small quantities of water used (and therefore the corresponding amount of sewage) may easily be disposed of, without nuisance on the land immediately surrounding the premises. It is only in the case of a pipe-borne water supplied district in an unsewered or partially sewered area, that the formation of contaminated waters on any large scale is possible. Examples of polluted water courses are found on the town side of Stephens area, Coorparoo, Brisbane, Ithaca, Toowong, Windsor, Balmoral, and South Brisbane.

Watercourse pollution literally means the artificial selection of Culex 5-fasciatus as the dominant domestic mosquito -- a condition following on the banishment of all natural enemies of mosquito-larvae.

Not only sewers and house drains but industrial wastes (such as those emanating from tanneries) must be considered as sources of contamination which lead to this result.

In the pollution of waters by sewage almost all living organisms are expelled save a few species of the putrefactive Bacteria and Fungi which have the faculty of living in very crude sewage. It is only by the natural processes of sedimentation, oxidation and by biological means that a polluted watercourse can purify itself sufficiently to allow fish to live in it again, but generally speaking the streamlet is too short, or self-purification is only effective after the waters pass away from habitation.

The case of the Victoria Park watercourse, Brisbane, is interesting as being a place where myriads of C.5-fasciatus are produced, in the near vicinity of a large General Hospital where cases of filariasis are frequently under treatment. It would be interesting to secure data in connection with a possible Filarial endemicity of the population of Herston and Bowen Hills - localities immediately surrounding the Brisbane General Hospital.

5. Septic Tanks. Several septic tanks were examined but were found to be practically mosquito proof, excepting in the case of Wattlebrae Hospital Septic tank, Herston (Brisbane), where a few larvae of C.5-fasciatus were noticed in the anaerobic chamber. The effluent pipe was eaten through by sewer gases, having thus afforded a ready means of ingress and egress of mosquitos.

6. Street Gully traps contribute very freely towards the breeding of C.5-fasciatus in sewered localities.

7. Salt marshes and pools. The more extensive salt marshes in Brisbane have gradually disappeared in recent years. The expansion of the City has necessitated a large amount of swamp reclamation especially in the way of filling. There are however, several smaller pools and marshes in and around Brisbane, the filling and draining of which should be expedited. The outlying areas of Brisbane show some very extensive salt marshes, of which those about NudgeeCollege, Sandgate, Hay's Inlet, the Kippering, and Lytton have already been dealt with in detail.

8. Clean Natural Waters. As these constitute the chief breeding places for Anopheles (Nyssorhynchus) annulipes, and as they are invariably stocked with fish, their role in mosquito reduction work is of no importance except occasionally when an overgrowth of aquatic vegetation (water Hyacinth) acts as a mechanical obstruction and bar to the activities of larvivorous fishes. In certain areas as Ekibin (Stephens), Kelvin Grove (Ithaca), Nundah (Toombul), and Windsor the increase in water Hyacinth is instrumental in favouring the propagation of A.(N.)annulipes.

8. SUGGESTED MEASURES OF CONTROL.

A campaign for the reduction of disease-bearing species of mosquito and certain feral species would require to apply its efforts in three directions, viz., (a) against the essentially domestic and disease-bearing forms, (b) against the polluted-water-breeding (and also disease-bearing) species, and (c) against the salt-marsh breeding species.

(A). MEASURES AGAINST THE STRICTLY DOMESTIC SPECIES -CHIEFLY AEDES AEGYPTI AND TO A CERTAIN EXTENT CULEX 5-FASCIATUS.

Systematic house-to-house inspection. In active anti-mosquito work a special house-visitation party should systematically inspect the areas under control. The chief object would be, first of all, the location of household mosquito breeding places especially tanks, roof gutters,

water-holding receptacles etc. During the inspection, where necessary, notices of default under Part II of The Mosquito Prevention and Destruction Regulations of 1921 should be served on the occupier and owner, and at the same time specific directions as to how to rectify the nuisance should be given in writing.

Part I, para.3 of the aforementioned Regulations requires that the Local Authority shall enforce measures against mosquito-breeding.

Tanks should be screened with brass, copper, or bronze wire gauze not coarser than 18 meshes to the inch each way, and care should be taken to see that the screening of the overflow is not overlooked. The mesh of the gauze used is a matter which should be kept under close observation, and Brisbane plumbers could with advantage be notified officially of the liability of error from merely measuring in one direction, a given piece of gauze. Measurements should be made in two directions, at right angles, as the distance of the wires is liable to vary. Power should also be available to authorise Inspectors to measure any gauze or device advertised or exposed for sale as suitable for mosquito-proofing tanks or other water receptacles, and to prevent the sale of any which does not conform with the prescribed measurements and requirements.

The screening of wells is perhaps best undertaken by building over the shaft a wooden gird over which a flooring of boards may be laid. By continuing the brick or concrete shaft up a few inches above ground-level, white-ants may be prevented in the ordinary manner by intercepting the posts from the ground by a layer of sheet galvanized iron. The joints of the boards could be caulked with pitch or the whole wooden structure asphalted over. Care must be taken however, to provide screened air inlets; a manhole covered by a hinged flap may be supplied with advantage.

Roof gutters should be inspected regularly, especially after rain. Mosquito breeding in roof gutters takes place readily in houses overhung by foliage, especially during rainy seasons. As has been already indicated, however, there is no need to destory trees in general. The cutting away of over-hanging foliage will secure the desired result and is perhaps the most practical method of preventing the blocking of gutters. In certain cases gutters may require regarding. In new houses steps should be taken to secure proper grading during construction.

Barrels. (either of liquid manure or of rain water) may be screened by a piece of bagging secured over the top by hoop iron. The bagging may always be renewed at little or no cost. Liquid manure barrels are perhaps the chief breeding places of household origin for C.5-fasciatus.

Ornamental Ponds, except in rare instances are usually well stocked with Japanese gold fish or indigenous fish. The Australian Crimson Spotted Sun Fish (Melanotaenia nigrans (Richardson)) which has a fairly wide range in the southern portion of Australia generally, is a species which not only presents a pleasing sight, but devours mosquito larvae with avidity. It can always be obtained from any fresh water streamlet about Brisbane and after acclimatising to artificial conditions will live in an aquarium for many years.

The strictly domestic utensils which hold water (viz., neglected bedroom water-jugs, flower-pot saucers, saucers under the legs of food-safes, flower cases etc. etc.) are places which can never be dealt with in practice except by individual householders.

Systematic educational propaganda should never be lost sight of, and reminders should be given through the press from time to time, calling the attention of householders to their indispensable share in anti-mosquito work.

(B) MEASURES AGAINST SPECIES BREEDING IN POLLUTED WATERS, SOLELY AGAINST C.5-fasciatus.

Apart from minor breeding places (liquid-manure barrels, cesspools, septic tanks, water seals of acetylene gas-generators etc) which occur about houses, the chief source from which come the nocturnal mosquitos biting indoors in Brisbane, is polluted water. Municipal engineers in the past have failed to realise the seriousness of making a sewer empty its contents into the first watercourse with which it comes in contact. It is hoped that with the introduction of the Brisbane sewage scheme all polluted water courses will be cleared of contamination and thus be reconverted into their original form of natural streamlets abounding with fish. Until this work is accomplished, Brisbane mosquito work in connection with the reduction of C.5-fasciatus must remain as a series of compromises, and very much in the position of throwing good money after bad.

It is understood that Victoria park sewage course will probably be sewered in the near future, the outfall being Breakfast Creek. Attention should be chiefly directed to the peripheral areas of greater Brisbane,

areas which are now being settled on and which having been connected with a piped water service, are about to divert their sewage into the nearest water courses (e.g., Ekibin).

Tanneries. The time has come when no Local Authority in the Metropolitan District can safely proclaim part of its area as a noxious trade district. The residential growth of such areas as Toowong, Coorparoo, Ithaca, Windsor, Kedron or Taringa already scarcely permits the working of these trades without risk of continuance of the mosquito nuisance to large numbers of persons. From the standpoint of mosquito-reduction work, the essential attributes of a district suited to the continuance and development of these trades are, (a) that there should be a sufficient (and necessarily large) area of land available for each tannery, wool scour, etc. by which successful ~~treatment~~ land treatment of sewage may be effected; (b) that in the ansence of an extensive land area, there should be a large body of water into which effluents of the noxious trade establishments may be emptied without nuisance, (c) that for land treatment, the soil should be permeable; and (d) that pollution of the watercourses is entirely prevented.

Many square miles of land exist about the mouth of the Brisbane River which might be adapted to the development of a noxious trade area. The special advantage of having tanneries, wool scours, fellmongeries etc. about the mouth of a river is that there is always available a large volume of tidal water into which the trade effluents can discharge after preliminary treatment. With modern methods of dealing with trade wastes and trade fumes, no aesthetic objections need arise if this area were used.

The rapid growth and centrifugal migration of population, the small and scattered areas of land at present devoted to noxious trades and the obviously bad results of discharging sewage into watercourses, are arguments pointing to the need for discontinuance of the present system. The problem is a very large one, however, and must include, now or eventually, the question of permitting the continuance of existing trades of this class in the localities which they now occupy. From the experience of Sydney and Melbourne in the same connection it would appear wise to make a vigorous effort to settle it at the present stage of city development, as, whatever questions of compensation may arise today, will be magnified with each succeeding year.

Septic tanks. Whenever, as in the case of non-development of the surface-scum, - the anaerobic chambers or well syphons of septic tanks are observed to breed mosquitos, all the openings, intercepting traps, vent shafts, and man hole covers, should be screened, or rendered with close fitting joints as circumstances require. Wattlebrae Hospital septic tank might be made mosquito proof by repairing the effluent pipe. Septic tanks should be inspected from time to time especially after they have been cleaned out, when their liability to constitute mosquito breeding places is greatest.

Street Gully Traps. These should be petrolised once a week. The most economic method, however, is to fit an automatic oil-dropping can, hung over the water seal. The can may be regulated by a miniature stop cock to discharge a drop, say once every five minutes. A can of two or three quarts' capacity, under these conditions, would require refilling with oil only once a month or even every two months.

The use of flap-valves to gully traps is effective in countries where labour is had very cheaply, and where a gang of men is constantly employed in supervising, and in the prevention of accumulation of debris under the valves. It is improbable that any valve of this type would give satisfaction under the conditions in Brisbane. Attention is, however, being given by the Australian Institute of Tropical Medicine to the question of a mosquito-proof pattern of street gully-trap based on other principles, and the problem is not an insoluble one.

(C) MEASURES AGAINST THE SALT-MARSH BREEDING SPECIES.

Aedes (Ochlerotatus) vigilax, Culex sitiens and Mucidus alternans. The salt marsh land which occurs about Albion, Hamilton, Swan Hill (Windsor), Herston, and Mayne (Brisbane), Norman Creek and Bulimba (Balmoral), Coorparoo (Coorparoo), and Milton and Toowong (Toowong), should be filled in and drained. When these areas are filled in it will be impossible for A.vigilax or its salt water confreres to breed in Brisbane or its immediate surroundings.

The larger outlying salt marshes in the areas of Wynnum, Toombul, Kedron, Sandgate, Caboolture, and Redcliffe are places which should receive earnest consideration. The complete drainage of them would not be possible by gravity alone on account of the low lying nature of the lands but, failing their conversion into agricultural or pastoral land by a regular engineering scheme in the manner already indicated, there is much to be done in the way of canalisation and in some cases the interception of seepage waters from hills and (for example, the Kippering and the upper parts of Lytton swamp), crow's foot drains should be adopted in

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conjunction with circumvallating ones. Where practicable, invert channels should be protected from wandering animals by fencing, a measure specially recommended for Norman Park (Balmoral).

The clearing of bush in the vicinity of salt marshes would undoubtedly destroy the harbouring places of the adult mosquitos but this is a measure which, used alone, is more or less fruitless. By itself it merely encourages migration.

Borrow Pits. The borrowing of earth, especially on race-courses, roads, and railway lines, is a measure which should be carefully controlled. Para.10 of The Mosquito Prevention and Destruction Regulations of 1921 provided that borrow-pitting shall not be done unless the excavation is filled with "clean, sound material, finishing off level with the surface of the surrounding ground". Where gravity drainage is possible the desired result could be effected by this means.

The borrow-pits sunk on the Albion Park Race Course, especially, and on the Doomben Park Course should be filled in and the process should not be allowed to continue by reason of the very flat and low lying nature of the ground.

(D). MEASURES AGAINST ANOPHELINES.

These are not of an extensive nature. Broadly speaking the matter resolves itself into one of assisting the small larvivorous fresh water fishes by clearing streamlets and fresh swamps of superfluous growths of vegetation - especially of Hyacinth - which prevent them from getting at the larvae. A man with a drag-hook and a horse could do some very beneficial work in clearing such waters as are found at Ekibin (Stephens), Nundah (Toombul), Kelvin Grove (Ithaca), Windsor (Windsor) and Chelmer (Sherwood).

LANCELOT E. COOLING.
11-5-1923.

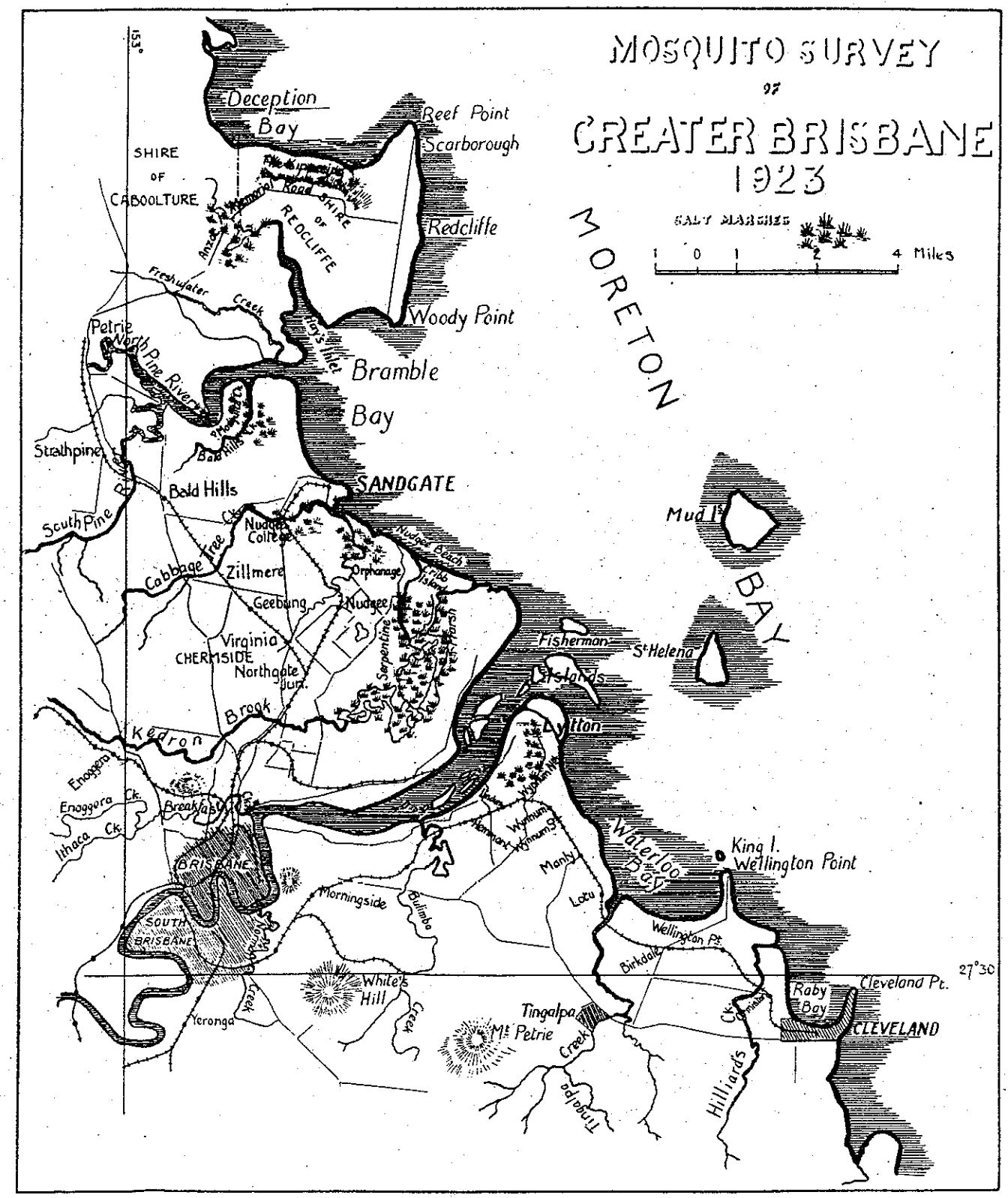
BRISBANE MOSQUITO SURVEY 1923.

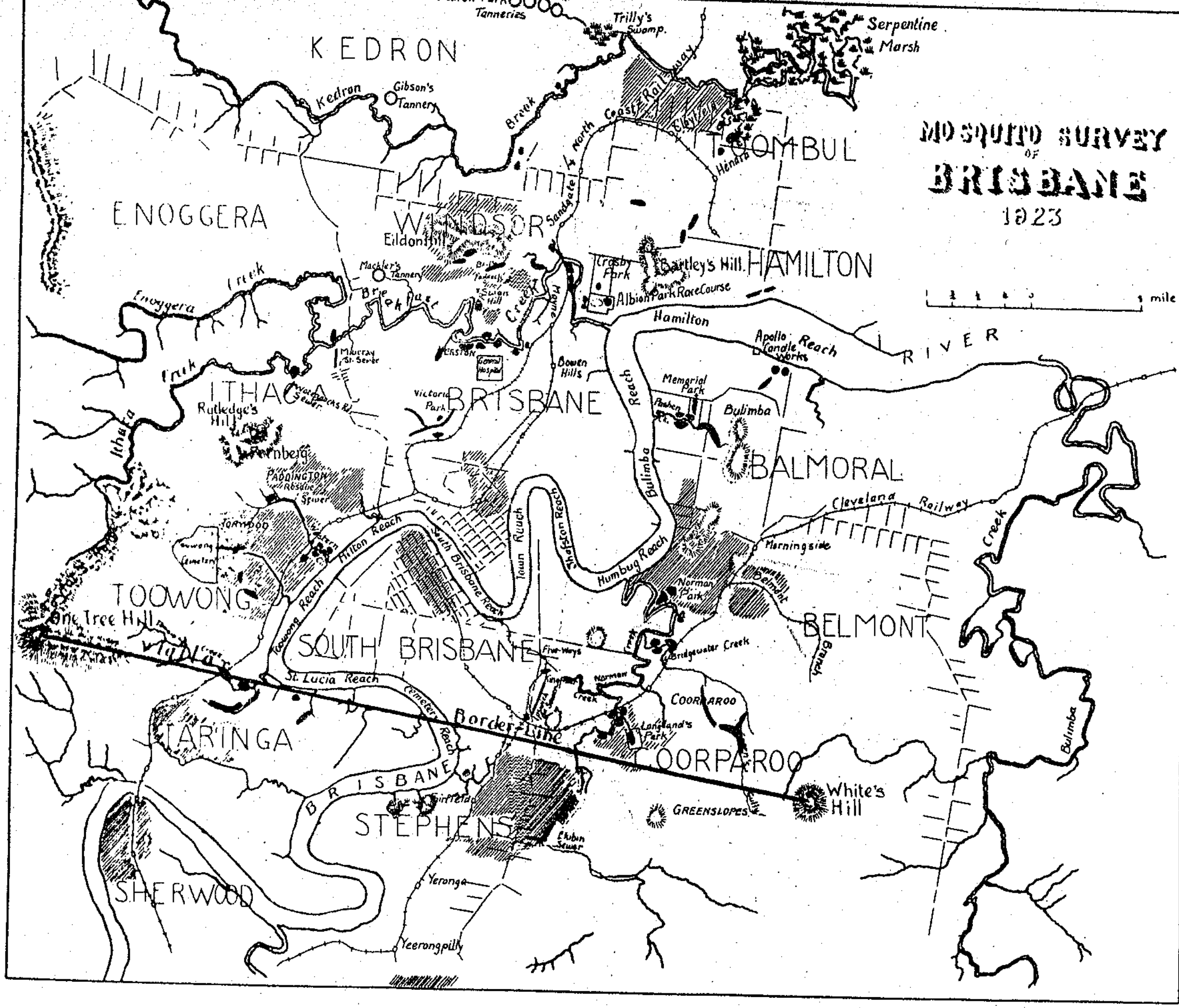
M A P S.

1. Distribution of Mosquito-breeding swamps and watercourses in Brisbane.

2. Distribution of salt marshes around Brisbane.

3. Detailed location of the various mosquito breeding places; areas covered by Stegomyia Survey Party. Boundaries of Local Authorities are approximately indicated in red.


MOSQUITO SURVEY
OF
GREATER BRISBANE
1923
SALT MARSHES
1 0 1 2 4 Miles
MORETON BAY
153°
27°30
Deception Bay
Reef Point
Scarborough
Redcliffe
Woody Point
Bramble Bay
SHIRE OF CABOOLTURE
SHIRE OF REDCLIFFE
Freshwater Creek
Petrie
North Pine River
Strathpine
South Pine R.
Bald Hills
SANDGATE
Nudgee College
Nudgee Beach
Orphanage
Cabbage Tree Ck
Zillmere
Geebung
Nudgee
Virginia
CHERMSIDE
Northgate Junc.
Serpentine Ck
Fisherman Islands
St Helena
Mud I.
Kedron Brook
Lytton
Enoggera
Enoggera Ck
Ithaca Ck
Breakfast Ck
BRISBANE
SOUTH BRISBANE
Morningside
Bulimba
Hawthorne
Wynnum
Wynnum Cr
Manly
Lota
Waterloo Bay
King I.
Wellington Point
Wellington Pt
Birkdale
Cleveland Pt.
Raby Bay
CLEVELAND
Tingalpa Creek
Mt Petrie
White's Hill
Yeronga
Hilliard's
Tingalpa



REFERENCE.

Salt Swamps breeding *Aedes (Ochlerotatus) vigilax*, or *Culex sitiens* (or both)

Polluted Streamlets, &c., breeding *Culex 5-fasciatus*, and occasionally *Lutzia halifaxi*.

Natural Waters (unpolluted, but overgrown with rank vegetation) breeding *Anopheles annulipes* and *Culex annulirostris* (or *Culex consimilis* Taylor).

Polluted Waters resulting from Tanneries, and breeding *C. 5-fasciatus*.

Boundaries of contiguous Local Authority Areas.

Areas covered by *Stegomyia* Survey Party.