

[Crown Copyright Reserved.]

WAR OFFICE.

OBSERVATIONS ON MALARIA.

BY

SEVERAL OFFICERS OF THE ARMY AND
OTHERS.

(Published December, 1919.)

Edited by

SIR RONALD ROSS, K.C.B., K.C.M.G., F.R.S., etc.,

Major, Indian Medical Service (*ret.*)

Temporary Colonel, Army Medical Service,

Consultant in Malaria, War Office.

LONDON:
HIS MAJESTY'S STATIONERY OFFICE.

Obtainable through any Bookseller or directly from

the Stationery Office at the following addresses:

LONDON, W.C. 2, and 28, ABINGDON STREET, LONDON, S.W. 1;

MANCHESTER, 1, ST. ANDREW'S CRESCENT, GARDEN

3, FORTH STREET, EDINBURGH;

AND SONBY, LTD., 118, GRAFTON STREET, DUBLIN.

1919.

Price 6/- net.

MILITARY BOOKS

Published by



Authority

LONDON:

PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE.

To be purchased through any Bookseller or directly from
H.M. STATIONERY OFFICE at the following addresses:
IMPERIAL HOUSE, KINGSWAY, LONDON, W.C. 2, and 28, ABINGDON STREET, LONDON, S.W. 1
37, PETER STREET, MANCHESTER; 1, ST. ANDREW'S CRESCENT, CARDIFF;
23, FORTH STREET, EDINBURGH;
or from E. PONSONBY, LTD., 116, GRAFTON STREET, DUBLIN.

(The prices in brackets are those at which the books are obtainable, post free, by Officers, Non-Commissioned Officers, and Men, in the manner prescribed by Appendix XXIII. of the King's Regulations and Orders for the Army, 1912. Applications should be made on Army Form L. 1372, and addressed to the Secretary, War Office, S.W. 1.)

ABYSSINIA. Expedition to. 2 vols. and maps. 1870. Half Morocco, £5 5s. Cloth, £4 4s.

ACCOUNTS. ARMY. See FINANCIAL INSTRUCTIONS.

AFRICA. Continent of. Geology of. Notes on. 1906. 3s. (2s. 4d.)

ALLOWANCES. ARMY. Regulations. 1914. (Reprinted 1918.) 9d. (9d.)
See also FIELD ALLOWANCE and PAY OF OFFICERS.

AMHARIC LANGUAGE. Short Manual of the. With Vocabulary. 1909. 5s. (3s. 6d.)

ANIMAL MANAGEMENT. 1908. (Reprinted 1918.) 2s. (1s. 9d.)

ANIMAL MANAGEMENT, &c. Catechism of. 1d. (1d.)
See also HORSES.

ARABIC GRAMMAR. Two parts. 1887. (Sold to Officers only.) 10s. (10s. 10d.)

ARMOURERS. Instructions for:—

Care, repair, browning, &c., of Small Arms, Machine Guns, "Parapet" Carriages, and for the care of Bicycles. 1912. (Reprinted, with Amendments, 1916.) 2s. 6d. (2s. 1d.)

Addendum, Jan. 1918. Care and repair of Rifles, Magazine, 303-inch Pattern. 1914. (In the press)

ARMY LIST. The Monthly. Officers on the Active List. (Publication was suspended during the War):—

Jan. 1919, and after. Each 5s. (4s. 1d.)

Quarterly Supplement. Officers Retired from the Active List; Victoria Cross; Orders of Knighthood; Foreign Orders; Soldiers' Balances Undisposed of; &c., &c. Jan. and after, 1919. Each 1s. (1s.)

ARMY LIST. The Quarterly (not issued in October, 1914). Each 15s.

ARMY ORDERS. Monthly. Each 3d. (3d.)

ARMY ORDERS. Covers for. 9d. (9d.)

ARMY REVIEW. Quarterly. July 1911 to Oct. 1914. (Vol. I., Nos. 1 and 2, out of print.) 1s. (Up to July 1914, 1s.; Oct. 1914, 11d.)
(Subsequent publication suspended)

ARMY SERVICE CORPS. See SERVICE.

ARTIFICERS. Military. Handbook. 10th edition. 1915. 9d.

ARTILLERY AT THE PICARDY MANŒUVRES in 1910. Translated from the French. 2s. 6d. (2s.)

ARTILLERY. Royal:—
Enginetakers. See that item.

Standing Orders for:—

Lieut.-Colonel's Command. R.G.A. (Coast and Siege). 1d. (1d.)

(B 14858) Wt. 20#29—632 5M 10/19 H & S

MILITARY BOOKS, published by Authority—continued

(As to prices in brackets, see top of page 2)

- Artillery Royal—continued.**
Training —
Field 1914 (Reprinted 1918) 1s (11d.)
Ditto Examples of Ranging (to supplement those given in Sec. 227).
2d (2a) (Under revision)
Garrison—
Vol I 1914 6d (6d.)
Vol II (Siege) 1911 (Reprinted, with Amendments, 1914) 9d (8d.)
Vol III 1911 (Reprinted, with Amendments, 1914). 1s (11d.)
ARTILLERY COLLEGE Reports upon the 14th to 18th Senior Classes
Each 1s (9d.) See also Ordnance College.
ARTILLERY INSTRUMENTS.—
Handbook of 1914. 1s 6d (1s 4d.)
Ditto Amendments 1d (1d.)
Ditto Addendum to 2d (2d.)
Ditto Appendix, Dec. 1915 (Periscopes, &c.); and Amendments to p 111
of the Handbook With Plates 1d. (1d.)
ARTILLERY MUSEUM in the Rotunda, Woolwich. Official Catalogue. 1906
(Sold at the Rotunda 1s. 6d.)
**ARTILLERY AND RIFLE RANGES ACT, 1885, and MILITARY
LANDS ACTS, 1892 to 1908** Byelaws under —
Aldburch, 1896, Ash (Aldershot Camp), 1887, Finborough, 1901, Hythe, 1894,
Inchkeith Battery, 1886, Kinghornness, 1896, Landguard, 1887, Lydd—
Lunenburg, 1895, Middlewick, 1890, Millbrook, 1888, Orchard Portman, 1896.
Scarborough, 1902, Scraps Gate, 1886, Shoeburyness, 1895, Southwold, 1896,
Strensall, 1900, Wash, 1891, Whitehaven Battery (Cumberland), 1896
Each 1d. (1d.)
Purfleet, 1911. 1s (9d.)
Salisbury Plain, 1900 4d. (4d.)
**ARTILLERY STORE ACCOUNTS AND THE CARE AND
PRESERVATION OF EQUIPMENT OF ROYAL ARTILLERY, HORSE,
FIELD, AND HEAVY BATTERIES** Notes on. Sept 1914 6d (5d.)
AUSTRIA CAMPAIGN OF 1866 AGAINST. See GERMANY
BARRACKS. Care of Instruction in 1901 9d. (7d.)
BASHFORTH CHRONOGRAPH Experiments with, to determine the resistance
of the air to the motion of projectiles Report on 1870 1s (9d.)
BERMUDA MILITIA ARTILLERY Regulations 1914 9d. (7d.)
BICYCLES. Military Handbook on 1911 (Reprinted, with Amendments, 1914).
1d (1d.)
BOUNTY TO SOLDIERS See FIELD ALLOWANCE
BRITISH MINOR EXPEDITIONS, 1746 to 1814. 1884. 2s 6d. (1s 11d.)
CADET LIST } See TERRITORIAL FORCE
CADET UNITS }
CAPE OF GOOD HOPE RECONNAISSANCE SURVEY, 1903-1911
Report on the 1s 6d (1s 1d.)
CASUALTY LIST, WAR OFFICE AND AIR MINISTRY WEEKLY,
commencing Aug 7, 1917 3d (3d.)
CAVALRY Technical Operations, Cavalry in an Army, Cavalry in Battle
Translated from the French of Captain Louv, XI Army Corps Staff With a
Preface by General Langlois With Maps 3s 6d. (2s 9d.)
CAVALRY OF THE LINE PEACE ORGANIZATION OF THE.
and Arrangements for Mobilization consequent on the establishment of Cavalry
Depots (Special A O, July 19, 1909) 1d. (1d.)
CAVALRY SCHOOL, NETHERAVON Standing Orders 1911 2d. (2d.)
CAVALRY TRAINING 1912 (Reprinted, with Amendments, 1915) 1s (11d.)
See also ITALIAN CAVALRY
CEREMONIAL 1912
Ditto Provisional Amendments, June 1914. (With Plates and Key) (Reprinting)
1918) 2d. (3d.)
CHEMISTRY. PRACTICAL. Quantitative and Qualitative. A Course of
5s (3s 8d.)
CHIROPODY. Manual of 2d (2d.)

MILITARY BOOKS, published by Authority—continued.

(As to prices in brackets, see top of page 2.)

- CLOTHING AND NECESSARIES** (including Materials). Priced Vocabulary of 1915 Provisional 1s (11d.)
- Ditto. Amendments, Jan., April, Aug., Nov. 1916, Feb., April, Dec. 1917, March, Nov. 1918; Jan. 1919 Each 1d. (1d.)
- CLOTHING Regulations**—
- Part I. Regular Forces (excluding the Special Reserve). 1914 6d. (6d.)
- Part II. Special Reserve. 1914. 3d. (3d.)
- COLCHESTER GARRISON.** Standing Orders. 1913. 9d. (7d.)
- COMMANDS, Military, and Staff in the United Kingdom** Reorganization of (Special A O), Jan. 6, 1905, with alterations to date Issued with Special A O., Nov. 11, 1907) 8d. (3d.)
- COMPANY TRAINING** Notes on For the use of the Special Reserve Territorial Force, and newly-raised Units of the Regular Army Sept. 1914. 1d. (1d.)
- COOKING AND DIETARY.** Military. Manual of 1918 6d. (6d.)
- COOKING.** Military Manual of 6d. (5d.)
- COST ACCOUNTING SCHEME FOR 1919—20** Provisional Instructions relating to Part I For the guidance of Staff, Regimental and Departmental Officers at Home. 3d. (3d.)
- CREWS OF WAR DEPARTMENT VESSELS AND BOATS AT HOME STATIONS** Regulations for the Appointment, Pay, and Promotion of. 1911 2d. (2d.)
- CYCLIST TRAINING.** 1917 Provisional. 6d. (5d.), Amendments, Aug. 1918 1d. (1d.)
- DEMOBILIZATION.** Army. Regulations:—
- Part I. With Diagram showing Method of Dispersal, and Map of Dispersal Stations and Areas in the United Kingdom 1s. 6d. (1s. 7d.)
- Part II. With Plan of Hutment Lines showing suggested Appropriation of Buildings for use as a Dispersal Station, and Map of Dispersal Stations and Areas in the United Kingdom 6d. (6d.)
- Part III
- Ditto Chap XXIV Labour Units 2d. (2d.)
- Ditto Chap XXV, Part 1 Dispersal of Officers of the Army Chaplain's Department. 1d. (1d.)
- Ditto Chap XXV, Part 2 Ordnance Services 2d. (2d.)
- Ditto Chap XXVI Q M A A C. 2d. (2d.)
- Ditto Chap XXVII Animals 3d. (3d.)
- Ditto Chap XXXII The Volunteer Force. 2d. (2d.)
- Ditto Chap XXXIII British West Indies Contingents 2d. (2d.)
- Addenda to Chap. V. Special Registration 1d. (1d.)
- Amendments —
- Nos. 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, 15, and 16 Each 1d. (1d.)
- To Parts I. and II. 1d. (1d.)
- DISABLED AND DISCHARGED SOLDIERS IN FRANCE.** Training and Treatment of Report by Sir Henry Norman, Bart., M.P., Liaison Officer of the Ministry of Munitions to the French Ministry of Inventions. 4d. (4d.)
- DISEASES, MEDICAL, IN THE TROPICAL AND SUB-TROPICAL WAR AREAS.**—Memoranda on. 1919. (With Plates, Diagrams, Text-figures, and Index) 2s 6d. (2s.)
- DRAINAGE MANUAL.** For the use of Royal Engineer Officers, and other persons, employed on the Construction and Maintenance of Drainage Works in connection with War Department Buildings in the United Kingdom or in similar climates Revised edition, 1907. (Reprinted 1915) 6s. (4s 4d.)
- DRAWING PLATES.** Military—
- Attack of Dufour's Countermine or 2nd plate of Mines, Canon's First System, Detached Forts, Concealed Defences, 1, 2, 3, 4, Printing Plate, A, B, C, &c.; Detail Plate, No 1, Do, No. 2, Neighbourhood of Woolwich, Village and Surrounding Ground Each 2d. (2d.)
- Attack of Fortress—Preliminary Operations, Do, Distant Attack; Do, Close Attack, Neighbourhood of Metz Each 3d. (3d.)
- Neighbourhood of Woolwich. Southern Side 1s 6d. (1s 1d.)
- Woods and Villages 6 plates Each 6d. (5d.)
- DYNAMICS** Notes on. See ORDNANCE COLLEGE,

MILITARY BOOKS, published by Authority—continued

(As to prices in brackets, see top of page 2)

- EGYPT BRITISH FORCE IN.** Standing Orders 1912 1s (10d)
- EGYPT CAMPAIGN OF 1882 IN.** Military History With Case of Maps Condensed Edition 1908 3s 6d (2s 8d)
- EGYPTIAN EXPEDITIONARY FORCE** Record of the Advance of the. *(In the press)*
- ELECTRICAL COMMUNICATIONS FIXED** Instructions as to 1912 (Reprinted, with Amendments, 1916) 4d. (4d)
- ELECTRICITY** Notes on 1915 1s (11d) *(Under revision)*
- ELECTRIC LIGHT APPARATUS. DEFENCE.** Instructions for the Working of 1915 1d (1d)
- ELECTRIC LIGHTING** Military Vol I 1s (11d), Vol II 1909 (Reprinted, with Amendments, 1915) 1s 6d (1s 4d), Vol III 1s (11d)
- ENCOUNTER THE BATTLE OF.** By Hans von Kriesling Part I Practical Translated 1s 6d (1s 3d)
- ENGINEER SERVICES** Regulations. Peace —
Part I 1910 (Reprinted with Amendments published up to May 1, 1915) 1s (11d)
Part II 1911 Technical Treatises (Reprinted, with Amendments to May 1, 1915) 9d (8d)
- ENGINEER TRAINING** 1912 (Reprinted, with Amendments, 1914) 6d. (6d)
- ENGINEERING** Field. Manual of 1911 9d (9d)
- ENGINEERING. Military** —
Part I Field Defences 1908 1s 6d (1s 3d)
Part II Attack and Defence of Fortresses 1910 9d (8d)
Part IIIa Military Bridging—General Principles and Materials 1913 1s (11d)
Ditto Ditto—Ditto Index to 1d (1d)
Part IIIb Ditto—Bridges 1914 (Reprinted 1918) 2s (1s 8d)
Part IV Mining and Demolitions 1910 (Reprinted, 1915, with Amendments to 1912 inclusive). 1s (11d)
Part V Miscellaneous 1914 1s (11d)
Part VI Military Railways 1898 *(Out of print)*
- ENTRANCE ARMY.** Regulations —
R M Academy Admission to, and for First Appointments therefrom to the Royal Artillery and Royal Engineers *(Under revision)*
R M College Admission to, and for First Appointments therefrom to the Regular Army *(Under revision)*
Military Forces of the Self-governing Dominions and Crown Colonies Officers of the 1912 1d (1d)
Militia and Imperial Yeomanry (Officers of 1907 1d (1d)
Special Reserve of Officers, Malta Militia, Bermuda Militia, Channel Islands Militia, and Territorial Force Officers of the 1912 1d (1d) *(Issue suspended)*
University Candidates, 1912 1d (1d)
Warrant Officers and NCO of the Regular Army **Combatant Commissions as Second Lieutenants** 1914 Provisional 1d (1d)
See also MEDICAL CORPS
- EQUIPMENT. INFANTRY** Pattern 1908 Web 1913 2d. (2d)
See also VALISE EQUIPMENT
- EQUIPMENT** Regulations —
Part 1 1912 (Reprinted, with Amendments published in Army Orders up to Aug 31, 1914) 1s (11d)
Part 2 Details —
Section
- | | | |
|---|---------------------------|------|
| I Infantry (Regular Army) | Section. | |
| 1913 (Reprinted, with Amendments published in Army Orders up to Dec. 31 1915) 6d (5d) | Ia Mounted Infantry | 1912 |
| | 6d (5d) | |
| | II Cavalry (Regular Army) | |
| | 1914. 3d. (3a) | |

MILITARY BOOKS, published by Authority—continued.

(As to prices in brackets, see top of page 2)

Equipment Regulations—continued

Part 2 Details—continued.

Section

- III Army Service Corps (Regular Army) 1913 (Reprinted, with Amendments published in Army Orders up to Dec 31, 1915) 6d (6d)
- V Royal Army Medical Corps (Regular Army) 1914 2d (2d)
- VI-IX R M Academy, R M and Staff Colleges, Garrison Staff and Schools of Instruction, Military Prisons, Detention Barracks and Military Provost Staff Corps (Regular Army) 1914. 2d. (2d.)
- Xa Engineer General Fortress Survey, Railway, and Depot Units Peace and War (Regular Army) 1914 2d (3d.)
- Xb Field Troop (Regular Army) 1912 2d. (2d.)
- Xc Field Company (Regular Army) 1914 2d. (2d)
- Xd Divisional Signal Company (Regular Army) 1914. 2d (2d.)
- Xe Signal Company (Wireless) (Regular Army) 1912. 2d (2d)
- Xf Headquarters Signal Units (Regular Army). 1914. 2d (2d.)
- Xg Signal Company (Cable) (Regular Army). 1912 2d (2d)
- Xh Signal Squadron (Regular Army) 1914. 2d. (2d.)
- Xj Signal Troop with Cavalry Brigade (Regular Army) 1912 2d (2d)
- Xk Signal Troop with a Cavalry Brigade not allotted to a Cavalry Division (Regular Army). 1914. 2d (2d.)
- Xl Signal Company (South Africa) (Regular Army) 1912 2d (2d.)
- Xm Bidding Train (Regular Army). 1912. 2d. (2d)

Section

- Xn Field Squadron (Regular Army) 1914 2d (2d.)
- Xia Horse Artillery Q F 13-pr (Regular Army) 1913 9d (8d.)
- Xib Field Artillery Q F 18-pr (Regular Army) 1914 9d (8d.)
- Xic Ditto Q F 45-in Howitzer (Regular Army) 1913 (Reprinted, with Amendments up to Aug 1, 1914) 9d (8d)
- Xid Reserve Brigades with Q F 18-pr Equipment, Horse and Field Artillery Staff and Depots, Riding Establishment, School of Gunnery (Horse and Field) and Mounted Band (Regular Army) 1914 6d (6d)
- Xie Mountain Artillery with B L 270-in Equipment Mountain Battery and Ammunition Column Mule Transport (Regular Army) 1914 Provisional 6d (6d)
- XIia Royal Garrison Artillery (Regular Army) 1914 2s 6d (1s 11d)
- XIib Royal Garrison Artillery, Siege Artillery Movable Armament and Machine Guns in Armaments 1913 1s (10d)
- XV. Camel Corps School Egypt (Regular Army) 1914 1s (2d)
- XVI Special Reserve 1913 4d (4d)
- XVII Officers Training Corps 1912 3d (3d)
- Practice Batteries and Drill Guns (Fixed Mountings) of the Royal Garrison Artillery (Part 2, Sections XIa and XVI and Part 3) 1909 1s 6d (1s 2d)

Part 3 Territorial Force 1914. 6d (6d)

Ditto Details —

Sec IX. Artillery 1912

Ditto Amendments, April 1912, Feb 1914 Each 1d. (1d.) (Out of print)

Sec X Engineer 1912 3d (3d.)

Amendments to Part 1 Feb 1916 1d (1d)

Amendments to Part 2 Feb, July (two issues), Aug 1914 Each 1d (1d)

Amendments to Parts 1, 2, and 3 Nov 1913 1d (1d)

Amendments to Parts 1, 2, and 3 March, July 1913, April, Aug 1914 Each 2d. (2d)

Continued.

of page 2.)

of which the dates are omitted

- March 1906; Sept. 1909; March, Sept. 1910;
Each 6d. (5d.)
I.M. College, Qualifying Test for Commissions
(1d.)
Entrance: R.M. Academy; R.M. College; Indian Army College, Wellington.
Supplementary First Appointments in the Royal Marines. Appointments in
the India Police Force. Appointments in the Police Force of Ceylon. Cadet-
ships in the Royal Navy (Special Entry). June-July 1915. 1s. (11d.)
Entrance: R.M. Academy; R.M. College; Indian Army College, Wellington.
Nov.-Dec. 1915. 1s. (10d.)
Entrance: R.M. Academy; R.M. College; Indian Army College, Wellington.
Supplementary First Appointments in the Royal Marines. Cadetships in the
Royal Navy (Special Entry). June-July 1916. 1s. (1s.)
Entrance: R.M. Academy; R.M. College; Indian Army College, Quetta. Nov.
1916. 1s. (1s.)
Entrance: R.M. Academy; R.M. College; Indian Army College, Quetta. Cadet
ships in the Royal Navy (Special Entry). March 1918. 6d. (6d.)
Freehand Drawing at the Army Entrance Examination of Nov. 1913. Specimen
Paper to illustrate the kind of questions that will be set in. 6d. (3d.)
R.M. Academy, Fourth Class; R.M. College, Fourth, Third and Second Divisions,
July, Dec. 1904; June 1905. Each 1s.
R.M. Academy, Fourth Class; R.M. College, Senior Division. Dec. 1905;
June, Dec. 1906; July, Dec. 1907. Each 1s.
Staff College. Admission. Aug. 1909; July 1911; June-July 1912; June-July
1913. Each 1s. (6d.)
Officers for Promotion. Dec. 1912; Dec. 1913; April 1914. Each 1s. (6d.)
Militia, Imperial Yeomanry, and University Candidates. March 1904; Sept. 1905;
Oct. 1906. Each 1s.
Special Reserve, Militia, Territorial Force, and University Candidates. Oct.
1911; March, Oct. 1912; March, Oct. 1913. Each 1s. (6d.)
Special Reserve, Militia, Territorial Force, Non-Commissioned Officers, and
University Candidates. March 1914. 1s. (6d.)
Officers Training Corps:—
Cadets of the Senior Division. Certificate A. Dec. 1908. 6d. (5d.)
Cadets of the Junior and Senior Divisions. Certificates A and B. Spring of
1909; May, Nov. 1911; March, Nov. 1912; March 1914. Each 6d. (6d.)
Foreign Languages. Modern. Jan., June, Oct. 1910; Jan. 1911; June 1912; June
1913. Each 1s. (6d.)
FAMILY ALLOWANCE. See PAY FOR SOLDIERS and SEPARATION ALLOWANCE.
FIELD ALLOWANCE to the Commander of an Army and to the Commander of an
Army Corps or Group of Divisions; **Promotion of Lieutenants of the Army**
Veterinary Corps, Special Reserve, and Territorial Force; **Bounty to Soldiers.**
Special Army Order, June 20, 1916. 1d. (1d.)
FIELD ALMANAC. 1918. 1d. (1d.)
FIELD SERVICE MANUALS:—
Ammunition Column. Divisional. New Armies. 1915. 3d. (3d.)
Artillery. Heavy (B.L. 60-pr.) Battery and Ammunition Column. Expeditionary
Force. 1916. 3d. (3d.)
Ditto. Horse. Brigade. 13-pr. Q.F. 1908. 3d. (3d.)
Cavalry Regiment. Expeditionary Force. 1913. 3d. (3d.)
Engineers. Bridging Train. Expeditionary Force. 1915. 3d. (3d.)
Ditto. Field Company. Expeditionary Force. 1915. 3d. (3d.)
Ditto. Field Squadron. Expeditionary Force. 1914. 3d. (3d.)
Ditto. Works Company. Expeditionary Force. 1910. 3d. (3d.)
Headquarters Units. Expeditionary Force. 1911. 3d. (3d.)
Infantry Battalion. Expeditionary Force. 1914. 3d. (3d.)
Infantry (Mounted) Battalion. Expeditionary Force. 1913. 3d. (3d.)
Medical Service. Army. Expeditionary Force. 1914. 3d. (3d.)
Signal Service. Signal Company (Air Line). Expeditionary Force. 1913.
3d. (3d.)
Ditto. Ditto. (Cable). Expeditionary Force. 1913. 3d. (3d.)
Ditto. Ditto. (Divisional). Expeditionary Force. 1915.
3d. (3d.)

(As to pri

FIELD SERVICE POCHE

1916). 1s. (11*d.*); Addendum No. of the Dead. 1*d.* (1*d.*)

FIELD SERVICE REGULATIONS:—

Part I. Operations. 1909. (Reprinted, with
Part II. Organization and Administration. 1909.
Amendments to Oct. 1914). 1s. (10*d.*)

with

Ditto. Amendments, April 1915. 1*d.* (1*d.*)

Ditto. Addendum, Jan. 1917, for the Guidance of Troops operating in F and Belgium. Duties and Responsibilities of the Quartermaster General, the Director-General of Transportation, and the G-Officer Commanding Lines of Communication Area. 1*d.* (1*d.*)

Ditto. Additions and Corrections, March 1917. Duties and Responsibilities of the Engineer-in-Chief, and of Chief Engineers, &c. 1*d.* (1*d.*)

(In the

FINANCIAL INSTRUCTIONS IN RELATION TO ARMY ACCOUNTS

1910. (Reprinted, with Amendments to Oct. 1, 1917.) 6*d.* (5*d.*)

FIRE MANUAL, ARMY. 1918. 2*d.* (3*d.*)

FLYING CORPS, ROYAL. Training Manual:—

Part I. 1914. Provisional. 1s. (10*d.*)

Ditto. Amendments, Jan. 1915. 1*d.* (1*d.*)

FOREIGN LANGUAGES. STUDY OF. Regulations. 1913. 2*d.* (2*d.*)

FOREIGN PRESS. Supplements to the Daily Review of the:—

Economic. Fortnightly, commencing with that of Aug. 20, 1918, to Aug. 12, 1919. Each 6*d.* (6*d.*)

Medical (compiled by the Medical Research Committee). Monthly, commencing with that of June 1918, to April, 1919. Each 1s. (10*d.*)

Reconstruction. Fortnightly, commencing with that of Aug. 13, 1918, to July 30, 1919. Each 6*d.* (6*d.*)

Technical. Fortnightly, commencing with that of May 28, 1918, to Aug. 4, 1919. Each 6*d.* (6*d.*)

Index to the Economic and Reconstruction Supplements, May to Nov. 1918. 1s. (11*d.*)

Index to the Medical Supplement. Vol. I. Jan. to Dec. 1918. 1s. (10*d.*)

Ditto. Vol. II. Jan. to April 1919. 1s. (10*d.*)

Index to the Technical Supplement, Vol. II, July to Dec. 1918. 6*d.* (6*d.*)

Political. Vol. 7. Weekly:—

Section 1. Central Europe. 6*d.* (6*d.*)

(Out of print)

Ditto 2. East and North-East Europe. 6*d.* (6*d.*)

(Out of print)

Ditto 4. Western Europe. 6*d.* (6*d.*)

(Out of print)

Ditto 5. America and the Pacific. 6*d.* (6*d.*)

(Out of print)

FORTIFICATION PERMANENT. For the Imperial Military Training Establishments and for the Instruction of Officers of all Arms of the Austro-Hungarian Army. 7th Edition. Translated. 4s. (2s. 11*d.*)

FRANCE. DISABLED AND DISCHARGED SOLDIERS IN. See DISABLED.

FRANCO-GERMAN WAR, 1870-71. Translated from the German Official Account:—

First Part—History of the War to the Downfall of the Empire—

Vol. 1 (Secns. 1 to 5). Outbreak of Hostilities to Battle of Gravelotte.

(Out of print)

Vol. 2 (Secns. 6 to 9). Battle of Gravelotte to Downfall of the Empire.

(Out of print)

Second Part—History of the War against the Republic—

Vol. 1 (Secns. 10 to 13). Investment of Paris to Re-occupation of Orleans by the Germans. £1 6s. (18s. 6*d.*)

Vol. 2 (Secns. 14 to 18). Events in Northern France from end of Nov. In North-west from beginning of Dec. Siege of Paris from commencement of Dec. to the Armistice. Operations in the South-east from middle of Nov. to middle of Jan. £1 6s. (19s.)

Vol. 3 (Secns. 19 and 20). Events in South-east France from middle of Jan. to Termination of Hostilities. Rearward Communications. The Armistice Homeward March and Occupation. Retrospect. £1 11s. 6*d.* (£1 2s. 3*d.*)

{Crown Copyright Reserved.

OBSERVATIONS ON MALARIA.

BY

**MEDICAL OFFICERS OF THE ARMY AND
OTHERS.**

(Published December, 1919.)

Edited by

SIR RONALD ROSS, K.C.B., K.C.M.G., F.R.S., etc.,
Major, Indian Medical Service (*ret.*),
Temporary Colonel, Army Medical Service,
Consultant in Malaria, War Office.

LONDON
PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE

To be purchased through any Bookseller or directly from
H M STATIONERY OFFICE at the following addresses
IMPERIAL HOUSE, KINGSWAY, LONDON, W C 2, and 28, ABINGDON STREET, LONDON, S W 1;
37, PETER STREET, MANCHESTER, 1, ST ANDREW'S CRESCENT, CARDIFF,
23, FORBES STREET, EDINBURGH,
or from E PONSONBY, LTD., 116 GRAFTON STREET, DUBLIN

1919

Price 6/- net.

✓ CONTENTS.

	PAGE
PREFATORY NOTE By Lieutenant-General Sir John Goodwin, KCB, CMG, DSO, KHS, Director-General, Medical Services, War Office	3
I REPORT ON THE EXCRETION OF QUININE IN URINE By M Nierenstein, DSc, PhD, FCS, Staff-Sergeant R A M C	4
II EXPERIMENTS ON THE COMPLEMENT FIXATION IN MALARIA WITH ANTIGENS PREPARED FROM CULTURES OF MALARIA PARASITES (<i>P Falciparum</i> AND <i>P Vivax</i>) By J Gordon Thomson, MA, MB Ch B, Captain R A M C (TC)	80
III. PRACTICAL NOTES ON MOSQUITO SURVEYS OF CAMPS AND BARRACKS DURING 1917 AND 1918 By A C Parsons, MRCS, LRCP, DPH, Captain R A M C (TC)	95
IV REPORT ON THE TREATMENT OF MALARIA-INFECTED TROOPS IN FRANCE By J Dalrymple, CMG, OBE, LRCP, LRCS, Lieutenant-Colonel R A M C (TC)	132
V A SHORT REPORT ON THE ANTI-MALARIA CAMPAIGN AT TARANTO DURING 1918 By Colonel J C Robertson, CMG, CIE, MB, CM, IMS	149
VI. REPORT ON INDIGENOUS MALARIA AND ON MALARIA WORK PERFORMED IN CONNECTION WITH THE TROOPS IN ENGLAND DURING THE YEAR 1918 By Angus Macdonald, OBE, MD, DPH, DTM., Major R A M C (TC)	178
VII OBSERVATIONS ON THE PATHOLOGY AND TREATMENT OF MALARIA By R. W Harold Row, BSc, FLS, FZS	259
VIII SOME OBSERVATIONS ON THE MALARIA PARASITES UNDER THE INFLUENCE OF VARIOUS DOSES OF QUININE ADMINISTERED ORALLY ENUMERATIVE METHODS EMPLOYED By T Gardner, MD, Captain R A M C (TC)	299
ADDENDA (<i>Reprints</i>)	
I PROVISIONAL INSTRUCTIONS FOR THE TREATMENT OF MALARIA IN THE UNITED KINGDOM ..	319
II. AN INTERIM REPORT ON THE TREATMENT OF MALARIA -ABSTRACT OF 2,460 CASES By Colonel Sir Ronald Ross, KCB, FR S ..	323

PREFATORY NOTE.

THIS publication consists of reports and papers submitted under the Instruction which follows below

It is not intended that this volume shall conflict in any way with the Medical History of the War, now in course of preparation, but the information contained in it is hereby published in a form which should be useful for future reference in that later work, or elsewhere.

T H J GOODWIN,
Director-General

6th December, 1918

24/Gen No /6764 (A M D 2B)

SIR,

I am directed to inform you that it is proposed to publish early next year a Paper containing scientific observations on malaria, especially from the military point of view, written by medical officers of the army and others who are specially qualified to deal with the subject. The publication will include articles on the treatment, pathology, biochemistry, epidemiology, medical entomology, prevention, and the general subject of the management of malaria in armies.

I shall therefore be glad if you will make this proposal known to such of your officers as you think are particularly qualified to impart information of value on these subjects.

Articles offered for this purpose should be marked "War Office Malaria Publication," and should be forwarded to me through the usual channel, as soon as possible. But it should be understood that it may not be found feasible to include in the publication all articles so received, while others may be included only in part or in abstract.

The result of extensive observations or investigations should be presented as far as possible in abstract, and special clinical cases, charts and detailed statistics should be avoided unless absolutely required.

I am, Sir,
Your obedient Servant,

(Signed) T R ST JOHNSTON,
For Director-General, Army Medical Service

The Director of Medical Service, Mesopotamia,
Salonica, Egypt, Italy, France

I.—REPORT ON THE EXCRETION OF QUININE IN THE URINE.

(WAR OFFICE INVESTIGATIONS)

By M. NIERENSTEIN, D.Sc., Ph.D., F.C.S., Staff-Serjeant,
Royal Army Medical Corps

INTRODUCTION.

THE investigations recorded in this Report were undertaken at the orders and carried out under the directions of the Consultant in Malaria, Colonel Sir Ronald Ross, at the Malaria Laboratory, 4th London General Hospital, under the command of Lieut.-Colonel Sir Nestor Tirard. They were begun on April 13th, 1917, and concluded on November 30th, 1918, during which period 834 specimens of urine were examined, which, without exception, came from cases which showed parasites in the blood at the commencement of quinine treatment. The specimens investigated were from 86 cases of the Malaria Wards of the 4th London General Hospital. The urines were collected under the supervision of the Medical Officers in charge of the Malaria Wards, and the whole 24 hours' specimens were sent to the Laboratory for investigation.

The objects of the investigation were :—

(i) To study the behaviour of quinine in the human organism by estimating—

- (a) How much of it is excreted
- (b) How much of it is either absorbed or disintegrated

(ii) To study the behaviour of the different salts and derivatives as to their—

- (a) Excretion
- (b) Absorption, and
- (c) Disintegration

(iii) To study the excretion of quinine if given—

- (a) Orally
- (b) Intramuscularly
- (c) Intravenously
- (d) In combination of oral and intramuscular administration

(iv) To establish whether the so-called excreted quinine mentioned in the literature on the subject is—

- (a) Quinine
- (b) Modified quinine
- (c) A mixture of both

PART I.

QUALITATIVE DETECTION OF QUININE IN THE URINE.

SECTION A.—SOME QUALITATIVE TESTS FOR QUININE.

I. THALLEO-QUININE TEST

*Manson** was the first to observe, in 1835, that quinine discharges a *green* colour when exposed to the action of chlorine-gas and subsequently treated with ammonia. This observation was confirmed by *Schweitzer*, who employed chlorine-water instead of chlorine-gas, and also by *Brandes*, who used both chlorine-water and chlorine-gas. Similar observations were made by *André*, who employed only chlorine-water for the reaction. It was *Brandes* who suggested the name Thalleo-quinine† for the green colouration and Thalleo-quinine reaction' for this test, under which name it is generally known both in the English and German literature. In French publications, however, it is mostly referred to as *J. J. André's Test for Quinine ‡*

There have been many modifications of the Thalleo-quinine test. They are arranged in their historical sequence as follows.—

- (a) *Fluckiger's Modification §* The quinine solution is saturated with bromine water vapours until the solution becomes permanently yellow on *shaking*. Ammonia is then added carefully by letting it run slowly down the sides of the test-tube. It is claimed that quinine can thus be detected in a dilution of 1 : 20,000.
- (b) *Vulpus' Modification* A few quinine-sulphate crystals are carefully mixed with powdered potassium perchloride and then moistened with a few drops conc sulphuric acid. Ammonia discharges the green colour.
- (c) *Vitali's Modification*. Identical with *Vulpus' modification*

* In some German publications the name is wrongly given as *Meeson*

† The name Dalleo-quinine reaction as used by *Koechlein* is obviously an error

‡ Some German publications refer to it also as the *Hoper-André's Test* (See for example *Merck*)

§ Compare *Mylus*

- (d) *Blaise's Modification* Identical with *Fluckiger's* modification *
- (e) *Hyde's Modification* To 0.003-0.005 grms quinine sulphate or hydrochloride dissolved in 5 cc. water is added a clear solution of bleaching powder, until the blue fluorescence disappears, which is then followed by a few drops of *dilute* ammonia (1-3)
- (f) *Pollaci's Modification* About 0.01 grms of a quinine salt is dissolved in 1 cc water and two drops sulphuric acid added. The solution is boiled with a small piece of lead peroxide for a short time and then diluted with 3-4 cc water. Ammonia is added to the carefully cooled solution
- (g) *Reichard's Modification* Quinine sulphate is carefully mixed with powdered ammonium persulphate and moistened with strong hydrochloric acid, when the green colour is discharged
- (h) *Abensour's Modification* Not less than 10 cc of the solution to be examined are used to which are added drop by drop a saturated bromine solution until the fluorescence disappears. This is followed by its own volume of alcohol and 1 or 2 drops ammonia
- (i) *Vondrasek's Modification* About 0.01 gram of a quinine salt are dissolved in 1 cc n HCl and boiled with 2 cc potassium bromate (5 per cent) until the solution turns orange yellow. On cooling 1-2 cc ammonia are added which produces a dark green solution.
- (j) *Legèr's Modification* *Legèr* finds that the test is only reliable if exact proportions of quinine and reagents are present. According to his observations which have since been confirmed by *Guigues*, *Vignerot* and *Denigès*, 10 cc of a 0.05 per cent. quinine solution required either 1 cc bromine-water made up of 0.5 cc. saturated bromine-water and 0.5 cc water and 1 drop strong ammonia or 1 drop saturated bromine-water solution and 1 drop strong ammonia
- (k) *Harrandeau's Modification* 10 cc of a quinine solution are shaken with an excess of ammonia and alcohol and then afterwards evaporated to dryness. The residue is dissolved in 10 cc acetic

* *Blaise's Modification* is a combination of *Fluckiger's* Thalleo-quinine and *Vogel's* Erythro-quinine test

acid (0.5 per cent) and treated with 0.5 cc NaHSO_3 (1 per cent) and 0.5 cc formol and saturated bromine-water, the latter being added drop by drop until a permanent yellow colour appears. The addition of two drops sodium hydroxide and 4 drops ammonia produce a permanent green colour.

(l) *Ramsden and Lipkin's Modification* These authors find that the amount of bromine-water must be carefully proportioned to that of quinine—neither, too little nor too much, and an appreciable interval must be allowed before ammonia is added. The addition of ammonia must not be delayed too much. By the following procedure they claim to be able to detect with ease and certainty 1 : 40,000, and with difficulty 1 : 400,000.

(i) Pour into each of six small test-tubes 1 drop of strong ammonia solution.

(ii) To 10 cc of the quinine solution feebly acidified with hydrochloric acid, kept agitated and held against a white background, add 1/10th saturated bromine-water drop by drop until its slight yellow colour is no longer instantly discharged. Then at intervals of 5 seconds remove successive lots of about 2 cc of the mixture and transfer each at once to one of the ammoniated test-tubes. Finally mix all together and extract any green pigment, with chloroform or amyl alcohol.

Experiments with the Thalleo-Quinine Test

The following experiments were made. In each case 10 cc of a 0.1 per cent quinine sulphate were used. The results thus obtained were as follows—

Modification	Number of Experiments	Number of Positive Results	Error Per Cent
Flückiger's	26	17	34.62
Hyde's	14	11	21.43
Reichard's	8	5	37.50
Abensour's	22	16	25.23
Vondrasck's	18	12	33.33
Harrandeau's	9	6	33.33
Ramsden and Lipkin's	16	11	31.25

As regards the sensitiveness of this test towards dilutions it was found possible to detect with it quinine in dilution of 1 : 5,000, 1 : 10,000, 1 : 20,000 and 1 : 40,000, doubtfully possible at 1 : 80,000 and impossible at 1 : 100,000. For these experiments *Hyde's*, *Abensour's* and also *Ramsden & Lipkin's* modifications of the Thalleo-quinine test were used.

The impression gained in this Laboratory is that the *Thalleo-quinine test can only be regarded as a valuable positive test for quinine and that a negative result in no way indicated the absence of quinine*. Similar results have been obtained by *Vulpus, Leger, Guges, Vigneron, Demgès, Fuhner, † Kimura, Toronoff, Lenz, Baldoni, Mannich and Schwabes, ‡ Griemsa and Schaumann, Buraczewski and Zbijewski* and also *Commanducci §*

2. ERYTHRO-QUININE TEST.

This test was discovered by *Vogel*, who found that quinine gives a pronounced *red* colouration when treated with chlorine-water, potassium-ferrocyanide and ammonium carbonate. *Eiloart* later on used bromine-water and mercuric cyanide to which he added chalk. *Harrandeau* proceeds on the same lines as for the *Thalleo-quinine test*, but adds instead of sodium hydroxide and ammonia, a few drops of potassium ferrocyanide ($2\frac{1}{2}$ per cent) and 1 drop of ammonia

EXPERIMENTS WITH THE ERYTHRO-QUININE TEST.

Modification.	Number of Experiments.	Number of Positive Results	Error Per Cent.
<i>Vogel's</i>	22	16	27·28
<i>Eiloart's</i>	26	20	23·18
<i>Harrandeau's</i>	11	7	26·37

The *Erythro-quinine test* can in no way be regarded as being superior to the *Thalleo-quinine test* which confirms the

* *Vigneron* was the first to suggest the extraction of the green pigment with chloroform. *Salomon* extracts either with chloroform or carbontetrachloride by which method he detects 1/40,000

† *Fuhner* finds that p-oxyquinoline gives the *Thalleo-quinine test*. *Kaufmann* and *Kaufmann* and *Huber* have also prepared some quinoline derivatives which give the *Thalleo-quinine test*

‡ *Mannich* and *Schwabes* find that the presence of caffeine, antipyrine and pyramidon interferes with the reaction. If antipyrine is present the colour produced with bromine-water and ammonia is not green but *red*. *Carrez's Quinerythropyrin test* is based on this colour change and consists in using equal parts of quinine and antipyrine dissolved in water. This mixture gives with bromine-water and ammonia a red colouration which can be extracted with chloroform and which turns red with acids and violet-red with alkalines. *Carrez* recommends this test for the detection of quinine or antipyrine in the urine

§ *Commanducci* has made a very careful study of the products formed during the *Thalleo-quinine reaction*. He was able to show that even the smallest variation in the procedure produces a different product. *Commanducci* has isolated the following substances when varying the conditions under which bromine-water and ammonia were added (1) *André's Thalleo-quinine*, (2) *Vogel's Erythroquinine*, (3) *Brandes' Rosioquinine*; (4) *Brandes' Melanoquinine*, (5) A new violet substance (*Rubroquinine*), (6) *André's white quinine*, (7) A new white substance (*Leucoquinine*).

view of *Legèr, Guigues, Vigneron, Denigès* and *Commanducci*. In dilution, however, the Erythro-quinine test is apparently inferior to the Thalleo-quinine test, as it was found to fail even at a dilution of 1 : 200.

3. BATTANDIER'S TEST.*

A feebly acid quinine solution is allowed to absorb bromine-water vapours until it becomes pale-yellow; one drop of a dilute copper sulphate solution is added followed by a gradual addition of ammonia. A *pink* colour is produced which changes to violet and finally to green.

Out of 18 experiments, 11 gave positive results corresponding to an error of 38·89 per cent., which shows that this test is not superior to the other colour tests already mentioned. In dilutions of 1 : 200 this test failed like the Erythro-quinine test.

4. HIRSCHSON'S TEST.

One drop hydrogenperoxide (2 per cent) and one drop copper sulphate (10 per cent) are added to the quinine solution and boiled for a few minutes. A *strawberry-red* colouration is thus produced which changes from blue-violet to blue, and finally becomes green on standing.

This test was found to be fairly reliable, out of 11 experiments, 8 were positive, corresponding to 27·28 per cent. error. It must, however, be mentioned that the colour changes were not as clear as one would expect from Hirschson's description. The red colouration appeared in all the 11 cases, but in 8 cases only the change to blue-violet and blue was noticed, of these only 3 became green after standing 30 minutes; two after 1 hour 20 minutes, and three after about 2 hours. *The impression gained is that this test is not reliable*

5. FLUORESCENCE.

Eloart recommends to add to a quinine solution an excess of bromine-water, the excess of bromine being removed on boiling. The cold solution shows green fluorescence. It is claimed that it is thus possible to detect quinine in a dilution of 1 : 50,000. *Denigès* and also *Pépin* recommended the fluorescence of the sulphate,† as a qualitative test. They claim to be able to detect 1 : 75,000. *Matolcsy* uses the acetate and claims to detect 1 : 40,000. *Ramsden* and *Lipkin*

* This test is sometimes incorrectly referred to as *Battandier's* test (Compare *Merck*)

† According to *Buckingham* the strongest fluorescence is possessed by the disulphate. According to *Wastky*, who uses a special fluorescence microscope, it is possible to detect the hydrochloride in dilutions of 1 : and 1,000,000 the disulphate in dilutions of 1 : 100,000,000.

recommend the employment of transparent silica test tubes, using the sulphate, acetate or tartrate. They are thus able to detect 1 : 40,000.

The sulphate was used for all the experiments made in this laboratory and it was found that the fluorescence was positive in a dilution of 1 : 100,000, doubtfully positive at 1 : 150,000, and it always failed at 1 : 200,000. It is doubtful if this test could be recommended since many substances increase or decrease the fluorescence of a compound. Experiments made by the author for example have shown that urea hydrochloride in a dilution of 1 : 200 reduces the sensitiveness of the fluorescence test applied to quinine to 1 : 10,000. Similar observations have also been made by *Ramsden* and *Lipkin*, who say "chloride and numerous other substances, even in traces, greatly diminish or abolish fluorescence. The test is not a very useful one."*

6. MAYER'S REAGENT †

The original *Mayer's* Reagent is prepared by dissolving 13.5 grms mercuric perchloride‡ and 50 grms potassium iodide in a litre of water. *Tanret's* solution, which was used by the author, is prepared in the following manner — Dissolve 1.35 grms. of mercuric perchloride in 75 cc. water and 5 grms potassium iodide in 20 cc water in a 100 cc. measuring flask. Pour the mercuric solution into the iodide solution under agitation and fill up with water to the mark (compare *Ramsden* and *Lipkin*) *This reagent was found never to fail and is also very delicate.* It was always possible to detect by it quinine in dilutions of 1 : 300,000 to 1 : 450,000. Our results confirm *Ramsden* and *Lipkin's* observations as to the great delicacy of this test, though we were never able to detect quinine in dilutions of 1 : 500,000, as observed by these authors.

Whereas it was possible to detect quinine when using *Mayer's* Reagent of a strength corresponding to 1/10th n, 1/50th n, and 1/100th n, further dilution showed a marked decrease in the reliability of the reagent, and it was found that a 1/10,000th n, solution entirely loses its precipitating and turbidity-producing properties

* *Hariman* and *Zila* have recently published a quantitative method which is based on the fluorescence of the sulphate, which requires expensive apparatus and which sounds not very promising in view of the general experiences with the fluorescence of quinine and other substances already mentioned.

† Synonymous with the reagent of *Tanret*, *Artus*, *Valser*, *Böhm*, *Delffs*, *Grove*, *Masing* (not *Masin* as frequently given), *v Planta*, *Thoulet* (not *Toulet*, as frequently given), *de Vrij*, *Winckler* (not *Winkler* as frequently given).

‡ *Valser*, *Böhm*, *Delffs*, *v Planta* and *de Vrij* use HgI₂, instead of HgCl₂. Experiments were also made replacing mercuric perchloride by bin-iodide in *Tanret's* reagent. The results were, however, the same as with the original reagent.

Giemsa and *Schaumann* have employed an acidulated *Mayer's* solution (*Tanret's* reagent plus 1 per cent glacial acetic acid) Experiments carried out with this reagent gave results which were definitely positive for dilutions varying from 1 5,000 to 1 20,000, doubtfully positive at 1 40,000, and the test always fails for 1 80,000 This confirms the observation of *Ramsden* and *Lipkin* that this modified reagent is not as sensitive as the original *Mayer's* or *Tanret's* reagent *

7 WAGNER'S REAGENT †

This reagent consists of 1 grm iodine, 1 5 grms. potassium iodide and water made up to 100 cc The experiments with this reagent have been very encouraging It was found never to fail in dilutions of 1 3,000,000, in addition to this the reagent does not lose its sensitiveness on being diluted as does happen with *Mayer's* reagent It was, namely, found that it behaved in the same manner if used in dilutions of 1/10th n, 1/100th n, 1/1,000th n, 1/10,000th n, and 1/15,000th n. The only drawback is that the solution is very highly coloured, as already pointed out by *Ramsden* and *Lipkin*, which, however, can be remedied by using a strong light such as a *Mill's* apparatus

8 HERAPATH'S TEST

This test was discovered in 1853 by the late Dr. Herapath of the Bristol School of Medicine, and is certainly the most reliable qualitative test for quinine It is based on the low solubility of herapathite (artificial tourmaline) in alcohol and the ease with which it forms crystals with a highly characteristic polarising effect, especially when examined microscopically in conjunction with a Nicol's prism

Herapath's observations were shortly afterwards confirmed by *Hardinger*, *Bournewyn*, *de Vrij* and also *Dewar*, modifications of *Herapath's* reagent have been suggested by *Jorgensen* and also *Christensen*, and in recent years the test has been strongly recommended by *Hulle*, *Host-Madsen*, and also *Ramsden* and *Lipkin*. The latter have elaborated a most convenient

* Synonymous with the reagents of *Hilger* (not *Hilger*, as sometimes given) and *Kippenberg*, sometimes referred to as *Selmi's* reagent, which is, correctly speaking, not the case since *Selmi* employs *Wagner's* reagent in combination with gold chloride, potassium-platinum-iodide and other salts *Simoncelli* and also *Scrapitti* have carried out extensive experiments with a view of replacing iodine plus potassium iodide by *Pruitt's* reagent (iodised paræthoxy-phenyl-succinimide) They came to the conclusion that *Pruitt's* reagent is in no way superior to *Wagner's* reagent

† Compare *Ramsden* and *Lipkin's* criticism of *Teichmann's* work on quinine Also *Giemsa* and *Halberkann*, *Loewenstern* and *Kosian* and *Loewenstern* and *Neuschloss*

method which will be described later on and by which it is possible to detect quinine with certainty even in dilutions of 1 : 20,000,000.

- (a) *Herapath's original reagent*—Two solutions are used. Solution 1 consists of 12 grms. acetic acid, 4 grms. alcohol and 6 drops dilute sulphuric acid; Solution 2 is made up of 1 gm. iodine in 100 cc. alcohol. To carry out the test, use 1 drop of Solution 1 and 6 drops of Solution 2
- (b) *Jorgensen's reagent* is a solution of 1.96 grms. iodine, 10 grms. hydriodic acid (10 per cent), 10 grms. dilute sulphuric acid (containing 10 per cent. SO_3) made up to 250 c.c. with alcohol
- (c) *Christensen's reagent** is a solution of 1 gm. iodine in 1 gm. hydriodic acid (50 per cent), 0.8 grms. sulphuric acid and 50 grms. alcohol (70 per cent). *Ramsden* and *Lipkin* employ this reagent and prefer it to *Jorgensen's* reagent

Attempts have also been made to replace iodine by bromine and hydriodic acid by hydrobromic acid (*Colson*, *Christensen*, *Host-Madsen*), but these reagents have been found inferior to the original one. Similar results were also obtained by the author when using the following combinations—bromine in hydriodic acid, bromine in hydrobromic acid and iodine in hydrobromic acid. These new reagents were found in every way inferior to the usual solution of iodine in hydriodic acid

Lipkin and *Ramsden's* method, when using *Christensen's* reagent, consists of the following details.—

- (1) Dissolve 5 grms. of ammonium sulphate in every 10 cc. of the quinine solution, alkalise it with ammonia and extract the quinine by shaking with three successive 5 cc. lots of purified ether, transferring each lot as it separates into a small silica crucible on a water bath. Aspiration of air from its interior greatly accelerates drying.
- (2) Dissolve the residue when quite dry in a minimum of anhydrous ether squirted repeatedly down the sides of the crucible by means of a teat-pipette
- (3) Bring the ether solution in successive drops on to a warm microscopic slide in such a way that the residue left by its evaporation is spread over a minimal area

* *Christensen* states that the reagent alters on standing. This has been contradicted by *Host-Madsen*. According to observations made by the author *Christensen's* and also *Jorgensen's* reagents alter on standing (3-4 months) as they produce crystals which are not as typical as those obtained when using freshly prepared reagents

- (4) Put on a cover-slip, add just enough of *Christensen's Herapathite* reagent to fill up to about one-third of the enclosed space, and by gentle pressure force it into contact with all the residue left by the ether—if quinine be present, blackening will usually be visible to the naked eye. Examine microscopically and observe the effects of rotating a Nicol's prism over the eyepiece on the illumination of the crystals. If only dark masses are present without appreciable polarising effects, warm the slide gently and more characteristic crystals will form as it cools.
- (5) Wash and heat the crucible to redness before using it again for the test.*

A great number of experiments when using dilutions of 1/500th to 1/15,000,000th were made by *Ramsden* and *Lipkin's* method, and they gave the most satisfactory results. *In fact the test was never found to fail*

9 ROBERTSON'S TEST.

A precipitate or turbidity is obtained when a quinine solution is treated with an ammonium thiocyanate solution in the presence of zinc sulphate. It is claimed that it is possible thus to detect quinine in a dilution of 1:50,000. A few experiments were also made with this reagent and the results were very encouraging. The reagent never failed to give positive results and it was possible to detect quinine in dilutions of 1 50,000.

SECTION B—DETECTION OF QUININE IN THE URINE.

I. DETECTION OF QUININE WITHOUT PREVIOUSLY ISOLATING IT FROM THE URINE.

(A) *Thalleo-quinine Test.*

Dielt, Kerner, Binz and comparatively recently *Sestini* and *Camponi*, have suggested to test the urine direct for quinine by the Thalleo-quinine test. A few experiments were made, though this is obviously only possible if large quantities of bromine water are used, since large quantities of bromine are required for the decomposition of urea preceding the action of bromine on quinine. *None of those experiments gave satisfactory results, and the test is doubtlessly not suitable for this purpose*

(B) *Mayer's or Tanret's Reagent.*

This reagent has extensively been used by *Giemsa* and *Schaumann, Terchmann, Giemsa* and *Halberkann, Salomon,*

* *Ramsden* and *Lipkin* state that crystals with similar optical properties are given also by quinidine, cinchonine and cinchonidine.

Loewenstein and *Neuschloss* and *Loewenstein* and *Kosian* *Giemsa* and his co-workers used the modified *Tanret's* reagent, and to guard against errors from the presence of albumin they recommended that after the addition of the reagent the urine should be boiled and filtered hot, if the filtrate becomes cloudy when cool the presence of quinine may be inferred. This procedure does not exclude fallacies from proteoses and peptones (*Giemsa* and *Schaumann*). According to *Brault* and *Jeanseline* and *Dalimier* and *Soulier* reliable quantitative values on comparison with urine containing known amounts of quinine can be obtained with *Tanret's* reagent. This seems, however, not to be the case, at least as far as it is possible to judge from the experiments made in this laboratory. The results given are comparative values between (1) the amount added to the urine and found when using (2) *Tanret's* reagent, (3) *Tanret's* reagent as modified by *Giemsa* and *Schaumann*, and (4) when using the gravimetric method in general use in this laboratory.

Amount Added to 150 cc of Urine	Found in 50 cc by <i>Tanret's</i> Re- agent	Found in 50 cc by <i>Giemsa's</i> Re- agent	Found in 50 cc by Gravi- metric Method
Grms	Grms	Grms	Grms
o 9462	o 1724	o 1612	o 3012
o 8246	o 1128	o 1964	o 2684
o 9482	o 2716	o 2412	o 3098

For *qualitative* purposes, however, the reagent can certainly be recommended, provided the urine is first tested for albumin in the usual way, when the boiling test, according to *Giemsa* and *Schaumann*, is absolutely necessary*. When using this method it was possible to detect quinine in the urine of three normal individuals in a few minutes after oral administration of 5 grains quinine sulphate.

(c) *Fluorescence*

Kerner recommended the fluorescence of the urine following administration of quinine as a qualitative test of quinine in the urine. *Giemsa* and *Schaumann* have pointed out that this is not a reliable test, and the following observations made by me confirm their contention. Out of 624 urines analysed in this laboratory, which were found to contain quinine, only 122 specimens showed fluorescence, which corresponds to an error of 80.45 per cent. A modification of *Kerner's* method

* *Ramsden* and *Lipkin* prefer their "defaecation" process to *Giemsa* and *Schaumann's* "boiling test," as they find that the turbidity fails to reappear when a heated urine is cooled.

which consists in the use of a strong beam of sidelight, which is brought to focus in the urine, gave the following result. Out of 156 specimens of urine which contained quinine, only 42 showed fluorescence, corresponding to an error of 73.02 per cent

(D) *Picric Acid or Esbach's Reagent* *†

Baur and Reveillet have described an approximate quantitative test for quinine in the urine which has been in use extensively by the French Authorities. It consists in the precipitation of quinine in the urine by picric acid. *This method can only be used for urines free from other alkaloids and albumin*. A set of 10 test-tubes are prepared with normal urine containing progressive amounts of quinine from 0 or to 0.10 grms per litre. To each tube is added 5 cc of a 1 per cent solution of picric acid, and the contents well shaken. This gives a set of standards with which the turbidity of the urines to be tested is compared. Five minutes standing should be allowed before reading. The urines must be free from other alkaloids and albumin. Uric acid crystallises on the walls of the tube without causing turbidity.

This method has been given a careful trial, and, as far as the experiments go, can be safely recommended for clinical routine examination

EXPERIMENTS WITH BAUR AND REVEILLET'S METHOD. 24
HOURLY QUININE EXCRETIONS

Found By Gravi-metric Method Per Cent	Found By B & R's Method Per Cent
65.60	63.20
44.90	39.80
67.07	63.80
38.90	38.60
46.45	31.80
46.96	34.80
39.50	37.60
61.34	60.20
43.68	41.70
11.62	8.40
26.95	24.70
10.90	11.60
30.93	31.60
27.16	21.40

* Sometimes wrongly called *Eschbach's* reagent. It is synonymous with *Fluckiger's*, *Hager's* and *Johnson's* reagents. *Christomanos* strongly recommends picric acid as a qualitative test for quinine in the urine. According to his observations the precipitate obtained from quinine, which is yellowish-white, differs in appearance from that due to uric acid or creatinine.

During some investigations on the estimation of creatinine in malarial urines by *Folin's* method I failed to obtain reliable results owing to the presence of quinine in the urine. All attempts to correct such errors lead to negative results.

II.—DETECTION OF QUININE AFTER ISOLATING THE QUININE FROM THE URINE.

To isolate quinine from the urine or any other solution, it is set free by alkali and extracted with ether (methyl or ethyl), ethylacetate, chloroform or amyl alcohol. Different opinions have been expressed as to the use of ammonia, sodium or potassium hydroxide or baryta, and of the different extractives mentioned above (*de Vrij*, *Rupp* and *Seigers*, *Duncan*, *Dourmer* and *Deaux*, *Kleist*, *Thomas* and *Taillardier*, *Glénard* and *Guillermond*, *Iobst*, *Sperling*, and many others). The author has based his work on the very careful investigations of *Dourmer* and *Deaux*, who find that "complete isolation of the base is only obtained when using considerable quantities of high concentration or alkalies containing *carbonate*." About 50 per cent. sodium hydroxide solutions were used. They were allowed freely to absorb carbon dioxide from the air. For extraction mostly methylated ether was employed, but it was also found that for qualitative work, chloroform gave as good results as ether.

- (a) *Thalleo-quinine Test*.—Only a few experiments were made by this test in view of the discouraging results already obtained by this test.
- (b) *Mayer's or Tanret's Reagents*.—Gave excellent results even when only 10 cc. of urine were used.
- (c) *Herapath's Test*.—The urine was made alkaline with ammonia as recommended by *Herapath* and extracted with ether. It was then examined according to *Ramsden* and *Lipkin's* technique. Very good results were obtained, and quinine was easily detected in 10 cc. urine.
- (d) *Picric Acid*.—A 0.05 picric acid solution, as recommended by *Richtier*, was used. The results, however, were not as good as those obtained when *Mayer's* or *Herapath's* reagents were used. *On several occasions when positive results had been obtained by those two reagents, it was found that the picric acid test did not indicate the presence of quinine in the urine.*

SECTION C.—EXPERIMENTS AS TO THE APPEARANCE AND DISAPPEARANCE OF QUININE IN THE URINE AFTER ORAL AND INTRAMUSCULAR ADMINISTRATION OF QUININE.

GENERAL TECHNIQUE.

A hundred cc. of urine were used unless otherwise stated, and the alkaline solution twice extracted with two lots of

30 cc. each of ether. After evaporation of the ether a few drops of dilute acetic acid were added and made up to 1 cc. with water in a narrow test tube made from glass tubing. To the solutions are then added 2 cc. Tanret's reagent and the turbidity, if any, is noted. The extraction of quinine becomes less tedious when *Ramsden* and *Lipkin's Defaecation* process is employed.* For every 100 cc. of urine add 5 cc. of 25 per cent. acetate solution containing 2.5 per cent. acid and mix thoroughly; then add 5 cc. saturated ammonium sulphate solution and filter until a clear lead-free filtrate is obtained. Receive a drop on filter paper, moisten with sodium sulphide to test for lead. Then follows extraction with ether as above. This "defaecation" process has been in general use in this laboratory since its publication by *Ramsden* and *Lipkin*.

SUMMARY OF RESULTS.

Mode of Administration	Lapse of Time Since Administration	Positive	Negative	Remarks
Q Sulphate orally	5 mins ..	3	2	Defaecated
	1 hr 40 mins ..	8	1	"
	3 days 8 hrs †	0	3	Not defaecated
Q Hydrochloride orally	3 hrs 20 mins ..	6	0	"
	12 hrs ..	10	0	"
	30 hrs ..	8	0	Defaecated.
	3 days 6 hrs ..	1	9	"
	4 days ..	0	5	"
	5 days † ..	2	0	300 cc. urine investigated.
Q Hydrochloride intramuscularly	10 mins ..	1	0	Not defaecated.
	8 hrs 30 mins ..	5	0	"
	30 hrs ..	2	0	"
	3 days ..	1	4	"
	4 days ..	0	3	Not defaecated 300 cc. urine were investigated

* *Ramsden* and *Lipkin* state "very exceptionally urines are met with which give filtrates containing lead, notwithstanding the presence of excess of sulphate." This has been confirmed also in this Laboratory out of 38 urines "defaecated" only one showed these peculiar properties

† *Ramsden*, *Lipkin* and *Whitly* found that the excretion period differs greatly in different men—ranging from 41 hours (after a single dose by mouth) to 7½ days (after the last succession of large doses)

PART II.
QUANTITATIVE ESTIMATION OF QUININE
IN THE URINE.

SECTION A.—SOME QUANTITATIVE METHODS FOR THE
ESTIMATION OF QUININE IN THE URINE.

The following methods for the quantitative estimation of quinine in the urine have been reinvestigated in this laboratory for the purpose of being used in this investigation. Known amounts of quinine salts were added to normal urine and the quinine estimated.

KERNER'S FIRST METHOD

In this method the quinine is precipitated by phosphotungstic acid, from which it is liberated by a strong solution of baryta. The following results were obtained.—

Amount Added.	Amount Recovered	Percentage	Error .
Gr.	Gr.		Per cent.
0·2246	0·2984	132·86	+33·86
0·3046	0·3852	126 58	+26·58
0·2856	0·3162	113·36	+13·36
0·2846	0·2988	105·00	+ 5·00
0·2642	0·2756	104·38	+44·38
0·2956	0 3072	103 98	+ 3 98
Average error found = +12·69 per cent.			

KERNER'S SECOND METHOD.

Potassium mercuriodide is used as the precipitating agent, and the quinine compound decomposed by hydrogen-sulphide.

Amount Added.	Amount Recovered.	Percentage.	Error.
Gr.	Gr.		Per Cent.
0·2146	0·1712	79·77	-20·23
0·1746	0·1278	73·20	-26·80
0·2456	0·1972	80·30	-90·70
0·1824	0·1258	68·97	-31·03
0·1842	0·1472	79·92	-20 08
0·1942	0·1492	76 84	-23·16
Average error found = - 23·50 per cent.			

KLEINE'S METHOD.*

Quinine is precipitated with picric acid and liberated by alkali. The quinine is extracted with chloroform.

Amount Added	Amount Recovered.	Percentage	Error
Gr	Gr		Per Cent.
0.2864	0.2752	96.09	-3.91
0.3856	0.3758	97.46	-2.54
0.2746	0.2712	98.76	-1.24
0.3146	0.3084	98.04	-1.96
0.2746	0.2708	96.30	-3.70
0.3156	0.3122	96.66	-3.34

Average error found = - 2.78 per cent.

MERKEL'S METHOD.

The urine is evaporated to dryness and the residue extracted with alcohol. The insoluble part left in the evaporating dish is made alkaline and extracted with ether. The residue left on evaporation of the ether is weighed as quinine.

Amount Added	Amount Recovered	Percentage.	Error
Gr.	Gr		Per Cent
0.2212	0.2056	92.94	-7.06
0.1756	0.1658	94.42	-5.58
0.1922	0.1774	92.30	-7.70
0.1856	0.1756	94.61	-5.39
0.1812	0.1712	94.48	-5.52
0.1948	0.1852	95.08	-4.92

Average error found = - 6.02 per cent

GIEMSA AND SCHAUMANN'S METHOD.†

The urine is made alkaline and extracted with ether. The ether is evaporated and the residue several times treated

* *Ramsden* and *Lipkin* abandoned this method as unsatisfactory

† *Ramsden* and *Lipkin* use specially purified ether. They object however, to *Giemsa* and *Schaumann's* method for the following reasons —

(1) Large quantities of ether are necessary, and the ether must be carefully purified

(2) It cannot, owing to emulsion difficulties, be applied at all to urine which had been concentrated by boiling

with chloroform, filtered and evaporated. The final residue is weighed as quinine.

Amount Added.	Amount Recovered	Percentage	Error.
Gr.	Gr		Per Cent.
0.9846	0.9832	99.84	-0.16
1.2236	1.1174	91.34	-0.66
0.5462	0.5296	96.96	-3.04
0.2864	0.2836	99.03	-0.97
0.3642	0.3618	99.34	-0.66
0.3258	0.3212	98.59	-1.42

Average error found = - 2.48 per cent

GIEMSA AND SCHAUMANN'S MODIFICATION OF KLEINE'S METHOD.

The modification consists in that the residue which is left after the evaporation of the ether is redissolved in dilute alcohol, 60 per cent. alcohol being used

Amount Added	Amount Recovered	Percentage	Error
Gr	Gr.		Per Cent.
0.2946	0.2916	98.98	-1.02
0.2646	0.2582	97.58	-2.42
0.3026	0.2978	98.40	-2.60
0.2816	0.2732	97.03	-2.97
0.3158	0.3074	97.34	-2.66

The average error found was - 2.33 per cent

GAGLIO'S METHOD.*

The urine is evaporated with magnesia and the residue extracted with chloroform.

Amount Added.	Amount Recovered	Percentage	Error
Gr.	Gr.		Per Cent
0.2642	0.2312	87.51	-12.49
0.1912	0.1784	93.30	- 6.70
0.1746	0.1568	89.80	-10.20
0.1916	0.1774	92.60	- 7.40
0.2256	0.2092	92.73	- 7.23
0.1658	0.1474	88.90	-11.10

Average error found = - 9.18 per cent

* Ramsden and Lephin were not satisfied with this method

GIEMSA AND SCHAUMANN'S MODIFICATION OF GAGLIO'S METHOD.

The extraction with chloroform is carried out on the water-bath, a Soxhlet extractor being used.

Amount Added	Amount Recovered.	Percentage	Error.
Gr.	Gr		Per Cent.
0.2964	0.2856	96.35	- 3.65
0.2622	0.2532	96.56	- 3.44
0.3456	0.3374	97.63	- 2.37
0.2856	0.2712	94.96	- 5.04
0.3156	0.3014	95.90	- 4.50
0.3456	0.3272	94.68	- 5.32

Average error found = - 4.05 per cent

SCHMITZ'S MODIFICATION OF KLEINE'S METHOD (I).

The quinine recovered by Kleine's method is dissolved in acetone and the double-compound of quinine acetone is recovered. This method has been successfully employed by *Gordin* for the isolation of berberin which yields a well defined berberin-acetone-compound. Both *Gordin* and *Schmitz* have apparently succeeded in obtaining the quinine-acetone-compound, but I have failed to do so; I have consequently not further investigated *Schmitz's* modification of *Kleine's* method.

SCHMITZ'S METHOD (II).*

This method consists in the titration of the hydrochloric acid, the recovered quinine being converted into quinine hydrochloride. I have carried out about 30 estimations by this method, and the error in the individual analysis varied from -43 to +8 per cent. This method is open to severe criticism, since apparently *Schmitz* accepts *a priori* that all the quinine is converted into the hydrochloride, and disregards the possibility of bihydrochloride also being formed. It is possible that *Schmitz* has accounted for this in his dissertation published in 1907, but I only had the opportunity of reading the summary of his work published by him in the Archives of Experimental Pathology and Pharmacology as quoted. It must be noted that *Grosser*, who has repeated *Schmitz's* method, has come to similar conclusions and has expressed the same criticism as myself.

* Compare *Eluove*, *Kippenberg* and also *Ramsden and Liphin*.

BARRATT AND YORK'S MODIFICATION OF GIEMSA AND
SCHAUMANN'S METHOD.

The authors have only slightly modified the original *Giemsa* and *Schaumann's* method. Their modification consists in accounting for the residue left on evaporation of the reagents employed, ether, alcohol and chloroform. Though slight, *this modification gave the best results so far obtained by me for the estimation of quinine in the urine.*

Amount Added	Amount Recovered.	Percentage	Error.
Gr.	Gr		Per Cent
0.3428	0.3406	99.33	- 0.67
0.2846	0.2802	98.46	- 1.54
0.3156	0.3122	98.92	- 1.08
0.2756	0.2716	98.55	- 1.45
0.2946	0.2900	98.44	- 1.56
0.3042	0.3016	99.15	- 0.85

Average error found = - 1.18 per cent

NISHI'S METHOD.

The urine is made alkaline and extracted with ether. The ethereal solution is treated with an alcoholic solution of citric acid and the quinine weighed as the citrate of quinine, $C_{20}H_{24}N_2O_2C_6H_8O_7$, which melts at 204° .

Amount Added.	Amount Recovered	Percentage	Error.
Gr.	Gr.		Per Cent.
0.2246	0.1856	82.66	-17.34
0.2056	0.1528	74.28	-25.72
0.1846	0.1362	73.84	-26.16
0.1912	0.1400	73.24	-26.76
0.1642	0.1188	72.35	-27.65
0.1972	0.1400	71.18	-28.82

Average error found = - 25.40 per cent

COCKBURN AND BLOCK'S MODIFICATION OF NISHI'S METHOD.

The urine is made strongly alkaline and extracted with ether at as high a temperature as it is consistent with safety. The residue on evaporation of the ether is dried in the water-bath and dissolved in 20 cc. of *anhydrous* ether, filtered and

precipitated with 10 cc of a saturated ethereal solution of citric acid and allowed to stand for 24 hours. The quinine is weighed as the citrate

Amount Added	Amount Recovered	Percentage.	Error.
Gr	Gr		Per Cent.
0.2462	0.1802	73.14	-26.86
0.1912	0.1534	80.20	-19.80
0.1826	0.1510	82.66	-17.34
0.1912	0.1594	83.34	-16.66
0.1912	0.1560	81.57	-18.43
0.1856	0.1462	79.90	-20.10

Average error found = - 19.76 per cent

SUMMARY TO SECTION A.

	Average Error Found Per Cent.
<i>Kerner's</i> First method	+ 12.69
<i>Kerner's</i> Second method	- 23.50
<i>Kleine's</i> method	- 2.78
<i>Merkel's</i> method	- 6.02
<i>Giemsa</i> and <i>Schaumann's</i> method	- 2.48
<i>Giemsa</i> and <i>Schaumann's</i> modification of <i>Kleine's</i> method	- 2.33
<i>Gaglio's</i> method	- 9.18
<i>Giemsa</i> and <i>Schaumann's</i> modification of <i>Gaglio's</i> method	- 4.05
<i>Schmitz's</i> modification of <i>Kleine's</i> method	This method was not used as I was unable to obtain the quinine-acetone-compound.
<i>Schmitz's</i> method*	This method was found unreliable. Individual error of the analyses vary from - 43 per cent. to + 8 per cent
	Per Cent
<i>Barratt</i> and <i>York's</i> modification of <i>Giemsa</i> and <i>Schaumann's</i> method	- 1.18
<i>Nishi's</i> method	- 25.40
<i>Cockburn</i> and <i>Block's</i> modification of <i>Nishi's</i> method	- 19.76

* *Ramsden* and *Lipkin* employ *Gordon's* titration method as used by *Schmitz* as a control, which they find "both useful and reliable" I have had no experience with this method, but I find that *Katz* does not regard it as a reliable method. He has not only used it for quinine but also for a number of other alkaloids, and he is of the opinion that this method is of no value for the analysis of either quinine or of the other alkaloids

SECTION B.—QUANTITATIVE ESTIMATION OF QUININE
IN THE URINE.

All the results recorded in this section were obtained by *Barratt* and *York's* modification of *Giemsa* and *Schaumann's* method. Two analyses were made and the *average* recorded. Very often, however, more than two estimations were carried out, especially when there was too great a difference between the two estimations. Altogether 1,668 estimations were made.

Daily dose of Q B* in grs	Daily excretion of Q B in grs	Daily secretion of Urine in c c	Daily excretion of Q B in grs per litre of Urine	Daily excretion of Q B in per cent	Appearance of Urine	Specific gravity of Urine	Albumin
CASE No 177.				TREATMENT † 20 grs. Sulphate Orally.			
15·39	6·60	1,180	5·60	42·88	Dark ..	1,020	Neg
15·39	1·32	520	2·54	10·80	Light ..	1,025	"
15·39	5·13	840	6·10	33·33	Dark ..	1,025	"
15·39	16·50	1,910	8·64	107·14	" ..	1,026	"
15·39	5·40	470	9·12	35·08	Light ..	1,017	"
15·39	12·50	1,570	7·96	80·86	Dark ..	1,015	"
15·39	..	..	..	..	..	..	..
15·39	16·07	1,280	12·55	104·48	Light .	1,015	Neg
15·39	7·56	1,370	5·52	49·12	Cloudy	1,015	"
15·39	7·34	1,240	5·91	47·60	Dark ..	1,020	"
15·39	18·82	1,360	13·84	122·28	" ..	1,020	"
15·39	2·17	380	5·71	14·43	Light .	..	"
15·39	15·48	1,140	13·58	100·64	Dark ..	1,020	"
15·39	5·32	350	15·20	34·57	" ..	1,030	"
15·39	7·46	480	15·54	48·48	" ..	1,031	"
15·39	7·50	580	12·94	48·73	" ..	1,026	"
15·39	11·86	940	12·62	77·06	Brown	1,020	"
15·39	10·40	1,270	8·10	67·60	Light ..	1,015	"
15·39	11·40	1,520	7·52	74·06	" ..	1,015	"
15·39	11·93	1,580	7·23	74·27	" ..	..	"
15·39	7·14	1,130	6·77	45·34	" ..	1,012	"
CASE No 224				TREATMENT 20 grs Sulphate Orally			
15·39	4·32	475	9·10	28·07	Light	1,015	Neg.
15·39	4·05	670	6·04	26·32	"	1,030	"
15·39	9·62	740	13·00	62·50	" ..	1,028	"
15·39	13·26	840	15·70	85·78	" ..	1,026	"
15·39	7·97	1,650	4·83	51·80	Dark .	1,020	"
15·39	11·78	1,550	7·60	76·55	" ..	1,020	"
15·39	17·47	1,200	14·36	115·68	Light ..	1,015	"
15·39	6·93	1,200	5·77	45·03	" ..	1,018	"
15·39	10·09	1,460	7·07	65·56	" ..	1,020	"

* Q B = Quinine Base

† The Treatments are *daily treatments*

QUANTITATIVE ESTIMATION OF QUININE IN THE URINE—
continued.

Daily dose of Q B in grs	Daily excretion of Q B in grs	Daily secretion of Urine in c c	Daily excretion of Q B in grs per litre of Urine	Daily excretion of Q B in per cent	Appearance of Urine	Specific gravity of Urine,	Albumin
CASE No. 224				TREATMENT 20 grs Sulphate Orally.			
15·36	12 01	1,280	9·38	78 04	Dark ..	1,020	Neg
15·39	3·17	680	4·66	20 60	" ..	1,018	"
15·39	9 50	820	11·57	61·73	Light ..	"	"
15·39	5·39	720	7·48	35·02	" ..	1,022	"
15·39	6·15	550	11 18	39·95	Dark ..	1,022	"
15·39	9·82	720	13 64	63·80	Light ..	1,028	"
15·39	2·58	380	6 79	16·76	" ..	1,028	"
15·39	15·18	950	15 98	78 35	" ..	1,025	"
15·39	10·01	940	10 64	65·04	" ..	1,027	"
15·39	6·22	1,020	6·10	40·42	Dark ..	1,024	"
15·39	10 08	940	10 72	65 60	" ..	1,020	"
15 39	11 66	1,080	10 80	75·75	Light ..	1,026	"
15·39	15·95	1,460	10·92	103 64	" ..	1,020	"
CASE No 247				TREATMENT 20 grs Sulphate Orally			
15·39	2 39	480	4 98	15·54	Light	1,025	Neg
15·39	4·51	750	6·02	29·30	" ..	1,027	"
15·39	9·32	1,750	5·33	60·56	" ..	1,015	"
15·39	7·68	1,560	4·92	49·90	" ..	1,018	"
15·39	6·40	950	8·48	41·60	" ..	1,020	"
15·39	7·47	650	11·50	48·54	" ..	1,015	"
15·39	5·48	770	7·12	35 60	Dark ..	1,025	"
15·39	9·39	830	11 32	61·00	" ..	1,020	"
15·39	5·54	850	6 66	36 00	Light	1,016	"
15·39	5 90	750	7 86	38·34	" ..	1,022	"
15·39	3·14	510	6 08	20·61	" ..	1,025	"
CASE No 293				TREATMENT 20 grs Sulphate (Tablets) Orally			
15 39	11 07	1,520	7·28	71·93	Dark	1,017	Neg
15 39	7 02	870	8 07	45 62	Light	1,018	"
15·39	"	"	"	"	"	"	"
15·39	7 97	1,160	6 87	51·78	Light	1,024	Neg
15 39	11 84	1,920	6 16	76 94	" ..	1,012	"
15 39	11·42	1,840	6·20	74·20	" ..	1,016	"
15·39	10·19	1,790	5·69	66 21	" ..	1,018	"
15·39	11·32	1,890	6·32	73·56	" ..	1,018	"
15·39	13 58	2,130	6 38	88 24	" ..	1,016	"

QUANTITATIVE ESTIMATION OF QUININE IN THE URINE—
continued.

Daily dose of Q.B. in grs.	Daily excretion of Q.B. in grs.	Daily secretion of Urine in c.c.	Daily excretion of Q.B. in grs. per litre of Urine.	Daily excretion of Q.B. in per cent.	Appearance of Urine.	Specific gravity of Urine.	Albumin.
CASE No. 293.			TREATMENT : 20 grs. Sulphate (Tablets) Orally.				
15·39	11·75	1,360	8·52	76·52	Light	1,016	Neg.
15·39	15·11	1,410	10·72	98·18	"	1,015	"
15·39	5·19	920	5·64	33·72	"	1,012	"
15·39	..	..	..	..	"	..	..
15·39	6·15	1,080	5·70	39·96	Dark	1,018	Neg.
15·39	13·48	1,140	11·82	87·08	Light	1,018	"
15·39	11·33	1,020	11·10	73·62	"	1,018	"
15·39	14·98	1,140	13·14	97·34	"	1,018	"
15·39	9·52	1,020	9·34	61·85	"	1,020	"
15·39	7·31	1,070	6·84	47·50	"	1,020	"
15·39	3·30	580	5·68	21·44	"	1,024	"
CASE No. 203.			TREATMENT : Sulphate 1st and 2nd day, 24 grs.; 3rd day, 12 grs. Orally.				
18·47	7·06	1,290	5·48	38·24	Light	..	Neg.
18·47	12·82	5,100	2·54	69·41	"	..	"
9·23	3·58	4,780	0·75	38·78	"	..	"
Nil	Traces	4,820	Traces	Traces	"	..	"
CASE No. 58.			TREATMENT : 30 grs. Sulphate Orally.				
23·08	15·14	2,400	6·15	65·60	Light & clear	1,012	Neg.
23·08	10·36	1,790	5·78	44·90	Light & cloudy	1,020	"
23·08	10·27	1,640	6·26	44·50	" "	1,022	"
23·08	11·23	1,720	6·53	48·66	" "	1,018	"
23·08	12·56	1,640	7·65	54·42	Light & clear	1,018	"
23·08	12·10	1,780	6·79	52·25	" "	1,018	"
23·08	15·48	1,940	7·99	67·07	" "	1,014	"
23·08	15·82	1,810	8·74	68·54	" "	1,016	"
23·08	8·50	1,770	4·82	36·08	" "	1,016	"
23·08	11·55	2,080	5·58	50·22	" "	1,016	"
23·08	8·97	1,970	4·55	38·90	" "	1,020	"
23·08	10·72	2,040	5·26	46·45	" "	1,016	"
23·08	15·03	1,840	8·16	65·12	" "	1,018	"

QUANTITATIVE ESTIMATION OF QUININE IN THE URINE—
continued.

Daily dose of Q.B. in grs.	Daily excretion of Q.B. in grs.	Daily secretion of Urine in c.c.	Daily excretion of Q.B. in grs. per litre of Urine.	Daily excretion of Q.B. in per cent.	Appearance of Urine.	Specific gravity of Urine.	Albumin.
CASE No. 173.				TREATMENT : 30 grs. Sulphate Orally.			
23·08	13·62	1,140	11·07	59·00	Clear	1,018	Neg.
23·08	15·15	1,020	14·35	65·64	Light	1,014	"
23·08	13·15	1,220	10·73	56·97	"	1,014	"
23·08	"	"	"	"	"	"	"
23·08	"	"	"	"	"	"	"
23·08	15·28	1,380	11·01	66·20	Dark	1,016	Neg.
23·08	7·65	1,080	7·08	33·15	Light	1,020	"
CASE No. 224.				TREATMENT : 30 grs. Sulphate Orally.			
23·08	7·36	620	11·88	31·90	Dark	"	Neg.
23·08	5·14	420	12·24	22·27	"	1,028	"
Nil	4·24	630	6·88	18·36	"	1,025	"
"	Traces	380	Traces	Traces	Light	1,020	"
"	"	650	"	"	"	1,024	"
23·08	18·92	1,350	14·01	81·96	"	"	"
23·08	11·66	1,260	9·26	50·52	"	1,020	"
Nil	2·46	450	5·46	10·66	"	1,025	"
Nil	Traces	430	Traces	Traces	"	1,024	"
CASE No. 260.				TREATMENT : 30 grs. Sulphate Orally.			
23·08	12·16	1,460	8·32	52·68	Light	1,020	Neg.
23·08	10·84	1,170	9·26	46·96	"	1,016	"
23·08	11·72	1,260	9·30	50·78	"	1,018	"
23·08	14·16	1,480	9·56	61·35	"	1,020	"
23·08	7·12	1,730	4·08	30·85	"	1,018	"
23·08	9·56	1,560	6·12	41·42	"	1,018	"
23·08	10·75	1,280	8·39	46·53	"	1,018	"
23·08	11·16	1,490	7·50	48·35	"	1,018	"
23·08	12·42	1,270	9·78	53·80	"	1,018	"
23·08	10·72	1,240	8·64	46·45	"	1,018	"
23·08	9·12	1,180	7·72	39·50	"	1,016	"
23·08	14·16	1,420	9·98	61·34	"	1,020	"
23·08	10·02	1,370	7·32	43·42	"	1,018	"
23·08	14·26	1,280	11·14	53·98	"	1,018	"
23·08	12·17	1,160	10·50	52·73	"	1,020	"
23·08	15·16	1,080	11·15	65·68	"	1,020	"
23·08	10·08	1,430	7·05	43·68	"	1,018	"
23·08	11·56	1,160	9·96	50·09	"	1,016	"
23·08	15·17	1,180	12·85	65·72	"	1,020	"

QUANTITATIVE ESTIMATION OF QUININE IN THE URINE—
continued.

Daily dose of Q B in grs	Daily excretion of Q B in grs.	Daily secretion of Urine in c c	Daily excretion of Q B in grs per litre of Urine	Daily excretion of Q B in per cent	Appearance of Urine	Specific gravity of Urine	Albumin
CASE No. 260				TREATMENT : 30 grs. Sulphate Orally.			
23·08	19·22	1,480	12·98	83·28	Light	1,018	Neg
23·08	17·46	1,560	11·20	75·65	"	1,018	"
23·08	18·12	1,730	10·48	78·50	"	1,018	"
23·08	21·56	1,890	11·40	93·42	"	1,020	"
23·08	22·17	1,640	13·52	96·20	"	1,018	"
23·08	23·12	1,730	13·36	100·02	"	1,018	"
23·08	20·84	1,260	16·54	90·30	"	1,018	"
CASE No. 381.				TREATMENT : 30 grs Sulphate Orally			
23·08	12·77	890	14·35	55·32	Dark	1,025	Neg.
23·08	10·95	920	11·90	47·44	Light	1,020	"
23·08	12·00	1,040	11·52	51·90	Dark	1,020	"
23·08	5·02	820	6·12	21·75	Light	1,024	"
23·08	4·53	740	6·12	19·62	Dark	1,018	"
23·08	3·38	950	3·55	14·64	"	1,020	"
23·08	..	..	..	..	..	..	..
23·08	2·68	480	5·58	11·62	Dark	1,024	Neg
23·08	12·28	1,080	11·37	53·20	Light	1,012	"
23·08	10·43	980	10·65	45·19	Dark	1,016	"
CASE No. 424.				TREATMENT : 30 grs. Sulphate Orally			
23·08	18·64	1,600	10·29	80·76	Dark	1,025	Neg.
23·08	12·63	1,580	7·99	54·72	"	1,024	"
23·08	15·32	1,640	9·34	40·46	"	1,024	"
23·08	8·25	1,240	6·65	35·75	"	1,028	"
23·08	10·49	1,750	5·93	45·45	"	1,022	"
23·08	9·76	1,600	6·10	42·28	Light	1,028	"
23·08	6·22	820	7·58	26·95	Dark	1,016	"
23·08	21·63	1,570	11·00	93·72	"	1,020	"
23·08	10·27	1,720	6·50	43·90	Light	1,014	"
23·08	24·06	1,960	12·28	104·28	"	1,010	"
23·08	2·52	790	3·06	10·90	Dark	1,020	"
23·08	9·52	920	10·33	41·24	Light	1,028	"
23·08	12·25	1,140	9·86	53·07	"	1,022	"
23·08	11·35	1,280	11·27	49·06	"	1,020	"
23·08	15·09	1,420	10·38	65·38	"	1,020	"
23·08	18·18	1,640	11·08	78·76	"	1,018	"

QUANTITATIVE ESTIMATION OF QUININE IN THE URINE—
continued.

Daily dose of Q B in grs	Daily excretion of Q B in grs	Daily secretion of Urine in c c	Daily excretion of Q B in grs per litre of Urine	Daily excretion of Q B in per cent	Appearance of Urine	Specific gravity of Urine	Albumin
CASE No. 426				TREATMENT: 30 grs Sulphate Orally			
23-08	7-22	1,080	6-68	31-28	Dark	1,018	Neg
23-08	7-12	1,040	6-84	30-84	"	1,022	"
23-08	9-82	930	10-56	42-54	"	1,022	"
23-08	2-64	580	4-55	11-43	"	1,026	"
23-08	..	..	..	..	..	..	..
23-08	6-93	480	14-42	30-93	Dark	1,024	Neg
23-08	10-26	940	10-92	44-46	"	1,020	"
23-08	13-48	1,430	11-80	58-40	"	1,028	"
23-08	7-14	1,140	6-26	30-94	"	1,020	"
23-08	6-12	1,580	3-88	26-51	"	1,018	"
23-08	5-22	1,260	4-14	22-60	"	1,022	"
23-08	4-72	1,190	3-96	20-44	"	1,020	"
23-08	6-18	1,270	4-86	26-78	"	1,016	"
23-08	7-18	1,140	6-30	31-10	"	1,018	"
23-08	5-22	1,100	4-74	22-62	"	1,017	"
23-08	4-48	1,020	4-40	19-40	"	1,018	"
23-08	4-12	1,260	3-27	7-85	"	1,018	"
23-08	6-22	1,440	4-32	26-95	"	1,020	"
23-08	8-19	1,620	5-06	35-50	"	1,020	"
23-08	9-17	1,090	8-42	39-72	"	1,022	"
23-08	6-42	1,270	5-94	27-82	"	1,022	"
23-08	5-12	1,290	3-97	22-18	"	1,016	"
23-08	11-14	1,140	9-78	48-28	Light	1,018	"
23-08	9-17	1,460	6-28	39-73	"	1,018	"
23-08	8-16	1,620	5-04	35-55	"	1,020	"
23-08	14-16	1,180	12-00	61-36	"	1,020	"
23-08	7-22	1,100	6-56	31-18	"	1,020	"
23-08	6-27	1,270	4-94	27-16	Dark	1,018	"
23-08	8-14	1,640	4-96	35-26	"	1,020	"
23-08	12-40	1,480	8-38	53-72	"	1,020	"
23-08	6-12	1,170	5-23	26-52	"	1,018	"
CASE No 524				TREATMENT: 30 grs Sulphate Orally			
23-08	15-09	1,280	11-80	65-38	Dark	1,022	Ne
23-08	7-68	470	16-34	33-28	"	1,024	"
23-08	9-69	780	12-42	41-98	Light	1,016	"
23-08	7-76	720	8-00	33-62	"	1,018	"
23-08	11-30	970	11-64	48-96	"	1,014	"
23-08	6-06	540	11-20	26-26	Dark	1,020	"
23-08	5-96	370	11-04	25-82	"	1,018	"
23-08	..	..	..	..	..	..	..
23-08	10-90	840	13-26	47-22	Dark	1,020	Neg

QUANTITATIVE ESTIMATION OF QUININE IN THE URINE—
continued.

Daily dose of Q B in grs.	Daily excretion of Q B in grs	Daily secretion of Urine in c c	Daily excretion of Q B in grs per litre of Urine	Daily excretion of Q B in per cent	Appearance of Urine	Specific gravity of Urine	Albumin
CASE No. 610				TREATMENT : 30 grs Sulphate Orally.			
23-08	9.92	1,780	5.58	42.98	Light	1,012	Neg.
23-08	13.47	2,040	6.60	58.36	"	1,012	"
23-08	12.11	1,230	9.84	52.47	"	1,012	"
23-08	12.54	1,240	10.10	54.33	"	1,016	"
23-08	12.72	1,940	8.26	55.11	"	1,014	"
23-08	18.74	1,780	7.72	58.45	"	1,018	"
23-08	16.10	1,720	9.36	69.75	"	1,014	"
23-08	12.80	1,280	10.14	55.46	"	1,018	"
CASE No 640.				TREATMENT : 30 grs. Sulphate Orally.			
23-08	7.15	450	15.88	30.98	Dark	1,022	Neg
23-08	10.21	940	10.86	44.24	Light	1,016	"
23-08	7.15	1,140	6.24	30.98	Dark	1,020	"
CASE No. 504.				TREATMENT : 30 grs. Sulphate (Tablets) Orally.			
23-08	11.07	1,040	10.63	47.96	Light	1,022	Neg
23-08	6.80	1,180	5.76	29.46	"	1,020	"
23-08	7.40	1,200	6.16	32.06	"	1,020	"
23-08	12.30	1,690	6.90	50.70	"	1,018	"
23-08	11.91	1,540	7.73	51.60	"	1,016	"
23-08	..	..	..	..	..	..	..
23-08	6.69	940	7.12	28.98	Light	1,018	Neg.
23-08	6.92	1,170	5.92	29.98	"	1,012	"
23-08	15.12	1,260	12.00	65.51	"	1,018	"
23-08	7.36	640	11.50	31.88	"	1,014	"
CASE No. 506.				TREATMENT : 30 grs Sulphate (Tablets) Orally.			
23-08	15.40	1,840	8.37	66.72	Light	1,020	Neg
23-08	17.34	1,760	9.85	75.13	Dark	1,024	"
23-08	16.56	1,680	9.84	71.75	Light	1,024	"
23-08	16.63	1,740	9.55	72.05	"	1,020	±
23-08	7.91	780	10.14	34.26	"	1,026	"
23-08	2.51	980	2.56	10.88	Dark	1,020	"
23-08	12.52	1,070	11.70	54.24	Light	1,018	"
23-08	13.43	1,480	9.08	58.20	"	1,012	"
23-08	14.00	1,270	11.00	60.65	"	1,018	"
23-08	9.00	1,290	6.97	39.00	"	1,012	"

QUANTITATIVE ESTIMATION OF QUININE IN THE URINE—
continued.

Daily dose of Q B in grs	Daily excretion of Q B in grs	Daily secretion of Urine in c c	Daily excretion of Q B in grs per litre of Urine	Daily excretion of Q B in per cent	Appearance of Urine	Specific gravity of Urine	Albumin
CASE No 621			TREATMENT : 30 grs Sulphate (Tablet) Orally				
23 08	18.41	1,840	10 00	79.78	Dark	1,018	Pos.
23 08	9.20	1,280	7.18	39.86	Light	1,016	"
23 08	10.84	1,530	7.08	46.96	Dark	1,020	"
23 08	10.28	1,430	7.18	44.54	"	1,022	"
23 08	10.80	1,140	9.48	46.80	"	1,022	"
23 08	7.33	870	8.42	31.76	Light	1,026	"
23 08	6.33	960	6.70	27.43	"	1,022	"
23 08	6.84	780	8.78	29.64	"	1,026	"
23 08	7.30	980	7.44	31.63	"	1,020	"
23 08	7.60	1,180	6.50	32.93	"	1,016	"
23 08	9.31	1,270	7.34	40.34	"	1,018	"
23 08	9.74	1,270	7.66	42.20	"	1,014	Neg
23 08	14.76	1,940	7.68	63.52	"	1,012	"
23 08	14.30	1,870	6.98	61.96	"	1,014	"
CASE No 260			TREATMENT : 58 grs. Sulphate Orally				
44 64	15.55	610	25.49	35.35	Dark	..	Pos.
Nil	10.89	420	25.93	24.75	"	..	"
Nil	Traces	870	Traces	Traces	"	..	"
Nil	"	1,030	"	"	"	..	"
CASE No 258.			TREATMENT : 70 grs Sulphate Orally.				
53 88	6.94	960	7.23	12.88	Dark	1,025	Neg.
Nil	6.85	480	14.27	12.72	"	1,028	Pos
Nil	Traces	540	Traces	Traces	"	1,020	"
Nil	"	750	"	"	"	1,020	"
CASE No 683.			TREATMENT . 30 grs Hydrochloride Orally.				
24.54	10.84	1,780	7.64	44.18	Light	1,018	Neg.
24.54	14.39	1,890	7.62	58.64	"	1,018	"
24.54	14.06	1,820	7.72	57.30	"	1,024	"
24.54	17.33	1,490	14.64	70.62	Dark	1,022	"
24.54	12.81	1,580	8.10	52.32	Light	1,020	"
24.54	12.28	1,640	7.48	50.04	"	1,022	"
24.54	19.56	1,780	11.00	79.70	"	1,020	"
24.54	18.81	1,840	10.15	76.65	"	1,018	"

QUANTITATIVE ESTIMATION OF QUININE IN THE URINE—
continued

Daily dose of Q B in grs	Daily excretion of Q B in grs	Daily secretion of Urine in c c	Daily excretion of Q B in grs per litre of Urine	Daily excretion of Q B in per cent	Appearance of Urine	Specific gravity of Urine	Albumin
TREATMENT . 30 grs Hydrochloride Orally							
CASE No 691.							
24 54	14 83	1,280	11.56	60 43	Dark	1,022	Neg
24 54	12 53	1,170	10 70	51 06	Light	1,014	"
24 54	10 38	1,200	9 93	42 30	Dark	1,022	"
24 54	12 48	1,280	9 75	50 86	Light	1,020	"
24 54	12 59	1,400	8 99	51 30	"	1,022	"
24 54	"	"	"	"	"	"	"
24 54	19 11	1,680	11 36	77 87	Light	1,018	Neg
24 54	11 50	1,640	7 02	46 87	"	1,018	"
TREATMENT : 30 grs Hydrochloride Orally							
CASE No 694							
24 54	11 47	1,740	6 60	46 74	Light	1,018	Neg
24 54	11 50	1,860	6 18	46 86	"	1,018	"
24 54	13 17	1,940	6 78	53 67	"	1,018	"
24 54	8 25	1,730	4 77	33 62	"	1,018	"
24 54	14 30	1,870	7 64	58 28	"	1,018	"
24 54	8 75	1,740	5 04	35 66	"	1,018	"
TREATMENT 30 grs. Hydrochloride Orally							
CASE No 703							
24 54	18 96	2,040	9 30	77 26	Light	1,022	Neg.
24 54	11 70	1,980	5 91	47 68	"	1,020	"
24 54	10 96	1,740	10 96	44 66	"	1,018	"
24 54	10 38	1,730	6 00	42 30	"	1,018	"
24 54	9 02	1,640	5 74	38 38	"	1,016	"
24 54	15 38	1,620	9 50	62 67	"	1,020	"
24 54	10 00	1,680	5 95	40 75	"	1,022	"
24 54	12 68	1,770	7 33	51 67	"	1,020	"
TREATMENT : 30 grs Hydrochloride Orally							
CASE No 706							
24 54	11 04	1,760	6 28	44 98	Light	1,018	Neg
24 54	10 98	1,840	5 96	44 75	"	1,020	"
24 54	11 82	1,730	6 84	48 28	"	1,018	"
24 54	15 37	1,940	7 92	62 64	"	1,018	"
24 54	16 04	1,860	8 62	65 36	"	1,020	"
24 54	16 13	1,770	9 12	65 88	"	1,018	"
24 54	12 24	1,720	7 12	49 88	"	1,020	"
24 54	13 31	1,840	7 24	54 24	"	1,018	"

QUANTITATIVE ESTIMATION OF QUININE IN THE URINE—
continued

Daily dose of Q B in grs	Daily excretion of Q B in grs	Daily excretion of Urine in c.c.	Daily excretion of Q B in grs per litre of Urine	Daily excretion of Q B in per cent	Appearance of Urine	Specific gravity of Urine	Albumin
CASE No 708			TREATMENT : 30 grs Hydrochloride Orally				
24 54	18.92	1,870	10 12	77 10	Light	1,020	Neg
24 54	19 64	1,940	12 78	80 03	"	1,022	Pos
24 54	19.30	2,040	7 87	78 64	"	1,020	"
24 54	13 14	2,460	5.34	53 55	"	1,018	"
24 54	10.62	2,120	5.09	43.28	"	1,020	"
24 54	10 43	1,740	6.00	42 50	"	1,020	"
CASE No. 709			TREATMENT : 30 grs. Hydrochloride Orally.				
24 54	13.76	1,940	7 09	56.08	Light	1,022	Neg
24 54	12 72	2,080	6 12	51.84	"	1,018	"
24 54	16 35	1,810	8 74	66 62	"	1,018	"
24 54	14.22	1,740	8.18	57 94	"	1,016	"
24 54	15.13	1,730	8.74	61 66	"	1,018	"
24 54	11.56	1,940	5 96	47.10	"	1,018	"
CASE No 733			TREATMENT : 30 grs Hydrochloride Orally.				
24 54	11 93	1,870	6.38	48.62	Light	1,018	Neg
24 54	11 85	1,930	6.14	48.29	"	1,018	"
24 54	12 02	1,740	6 90	48.98	"	1,018	"
24 54	11.87	1,840	6.45	48.37	"	1,016	"
24 54	14.51	1,850	7.67	59.12	"	1,020	"
24 54	11 13	1,770	6.30	45.36	"	1,022	"
24 54	11 83	1,680	7.04	48.20	"	1,020	"
24 54	11.90	1,740	6.43	45 60	"	1,018	"
CASE No. 979			TREATMENT : 30 grs Hydrochloride Orally				
24 54	11 24	1,870	6.01	45 80	Light	1,022	Neg
24 54	11 45	1,740	6.58	46.65	"	1,022	"
24 54	9 39	1,590	5.56	38 26	"	1,018	"
24 54	9.47	1,540	6.16	38.58	"	1,018	"
24 54	10.70	1,640	6 52	43 60	"	1,018	"
24 54	10.20	1,740	5 86	41.57	"	1,018	"
24 54	10 57	1,690	6.26	43.07	"	1,018	"

QUANTITATIVE ESTIMATION OF QUININE IN THE URINE—
continued

Daily dose of Q B in grs	Daily excretion of Q B in grs	Daily secretion of Urine in c c	Daily excretion of Q B in grs per litre of Urine	Daily excret on of Q B in per cent	Appearance of Urine	Specific gravity of Urine	Albu- min
TREATMENT : 70 grs Hydrochloride Orally							
CASE No. 841							
57·28	20·35	1,560	13·15	35·53	Dark	1,020	Pos
TREATMENT · 70 grs Hydrochloride Orally							
CASE No. 981							
57·28·	28·94	1,680	17·22	50·53	Dark	1,022	Pos.
57·28	19·89	1,460	13·62	34·74	..	1,022	..
TREATMENT 70 grs Hydrochloride Orally.							
CASE No 982.							
57·28	21·39	1,480	14·46	59·20	Dark	1,020	Pos
57·28	15·40	1,160	13·26	26·90	..	1,020	..
TREATMENT 30 grs Bhydrochloride Orally.							
CASE No. 697.							
24·48	14·07	2,260	6·22	57·46	Light	1,018	Neg
24·48	15·95	1,780	8·96	65·15	..	1,018	..
24·48	15·24	1,690	9·02	62·24	..	1,018	..
24·48	14·79	1,760	8·40	60·42	..	1,016	..
24·48	10·84	1,690	6·42	44·28	..	1,020	..
24·48	11·82	1,740	6·68	48·28	..	1,022	..
TREATMENT 30 grs Bhydrochloride Orally							
CASE No 732							
24·48	16·62	1,740	9·35	67·90	Light	1,018	Neg
24·48	16·06	1,680	9·56	65·60	..	1,016	..
24·48	14·71	1,890	7·78	60·09	..	1,016	..
24·48	15·44	1,790	8·62	63·06	..	1,018	..
24·48	12·56	1,640	7·66	51·30	..	1,018	..

QUANTITATIVE ESTIMATION OF QUININE IN THE URINE—
continued

Daily dose of Q B in grs	Daily excretion of Q B in grs	Daily secretion of Urine in c.c.	Daily excretion of Q B in grs per litre of Urine	Daily excretion of Q B in per cent	Appearance of Urine	Specific gravity of Urine	Albumin
CASE No 849			TREATMENT 30 grs Bihydrochloride Orally				
24 48	13 01	1,280	12.50	53.14	Light	1,018	Pos
24 48	9 35	1,420	6 74	38.20	"	1,018	"
24 48	8.56	1,260	6 80	34.96	"	1,020	"
24 48	10 86	1,690	6.42	44.36	"	1,020	Neg
24 48	9 81	1,590	6 18	40.06	"	1,018	"
24 48	10.04	1,640	6 34	42.86	"	1,018	"
CASE No 928.			TREATMENT 30 grs Bihydrochloride Orally.				
24 48	18 19	1,560	11 66	74.30	Light	1,020	Neg
24 48	9 57	1,040	9.20	39.10	"	1,022	"
24 48	13.05	1,160	11 25	53.31	"	1,022	"
24 48	16 78	1,440	11 64	68.55	"	1,020	"
24 48	16 16	1,560	10 36	66.02	"	1,018	"
24 48	17 79	1,590	11.20	72 67	"	1,018	"
24 48	17 47	1,520	11.50	71 36	"	1,018	"
CASE No 929			TREATMENT: 30 grs Bihydrochloride Orally				
24 48	13.42	1,460	9.20	54.82	Dark	1,022	Neg.
24 48	11.46	1,170	9 80	46 82	Light	1,018	"
24 48	15.75	1,290	12.20	64.34	"	1,018	"
24 48	16 43	1,460	11.24	67.12	"	1,016	"
24 48	15.46	1,420	10.64	63.16	"	1,018	"
24 48	17 66	1,540	11.46	72 14	"	1,016	"
24 48	16 92	1,490	11.36	69.10	"	1,018	"
CASE No 945			TREATMENT. 30 grs Bihydrochloride Orally				
24 48	9 01	1,460	6.18	36.80	Light	1,018	Neg
24 48	9 80	1,590	6 16	40 04	"	1,018	"
24 48	14.80	1,690	9.17	60.45	"	1,020	"
24 48	13.55	1,640	8.26	55.34	"	1,018	"
24 48	9 09	1,460	6.22	37.13	"	1,016	"

QUANTITATIVE ESTIMATION OF QUININE IN THE URINE—
continued.

Daily dose of Q B in grs	Daily excretion of Q B in grs	Daily secretion of Urine in c.c	Daily excretion of Q B in grs per litre of Urine	Daily excretion of Q B in per cent	Appearance of Urine	Specific gravity of Urine	Albumin
CASE No 946.			TREATMENT 30 grs. Bihydrochloride Orally				
24.48	9.67	1,680	5.74	39.50	Light	1,020	Neg
24.48	11.91	1,860	6.30	48.65	"	1,016	"
24.48	15.70	1,740	6.44	64.12	"	1,018	"
24.48	15.95	1,890	8.64	65.16	"	1,016	"
24.48	10.98	1,680	6.54	44.86	"	1,018	"
CASE No. 908.			TREATMENT. 45 grs Bihydrochloride Orally				
36.76	17.58	1,460	12.04	47.86	Light	1,024	Pos
36.76	17.66	1,590	11.10	48.09	"	1,022	"
36.76	19.02	1,940	9.80	51.80	"	1,020	Neg
36.76	15.35	2,060	7.38	41.80	"	1,018	"
36.76	17.37	1,970	8.82	37.12	"	1,018	"
36.76	19.55	1,980	9.88	53.25	"	1,018	"
36.76	17.96	1,860	9.66	48.90	"	1,020	"
CASE No. 910.			TREATMENT 45 grs Bihydrochloride Orally				
36.76	18.75	1,450	12.92	51.06	Light	1,022	Neg
36.76	16.76	1,690	9.92	45.74	"	1,020	"
36.76	20.00	1,740	11.50	54.45	"	1,020	"
36.76	20.00	1,860	10.76	54.45	"	1,020	"
36.76	15.39	1,740	8.84	41.90	"	1,020	"
36.76	18.40	1,690	10.90	50.10	"	1,022	"
36.76	20.21	1,740	11.34	55.02	"	1,020	"
CASE No 938			TREATMENT 45 grs Bihydrochloride Orally				
36.76	16.56	1,240	13.36	45.09	Light	1,018	Neg
36.76	.	.	"	.	"	.	.
36.76	18.74	1,490	12.58	51.02	Light	1,022	Pos
36.76	18.72	1,590	11.71	50.98	"	1,018	"
36.76	14.43	1,260	11.44	39.29	"	1,018	"
36.76	18.72	1,590	11.77	50.96	"	1,022	"

QUANTITATIVE ESTIMATION OF QUININE IN THE URINE—
continued.

Daily dose of Q B in grs	Daily excretion of Q B in grs	Daily secretion of Urine in c c	Daily excretion of Q B in grs per litre of Urine	Daily excretion of Q B in per cent	Appearance of Urine	Specific gravity of Urine	Albumin
CASE No. 939.				TREATMENT : 45 grs Bihydrochloride Orally			
36·76	18·64	1,260	14·80	50·75	Light	1,018	Pos
36·76	..	..	..	..	..	..	..
36·76	..	..	..	..	..	..	..
36·76	16·87	1,460	11·56	45·94	Light	1,018	Pos.
36·76	18·12	1,480	12·24	48·22	"	1,020	"
36·76	9·78	1,660	5·90	26·62	"	1,020	"
CASE No 202 *				TREATMENT : 30 grs Hydrobromide Orally.			
24·00	17·15	2,630	6·68	73·12	Light	..	Neg.
24·00	35·55	4,950	6·17	127·82	"	..	"
Nil	Traces	6,240	Traces	Traces	"	..	"
CASE No 202 *				TREATMENT 30 grs. Hydrobromide Orally.			
24 00	4 88	5,280	0 92	20·32	Clear	..	Neg
24 00	34 42	4,620	7·45	146·78	"	..	"
Nil	Traces	3,640	Traces	Traces	"	..	"
CASE No 605				TREATMENT .. 30 grs Hydrobromide Orally.			
24 00	14 19	1,740	8·15	59·12	Light	1,018	Neg.
24·00	..	..	..	..	..	..	..
24·00	10 77	1,620	6 64	44·88	Light	1,014	Neg.
24·00	11 66	1,680	7 02	48·58	"	1,016	"
24·00	3 58	1,750	2 06	14·92	"	1,014	"
24 00	11 51	1,630	7 06	47·96	"	1,018	"
24·00	13 43	1 700	9 94	55·96	"	1,018	"
24 00	13 73	1,740	7 89	57·22	"	1,018	"
24·00	5 46	1,980	2·76	22·23	"	1,014	"

* See footnote, p. 49

QUANTITATIVE ESTIMATION OF QUININE IN THE URINE—
continued

Daily dose of Q B in grs	Daily excretion of Q B in grs	Daily secretion of Urine in c c	Daily excretion of Q B. in grs per litre of Urine	Daily excretion of Q B in per cent	Appearance of Urine	Specific gravity of Urine	Albumin
CASE No 606.			TREATMENT. 30 grs Hydrobromide Orally.				
24·00	8·95	1,780	5·03	37·30	Dark	1,018	Neg
24·00	7·26	1,970	3·68	30·25	..	1,016	..
24·00	7·86	1,790	3·95	32·75	..	1,012	..
24·00	6·85	1,840	3·72	28·59	..	1,018	..
24·00	....	..	..	..	..	..	..
24·00	5·44	2,020	2·70	22·66	Dark	1,016	Neg
24·00	5·60	1,870	3·00	23·33	..	1,018	..
24·00	6·53	1,740	3·75	27·21	..	1,018	..
24·00	10·04	1,980	5·08	41·84	Light	1,014	..
24·00	9·28	1,740	5·33	38·66	..	1,018	..
24·00	12·38	1,920	6·45	51·58	..	1,016	..
24·00	18·84	1,690	11·14	78·50	..	1,020	..
24·00	12·48	1,780	7·02	52·00	..	1,016	..
24·00	10·06	1,680	6·00	41·92	..	1,020	..
24·00	10·65	1,770	6·02	44·38	..	1,014	..
24·00	10·98	1,840	5·96	45·75	..	1,016	..
CASE No 636.			TREATMENT : 30 grs Hydrobromide Orally.				
24·00	15·55	1,490	10·37	44·80	Dark	1,018	Neg
24·00	9·82	1,470	6·68	40·92	Light	1,016	..
CASE No. 652			TREATMENT 30 grs Hydrobromide Orally				
24·00	16·82	2,780	6·06	70·09	Light	1,012	Neg
24·00	17·24	1,780	9·68	70·20	..	1,014	..
24·00	12·62	1,540	8·20	52·58	..	1,018	..
24·00	13·48	1,870	7·20	56·17	..	1,016	..
24·00	12·62	1,490	8·47	52·58	..	1,018	..
24·00	10·77	1,140	6·56	44·88	..	1,018	..
24·00	12·78	1,280	9·98	53·25	..	1,016	..
24·00	12·80	1,480	8·64	53·30	..	1,018	..

QUANTITATIVE ESTIMATION OF QUININE IN THE URINE—
continued

Daily dose of Q B in grs	Daily excretion of Q B in grs	Daily secretion of Urine in c c	Daily excretion of Q B in grs per litre of Urine.	Daily excretion of Q B in per cent	Appearance of Urine	Specific gravity of Urine.	Albu- min
CASE No 688				TREATMENT : 30 grs Hydrobromide Orally.			
24 00	13 24	1,070	12 36	55 17	Light	1,018	Neg
24 00	8 88	1,140	7 62	36.66	"	1,018	"
24 00	12.77	1,290	9 90	53 20	"	1,020	"
24 00	14.68	1,440	12 82	61.12	"	1,018	"
24 00	15.72	1,680	9 36	65.50	"	1,020	"
24.00	10 74	1,740	6 18	44.75	"	1,018	"
24.00	15.92	1,680	9 48	66.34	"	1,022	"
24 00	16 80	1,730	9 71	17.00	"	1,018	"
CASE No 749				TREATMENT · 30 grs Hydrobromide Orally.			
24.00	20.30	1,870	10.86	84 58	Light	1,018	Neg
24.00	22.20	1,940	11.44	92.54	"	1,016	"
24.00	19 05	1,680	11 32	79.37	"	1,022	"
24.00	12.65	1,180	10.72	52.70	"	..	"
24.00	13.77	1,460	9 44	57.38	"	..	"
24 00	20.16	2,260	11 18	84.00	"	..	"
24 00	17.80	1,940	11 54	14.17	"	..	"
CASE No 786				TREATMENT : 30 grs Hydrobromide Orally.			
24.00	13 96	1,180	11.82	58.16	Light	1,018	Neg.
24.00	16 39	1,690	9.70	68.30	"	1,018	"
24.00	19 66	1,740	11.30	81.92	"	1,018	"
24.00	19 73	1,690	11 66	82.20	"	1,020	"
24.00	18.02	1,790	10.06	75.08	"	..	"
24.00	18.11	1,980	9.14	75.46	"	.	"
CASE No 732				TREATMENT · 30 grs Lactate Orally.			
23.46	9.33	1,480	6.30	39.76	Light	1,018	Neg
23.46	11.53	1,890	6.10	49.15	"	1,016	"
23.46	11 04	1,760	6.28	47.06	"	1,018	"
23.46	12.45	1,840	6.76	53.07	"	1,018	"
23.46	10.84	1,640	6 61	46.20	"	1,018	"

QUANTITATIVE ESTIMATION OF QUININE IN THE URINE—
continued

Daily dose of Q B in grs	Daily excretion of Q B in grs	Daily secretion of Urine in c c	Daily excretion of Q B in grs per litre of Urine	Daily excretion of Q B in per cent	Appearance of Urine	Specific gravity of Urine	Albumin
CASE No. 816.				TREATMENT 30 grs Lactate Orally			
23·46	7·13	740	9·63	30·40	Light	1,026	Neg
23·46	11·70	1,170	10·00	49·86	"	1,022	"
23·46	11·62	1,170	9·94	49·52	"	1,022	"
23·46	..	..	..	..	"	..	..
23·46	..	..	..	..	"	..	..
23·46	8·27	1,170	7·06	35·26	Light	1,022	Neg
23·46	9·38	1,460	6·42	39·98	"	1,018	"
23·46	9·68	1,630	6·00	41·26	"	1,016	"
CASE No 818				TREATMENT 30 grs Lactate Orally			
23·46	5·68	1,180	4·82	24·16	Light	1,022	Neg
23·46	6·60	970	6·65	28·14	"	1,022	"
23·46	..	..	..	..	"	..	..
23·46	..	..	..	..	"	..	..
23·46	6·53	1,070	6·10	27·83	Light	1,022	Neg
23·46	7·77	1,140	6·87	33·10	"	1,020	"
23·46	7·52	1,240	6·06	32·04	"	1,016	"
23·46	7·42	1,170	6·34	31·62	"	1,018	"
23·46	8·25	1,290	6·40	35·16	"	1,018	"
CASE No 828				TREATMENT : 30 grs Lactate Orally			
23·46	11·08	1,180	10·30	47·34	Light	1,018	Neg
23·46	..	..	..	..	"	..	..
23·46	9·68	1,060	9·13	41·26	Light	1,018	Neg
23·46	8·42	1,140	7·38	35·88	"	1,018	"
23·46	8·51	1,280	6·64	36·28	"	1,020	"
23·46	11·66	1,890	6·16	49·70	"	1,016	"
23·46	11·30	1,840	6·14	48·16	"	1,016	"
CASE No 994				TREATMENT 30 grs Lactate Orally			
23·46	11·92	1,940	6·14	50·18	Light	1,018	Neg
23·46	14·80	1,870	7·91	63·10	"	1,016	"
23·46	10·38	1,740	5·96	44·24	"	1,018	"
23·46	9·69	1,640	5·90	41·30	"	1,018	"
23·46	9·49	1,540	6·16	41·40	"	1,020	"
23·46	11·07	1,840	6·30	47·20	"	1,018	"
23·46	10·85	1,740	6·24	46·24	"	1,018	"

QUANTITATIVE ESTIMATION OF QUININE IN THE URINE —
continued

Daily dose of Q B in grs.	Daily excretion of Q B in grs	Daily secretion of Urine in c c	Daily excretion of Q B in grs per litre of Urine	Daily excretion of Q B in per cent	Appearance of Urine	Specific gravity of Urine	Albu min.
CASE No 982				TREATMENT : 45 grs. Lactate Orally.			
35·19	11 25	1,450	7·76	31·97	Light	1,018	Neg
35·19	8 54	1,620	5 28	24·27	"	1,018	"
35 19	"	"	"	"	"	"	"
35·19	9·57	1,480	6 46	27·20	Light	1,018	Neg
35·19	10 62	1,840	5 78	30·16	"	1,018	"
35·19	10 86	1,690	6·42	30 86	"	1,020	"
CASE No 1,014				TREATMENT : 45 grs. Lactate Orally			
35 19	7 83	1,260	6 22	22 24	Light	1,020	Neg.
35·19	9 39	1,720	5·46	27 94	"	1,018	"
35 19	"	"	"	"	"	"	"
35 19	10 18	1,640	6·20	28 92	Light	1,018	Neg
35 19	10 64	1,740	6·12	30·24	"	1,020	"
35 19	11·10	1,940	5 72	25·06	"	1,016	"
CASE No 314				TREATMENT 40·75 grs. Alkaloid Orally			
40 75	17 47	1,020	17 10	42 87	Dark	1,025	Neg
40 75	8·38	610	13 74	20·56	"	1,027	Pos.
40·75	12·09	980	12 33	29·67	Light	1,025	"
Nil	Traces	220	Traces	Traces	"	1,020	Neg.
Nil	"	780	"	"	"	1,022	"
Nil	"	840	"	"	"	1,020	"
CASE No 310				TREATMENT . 47·25 grs. Alkaloid Orally			
47 25	20 90	940	22·24	44·24	Dark	1,025	Neg
47 25	22 20	1,110	20 00	46·98	"	1,020	Pos
47 25	9 71	720	13 80	20·55	"	1,026	Neg
Nil	Traces	870	Traces	Traces	"	1,024	"
Nil	"	920	"	"	"	1,020	"
CASE No 821				TREATMENT 45 grs. Euquinine Orally			
33 68	6 58	1,190	5 52	19·55	Dark	1,020	Neg
33 68	8·35	1,390	6 00	24·80	"	1,022	"
33 68	8 27	1,590	5·22	24·56	"	1,020	"
33 68	9 56	1,520	6 29	28·33	"	1,018	"
33 68	8 46	1,490	5 67	25·12	"	1,020	"
33 68	8·52	1,570	5·42	25·30	"	1,018	"

QUANTITATIVE ESTIMATION OF QUININE IN THE URINE—
continued

Daily dose of Q B in grs	Daily excretion of Q B in grs	Daily secretion of Urine in c c	Daily excretion of Q B in grs per litre of Urine.	Daily excretion of Q B in per cent	Appearance of Urine	Specific gravity of Urine	Albumin
TREATMENT : 45 grs Euquinine Orally.							
CASE No. 917							
33-68	7.76	1,260	6.16	23.05	Dark	1,022	Neg
33 68	6.85	1,120	5.97	16.16	"	1,022	"
33 68	8 68	1,640	5 18	25.78	"	1,022	"
33-68	8 66	1,530	5 66	25.72	"	1,020	"
33-68	8.34	1,470	5.67	24 77	Light	1,018	"
33-68	9.83	1,520	6.46	29.20	"	1,018	"
TREATMENT 45 grs Euquinine Orally							
CASE No 1,067							
33-68	10 09	1,640	6 64	32 36	Dark	1,022	Neg
33-68	11.01	1,690	6.52	32.70	"	1,020	"
TREATMENT 45 grs Euquinine Orally							
CASE No 1,070							
33-68	8 37	1,520	5 50	24 84	Dark	1,024	Pos
33 68	9 84	1,620	6 08	29 22	"	1,018	"
TREATMENT 45 grs. Euquinine Orally							
CASE No 1,071							
33-68	10.16	1,760	5.77	30.16	Dark	1,018	Neg
33-68	12.36	1,840	6 72	36 70	"	1,022	"
TREATMENT : 15 grs Bhydrochloride Intramuscularly.							
CASE No 647							
12-24	2.35	740	3.18	19.20	Dark	1,018	Neg
12-24	5.40	970	5.56	27.78	"	1,016	"
12-24	6.86	1,140	6.02	56.04	Light	1,016	"
12-24	6.50	740	8.78	53.10	"	1,018	"
12-24	6.76	820	8.24	55.22	"	1,020	"
12-24	8.40	1,240	6.78	71 85	"	1,018	"

QUANTITATIVE ESTIMATION OF QUININE IN THE URINE—
continued

Daily dose of Q B in grs	Daily excretion of Q B in grs	Daily secretion of Urine in c c	Daily excretion of Q B in grs per litre of Urine	Daily excretion of Q B in per cent	Appearance of Urine	Specific gravity of Urine	Albumin
CASE No 648				TREATMENT: 15 grs Bihydrochloride Intramuscularly			
12 24	4 85	840	5.77	39 62	Light	1,016	Neg
12 24	5 65	960	5 88	58 10	"	1,012	"
12 24	6 68	1,090	6 12	54 58	"	1,016	"
12 24	7 85	940	8 36	64.14	"	1,014	"
12 24	8 66	1,070	8 10	70 75	"	1,016	"
12 24	6 14	940	6 54	50.16	"	1,022	"
12 24	6 56	1,070	6 14	53 60	"	1,018	"
CASE No 64				TREATMENT 22.5 grs Bihydrochloride Intramuscularly			
18 36	8 93	840	10 60	48 63	Cloudy	..	Neg
18 36	1 11	1,040	Traces	Traces	"	..	"
18 36	4.19	1,520	2 70	22.28	"	..	"
18 36	5 65	1,150	4 80	30 76	"	..	"
Nil	Traces	1,260	Traces	Traces	Clear	..	"
Nil	"	1,650	"	"	"	..	"
CASE No 163				TREATMENT. 22 5 grs Bihydrochloride Intramuscularly			
18 36	15 06	970	15 50	82 02	Cloudy	..	Pos
18 36	13 12	1,080	12 00	71.46	"	..	"
18 36	2.07	1,230	1 68	11.27	"	..	"
Nil	Traces	1,460	Traces	Traces	"	..	"
Nil	"	550	"	"	"	..	"
CASE No 177				TREATMENT 22.5 grs Bihydrochloride Intramuscularly			
18 36	15.49	620	22 98	84.37	Cloudy	..	Neg
18 36	6.94	345	20 12	37.80	"	..	Pos
18 36	2.55	1,620	1 58	15.57	"	..	"
18 36	4.17	350	11.90	22.71	Dark & Clear	..	"
18 36	12.46	1,140	10 90	67.86	Cloudy	..	"
18 36	8.34	460	18.13	45.42	"	..	"
18 36	8.31	910	9.11	45.48	Clear	..	Neg.
Nil	Traces	1,180	Traces	Traces	"	..	"
Nil	"	780	"	"	"	..	"

QUANTITATIVE ESTIMATION OF QUININE IN THE URINE—
continued

Daily dose of Q B in grs.	Daily excretion of Q B in grs	Daily secretion of Urine in c c	Daily excretion of Q B in grs per litre of Urine	Daily excretion of Q B in per cent	Appearance of Urine	Specific gravity of Urine	Albumin
CASE No 1,049			TREATMENT : 30 grs. Bihydrochloride Intramuscularly				
24·48	10·11	1,680	6·02	41·30	Light	1,020	Pos.
24·48	15·66	1,740	9·00	63·97	"	1,022	"
24·48	15·35	1,690	9·08	62·70	"	1,024	"
CASE No 1,069			TREATMENT . 30 grs Bihydrochloride Intramuscularly.				
24·48	16·60	1,960	8·46	67·84	Light	1,022	Pos
24·48	14·31	1,760	8·13	58·46	"	1,020	"
24·48	13·74	1,860	7·38	56·12	"	1,022	"
24·48	11·31	1,680	6·74	46·20	"	1,024	"
CASE No 1,113			TREATMENT · 30 grs Bihydrochloride Intramuscularly				
24·48	12·13	1,480	8·20	49·55	Light	1,020	Neg
24·48	11·06	1,540	7·18	45·18	"	1,022	Pos
24·48	12·18	1,490	8·18	49·76	"	1,020	"
24·48	9·35	1,480	6·32	38·20	"	1,026	"
CASE No 97.			TREATMENT . 22·5 grs Bihydrochloride Intravenously				
18·36	6·66	980	6·80	36·27	Clear & Dark	..	.
CASE No 110.			TREATMENT 22·5 grs Bihydrochloride Intravenously.				
18·36	14·70	2,130	6·90	80·05	Light & Clear	..	..
CASE No 139			TREATMENT · 22·5 grs Bihydrochloride Intravenously.				
18·36	10·43	1,410	7·40	56·80	Dark & Cloudy	..	..

QUANTITATIVE ESTIMATION OF QUININE IN THE URINE—
continued

Daily dose of Q B in grs	Daily excretion of Q B in grs	Daily secretion of Urine in c c	Daily excretion of Q B in grs per litre of Urine	Daily excretion of Q B in per cent	Appearance of Urine	Specific gravity of Urine	Albumin
CASE No 734 TREATMENT 10 grs Bihydrochloride Intramuscularly and 30 grs Sulphate Orally							
31 24	19 77	1,680	11 77	63 28	Dark	1,024	Pos
31 24	22 23	1,940	11 46	71 16	"	1,022	Neg
31 24	21 08	1,790	11 74	67 48	Light	1,024	"
31 24	22 32	1,870	11 49	71 44	"	1,026	"
31 24	21 22	1,890	11 22	67 92	"	1,026	"
31 24	24 22	2,090	11 58	77 53	"	1,024	"
CASE No 799 TREATMENT 10 grs Bihydrochloride In- tramuscularly, and 30 grs Sulphate Orally							
31 24	12 67	1,040	12 10	40 56	Dark	1,022	Pos
CASE No 731 TREATMENT 10 grs Bihydrochloride Intramuscularly and 30 grs Hydrochloride Orally							
32 70	26 38	1,570	16 82	80 67	Light	1,018	Neg
32 70	19 31	1,690	11 42	59 05	"	1,016	Pos
32 70	21 63	1,940	11 15	66 15	"	1,016	"
32 70	22 57	1,870	12 07	69 02	"	1,018	"
32 70	17 58	1,970	8 92	53 76	"	1,016	"
32 70	20 25	1,790	11 32	61 92	"	1,020	"
CASE No 849 TREATMENT 15 grs Bihydrochloride Intramuscularly and 30 grs Bihydrochloride Orally							
36 76	22 21	1,850	12 02	60 48	Dark	1,022	Pos
36 76	17 57	1,780	9 84	47 84	Light	1,020	"
36 76	17 52	1,790	9 78	47 70	"	1,020	Neg.
36 76	15 42	1,620	9 52	41 90	"	1,022	"
36 76	15 68	1,260	12 45	42 70	"	1,020	"
36 76	11 83	1,220	9 69	31 45	"	1,020	Pos
36 76	13 30	1,140	11 66	36 22	"	1,020	"

QUANTITATIVE ESTIMATION OF QUININE IN THE URINE—
continued

Daily dose of Q B in grs	Daily excretion of Q B in grs	Daily secretion of Urine in c c	Daily excretion of Q B in grs per litre of Urine	Daily excretion of Q B in per cent	Appearance of Urine	Specific gravity of Urine.	Albumin
CASE No 68 *				TREATMENT 10 grs Sulphate Orally			
7.69	3.01	1,120	2.68	39.14	Dark	..	..
Nil	Traces	940	Traces	Traces	"	..	..
Nil	"	1,980	"	"	Light Brown	.	..
CASE No 980 *				TREATMENT. 40 grs. Hydrochloride Orally			
32.72	Traces	1,420	Traces	Traces	Dark	1,020	Pos
Nil	"	1,180	"	"	"	1,020	"
Nil	"	1,270	"	"	"	1,020	"

SUMMARY.

Amount Given	No of Cases	Average Maximum Excretion	Average Minimum Excretion	Average Total Excretion
QUININE SULPHATE ORALLY				
		Per Cent	Per Cent	Per Cent
20 grains	3	98.65	16.05	52.73
20 grains (tablets)	1	98.18	21.44	69.32
24 grains	1	69.41	38.24	50.82
30 grains	12	63.11	27.40	46.66
30 grains (tablets)	3	73.47	22.43	46.81
58 grains	1	35.35	5.75	65.85**||
70 grains	1	12.88	6.02	31.62†||
QUININE HYDROCHLORIDE ORALLY				
30 grains	10	65.45	42.11	52.04
70 grains	3	54.86	30.82	36.74

* This was a case of Black-Water Fever

** This case (No 260) had one dose of 58 grains quinine sulphate = 44.64 grains quinine base and excreted on the 1st day, 15.55 grains, 2nd day, 10.89 grains, 3rd day, 1.16 grains, 4th day, traces quinine base

† This case (No 258) had one dose of 70 grains quinine sulphate = 53.88 grains quinine base and excreted on the 1st day, 6.94 grains, 2nd day, 6.85 grains; 3rd day, 1.46; 4th day, traces quinine base

|| These two cases (No 260 and No 258) vomited soon after the oral administration of quinine. On analysis only traces of quinine were found in the respective vomits. Similar observations have also been made by Prof. W. Ramsden (private information)

SUMMARY—continued

Amount Given	No of Cases	Average Maximum Excretion	Average Minimum Excretion	Average Total Excretion.	
QUININE HYDROCHLORIDE ORALLY					
30 grains	..	7	Per Cent 77.60	Per Cent 41.82	Per Cent 54.91
45 grains	..	4	52.51	36.47	47.08
QUININE HYDROBROMIDE ORALLY					
30 grains	9	87.99	41.33	64.91
QUININE LACTATE ORALLY					
30 grains	.. .	5	50.17	34.30	41.89
45 grains	.. .	2	31.10	23.25	28.40
QUININE ALKALOID, ORALLY					
40 75 grains	..	1	42.87	20.56	31.02*
47 25 grains	..	1	46.98	20.55	37.25*
EUQUININE, ORALLY					
45 grains	5	31.23	24.61	28.34
QUININE BIHYDROCHLORIDE, INTRAMUSCULARLY					
15 grains	..	2	71.30	29.41	51.76
22.5 grains	..	3	71.67	30.42	42.40
30 grains	..	3	60.52	43.23	52.86
QUININE BIHYDROCHLORIDE, INTRAVENOUSLY					
22 5 grains	..	3	..	..	57.70
QUININE BIHYDROCHLORIDE, INTRAMUSCULARLY AND QUININE SULPHATE, ORALLY					
10 and 30 grains	..	2	77.53	63.28	55.18

* These two cases (No 314 and No 310) vomited soon after the oral administration of quinine. On analysis only traces of quinine were found in the vomits. Similar observations have also been made by Prof W Ramsden (private information)

SUMMARY—*continued*

Amount Given	No of Cases	Average Maximum Excretion	Average Minimum Excretion	Average Total Excretion
QUININE BIHYDROCHLORIDE, INTRAMUSCULARLY AND QUININE HYDROCHLORIDE, ORALLY				
10 and 30 grains	1	80.67	61.92	65.03
QUININE BIHYDROCHLORIDE INTRAMUSCULARLY AND QUININE BIHYDROCHLORIDE, ORALLY				
15 and 30 grains	1	60.48	31.48	33.90

EXCRETION OF QUININE IN "BLACK WATER."

The two previous investigations on the excretion of Quinine in "Black Water" are by Marchoux and by Giemsa and Schaumann. According to Marchoux, who has investigated three cases only, traces of Quinine are excreted in the urine during attacks of "Black-Water." According to Giemsa and Schaumann, who have investigated six cases, the excretion amounts to 34.30 per cent. It is therefore of interest to note that of the two cases investigated in this laboratory Case No. 68 excreted 39.14 per cent, Case No. 980 excreted only traces.

Thus confirming both the results of Marchoux and also those of Giemsa and Schaumann.

GENERAL SUMMARY

The following is a Summary of the *average* excretions found.—

Quinine sulphate orally	.. .. .	51.95
Quinine hydrochloride orally	. . . . .	44.39
Quinine bihydrochloride orally	. . . . .	50.99
Quinine bihydrochloride intramuscularly	.. . . .	42.34
Quinine bihydrochloride intravenously	.. . . .	57.70
Quinine bihydrochloride intramuscularly and quinine bihydrochloride orally	.. . . .	43.90
Quinine bihydrochloride intramuscularly and quinine sulphate orally	.. . . .	55.18
Quinine bihydrochloride intramuscularly and quinine hydrochloride orally	.. . . .	65.08
Quinine hydrobromide orally	.. . . .	64.91
Quinine lactate orally	. . . . .	40.14
Quinine alkaloid orally	. . . . .	34.13
Euquinine orally	.. .. .	28.34

The apparent differences become, however, less marked if a comparison between the dosages and the average excretion where possible is made

30 Grains Daily				Per Cent.
Quinine Sulphate orally	..	.	..	46.73
Quinine hydrochloride orally	.	.	..	52.04
Quinine bihydrochloride orally	..	..	..	54.91
Quinine hydrobromide orally*	..	..	..	57.68
Quinine lactate orally	..	..	..	41.89
45 Grains Daily				
Quinine bihydrochloride orally	..	.	..	47.08
Quinine bihydrochloride intramuscularly and quinine bihydrochloride orally	..	..	..	43.90
Quinine lactate orally	..	.	..	28.40
Euquinine orally	..	..	..	28.34
70 Grains Daily				
Quinine sulphate orally	..	.	..	31.62
Quinine hydrochloride orally	..	.	..	36.74

COMPARISON BETWEEN THE AVERAGE EXCRETION OBTAINED AND THE AVERAGE EXCRETIONS OBSERVED BY OTHER WORKERS

Average Obtained	Average of Other Workers.				
Per Cent	QUININE SULPHATE ORALLY				Per Cent.
51.95	<i>Quevonne</i>	..	.	..	38.00
	<i>Herapath</i>	..	..	..	41.00
	<i>Briquet</i>	..	..	..	39.24
	<i>Vitalh</i>	..	..	..	19.60
	<i>Thau</i>	..	..	..	94.80
	<i>Personne</i>	..	..	..	52.60
	<i>Lepidi-Chrotti</i>	..	..	..	29.56
	<i>Gaglio</i>	..	.	..	41.80
	<i>Marianni</i>	..	..	..	43.97
	<i>Flaminis</i>	..	.	..	41.97
	<i>Schmitz</i>	..	..	..	28.70
	<i>Grosser</i>	..	..	..	32.60
	<i>Nishi</i>	..	..	..	35.60
	<i>McGilchrist</i>	..	..	..	41.16
	<i>Baur and Reveillet</i>	..	..	..	29.12
	<i>Porak</i>	..	..	..	22.47
	QUININE HYDROCHLORIDE ORALLY				
44.39	<i>Kiesne</i>	..	.	..	21.91
	<i>Briquet</i>	..	.	..	42.64
	<i>Vitalh</i>	..	..	..	24.16
	<i>Celli</i>	..	..	..	27.19
	<i>Lepidi-Chrotti</i>	..	..	..	36.22
	<i>Gaglio</i>	..	.	..	39.56
	<i>Marianni</i>	..	..	..	44.45
	<i>Gremsa and Schaumann</i>	..	..	..	27.80
	<i>Grosser</i>	..	..	..	26.80
	<i>Baur and Reveillet</i>	..	..	..	31.25

* Does not include the results of Cases No. 202. Those two cases imbibed large amounts of fluid and secreted in the average 4,560 c c urine daily

COMPARISON BETWEEN THE AVERAGE EXCRETION OBTAINED
AND THE AVERAGE EXCRETIONS OBSERVED BY OTHER
WORKERS—*continued.*

Average Obtained	Average of Other Workers					
	QUININE BIHYDROCHLORIDE ORALLY.					
Per Cent						Per Cent.
50·90	<i>Mariann</i>	..	..	..	..	29·45
	<i>Giemsa and Schaumann</i>	..	..	..	..	23·30
	<i>Baur and Reveillet</i>	..	..	..	..	38·16
	QUININE HYDROBROMIDE ORALLY					
64·91	<i>Mariann</i>	..	..	..	..	38 12
	<i>Marchoux</i>	..	..	..	..	49 78
	<i>Ufer</i>	..	..	..	..	51·12
	QUININE LACTATE ORALLY.					
40·14	<i>Giemsa and Schaumann</i>	..	..	..	..	22 13
	QUININE ALKALOID ORALLY					
34 13	<i>Mariann</i>	..	..	..	..	32 12
	EUQUININE ORALLY *					
28 34	<i>Grosser</i>	..	..	..	..	12·70
	QUININE BIHYDROCHLORIDE INTRAMUSCULARLY					
42·34	<i>Mariann</i>	..	..	..	..	34·26
	<i>Giemsa and Schaumann</i>	..	..	..	..	32·16
	<i>Baur and Reveillet</i>	..	..	..	..	27 48
	QUININE BIHYDROCHLORIDE INTRAVENOUSLY.					
57 70	<i>Ufer</i>	..	..	..	..	49·16
	QUININE BIHYDROCHLORIDE INTRAMUSCULARLY AND QUININE SUL- PHATE ORALLY					
60·20	No reference to be found					
	QUININE BIHYDROCHLORIDE INTRAMUSCULARLY AND QUININE HYDRO- CHLORIDE ORALLY					
65·08	No reference to be found					
	QUININE BIHYDROCHLORIDE INTRAMUSCULARLY AND QUININE BI- HYDROCHLORIDE ORALLY.					
43 90	No reference to be found					

* *Katz* found that the average excretion for euquinine in the dog, given intramuscularly, was 7·58 per cent and that of quinine hydrochloride intramuscularly 10 74 per cent

SECTION C.—RELATIONSHIP BETWEEN THE AVERAGE CONCENTRATION OF QUININE BASE PER LITRE OF URINE AND THE DOSAGE OF QUININE.

Case Number	Dose	Average Concentration of Quinine Base per Litre of Urine.
QUININE SULPHATE ORALLY.		
	Grs	Grs
177	20	8 60
224	20	9 96
247	20	7 29
293	20 (tablets)	7 84
*203	24	2 92
58	30	6 63
178	30	10 84
224	30	10 33
225	30	9 57
QUININE SULPHATE ORALLY.		
		.
260	30	10·98
381	30	9 01
424	30	8 74
426	30	9 39
426	30	5 76
524	30	11 96
610	30	8·31
640	30	10 99
504	30 (tablets)	8 06
506	30 "	8 91
621	30 "	7 74
260	58	18 16
258	70	9 16
QUININE HYDROCHLORIDE ORALLY.		
683	30	9·29
691	30	9·90
694	30	6·16
703	30	7·58
706	30	7·38
708	30	7·86
709	30	7·47
733	30	6 66
979	30	6 18
979	30	6 06
841	70	13 15
981	70	15 41
982	70	13·91

† This case imbibed large amounts of fluid.

SECTION C—*continued.*

Case Number	Dose	Average Concentration of Quinine Base per Litre of Urine
-------------	------	--

QUININE BIHYDROCHLORIDE ORALLY

	Grs.	Grs
697	30	7.61
732	30	8.61
849	30	7.49
928	30	10.97
929	30	10.83
945	30	7.19
946	30	6.61
908	45	9.36
910	45	10.91
928	45	12.81
939	45	11.12

QUININE HYDROBROMIDE ORALLY

*202	30	6.42
*202	30	4.18
605	30	6.44
606	30	5.25
636	30	8.52
652	30	8.09
688	30	9.67
749	30	10.92
786	30	10.67

QUININE LACTATE ORALLY

732	30	6.41
816	30	8.17
818	30	6.02
828	30	7.62
994	30	6.37
982	45	6.34
1,014	45	5.94

QUININE ALKALOID ORALLY.

314	40.75	14.39
310	47.25	18.68

* These cases imbibed large amounts of fluid

SECTION C—*continued.*

Case Number.	Dose	Average Concentration of Quinine Base per Litre of Urine.
EUQUININE ORALLY.		
	Grs	Grs
821	45	6.20
917	45	5.85
1,067	45	6.58
1,070	45	5.79
1,071	45	6.24
BIHYDROCHLORIDE INTRAMUSCULARLY		
647	15	6.42
648	15	6.71
64	22.5	6.03
163	22.5	9.72
177	22.5	13.69
1,049	30	8.03
1,069	30	7.67
1,113	30	7.47
BIHYDROCHLORIDE INTRAVENOUSLY		
97	22.5	6.80
110	22.5	6.90
139	22.5	7.40
BIHYDROCHLORIDE INTRAMUSCULARLY AND SULPHATE ORALLY		
734	10 & 30	11.62
799	10 & 30	12.10
BIHYDROCHLORIDE INTRAMUSCULARLY AND HYDROCHLORIDE ORALLY.		
731	10 & 30	11.28
BIHYDROCHLORIDE INTRAMUSCULARLY AND HYDROCHLORIDE ORALLY.		
849	15 & 30	10.71

SUMMARY TO SECTION C.

Average maximum = 18.68 grs. quinine base per litre of urine, referring to Case No. 310, which had 47.25 grs. quinine alkaloid orally.

Average minimum = 2.92 grs. quinine base per litre of urine referring to Case No 203, which had 24 grs. quinine sulphate orally and imbibed large amounts of fluid.

Total average = 8.61 grs quinine base per litre of urine.

The regularity with which the quinine base is excreted in the urine is of interest This is well illustrated in Section C which shows that the organism is able to excrete about 7 to 11 grs of quinine base per litre of urine. If the demand for quinine transport is increased, complications apparently set in which produce a passing albuminuria, as shown in Section D of this report.

Very few of the previous workers seem to have recorded the amount of urine collected. In few cases, however, where this was done, I have been able to calculate the concentrations found by them. They are as follows —

Calculated from three cases published by *Grosser* :—

- (i) 9.28 grs. quinine base per litre of urine.
- (ii) 7.22 grs quinine base per litre of urine.
- (iii) 4.21 grs. quinine base per litre of urine.

Calculated from two cases published by *Schmitz** :—

- (i) 3.95 grs. quinine base per litre of urine.
- (ii) 4.86 grs. quinine base per litre of urine.

Calculated from one case published by *Nishi* :—

9.60 grs. quinine base per litre of urine.

Calculations made from experiments carried out by *Katz* on three dogs† gave the following results.—

- (i) 2.24 grs. quinine base per litre of urine.
- (ii) 1.56 grs quinine base per litre of urine.
- (iii) 2.84 grs quinine base per litre of urine

* *Schmitz* has carried out his estimations by his own method, which has not been found to be reliable both by *Grosser* and the author

† The author has particularly noticed that a great deal of work on the excretion of quinine has been done on dogs (*Merkel, Katz, Griemsa* and *Schaumann* and others) This is to be regretted, and the conclusions drawn from those investigations must be misleading *The dog is the only animal used for experimental work, which excretes a quinoline derivative (Kynuric acid) normally in the urine, and it is therefore legitimate to conclude that the dog would naturally react differently from the human organism towards a quinoline compound such as quinine*

SECTION D.—RELATIONSHIP BETWEEN THE DOSAGE
OF QUININE AND THE PRESENCE OF ALBUMIN
IN THE URINE.

Case No.	Daily Dose	Number of Days	Examination for Albumin ; Number of Days
----------	------------	----------------	---

QUININE SULPHATE ORALLY.

	Grs.		Positive.	Negative.
177	20	20	0	20
224	20	22	0	22
247	20	11	0	11
293	20 (tablets)	18	0	18
203	24	3	0	3
58	30	13	0	13
173	30	5	0	5
224	30	2	0	2
225	30	2	0	2
260	30	26	0	26
381	30	9	0	9
424	30	16	0	16
426	30	7	0	7
426	30	23	0	23
524	30	8	0	8
610	30	9	0	9
640	30	3	0	3
504	30 (tablets)	10	0	10
506	30 "	10	0	10
621	30 "	14	11	3
260	58	1	4	0
258	70	1	3	1

QUININE HYDROCHLORIDE ORALLY.

683	30	8	0	8
694	30	7	0	7
691	30	7	0	7
703	30	8	0	8
706	30	8	0	8
708	30	6	5	1
709	30	6	0	6
733	30	8	0	8
979	30	5	0	5
979	30	2	2	0
841	70	1	1	0
981	70	2	2	0
982	70	2	2	0

SECTION D—continued.

Case No.	Daily Dose	Number of Days	Examination for Albumin, Number of Days.	
QUININE BIHYDROCHLORIDE ORALLY				
	Grs		Positive	Negative.
697	30	6	0	6
732	30	5	0	5
849	30	6	0	6
928	30	7	0	7
929	30	7	0	7
945	30	5	0	5
946	30	5	0	5
908	45	7	2	5
910	45	7	0	7
938	45	5	4	1
939	45	4	4	0
QUININE HYDROBROMIDE ORALLY				
202	30	2	0	1
202	30	2	0	3
605	30	8	0	8
606	30	15	0	15
636	30	2	0	4
652	30	8	0	8
688	30	8	0	8
749	30	7	0	7
786	30	6	0	6
QUININE LACTATE ORALLY.				
732	30	5	0	5
816	30	6	0	6
818	30	7	0	7
828	30	6	0	6
994	30	7	0	7
982	45	5	0	5
1,014	45	5	0	5
QUININE ALKALOID ORALLY				
314	40.75	6	2	4
310	47.25	5	1	4
EUQUININE ORALLY				
821	45	6	0	6
917	45	6	0	6
1,067	45	2	0	2
1,070	45	2	2	0
1,071	45	2	0	2

SECTION D—continued

Case No.	Daily Dose	Number of Days.	Examination for Albumin : Number of Days.	
BIHYDROCHLORIDE INTRAMUSCULARLY				
647	15	6	0	6
648	15	7	0	7
64	22 5	4	0	6
163	22 5	3	4	1
177	22 5	7	4	5
149	30	3	3	0
1,069	30	4	4	0
1,113	30	4	3	1
INTRAMUSCULARLY AND ORALLY				
731	10 grs bihydrochloride and 30 grs hydrochloride	6	6	0
738	10 grs bihydrochloride and 30 grs sulphate	6	1	5
799	" "	1	1	0
849	15 grs bihydrochloride and 30 grs bihydrochloride	7	5	2

SUMMARY TO SECTION D.

Quinine	Daily Dosage Grains	Number of Days when Tested for Albumin	Percentage.	
ORALLY				
Sulphate	20	71	0	100
"	24	4	0	100
"	30	163	6·74	93·26
"	58	4	100	0
"	70	4	75	25
Hydrochloride	30	65	10·7	89·24
"	70	5	100	0
Bihydrochloride	30	41	0	100
"	45	23	43·47	56·53
Hydrobromide	30	59	0	100
Lactate	30	31	0	100
"	45	10	0	100
Alkaloid	40·75	6	33·33	66·67
"	47·25	5	80	20
Euquinine	45	18	11·11	88·89

SUMMARY TO SECTION D—*continued*

Quinine.	Daily Dosage Grains	Number of Days when Tested for Albumin	Percentage	
INTRAMUSCULARLY.				
Bihydrochloride	15	13	Positive 0	Negative 100
"	22.5	14	57.14	42.86
"	30	18	55.55	44.45
INTRAMUSCULARLY AND ORALLY				
Bihydrochloride and Bihydrochloride ..	15 30	7	71.11	28.89
Bihydrochloride and Hydrochloride .	10 30	6	100	0
Bihydrochloride and Sulphate ..	10 30	7	24.44	75.56

These observations establish the fact that there is a relationship between the dosage of quinine and the presence of albumin in the urine. Such a relationship has already been observed by *Brau* and *Billmoz*, and also by *Porak*, who found albumin in the urine in doses over 30 grs given orally, which is fully confirmed by the observations made in this laboratory. It is of interest that euquinine and also quinine lactate when given in higher doses than 30 grs do not generally produce albuminuria, the low excretions of these salts may perhaps account for it. So far as it is possible to deduce from the material at hand, the bihydrochloride of quinine, if given intramuscularly produced albuminuria even in doses of 22.5 grs.

SECTION E.—APPEARANCE OF URINE.

The urines received for analysis were mostly light in colour, but occasionally dark coloured urines were also observed. Out of 854 specimens analysed, 126 were dark coloured, corresponding to 14.76 per cent. They came from the following cases :—

Case No	Daily Dose.	Number of Dark Urines.
QUININE SULPHATE ORALLY.		
	Grs	
177	20	8
224	20	4
247	20	2
293	20	2
173	30	1
224	30	3
381	30	6
424	30	7
426	30	7
426	30	22
524	30	5
640	30	2
506	30	2
621	30	4
260	58	2
258	70	2
HYDROCHLORIDE ORALLY		
683	30	1
691	30	2
841	70	1
981	70	2
128	70	2
BIHYDROCHLORIDE ORALLY.		
929	30	1
HYDROBROMIDE ORALLY		
606	30	7
636	30	1
ALKALOID ORALLY		
314	40.75	2
310	45.24	3

SECTION E—*continued.*

Case No.	Daily Dose.	Number of Dark Urines
EUQUININE ORALLY		
	Grs.	
821	45	6
917	45	4
1,067	45	2
1,070	45	2
1,071	45	2
BIHYDROCHLORIDE INTRAMUSCULARLY		
647	15	2
177	22.5	1
BIHYDROCHLORIDE INTRAVENOUSLY		
97	22.5	1
139	22.5	1
BIHYDROCHLORIDE INTRAMUSCULARLY AND SULPHATE ORALLY		
734	40	2
799	40	1
BIHYDROCHLORIDE INTRAMUSCULARLY AND BIHYDROCHLORIDE ORALLY.		
849	45	1

Since it was possible that the dark colour of the urine might be due to the presence of kynuric acid, which could be formed from quinine, and which is supposed to cause the dark colour of the urine of the dog, it was thought also of interest to investigate some of the dark urines for the presence of kynuric acid. Out of the 126 specimens of dark urines 53 were examined for kynuric acid, which corresponds to 42.06 per cent., but in none of those specimens was kynuric acid found. The method employed for the isolation of kynuric acid was that of *Ellinger* *

* Compare Part IV, Section B of this Report

PART III.

IDENTIFICATION OF THE EXCRETED QUININE.

Landerer and also *Valeé* were the first to observe that quinine is excreted in the urine when given orally. It was, however, *Personne* who was able to demonstrate that the excretion product is actually quinine. In evidence of his contention he submitted to the Academy of Science at Paris on August 27th, 1878, a sample of 24 gr quinine sulphate which he had prepared from the excreted quinine. His sulphate of quinine had the optical rotation of -163.5° , and he found for a sample of quinine sulphate which had not passed through the organism the optical rotation of -163.7° , -164.2° , from which he concluded. "que la quinine éliminée par les urines n'a éprouvée aucune alteration par passage dans l'économie." His observations did not, however, agree with those of *Kerner*, who found that the excretion product is *not* quinine but dihydroxy-quinine $C_{20}H_{24}N_2O_2(OH)_2$, which was later on obtained by *Skraup* by the oxidation of quinine with potassium permanganate *Skraup's* dihydroxyquinine or quinine as he called his oxidation product has, however, the following constitution $C_{19}H_{22}N_2O_2 \cdot H_2O$. *Merkel* claims to have recovered from the urine not quinine but a modification product from which he prepared the *Platinate* $C_{23}H_{22}N_2O_2PtCl_4HCl$. *Giemsa* and *Schaumann* have severely criticised the work of *Merkel*. They say "für die Platinchloriddoppeltverbindung stellte er eine Formel auf, ohne jedoch im übrigen eine genaue und gründliche chemische Untersuchung dieser Verbindung vorzunehmen." This is fully supported by the impressions gained by me on reading the publication of *Merkel*, which is indeed an excellent example of how chemical investigations ought not to be carried out. Of more recent date are the investigations of *Schmitz*, who recovered quinine as such from the urine and prepared from it the *Chlorplatinate of Quinine* $C_{20}H_{24}N_2O_2PtCl_6H_2O$, and also by *Giemsa* and *Schaumann* who recovered quinine from urine which they have submitted to a full chemical analysis. *Schmitz* and also *Giemsa* concluded in accordance with *Personne* that quinine does not alter on passage through the organism.

The investigations carried out in this laboratory with a view of identifying the excretion product of quinine concern themselves with the following points —

- (1) The optical rotation of the excreted *trihydrate of quinine*
- (2) The melting point of the *trihydrate of quinine*.

- (3) The optical rotation of the excreted *anhydrous quinine*
- (4) The melting point of *anhydrous quinine*.
- (5) The melting point of the *quinine picrate*.
- (6) The recovery of quinine on a large scale from urine and the following investigation of the same :—
 - (a) Full chemical analysis of the anhydrous quinine
 - (b) Chemical analysis of the quinine sulphate.
 - (c) Melting point estimations of the trihydrate of quinine, anhydrous quinine, and picrate of quinine.
 - (d) Polariscopical investigation of anhydrous quinine

I. POLARISCOPICAL INVESTIGATIONS OF THE RECOVERED TRIHYDRATE OF QUININE.

The quinine recovered during the analysis recorded in Part II was dissolved in 60 per cent. alcohol, and the rotation estimated in a *Schmidt* and *Haensch* polariscope and in an *Emil Fischer* microtube.

The *average* rotations found for the trihydrate from the urine of the following cases were as follows :—

Case Number	Average Rotation	Number of Daily Examinations
58	- 38.2°	13
173	- 36.3°	5
424	- 37.7°	16
426	- 34.1°	6
504	- 34.4°	10
506	- 34.4°	10
524	- 40.2°	8
605	- 35.3°	8
606	- 33.6°	16
610	- 38.5°	9
621	- 35.2°	14
647	- 36.7°	6
648	- 35.6°	7
652	- 34.7°	8
683	- 37.3°	8
688	- 35.6°	8
691	- 35.8°	7
694	- 36.6°	6
703	- 34.7°	7
706	- 36.4°	8
708	- 34.3°	6
709	- 33.8°	6
731	- 34.9°	6
733	- 32.2°	7
734	- 35.3°	7

AVERAGE ROTATION OF THE TRIHYDRATE OF QUININE.

Found	..	..	..	..	- 39 6°
Required	..	..	..	...	- 41 7°
Error	..	.	..	..	- 2.1°

2 MELTING POINT ESTIMATIONS OF THE RECOVERED TRIHYDRATE OF QUININE.

The alcoholic solutions used for the polariscopical investigations of the trihydrate were concentrated on the water bath, and the crystals, after draining on porous plate used for the melting point estimations. In some cases mixed melting point estimations with trihydrate of quinine were also made. *In no cases were depressions of the melting point observed.* The mixed melting point estimations were carried out according to the method of *O C M. Davis* *

Case Number	Average Melting Point	Number of Daily Examinations
58	49°	13
173	48°	5
424	49°	13
426	46°	6
504	46°	10
506	49°	10
524	59°	8
605	51°	8
606	49°	16
610	51°	9
621	49°	14
647	51°	6
648	51°	7
652	52°	8
683	49°	8
688	51°	8
691	46°	7
694	50°	6
703	52°	7
706	49°	8
708	51°	6
709	48°	6
731	50°	6
733	51°	6
734	50°	7

AVERAGE MELTING POINT OF THE TRIHYDRATE.

Found	..	..	..	..	49 6°
Required	..	..	..	..	49.5°
Error	..	..	..	..	0.1°

* See also *Kipping and Pope*.

3. POLARISCOPICAL INVESTIGATION OF THE RECOVERED ANHYDROUS QUININE.

The quinine recovered during the analysis was carefully dried at 130°C, and then dissolved in *absolute* alcohol, twice distilled over calcium chloride. The rotation was estimated in a Schmidt and Haensch polariscope and an Emil Fischer microtube.

The *average* rotations found for the anhydrous quinine from the urines of the following cases were as follows:—

Case Number,	Average Rotation	Number of Daily Examinations
260	- 140 00°	26
697	- 140 00°	6
732	- 146 30°	5
732	- 142 20°	5
994	- 148 20°	7

AVERAGE ROTATION OF THE ANHYDROUS QUININE.

Found	..	..	..	..	- 143 20°
Required	..	..	..	..	- 158 20°
Error	..	..	..	..	- 15 00°

4. MELTING POINT ESTIMATIONS OF THE RECOVERED ANHYDROUS QUININE.

The melting point of the anhydrous quinine was taken on heating the trihydrate at 130° for some time, and then raising the temperature until the quinine began to melt again.

Case Number.	Average Melting Point.	Number of Daily Examinations.
260	168.2°	26
979	170 1°	5
981	170 0°	2
982	171 0°	2
697	170 5°	5
732	170 5°	5
849	171 0°	6
928	170 5°	7
929	171 0°	7
945	171 0°	5
946	171 0°	5
908	171 5°	7
910	171 0°	7

MELTING POINT ESTIMATIONS OF THE RECOVERED ANHYDROUS
QUININE—*continued.*

Case Number	Average Melting Point	Number of Daily Examinations
938	170.5°	5
939	171.5°	4
749	171.5°	7
786	170.0°	6
732	171.5°	5
816	170.5°	6
818	170.5°	7
828	169.5°	6
994	172.5°	7
821	171.5°	6
917	171.0°	6
734	170.5°	6
799	171.0°	1
731	170.5°	6
849	170.5°	6

AVERAGE MELTING POINT OF ANHYDROUS QUININE.

Found	..	..	..	..	170.6°
Required	..	..	..	..	174.5°
Error	..	..	..	..	3.9°

5. MELTING POINT ESTIMATIONS OF THE PICRATE.

The picrate was obtained by adding a *dilute* solution of picric acid to the alcoholic solution of the anhydrous quinine.

Case Number	Average Melting Point	Number of Daily Examinations
683	98.5°	8
691	99.0°	9
694	99.5°	6
703	99.0°	7
706	98.5°	7
708	101.5°	6
709	98.5°	6
733	99.5°	6
688	98.5°	8

AVERAGE MELTING POINT OF THE PICRATE OF QUININE.

Found	..	..	..	..	99.5°
Required	..	..	..	..	101.0°
Error	..	..	..	..	1.5°

On a few occasions only the *citrate of quinine* was also prepared. The results obtained were as follows:—

Case Number	Average Melting Point.	Number of Daily Examinations
1,067	202°	2
1,070	202°	2
1,071	203°	2

AVERAGE MELTING POINT OF THE CITRATE OF QUININE.

Found	.. .. .	202.5°
Required	.. .. .	202°
Error	.. .. .	0.5°

6. RECOVERY OF THE QUININE ON A LARGE SCALE FROM URINE CONTAINING QUININE.

Altogether 62 Winchester quarts of urine were investigated and the quinine recovered by extraction with ether. The quinine was purified by dissolving in chloroform and crystallising from alcohol.

INVESTIGATION OF THE QUININE BASE.

M P. of trihydrate	.. .. .	Found	49°	Required	49.5°
M P. of anhydrous quinine	.. .. .		172°		174.5°
Rotation of anhydrous quinine	.. .. .		-151.5°		-158.2°
M P. of picrate of quinine	.. .. .		101.2°		101°

Analysis:— $C_{20}H_{24}O_2N_2$.

	Found	Required
	Per Cent.	Per Cent
C	73.94	74.07
H	7.64	7.40
N	8.81	8.67
O	8.61	9.86

INVESTIGATION OF THE QUININE SULPHATE.

Part of the quinine was converted into *sulphate* and analysed.

Analysis:— $2 C_{20}H_{24}N_2O_2 \cdot H_2SO_4 \cdot 2 H_2O$.

	Found.	Required.
	Per Cent.	Per Cent.
H ₂ O	4.78	4.60
H ₂ SO ₄	12.98	13.14

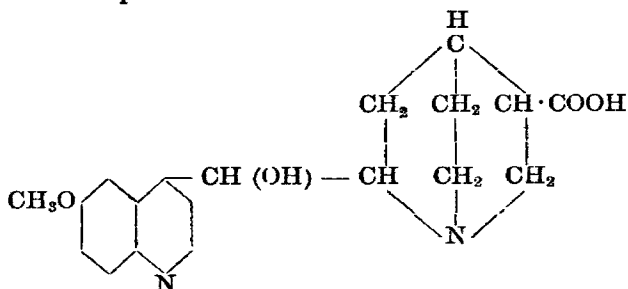
Some of the quinine was also converted into the *hydrochloride* but not analysed.

PART IV.

ISOLATION OF DISINTEGRATION PRODUCTS
OF QUININE.

SECTION A — ISOLATION OF QUITININE.

The investigation of the picrate of quinine prepared from large quantities of urine secreted during the first two to three hours after administration of quinine showed it to contain in addition to quinine some other substance. On careful fractionation it was found that one of these substances was the picrate of quitinine:



(a) METHOD OF ISOLATION OF THE QUITININE FROM THE URINE.

About 130 litres of urine from a normal individual which had been collected during the first two to three hours after the oral administration of quinine sulphate were treated with a 0.3 per cent. solution of picric acid, and the precipitates collected. The carefully dried precipitates were dissolved in absolute alcohol and fractionated with water. Out of 52 grms. of the picrate five fractions were thus obtained.

				Grms
Fraction I	..	..	..	0.8
" II	..	..	..	22.6
" III	..	..	..	11.6
" IV	..	..	..	16.4
" V	..	..	..	Traces

The investigation of the fractions 2 and 3 after the removal of picric acid show it to be unchanged quinine, whereas fraction 4 proved to be quitinine.

(14557)

E 2

(b) INVESTIGATION OF THE ISOLATED QUITININE.

The quitinine obtained from the urine crystallised from dilute alcohol in prisms, which melted at 281° – 282° when quickly heated, carbon dioxide being evolved. The melting point of quitinine is given as 286° (Skraup). At 110° it loses water of crystallisation (Found $\text{H}_2\text{O} = 21.56$ per cent, calculated for $\text{C}_{15}\text{H}_{22}\text{N}_2\text{O}_4 \cdot 4 \text{H}_2\text{O} = 21.05$ per cent) On combustion the following data were obtained:—

Found. Per Cent	Calculated from $\text{C}_{15}\text{H}_{22}\text{N}_2\text{O}_4$ Per Cent.
C = 65.8, 66.2	C = 66.7
H = 7.8, 7.2	H = 6.4
N = 8.1	N = 8.2

(c) COMPARISON BETWEEN QUITININE ISOLATED FROM URINE AND QUITININE PREPARED ACCORDING TO SKRAUP'S METHOD.

	Quitinine from Urine	Skraup's Quitinine
Appearance	Small prisms	Small prisms
Melting point	281° – 284°	281° – 282°
Mixed melting point ..	281° – 282°	281° – 282°
Rotation	– 122.6°	– 118.4°

(d) COMPARISON BETWEEN QUININE AND QUITININE

	Quinine	Quitinine
Thalleo-quinine test ..	Positive	Positive
Herapath test	Positive	Not definite
Tanret's turbidity	Positive	Positive, however not as delicate as quinine
Battandier's test	Positive	Positive
Fluorescence	Positive	"
Robertson's test	Positive	Not definite
Picric acid	Positive	Positive

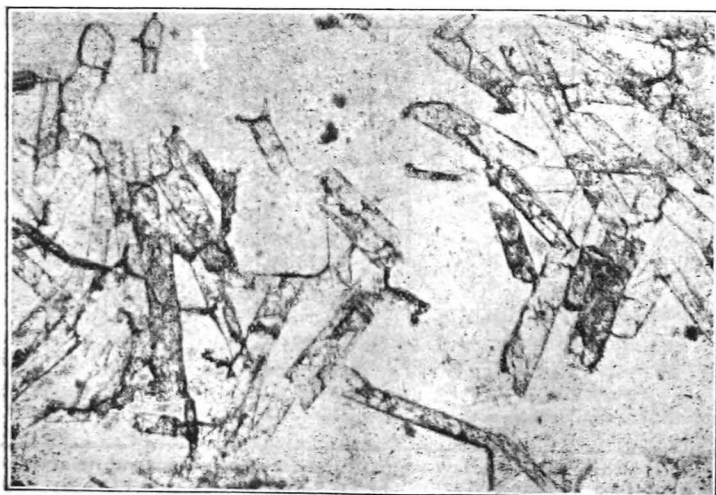
SECTION B.—HAEMOQUINIC ACID, A NEW DISINTEGRATION PRODUCT OF QUININE PRESENT IN THE URINE, ESPECIALLY IN "BLACK-WATER" FEVER.

The urines secreted after the administration of quinine which had been investigated in this laboratory were mostly light in colour, but occasionally dark-coloured urines were also observed. Out of 854 specimens analysed 126 were dark-coloured, corresponding to 14.76 per cent which suggested the possibility of the presence of some disintegration product of quinine in the urine. These urines were therefore investigated for kynuric acid, since the latter is supposed to cause the dark colour of the urine of the dog, and also since

the formation of kynuric acid from quinine could have been expected. Out of the 126 specimens, 53 were examined for kynuric acid, but in none of those was kynuric acid found. *Ellinger's* method for the isolation of kynuric acid was used for these investigations. The extension of this method in a somewhat modified form to "Black-Water" fever urines led however, to the isolation of a new disintegration product of quinine. This new substance shows pronounced *haemolytic properties* towards human and sheep blood corpuscles, which led to the provisional designation of *haemoquinic acid*.

METHOD OF ISOLATION OF HAEMOQUINIC ACID FROM "BLACK WATER."

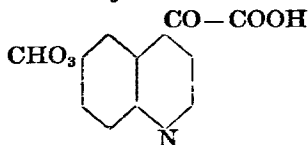
The urine is evaporated to dryness under strongly reduced pressure and the residue dissolved in a little cold water and filtered. The filtrate is again evaporated, and the residue dissolved in strong hydrochloric acid. A solution of a 10 per cent. phosphotungstic acid is then added until no more precipitation takes place. The precipitate is collected and decomposed with a 10 per cent. baryta or sodium hydroxide solution, and the filtrate evaporated to about one third of its volume. Haemoquinic acid begins to crystallise out after about 12 hours standing and is purified by several crystallisations from dilute alcohol. Inoculation with a small crystal of haemoquinic acid hastens the crystallisation. Haemoquinic acid crystallises very typically as shown in the accompanying micro-photograph.



Haemoquinic acid melts sharply at 183°, carbon dioxide being evolved. When warmed with concentrated sulphuric acid carbon monoxide is evolved. With *Herapath's* reagent for quinine a beautiful blue solution is obtained by which it is possible to detect haemoquinic acid in dilution of 1:5,000. Better results are obtained if *Jorgensen's* modification of *Herapath's* reagent is used, and the excess of iodine removed with a drop of chloroform * Haemoquinic acid yields a picrate which melts at 224°. Two combustions were made —

—	Combustion.	Combustion	Average.
	Per Cent	Per Cent	Per Cent.
C .. .	66.56	66 74	66 65
H	4 58	5 36	4 47
N .. .	6.40	6 48	6 44

It is possible that haemoquinic acid is 3-methoxy—quinoline— γ -keto-carboxylic acid :



which requires C = 66.98 per cent H = 4.18 per cent. and N = 6.52 per cent. The sulphate requires sulphuric acid = 31.30 per cent.

TABLE I.

Serial No.	Amount of Urine Investigated	Amount of Haemoquinic Acid Recovered	Melting Point of Haemoquinic Acid	Melting Point of Picrate.
	CC	Grms		
1 .. .	Not known	Not known	183°	224°
2 .. .	1,140	0 24	183°	223°
3 .. .	130	0.03	183°	220°–223°
4 .. .	207	0 14	183°	223°
5 .. .	1,160	0 24	183°	220°–222°
6 .. .	120	Nil	—	—
7 .. .	5,090	0 36	183°	222°–223°
8 .. .	2,360	0 12	182°	223°
9 .. .	3,370	0 32	183°	223°
10 .. .	1,380	0 22	183°	221°–223°
11 .. .	2,650	0 12	183°	222°
12 .. .	1,840	0 28	183°	222°–223°
13 .. .	2,640	0 26	183°	224°

* By this method it was possible to detect haemoquinic acid in the se of two "Black-Water" fever cases kindly provided by Captain W Fletcher, R A M C, University Hospital, Southampton

In addition to "Black-Water" urine the following urines of malaria cases were also examined. —

- (1) Mixed urines of patients who were having quinine.
- (2) Urines of patients soon after the rigor.
- (3) Urines of patients some time after rigor.

TABLE II

—	Amount of Urine Investigated	Amount of Haemoquinic Acid Recovered	Melting Point of Haemoquinic Acid	Melting Point of Picrate.
Mixed urines	CC 42,000	Grms 0 3	183°	223°
Rigor urines	21,000	0 18	183°	222°-223°
Non-rigor urines	8 400	Nil	—	—

These investigations suggest a possible relationship between the formation of haemoquinic acid in the organism and the production of "Black-Water." This relationship would be based on a specific quinine idiosyncrasy, since apparently in "Black-Water" fever haemoquinic acid is produced in larger quantities than in malaria rigor cases, the ratio being 578 1

GENERAL CONCLUSIONS

1 The following *qualitative* tests for quinine were re-investigated —The Thalleo-quinine test, the Erythro-quinine test, *Battandier's* test, *Hirschsohn's* test, the Fluorescence test, *Mayer-Tanret's* reagent, *Wagner's* reagent, *Herapath's* test, and *Robertson's* test. Reliable results were only obtained when using the four last tests. Really satisfactory results were given by the *Mayer-Tanret* reagent and the *Herapath* test, but preference was given to the latter as the *Mayer-Tanret* reagent loses in reliability on dilution.

2 *Baur* and *Reveille's* picric acid method for the detection of quinine in the urine gave good approximately quantitative results, and was found to be so far reliable as to warrant its recommendation for *clinical* routine examinations.

3 It was found possible to detect quinine qualitatively in the urine (1) in a few minutes after oral administration, and (2) 70 hours after administration had ceased.

4. Only traces of quinine were found in the vomits of four cases soon after oral administration of large doses of quinine.

5. The following quantitative methods for the estimation of quinine were re-investigated—*Kerner's* first method, *Kerner's* second method, *Kleine's* method, *Merkel's* method, *Giemsa* and *Schaumann's* modification of *Kleine's* method, *Gaglio's* method, *Giemsa* and *Schaumann's* modification of *Gaglio's* method, *Schmitz's* method, *Barratt* and *York's* modification of *Giemsa* and *Schaumann's* method, *Nishi's* method, *Cockburn* and *Block's* modification of *Nishi's* method. Reliable results were only obtained by.—*Kleine's* method, *Giemsa* and *Schaumann's* method, *Giemsa* and *Schaumann's* modification of *Gaglio's* method, and *Barratt* and *York's* modification of *Giemsa* and *Schaumann's* method. Preference was given to *Barratt* and *York's* modification, as it only gave an error of -1.18 per cent, by which method all the analyses were made in duplicates. Altogether 1,668 estimations were made by this method.

6. It was found that *Ramsden* and *Lipkin's* "defaecation" process greatly assisted the qualitative and quantitative estimation of quinine in the urine

7. It was found —

- (1) That the excretion of quinine showed marked individual and daily differences
- (2) That there was no appreciable difference in the excretion of the bi-hydrochloride of quinine if given orally, intramuscularly, intravenously, or in intramuscular and oral combination
- (3) That there was no marked difference in the excretion of the bi-hydrochloride, hydrochloride, hydrobromide, bi-hydrobromide and sulphate if given orally.
- (4) That there was no marked difference in the excretion of the salts mentioned in paragraph (3) if compared with that of the free alkaloid given orally
- (5) That less quinine was excreted when given orally as the lactate or Euquinine.
- (6) That the metabolised quinine is in proportion to the dose given
- (7) That there was a tendency for the quinine to reach a concentration of 7 to 11 grs. Quinine Base per litre of secreted urine.
- (8) It was found that the specific gravity of the urine was normal during the excretion of quinine.

- (9) It was found that doses which produce a higher concentration than 11 grs. Quinine Base per litre of secreted urine frequently precipitate *albuminuria*
- (10) It was observed that some unknown disintegration product of quinine in the urine sometimes produces dark-coloured urines.
- (11) It was proved that the excreted quinine was *unchanged* quinine.
- (12) *Quitinine*, a disintegration product of quinine, was found in the urine during the early stages of the quinine excretion
- (13) *Black Water* urines were found to contain a new disintegration product of quinine. This new substance showed *haemolytic* properties, and was provisionally called *Haemoquinic Acid*. The urines of 13 cases of Black Water fever were investigated and in 12 of those urines Haemoquinic Acid was found
- (14) Haemoquinic Acid was also found to be present in Malarial urines after quinine treatment, but in appreciably less quantity, the ratio being —
- $$\frac{\text{Haemoquinic Acid in Black Water urines}}{\text{Haemoquinic Acid in Malarial urines}} = \frac{578}{1}$$
- (15) A provisional formula was suggested for Haemoquinic Acid, based on the analytical data so far at hand

I take this opportunity to express my thanks to Colonel Sir Ronald Ross and to Lieut-Colonel Sir Nestor Tirard for their permission to publish these results, and for all the facilities granted to me to carry out these investigations. I also wish to thank Lieut-Colonel F W Mott for all the kindness and interest he has shown me all the time I worked in his laboratory. My thanks are also due to Captains G. B. Bartlett, W Murray and J G Thomson, and also to the late Mr. H Row, who were at different times in charge of the laboratory. I also thank Corporals C Biddulph and W M. Gay and Privates R. Barr, W Cooper, A Farrier, R Hobson and R. Price for much help and assistance.

APPENDIX I.

Professor W Ramsden, to whom I sent a specimen of Haemoquinic Acid has discovered a new test for Haemoquinic Acid, which is extraordinarily delicate and highly specific I append the following details which he, kindly, permitted me to publish in this Report Professor Ramsden states in his letter dated May 7th, 1919, as follows —

“ Even a single microscopic crystal of Haemoquinic Acid, kindly supplied to me by Dr Nierenstein when a micro-drop of 25 per cent iodine solution in 95 per cent alcohol is added under a cover slip gives almost instantly numerous crystals of two different types —

“ (a) Oblong light-brown plates which polarise light as completely as does Tourmaline or Herapathite

“ (b) Light yellow needle prisms which tend to group themselves like Phenyl-glucosazone and have comparatively slight polarising power

“ Both types are almost insoluble in alcohol Both are formed when iodine is added in great excess

“ The test is extraordinarily delicate (0.01 milligram more than suffices) and is obviously highly specific Explanation must await further investigation ”

It must be added that Professor Ramsden failed to get the *Herapath-Jorgensen* test as used for Haemoquinic Acid with the Haemoquinic Acid I sent him

APPENDIX II.

In a recent publication entitled “ An Investigation upon the Influence of Malaria on the Wassermann Reaction ” Captain J G Thompson and Mr C H Mills state as follows “ An important point definitely established in this series of observations is that the presence of quinine in detectable quantities in the serum in no way effects the Wassermann reaction in syphilitic cases This was proved by Staff-Serjeant Nierenstein, D Sc , Ph D ”

The apparent importance of these observations warrant a description of the methods employed by me for these experiments —

- (1) In a number of cases quinine was qualitatively detected by the *Mayer-Tanret* reagent after isolating it from the serum according to Ramsden and Liphin's method
- (2) In other cases quinine was isolated as above and precipitated with an excess of 1-10,000-n *Wagner's* reagent, filtered through an asbestos plug and a tube as used in the analysis of sugar and then titrated with *freshly prepared* 1-10,000-n thiosulphate solution This method gave higher values than the nephelometric method of Ramsden and Liphin

Attempts were also made to use the *Mayer-Tanret* reagent or the *Planta* reagent in a similar way to the *Wagner* reagent, i e , to proceed as stated in case of Method 2 and to liberate the iodine with dilute nitric acid and then to titrate with thiosulphate It was, however, found that both the *Mayer-Tanret* and the *Planta* reagent lose their precipitating and turbidity producing properties in a dilution of 1-10,000-n as required

All the sera investigated by me for Captain Thomson and Mr Mills contained detectable amounts of quinine.

BIBLIOGRAPHY.

- 1 ABENSOUR, *Jour pharm et chim*, 1907 (4), Vol XXVI, p 25
- 2 ALLEN, *Analyst*, 1896, Vol XXI, p 85
- 3 ANDRÉ, *Jour pharm et chim*, 1839, Vol XXII, p 132
- 4 ANDRÉ, *The Chemist*, 1840, Vol I, p 109
- 5 ARNAUD, *Compt rend soc biol*, 1905, Vol LVIII, p 628
- 6 APERY, *Gaz med d'Orient*, 1905, Vol VII, p 54
- 7 ARTUS, *Jour prakt Chemie*, 1838, Vol XV, p 125.
- 8 BALDONI, *Policlinc, Roma*, 1916, Vol XXIII, p 59
- 9 BALDONI, *Arch farm sperim*, 1912, Vol VIII, p 324
- 10 BARONI AND BOLINETTO, *Giorn Farm Chim*, 1911, Vol LX,
p 241
11. BARRATT AND YORK, *Ann Trop Med and Parasit*, 1909,
Vol III, p 12
- 12 BATTANDIER, *Jour pharm & Chim*, 1904 (4), Vol XXIII,
p 151
- 13 BAUR AND REVEILLET, *Bul Soc Med*, 1918, Vol XLII, p 122
- 14 BAUR AND REVEILLET, *Bull soc med des hop*, 1918, Vol XLII
p 119
- 15 BECKURT, *Jahrb Fortschr d Pharm*, 1887, p 244
- 16 BEHRENS, *Rec trav chim*, 1894, Vol XIII, p 1
- 17 BIDDLE, *Science*, 1912, Vol LII, p 486
- 18 BIDDLE, *Ber Deutsch chem Gesellsch*, 1912, Vol XLV, p '526.
- 19 BINZ, *Arch f path Anatomie*, 1869, Vol XLVI, p 164.
- 20 BLAISE, *Pharm Centralh*, 1897, Vol XX, p 343
- 21 BLYTH, *Analyst*, 1881, p 162
- 22 BOHN, *Arch f exper Pathol u Pharm*, 1866, Vol XIX, p 70
- 23 BONNEWYN, *Jour pharm Trans*, 1834, Vol XXVII, p 387
- 24 BONNEWYN, *Jour pharm Trans*, 1856 (3), Vol XXVII, p 380
- 25 BRANDES, *Arch d Pharm*, 1837, Vol XIII, p 65
- 26 BRANDES AND LEBER, *Arch d Pharm*, 1838, Vol XV, p 259
- 27 BRANDES AND LEBER, *Arch d Pharm*, 1839, Vol XVII, p 297
- 28 BRAUN AND BIELLEMOZ, *Bull soc path exot* 1918 Vol XI,
p 80
- 29 BRIQUET, *Compt rend*, 1827 Vol XXVII, p 549
- 30 BRIQUET, *Jour chim med*, 1855, Vol XII, p 22
- 31 BUCKINGHAM, *Z phys Chem*, 1894, Vol XIV, p 129
- 32 BRAULT, *Atti d soc p g studs della Malaria*, 1910, Vol II, p 137
- 33 BURACZEWSKI AND ZBIJEWSKI, *Anz Akad Wissensch Krakau*
1910, p 35
- 34 CARREZ, *Jour pharm*, 1896 (6), Vol III, p 253
- 35 CELLI, *Arch Schiffs u Tropen Hyg*, 1907, Vol IX, p 126
- 36 CHRISTENSEN, *Jour pkt Chemie*, 1901 (2), Vol LXIII, p 313
- 37 CHRISTENSEN, *Jour pkt Chemie*, 1904 (2), Vol LXIX, p 193
- 38 CHRISTENSEN, *Jour pkt Chemie*, 1904 (2), Vol LXVIII, p 424
- 39 CHRISTENSEN, *Pharm Jour Trans*, 1881 (3), Vol XII, p 602
- 40 CHRISTENSEN, *Apoth Zeitung*, 1907, Vol XXII, p 177
- 41 CHRISTOMANOS, *Berl Klin Wochenschr*, 1898, Vol XXXV,
p 976
- 42 COCKBURN AND BLOCK, *Analyst*, 1911, Vol XXXVI, p 396
- 43 COLSON, *Compt rend*, 1889, Vol CVIII, p 678
- 44 COMMANDUCCI, *R d R Accad scien fis et mat Napoli*, 1910,
Vol XXVI, p 12
45. DAVY, *Pharm Jour Trans*, (3), Vol XI, p 756
- 46 DELLFS, *Zeitschr analyt Chemie*, 1857, Vol III, p 152
- 47 DENIGÈS, *Jour pharm chim*, 1903, Vol XVII, p 505
- 48 DENIGÈS, *Bull soc pharm de Bordeaux*, 1911, Vol LI, p 155.
- 49 DIELT, *Wiener med Wochan schr*, 1852, p 745

BIBLIOGRAPHY—continued

- 50 DOUMER AND DREAUX, *Jour Pharm Trans*, 1895 (6), Vol I, p 50
- 51 DUNCAN, *Pharm Jour. Trans*, 1905, Vol LXXIV, p 438
- 52 DWARS, *Arch d Pharm*, 1879 (3), Vol XIV, p 329
- 53 EILOART, *Chemical News*, 1884, Vol L, p 102
- 54 EILOART, *Z f analyt Chemie*, 1886, Vol XXV, p 248
- 55 ELLINGER, *Zeitsch f physiol Chemie*, 1904, Vol XLIII, p 325.
- 56 ELVOVE, *U S A Hyg Lab Bulletin*, No 54, 1910
- 57 FLAMINI, *Atti soc gli studi Malaria*, 1906, Vol VII, p 46
- 58 FLORENCE, *Bull science pharm*, 1907, Vol XIII, p 365
- 59 FLUCKIGER, *Zeitsch analyt Chemie*, 1872, Vol XI, p 317
- 60 FUHNER, *Ber d Deutsch chem. Gesellsch*, 1905, Vol XXXVIII, p 2713
- 61 GAGLIO, *Atti d Soc p g studi della Malaria*, 1907, Vol VIII, p 243
- 62 GEVAERT, *Arch med biolge*, 1885 (3), Vol XXVIII, p 388
- 63 GIEMSA, *Arch f Schiff's u Tropen Hyg*, 1908, Vol XII, p 78.
- 64 GIEMSA AND HALBERKANN, *Arch f Schiff's u Tropen Hyg*, 1917, Vol XXI, p 333
- 65 GIEMSA AND HALBERKANN, *D med Wochenschr*, 1917, Vol. XLIII, p 1501
- 66 GIEMSA AND PROVAZEK, *Arch f Schiff's u Tropen Hyg*, 1908, Vol XII, p 88
- 67 GIEMSA AND SCHAUMANN, *Arch f Schiff's u Tropen Hyg*, 1907, Vol XI, p 29
- 68 GLENARD AND GUILLERMOND, *Jour prakt Chemie*, 1859, Vol LXXXVII, p 63
- 69 GROSSEK, *Biochem. Zeitschr*, 1918, Vol VIII, p 102
- 70 GROVE, *Jour chem soc*, 1868, Vol XII, p 97
- 71 GUIGUES, *Jour pharm et chim*, 1905 (4), Vol XXIV, p 55
- 72 GRESSHOFF, *Pharm Weekblad*, 1903, Vol XL, p 541
- 73 HARRANDEAU, *Bull. soc pharm de Bordeaux*, 1913, Vol LIII, p 28
- 74 HARTMANN AND ZILA, *Arch f experim Path u Pharm*, 1918, Vol LXXXIII, p 221
- 75 HAIDINGER, *Phil Mag*, 1853 (4), Vol VI, p 273
- 76 HERAPATH, *Phil Mag*, 1853 (4), Vol VI, p 171
- 77 HERAPATH, *Phil Mag*, 1853 (4), Vol VI, p 346
- 78 HERAPATH, *Phil Mag*, 1856 (4), Vol IX, p 366
- 79 HERAPATH, *Pharm Jour trans*, 1856 (3), Vol XXVII, p 205.
- 80 HERAPATH, *Proc Royal Soc*, 1857, Vol VIII, p 340
- 81 HERDER, *Arch d Pharm*, 1905, Vol CCXLIV, p 120
- 82 HESSE, *Arch d Pharm*, 1878, Vol XIII, p 495
- 83 HESSE, *Arch d Pharm*, 1896, Vol CCXXXIV, p 195
- 84 HESSE, *Arch d Pharm*, 1897, Vol CCXXXV, p 114
- 85 HILDEBRANDT, *Arch f exper Path u Pharm*, 1908, Vol. LIX, p 127
- 86 HILGER, *Arch d Pharm*, 1875, p 509
- 87 HILLE, *Arch d Pharm*, 1903, Vol CCXL, p 54
- 88 HIRSCHSOHN, *Pharm Centralhalle*, 1902, Vol XLIII, p 367
89. HORSLEY, *Chemical News*, Vol V, p 355
90. HOST-MADSEN, *Ber d D pharm Gesellsch*, 1907, Vol XVI, p 442
- 91 HYDE, *Jour Amer chem soc*, 1897, Vol XIX, p 331
92. JAWROWSKI, *Zeitschr f analyt Chemie* 1897, Vol XXXVI, p 208
93. JAWROWSKI, *Pharm Zeitschr Russ*, 1897, Vol. XXXV, p 326
94. JEANSELEME AND DALIMIER, *Press med*, 1917, Vol XXV, p 441
95. JOBST, *Arch d Pharm*, 1877, Vol XII, p 331

BIBLIOGRAPHY—continued.

- 96 JONESCU, *Ber Deutsch pharm Gesellsch*, 1906, Vol XVI, p 130.
 97 JORGENSEN, *Jour. prakt Chemie*, 1877 (2), Vol XVI, p 213.
 98 JORGENSEN, *Jour. prakt Chemie*, 1877 (2), Vol XV, p 356
 99 JORGENSEN, *Jour. prakt Chemie*, 1877 (2), Vol XV, p 418
 100 KATZ, *Biochem Zeitschr*, 1911, Vol XXVI, p 144
 101 KEBLER, *Jour. Amer Chem Soc*, 1895, Vol XLVI, p 822
 102 KERNER, *Archiv f d ges Physiol*, 1869, p 200
 103 KIMURA, *Rinsho Yakuseki Schimpo Tokyo*, 1905, p 393
 104 KIPPENBERG, *Zeitschr analyt Chemie* (1896), Vol XXXIV,
 p 318
 105 KIPPENBERG, *Zeitschr analyt Chemie* (1896), Vol XXXV, p 10.
 106 KLEINE, *Zeitsch f Hyg u Infekts Krankh*, 1901, Vol
 XXXVIII, p 458
 107 KLEIST, *Jour. prakt Chemie*, 1860, Vol LXXXIX, p 131
 108 KLETZINSKI, *Rept Pharm*, 1817, Vol II, p 567.
 109 KOCHLEIN, *Bull. soc industr*, 1860, Vol XXX, p 458
 110 KRAMERS, *Rec trav chim*, 1896, Vol XV, p 138
 111 KRUYSE, *Pharm Weekblad*, 1912, Vol XLIX, p 1117.
 112 KUBLI, *Arch d Pharm*, 1896, Vol CCXXXIV, p 195
 113 KUBLI, *Pharm Zeitung Russ*, 1896, Vol XXXIV, p 593.
 114 LANDERER, *Buchners Rpt*, 1836, Vol V, p 224
 115 LEGER, *Jour. pharm et chim*, 1904 (4), Vol XXIII, pp 281,
 427
 116 LENZ, *Zeitschr analyt Chemie*, 1888, Vol XXVII, p 549
 117 LEPIDI-CHIOTTI, *Sul assorb et elim della chimina*, 1876
 118 LINDE, *Arch d Pharm*, 1899, Vol CCXXXVII, p 176
 119 LIPKIN AND RAMSDEN, *Brit Med Jour*, 1819, p 560
 120 LOEWENSTEIN AND KOSIAN, *Zeitsch f Hyg u Infekt. Krankh*,
 1917, Vol LXXXIV, p 325
 121 LOEWENSTEIN AND NEUSCHLOSS, *Zeitschr f Hyg u Infekt.*
Krankh, 1917, Vol LXXXIV, p 257
 122 MANNICH AND SCHWABES, *Apotheker Zig*, 1912, Vol XXVII,
 p 323
 123 MANSON, *Phil Mag*, 1835, Vol VI, p 158
 124 MARCHOUX, *Compt rend soc Biol*, 1904, Vol CLVIII, p 212.
 125 MARIANNI, *Atti soc gli studi Malaria*, 1904, Vol V, p 26.
 126 MARX, *Wien Klin Wochenschr*, 1902, Vol XVI, p 722
 127 MASING, *Archiv d Pharm*, 1876, p 310
 128 MATOLCSY, *Pharm Post*, 1904, Vol XXXVII, p 177
 129 MAYER, *Jour. prakt Chemie*, 1832, Vol IX, p 246
 130 MCGILCHRIST, *Indian Jour med res*, 1914, Vol II, p. 329
 131 MERCK, *Reagenzien-Verzeichnis*, 2nd edition
 132 MERKEL, *Arch experim Pathol u Pharm*, 1902, Vol XLVII,
 p 165
 133 v MILLER AND RHODE, *Ber Deutsch chem Gesellsch*, 1895,
 Vol XXVIII, p 1058
 134 v MILLER AND RHODE, *Ber Deutch chem Gesellsch*, 1900,
 Vol XXXIII, p 3227
 135 MYLIUS, *Pharm Centralh*, 1886, Vol IX, p 292
 136 NIERENSTEIN, "Interim Report on Malaria," by Sir R Ross,
War Office Investigations, 1917, 24 Gen No (A M D 2) 6198
 137 NIERENSTEIN, "An Interim Report on the Treatment of
 Malaria," by Col Sir Ronald Ross (Discussion), *Trans Soc.*
Trop Med and Hyg, 1918, Vol XII, p 212
 138 NISHI, *Arch f exper Pathol u Pharm*, 1909, Vol LX, p 321
 139 OECHSNER DE CONINCK, *Compt rend*, 1897, Vol CXXXIV,
 p 173
 140 OUDEMANOS, *Annalen der Chemie*, 1876, Vol CLXXXII, p 44
 141 PELOUZE, *Ann chim. phys*, 1833 (2), Vol LIV, p 337

BIBLIOGRAPHY—*continued*.

142. PÉPIN, *Bull scienc pharm*, 1918, Vol XXV, p 19
 143. PERSONNE, *Jour chem et pharm*, 1878, Vol XXVIII, p 354.
 144. v PLANTA, *Annalen d Chemie*, Vol LXXIV, p 245
 145. POLLOICI, *Gazz chim ital*, 1898, Vol XXVIII, p 391
 146. PORAK, *Compt rend soc Biol*, 1918, Vol LXXXI, p 136
 147. PORCHINSKI, *Med Sbornik Tiflis*, 1881, Vol, XVIII, p 151
 148. PRIMAVERA, *Morgagni*, 1869, Vol XI, p 93
 149. POZZI-ESCOT, *Compt rend*, 1901, Vol CXXXXII, p 1062
 150. QUEVENNE, *Jour Chim med* 1838, Vol IV, p 468
 151. QUEVENNE, *Experience*, 1838, Vol II, p 97
 152. RABE, *Ber Deutsch chem Gesellsch*, 1912, Vol XLV, p 1447.
 153. RAMMSTEDT, *Pharm Zeitg*, 1908, Vol LIII, p 674
 154. RAMSDEN AND LIPKIN, *Annals Trop med and Parasit* 1918,
 Vol XI, p 443.
 155. REICHARD, *Pharm Zeitung*, 1905, Vol L, p 314
 156. REICHARD, *Pharm Ztg*, 1905, Vol L, p 430
 157. DE RENZI AND BOFFITO, *Salute, Genova*, 1876, Vol II, p 161.
 158. RICHMOND, *Analyst*, 1890, Vol XV, p 42
 159. RICHTER, *Apoth Zeitung*, 1913, Vol XXVII, p 949
 160. ROBERT, *Jour Pharm Trans*, 1821, Vol IV, p 197
 161. ROBERTSON, *Proc Chem Soc*, 1905, Vol XXI, p 242
 162. RUPP AND SEEGERS, *Arch d Pharm*, 1907, p 662
 163. SALOMON, *Ber Deusch pharm Gessellsch*, 1918, Vol XXVIII,
 p 273
 164. SALOMONSON, *Ned Tydschr pharm*, 1896, Vol VII, p 19
 165. SCHMITZ, *Arch f experim Pathol u Pharm*, 1907, Vol LVI,
 p 30
 166. SCHRAGE, *Arch d Pharm*, 1878, Vol XIII, p 25
 167. VON SCHROFF, *Wiener med Jahrb*, 1875, Vol V, p 175.
 168. SCHULZ, *Arch f path Anatomie*, 1887, Vol LIX, p 21.
 169. SCHWEIZER, *London Med gaz*, 1837, p 173
 170. SCHWENGERS, *Der Nachweis des Chinins im Harn*, Dissertation
 Bonn, 1868
 171. SELMI, *Nuovo processo generale per la uicerca delle sostanze
 venefiche*, Bologna, 1875
 172. SESTINI AND CAMPANI, *L'Orso*, 1892, Vol XIV, p 304
 173. SIMONCELLI, *Gazz chim ital*, 1898, Vol XXVIII, p 171.
 174. SKRAUP, *Monatshefte f Chemie*, 1893, Vol XIV, p 431
 175. SOULIER, *Bull soc path exot*, 1917, Vol X, p 217
 176. SPERLING, *Zeitschr Oesterr Apoth Verein*, 1903, Vol XLI,
 p. 827.
 177. SCRAPITTI, *Gazz chim ital*, 1898, Vol XXVIII, p 177.
 178. SURRE, *Bull soc chim*, 1902 (3), Vol XXVII, p 626
 179. TANRET, *Jour pharm et chim*, 1909 (4), Vol XXVIII, p 490.
 180. TARNOFF, *Med Sbornik Tiflis*, 1866, p 3
 181. TEICHMANN, *Deutsch med Wochenschr*, 1917, Vol XLIII,
 p 1092
 182. THAU, *Buchner's Rpt*, 1836, Vol V, p 381
 183. THOMS, *Ber Deutsch chem Gesellsch*, 1905, Vol XV, p 85
 184. THOMAS AND TAILLANDIER, *Report chim appl*, 1859, Vol. I,
 p. 283
 185. THOULET, *Bull Soc mineralog. de France*, 1879, Vol I, p 86.
 186. UFER, *Dessertation*, 1905
 187. VALSER, *Zeitschr analyt Chemie*, 1864, Vol II, p 79
 188. VIGNERON, *Jour pharm et chim*, 1906 (4), Vol XXV, p. 180.
 189. VITALI, *Jour Chem med*, 1874, Vol XLVI, p 22
 190. VITALI, *Zeitschr analyt Chemie*, 1887, Vol XXVI, p 740.
 191. VOGEL, *Annalen d Chemie*, 1850, Vol LXXXIII, p 221.
 192. VONDRASEK, *Pharm Post*, 1908, Vol XLI, p 605

BIBLIOGRAPHY—continued

- 193 DE VRIJ, *Pharm Jour Trans*, 1876 (3), Vol VI, p 461
 194 DE VRIJ, *Arch d Pharm*, 1878, Vol X, p 72.
 195. DE VRIJ, *Arch d Pharm*, 1887 (3), Vol XXIV, p 1073
 196 DE VRIJ, *Pharm Jour Trans*, 1881 (3), Vol XII, p 602.
 197 VULPIUS, *Zeitschr analyt Chemie*, 1887, Vol XXVI, p 739
 198 WAGNER, *Arch d Pharm*, 1863, p 260
 199. WASIEKY, *Verhandig Gesellsch Deutsch Naturvorscher und Aerzte*, 1913, Vol LXXXV, p 534
 200 WEDEKIND AND KOCH, *Ber Deutsch chem Gesellsch*, 1906, Vol XXXVIII, p 421
 201 WELLER, *Pharm Centralhalle*, 1886, p 270
 202 WILLGERODT, *Die organischen Verbindungen mit mehrwertigem Jod Stuttgart*, 1914
 203 WINCKLER, *Rep d Pharm*, Vol. XXXV, p 57
 204 WOKER, *Jour phys Chemistry*, 1906, Vol X, p 370
 205. WORMLEY, *Amer Jour Pharm*, 1894 (4), Vol XXIV, p 561.

APPENDIX TO BIBLIOGRAPHY.

- 206 COHEN, *Pharm Weekblad*, 1908, Vol. XLV, p 1089
 207 DAVIS, *British Medical Jour*, 1913, p 430
 208 FOLLIN, *Zeitschr physiol Chem*, 1904, Vol XLI, p 235
 209 FOLLIN, *Amer Jour of Physiol*, 1905, Vol XIII, p 118
 210 FUHNER, *Arch f exp Pathol u Pharm*, 1918, Vol LXXXII, p 205
 211 GIEMSA AND HALBERKANN, *Ber d Deutsch chem Gesellsch* 1918, Vol LI, p 1325
 212 GOMBERG AND CONE, *Annalen d Chemie*, Vol CCCLXXXVI, p 191.
 213 HEIKEL, *Chem Zeig*, 1908, Vol XXXII, p. 1149
 214 VON HOROSKIEWICZ AND MARK, *Zeitschr f analyt Chemie*, 1907, Vol XLVI, p 565
 215 KAUFMANN, *Ber d Deutsch Chem Gesellsch*, 1913, Vol. XLVI, p 1823.
 216 KAUFMANN AND HUBER, *Ber d Deutsch chem Gesellsch*, 1913, Vol XLVI, p 2913
 217 KIPPING AND POPE, *Jour Chem Soc*, 1893, Vol LXIII, p 558
 218 VAN LEERSUM, *Wisk en Nath Afd*, 1910, Vol XIX, p 119
 219 MATTHES AND RAMSTEDT, *Zeitschr f analyt Chemie*, 1907, Vol XLVI, p 565
 220 NIERENSTEIN, *Jour Royal Army Medical Corps*, 1919, Vol XXXII, p 215.
 221 NIERENSTEIN, *Jour. Royal Army Medical Corps*, 1919, Vol. XXXII, p 218
 222 RAMSDEN, LIPKIN AND WHITLEY, *Ann Trop Med and Parasit* 1918, Vol XII, p 223
 223 ROSENTHALER AND GORNER, *Zeitschr f analyt. Chemie*, 1910, Vol XLIX, p 340
 224 SCHOLZ, *Deutsch med Wochenschr*, 1918, Vol XLIV, p 965.
 225 THOMSON AND MILLS, *Lancet*, 1919, May 10th, p 784.
 226 VIGNERON, *Jour Pharm et Chimie*, 1911, Vol III, p 103
 227 WEBER, *Arch f exper Path u. Pharm*, 1908, Vol LVIII, p 93
 228 WHERRY AND YANOWSKY, *Jour. Amer Chem Soc*, 1918, Vol XL, p 1063
 229 WILSON, *Amer Jour Physiol*, 1907, Vol. XIX, p 445

II. EXPERIMENTS ON THE COMPLEMENT FIXATION IN MALARIA WITH ANTIGENS PREPARED FROM CULTURES OF MALARIA PARASITES.— (*P. Falciparum* and *P. Vivax*.)

(WAR OFFICE INVESTIGATIONS)

By J. GORDON THOMSON, M.A., M.B., Ch.B., Captain,
Royal Army Medical Corps (T.C.),

*Officer in Command of Malaria Laboratory, 4th London
General Hospital,
Protozoologist to London School of Tropical Medicine.*

THIS research was carried out for the purpose of finding a more accurate test for cases of malaria. The only certain method of diagnosing malaria is to find the parasites in the peripheral blood, this is only possible when the infection is heavy enough to enable the pathologist to find parasites after a reasonable search in a thick film.

Many cases are admitted to hospital with a diagnosis of malaria on clinical grounds only, and many have received treatment with quinine before being examined for parasites, the result being that a large proportion of cases are labelled as malaria on the history alone.

A differential leucocyte count in cases where no parasites are found is of great assistance in diagnosing these cases, and when the large mononuclears show a marked increase we can be fairly certain that the case is one of malaria, especially when there is a marked anæmia and splenic enlargement, with a definite history of rigors and temperature.

The blood picture alone, however, with the absence of malaria parasites, always leaves us in some doubt that the case is actually one of malaria, especially if no parasitic relapse occurs while the patient is under observations without treatment.

Many cases in the tropics have been diagnosed as malaria which are not malaria, and it is a common error to send into hospitals cases diagnosed as typhoid which are proved afterwards to be malaria. Comatose malaria has again and again been confused with heat stroke, with disastrous results.

A golden rule ought to be framed by physicians in a tropical country, namely, in all cases of obscure fever, before commencing treatment, examine a blood film for parasites, and, if that is negative, have a blood culture done. If this were carried out, many mistakes and disasters would be avoided.

On treatment by quinine (X grs t i d) malaria parasites rapidly disappear from the peripheral blood, so that about the fourth day asexual forms are so scarce that, as a rule, they cannot be found even after prolonged search (*vide* reports of Captain Gardner and Mr Row).

Many methods of treatment have been tried, but there is no accurate means of diagnosing whether the patient is absolutely cured or not. We know that treatment must be continuous and prolonged if relapses are to be avoided, but we are never able to guarantee that the fever will not return.

If a disease is not cured, and a specific organism is still present in the body in large enough numbers to produce a certain quantity of antibody, we know that if we can produce a specific antigen it ought to be possible to deviate the complement. The strength and sensitiveness of this reaction depends on the presence of sufficient antibody and its specific antigen.

Little is known about the antibodies formed against the malaria parasites, but there must be some, and there is no doubt these play a great part in the production of a natural immunity, and eventually many cases of malaria recover without treatment, usually after many attacks of fever over a prolonged period.

Immunity is established to a certain extent if it is not quite absolute, and in a specific complement fixation reaction we are able to measure the defensive activity of the infected host. Complement is deviated or fixed when antibody and its specific antigen are present in the test, and in this series of experiments we have prepared a malarial antigen successfully in the following manner. The preparation of this is entirely due to the discovery of Captain David Thomson.

PREPARATION OF MALARIAL ANTIGENS

In a preliminary note published in the *British Medical Journal* (1918) we described shortly the technique for making antigen, so that other experimenters might work along similar lines and perhaps improve the method.

Cultures are prepared of malaria parasites, either benign or malignant tertian, according to the method elaborated by J. G. Thomson and D. Thomson (1913). Cases where the peripheral blood is heavily loaded with parasites are to be preferred, and, if possible, they should have received no previous quinine treatment.

After growing in the incubator at 37° C. for 24 to 48 hours, the supernatant serum is pipetted off and an excess of sterile distilled water is added to the remaining sedimented corpuscles in the tube. Shake well up and so lake the corpuscles. Centrifuge and pipette off the red hæmoglobin stained

water, so leaving a deposit of *debris* of corpuscles, leucocytes and parasites. Add again an excess of distilled water, shake up and centrifuge, and so on until the supernatant water is practically colourless, and thus the whole of the hæmoglobin is removed. We now have a deposit of malaria parasites, and if this deposit is smeared on a slide and stained, we find, if the culture was a good one, that we have almost a solid mass of parasites, with some leucocytes and the empty envelopes of red blood corpuscles.

Dissolve this sediment in as small a quantity as possible of N/10 Na O.H., and a viscid yellow fluid is obtained. Neutralise this carefully with normal HCl. If too much acid is added, we cause a precipitate, and this must be avoided (*vide* D. Thomson, 1918).

So far we have found this concentrated solution of parasites too anti-complementary to use as it is, and dilution is necessary with normal saline. The ideal aimed at is to obtain as concentrated an antigen as possible, which is not too anti-complementary, for it is by getting a strong antigen that we will expect to get more sensitive and reliable results.

Dilute this antigen ten times with normal saline and carry out a preliminary titration with complement (guinea pig's serum). The actual test is that recommended by D. Thomson (1918).

Take 12 Wasserman tubes and add 0.1 cc of guinea-pig's serum (complement), diluted as follows —

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1/10	1/20	1/30	1/40	1/50	1/60	1/70	1/80	1/90
(10)	(11)	(12)	= dilutions of complement.					
1/100	1/110	1/120						

Add to each 0.1 cc of antigen (diluted 1 in 10). At the same time, when testing each new batch of antigen, it is better to conduct similar tests, the antigen being diluted 1 in 20, 1 in 30, 1 in 40, 1 in 50, 1 in 60, 1 in 70, 1 in 80, 1 in 90, and 1 in 100. It can thus be found out without waste of time which dilution can be best used which has not too much anti-complementary action. This complete test will take, therefore, ten rows of tubes, but it can be made shorter by making jumps. For example, the antigen could be tested 1 in 10, 1 in 40, 1 in 50, and, if found to be unsatisfactory in these dilutions, higher dilutions could be carried out later.

Having added the complement and the antigen to the tubes, place them all in the ice chest for at least one hour and then give half an hour in the water-bath at 37° C. Add to each tube 0.1 cc. of sensitised sheep's corpuscles (3 per cent. suspension). Place the trays immediately in water bath at 37° C., and read the result in 15 minutes. The lowest dilution of complement which produces complete hæmolysis

in that time should be taken as the minimum hæmolytic dose. Note the dilution of antigen which gives a satisfactory result, and dilute antigen accordingly. As I have pointed out, the stronger the antigen is the better, provided it is not too anti-complementary. So far, I am quite unable to explain why some antigens are so anti-complementary, but further experimental work may throw some light on this.

The actual test of the malarial sera is based on the technique of Captain D Thomson (1918)

Four tubes—A, B, C and D—are employed for the serum of each suspected malaria

To A, B and C add 0.1 cc of serum (inactivated at 56° C. for 10 minutes) and diluted 1 in 10 with normal saline. Sometimes it is better to dilute the serum only 1 in 5.

To tube "A" add complement 0.1 cc, containing 3½ minimum hæmolytic doses.

To tube "B" add complement 0.1 cc, containing 3 minimum hæmolytic doses

To "C" add complement 0.1 cc, containing 2½ minimum hæmolytic doses

To "D" add complement 0.1 cc., containing 2½ hæmolytic doses

To A, B and C add 0.1 cc of antigen, preferably a compound antigen, made up of different strains of parasites, and diluted according to what has been found necessary after titration against the complement used

To tube "D" add no antigen, but 0.1 cc of normal saline, so this acts as a serum control.

Place all the tubes in the ice chest over the night, and add to each next morning 0.1 cc of sensitised sheep's corpuscles. Place immediately in the water-bath, and read the results quickly in exactly 15 minutes

With each batch of sera tested, introduce two known positive malaria sera at least and two known negative sera, that is, the sera of persons who have never had malaria, and which we know possess no anti-complementary action *per se*.

As soon as the control tubes D show complete hæmolysis and the negative sera show hæmolysis, the results in A, B and C ought to be read and noted at the end of 15 minutes

If left longer and the reaction is a weak one, we fail to detect weak positive reactions, an antigen control containing no serum, but an equal amount of saline and 2½ M.H.D. is necessary, since antigen may absorb complement during the night in the ice chest.

If control sera are unsatisfactory, it is quite impossible to read the test, and the experiments will require to be repeated. As the reaction is a delicate one, which requires to be very carefully controlled, we must avoid using old serum, which is perhaps contaminated, and thus develops anti-

complementary power, apart from any specific antibody in it. Sera previously heated and kept for a few days must be heated again immediately before the test

RESULTS OF EXPERIMENTS ON THE COMPLEMENT DEVIATION ON 200 CASES OF MALARIAL INFECTION.

It was first necessary to test the sera of known malaria cases with parasites present in the blood in order to find if positive results could be obtained with the antigen used. At first antigens were prepared from single cases of malaria and used unmixed with other strains. Separate antigens were prepared from benign and malignant tertian malaria and from the spleen of a malignant tertian malaria. This latter method of obtaining antigen may prove to be the best, but, unfortunately for our experiments here, we have not yet been able to obtain a heavily-infected spleen.

The spleen antigen prepared here did give positive results, but these were weak and unsatisfactory. The actual experiments carried out were as follows :—

A.—PRELIMINARY EXPERIMENTS CARRIED OUT IN KNOWN CASES OF BENIGN TERTIAN MALARIA, ALL WITH *P. Vivax* PRESENT IN THE BLOOD, USING ANTIGEN PREPARED FROM A SINGLE STRAIN OF PARASITES (*P. Vivax*).

TABLE A.

No of Cases Examined.	Cases	Doses of Complement			
		2½	3	3½	2½*
8	Eight cases, all with numerous parasites. <i>P. vivax</i> infections, no treatment	+	+	+	—
1	On case, <i>P. vivax</i> present in small numbers, no treatment	+	+	—	—
4	Four cases, all with parasites present in blood, no treatment	+	—	—	—
1	One case, rigor day before, no treatment. Parasites numerous	+	—	—	—
1	One case, <i>P. vivax</i> numerous	—	—	—	—
1	One case, <i>P. vivax</i> present. 4 doses of quinine, each grs. 10	+	+	+	—
1	One case, <i>P. vivax</i> present, only 30 grs quinine	+	—	—	—
1	One case, <i>P. vivax</i> , 30 grs quinine only	+	+	+	—
1	One case, <i>P. vivax</i> 30 grs quinine only	+	—	—	—

* Serum control

All these cases in Table A were done with an antigen prepared from a single strain of *P vivax* (a Salonica strain) It will be noted that 7 out of the 19 gave only weak positive results, and that one serum gave a completely negative result, although the blood contained numerous parasites, the patient having had a rigor on the day previous. The remaining 11 cases gave malaria positive results, and all after standing in the tubes for a short time became negative. For this reason the results must be read quickly after the control serum and the known negative sera show complete hæmolysis.

The serum which gave a completely negative result must have either been very deficient in antibody or the antigen used was not specific to that particular strain. We shall discuss this later under a separate section.

B.—EXPERIMENTS CARRIED OUT IN ORDER TO DETERMINE IF SEPARATE STRAINS OF PARASITES REACTED DIFFERENTLY TO VARIOUS ANTIGENS

In this series of observations an attempt was made to determine if some antigens were specific to certain strains of parasites. The cases under discussion were all benign tertian, and all at the time of examination had parasites (*P. vivax*) present in the blood. It was thought that strains from Salonica, Mesopotamia, Egypt, East Africa or Palestine might react differently to different antigens. This point we have been quite unable to settle, because it is possible that the real cause of these varying reactions is due to differences in the preparation of the antigen.

TABLE B

No of Cases Examined	Cases	Doses of Complement			
		2½	3½	3½	2½
	ANTIGEN No 1 BENIGN TERTIAN PARASITES				
4	Four cases, <i>P. vivax</i> present in blood No quinine	+	-	-	-
1	One case, <i>P. vivax</i> numerous No quinine	-	-	-	-
	ANTIGEN No 2 BENIGN TERTIAN PARASITES				
4	Four cases, same as above	+	+	+	-
1	One case, same as above	+	+	+	-

It is evident from these experiments in Table B that antigen No. 2 gave a much stronger reaction with these cases. This may be due to the fact that the antigen was stronger or to the strain of the parasites used in its manufacture.

C.—EXPERIMENTS CONDUCTED FOR THE PURPOSE OF DETERMINING IF SPECIFIC ANTIGENS COULD BE PREPARED FOR BENIGN AND MALIGNANT AND TERTIAN MALARIA.

The first few experiments conducted led us to believe that the reaction was a specific one, and we are still in doubt about this matter, as it is extremely difficult to determine whether or not a patient may at one time or another have been doubly infected. Experience of over 3,000 infections show us that it is quite common for a patient to have a primary infection with *P. falciparum* and afterwards return to hospital with a *P. vivax* infection, which seems to persist longer.

As there are frequently no records of the parasites in previous attacks, it is quite impossible to exclude double infections. Difficulties also in the sensitiveness and strength of the antigen prepared seems to play a part in these observations.

TABLE C

No of Cases Examined	Cases	Doses of Complement			
		2½	3	3½	2¼
3	(1) MALIGNANT TERTIAN ANTIGEN Three cases, <i>P. falciparum</i> infection	+	-	-	-
1	One case, <i>P. vivax</i> ..	-	+	-	-
3	(2) BENIGN TERTIAN ANTIGEN Same three cases of <i>P. falciparum</i>	-	-	-	-
1	One case of <i>P. vivax</i> , same case as above ..	+	+	-	-

This series of experiments show that there may be a certain specific action, but it also tends to show that there is probably a group reaction for malaria. Experiments conducted by Noguchi and Craig seemed to prove that there are specific group reactions in the way of complement fixation between *Treponema pallidum*, *Treponema pertenue* and *Treponema microdentium*, as antigens prepared from pure cultures of these may give complement fixations in the presence of syphilis serum.

D—FURTHER EXPERIMENTS MADE BY USING AN ANTIGEN PREPARED FROM SPLEEN OF A MALIGNANT TERTIAN CASE AND ANTIGEN PREPARED FROM CULTURES OF *P. Vivax*

TABLE D

No of Cases Examined	Cases	Doses of Complement			
		2½	3	3½	2½
	(1) SPLEEN ANTIGEN <i>P. falciparum</i>				
I	One case, <i>P. vivax</i>	+	-	-	-
I	One case, <i>P. vivax</i>	+	-	-	-
I	One case, <i>P. vivax</i> (heavy infection)	+	+	+	-
I	One case, <i>P. vivax</i> (rigor case) ..	+	+	+	-
I	One case Malignant tertian malaria	+	+	+	-
I	One case Malignant tertian Crescents only	+	+	-	-
	(2) BENIGN TERTIAN ANTIGEN (Results with same sera as above)				
I	One case, <i>P. vivax</i>	+	+	-	-
I	One case, <i>P. vivax</i>	+	-	-	-
I	One case, <i>P. vivax</i> (heavy infection)	+	+	+	-
I	One case, <i>P. vivax</i> (rigor case) ..	+	+	+	-
I	One case, Malignant tertian malaria	-	-	-	-
I	One case, Malignant tertian	+	+	+	-

This table shows that certain cases gave specific reaction to the infection found, but in other cases a positive reaction was obtained when using either antigen

SERIES OF CASES DONE USING A COMPOUND MALARIA ANTIGEN COMPOSED OF TEN CULTURES OF BENIGN TERTIAN MALARIA (*P. VIVAX*)

Cases of benign tertian were chosen which had been infected in different zones The following strains of parasites were added in as far as possible equal quantities to the same tube and mixed—

A strain (<i>P. vivax</i>)	Salonica
B strain (<i>P. vivax</i>)	Salonica
C strain (<i>P. vivax</i>)	Salonica
D strain (<i>P. vivax</i>)	Egypt
E strain (<i>P. vivax</i>)	Egypt
F strain (<i>P. vivax</i>)	Egypt
G strain (<i>P. vivax</i>)	East Africa
H strain (<i>P. vivax</i>)	East Africa
I strain (<i>P. vivax</i>)	Italy
J strain (<i>P. vivax</i>)	Palestine

It was found necessary to dilute the original solution of the parasites 1 in 100 with normal saline in order to get rid of the anticomplementary action, which means that our antigen was very much weakened

With this antigen we have obtained positive results with a large number of cases, both benign and malignant tertian malaria, all of which had parasites in the peripheral blood at the time the serum was examined.

TABLE E.—EXPERIMENTS ON COMPLEMENT DEVIATION USING A BENIGN TERTIAN ANTIGEN COMPOSED OF TEN DIFFERENT STRAINS OF PARASITES

TABLE E.

No of Cases	Type of Case	Complement Doses			
		2½	3	3½	2½*
2	Two cases <i>P vivax</i> , blood drawn during rigor	+	+	+	-
1	One case <i>P vivax</i> , blood drawn two hours after rigor Temp 103° F	+	±	-	-
1	One case <i>P vivax</i> , blood drawn when temp. 102° F. Rigor day before Parasites numerous	-	-	-	-
1	One case <i>P vivax</i> Rigor day before Quinine 2 grains every four hours for two days	+	+	+	-
1	One case <i>P vivax</i> , half-grown and full-grown numerous Rigor day before	+	+	+	-
14	Fourteen cases of <i>P vivax</i> , all with numerous parasites No treatment	+	+	+	-
1	One case, <i>P vivax</i> Only 15 grains of quinine	+	+	+	-
1	One case <i>P vivax</i> Two days, quinine of 2 grs every four hours	+	+	+	-
1	One case <i>P falciparum</i> (rings and crescents numerous) No quinine	+	+	-	-
1	One case <i>P falciparum</i> . Crescents only present	+	+	-	-
1	One case <i>P falciparum</i> Crescents very numerous	+	+	+	-
1	One case <i>P falciparum</i> (rings and crescents present) 30 grs a day for two days	+	+	+	-
1	One case <i>P falciparum</i> (rings and crescents present)	+	+	+	-

* Serum control

It will be noted that all these cases had parasites present in the blood when examined, and that one case, a benign tertian case, gave a completely negative result, indicating that there must have been extremely little antibody present in the serum. Negative results in such cases are difficult to explain, but it is quite possible that at certain stages even when parasites are present in the blood stream, antibodies are scarce, probably because they have not had time to form or because the patient was deficient in reaction to the parasites.

TABLE F.—TABLE OF EXPERIMENTS OF COMPLEMENT DEVIATION IN CASES OF MALARIA UNDER VARIOUS COURSES OF QUININE TREATMENT

TABLE F

No of cases	Cases	Quinine	Doses of Complement			
			2½	3	3½	2½
3	Cases, <i>P vivax</i> Many relapses	7 days, quinine, X grs t i d	+	-	-	-
			+	+	+	-
2	Two cases, <i>P vivax</i> Many relapses	4 days, quinine, X grs t i d	+	+	+	-
1	One case, <i>P vivax</i> Many relapses	5 days, quinine, X grs t i d	+	+	+	-
1	One case, <i>P vivax</i> Many relapses	2 days, quinine, X grs t i d	+	+	+	-
1	One case, <i>P vivax</i>	8 days ..	+	-	-	-
3	Three cases, <i>P vivax</i> Relapses numerous	9 days, quinine, X grs t i d	+	+	+	-
			+	+	+	-
			+	+	-	-
1	One case, <i>P vivax</i>	10 days, quinine, X grs t i d	+	+	+	-
4	Four cases, <i>P vivax</i> Relapses numerous	14 days, quinine, X grs t i d	-	-	-	-
			+	+	+	-
			+	+	-	-
1	One case, <i>P vivax</i>	15 days	+	+	+	-
1	One case, infection ..	16 days, quinine, X grs t i d	-	-	-	-
2	Two cases, <i>P vivax</i>	16 days, quinine, X grs t i d	+	+	-	-
			+	+	+	-
3	Three cases, <i>P vivax</i> Several relapses	17 days, quinine X grs t i d	+	-	-	-
			+	-	-	-
			+	-	-	-

TABLE F—*continued.*

No. of Cases.	Cases.	Quinine.	Doses of Complement.			
			2½	3	3½	2¼
2	Two cases, <i>P. vivax</i> . Several relapses	15 days, quinine, X grs. t. i. d.	+	+	-	-
1	One case, <i>P. vivax</i> French case. Recent infection	19 days, quinine, X grs t. i. d.	+	±	-	-
2	Two cases, <i>P. vivax</i> ..	20 days, quinine, X grs t. i. d.	+	-	-	-
6	Six cases, <i>P. vivax</i> ..	21 days, quinine, X grs t. i. d.	-	-	-	-
			-	-	-	-
			+	+	-	-
			+	±	-	-
			+	-	-	-
2	Two cases, <i>P. vivax</i> ..	22 days, quinine, X grs. t. i. d.	+	+	-	-
6	Six cases, <i>P. vivax</i> ..	1 month, quinine, X grs t. i. d.	-	-	-	-
			-	-	-	-
			+	+	-	-
			+	±	-	-
			+	-	-	-
			+	+	-	-
1	One case, <i>P. vivax</i> ..	38 days, XLV grs a day	+	-	-	-
1	One case, <i>P. vivax</i> ..	39 days, X grs t. i. d.	+	+	-	-
1	One case, <i>P. vivax</i> ..	41 days, quinine, X grs t. i. d.	+	+	+	-
1	One case, <i>P. vivax</i> ..	5 weeks, quinine, X grs. t. i. d.	+	+	+	-
1	One case, <i>P. vivax</i> ..	9 weeks' treat- ment in Cairo, 5 weeks, t. i. d., grs. X	-	-	-	-
1	One case, <i>P. vivax</i> ..	2 months' treat- ment, quinine, X grs t. i. d.	+	+	+	-
1	Two cases, <i>P. vivax</i> ..	Several courses treatment over 3 months	+	-	-	-
1	One case, <i>P. vivax</i> ..	3 courses of treatment dur- ing last 5 months	-	-	-	-

TABLE F—continued

No of cases	Cases	Quinine	Doses of Comple- ment.			
			2½	3	3½	2½
1	One case, <i>P vivax</i>	4 days, XC grs of quinine a day Then XXX grs a day for 1 month	-	-	-	-
1	One case Parasites not found	Several long courses of treatment	-	-	-	-
1	One case, <i>P vivax</i>	Two intravenous injections and oral quinine for 2 months	+	±	-	-
1	One case, <i>P vivax</i>	Two intravenous doses and 10 days oral quinine	+	+	-	-
1	One case, <i>P falciparum</i> and Black Water Fever	Euquinine, grs X t i d for 5 weeks	+	-	-	-
1	One case, <i>P vivax</i>	Intramuscular injections and long course of oral quinine	+	-	-	-
1	One case, <i>P vivax</i>	7 intramuscular injections with relapse and 14 days quinine, X grs t i d.	+	+	-	-
1	One case, <i>P vivax</i>	29 days of XXX grs a day, XLV grs. a day for a week XC grs a day for a week, X grs for a week	+	+	-	-
1	One case Infection	No quinine for a long time. Sodium salicylate for rheumatism	+	+	+	-
1	One case No malaria ever found Trench fever 2 months in hospital	No quinine	+	±	-	-
1	Last attack of malaria 7 years ago	No quinine recently	-	-	-	-
1	One case, <i>P vivax</i> Recent infection in France	11 days, XXX grs a day, 7 days, XV grs a day, 7 days, X grs a day	-	-	-	-

TABLE F—continued.

No. of Cases	Cases	Quinine	Doses of Complement			
			2½	3	3½	2½
1	One case, <i>P. vivax</i> Recent infection in France	7 days, XV, 6 hourly, 7 days, X grs, 6 hourly, 7 days, X grs t i d	+	+	-	-
1	One case, no parasites found	2 days, X grs t i d	+	-	-	-
1	One case, <i>P. vivax</i>	7 injections of Di-sodium lugargol Long oral course	-	-	-	-
1	One case, <i>P. vivax</i>	Last fever 3 months ago	+	±	-	-
1	One case Denied ever having had malaria	No quinine	-	-	-	-
1	One case No fever for several years	No quinine recently	±	-	-	-
1	One case Long courses of treatment over a year	No quinine recently	+	+	-	-

The above table shows that it is extremely difficult to estimate what is a sufficient treatment for any individual case of malaria. Most of these cases had many attacks of malaria and numerous admissions to hospital. On each admission to hospital the patient was treated with quinine and discharged after varying intervals.

A study of the results obtained in complement deviation shows that certain patients react very rapidly to the treatment, but others remain positive, in spite of prolonged dosage with the drug. It would seem to us that we have here a parallel in syphilis, where it is well known that the best results are obtained by attacking the disease during the primary stage, and complete cure is not uncommon. If, however, the disease becomes chronic, in many cases it is incurable. Inefficient treatment of malaria during the initial attack only leads to difficulties, and makes the condition much more resistant to cure afterwards.

Patients who come into hospital with malaria undergo a course of treatment with quinine and are discharged. Some of these return after varying intervals with a fresh attack, but others disappear and seem to carry on without relapsing,

or at least without having sufficient fever to make them ask admission to hospital

It will be noted that many of the above cases gave a positive result after very prolonged treatment, and that others became negative, but so far we have not been able to trace whether the patients relapsed or not

In nearly every case where a patient had been free from malarial attacks for a period of one year the blood was found by us to be negative

EXPERIMENTS DONE CO-RELATING THE LARGE-MONONUCLEUR COUNT WITH THE COMPLEMENT DEVIATION

A few observations were made co-relating the large mononucleur leucocyte count with the complement deviation, and it was found that cases showing a marked increase of the large mononucleus in every case gave a positive deviation of the complement.

A few examples are given in the following table, where the differential counts were kindly done by Mr Row, Protozoologist to the Malaria Laboratory —

TABLE G.

Case	Relative Leucocyte Count	Complement Deviation			
		2½	3	3½	2½
i	Large monos , 12 5 per cent	+	-	-	-
i	Large monos , 8 per cent	+	+	-	-
i	Large monos , 13 per cent	+	+	-	-
i	Large monos , 11 5 per cent	+	+	+	-
i	Large monos , 10 5 per cent	+	+	+	-
i	Large monos , 12 5 per cent	+	+	+	-
i	Large monos , 13 5 per cent	+	-	-	-
i	Large monos , 6 5 per cent	+	-	-	-
i	Large monos , 5 5 per cent	-	-	-	-
i	Large monos , 4 per cent	-	-	-	-

The presence of quinine in the blood in detectable quantities in the serum did not seem to affect the test for the deviation of complement. A large number of known cases of syphilis were tested against malarial antigens and were found to give positive results, and it is therefore necessary to exclude this disease, which is easily done by having an ordinary Wasserman reaction done on the serum.

In another section we show that the Wasserman reaction for syphilis is in no way affected by an attack of malaria.

CONCLUSIONS.

1. It is possible to obtain a deviation of the complement in cases of malaria by using a specific antigen prepared from cultures, or from antigen prepared from heavily infected spleen pulp.

2. How far the test will prove to be of practical value in diagnosis is difficult to estimate, as the test is a delicate one and subject to great error, especially if the test is prepared by an unskilled observer

3. The effect of treatment seems to vary greatly. Some patients react more quickly to quinine than others. This may mean that the parasite is more resistant in some cases or that the body of the host is able to react more strongly in certain individuals when quinine is administered.

4. The method of preparing antigen is a new one. It is not a watery nor alcoholic extract, but a complete solution of the whole parasite, and we would thus expect it to contain the specific substances necessary for a good reaction in the presence of antibody

5. Positive reactions are obtained with syphilitic sera, but this is probably due to lipoidal substances, and is not in any sense a specific reaction

6. The experiments conducted so far point to the possibility of a specific reaction for benign and malignant tertian malaria, and there is evidently a group reaction as well. It is thus better to use a compound antigen made up of many different strains of malarial parasites

7. To every batch of ten sera tested, it is advisable to introduce two known negative sera, which are known to have no anticomplementary action *per se*

REFERENCES.

(1913) Thomson, J. Gordon and Thomson, D. "The Growth and Sporulation of the Benign and Malignant Tertian Malarial Parasites in the Culture Tube and the Human Host" *Proc Roy. Soc.*, 1913, B, lxxxvii, pp 77-87, and *Ann Trop Med and Parasit*, 1913, vii, pp 153-164

(1919) Thomson, J. Gordon. "Preliminary Note on the Complement Deviation in Cases of Malaria—a New Aid to Diagnosis" *Brit Med Journ*, 1918, ii, p 628

(1918) Thomson, D. "The Laboratory Diagnosis of Gonococcal Infections." Special Report Series, No. 19, Medical Research Committee, 1918.

III. PRACTICAL NOTES ON MOSQUITO SURVEYS OF CAMPS AND BARRACKS DURING 1917 AND 1918.

By A. C. PARSONS, M R C S , L R C P , D P H ,
Captain Royal Army Medical Corps (T C.)

CONTENTS		PAGES
I	GENERAL CONSIDERATIONS .. .	95
II	SCHEME ADOPTED IN MAKING SURVEYS OF MILITARY STATIONS .. .	96
III	NOTES CONCERNING ADULT ANOPHELES . . .	98
	(a) <i>Habitat</i>	
	(i) Permanent buildings	
	(ii) Huts	
	(iii) Canvas quarters	
	(iv) Non-sleeping quarters	
	(v) Domestic animals' quarters	
	(b) <i>Identification of Anopheline Mosquitoes</i>	
	(c) <i>Range of Flight</i>	
	(d) <i>Species</i>	
	(e) <i>Equipment and methods of search</i>	
IV	FIELD NOTES CONCERNING AQUATIC FORMS OF ANOPHELES	103
	(a) <i>Naked eye appearance of Anopheline larvæ</i>	
	(b) <i>Habits</i>	
	(c) <i>Characteristics of typical Anopheles breeding places</i> (with a classified list of the various kinds of breeding places in which <i>Anopheles</i> has been found)	
	(d) <i>Natural Enemies and inimical conditions</i>	
	(i) Fish	
	(ii) Other aquatic insects	
	(iii) Frogs and newts	
	(iv) Ducks	
	(v) Absence of direct sunlight	
	(vi) Absence of visible vegetation	
	(vii) Excess of weeds	
	(viii) Unsuitable waters	
	(e) <i>Detection of Anopheles Larvæ and Pupæ</i>	
	(f) <i>Methods of search and equipment</i>	
V	LIST OF MILITARY CENTRES INSPECTED BY THE AUTHOR	113

I—GENERAL CONSIDERATIONS

With the exception of the Aldershot Command, in which a more detailed survey was carried out in 1917, investigations of malaria conditions have been confined to those military stations and camps in England where the actual or possible presence of malaria-infected soldiers called for special precautions. In the case of certain camps near popular resorts,

and especially in seaside towns and others where soldiers are billeted, the interests of the civilian inhabitants have been kept in view; but, as a general rule, the prevention of malaria among the troops in the United Kingdom has been the chief consideration.

A list of military stations and camps that have been visited and inspected by the specialist malaria officers since June, 1917, will be found as an appendix at the end of this section.

It will be easily understood that military considerations have made it necessary to concentrate troops—including malaria subjects and other low-category men—in just those parts of England (East Anglia, Essex, Kent and Sussex) where ague was prevalent in the past and where *Anopheles* mosquitos are plentifully distributed to-day. Moreover, the kind of country suitable for summer training-camps often possesses those physical features that are commonly associated with mosquito-breeding areas. This point is well and frequently illustrated in the Aldershot Command. Camps situated in parks and private grounds, also, are often surrounded by ideal mosquito conditions, and, in the case of small units billeted in or camped near farms it is rare not to find mosquitos and their larvæ in more or less abundance

II.—SCHEME ADOPTED IN MAKING SURVEYS OF MILITARY STATIONS AND CAMPS.

As a matter of course and courtesy, the Officer Commanding and the Senior Medical Officer have always been consulted with regard to the proposed inspection of any camp or barracks, and where possible the guidance and help of the Sanitary Officer have also been sought and obtained.

Next, a study is made of any local maps that can be seen, and the maps that have proved most generally useful are :—
 (i) A quarter or half-inch to the mile Ordnance Survey map, which gives a general idea of the geography of the district; (ii) a six-inches to the mile O.S. map, which, through its conventional signs, shows the physical features of the neighbourhood; (iii) a twenty-five-inch to the mile map or sketch plan, which depicts the various tents, huts and other quarters comprising the camp, and also shows in more detail the relative positions of the various natural and artificial collections of water.

Before beginning detailed inspections, the practice has been to take a walk round the outskirts of the camp, noting the general lie of the land, marking the position of any farms and obvious collections of water, and, where possible, obtaining information from the M.O.H., local naturalists, and old

inhabitants. Enquiries about collections of water should be accompanied by exact descriptions of likely breeding-places, for, in the imagination of many, nothing less than a river or large marsh need be considered in connection with mosquito breeding.

When examining, too, the medical inspection room records of "mosquito bites," it is necessary to discriminate between those injuries which are received actually in the sleeping quarters and those which are received while the men are amusing themselves out of camp, otherwise a wrong impression of the mosquito incidence of the camp is obtained. In some cases, moreover, the "bites" are not inflicted by mosquitos at all, but by a small evening midge, *Culicoides nubeculosus*. An increasing number of people, however, are becoming personally acquainted with mosquitos, and when some of these say that they are "bitten" in the hut or tent after "lights out" by winged insects that "keep buzzing about," it is fairly safe to infer that the quarters in question are visited by some kind of mosquito, and that very probably *Anopheles*.

It has not been expedient as a rule to examine soldiers' sleeping quarters for mosquitos at nights, and the practice has been to inspect huts, &c, as early in the day as possible, when the men are on parade or otherwise engaged out of doors. Since this practice has been universally adopted the comparative results of barrack inspections are of some value, though the day-time census of *Anophelines* does not give the actual number that may visit the huts at night.

In the case of a camp where it is thought that a case of locally-contracted malaria has occurred, the quarters in which the patient was actually sleeping when taken ill are, of course, carefully examined, together with those in the immediate neighbourhood. But after enquiring into the question of the patient's movements during the three weeks prior to his attacks, it has sometimes been necessary to visit also a neighbouring outpost, musketry camp or hospital, where the soldier in question may have been posted or detained.

In routine day-time inspections it is sufficient, as a rule, and for reasons to be mentioned later, to inspect only those quarters which are nearest the proven breeding-places.

The search for breeding-places—though often carried out synchronously with the inspection of quarters—is conveniently conducted in the afternoons and evenings, when the men are more frequently found in their quarters, and when the time is more pleasant for walking. It is well to begin the search for larvæ with an inspection of the actual barracks or camping ground, even though one is assured that there is "not a drop of water to be found in the camp,"

and this precaution is especially necessary in districts that happen to possess a marsh within walking distance of a camp. Two instances are recalled in which marshes were thought to be responsible for the presence of mosquitos in camp, when *Anopheles* larvæ were found in plenty within a few yards of the camp headquarters.

Often, too, in the present-time camps cottages and cattle sheds have been left undisturbed in the midst of the lines. It is imperative, however, to make a thorough tour of inspection of the confines of the camp or barracks, and the practice has been to confine such inspections within a radius of half a mile from the periphery of the camp.

III.—NOTES CONCERNING ADULT ANOPHELINES.

(a) HABITAT

Permanent Buildings—In stone or brick barracks, such as exist at Aldershot, it was found that *Anopheles* seems to prefer small rooms rather than the large dormitories, so that, if in a set of barrack buildings, the married quarters, for instance, contained no *Anophelines*, it is very unlikely that these insects will be found in the adjoining large barrack-rooms.

Mosquitos of all kinds, including *Anopheles*, have been found in greatest numbers in those houses or barracks that are surrounded by gardens, shrubberies or woods, and where the buildings themselves are creeper-clad. In several cases it has been noticed that, whereas in summer the *Culicines* predominate in the lower rooms, the *Anophelines* seem to prefer the upper storeys, which, of course, in many cases, contain the sleeping rooms. An exception to this, however, occurred in certain cavalry barracks, in which the men's quarters above the stables were singularly free from all mosquitos. Not only are the upper storeys of houses and barracks favoured by *Anophelines*, but it has very frequently happened that in particular rooms *Anophelines* are resting out of reach high up upon the walls or ceiling, and preferably near a corner of the room. The retiring disposition of *Anophelines* is also shown by the way in which they often hide in cupboards, wardrobes, curtained recesses and cistern rooms.

Huts.—Those huts that have dark interiors are often difficult to examine for mosquitos; but at the same time very careful inspections during the day frequently fail to establish the presence of *Anophelines*, even though they may be prevalent in other parts of the camp. Possibly many huts, and especially those used as wards in hospitals, are too well lighted and too well ventilated to make them popular with *Anopheles*. *Anopheline* mosquitos, however, have been

found in the small service rooms with which the more elaborate type of hut is furnished. When seen in the ordinary kind of hut *Anopheles* are generally discovered on the rafters (when they are occasionally closely simulated by blackened tags of wood), beneath the clothes shelves, and especially in the corners. This predilection for corners is not confined to the case of huts, but applies to all compartments, moreover, the most popular corners are those which flank the doorway, since presumably these positions are the least illuminated and the most free from draughts. It is also very common to find that the men who most complain of being bitten at night are those who occupy corner beds. It may be mentioned here that repeated investigations by the writer have failed to show that *Anopheles* in England hide beneath bedsteads, as they are so fond of doing in West Africa.

Canvas Quarters.—It might be laid down almost as a rule that, if in a mixed camp no *Anopheles* can be found in the marquees and tents, then none will be found in the huts or permanent buildings used by humans. Time after time it has happened that, after searching barrack rooms and huts in vain, a visit to a neighbouring marquee or tent has shown *Anopheles* at once.

A tent, perhaps, admits of quicker and easier inspection than any other kind of sleeping quarters. In the day time, at any rate, the *Anopheles* are almost always confined to the "cup" of the tent or the upper part of the pole. If none are detected in these positions, a poke round with a stick will often dislodge an insect or two. In the case of marquees *Anopheles* again conforms to rule by settling on the roof, out of reach, and especially near the midrib. It should be added that a few try to escape detection by hiding between the folds of the curtain near the entrance or behind the short curtain at the edge of the "fly." Here, again, the corners of the marquee are the most promising places in which to look. Mosquitos on occasions have been seen retreating through the ventilators to the space between the inner and outer "fly" of hospital marquees, but it is difficult to detect and dislodge insects in such circumstances. At the present time, however, bell tents are not usually provided with an outer fly.

Non-sleeping Quarters.—During the summer months the ceilings of barrack ablution rooms at Aldershot have been seen literally brown with *C. pipiens*, with, perhaps, here and there an *Anopheles*. Dampness does not seem to have the attraction for *Anopheles* which it undoubtedly possesses for *Culicines*. These specific idiosyncrasies are even more marked in the case of mosquitos wintering in cellars, since the *Culicines* select the damp patches of the wall, while the

Anophelines are confined to the dry parts. The dark end of corridors, coal sheds and privies are special summer haunts of *Anopheles*.

Domestic Animals' Quarters—In no human habitation during summer or winter has a day-time search shown such quantities of *Anopheles* (chiefly *A maculipennis*) as have obtained in certain animal sheds. In order of precedence piggeries, stables and cow-byres, when respectively occupied, are the chief *Anopheline* resorts. Rabbit hutches and poultry sheds are not apparently used as resting-places by mosquitos.

It would almost seem as if the near presence of certain domestic animals provided a valuable counter-attraction to mosquitos, for a large proportion of the female insects found in these animal sheds, &c, have shown signs of a recent blood feed, and presumably the respective animals have been the victims. Thus, in a boatman's cottage on the Aldershot Canal no *Anophelines* were seen in the cottage proper, but in a stable under the same roof, and in which goats were kept, *Anopheles* could always be found, and during the summer and autumn a large proportion of these were blood-fed.

At Walton, only some half-dozen *Anophelines* were found in over 100 occupied rooms of a certain hospital, while in five pigstyes a few yards away 45 *Anophelines* were counted in five minutes.

Lastly, particular attention was paid to a large mansion in Norfolk, where a detachment of "Y Scheme" men was quartered. Not a single mosquito could be seen in the house itself, nor were any found in the gamekeeper's house 100 yards away. Among the home farm buildings (which included the gamekeeper's house) were some stables and wagon sheds, used by horses of the R A S C. In these stables *A maculipennis* and *A bifurcatus* were in plentiful evidence.

Just as tents may be regarded as valuable criteria in the case of camps, so may farms be looked upon as very important test places when enquiring into the *Anopheline* incidence of a district. Mention has been made of the inevitable frequency with which camps, large and small, are intimately associated with farms or farm buildings, and in at least one instance farm mosquitos have been responsible for a case of indigenous malaria.

In cattle houses especially, and in other places frequented by spiders, *Anophelines* have a very marked habit of hanging from cobwebs, though they seldom seem to be caught in the snare. In a typical *Anopheles*-haunted stable festoons of rigid *Anophelines* may be seen hanging from the dusty webs that bridge the corners of the stable, and if none are seen in these positions they will often fly out if the stick is poked

among the dirty cobwebs in the roof above the manger. A stir up, too, is often needed to convince an untrained onlooker that the pendant mosquitos are really alive and not the inanimate remains of a spider's victims

(b) IDENTIFICATION OF ANOPHELINE MOSQUITOS

There is no need to reiterate what is so often written about the characteristic differences between the pose of *Anopheles* and *Culicines* respectively. It is generally a vertical plane, however, which is chosen to illustrate the respective attitudes of typical *Anopheles* and *Culicines*, and, provided an insect is viewed from several points (it *must* be seen in profile), there is seldom much difficulty—as far as females are concerned—in distinguishing the hump-backed sprawling *Culicine* from the longer-legged and more delicately-poised *Anopheline*.

In the case of male insects, however, the identification is not always quite so easy, since the long, feathered palpi and plumed antennæ of certain male *Culicines* appear to straighten their backs and make the resting position of these insects closely resemble that of the *Anopheles*.

As regards a horizontal plane, the position of a mosquito relative to the surface on which it rests is of less importance, since the body of any mosquito—especially when distended with blood—may tend to hang more or less vertically.

Possibly owing to its spotted wings and formidable aspect, *Theobaldia annulata* has, by the uninitiated, been more often mistaken for *Anopheles* than any other mosquito. Its comparative largeness, coupled with its brindled legs, however, should make the distinction clear, whatever the sex of the insect. Among other Diptera some small species of Crane flies (*Tipula*) have often been brought in as *Anopheline* mosquitos by those not sufficiently acquainted with the distinctive mouth parts of mosquitos. At a distance some of these Crane flies may closely resemble an *Anopheles*, but, as a rule, the wings of a Tipulid fly when at rest assume a pear-shaped contour, with the apex forwards, while the edges of a Culicid's wings are practically parallel.

On more than one occasion a place has been described as "swarming with mosquitos," which on investigation have proved to be *Chironomus* sp. In its flight a *Chironomus* certainly does resemble very closely a mosquito, but it alights much more quickly and deliberately when disturbed, and a closer inspection shows, among other things, that the wings when closed do not, in the case of the common species, cover the extremity of the abdomen as is the case with mosquitos. A *Chironomus* fly, also, often has its front legs free in the air,

while a mosquito always has these limbs fixed, but is fond of waving its hind legs

One of the Window Flies (*Rhyphus fenestralis* Scopoli) can look very like a mosquito, and may deceive the very elect. The fly is often sent to the British Museum as *A. maculipennis*. *R. fenestralis* has spotted wings like *A. maculipennis*, but the insect is of stouter build than a *Culicid* and has no piercing mouth parts

In the dark corners of rooms and in outhouses the larval cases of the case-making Clothes Moth (*Tinea pellionella*) when hanging from the ceiling, simulate dependent *Anophelines*, but a close inspection soon dispels the illusion

Lastly, blackened tags of cobwebs and small, dark projections from unplanned rafters often resemble *Anophelines* very closely, but the stick soon clears up the point

(c) RANGE OF FLIGHT.

The questions as to how far *Anophelines* can, and usually do, travel are frequently asked, but such queries are difficult to answer with any degree of assurance. As a working basis it has been the practice to consider any breeding-place within half a mile of the outskirts of a camp as potentially dangerous, but in most cases the probable source of mosquito supply has been much nearer home than this

On several occasions it has been noticed that where the supply of *Anophelines* is moderate the journeys of *Anophelines* in quest of blood or shelter have been arrested at the line of huts or tents nearest their breeding grounds. Where the supply is more plentiful some insects will go beyond the first line of huts, and will be found in diminishing numbers among the huts behind the first line

In the case of a large training area at Thetford it appeared that the insects had used various camps and isolated groups of sleeping quarters as stepping-stones, so to speak, in order to reach a large camp which was more than half a mile away from the nearest breeding place

No migrations of *Anophelines* have been observed in any of the districts visited. The keeper of the Parkestone Golf Links, near Dovercourt, described what he considered a swarm of mosquitos, which passed over the neighbouring market gardens about 7 p.m. on a summer's evening in August, 1917. The noise of the insects was said to resemble that of a passing train. There is no expert evidence that the swarming insects were mosquitos, though it may be said that both *Anophelines* and *Culicines* were extremely plentiful in the district during the autumn of 1918

(d) SPECIES OF Anophelines.

As far as the inspection of stations and camps in England is concerned, the commonest species of *Anopheles* has proved to be *A. maculipennis*. Though not uncommon, *A. bifurcatus* has been seen much less frequently and then generally in company with *A. maculipennis*. On several occasions it was the smaller size of *A. bifurcatus* that led to its detection. *A. plumbens (nigripes)* has not been identified by the writer in houses or animal sheds.

As regards the distribution of the sexes, rough observations have shown that in the spring the males are the first to appear. Then, during the summer months, most of the insects seen in houses are females, while in the autumn males are seen in company with females. Of the two species it was found at Southampton that *A. bifurcatus* were in evidence some few weeks before *A. maculipennis*. After October both males and females of *A. bifurcatus* have been found to disappear, while females of *A. maculipennis* may be found wintering in cellars and various outhouses.

(e) EQUIPMENT AND METHODS OF SEARCH FOR ANOPHELES.

A good pair of eyes and a pocket lens, together with a few test tubes and a walking stick, are all that have been found necessary for mosquito hunting. Each type of building or quarters has its special Anopheline retreat (*see* preceding section), and these are carefully worked first.

The stick is invaluable for poking into otherwise inaccessible corners and crevices, and for moving on a mosquito into a position more suitable for its capture. It also enables living mosquitos to be distinguished from dead insects and other inanimate objects. The stick, too, is useful for striking bundles of clothes, curtains and other objects on, or behind, which *Anophelines* often lurk, while in small rooms the fumes of tobacco smoke will often make mosquitos appear. It is rarely worth while spending much time inspecting rooms that are exceptionally well lighted by many windows.

IV—FIELD NOTES CONCERNING AQUATIC FORMS OF ANOPHELINES

(a) NAKED EYE APPEARANCE OF Anopheline LARVÆ

The newly-hatched larva is only just visible to the naked eye, and suggests more than anything else, perhaps, a minute thorn. Until it is about half grown the *Anopheles* larva (*A. maculipennis* and *A. bifurcatus*) is conspicuously black in colour. The later moults are accompanied by varying

changes in colour, so that grey, green, brown, brownish red and blackish specimens have all been seen

Besides the general colouring—which often closely corresponds with that of the surroundings—it has been frequently noticed that some larvæ are marked on the dorsal surface by a chain of light blotches. Others, again, show a median design, extending from the head to the tail, and this design may be a faint lilac, cream or cinnamon in colour. These markings, which are often very beautiful, make the larvæ very noticeable on the water, but, as far as observations go, larvæ so ornamented do not give rise to imagines which differ from those emerging from the plainer larvæ

As stated before, a young *Anopheles* larva resembles a thorn, the point being the tail. The tail continues to be narrower than the head, thorax and first abdominal segments, but the fore parts of an *Anopheles* larva are not so preponderating in size as they are in the case of *Culicine* larvæ.

(b) HABITS.

The peculiar way in which *Anopheline* larvæ cling to the under part of the surface film serves to distinguish them at once from larvæ of the *Culicine* group and from other aquatic associates. But the characteristic pose, parallel with the surface of the water, is sometimes adopted by the larvæ of *Dixa* that have been driven out into the open water. In their movements also the *Anopheline* larvæ differ from the *Culicines* and do not so easily take fright. In a laboratory the mere walking past the aquaria is sufficient to send the *Culicines* scurrying down to the bottom of their jars, while the *Anophelines* continue browsing unconcernedly at the surface. In pools, too, if disturbed with a stick, the *Anophelines* edge away by "scooting" backwards across the surface. If the teasing continues they take cover in some little recess beneath the bank, or perhaps stealthily sink to the bottom. Here they may sham dead in a wonderful way, and it is not uncommon to see *Anopheles* larvæ being rolled over and over with the sediment at the bottom of the dipper, until the water comes to rest, when they suddenly spring to life once more and flick their way to the surface. When in the dipper, too, *Anopheles* larvæ show far more tendency to arrange themselves along the sides than do *Culicines*.

In the majority of cases *Anopheles* larvæ have been found unassociated with *Culicines*, and the instances in which the two kinds of larvæ have been found living together include all the recorded cases of artificial breeding-places, such as tanks, barrels, boats, &c

(c) CHARACTERISTICS OF TYPICAL *Anopheles* BREEDING-PLACES.

1. *The water should be of a certain depth and temperature, fairly clean and practically motionless*

It is difficult to say if there is any limit in depth, for, while larvæ have been found in shallow depressions which did not hold more than a cupful of water, they have also been taken from the middle of a Thames backwater, where the water was nearly 6 ft deep. As a general rule, however, they have been taken in waters, or in those parts of natural waters, where the bottom could be reached with the dipper.

As regards the temperature best suited for the development of *Anopheles* larvæ, it may be said at once that no accurate observations have been made. It is certainly a fact, however, that *A. maculipennis* prefers waters that are warmed by the sun, and they have been known to disappear from such places when the water has become cold. *A. bifurcatus*, on the other hand, has been found in deeply-shaded ditches in the summer, while in the winter larvæ have withstood being embedded in ice.

The typical *Anopheles* breeding-place is one in which the water is transparent, though easily muddied by disturbing the sides and bottom of the pool. Larvæ have been taken, however, from trenches where the water was opaque with earthy matter in suspension, and similarly from ponds.

Almost always it has been noticed that *Anopheles* prefers still waters, and in large ponds, where the main surface has been ruffled with the wind, larvæ have only been found in those sheltered nooks and little bays where the water is more or less undisturbed. Moreover, in large expanses of water it is the leeward shore, against which much flotsam and jetsam has been thrown up, that larvæ have usually been found. In the same way, it is the small bays and bends which afford retreats for larvæ in those rivers and streams where there is a permanent flow, or where the current is intermittent and dependent on storm water. In some cases it has seemed reasonable to suppose that the presence of larvæ in rivers and streams was due to the fact that they had been brought thither either as eggs or larvæ by floods and rains, which had scoured out their original homes.

2 *The Breeding-place should be Exposed to the Sun for Part of the Day.*—As far as *A. maculipennis* is concerned, it may be said that all the breeding-places which have been examined had this in common, that, for at least part of the day, they were exposed to the sun, and, in the majority of cases, the breeding-places were open to the sun all day. The

Aldershot Canal furnishes a good example of this fact, for while *Anopheles maculipennis* is widely distributed in those sections of the canal that are situated among meadows or open heath, larvæ have not been found in those heavily shaded reaches such as are found at Deep Cut. It is not easy to say how the sun affects the larvæ, whether directly by means of heat or light rays, or indirectly by influencing the growth of vegetation in the water.

3 *There should be a Certain Amount of Vegetation Growing in or close to the Water.*—In the vast majority of cases *Anopheles* larvæ have been found in waters containing some form of aquatic flora. Such breeding-places may be described as "natural" in contradistinction to "artificial" breeding-places, such as tins, tanks, barrels, &c, where the vegetation is either very scanty or entirely absent. Some interesting exceptions to the general rule are recorded in the subsequent list of breeding-places, and are noted in the nominal roll of places inspected. The flora most commonly associated with *Anopheles* breeding-places include various Algæ, such as *Spirogyra*, *Chara*, &c; Duckweeds (*Lemna minor*, and less commonly *Lemna trisulca*) and certain Pondweeds, more particularly the Broad-Leafed Pondweed (*Potamogeton aquaticus*) and the Grassy Pondweed (*Potamogeton gramineus*). In rivers, canals and dykes the Yellow Iris Flag (*Lysimachus vulgaris*) often forms small peaceful havens where Duckweeds grow and larvæ thrive, or the Branched Burweed (*Sparganium ramosum*) may take the place of the Bur-reed. Among the submerged plants in these situations the American Pondweed (*Elodea Canadense*) and Hornwort (*Ceratophyllum demersum*) are the most frequently noticed. Rush-fringed ponds with patches of Duckweed have seldom failed to yield *Anopheles* larvæ—other essential factors being present—and partially submerged grass, wherever found, seems to be a favourite playground for *Anopheles*. At times larvæ seem content with dead or decaying vegetable matter, and perhaps the most concentrated collection (30 to 40 per dip) of *Anopheles* larvæ were seen in a grotto pool near the Thames, in which there was no living vegetation, but much *débris* of fallen leaves and bits of wood.

The semi-marine waters of dykes, such as have been examined at Southwold, Harwich, Tilbury, Sandwich and Southampton, have as their characteristic flora two curious-looking green Algæ (*Enteromorpha compressa* and *Enteromorpha intestinalis*). These plants often extend throughout the entire length of a dyke, but in the small clear spaces, and among the thread-like leaves of the Water Milfoil (*Myriophyllum spicatum*) *Anopheles* larva have been found, and in company with shrimps.

4 In the following table are classified, in order of frequency, the various kinds of *Anopheles* breeding-places noted by the writer of this section during his inspections in England and Wales —

Ponds	43
Ditches	30
Rivers and streams	18
Small pools	15
Waterlogged fields and swamps	12
Dykes	10
"Lakes," ornamental waters, reservoirs	7
Borrow pits	7
Military trenches	6
Barrels	4
Metal tanks	3
Backwaters (Thames)	2
Boats	2
Canal	1
Concrete drain	1
Stone trough	1

(d) NATURAL ENEMIES AND INIMICAL CONDITIONS

1. *Fish*—There have been no opportunities for catching and dissecting fresh water fish with a view to estimating their larva-eating propensities or otherwise. It has seemed probable that only young fish and small fry attack larvæ, for the marginal shallows, where *Anopheles* larvæ mainly disport themselves, are not accessible to large fish. Also there have been many instances of larvæ being taken in "fish ponds" and other waters where large fish were numerous.

On the other hand, it has been very rare to find both larvæ and fish fry in small collections of water which the latter could thoroughly work. In some isolated pools at Southwold the introduction by Dr Collings of Sticklebacks (*Gasterosteus aculeatus*) and "Miller's Thumbs" (*Cottus gobio*) was followed by the disappearance of the previously existing *Anophelinae* larvæ.

In some notes on "Fish which Attack Mosquito Larvæ under Laboratory Conditions," Lance-Corporal Brook, R A M C., writing from Aldershot, says.—"Minnows (*Leuciscus phoxinus*) come easily first as being extremely quick-sighted, voracious eaters of mosquito larvæ and pupæ. A medium-sized minnow will eat a hundred larvæ in a day, and this is an estimate that does not err on the side of exaggeration. Larvæ are no sooner introduced into the tank than they are devoured—in preference to meat. I have never seen one larva given a sporting chance of reaching the bottom. Sticklebacks are not such satisfactory larvæ eaters as minnows, and—under laboratory conditions—not nearly so hardy. Young Carp and Tench cat larvæ, but, being bottom feeders, do not see many. They are also too slow in their movements."

2. *Other Aquatic Insects*—While the beetle itself seems to consider mosquito larvæ as beneath its notice, the larvæ of *Dytiscus marginalis* will certainly catch larvæ among the aquatic insects and suck them to death. Under laboratory conditions the larvæ of certain Dragon flies will account for a good many mosquito larvæ in their characteristic fashion while under natural circumstances it has been very rare to find many *Anophelines* in the haunts of Dragon fly larvæ.

Not a few larvæ have been taken that were acting as hosts for a small red mite, and occasionally larvæ, especially when kept in aquaria, become affected with fungus disease. But probably these parasites are not of much economic importance.

3. *Frogs and Newts*—Frogs have been constantly found in pools and ponds where mosquito larvæ were numerous, and it is probable that these creatures do not prey upon larvæ. In captivity newts will certainly devour larvæ, and in one of the ponds on Southampton Common, where repeated examinations only resulted in the discovery of one *Anopheles* larva, newts were abundant.

4. *Ducks*—At Kinmell Park it was very noteworthy that on two out of the three ponds which contained no *Anophelines* or *Culicines*, ducks were kept. These birds probably keep down larvæ by eating up the duckweed and by generally grubbing about along the edges of the pond, thereby breaking up any weedy hiding-places. In the literature on the subject there is a diversity of opinion as to the efficacy of ducks as larvæ controllers, and possibly in those cases where these birds failed to keep down larvæ they were not in sufficient numbers to thoroughly work the particular ponds to which they were delegated.

5. *Absence of Direct Sunlight*.—There is a point of some practical importance in connection with the dislike of *A. maculipennis* for waters that are not exposed to the sun, for an ill-considered clearing of ditches and streams which are shrouded in briar and bracken may actually encourage *A. maculipennis* to breed in places that were previously avoided.

6. *Absence of Visible Vegetation*—As previously stated *Anopheline* breeding-places are nearly always characterised by the presence of some kind of aquatic flora, belonging either to the *Confervæ*, *Algæ* or higher plants, and the removal of such vegetation from a pond or pool will sensibly diminish the number of larvæ present. In view of the exceptions to the general rule (noted elsewhere) it is not safe to assume that larvæ will be absent from all collections of water where vegetation is apparently absent.

7 *Excess of Weeds*—The general experience that *Anophele* larvæ are not found in ponds, &c., where the water is completely covered with duckweed has been for the most part corroborated. Very young forms have, however, been taken from beneath a dense matting of *Lemna minor*. Possibly in such cases the eggs were laid while as yet the quickly-spreading weed had not completely covered the pond.

Though, as has been mentioned, *Anophele* larvæ have been found in the clear spaces among *Enteromorpha compressa* and *E. intestinalis*, it is nevertheless probable that, if these *Algæ* are left undisturbed, so that they completely cover a dyke (as they often do), they must make it very difficult for *Culicid* larvæ to exist.

The effect of excessive vegetation is probably also seen in the case of some swamp and marshes, where the tall rank grasses, with rushes and other marsh plants, prevent the sun's rays from reaching the water in which they grow. Be that as it may, certain marshes which have been examined, and which were supposed to be dangerous breeding areas, have been found free of *Anophele* larvæ.

8 *Unsuitable Water*.—It is perhaps unfortunate that the word "stagnant" (instead of "stationary") is so often used to describe waters in which mosquitos breed, for the common impression seems to be that the more foul the water the more suitable it is for mosquito breeding generally. While some non-*Anopheles*, notably *Culex pipiens* and *Theobaldia annulata*, will breed in sewage, *Anopheles* is much more particular, and, as a rule, breeds only in fairly clear waters, such as those inhabited by *Dixa* and *Ephemeroidea* larvæ. The grossly contaminated waters in which the "rat-tailed" larva of *Eristalis tenax* and the maggot-like larva of *Stratiomys* delight are never chosen by *Anopheles* for breeding purposes. On the other hand, the little clear streams and brooks in which the aquatic forms of *Simulium* are cradled do not yield mosquito larvæ; nor do those streams which quietly trickle through a dense vegetation of cresses, mints and forget-me-nots, and which are frequented by stone flies (*Perlida*) and caddis flies (*Trichoptera*). Possibly the caddis worm preys upon mosquito larvæ. At any rate, those waters in which caddis worms are numerous are not such as should be examined very long for *Anophele* larvæ. As a rough working rule it has been found that a prolonged search also is not necessary in those waters which cannot be muddied by rubbing the bowl of the dipper along the bottom of the pool.

Brackish water in itself does not appear to be altogether unsuitable for *Anopheles*, as proved by investigations at Southwold, Harwich and other places, but on the Avon, at Christchurch, it appeared as if the tidal movements prevented

the breeding of mosquitos in places near the river that otherwise seemed very suitable

The reddish waters impregnated with iron salts have proved consistently negative as regards all kinds of mosquito larvæ. A sample of such water was analysed at Aldershot, and it was found that the bulk of the iron is in suspension, and that only a trace exists in solution. The actual figures were :—

Total iron (as Fe ₂ O ₃) =	21	00	parts per 10,000
Iron in solution =	68		”
Iron in suspension =	20	32	”

Possibly the presence of the metal influences larval life indirectly by preventing the growth of small animal and vegetable organisms that are necessary as food. Also the flocculent hydrates in suspension must offer a mechanical impediment to actively motile larvæ.

Very rarely, indeed, have mosquito larvæ been found in the mud-less shallow pools of moorland country that have come under observation, and possibly the water in such situations may be unpleasant to larvæ on account of dissolved earth acids.

In his “Medical Aspects of Bournemouth and its Surroundings, 1886,” Dobell quotes the Rev Richard Bingham as saying that ague does not flourish in the Bournemouth district, “as the poison of the disease is destroyed by the acids of the heathy ground in this part of the country.”

(e) DETECTION OF *Anopheles* LARVÆ AND PUPÆ

The minute *Anopheles* larvæ may be very closely simulated in the dipper by various small inanimate objects, and particularly by small thorns from gorse bushes which have been charred by heath fires.

Still more striking, perhaps, is the resemblance between the black forms of *Anopheles* larvæ and the larvæ of *Dixa*. The resemblance is chiefly superficial, since there are really many marked differences in the structure and habits of the two species of insects. Thus, while *Anopheles* larvæ always have a tapering tail extremity, *Dixa* appears square-ended, and this test alone will serve to distinguish the two species, even in the case of minute forms where the similarity is most marked. *Dixa* larvæ, moreover, have a whitish ruff near the head, giving it an appearance not noticed in *Anophelinae* larvæ, unless they happen to be attacked by fungus disease. Finally, no amount of persuasion will ever induce an active *Anopheles* larvæ to leave the water and become stranded high and dry on the sides of the dipper. A *Dixa* larva, on the other hand, likes to be made the subject of such an experiment,

and will even loop its way to a submerged finger, so anxious is it to leave the water

No other aquatic insects have been found to cause confusion, though novices occasionally bring in the larvæ of *Ephemeridæ* and *Perlidæ* before they appreciate the fact that these creatures differ from the larvæ of *Culicidæ* in possessing legs

Differential diagnosis in the case of the nymphs or pupal forms of *Anopheles* is not such an easy matter, and the practice has been to postpone diagnosis until—in captivity—the perfect insects have emerged. The transit in tubes or jars, it may be noted, appears to precipitate this process. It has been observed on many occasions that in the case of *Culicine* pools the visible proportion of pupæ to larvæ is much higher than in the case of *Anopheles* breeding-places, where, though the larvæ may be numerous, the pupæ seem to be remarkably few. It is, naturally, to other *Culicid* nymphs that *Anopheline* pupæ bear the greatest resemblance, and the shape and position of the respiratory tubes afford a means of separating the species. It has been observed, too, that *Anopheline* pupæ are smaller than the *Culicines* generally, and, like the full-grown larvæ, show a wide range of coloration. Red, brown, green and pearl-coloured pupæ have been noticed, while the *Culicine* pupæ seem to range only from brown to nearly black.

(f) METHODS OF SEARCH AND EQUIPMENT.

The handiest implement for examining samples of water in which larvæ are sought is a white enamelled soup-ladle, and the bigger the bowl the better. In many such ladles the handle is conveniently semicircular in cross-section, so that the "dipper" can be easily attached by string or umbrella rings to the walking-stick, which, again, is a most useful accessory in field work.

The notes recorded under sub-sections (b), (c) and (d) of this section indicate *where* to look for *Anopheles* larvæ. As to *when* field observations should be carried out, it may be said that the season for *A. maculipennis* larvæ extends apparently from about May to the end of October, while in the case of *A. bifurcatus* (which hibernates as imperfect forms) the larvæ may be found, on and off, throughout the year. It has been noticed that, apart from such severe conditions as frost and snow, mosquito larvæ are also affected by other meteorological factors, such as rain, wind and absence of sun so that it seems unsafe to assume that any pool is free from larvæ unless it has been found so under favourable conditions. Rain in particular seems to be an important influence, and the same pools which have been found negative on a wet morning

have proved positive in the afternoon when the rain had stopped and the sun was shining.

Concerning *how* to look for *Anopheles* larvæ, the practice has been to rely chiefly on the dipper, which is introduced sharply but cautiously into the water at the points where the larvæ are suspected to be present. If, for example, a patch of duckweed is being worked, the aim should be to scrape, as it were, the under-surface of the weedy patch by a quick, deliberate traverse with the submerged dipper, which is then brought smartly out of the water with the bowl full of water. In the case of rushes, reeds, &c., the inundated parts of these plants should be also "scraped" from below upwards, while the edges of streams and the little pools and corners should be worked in much the same way as' prawns are sought among rocks and seaweed at low water.

In all the above operations the water should be disturbed as little as possible, but there should now follow another and altogether different process, which was taught the writer by Lieut.-Colonel S. P. James, I.M.S. It consists in stirring up the bottom of the pool and "beating" all the vegetation growing in and around the water, so that any larvæ or pupæ which may be lurking at the bottom or hiding among the vegetation are driven out into the open water. The disturbance should be vigorous and thorough, and repeated once or twice. This method has proved most useful, and where *Anophelines* are present the dipper is not as a rule needed to show the fact, since the larvæ can be easily seen against the muddied water.

In some places *Anopheles* larvæ can be primarily detected by mere inspection, if the observer can place himself so that the light is suitable for showing up objects in the water. At other times, and in certain lights, when the larvæ cannot be seen in detail, their presence is often indicated by the surface of the water showing little puckers. Sometimes, also, the shadows of larvæ are reflected by the bottom of the pool, but it takes some practice to distinguish such shadows from those caused by certain true surface insects and by inanimate objects.

ALLAN C. PARSONS, Captain R.A.M.C.

V. LIST OF MILITARY CENTRES INSPECTED BY CAPTAIN A. C. PARSONS, R.A.M.C.,
1917-1918

(B 14557)

Place Inspected	Character of Station, Camp, &c	Dates of Inspection	<i>Anopheles</i> Conditions	Indigenous Cases of Malaria	Remarks
I—ALDERSHOT COMMAND.					
1. Aldershot (Marlborough Lanes)	Permanent single storey barracks with accessory huts Connaught Hospital included in these Lines	Aug, 1917	<i>Anopheles</i> common in Blenheim Barracks and Tournai Mess Breeding in Smallshott Bottom, Queens Parade and Government House grounds	..	Great numbers of <i>Culisines</i> Malaria patients treated at Connaught Hospital, but <i>Anopheles</i> rare in wards
2. Aldershot (Stanhope Lanes)	Permanent buildings, mostly two storeys, many married quarters—good many huts—includes the Cambridge Hospital	Aug, 1917 and Sept, 1917	<i>Anopheles</i> widespread but nowhere plentiful Breeding in Canal	.	No complaints of <i>Anopheles</i> in Cambridge Hospital <i>Culisines</i> prevalent everywhere.
3. Aldershot (Wellington Lanes)	Oldest type of permanent barracks, two or three storeys Includes many stables	Aug, 1917, and Sept, 1917	<i>Anopheles</i> rare throughout	..	<i>Culisines</i> comparatively rare.
4. Aldershot (Government House)	Large house standing in pleasure grounds and surrounded by trees	Aug, Sept., and Oct, 1917	<i>Anopheles</i> common, especially in upper storeys Breeding in a partially filled-in pond	..	<i>Culisines</i> also plentiful. Special anti-mosquito measures with chloquine gas carried out.

113

H

LIST OF MILITARY CENTRES INSPECTED—*continued.*

Place Inspected	Character of Station, Camp, &c	Dates of Inspection.	<i>Anopheles</i> Conditions.	Indigenous Cases of Malaria	Remarks
I—ALDERSHOT COMMAND— <i>continued.</i>					
5. <i>Farnborough, Pinehurst</i>	New type of semi-permanent barracks, also model workmen's cottages in connection with aircraft factory	Sept. 14, 1917 Oct 5, 1917	<i>Anopheles</i> prevalent in barracks bordering on the Cove meadows, which form ideal breeding grounds	..	One of the chief <i>Anopheles</i> foci of Aldershot.
6 <i>Farnborough (Cove Pond)</i>	Semi-artificial pond or reservoir, 260 by 200 yds, with ideal mosquito breeding conditions	1917 and 1918 at intervals	Important breeding centre for <i>Anopheles</i>	..	Probably affects R A F. camps and aircraft factory.
7 <i>Mytchett</i>	Hutted camp used for men undergoing courses in musketry—also Mytchett House	Sept 15, 1917	Few <i>Anopheles</i> in huts nearest Mytchett Lake and Little Mytchett Flash <i>Anopheles</i> and many <i>Culisines</i> in Mytchett House	..	Mytchett House also treated with chlorine gas <i>Ochlerotatus nemorosus</i> breeds abundantly in woods round Mytchett Lake
8 <i>North Camp</i> ..	Includes some permanent type barracks and outlying buildings, military and civil	Sept 20, 1917, and Sept 29, 1917	Many <i>Anopheles</i> breeding grounds in meadows and waste places near North Camp Station	..	Mosquito prevalence chiefly affects civilian authorities

(B 14557)

9. <i>Blackdown</i>	..	Large hutted camp on high ground with some original permanent barracks	Sept. 19, 1917	No adults seen, and no breeding places near	..	<i>Culisces</i> also comparatively rare.
10. <i>Deep Cut</i>	..	Minden barracks, some permanent buildings, but chiefly huts, canal near by	Sept 26, 1917	No adults, a few larvæ in adjoining field	..	Canal here is deeply shaded and free of larvæ
11. <i>Pirbright</i>	..	Large camp on healthy site, semi-permanent barracks of Pinehurst type	Aug 5, 1917 and Sept 22, 1917	<i>Anopheles</i> found on Aug 5, 1917, by S M O in hut where indigenous case occurred. No breeding places discovered	I	In September no <i>Anopheles</i> seen
12. <i>Woking</i>	..	Knaphill Barracks, consisting of Woking Gaol buildings and wooden huts	Sept 24, 1917	No adults seen in any part of camp. Larvæ taken from canal near St John's Bridge, 1/4 mile away	..	<i>Culisces</i> breeding in pools on parade ground. Many infected South African troops from G E A in this camp
13. <i>Bisley</i>	..	Wooden huts and bungalows	Sept 20, 1917	No adults seen in September, but a few were taken in Aug from hut No 5, where an indigenous case occurred. Few larvæ from a "fish" of the canal	I	<i>Culisces</i> breeding in enormous numbers in adjoining sewage farm.
14. <i>Ascot</i>	..	"Inglemere" Private house used as W A A C hostel, situated in grounds near the Race Course	Spring and summer, 1918	Many <i>Anopheles</i> hibernating in cellars and store rooms. No breeding places found	..	Various anti-mosquito measures carried out here.

115

H 2

LIST OF MILITARY CENTRES INSPECTED—*continued.*

Place Inspected	Character of Station, Camp, &c	Dates of Inspection	<i>Anopheles</i> Conditions	Indigenous Cases of Malaria	Remarks.
I—ALDERSHOT COMMAND— <i>continued.</i>					
15 <i>Camberley</i>	.. Staff College, large, many-roomed four-storey building used by cadets Surrounded by trees	Sept 17, 1917	No adults seen, larvæ breeding in Upper Lake close by	..	
16 <i>Sandhurst</i>	. Royal Military College Two large, many-roomed buildings in open grounds with spinneys	Sept 17, 1917	One adult only seen in the new building Lower Lake and Swimming pond both negative as regards larvæ	.. ..	Lower Lake examined several times but no <i>Anopheles</i> larvæ found
17 <i>Fleet</i>	.. .. Bramshot camping ground bordering on Fleet pond No permanent quarters	Sept 18, 1917, and on other occasions	<i>Anopheles</i> absent from portion of pond near camping ground but plentiful near the Railway bridge at Fleet	..	No camp existed at time of visit. Part of pond near camping ground unsuitable for <i>Anopheles</i> .
18. <i>Crookham</i>..	.. Tweezledown Barracks, wooden huts and stables	Sept. 26, 1917	No <i>Anopheles</i> seen and no breeding ground nearer than the canal discovered.	..	

19. Ewshott	Leipsc Barracks, used by New Zealand Field Artillery; huts	Sept. 26 ..	One <i>Anopheles</i> only seen. Larvæ taken from horse pond $\frac{1}{2}$ mile to S W of camp	..	
20 Wellington College, near	"Heatherside," private house, adapted as Convalescent Hospital, on main road	Oct 21, 1917	No <i>Anopheles</i> seen, but large numbers of wintering <i>Culisines</i> in cellars	..	This hospital was used for malaria convalescents. Nothing found in open-air swimming baths of Wellington College, $\frac{1}{2}$ mile away.
21. Hook	Sheldon's Farm Private house used as convalescent hospital and situated among fields	Oct. 19 ..	No <i>Anopheles</i> seen in the building but found breeding in a horse pond $\frac{1}{2}$ mile away	..	Used as a convalescent hospital for malaria patients
22 Aldershot (Thornhill)	Isolation hospital Administrative blocks brick, wards wooden huts Gardens and shrubberies surrounding hospital	Sept 8, 1917, and other occasions	<i>Anopheles</i> common in permanent buildings, none in ward huts	..	<i>Culex</i> also very prevalent Canal runs at foot of Thornhill
23. Bordon	Large camp of permanent and also hutted buildings occupied by R F A.	Several occasions, 1917	<i>Anopheles</i> very plentiful especially in 'marned quarters'—Breed extensively in ponds near by.	..	<i>Anopheles</i> much more prevalent in these camps than in any military station in the North Aldershot district In some quarters the <i>Anopheles</i> exceed the number of <i>Culisines</i> .
24 Longmoor ..	Large camp chiefly composed of huts on high ground overlooking Wolmer Pond. Occupied by R.E.; R O D	Aug and Sept., 1917	<i>Anopheles</i> adults common in huts nearest to Wolmer Pond, larvæ locally distributed in pond.		

LIST OF MILITARY CENTRES INSPECTED—continued.

Place Inspected	Character of Station, Camp, &c	Dates of Inspection	<i>Anopheles</i> Conditions.	Indigenous Cases of Malaria.	Remarks.
I—ALDERSHOT COMMAND—continued.					
25 Willey	Large hutted camp on high ground with wooded ravines near. Occupied by Canadian troops	Sept, 1917	<i>Anopheles</i> plentiful		
26. The Basingstoke Canal	Traverses the Command from East to West and roughly bisects the Aldershot Military Station	Various occasions	A prolific breeding ground for <i>Anopheles</i> , more especially the Western portion. Shaded parts apparently not frequented by mosquitos and the stretch between Deepcuts and Woking, which has many locks, is much less popular, than the reaches further west where locks are much less common.		

II SOUTHERN COMMAND

27	Southampton (Embarkation Rest Camp)	Huts and tents on the Common Several ponds and many ditches	April and May, 1918 and Aug 1, 1918	No adults found in the hutted quarters or in hospital tents <i>A bifurcatus</i> breeding in certain small streams on the Common	..	Very useful work has been done here in the matter of anti-mosquito problems and entomological research
28	Southampton (University War Hospital)	Permanent buildings and huts situated on high ground near Highfield Brickfields	May, 1918	No adults seen in actual hospital buildings <i>A maculipennis</i> breeding plentifully in borrow pits of brickfields	..	Malaria patients landing at Southampton go to University War Hospital for any necessary treatment
29	Southampton (Milbrook Marshes)	Estuarial marshes close to the Southampton Bournemouth Railway	May, 1918	No <i>anopheles</i> .. ..	..	<i>Ochlerotatus dorsalis</i> and <i>O salinus</i> numerous.
30	Brochenhurst ..	No 2 N Z General Hospital consisting of pavilion huts and marquees, together with three private houses used as annexes, all situated in the New Forest	Aug, 1918.	No adults seen in the hospital proper or in the Annexes Larvae of <i>A bifurcatus</i> found in ditch near main hospital	..	Weather conditions very bad on day of visit
31.	Christchurch (The Barracks)	Permanent brick buildings formerly used by the Royal Artillery, also tented camp Both situated on banks of the Stour	July 22-27	In the stables <i>A maculipennis</i> and <i>A bifurcatus</i> were common <i>A maculipennis</i> also plentiful in married quarters No mosquitos of any sort in large barrack rooms	..	Larvae found in a small bay of the Stour just below officers' mess In the tented portion of camp only two <i>Anopheles</i> seen

LIST OF MILITARY CENTRES INSPECTED—*continued.*

Place Inspected.	Character of Station, Camp, &c.	Dates of Inspection	<i>Anopheles</i> Conditions.	Indigenous Cases of Malaria.	Remarks.
------------------	---------------------------------	---------------------	------------------------------	------------------------------	----------

II.—SOUTHERN COMMAND—*continued.*

32	<i>Christchurch</i> (Iford Camp)	Tented camp on rising ground near River Stour	July 23, 1918	No <i>Anopheles</i> seen in the tents but solitary specimens taken from a pig-stye and also from stables on the camp site	..	Malaria subjects in <i>Christchurch</i> district are posted to this camp.
33	<i>Christchurch</i> (Jumpers Camp)	Small tented camp $\frac{1}{2}$ mile from the Barracks and lying between the Rivers Stour and Avon	July 24, 1918	Camp free from <i>Anopheles</i>	..	
34	<i>Christchurch</i> (Buer Farm Camp)	A temporary camp of over 20 tents near Buer Farm, Mudford, and close to a running stream	July 25, 1918	Three tents contained <i>Anopheles</i> No larvæ could be found	..	Farm also inspected, but only one <i>Anopheles</i> seen.
35	<i>Wareham Camp</i> ..	Hutted camp on high ground along Dorchester Road occupied by some 2,200 young soldiers of Tank Reserve Unit	July 27, 1918	No adults seen in tents, huts or stables, only a few larvæ found within 400 yards of camp, but beyond this distance there were several breeding places	..	No malaria subjects in this camp.

36	<i>Bovington</i> . . .	Hospital (huts and marquees) serving large hutted camp of Tank Corps on rising ground facing Wool Heath	July 29, 1918	No adults seen and no larvæ noticed nearer than meadows adjoining Wool Station 2 miles away	
37	<i>Blandford</i> . . .	Large camp on Monkton Down, huts and tents Site is high up on chalky treeless downs Accommodation for 18,000 troops, R A F	July 30, 1918	No evidence of any mosquito life at all in the camp	Conditions on the Downs unfavourable for mosquitos
38	<i>Swanage</i> . . .	Five camps (huts and tents) situated on south slope of Ballard Downs, close to the sea Occupied chiefly by No 3 "C" Reserve Brigade, R F A.	July 31, 1918	Only two adults found in the camps Breeding place few and chiefly situated at the western end of the site	A relatively large number of the troops are malaria subjects from Salonika.
39	<i>Lulworth</i> . . .	Small camp (tents) of 500 (circ) men of the Tank Corps—situated on cliff overlooking sea near Lulworth Cove	Aug 8, 1918	No evidence of any <i>Anopheles</i> condition	

LIST OF MILITARY CENTRES INSPECTED—*continued.*

Place Inspected	Character of Station, Camp, &c	Dates of Inspection	<i>Anopheles</i> Conditions	Indigenous Cases of Malaria.	Remarks
II—SOUTHERN COMMAND— <i>continued</i>					
40. <i>Poole</i>	Recently organised tented camp on spit of land in Poole Harbour	Aug 6, 1918	No adults seen, but larvæ found in dyke 250 yds from camp and also in bricked pits nearer the Camp	..	In the dyke only one larva was noticed in the morning when there was much rain; that afternoon when the weather was fine many were seen
41 <i>Portsmouth</i> .	Fort Gomer, one of the old fortifications of Gosport, a tented camp adjoins	Aug. 1, 1918	<i>Anopheles</i> adults were found in some of the bricked recesses of the ramparts Moat and canal examined for larvæ with negative result	..	Weather conditions very bad for field work. There are probably breeding grounds in the swampy fields near the camp.
III. LONDON DISTRICT					
42 <i>Wimbledon</i> ..	Hutted camp on Wimbledon Common accommodating 3,000 troops of Reserve Battalions London Regt, all young soldiers	June 17 and 20	No <i>Anopheles</i> discovered in some 50 huts examined No larvæ found except two specimens in Scio Pond over half a mile away from camp	..	Some alarm had arisen in the civil community because of the presence of malaria infected troops from Africa and the reports as to mosquitos on the Com-

43 Putney

Six large and medium sized private houses in Putney where men of the 25th Battalion, Royal Fusiliers were quartered in early spring of 1918

June 17, 1918 to June 20, 1918

No adult *Anopheles* found in any of the 100 rooms examined, and only three *Culis* were seen

mon. The insects which undoubtedly caused "bites" were probably not mosquitoes. This camp was since used as a malaria concentration centre

44. Walton-on-Thames (Mt Felix)

No. 2 New Zealand General Hospital comprising the mansion (Mt Felix) several huts, marquees and shelters. The grounds slope down from the house to the River Thames

June 24, 1918 to June 29, 1918

A. maculipennis and *A. bifurcatus* found in practically all the marquees and tents, no *Anopheles* seen in the huts, and only a very few in the permanent buildings. Unusually large number of larvæ found in a grotto pool in the grounds. Several other breeding places in the adjoining backwaters and meadows

2 in 1917

The nurse developed malaria after nursing Pte. Swallow. She was getting attacks when visited at Brockenhurst in August, 1918.

45 Walton-on-Thames (Oatlands)

Large hotel standing in extensive grounds overlooking a Thames backwater, together with marquees and huts, the whole forming another division of the No. 2 N.Z. General Hospital.

Here also the *Anopheles* were practically confined to the marquees as far as the hospital was concerned; in the piggery they were very numerous, breeding plentifully along shores of backwater

Larvæ also found in the deep central portion of the backwater among patches of *Vallisneria spiralis*.

LIST OF MILITARY CENTRES INSPECTED—*continued.*

Place Inspected	Character of Station, Camp, &c.	Dates of Inspection.	<i>Anopheles</i> Conditions	Indigenous Cases of Malaria.	Remarks.
-----------------	---------------------------------	----------------------	-----------------------------	------------------------------	----------

III—LONDON DISTRICT—*continued.*

46. <i>Walton-on-Thames</i> Various staff billets in the village	Private houses, all with gardens, in which were accommodated medical officers, nursing staff and personnel		No <i>Anopheles</i> adults seen in any of the houses		<i>Anopheles</i> larvæ together with <i>C. pipiens</i> larvæ found in a greenhouse tank at Walton House
---	--	--	--	--	---

124

IV—WESTERN COMMAND.

47. <i>Kinmel Park</i> (Rhyll)	A large hutted camp with accommodation for 25,000 troops, situated on the lower slopes of the hill on which Kinmel Park and Bodelwyddan Park are laid out. Nearest town Rhyll: Rhuddlan marshes two miles to the North		In the huts <i>Anopheles</i> adults were few and far between, but they were common in various non-military buildings in and near the Camp. In the great majority of the 20 ponds situated in the camp <i>Anopheles maculipennis</i>		<i>A. bifurcatus</i> found with <i>A. maculipennis</i> in a stable close to edge of camp. Number of adults found in the huts very small compared to the large number of larvæ-containing pools and ponds which are dotted about among the huts.
-----------------------------------	--	--	---	--	---

48	<i>Morfa Camp</i> (Conway)	A hutted camp in the estuary of the River Conway used by some 2,000 R E	Aug 18, 1918	<p><i>ms</i> was found in large numbers and also in two streams that cross the camp</p> <p>No <i>Anopheles</i> adults or larvæ found on this occasion.</p>	..	The marshy pools in which <i>Anopheles</i> were previously found to be breed had dried up.
49.	<i>Prees Heath Camp</i> (Whitchurch, Salop)	Hutted encampment 1 mile from Whitchurch station and containing on an average 8,000—14,000 troops—situated in open country with farms near	Aug. 20, 1918	<p>Only two adults seen in the Reserve Depot, A S C lines, but plenty found in cattle sheds at Shaw's Farm and Twemlow Hall Ponds on "Brown Moss," $\frac{1}{4}$ mile away, well stocked with <i>Anopheles</i> larvæ, which were also found in a pond at Twemlow Hall and other places</p>	.	About 160 "Y scheme" men quartered in the Reserve Depot, A S C. lines. These were under careful supervision and treatment
50.	<i>Bettisfield Park,</i> Flint	Hutted camp in park grounds, of which a prominent feature is an ornamental lake in the centre of the camp	Aug 20, 1918	<p>No adults seen in tents nearest the lake Larvæ in lake, but localised at one extremity</p>	..	Malaria cases quartered in the huts furthest removed from lake.

LIST OF MILITARY CENTRES INSPECTED—*continued.*

Place Inspected.	Character of Station, Camp, &c	Dates of Inspection.	<i>Anopheles</i> Conditions.	Indigenous Cases of Malaria	Remarks.
------------------	-----------------------------------	----------------------------	------------------------------	-----------------------------------	----------

IV—WESTERN COMMAND—*continued.*

51. <i>Oswestry Camp</i>	Hutted camp laid out in the private grounds of Whittington Park. Large hospital huts and marquees just outside park	Aug. 21, 1918	No adults seen in the huts composing lines where the indigenous case occurred, nor in other huts of the camp. Plenty of <i>Anopheles</i> were found in the Home Farm buildings which adjoin the quarters where the case of malaria arose. <i>Anopheles</i> larvae were found extensively throughout the park in ponds, ditches, barrels and in a stone horse trough. Adult insects also plentiful in the stables of Whittington Park	1 June 24, 1918.	Special wards are set apart for malaria patients at the camp hospital, and there is a laboratory where all imported cases of malaria are examined bacteriologically. Two ponds had been filled in previous to inspection. Conditions generally in and near this camp very favourable for mosquito breeding
--------------------------	---	------------------	--	------------------------	--

V. N COMMAND.

52. <i>Costessy Hall</i> (Norwich)	Dismantled mansion, standing in park with River Tud within 50	May 26, 1918	No adults seen in the lofty rooms of the hall but both <i>A</i>		Apparently the mosquitos preferred to feed on the horses rather
---------------------------------------	---	-----------------	---	--	---

	yds Farm buildings 100 yds away on other side of river 80 " Y scheme " men quartered in the hall			<i>maculispennis</i> and <i>A bifurcatus</i> found plen- tifully in the farm stables Breeding place certain portions of the River Tud		than on the " Y scheme " men, which was fortunate. The hall was evacuated of " Y scheme " men.
53 <i>Thorpe-next-Nor- wich</i>	Thorpe Military Hos- pital, in pre-war days the Norfolk County Asylum Two parts the older asylum quarters being situated close to marshes and the newer portion with very large wards being built on much higher ground	May 27, 1918		No adults found in either portion of hos- pital, but <i>Anopheles</i> breed extensively in the marsh dykes near the old Asylum	..	This hospital was not considered altogether suitable for the treat- ment of malaria pa- tients.
54 <i>Southwold (Town)</i>	This town, of 2,000- 4,000, is roughly tri- angular in shape and bounded by the sea, River Blyth and Buss Creek With excep- tion of a few tents on the common all the troops are quartered in billets in the town. Inland the town is surrounded by low- lying country subject to floods	June 10, 1918 to June 14, 1918		Out of 14 billets exam- ined in the town; 13 contained adult <i>Ano- pheles</i> ; they were also plentiful in the Golf Club House Larvæ found in dykes near Salt Creek	2 17 1917.	<i>Anopheles</i> practically ubiquitous in the town Larvæ had disap- peared from Salt Creek owing to draining and introduction of fish Water in dykes is brackish

LIST OF MILITARY CENTRES INSPECTED—*continued.*

Place Inspected.	Character of Station, Camp, &c	Dates of Inspection.	<i>Anopheles</i> Conditions.	Indigenous Cases of Malaria.	Remarks.
V—EASTERN COMMAND— <i>continued</i>					
55. <i>Southwold</i> , near Sallow Walk Covert	R F A post, quartered in huts on heathy ground near woods	June 10, 1918 to June 14, 1918	<i>Anopheles</i> adults quickly discovered in the huts	..	} <i>Culisines</i> very uncommon <i>A maculipennis</i> and <i>A bifurcatus</i> both found, former predominating. Males much more numerous than females.
56. <i>Southwold</i> , near Eastwood Lodge	Farm buildings (winter quarters) and some 20 tents occupied by R G A detachment Two ponds on farm and marshes near	Do	Numerous adults found at 3 p m in each of the tents, none seen in the farm house. Both ponds negative as regards larvæ	..	
57. <i>Southwold</i> , near Hoist Covert	Two small detachments stationed on a knoll overlooking marshes and near woods R F A in tents, 17th Hants in huts	Do	<i>Anopheles</i> found in the tents but none in the huts	..	
58. <i>Southwold</i> , near Walberswick	Encampment on the beach close to sea, huts and tents	Do	No mosquitos seen	..	
59. <i>Southwold</i> , near Gaston Broad	Small hutted outpost near sea, N of Southwold	Do.	<i>Anopheles</i> found in huts	..	

60. Southwold, near the Gap	Ditto.	Do.	Ditto.	..	
(B 14557) 61. Southwold, near Cox's Farm	Infantry outpost quartered in huts near farm buildings and close to coast	Do	No <i>Anopheles</i> seen in huts	..	
62. Southwold, near Sleepy Hollow	Small hutted outpost camp in hollow among sand hills close to sea	June 13, 1918	No signs of any <i>Anopheles</i>	..	
63 Thetford (Command Depot Camp	Camp of huts and marquees about 1 mile from Thetford on the Newmarket Road Accommodates about 5,000 troops, chiefly R E. Site unusually dry. Though a distinct unit the Thetford Military Hospital (mainly huts) occupies part of the site of the Command Depot Camp	July 1918, to July 1918	None of the huts contained any visible <i>Anopheles A maculipennis</i> and <i>A bifurcatus</i> however, were common in the marquees and were taken from the marquee when the local case of malaria occurred. In the hospital, too, the <i>Anophelines</i> were found only in the marquees No breeding place discovered within $\frac{1}{4}$ mile of the Command Depot Camp	1 in 1918, May 29	Among the RE in the CD camp were many malaria subjects During April, May and June, 1918, there were 87 cases of malaria admitted to hospital In the Barnham Cross Camp only young soldiers were under training By a happy chance therefore the <i>Anophelines</i> in their passage through the camps reached the malaria subjects in the CD Camp after passing through the unaffected young soldier camp.

LIST OF MILITARY CENTRES INSPECTED—*continued.*

Place Inspected	Character of Station, Camp, &c	Dates of Inspection	<i>Anopheles</i> Conditions.	Indigenous Cases of Malaria	Remarks.
V—EASTERN COMMAND— <i>continued.</i>					
64. <i>Thetford</i> (Barnham Cross Camp)	A summer canvas camp about $\frac{1}{4}$ mile south of the C D camp, but linked up with it by various isolated group of quarters. The Little Ouse runs close by Barnham Cross Common.	July 2, 1918, to July 8, 1918	<i>Anopheles</i> larvæ found in pools and ditches connected with the Little Ouse, where it runs beneath the railway close to the S E. corner of the camp. Adults plentiful in the A S C tents nearest the river and traced up through the Barnham Cross Camp into the Command Depot Camp. Larvæ taken also from the Little Ouse near the Nunnery and in ditches beside the Thetford - Bury - Railway	..	

(B 14557)	Dovercourt (near Harwich, Ray Farm Camp)	A small tented camp placed on high ground near Parkestone but surrounded by much low lying marshy ground including lagoons on the right bank of the Stour The Parkestone Golf Course partially surrounds the camp	Aug 29, 1918 and Sept 15, 1918	Adults common in the tents of the camp and also found at the Club House of the Golf Club Larvæ breeding in trenches and ditches in and near the camp, especially on the Golf Course A disused iron tank in the quarry adjoining camp also contained many <i>Anopheles</i> larvæ together with <i>Culisines</i>	1 Sept 3, 1918	A large proportion of the men in this camp were malaria subjects from Salonika, the majority of these were eventually sent to the concentration camp at Otterpool.
	65 Dovercourt (Great Oakley Hall Camp,	Camp of some half dozen huts situated in a field near farm buildings Detachment of 15-20 men sleep in screened huts	Aug 30, 1918	No <i>Anopheles</i> adults were found in the huts, though a few <i>Culisines</i> were present In the farm buildings 100 yds. away, adults were very numerous and larvæ were present in the horse pond	1 Aug, 1918	The sleeping huts were screened after the case of malaria had occurred The farm mosquitos in all probability were concerned in the occurrence of this case of malaria
	66 Dovercourt (Crabknowe Spit Camp,	Small camp of huts and tents used for housing troops undergoing courses in musketry The camp is situated in marshes	Sept 1, 1918	<i>Anopheles</i> adults common in huts and tents and breeding close by in dykes and ditches	..	A potentially dangerous camp since large number of troops are temporarily quartered here Has a bad reputation for biting flies.

IV. REPORT ON THE TREATMENT OF MALARIA-INFECTED TROOPS IN FRANCE.

By J. DALRYMPLE, C M G, O B E, L R C P., L R C S.,
LIEUTENANT-COLONEL Royal Army Medical Corps.

COVERING LETTER

From—

FIELD MARSHAL SIR DOUGLAS HAIG, K T., G C B.,
G C V O, K C I E, Commander-in-Chief, British
Armies in France.

To—

THE SECRETARY, War Office, London, S W.

GENERAL HEADQUARTERS. *February 23rd, 1919*
SIR,

With reference to War Office Letter No 24/General Number/6754 (A M D. 2) dated February 3rd, 1919, I have the honour to forward herewith as requested therein, a report by Lieutenant-Colonel J Dalrymple, C.M G, O B E., Royal Army Medical Corps, relative to the large scale treatment of malaria amongst the battalions who arrived in this Command from the East.

The results obtained under the system adopted were highly satisfactory in bringing about the rapid restoration to the fighting ranks of men who, in many cases, had previously been for months under treatment without avail.

These results depended almost entirely on the fact that the medical control and orders for the systematic administration of quinine, amount of exercise, &c, under Lieutenant-Colonel Dalrymple, were the predominating factors in the arrangements set up by him.

That the measures taken were effective, and carried out with the utmost precision and judgment, is evidenced by the remarkably rapid rate at which battalions were restored to a state of fighting efficiency, and thus became available as reinforcements.

I have the honour to be, Sir,
Your obedient Servant,

G. H FOWKE,
Adjutant-General,

*For Field Marshal, Commanding-in-Chief, British Armies in
France.*

REPORT.

Dated February 14th, 1919.

I.—EXTENT OF INFECTION.

The arrival of malarially-infected troops, as reinforcements to the British Expeditionary Force, in France early in June, 1918, necessitated the formulation of some definite policy for their treatment and rapid restoration to the forward area, where their services were so much desired.

The Director-General Medical Services, British Armies in France, requested that I should define and direct this treatment. Twenty-two battalions of infantry arrived in rapid succession during the months of June and July, from Salonica—every battalion similarly infected with malaria. In consultation with the Medical Officers in charge of these regiments, and after a careful perusal and consideration of their daily sick returns, also by examination of large numbers of blood films, I decided that the whole of these battalions harboured the malarial parasite to an extent of 75—85 per cent. —

The first battalion of infantry I inspected was the 5th Battalion Connaught Rangers, on June 17th, 1918. They had arrived in France only a few days previously, and during this time had sent 273 men to hospital suffering from malaria. The remainder were obviously malarials, some of them actually either in the hot or cold stage of malaria at the time of inspection. Had this regiment been ordered for service to the forward area on this date, at least 50 per cent. of them would have been unable to comply with the order.

The following conditions prevailing at the time of inspection will help to show the extent of infection with malaria of each of the following battalions :—

TABLE 'A.'

Regiment.	Date of Inspection.	Percentage Infected with Malaria.	Date on which Quinine Treatment was Commenced.	Strength of Daily Sick Parade, number of Malarials and other remarks.
5th Connaught Rangers.	June 17, 1918 ..	80 per cent. ..	July 8, 1918 ..	Had this regiment been ordered for service in the forward area on this date at least 50 per cent of them would have been unable to comply with the order, owing to malaria. 273 men had been sent to No 2 Field Ambulance at Aire with malaria, previous to an order being published to stop evacuation of malarials to England 205 of these were sent to the United Kingdom. On August 12, none of these men had returned to France
5th Royal Irish Regiment.	June 18, 1918 ..	75 per cent. ..	June 19, 1918 ..	The regiment on the day of inspection had a strength of 650 other ranks, a large number having been sent to hospital with malaria. The daily sick parade from the remaining 650 other ranks averaged 60. Of these 30 had acute relapses of malaria.
2nd Royal Dublin Fusiliers.	June 19, 1918 ..	Every man during the last two years has had malaria.	June 20, 1918 ..	On date of inspection I saw 44 men in the medical inspection room who were suffering from acute malarial relapse, both hot and cold stages. Several others were actually on parade with temperatures due

				to malaria. Since June 1, 336 men had been sent to hospital with malaria. 50 blood films taken showed 25 per cent positive with the Benign Tertian parasite. On a route march held two days previously, distance 16 kilometres, 112 men fell out; 98 of these were malarial and had been sent to hospital. A census of malaria taken on June 10, when the strength of the regiment was 750 (including draft of new men who had not been to Salonica), 600 were found to have had malaria.
13th Black Watch (Scottish Horse)	June 25, 1918 .	80 per cent. ..	July 8, 1918 ..	Average daily number of men reporting sick with malaria equals 50. MO i/c reports that 80 per cent. of the battalion have had malaria. 50 blood films examined showed 25 positive with Tertian infection. On July 4, 100 films were examined, which were taken from the companies at random—not specially selected from known malarials—30 of these showed Benign Tertian.
14th King's Laverpools	June 27, 1918 ..	75 per cent. ..	July 8, 1918 ..	This regiment left Salonica June 15, 1918, and lost <i>en route</i> from malaria 138—of these 60 were admitted to hospital at Taranto and 22 at Faenza, &c. The present average daily sick parade is 60-70, mostly with malaria. I was informed that this regiment arrived in Salonica.

TABLE A—continued.

Regiment.	Date of Inspection.	Percentage Infected with Malaria.	Date on which Quinine Treatment was Commenced.	Strength of Daily Sick Parade, number of Malarials and other remarks.
14th King's Liverpools —continued.	June 27, 1918 ..	75 per cent. ..	July 8 1918 ..	somewhere about November, 1915, but received no quinine until May or June, 1916, and then 1's administration was continued for four months only They suffered most from malaria during the summer of 1917 I was also informed that the battalion had 30 grains of quinine given daily to all ranks, for 24 days, without any appreciable benefit No dose of quinine of any kind or size being given at the end of the 24 days' course.
5th Inniskilling Fusiliers.	June 29, 1918 ..	75 per cent. ..	July 14, 1918 ..	Present strength, 28 officers, 824 other ranks Of these, the M O. 1/c considers that 600 have had malaria About 30 report sick daily; 70 per cent. of these are malarial. Blood films have been taken of every pyrexial case for the last 15 months About 30 per cent. have been found to be positive
1st King's Own Yorkshire Light Infantry.	July 11, 1918 ..	70 per cent. ..	July 12, 1918 ..	Lost 26 men <i>en route</i> to France with malaria. Average daily sick parade 30-40, 80 per

				cent being malarial About 30 per cent. of the regiment have not had malaria. Similarly to other battalions, no prophylaxis with quinine was attempted until several months after their arrival in the Struma Valley. 120 men were sent home under the "Y" scheme
13th Manchester Regiment	July 13, 1918 .	80 per cent .	July 11, 1918 ..	No men were left <i>en route</i> Average number of fresh daily relapses, 4
9th Gloucester Regiment	July 18, 1918 .	80 per cent ..	July 18, 1918 ..	Census of malarials taken by companies recently showed the following results — "A" Company 63 malarial, 133 non-malarial "B" Company . 166 malarial, 196 non-malarial "C" Company . 80 malarial, 158 non-malarial "D" Company 57 malarial, 127 non-malarial Average daily sick parade equals 60-70 Mostly with relapsing malaria.
2nd Royal Munster Fusiliers.	June 19, 1918 ..	80 per cent Probably more Very difficult to estimate as men who never had acute Ma- laria whilst in	June 21, 1918 ..	The strength of this battalion on arriving in France June 1, was 782 other ranks, their present strength is 525, 257 having been admitted to hospital with malaria. The M O 1/c knows of 600 men in the battalion who have had malaria 40 blood films taken showed 6 positive with

TABLE A—*continued.*

Regiment.	Date of Inspection	Percentage Infected with Malaria	Date on which Quinine treatment was Commenced	Strength of Daily Sick Parade, number of Malarials and other remarks
13 th Manchester Regiment — <i>Continued</i>		Salonica, have developed their primary attack in France		the Benign Tertian parasite On inspecting the battahon, I found men on parade with acute malaria who had not reported sick
6th Inniskilling Fusiliers.	June 20, 1918 .	75 per cent ..	July 14, 1918 ..	Since their arrival on June 1, have sent 110 men to hospital with malaria Previous to arrival in France, and <i>en route</i> , 147 men had shown malarial symptoms Average daily sick parade 30-40 20 per cent of these have acute malaria
6th Leinster Regiment	June 21, 1918 ..	75 per cent. ..	July 9, 1918 ..	Since arrival in France June, 1, have lost 1 officer and 479 other ranks with malaria In addition 134 other ranks were found on parade who had shown acute malarial symptoms since June 1 Average daily sick parade, 30, practically all of them with malaria
5th Royal Irish Fusiliers.	June 22, 1918 ..	75 per cent .	July 10, 1918 ..	267 admitted to hospital for malaria since arrival on June 1 Saw 13 cases being treated in Field Ambulance, 11 of these were malarial. 64 men had been sent to

				hospital with malaria between June 1919, 1918, and June 22, 1918, inclusive Saw 27 other ranks on parade who had suffered from malaria during last 3 days
7th Wiltshire Regiment	July 3, 1918 ..	50 per cent. ..	July 11, 1918 ..	The M O. 1/c considers that 50 per cent have been the subjects to malarial attacks They are probably not so highly infected as some of the other battalions; only 4 men were lost <i>en route</i> to France
4th King's Royal Rifle Corps	July 4, 1918 ..	70 per cent. ..	July 11, 1918 ..	Strength 27 officers, 641 other ranks M O 1/c states that probably only 30 men of the battalion have not had malaria I was informed that "this battalion did not suffer from malaria to any great extent until September, 1906, about 300 then developed it Quinine was only given in summer at the rate of 10 grains, twice, a week; none was given in winter" After developing malaria in the battalion they used to have 18 to 20 fresh daily relapses.
2nd Northumberland Fusiliers	July 6, 1918 ..	80 per cent Probably more.	July 12, 1918 ..	146 men admitted to hospitals on the journey to France, from malaria Average daily sick parade, 70, 50 of these have acute malaria
10th Camerons (Lovat's Scouts).	July 7, 1918 ..	80 per cent. ..	July 10, 1918 ..	The sick parade on date of inspection numbered 210; 57 of these were men suffering from malarial relapses M O 1/c considers that only 40 men of the battalion are free from infection with malaria.

TABLE A—continued.

Regiment.	Date of Inspection	Per centage Infected with Malaria	Date on which Quinine Treatment was Commenced.	Strength of Daily Sick Parade, number of Malarials and other remarks
3rd Royal Fusiliers .	July 11, 1918	70 per cent .	July 12, 1918 ..	Average daily sick parade, 60-70, and out of these 8-10 relapses of malaria 34 men were lost <i>en route</i> to France, 20 of these with malaria 22 men sent to hospital on July 10 with febrile attacks This regiment was 6 months in Salonica before quinine was given as a prophylactic 270 men were sent to England under "Y" scheme
10th Black Watch ..	July 15, 1918 ..	80 per cent. ..	July 17, 1918 ..	During the last 2 months, 10 officers and 300 other ranks have had malarial relapses 28 men were lost <i>en route</i> from malaria Usually 30-40 malarial cases attending Sick parade this morning numbered 42, 17 of these had acute malaria
6th Royal Dublin Fusiliers	July 15, 1918 ..	80 per cent .	July 17, 1918 ..	Average sick parade, 70, 50 per cent of these malarial 40 men lost <i>en route</i>
12th Lancashire Fusiliers	July 18, 1918 ..	80 per cent	July 21, 1918 ..	214 all ranks have had malarial relapses during last 2 months 4 officers, 210 other ranks 5 men lost <i>en route</i> , and 28 other ranks sent to Field Ambulance at Serqueux on day of arrival, with malaria.

II. TREATMENT.

It will be perfectly clear to all that these troops were obviously unfit for immediate arduous military duties, particularly duties entailed in the forward area. It was therefore decided to form camps for their treatment at St. Martin Eglise, near Dieppe, and Haudricourt, near Aumale. They were used to form two divisions—the 50th and 66th—commanded respectively by Major-General Jackson, D S O., and Major-General K. G. Bethell, C.M.G., D S O. It was understood that, after systematic and regular treatment, and recovery from the disability from which they were suffering, these troops could resume their rôle of fighting men.

Removed from the zone of infection, and living under good hygienic conditions, with the best of food, obtainable in the army, for their consumption, I felt perfectly confident that the only thing remaining to be done was to ensure a regular systematic daily dosing with quinine. In dealing with such large numbers of men, and to make perfectly certain that none escaped the daily dose of quinine, it was necessary to enlist the sympathy, and co-operation, not only of the Medical Officers in charge of regiments, but also of the General Officers Commanding Divisions, Battalion and Company Commanders and Senior N C O's.

I attach copy of instructions (*see* Appendix) issued by me to Administrative Medical Officers of these divisions for distribution to the Regimental Medical Officers whose duty it would be to direct the administration of quinine under the supervision of the officers and N C O's. of the battalion.

At the same time I took the opportunity to interview the Divisional and Battalion Commanders and explain the situation generally, the policy as regards the amount of duty these men could perform, the necessity of encouraging games, competitions, sports and cheerful amusements: I decided that no man should be occupied on military duties (including fatigues), during the first stage of quinine administration, for more than four hours daily, and also that these four hours of occupation should not run consecutively. When off duty every facility to be given for games, and the men encouraged to take part in sports. What is known as the forward area ration was issued to these malarial troops, also bottled stout was available and could be ordered by the Medical Officers for any men whom they considered it would benefit. Battalion Commanders were made responsible by the General Officers Commanding Divisions that the treatment was faithfully carried out in their battalions; and, of course, in their turn the Company Commanders took their share of the responsibility.

All cases of malarial relapse were treated in a field ambulance, or small detention hospital, attached to each division,

so that the man was treated in his own unit, and not sent to hospitals in the area, where it was possible his case might have been diagnosed pyrexia of unknown origin or influenza, no quinine given, and no examination of his blood made. An order was sent round the various hospitals in France instructing the Officers Commanding that all N C O's. and other ranks belonging to the battalions involved should be returned at once to their units for treatment.

A large number of the troops arriving from Salonica had not been on leave for considerable periods. It was therefore arranged that men might be allowed to proceed on leave who had undergone 28 days' treatment without having a relapse—the Regimental Medical Officer being responsible in each case. Men proceeding on leave were given a supply of quinine tablets for 14 days' treatment, with definite instructions to take 10 grains a day; they were also given a postcard already addressed to their battalion headquarters, and in case of sickness and admission to hospital, they had to communicate their whereabouts, failure to do so being a breach of discipline. No officer or man who had been in a malarial region was allowed to escape the daily dose of quinine—although several asserted that they had never had malaria, it made no matter, they all got quinine. Several men as well as officers developed their primary attack of malaria in France, far removed from any possibility of infection locally.

It was impossible to say who did, or who did not, harbour malarial parasites in their blood—it was therefore necessary, as these troops were urgently required, to ensure that none escaped treatment. An officer of the 5th Inniskilling Fusiliers who had previously resided in well-known malarial countries—

Malay States	...	..	..	3 years or more
Salonica	...	...	..	2 years
Palestine	...	.	.	9 months

stated that he had never suffered from malaria. After exposure to a particularly warm sun during a route march on July 17th he had a rigor followed by the usual symptoms of malaria. An examination of his blood showed the parasite of Benign Tertian malaria.

I found that it was necessary to define the kind of duties or work which should be assigned to these men for the daily four hours which they were permitted to do during the first stage of quinine administration. Physical exercises, squad drill, instruction in signalling, Lewis gun and recreational exercises I considered most suitable.

As the treatment progressed, say at the end of 28 days, the daily number of hours for work was increased, and now commenced the trials to see what amount of work or exhaustion these men could stand without developing a relapse.

Route marches, commencing with a distance of five miles without packs were given—eight miles; then 10 miles, up to 14 miles *without packs*. Regimental Medical Officers accompanied these marches and rendered a report on return as follows—

- (1) Date of route march and hour of day.
- (2) Numbers on parade.
- (3) Distance.
- (4) Numbers falling out.
- (5) Causes in each instance of falling out.
- (6) Numbers of relapses on that or following day.

Having completed the series of route marches without packs, a series of marches were given with packs—commencing with light packs and working up to full packs. Then as a supreme test a 14-mile route march was held with field operations including a night in the open without blankets. Reports were rendered on all occasions. In this manner I was more or less able to form an opinion of the fitness or otherwise of any battalions undergoing treatment. Reports were also rendered daily by all Regimental Medical Officers as to the number of malarial relapses occurring within the last 24 hours—numbers remaining in hospital for malaria, &c.

Bathing parties in the sea were also permitted—it was the month of July—the men being marched to the sea, allowed to remain in the water for 10 to 15 minutes, and then marched back to camp. This, remarkable to relate, did not increase the number of relapses.

Every endeavour was made to amuse and interest the men during the treatment.

Inter-regimental football matches, regimental sports, and frequent concerts, were the order of the day. Passes were given freely to enable the men to visit a neighbouring town where beer was plentiful. I advised that there should be an ample supply of French beer in the regimental canteens—it is a good diuretic, tonic in its action, and contains very little alcohol. It is better, in my opinion, for malarials who are taking quinine than a lot of boiled tea where the chief constituent is tannin. The tannin combined with quinine makes an insoluble tannate.

Instructions were given to Medical Officers to impress the men, both in conversation, and lectures, that malaria was a disease of no importance, when quinine was obtainable, and when they were removed from the infected zone. It was explained to them how malaria was caused, method of transmission, particularly that it was not an incurable disease, that if they strictly followed the line of treatment laid down they would be as fit as ever they were. Every effort was made to remove any feelings of despondency.

III. RESULTS.

The results were excellent—as will be seen by reference to the attached table showing number of cases diagnosed malaria—during the various stages of treatment.

The average duration of treatment was 10 weeks.

Two divisions were put in the forward area *within* three months of commencement of treatment almost relapse free. I have never seen men look so well and so fit, in fact, in my opinion, they were the best-looking troops in France at the time. This opinion was shared by many others who had seen them, both on arrival in France and on completion of treatment. Both divisions distinguished themselves beyond all praise in the front line, and one of them earned the congratulations of the Army Commander.

At a later period returns received from the Administrative Medical Officers concerned showed a complete absence of anything like a malarial relapse.

TABLE B.
(Average duration of treatment, 10 weeks.)

50TH DIVISION

Number of Cases diagnosed Malaria	7th Wilt's Strength 865	1st K O Y L I Strength 796	2nd North Fusiliers Strength 765	6th Ro Innis Fusiliers Strength 706	2nd R Dublin Fusiliers Strength 701	13th Black Watch Strength 954	2nd R Munster Fusiliers Strength 626	4th K R R Strength 621	5th R Irish Regiment Strength 735	3rd R Fusiliers Strength 721
(a) During week of commencing treatment	154	42	209	21	175	573	80	10	58	20
(b) During week ending 1st stage	8	6	78	20	82	79	11	10	7	16
(c) During week ending 2nd stage*	3	4	57	6	62	10	1	4	1	1
(d) During week completing treatment	Nil	1	2	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Number of days under treatment	67	66	66	73	88	70	87	67	89	66

(Division proceeded to Front Area September 16, 1918)

* It was subsequently ascertained that the "second stage" mentioned in this table (but not in the body of the Report) was only adopted at first. The only difference between the second and third stages was that the Sunday dose was omitted in the latter; but this procedure was abandoned later. The words "during week ending 2nd stage" may be taken as meaning the sixth week of the whole treatment from the beginning.—RONALD ROSS

TABLE B—continued.
66TH DIVISION.
(Average strength of units, 800)

Number of Cases diagnosed Malaria	5th R. Irish Fusiliers	6th Leinsters	6th R. Dublin Fusiliers	5th R. Innis Fusiliers	14th Liverpool	13th Manchrs	10th Black Watch	12th Lancashire Fusiliers	9th Gloucester	5th Connaught Rangers
(a) During week of commencing treatment ..	80	87	110	175	146	52	140	56	50	82
(b) During week ending 1st stage ..	60	15	26	95	102	22	13	6	32	8
(c) During week ending 2nd stage* ..	1	3	29	67	19	2	69	1	35	Nil
(d) During week completing treatment ..	Nil	Nil	4	3	5	2	Nil	Nil	4	11
Number of days under treatment, before proceeding to Front Area ..	46	72	73	60	90	87	65	76	56	74

* It was subsequently ascertained that the "second stage" mentioned in this table (but not in the body of the Report) was only adopted at first. The only difference between the second and third stages was that the Sunday dose was omitted in the latter; but this procedure was abandoned later. The words "during week ending 2nd stage" may be taken as meaning the sixth week of the whole treatment from the beginning.—RONALD ROSS.

IV REMARKS ON LINE OF TREATMENT.

Without the cordial, and wholehearted, co-operation of the Divisional and Battalion Commanders it would have been impossible to ensure the success of this scheme which has its disciplinary, psychological and therapeutical side.

Blood films were taken in every pyrexial case and examined for malarial parasites—these when present were of the Benign Tertian type. In the bacteriological work I was ably assisted by Captain P. S. Hunter, R.A.M.C., Bacteriologist, Municipal Health Office, Singapore.

Hydrochloride was the salt of quinine mostly employed, and always in solution. On very few occasions was it necessary to have recourse to the sulphate or to use tabloids.

Great emphasis was made upon the importance of having the parade for quinine administration at a definite hour every day, and either 11 a.m. or 2 p.m. were specially selected. Tea is not a mid-day beverage in the Army, and in my opinion it is just as well to keep as far apart as you can the hour of quinine administration from the hours at which this often highly-tanninised beverage is taken. I was frequently informed by the troops from Salonica that when they did receive a daily dose of quinine it was usually at tea time.

Tea was excluded from the diet of a man whilst in hospital being treated for a relapse.

“ Y ” SCHEME.

The scheme of anti-relapse quinine prophylaxis having proved a success in the treatment of these malarially infected battalions, it was decided to send to, France, for similar treatment, troops sent to the United Kingdom under “ Y ” scheme suffering from malaria. In all 12,142 other ranks were despatched and treated on exactly the same lines with a similar amount of success.

They have now become available as reinforcements

J. DALRYMPLE,

Lieut.-Colonel R.A.M.C.

APPENDIX.

The following instructions are issued to the medical officers 1/c of regiments infected with malaria

The whole regiment, officers and other ranks, will receive a daily dose of quinine as follows —

15 grams of quinine, sulphate, or hydrochloride, preferable in solution, will be given daily for 14 successive days, with the regiment on parade, so that its administration may be supervised by the officers and N.C Os

Afterwards, for a period of two months, 60 grains will be given per week, at the rate of 10 grains every day for 6 days, Sundays being excepted

The parade will take place at some definite hour daily, if possible at 11 a m or 2 p m

Aperients should be given as a matter of routine, twice or thrice a week

If during the course of quinine, men have relapses, as they may have, they should be treated according to instructions given elsewhere, and on discharge to their battalions should commence over again the daily dose of quinine as described above

Men suffering from febrile malarial relapse will be admitted to the Field Ambulance or Detention Hospital, whichever is provided. The febrile relapse must be verified by the medical officer in charge and the man's temperature recorded on a chart. In no instance should a man's word be taken that he has had a "relapse". Men must be instructed to report occurrence of relapses to their medical officer at any hour they may occur by day or night. The temperature should be immediately taken and recorded on a chart, and subsequently a blood film taken for examination as to presence or absence of parasites

The following treatment will be adopted in all cases of malarial relapse admitted to hospital —

Quinine in solution (hydrochloride or sulphate) in 10 grain doses will be given every 4 hours until 40 grains are given in the 24 hours. This will be continued for 5 days. Should the man then be free from fever for 2 days, he will be discharged to his unit and will there recommence the anti-relapse treatment, taking 15 grams of quinine daily for 14 days, &c, &c

During relapse treatment each man will receive a dose of *mustura alba*, one ounce, every morning before any quinine is given

The diet for men suffering from relapse will be milk, *bovnil*, beef tea, arrowroot, rice, &c (No tea will be given)

J. DALRYMPLE,

Leut-Colonel, R.A.M.C

V. A SHORT REPORT ON THE ANTI-MALARIA CAMPAIGN AT TARANTO DURING 1918.

By COLONEL J C. ROBERTSON, C.M.G., C.I.E., M.B.,C.M.,
Indian Medical Service.

(Sanitary Commissioner with the Government of India, Seconded.)

Dated December 16th, 1918

GENERAL.

1 When it was first decided that Taranto must be used as the site of a large rest camp on the line of communication with the East, it was well known that the district was a highly malarious one, and, that that disease was likely to prove a serious menace to the health, not only of the troops stationed in the camp, but also of the much larger numbers passing through. A site the least likely to prove dangerous was therefore chosen, and arrangements were made for all the usual anti-malaria operations to be brought into force. Mosquito nets were issued, daily prophylactic doses of quinine were given to the troops, surface collections of water were searched for mosquito larvæ, and were oiled or drained, and all wells in camp found to be infected were either sprayed with oil or closed down altogether. Each of these measures is useful, and their total effect must have been to reduce the number of infections amongst the troops considerably. At the same time, they were far from being sufficiently thorough or extensive to deal effectively with the danger, and malaria infections still took place quite freely. Apparently, however, the precautions which were being taken engendered a false sense of security, while, at the same time, the damage being done was masked by faulty reporting of cases, so that it was not till late in the autumn of 1917, when reports came in from Egypt and Salonika regarding the arrival of badly infected troops at these places, that the full gravity of the position began to be recognised.

PREVALENCE OF MALARIA DURING 1917.

2 It is impossible now to gauge accurately how great the damage to the troops by malaria infection at Taranto during 1917 really was, as sufficiently careful and complete statistics were not kept. Some information regarding what

actually occurred during that period is, however, necessary, not only to justify the expenditure on the campaign of 1918, but also to measure the degree of success which has been attained. With this object in view, enquiries were started, but most of the information available was too open to fallacies to be of any value and had to be discarded. Certain facts and figures have been collected, however, which are more definite. These are given in the following paragraphs, and, though somewhat isolated and incomplete, they serve to form a picture of the real conditions as regards malaria prevalence in Taranto during 1917, which is useful.

HOSPITAL ADMISSIONS FOR MALARIA IN 1917.

3. The faulty reporting of cases of malaria during 1917 has already been referred to. This, apparently, was due, partly to inexperience of the disease on the part of the medical staff, but chiefly to an instruction that no patient was to be diagnosed malaria unless the parasite had actually been found in his blood. Many cases, though they were treated as malarias and re-acted at once to quinine, were labelled P U O., diarrhoea, sand-fly fever, influenza, &c., solely because no examination of their blood had been possible, or, because the one examination which was performed had proved negative. Any statistics, therefore, compiled from the hospital admission and discharge books, would give a very false impression of the malaria conditions that existed. But a full and careful investigation has been made by Captain O R Belcher, R A M.C., of all fever cases, more especially those marked P U O. or N.Y.D., admitted to 79 General Hospital from amongst the white troops forming the permanent staff of the camp between June, 1917, and April, 1918. His figures and revised diagnoses I have since carefully scrutinised, discarding every case in which there could be any reasonable doubt as to the disease. From this investigation, the following interesting results have been obtained.

The white troops of the permanent staff gradually increased from three officers and five other ranks on May 18th, 1917, to 105 officers and 1,468 other ranks on October 31st of the same year. The approximate white population exposed to infection during the autumn of 1917 was, therefore, 1,573. From amongst these there were 220 primary admissions to hospital due to malaria, of whom 28 had ultimately to be evacuated to England as permanently unfit, and six died in Taranto. This gives a known malaria infection rate of 14 per cent. and a wastage rate of 2.2: the actuals were probably somewhat greater.

MALARIA HISTORIES OF UNITS IN 1917.

4 Early in 1918 an attempt was made to trace the history, as regards malaria during the previous autumn, of some of the white troops stationed in the camp. For various reasons this was not possible in many cases, but the accounts of three detachments, one of which arrived early, and two late, in the season, are of interest as indicating the malaria conditions which then existed

- (a) A labour detachment of 101 men arrived in camp on May 21st, 1917. Excluding one man, whose history is not quite certain, 32 of the remainder had been admitted to hospital for malaria before November 15th. This gives a definite infection rate of 31 per cent., and if four others, who developed the disease later, are included, the very high rate of 35 per cent.
- (b) Another labour detachment of 96 men arrived on September 17th, 1917. Before the end of the year, five of these had developed malaria, and the number had increased to nine by the end of the following March. This gives an infection rate of just over 9 per cent., which is also very high, considering the late arrival of these men.
- (c) On September 21st, 1917, a draft of 31 men arrived to join the Sanitary Section. From these six must be excluded, four because they were posted to out-stations for varying periods, and two who were admitted to hospital immediately after arrival and were later invalided for other diseases. Of the remaining 25, six developed malaria before the end of the year, and one early in 1918—an infection rate of 25 per cent.

In each of these cases, the incidence of infection was high, and in the last exceptionally so.

STATEMENTS OF PATIENTS.

5. Many statements which are of interest in this connection were obtained in the course of investigations into the origin of primary attacks of malaria early in 1918. These statements were followed up and verified as far as possible, and those cited below may be taken as quite accurate on the whole.

(a) Private G Gattenby, 196 Labour Company—had never been out of England till he came to Taranto in May, 1917—slept in a bell tent with nine others till September—

took prophylactic quinine regularly—of the nine others two also had malaria and one was invalided to England.

(b) Corporal G H Hageman, 196 Labour Company—had never been out of England till sent to Taranto in May, 1917—lived in a tent with two others—had a mosquito net but rarely used it as was not troubled by mosquitos—took quinine regularly—the two others in same tent also got malaria and one died.

(c) Staff-Sergeant T. Oates, R.E—went to France in July, 1915—then to Taranto in June, 1917—never had been away from England before—occupied tent with two others—each had a net which he used regularly—took quinine daily—did not notice mosquitos much himself, though the others got bitten a good deal and they killed plenty in the mornings, full of blood—both the others got malaria and one was evacuated to England.

(d) Company Sergeant-Major S Aspin, 196 Labour Company—left England in May, 1917, for Taranto—had never been away before—lived in bell tent with one other—had mosquito nets and used them regularly—took quinine daily—there were lots of mosquitos and he was much bitten—other occupant of tent also got malaria and was invalided

(e) Sergeant T. Wheeler, R.E—arrived in Taranto in June, 1917—had never been out of England before—took quinine regularly but did not use net—there was one other occupant of tent who also got malaria and was invalided.

(f) Private C W Reeves, 196 Labour Company—came to Taranto in May, 1917—first time out of England—in bell tent with seven others—all took quinine regularly but seldom used nets except against flies in day time—was not troubled by mosquitos—only one other in tent got malaria

(g) Private H. Snape, 196 Labour Company—came to Taranto in May, 1917—never been out of England before, except to France—slept in bell tent with seven others—had nets but did not use them every night—took quinine regularly—saw and killed many mosquitos especially in mornings—was once excused duty for 10 days for septic bites on arms—remembered names of only three of others in tent—of these one had been to India and had had fever and ague there, one had malaria in Taranto, and was invalided, while the third never had fever.

(h) Lance-Corporal S. Ralph, R.E—came to Taranto in May, 1917—never been away from England except to France—slept in tent with three others—took quinine regularly but did not use nets—plenty of mosquitos but they did not bite him—two other occupants of tent also got malaria and one was invalided.

These are not selected cases but are taken in order from amongst those first enquired into, and later cases were a repetition more or less of the same story. In trying to place a true value on this evidence of the conditions in camp as regards malaria during 1917, however, it must be remembered that malaria is largely a place infection, and groups of cases tend to occur in the same tent or hut; the conditions noted above must be interpreted in a very general fashion and on no account be taken as representative of those in the tents and huts as a whole, or a very exaggerated notion of the prevalence of the disease would be formed.

INFECTION AMONGST TRANSIT TROOPS.

6. Towards the end of 1917 certain reports were received from Egypt regarding malaria infection amongst the troops arriving there. These are the reports already referred to as first attracting notice to the conditions at Taranto. They may be summarised as follows —

(a) On October 3rd, 1917, H.M.T. "Snaefell" sailed for Egypt with 24 officers and 396 other ranks whose average length of stay in Taranto had been 34 days. On arrival on October 8th, one man was transferred direct to hospital and subsequently died of cerebral malaria. Shortly after disembarkation 11 others were admitted to hospital with the same disease.

(b) On October 7th, 1917, H.M.T. "Aragon" left with 198 officers and 1,848 other ranks, the average length of whose stay in Taranto had been 29 days. Two men died on the voyage from malaria whilst 30 other cases were transferred direct to hospital on arrival on October 16th, and, of those, one died.

(c) On October 17th, 1917, H.M.T. "Briton" left for Egypt with 87 officers, 37 nurses and 1,598 other ranks, the average of whose stay in Taranto had only been two days. On arrival on October 20th, one case of malaria was transferred to hospital.

(d) Also on October 17th, 1917, H.M.T. "Kashmir" left with 104 officers and 2,005 other ranks, whose average stay in Taranto had been 10 days. On arrival in Egypt on October 20th, three men were transferred direct to hospital with malaria.

Considering the short duration of the voyage, these figures, more especially those of (a) and (b) indicate exceedingly high infection rates. Moreover, while the amount of sickness developing on board would naturally be affected somewhat by the dates of sailing, the very direct and marked relation which

exists in each case between the sickness and the length of stay in Taranto is worthy of special note as pointing to that place as the origin of the infection.

PREVALENCE OF ANOPHELINES.

7 In this same connection definite information regarding the prevalence of anophelines in the camp during the summer and early autumn of 1917 would have been of the greatest value. All are agreed that mosquitos were abundant, and even so late as December, hibernating anophelines were quite plentiful and could be taken in any of the permanent buildings in and around the camp. Unfortunately, the only definite record of anopheline catches during the autumn is one for a daily search in 11 tents near the centre of the camp, between October 19th and 31st, and made by the entomologist Sergeant Hargreaves, soon after his arrival. The total catch was 32, or just under a daily average of three. The number is not large, but, considering the lateness in the season, we may conclude that anophelines had been quite numerous during the earlier months.

CONCLUSIONS

8. The above facts and figures, which are all that we have to go in estimating the malaria conditions in the camp at Taranto during 1917, are far from complete. It must be remembered, also, that the incidence of infection must have varied greatly at different times and in different parts of the camp and, where this is the case and only a limited number of facts are recorded, the tendency is always for these to be the best or the worst and rarely an average. Making every allowance for this probability, however, the evidence still makes it difficult to avoid the conclusion that the evil reputation for malaria which the camp had acquired by the end of 1917 was not wholly without justification, and that it had become a matter of considerable urgency that, if at all possible, similar danger to the troops should not be allowed to recur during 1918.

CAMPAIGN DURING 1918.

9. In December, 1917, I was sent to Taranto to see what could be done. Fortunately, at that time Colonel Sir Ronald Ross was under orders for Salonika,* and he came out with me to Taranto on his way, so that I had the advantage of going

* No 121/Medical/3452 (A M D 1) of 20th November 1917, appointing me to represent the War Office in connection with malaria on the Mediterranean Lines of Communication and in the Salonika Force—R. Ross.

over the whole ground and discussing on the spot with him what I considered the chief danger points and the scheme of operations which I hoped to put into force. These plans I have already described fully in my note of May 19th (a copy of which is attached as Appendix A) so that it is not necessary to repeat them here, but only to explain how they had to be modified or extended to meet different difficulties as they arose

PROTECTION FROM MOSQUITOS.

10 In my original programme I had given a prominent place to protection of the troops from mosquito bites, and it was for this reason that hatted accommodation was asked for. Unfortunately the type of hut supplied for the greater part of the camp—the "Hospital Nissen"—is one which is structurally difficult to render mosquito-proof and, if fully proofed, would be almost untenable in a hot moist climate like that of Taranto. Later also, when the stone huts were erected, the gauze provided for the proofing was of too large a mesh to be effective. Various experiments were tried for rendering the mesh smaller by successive coats of paint, but this did not prove satisfactory and it was decided to use a double layer of the gauze should mosquitos become so numerous as to make this necessary. Fortunately this was never required.

DESTRUCTION OF MOSQUITOS.

11. The destruction of anopheline mosquitos usually takes the foremost place amongst the preventive operations in a campaign against malaria, but, for the reasons given above, it became almost our sole protection at Taranto. Fortunately the work was started early and from January onwards the training of the staff in seeking out and killing hibernating adults, and in searching for and oiling or draining the breeding places of larvæ was proceeded with continuously by Captain Parker, R.A.M.C., my assistant, and Sergeant Hargreaves, the entomologist. At the same time large-scale maps were prepared on which each place requiring regular attention such as houses, wells, troughs, ditches, pools, &c., were marked down and numbered. At first and throughout, attention was directed chiefly to the actual camp site and its immediate neighbourhood, but, as the work became fully organised in one place it was extended to another in an ever widening area so that first the camp, then the inner circle, later the outer circle and finally an area even somewhat beyond, was brought under control. This gradual extension of the work is a point of some moment as it ensures the earliest and greatest concentration on the more important areas and lessens the risk

of any danger points being overlooked. Moreover, the gradually increasing staff is more easily trained, and their keenness is stimulated by getting charge of sections as soon as they are fit for the work. Simultaneously, Major Kenworthy, R. E., was doing equally useful anti-malaria work in clearing and regrading the surface drains of the inner and outer circles, and in underdraining the main seepage areas as explained in my note of May 19th, 1918 (Appendix A). The chief cause of trouble at Taranto is that both the surface soil and the underlying rock are extremely absorbant of water. The surface is undulating and much of the rainfall soaks into the ground and later oozes out at a lower level forming extensive marshy patches on the slopes or in the hollows. The root idea of the drainage plan was to run off all rain water as quickly as possible, and so reduce soakage to a minimum and to further dry the ground by underdraining the broad marshy areas. This plan was quickly grasped and the whole work carried out by Major Kenworthy. A separate report written by him is attached as Appendix B.

To this early work against the hibernating mosquito, well before breeding has started, I attach the utmost importance at all times, but in the present case it was pushed to the utmost, and continued throughout the summer in an endeavour to make good the defects in the mosquito-proofing of the huts. As will be seen later, it has been attended with particularly successful results, and rendered the absence of efficient proofing of little moment.

BREEDING PLACES IN CAMP.

12. I had anticipated little trouble from any of the possible breeding grounds within the actual camp site, but later events proved that my hopes had been somewhat too sanguine. Along the full length of the northern edge of the camp, between it and the shore of the Mare Piccolo, is a rather steep bank, in which are several seepage areas. Like the similar areas in the Inner and Outer Circles, these are more or less extensive patches of constantly wet ground, due to water oozing out where a saturated stratum of rock, overlying a layer of clay, outcrops on the slope. Their permanence, even over prolonged periods of drought, is easily understood when one considers that, on experiment, samples of rock (a coarse, loose limestone) were found to be capable of absorbing about 30 per cent of their volume of water. Being always wet, these areas get covered with coarse, rank grass and flags, and, if at all extensive, are very troublesome to deal with by hand-oling. The only satisfactory method of treating them is by a series of underdrains, leading to a

common outfall, where the discharging water may be oiled by an automatic drip. This is a simple, inexpensive and reliable arrangement, and it was used in each of the areas in the Circles. It was also used for the largest of the wet areas on this bank, just under the Nurse's hostel and behind O O shed. Two smaller areas, one near the Reinforcement Camp North and the other at the R.A.F. Jetty, were not underdrained, as I had expected them to dry up quickly. They remained wet throughout the year, however, and had to be constantly treated by hand. They should certainly be underdrained if the camp is to be continued through another season.

Along the edge of the wharf the bank was cut back to give more accommodation, and was in part faced with stone, with weep holes at intervals, in part the cutting and digging continued throughout the year. From both these areas water percolated freely, and was collected in two main ditches, running along the length of the wharf, and several subsidiary ones at right angles. The ditches and bank remained wet throughout the year, and, though three automatic drips were kept going constantly, the greater part of the oiling had to be done by hand. On four occasions during the season larvæ were found in this area, but they were quite small, and had obviously only recently hatched out.

WELLS.

13 At first it had been intended to have all wells either fitted with pumps or closed down altogether. In actual practice this had to be modified somewhat to meet the conditions arising later on in the year and the requirements of the farmers. In some cases wells ran almost dry, so that the pumps would not work efficiently, and for these mosquito-proof lids had to be provided. As the demands for irrigation increased also, later in the summer, the number of pumps required would have been large. Arrangements were made, therefore, to have those wells which were used for irrigation only, oiled once a week.

Altogether 170 wells were treated, including 57 which had pumps fitted.

PALUDE TADDEO.

14 In the original scheme of operations the Palude Taddeo was omitted, as, owing to its distance from camp and its surroundings, I did not consider it likely to be a serious source of danger. Moreover, it is so large that, if it were to be dealt with at all efficiently, the expense would be heavy. Later on, as stated in my note of May 19th (Appendix A) the Italian

authorities started to drain the main part of this marsh, and it was decided that we should continue with that part nearest to us. The work was begun, but never got further than the taking of levels, as the progress made by the Italians was slow, and the dangerous season had passed before their main drain was sufficiently advanced to allow of our going on. Should the camp be continued next season, work on this marsh should be taken up again as the removal of the Italian Anti-Aircraft Station from its present site between our camp and the Palude Taddeo will enhance the potentialities for danger of the latter very materially.

BOUNDS.

15. The question of what areas should be considered as "out of bounds" for the troops on account of malaria was rather a difficult one. During the winter months, when there was no danger of malaria infection, the limits had been fixed on general grounds, and were made as wide as possible. They are shown as a heavy blue line in the attached map (Appendix C). As the summer advanced, however, *Anopheles* mosquitos began to swarm in the areas beyond the Outer Circle. The danger of infection was considerable, and the limits had to be drawn in as shown by the red line in the same map. But there was no means of arriving at a definite safety limit, and this latter line could only be regarded as a compromise between the danger of malaria infection, on the one hand, and the disadvantages, on general health grounds, of curtailing the men's walks in the evenings in a hot, damp climate like that of Taranto on the other. Meanwhile the mosquito infection rate and the incidence of malaria amongst the Italian troops at the Anti-aircraft Station (A on the map, were carefully watched, and as soon as these showed signs of increase, about the middle of August, the "out of bounds" line was drawn further back to the dotted red line. It is probable that some danger was incurred by allowing the men to go so far afield so late in the season, but, in the interests of the general health and comfort of the camp, the risk taken was, I think, a necessary one. As we shall see later, little harm appears to have resulted.

STAFF.

16. For malaria work it is much more important that the staff should be intelligent, well trained, active and thoroughly supervised than that its numbers should be large. That under Captain Parker was composed of skilled personnel from 112th Sanitary Section and picked men from 196th Labour Company for supervision and the more technical

duties, with a varying number of British West Indian troops for work on drainage maintenance. The strength varied slightly from month to month, according to the work which had to be done, but, so far as possible, the men once trained were never changed. In January the average daily number employed was seven N C Os. and men from the Sanitary Section and two B.W I's. By the month of June the numbers had risen to 12 N C.Os and men of the Sanitary Section, 4 privates from 196th Labour Company, and 17 B.W.I's., and, later, to 13, 7 and 21 respectively. The numbers are small for the area which had to be covered, and it would have been impossible for the staff to undertake the work but for the great saving in labour that resulted from the under-drainage and from the automatic drips. Supervision also was greatly facilitated by the use of one motor cycle and six ordinary bicycles

UNDERDRAINAGE

17 So soon as the surface drains were cleared and graded by Major Kenworthy, they were taken over by Captain Parker, and the maintenance was done by his staff, except in the case of difficult repairs, when Major Kenworthy again came to his help. From May to September the growth of vegetation was rapid, and the keeping of the drains clear of weeds, especially those which remained wet, would have required constant and unremitting attention. To avoid this heavy and recurring labour, the underdrainage was not confined to the seepage areas, but was extended also beneath the upper lengths of the surface drains, where the flow of water was in-constant and tended to stagnate and form pools. These latter underdrains proved most successful, as by drying the upper reaches of the surface drains the growth of vegetation was checked and the labour of clearance reduced to a minimum.

AUTOMATIC DRIPS.

18. The automatic drips also resulted in a great saving of labour. They were used in the lower lengths of the surface drains or wherever there was a constant flow of surface water. They worked well, and the only attention they required was refilling at intervals of from three to four days. At first the tins of oil were left in the open on small stands over the drains on which they were being used, but later they were fixed in small lock-up manholes, as shown in the drawings, Appendix D. This latter arrangement proved much more satisfactory, as it prevented interference and theft.

For use in these drips waste aeroplane oil was collected from the R A F., as also dirty oil which had leaked on to the

wharf from damaged tins. Both oils proved satisfactory, and the saving so effected was considerable. The same waste oils, mixed with an equal quantity of cresol, were used for spraying crabholes, or, with double the quantity of kerosene, for ditches. Kerosene alone was used for the wells.

The total quantity of oils and cresol used during the whole campaign was—Kerosene, 519½ gallons, waste oil, 587 gallons, cresol, 24 gallons. The quantities cannot be said to be excessive.

METEOROLOGICAL CONDITIONS

19. There was nothing out of the common in the weather conditions during 1918. The monthly rainfall from 1908 to 1918 is given in the chart (Appendix E) and the mean temperature and the humidity for the years 1916 to 1918 in the chart (Appendix F).

ANOPHELINES.

20. The *Anopheles* found here are *Anopheles maculipennis* and *Anopheles bifurcatus*. The former was chiefly prevalent to the east and south of the camp and later on in the year. The latter to the west and in the spring. This difference in distribution was due to the greater number of wells and troughs on the west of the camp and of ditches and marshes on the east and south. Only one specimen of *Anopheles superpictus* was taken, and it was probably, therefore, an importation.

The dissection of anophelines from different areas was started early in April, and continued regularly throughout the year as opportunity was found; 949 mosquitos in all were examined, and the results were as follows:—

Source	Stomachs		Per Cent	Salivary Glands		Per Cent
	Examined	Infected		Examined	Infected	
Camp	122	19	15	119	3	2
House 14	97	3	3	73	1	1.25
Sahna Grande	163	8	5	150	4	2.6
House 31	53	4	5	44	1	2
House 26 and Italian Anti-Aircraft Sta.	514	40	8	519	3	0.5

Anopheles maculipennis was more often infected than *Anopheles bifurcatus*. The first infection was found on June 24th, 1918, and the latest on November 25th, 1918.

One very interesting point in the above table is the very high percentage of stomach infections amongst the mosquitos caught in camp. This was most probably due to the frequency of human carriers amongst the troops invalided from Salonka, and shows the potentialities that existed for the disease to spread had *Anophelines* been at all numerous.

Of the three *Anophelines* caught in camp with infected salivary glands, and therefore in a condition to convey infection, two were caught in huts which had not been occupied for over a week, and one in a dugout near the Sister's quarters. None of them had fed recently, so that it is unlikely that they had done any harm.

DISTANCE OF FLIGHT OF MOSQUITOS.

21. The results of an interesting experiment in this connection are well shown in the chart, Appendix G. The curve in this chart represents the total weekly catches of *Anophelines* in three houses—Nos. 94, 92 and 89 in map, Appendix I. During the months of June and July the weekly catches had remained high, though all the neighbouring known breeding grounds had been abolished. On August 4th oiling of a large breeding ground on the opposite side of the Salina Grande (A to B in Map I) was started to see whether this would have any effect. Immediately the catches fell to zero, and remained so while the oiling of this ditch was continued. The mosquitos in these three houses had evidently been coming right across the Salina Grande, a distance of approximately 2,000 metres.

RESULTS OF 1918 CAMPAIGN.

PREVALENCE OF ANOPHELINE MOSQUITOS.

22 Early in January, 1918, at the commencement of the work, it was arranged that careful records should be kept of all adult *Anopheline* mosquitos caught and destroyed in the huts and tents within the camp, and also in certain houses scattered over the protected area. Such records are most useful in guiding the work, as not only do they quickly show the existence of any breeding grounds which may have escaped notice, but also frequently indicate their approximate position. Moreover, after the work is over, the records remain to show the progress that was made. It is for the latter purpose they have been used in the chart, Appendix H, attached.

In this chart the red curve shows the total weekly catches of *Anophelines* from January to November, 1918, in eight houses—numbered 14, 33, 35, 36, 94, 92, 89 and 26, and circled in red in the map, Appendix I—forming a semicircle round the camp, but near the outer limit of the protected area. The black curve in the same chart shows on a five-times larger scale the total number of *Anopheline* mosquitos caught week by week in a search of every hut and tent in the camp area, and also in three houses—Nos. 22, 23 and 24 in map I—immediately adjoining

The chief point of note in the charts is that both curves show a marked fall (decreased incidence of *Anophelines*) during the summer, instead of the usual rise. The results must appear almost incredible to anyone who had not actually experienced them, but the fact that the curves correspond so closely, though representing the catches of two squads working quite independently, vouches for the accuracy of the figures. To anyone living in the camp throughout, the facts were quite apparent. This aspect of the chart alone is sufficient to mark the campaign as a successful one.

A further point of interest is the rapid fall of both curves between January and April. This illustrates well the advantages of a vigorous campaign against the mosquito during the early months of the year, when breeding is still in abeyance or slow and intermittent. In this way the number of mosquitos left to start the summer's brood is reduced to a minimum, and swarming, if it does occur, must be greatly delayed. In the present case, for the whole period April 22nd to June 3rd not a single *Anopheline* was caught in the course of six weekly searches of every hut and tent in camp.

In June and July, with weather conditions more favourable to the mosquito and an increased flow in the springs following on the rain of March, April and May, there was a slight rise in the catches of *Anophelines*, but even during this period the catches must be considered remarkably small, when one thinks of the number of huts and tents that were searched weekly.

From the middle of July the catches again kept low till the end of September, when a sharp rise took place. From a consideration of the curves this was obviously due to some local breeding ground that had escaped notice, and, as a matter of fact, nearly all the mosquitos caught were taken in the eastern portion of the camp. Suspicion fell on the Italian Marconi Station, permission to enter which had not previously been granted. This was at once obtained. Two tank breeding-places were found, and after these were emptied the mosquito catches again quickly fell to zero, where they have since remained.

The reduction in mosquitos in the camp has been remarkable, and far exceeded my expectations. Perhaps the conditions may best be expressed by a statement that, during July, the worst month of 1918, *Anopheles* were five times less in evidence than they are normally in January. It can quite safely be said without exaggeration that the men who have seen even one *Anopheles* mosquito in camp this year must be few.

PRIMARY ATTACKS AMONGST THE PERMANENT STAFF.

23 The best of all tests of the success or otherwise of the campaign, however, is the actual number of infections that took place. For this reason the most scrupulous care has been observed in having every primary case of malaria reported and in enquiring into its previous history. The total number of such cases amongst the white troops forming the permanent staff of the camp from April 15th up to date has been 55, of which 18 were malignant tertian, 28 benign tertian, and 9 were diagnosed on clinical grounds. The usual basis of the latter diagnosis was the absence of other definite disease, the type of fever and reaction to quinine.

It has been quite impossible to obtain accurate figures which would give definite information regarding the number of troops resident in the camp during 1918 who had or had not previous exposure to infection, but out of a total of 2,398 present on November 1st, 1918, no less than 1,215 had been here during the malaria season of 1917 also.

Of the 55 primary cases of malaria referred to above, 34 gave definite histories of exposure to infection during 1917 (examples are given in para 5 above), and, in addition, of one or more attacks of undiagnosed fever with or without admission to hospital during the autumn of 1917 or the first three months of 1918. The actual treatment in all these cases is not known, but, in the majority, it was by quinine. These cases must obviously be taken as old infections contracted during 1917, and should, therefore, be excluded from this year's figures.

Of the remaining 21 cases, four give clear histories of having been severely bitten by mosquitos while on conducting duty with goods trains, which halted all night at Nassisi station, a few miles out of Taranto, and in a heavily-infected neighbourhood. Of these men three were on the same train, and were admitted to hospital within four days of each other. The fifth case gives a similar history of having been bitten while on a train halted at a station between Foggia and Bari, which is also a heavily-infected area. These five cases

should, therefore, also be definitely excluded from the number of local camp infections.

Sixteen primary infections remain, and must be accepted as local cases, but, even after full enquiry, considerable doubt as to whether they are real camp infections during 1918 must remain in all of them except one. With regard to the year of infection, seven were in Taranto during the malaria season of 1917, and may well have contracted their infections then, though the actual attack of fever did not develop till this year. Such cases are quite common, and no less than 17 (11 from Salonika, 2 from Palestine, and 1 each from Egypt, India, Mesopotamia, Mudros and the north of Italy) were admitted to the 79th General Hospital this year. In each of these cases there was a definite history of the patient having been in a malarious district for varying periods up to two years without any manifestation of the disease till on the journey to Taranto. But, even if these cases are all taken as this year's infections, the locality of that infection still remains doubtful. Eleven give quite definite statements of frequent walks in the evenings beyond the protected area into the dangerous zone outside, while four others were on duty on the motor launches, and frequently out late in the evenings all over the harbour. Considering the scarcity of mosquitos in the camp already referred to, and their abundance outside, the probabilities are all in favour of most, if not all, of these 15 infections having been contracted outside the protected zone. In only one case do the facts accord with a camp infection during 1918.

PRIMARY ATTACKS AMONGST TRANSIT TROOPS.

24. Statistics or information regarding possible infections amongst transit troops are not easy to obtain. Three such cases have, however, been reported.

One case was undoubtedly a primary infection. The patient had spent three days in camp, and may have got his infection there. At the same time he had been in the train in an infected area for the following two nights, and might equally have contracted the infection then. Considering the almost total absence of *Anopheles* in the camp, and the freedom from infection of the staff residing there permanently, the latter source is the more probable one.

The other two cases were naval details, one of whom had been in camp two and a-half months and the other 13 days. Both gave histories of having been out for walks in the dangerous area outside the camp, and one had served several years in different stations in the East.

PRIMARY ATTACKS AMONGST BRITISH WEST INDIANS.

25. I have no experience of the liability of British West Indians to malaria infection. They have, therefore, been excluded from the above statistics. That they are not immune, however, is shown by the fact that there were amongst them several relapses of old malaria infections contracted elsewhere. On the other hand, there were, on an average, 3,242 present in camp throughout the malaria season, but not a single primary infection was recorded, although the medical officers had been instructed to watch for the disease.

STATISTICS OF ITALIAN ANTI-AIRCRAFT STATION.

26. As a contrast to the above figures, the statistics of an Italian Anti-aircraft Battery, situated close to our camp, are of interest. In this battery there were 53 men, who arrived between December 26th, 1917, and August 7th, 1918, from non-malarious areas, and who had never had the disease. Out of these 24 became infected during 1918, and 14 were permanently invalided. This gives the very high infection rate of 45.3 per cent. and a wastage rate of 26.4 per cent. These figures show the possibilities which existed.

CONCLUSION.

27. In concluding this report, I wish to express my indebtedness to Captain W. Parker, R A M C., my assistant, Major Kenworthy, R E, and Sergt Hargreaves, R.A M C., the entomologist. Captain Parker was my right hand throughout; Major Kenworthy was responsible for the excellent drainage works constructed, and Sergt. Hargreaves showed the greatest keenness and interest in the work. To them is due the success that has been achieved. I could not have been better served, and my duties consisted solely in guidance and control. To Captain O. R. Belcher, R.A.M C, my thanks are also due for practically the whole of the statistical work, and for the keenness and interest he showed, in following out the histories of the different cases.

J. C ROBERTSON,

Colonel, I M.S., A D.M.S., Taranto.

TARANTO,

December 16th, 1918.

APPENDIX A.

A SHORT NOTE REGARDING THE ANTI-MALARIA PRECAUTIONS WHICH ARE BEING TAKEN AT TARANTO REST CAMP.

The parasites which cause malaria have a double life cycle in the blood of man and in the body of the mosquito. In the former, reproduction is a sexual and takes place by simple division of the two or three days' old adults into a number of young, which again mature and divide into fresh broods in two or three days' time, and so give rise to recurrent paroxysms of tertion or quatern fever according to the particular species of parasite concerned. Male and female forms of the parasites are produced in the blood of an infected man, but they do not conjugate or give rise to young until they are ingested during the act of feeding by certain species of *Anophele* mosquitos. In the body of the mosquito, on the other hand, the cycle is a sexual one, and reproduction occurs only by the conjugation of two individuals, male and female, with subsequent division into a swarm of young, which, lodging in the salivary glands of the mosquito, undergo no further developments until injected into man when the mosquito bites. This latter cycle in the *Anophele* mosquito, being sexual, may be considered as regenerative. Each of these cycles is restricted to the special host, and no infection takes place in nature from man to man except through the intervention of certain species of *Anophele* mosquitos or from mosquito to mosquito except through the intermediation of infected man.

2 The above facts regarding the life history of the malaria parasites have been definitely established, and on them are based the measures which are generally taken for the prevention of malaria infection. It is obvious that—

- (1) If man could be protected from mosquito bites, or (2) if all *Anophele* mosquitos could be destroyed, or (3) if *Anopheles* could be prevented from becoming infected,

malaria would soon disappear. Action directed towards any one of these objects, or towards preventing the development of the malaria parasite in anyone bitten by an infected mosquito, would be quite sufficient if only it could be made absolute. Unfortunately, this can rarely be done, and, in a place like Taranto, is, for many reasons, quite impossible. At that place, a combination of measures has therefore had to be relied on, those being selected which under the special conditions obtaining and with the materials available, appeared most likely to give the best results and, at the same time, to be cheapest and to offer a minimum of interference with military requirements. A knowledge of what these measures are, and how far they are likely to be successful, may best be attained by considering them in four groups according to the object at which they aimed.

3 *Protection from mosquito bites*—For the individual with a clear conception of the risk that mosquito bites entail within a malarious zone, personal protection from these bites is by far the most valuable prophylactic measures which he could adopt. It is simple, and if carefully carried out gives absolute security. With large and varying numbers of troops, however, the giving of facilities for complete individual protection would mean a prohibitive expenditure. Moreover, there would always be large numbers of men, especially amongst troops in transit, who would be ignorant of the risks, and would quite naturally look on the discomfort of the mosquito net, the avoidance of

walks in the evening without veils and gaunlets, the inconvenience of double closed doors to sleeping rooms, &c, as fussy and unnecessary restrictions to be avoided on every occasion on which they could do so undetected. For these reasons, and also because the Nissen huts, which form a large part of the accommodation at Taranto, are unsuited to a scheme of complete protection from mosquitos, and because of the difficulty of obtaining the necessary proofing materials, it has been necessary to relegate this method of malaria prophylaxis to a second place, and it is on mosquito destruction that main reliance will have to be placed. At the same time, very important protective measures under this head have been undertaken, all sleeping accommodation and the canteens, Y M C A, and other huts, where the men are likely to gather for the evenings, are being proofed against mosquitos as far as possible with gauze and double doors, all sleeping accommodation is regularly searched for any mosquitos which may have gained entrance or have been trapped between the double doors, the same barrack rooms will be fumigated at intervals, guards and other men on night duty are being provided with veils and gaunlets, areas where mosquitos have become prevalent will be placed out of bounds after sunset, and all troops will be warned of the danger of mosquito bites and be encouraged to take precautions against them by placards, notices and lectures. Specially proofed bell tents are also being got ready in case they have to be used.

4 *Destruction of Anophelinas* —(a) It very soon became evident that this would have to be the main defence against malaria at Taranto, and special care has been taken therefore to make it as complete and thorough as possible. A detailed survey of all the likely breeding places, both inside the camp and outside to a distance of one and a half miles from its border, was started early, so as to obtain information on which might be based as accurate an estimate as possible of the danger to be anticipated from the different areas, and of the relative importance and urgency of the works which might be necessary in each. This survey confirmed the general conclusions which I had previously arrived at, and which had been endorsed by Colonel Sir Ronald Ross at his visit, but it had also been of value in bringing to light some new breeding grounds of importance which previously had escaped notice.

(b) Each year a certain number of mosquitos and their larvæ hibernate over the cold weather, and it is from these that the first of the new season's brood is developed in the spring. In my previous experience I have found a rigid winter campaign against these hibernating mosquitos of the utmost value in lessening the risk of swarming and the work which had to be done later on. Such a campaign was therefore started early and carried out simultaneously with the survey already referred to. All possible resting places for mosquitos in houses, huts, sheds, &c, both within and outside the camp area, were carefully and repeatedly searched for *Anophelinas*, and these destroyed. At first it had been my intention to do this by fumigation. This would have been easier, but a suggestion to try it met with so much opposition on the part of the farmers that all further thought of it was abandoned, and the slower and more laborious method of searching was used instead. This change has not been without its advantages, however, as it enabled me to obtain periodical censuses of the mosquitos in particular areas, and these have been of great value in checking the results of the survey referred to above, and also in measuring the effects of the different anti-larval operations, draining, oiling, &c, which have been undertaken, and in estimating their relative value.

(c) Both the survey and the winter campaign have been of great help in enabling me to train a number of men in the work of recognising *Anophelina* mosquitos in the egg, larval and fully developed stages,

and of hunting out their breeding grounds, and in searching for the places where they lie up during the day. These men will be specially useful later on, and it is hoped that they will not be moved

(d) The whole of the breeding grounds which are likely to affect the health of the troops adversely have been conveniently grouped for descriptive purposes, into three areas —

- 1 The actual camp site ;
- 2 The inner circle ;
- 3 The outer circle ,

and this grouping may be adhered to as it emphasises rather well the important point of distance from the camp. The actual camp site occupies a semi-circular area of roughly 800 metres radius on the southern shore of the Mare Piccolo. The " Inner Circle " lies immediately outside of this, and is a concentric semicircular band about 1,000 metres in width, and the " Outer Circle " is a second concentric band outside that again

(e) As a result of the survey referred to, it was found that within the camp area the number of *Anophelinae* breeding places was not large, nor their extent great. They consisted chiefly of wells, tanks and cisterns. All of these have been fully dealt with—the wells by sealing them down completely, the tanks and cisterns by draining—and no further danger may be anticipated from them. At the same time, all low lying patches of ground where water might collect have been drained, tins and other pots which might act as receptacles of water have been collected and are being used for making paths, and all hollows in tree trunks which might hold water and act as potential mosquito places, have been plastered up with mud. Within the camp area, I think, it may safely be said that no single breeding ground for mosquitos now remains

(f) In the " Inner Circle " the breeding grounds, both actual and potential, were much more numerous and, adjoining the camp, as this area does on all sides, except to the north, it was by far the most dangerous from the point of view of malaria. It contains a large number of farms, each of which has numerous wells and troughs for the supply of drinking water, for watering of stock and for irrigation. Most of these were acting as reservoirs of hibernating mosquito larvæ, and would certainly have formed excellent breeding grounds during the mosquito season. They presented a very considerable difficulty, as obviously they could not be closed or oiled. Fortunately the Italian authorities came to our assistance and, by the issue of an Ordinance (copy attached B) that each owner would be held responsible for keeping every well or collection of water on his ground mosquito-free, placed us in the excellent position of being able to come to the help of the farmers in complying with the requirements of the Ordinance, instead of being outsiders interfering unnecessarily with their water arrangements. An agreement was quickly arrived at allowing us to close down most of the wells, and to drain some of the tanks and oil the others, on condition that we provided one or two cheap lift pumps for the remaining wells on each farm. The difficulty has been completely overcome, and without friction of any kind. At the same time, all trees in the inner circle close to the camp site have been treated similarly to those within the actual camp area, and all small collections of water have been kept free from larvæ by oiling or draining, pending the completion of the larger drainage works which have had to be undertaken.

These larger drainage works were necessary owing to the presence of numerous surface drains, much overgrown with long grass and reeds, and liable to contain water for considerable periods after rainfall, and

in some cases, permanently. In the eastern half of the circle, the area marked "2" in the map, there was also a large tract of low lying, swampy ground. This area "2" was much the most dangerous part of the inner circle and, indeed, was the chief source of *Anopheles* mosquitos in the camp, owing to the great extent of the drains and ditches which it contained, their proximity to the camp site, their dense overgrowth with grass and reeds, and also the fact that many of the ditches and also the low lying swampy ground were constantly supplied with water which percolated out of the hill sides at three points marked D, E and F, and known locally as No 17, the Wet Triangle, and R E Hill respectively. It was decided that all the drains and ditches in the inner circle should be cleared up and regraded to allow of storm water flowing off more rapidly, and at the three seepage areas, D, E and F, should be under-drained to three outfalls into the newly cleaned channels at which automatic oil drippers could be placed in manholes. All this work has been excellently carried out, and the control of mosquito breeding within the inner circle should present no great difficulty beyond the systematic upkeep of the drains in good condition, and attention to the automatic drippers.

(g) The question of how to deal with the outer circle was a more difficult problem. It contains three very extensive marshy areas, marked 5, 4 and 3 in the attached map, and named respectively the Salina Piccola, the Salina Grande and the Palude Taddeo. The two former have been partially drained and reclaimed by the Italian authorities but the drains had been allowed to get out of repair and to become overgrown and clogged, and all three areas were typical and extensive breeding grounds for *Anopheles*. All are somewhat remote from the camp area, and it was obviously out of the question to deal with them completely as in the case of the inner circle, as the cost of doing so would have been altogether out of proportion to any gain that was likely to accrue. In my experience little danger is to be anticipated from breeding places over one mile distant if the mosquitos have opportunities of feeding close at hand, and if the intervening ground, as at Taranto, is raised, wind swept and clear of all scrub and trees. The Salina Piccola comes well within the distance, however, and it appeared necessary that the northern part of it, at any rate, should be dealt with. The rising ground G, immediately to the east of this Salina, also remains constantly wet from numerous seepage springs, and this too it was considered desirable to treat. All the drains in this area have been cleared and regraded, so that very little water now lies for more than a day or two after heavy rain. The wet patch of ground also has been underdrained, and the outflow will be kept oiled by automatic drippers in manholes at the different outfalls.

(h) The nearest point of the Salina Grande is just over one mile from the camp, but slightly nearer where a number of drains which it was desirable should be cleared and re-graded. As all these drains have their outfall into the nearest portion of the peripheral drain of the Salina, it was thought advisable to clear and re-grade the latter also, as shown in the map.

(i) It was about Area 3, the Palude Taddeo, that I felt in most doubt. The nearest portion of this marsh is brackish, and *Anopheles* do not breed in it, while the further portion is a continuous breeding ground, and gradually extends in breadth as one goes further from the camp. Little advantage appeared likely to follow partial treatment, and to do the whole of it would have been a very large work. I postponed decision as long as possible in the hope that I should be able to get some definite evidence of the danger which might be expected if it

were left alone, but, though it was trapped continually, and all the houses between it and the Camp, and on the edge of the latter, were carefully searched each week, no evidence of any serious danger was forthcoming. On the contrary everything pointed to the probability of our being able to neglect it altogether without risk. At the same time the favourite walk of the men in Camp in the evenings was along the shore of the Mare Piccolo in this direction, and it was felt that it would be a serious hardship to them to put the whole of this part of the shore out of bounds. Fortunately the Italian authorities started to drain the main part of the marsh last month, and it was decided by the I G C on a visit shortly afterwards, that it would be well to drain the remaining portion, which is on the side nearest to our camp, at the same time. This work is now in progress.

(j) It is, of course, too early yet to be able to say how far the anti-mosquito measures which I have described will suffice to meet the requirements of the situation, or whether they will have to be extended. But, so far, the position appears satisfactory, for, while mosquitos are fast on the increase outside our area, they are becoming fewer within the inner circle and, inside the Camp itself, it is only rarely that an *Anopheles* can be found. Very careful watch, however, is being kept on all the known breeding places, new ones are being searched for, and all the houses and huts, both within the Camp and in the inner circle, are regularly examined for adult mosquitos so that any increase may be detected at once.

5 *Protection of Anopheles Mosquitos from Infection*—This is really a corollary of the protection of man from mosquito bites, and the measures under the two heads are very largely identical, at any rate so far as the healthy troops in Camp are concerned. Besides the healthy troops, however, there are three classes which require special notice:—

- (a) Men actually suffering from malaria,
- (b) Men who are probable "carriers", and
- (c) the resident population

(a) With reference to the first of these classes, all men suffering from fever, even if slight only, will be required to report for treatment, and will be admitted to hospital in which the wards will be absolutely proofed, or they will be transferred out of the danger zone to Faenza. During convalescence these men will be housed in separate barracks and carefully supervised until quite free from danger to others.

(b) "Carriers" are likely to be numerous amongst the men being evacuated under the "Y" scheme, and, as they will not be known, the whole of the "Y" scheme men will be accommodated in specially proofed barracks during such time as they may remain in camp.

(c) With regard to the resident population supervision will be less easy, but relations have already been established whereby not only do they permit us free ingress to the houses to search for mosquitos, but they also help us in the work. Later on, when mosquitos become more numerous and troublesome, it is hoped that they may allow us to proceed further and to fumigate their rooms at intervals when most of the infected *Anopheles* would be destroyed along with the others.

6 *Prevention of Malaria Developing in those who have been Bitten by Infected Mosquitos*—This is the fourth method of prophylaxis, and for various reasons it is probably the least important. Lately the taking of prophylactic quinine has rather fallen into disrepute, but this is probably largely due to the fact that too much has been expected of it. For the cure of malaria in man, that is, the suppression of parasites, the result of asexual reproduction, 20 grains of quinine at least

are given daily, and often more. It can hardly be expected, therefore, that 5 or 10 grains daily will in all cases be sufficient to prevent the development of that stage of the parasite injected into the blood by a mosquito, and which is the result of sexual reproductions and, presumably, therefore, much stronger. There is a considerable mass of evidence to show that the smaller doses of quinine do help in preventing the development of a considerable number of new infections, and also in reducing the number of relapses in old cases. They are, therefore, being regularly issued to all ranks in Taranto under supervision.

7 In carrying out the anti-malarial work in Taranto, I am greatly indebted to Major Kenworthy, R E., who has done excellent work in connection with the drainage, to Major Mattei, A A M C., to whose tact and resource the complete absence of friction with the Italian residents is very largely due, and to my assistant, Captain Parker, R A M C., who has shown indefatigable zeal and energy in connection with the field work.

J C ROBERTSON,
Lieut -Colonel, I M S

Headquarters, I G C.,
May 19, 1918

APPENDIX B.

OFFICE OF THE COMMANDER-IN-CHIEF OF THE DEPARTMENT AND OF THE NAVAL COMMAND OF TARANTO

We, Vice-Admiral Commandantore Emilio Solari, Commander-in-Chief of the Department and of the Naval Command, Taranto.

In view of the Royal Decree, May 25th, 1915, conferring on us full Military and Civil Powers

In view of paragraph No 636 of the Sanitary Law, August 1st, 1907, and General Sanitary Regulations approved by Royal Decree, February 3rd, 1901

In view of the Municipal Ordinances of August 15th, 1904, and September 7th, 1917

Having considered the necessity of enforcing more strictly the measures for the anti-malarial prophylaxis in the territory within the jurisdiction of this Naval Command

ORDER

Art 1—That within the publication of the present orders, it is compulsory for proprietors and tenants in the malarial regions comprised in the territory of this Naval Command, and in grounds suitably situated regarding altitudes, to adopt means for the natural flow of waters in such a way as to avoid the formation of ponds, wells, or sheets of stagnant water, either in large or small quantities, temporary or permanent, artificially created or existing naturally, within greater or lesser distances from dwellings

Art 2—That as a sequence of the above article, it is prohibited to allow any water which is drawn from wells, and which is required for irrigation, to remain in the tanks next to the "Norie," for more than 24 hours

Art 3—That drains, pipes and conduits, used from the "Norne" for irrigation of ground, must have sufficient fall and be kept clear so as to allow an easy flow of water and dispersion in ground without causing any stagnation.

Art 4—That mouths of wells or "Norne" and all openings in connection with them must be closed in such a way as to avoid the possible presence of larvae of *Anopheles* mosquitos

The improvements of water wells must be made so as to reduce the size of the mouth of the superstructures and supply a perfectly fitting wooden lid and frame; or, when this is not possible, the mouths of the wells must be completely closed, and suitable pumps fixed. Unused wells must be abolished or closed up with stone slabs.

Art 5—That it is compulsory for everybody charged with the construction of roads and canals to prevent waters from becoming stagnant in abandoned sump pits, also, to prevent water from stagnating in any hollow grounds and badly constructed or badly kept gutters

Art 6—That the sanitary authorities will enforce the instructions in the present Ordinances, making use of the police agents for the control and actions

Anybody not complying with the above orders will be tried by a Military Court and punished accordingly, as laid down in Article 129 of the above mentioned Sanitary Law, and the necessary works will be carried out at the expense of the interested parties by the Direzione del Genio Marina

Taranto, February 24th, 1918

Vice-Admiral (Signed) E SOLARI,
Commander-in-Chief

APPENDIX C.

REPORT ON THE ANTI-MALARIAL DRAINAGE OF CIMINON CAMP, TARANTO

On January 15th, 1918, I received orders from the Director of Works, Italy, to proceed to Taranto, collect the necessary data, and prepare plans for the thorough drainage of the inner circle, i.e., 2,000 metres, defined on the general plan of the Camp and to proceed with the work for which he approved an expenditure of £5,000, this not to be exceeded without authority

On arrival I consulted Colonel Robertson, A D M S, who stated his requirements, which consisted of—

- (1) The collection and drainage of all surface water;
- (2) The clearing of existing ditches,
- (3) The repairing and covering of all wells and water-storage tanks,
- (4) The installation of pumps on the storage tanks and wells indicated by him

The general plan of Cimino Camp and surrounding area marked "1" is divided into six mosquito areas, coloured and numbered from 1 to 6.

Areas Nos 1 and 2 comprise the inner circle;
Areas Nos 3, 4 and 5 comprise the outer circle,
Area No 6 comprises Tosies Yard (Celese River)

PROBLEM

The problem involved the drying up of all mosquito breeding grounds in the inner circle, *i. e.*, Areas 1 and 2, and limit as far as possible those in the outer circle Areas 3, 4 and 5.

As the whole of the areas 1 and 2 and portions of 4 and 5 are under cultivation great care was necessary not to interfere with farming operations, or cause inconvenience to the owners or occupiers of the lands.

DESCRIPTION.

Area No 1, or West Side, has a catchment area of about 520 acres with main outfall at point marked "A" on plan. This area is on the high land and appears free from springs

A system of open ditches running in a northerly direction exists, and are marked in blue on the plan. At least 95 degrees of this area is under cultivation

Area No. 2 comprises the "Pianura Erbarca," or marsh (lying to the south of the Camp), together with R. E. Hill, the wet triangle and House 17.

The catchment area is approximately 575 acres, the drainage from which passes off by means of catchwater ditches and main drains, the latter running under the road and railway bridges, and emptying into the Mare Piccolo at point marked "B" on plan.

R. E. Hill lies to the east of the marsh, and on the slope of the hill, several springs and a good deal of seepage from the adjoining high land crops out at this point

Wet Triangle, lies to the south of the marsh and consists of two natural water courses which drain this area, it is fed by seepage and, owing to the grade, many water holes existed.

House 17 lies to the south-east of the marsh on the slope of a hill, the land is cultivated, and a system of irrigation existed which consisted of open ditches connecting the springs to a storage tank from which the water was distributed to the land in stone channels.

Area No 3—The Taddeo marsh is a delta of about 650 acres. About 200 square miles of land, including the Georgia and Sahn Grando Areas, drain into the Mare Piccolo at this point

The outfall of the Salina Grando drainage is conducted through this low area in a high level canal.

There are innumerable springs along the foot hills lying to the south which cause the low area to be wet and boggy.

Area No 4—Salina Grande, situated about two miles to the south-east with 3,500 acres of bottom land and a catchment area of 6,300 acres

This basin has a gravity drainage system which is well laid out and in a fair state of repair with the exception of the catchwater ditches which have been allowed to become partially choked.

The land is only partially under cultivation owing to the alkali having been brought to the surface through lack of proper under-drainage

Area No 5, Salina Piccolo, lies about $1\frac{1}{2}$ miles to the south-west of the Camp, and is a low basin of about 300 acres, with a catchment area of 600 acres This land is drained into the sea through a stone culvert under the high land to the west

The drainage system is similar to No. 4 and suffers to the same extent from white and black alkali.

Area No 6 (Celese River Valley) part of the Tosies Yard area. This area lies on the north shore of the Mare Piccolo with about 300 acres of low lying land, like area No 3 there are many springs, some of large capacity. Many open ditches have been cut, but owing to the slight fall the ditches remain full of water, and overgrown weeds.

To carry into effect the before-mentioned requirements—

Rainfall records for the last 10 years were obtained ;
Surveys and plans of the areas made ;
Ditches and catchwater drain located ,
Levels of all drains taken and profiles drawn ,
Areas and run-off (based on maximum rainfall) figured out ;
Grades and capacities of ditches computed ,
Cement oiling chambers for the outfalls of main underdrains were constructed ,
Wells and water storage tanks repaired, lids fitted and pumps of suitable capacity provided and installed.

The following work has now been carried out —

Area No 1—All ditches were regarded and cleaned out, extra road ditches cut, making a total of 3,900 metres of open ditches completed in this area, as shown on plan

Area No. 2, The Marsh—The main outfall channel was regraded and sides terraced from point marked "B" to the road bridge. The two catchwater ditches, two main drains, and all open ditches and laterals were graded and enlarged, making a total of 13,500 metres of drains completed

The bridges were overhauled and the channel laid in cement, true to grade, to prevent pools of water forming under same

R E Hill—3,240 metres of ditches were cut, 1,060 of which were laid with underdrains

All springs were connected to the underdrains and the springs covered over

A cement oiling chamber was constructed at the outfall

Wet Triangle—4,150 metres of main ditches were graded and enlarged and 1,250 metres of underdrain cut and laid thus allowing ample capacity for storm water, will dry out the ditch within two days after rain

A cement oiling chamber was constructed at the outfall.

House 17—Here a complete system of under-drainage was constructed. All springs closed in and connected underdrains to the storage tank. The overflow carried underground to the outfall. A total of 3,050 metres of ditches, of which 1,650 were laid with underdrains

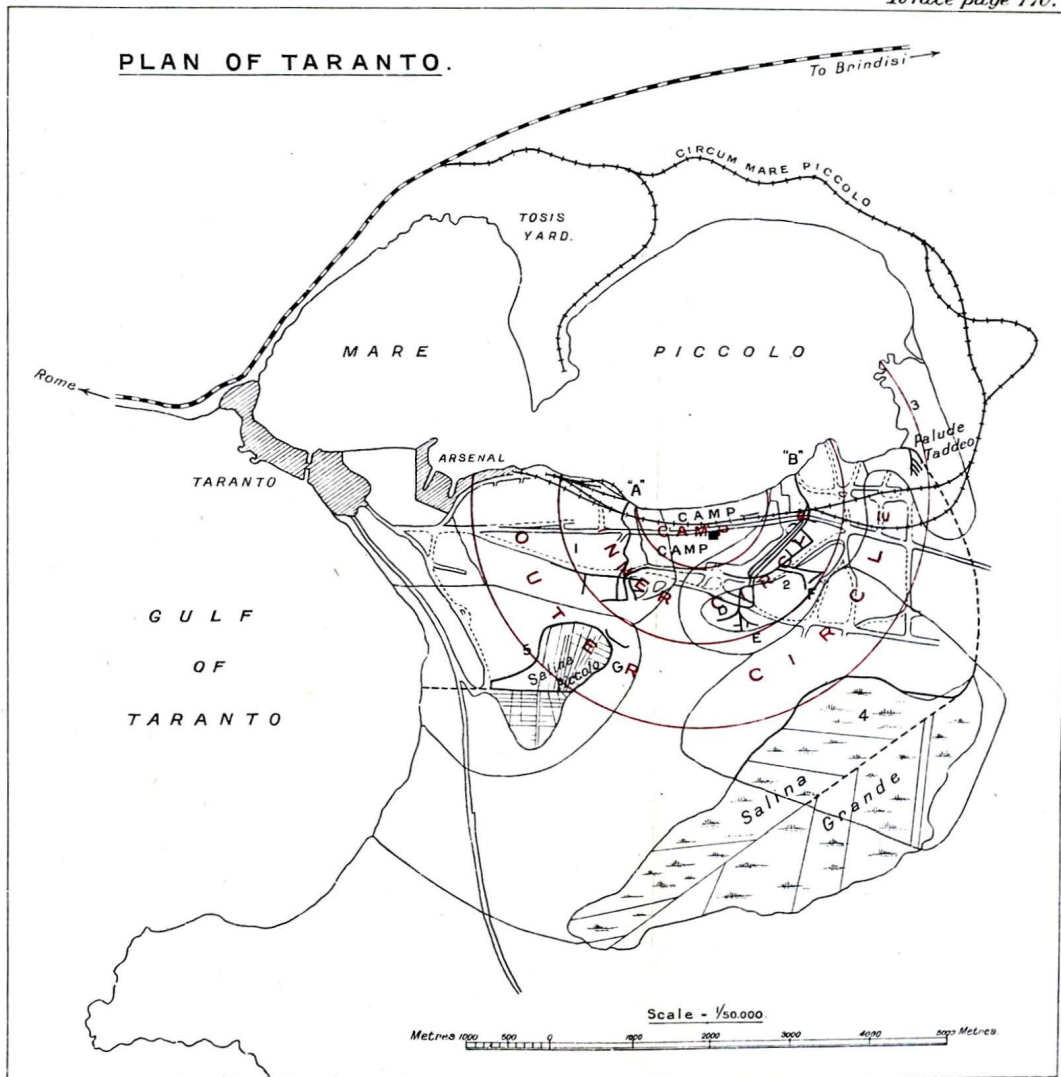
A cement oiling chamber was constructed at the outfall

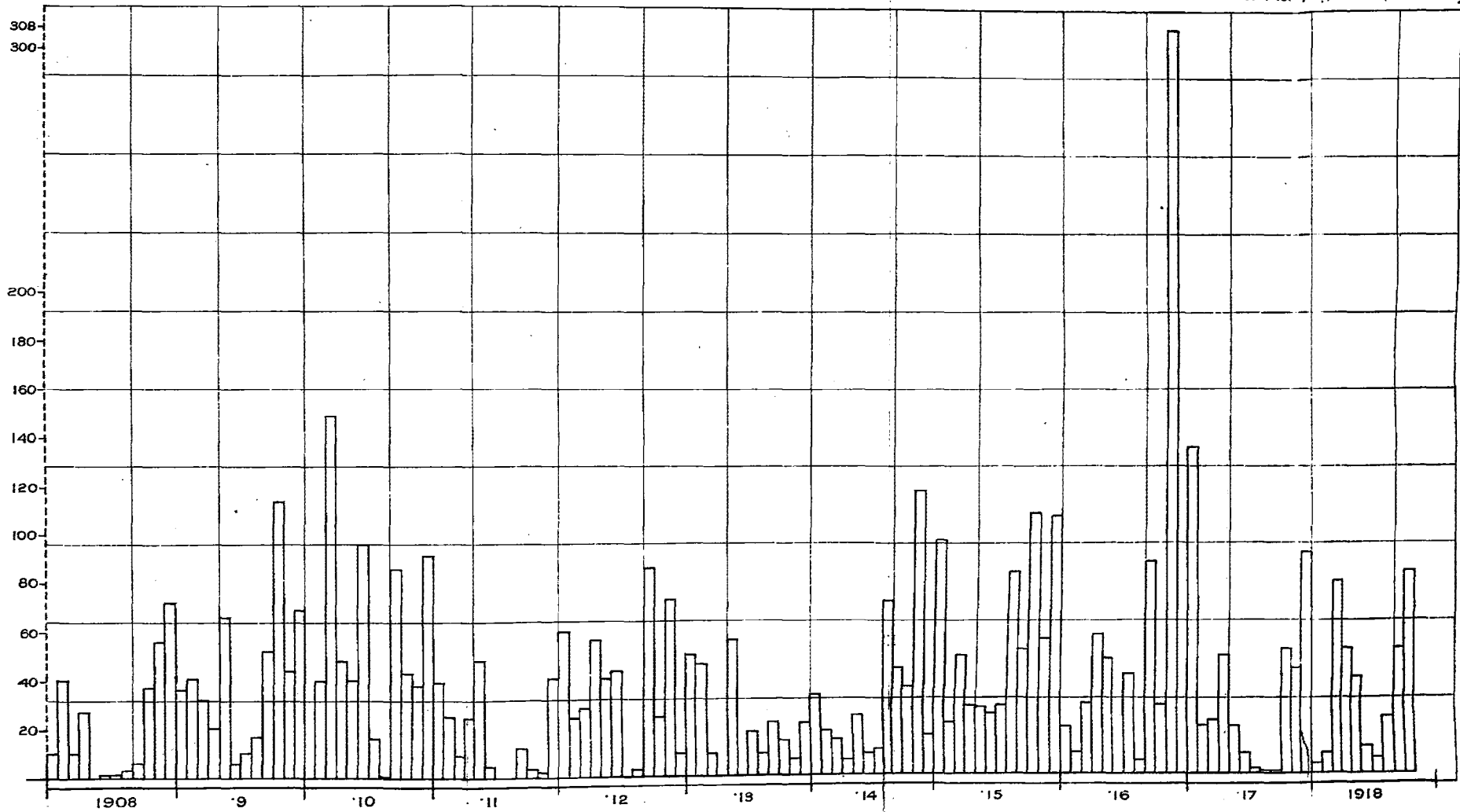
Area No 3—Levels have been taken over this area, but as the Italian authorities have undertaken the construction of a main drainage canal through this area to serve some 200 square miles of country

The drainage of the springs and low area has been delayed as the water would cause flooding in the canal during construction, it being proposed to use said canal as the main outfall.

Area No 4—The catchwater on the north side has been re-graded and terraced for 4,000 metres, in all 11,300 metres of open ditches have been graded and cleaned out

PLAN OF TARANTO.





MONTHLY RAIN RECORD TARANTO. 1908 TO '18. 1. DIVISION = 4 MILLIMETRES.

9181. 27362. 4732/066. 2006.12.19.

Mulby & Sons, Lith.

CHART SHEWING WEEKLY PREVALENCE OF ANOPHELINES IN AND AROUND CAMP DURING 1918.

WEEKLY TOTALS OF ANOPHELINES CAUGHT IN CAMP / Division = 1 Anopheline.
DITTO DO. DO. DO. DO. TREATED AREA AROUND CAMP / Division = 5 Anophelines.

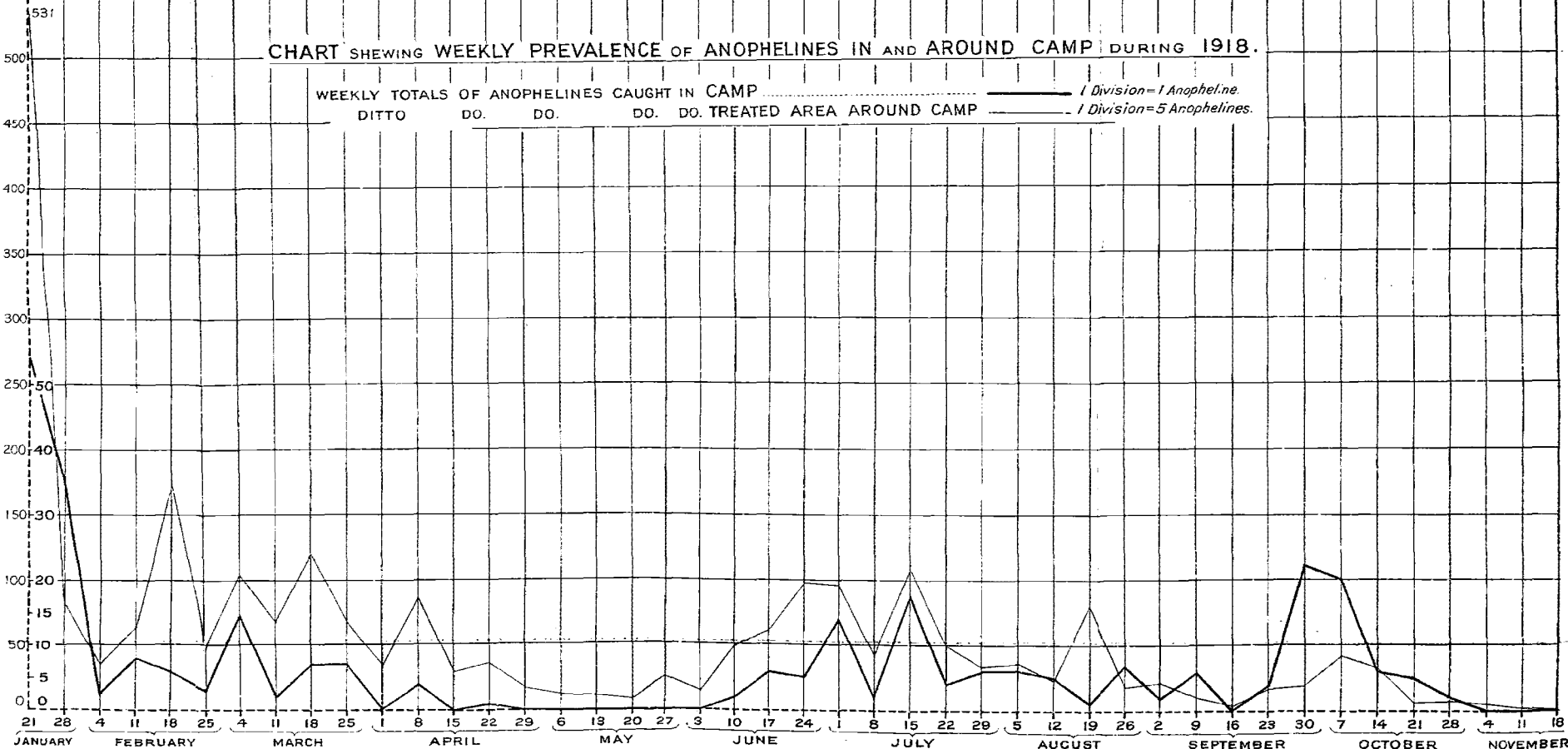
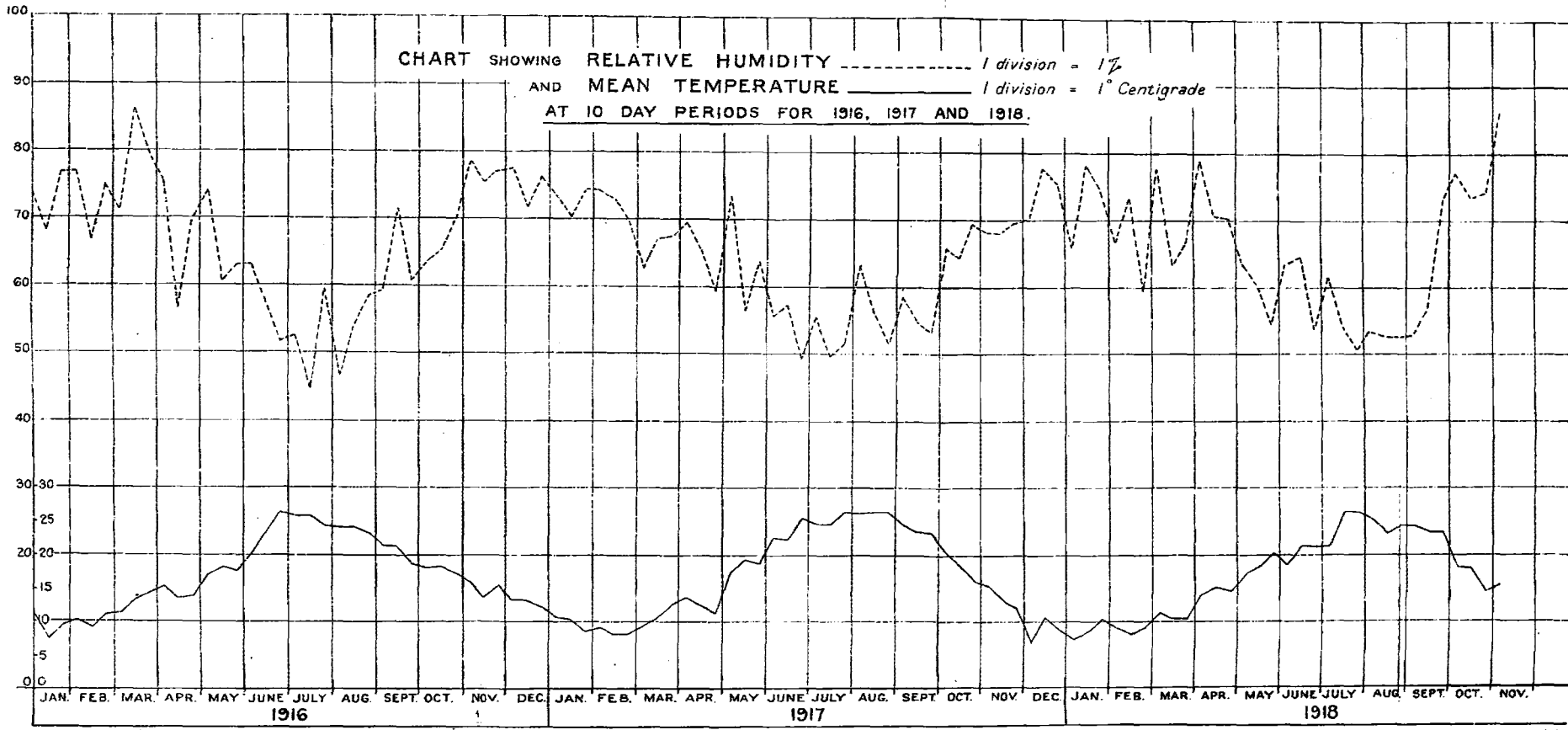


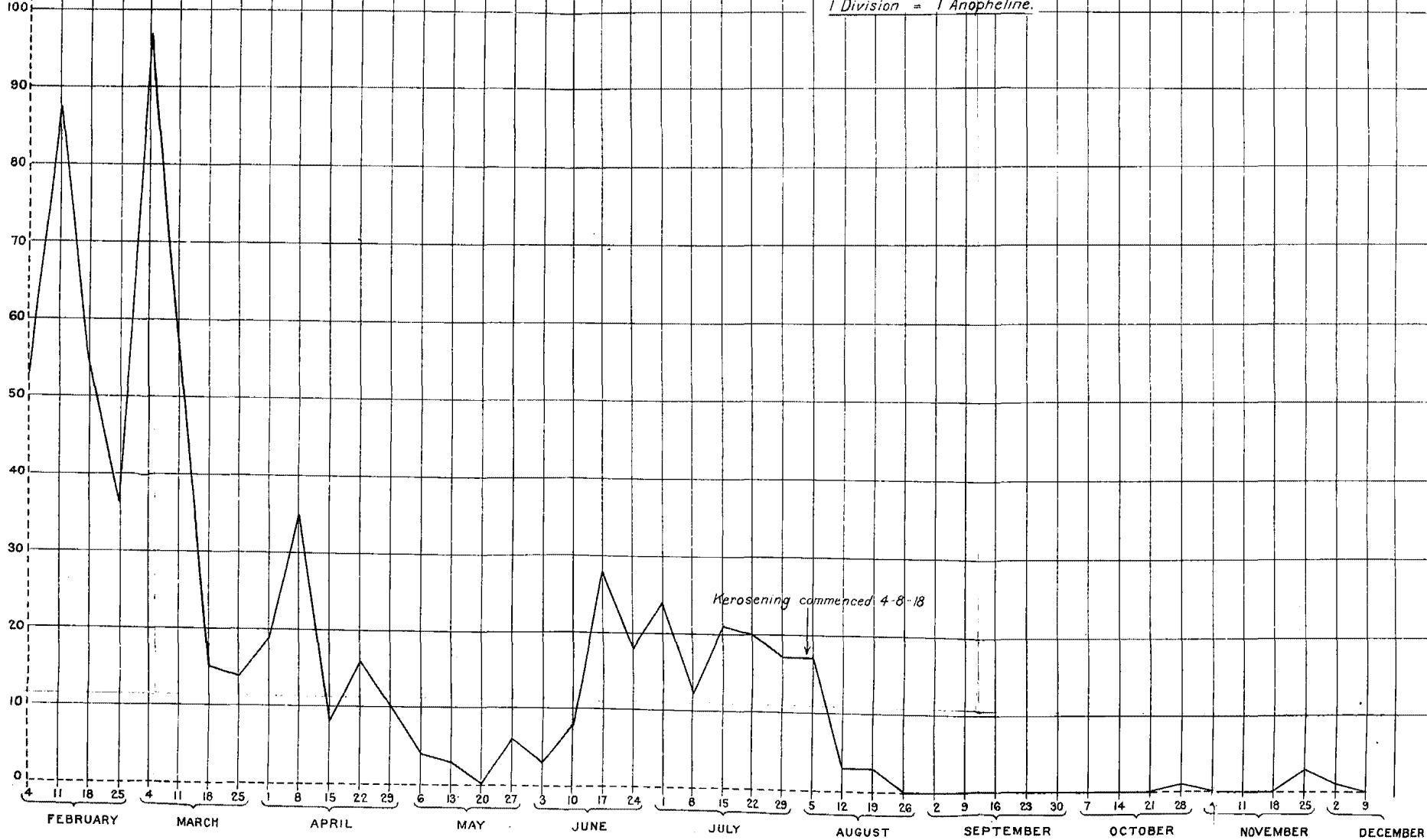
CHART SHOWING RELATIVE HUMIDITY ----- 1 division = 1%
AND MEAN TEMPERATURE _____ 1 division = 1° Centigrade
AT 10 DAY PERIODS FOR 1916, 1917 AND 1918.



(Chart IV)

CHART OF ANOPHELINES TAKEN IN HOUSES 89, 92 AND 94 INCLUSIVE

1 Division = 1 Anopheline.



Area No 5—The catchwater ditch on the north and east side has been regraded and terraced for 2,850 metres, and 3,300 metres of main drains and laterals have been graded

On the east side 3,600 metres of open ditches were cut, of which 1,500 were underdrained with cement outfalls.

The above work is now complete, and it only remains to deal with *Area No 2*, which owing to the slowness of the Italian Authorities, in finishing the first section of their main canal, has prevented this also being proceeded with

The heavy red lines shown on general plan indicate the work undertaken by the Italian authorities after the above work was finished, and is now in course of construction

The following plans, statements and copies of reports will accompany this report —*

General plan	Marked (1)
Rainfall records .. .. .	.. .. . (2)
Large scale plan of Drainage Area, No 2 .. .. .	.. .. . (3)
Large scale plan of drainage Area, No 3 .. .. .	.. .. . (4)
Copy of Report and Plan of Area, No 6 .. .. .	.. .. . (5)

Cimino Camp, Taranto.

August 17th, 1918.

(Signed) H KENWORTHY,
Major, R E.

LABOUR —EMPLOYED ON CLEANING AND REGRADING DITCHES CUTTING AND LAYING DRAINS, SHOWN IN MAN DAYS AT LIRE 7·00 FOR B W I AND LIRE 6 00 FOR ITALIAN

	B W I	Italian	Total
Area 1.—West Side..	250 at 7 lire = 1,750 lire	448 at 6 lire = 2,688 lire	Lire 4,438·00
Area 2 —			
The Marsh .	8,845 at 7 lire = 61,915 lire	—	—
R E Hill .	150 at 7 lire = 1,050 lire	851 at 6 lire = 5,106 lire	—
House 17 .	—	1,020 at 6 lire = 6,120 lire	—
Wet Triangle ..	1 200 at 7 lire = 8,400 lire	318 at 6 lire = 1,908 lire	84,499·00
Area 4 —Salina Grandi	4,963 at 7 lire = 34,741 lire	—	34,741·00
Area 5 —			
Salina Piccolo .	5,669 at 7 lire = 39,683 lire	—	—
East Slope, Under-drainage	445 at 7 lire = 3,115 lire	—	42,798 00
Grand total	.. .. .	.. .. .	166,476·00

* Not reproduced here.

**COST OF PUMPS AND LABOUR REQUIRED TO REPAIR WELLS, AND
INSTAL SAME FOR EACH HOUSE OR FARM SHOWN ON GENERAL
PLAN, BY NUMBER.**

House.	Number of Wells	Closed	Stonework Repaired	Fitted with Lids	Fitted with Pumps	Cost	
						Labour	Pumps and Pipe.
No 3	3	—	3	3	3	Lre 180.00	Lre 340.00
" 4	1	1	—	—	—	8.00	—
" 5	3	—	3	3	3	180.00	382.50
6 6	2	—	2	2	1	60.00	78.50
7 7	3	—	1	—	—	8.00	—
" 9	5	—	3	3	1	92.00	138.50
" 10	3	3	3	3	3	224.00	248.50
" 11	2	2	2	—	—	45.00	—
" 12	3	1	2	2	2	152.00	195.00
" 13	5	2	3	3	3	170.00	552.00
" 14	4	1	3	3	—	64.00	—
" 15	8	—	2	2	1	94.00	180.00
" 16	8	2	3	3	2	216.00	166.50
" 17	3	1	2	2	1	124.00	62.00
" 18	4	—	3	3	2	140.00	115.00
" 19	3	—	1	1	1	33.00	60.50
" 20	4	1	2	2	1	124.00	82.00
" 21	3	—	3	3	2	120.00	157.00
" 22	3	—	3	3	3	138.00	319.00
" 23	3	—	3	3	2	152.00	320.00
" 24	1	—	1	1	1	60.00	—
" 25	4	4	—	—	—	96.00	—
" 26	4	1	3	3	3	138.00	415.00
" 27	2	2	—	—	—	32.00	—
" 28	1	1	—	—	—	32.00	—
" 29	10	6	4	4	4	336.00	168.00
" 30	3	—	3	3	1	60.00	67.00
" 31	1	—	1	1	—	32.00	—
" 2	1	—	1	1	1	60.00	180.00
" 3	1	—	1	1	1	60.00	101.00
" 4	4	—	4	4	1	124.00	185.00
" 5	5	1	4	4	2	206.00	340.00
" 6	6	1	5	5	4	234.00	308.00
" 7	3	—	1	1	1	60.00	170.00
R A F Wharf Area.	2	2	—	—	—	124.00	72.00
No. 41	1	—	1	1	—	32.90	—
	135	32	77	74	51	4,030.00	5,583.00

TOTAL COST.

Material.

	Lire.
3,000 metres of 10 c m land drain pipe with collars at 1.60 lire per metre	4,800.00
4,000 metres of 7.5 c m land drain pipe with collars at 1.30 lire per metre	5,200.00
51 pumps	5,583.00

Labour

B.W 1's working on ditches and drains	150,654.00
Italians working on ditches and drains	15,822.00
Italians working on wells and pumps	4,030.00
Total lire	<u>186,089.00</u>

Cimino Camp, Taranto,

August 17th, 1918

(Signed) H. KENWORTHY,
Major, R.E.

VI, REPORT ON INDIGENOUS MALARIA AND ON MALARIA WORK PER- FORMED IN CONNECTION WITH THE TROOPS IN ENGLAND DURING THE YEAR 1918.

By ANGUS MACDONALD, O B E , M D , D P H , D T M ,
Major, Royal Army Medical Corps (T C)

Dated December, 1918

I. PRESENTATION "

A report on the varied epidemiological investigations, inspections and operations entrusted to me during the year 1918 may most suitably be presented as a record of —

1. General reports (*not included here*) ;
2. Control of malaria carriers ,
3. Indigenous malaria ,
4. Entomological observations , and
5. Sanitary operations

The record dates from February 20th, 1918, and I have to acknowledge having received, during the whole year, courtesy and assistance from officers and men of all services with whom I have come in contact, in my interpretation of varied and often indeterminate duties.

II. CONTROL OF MALARIA CARRIERS.

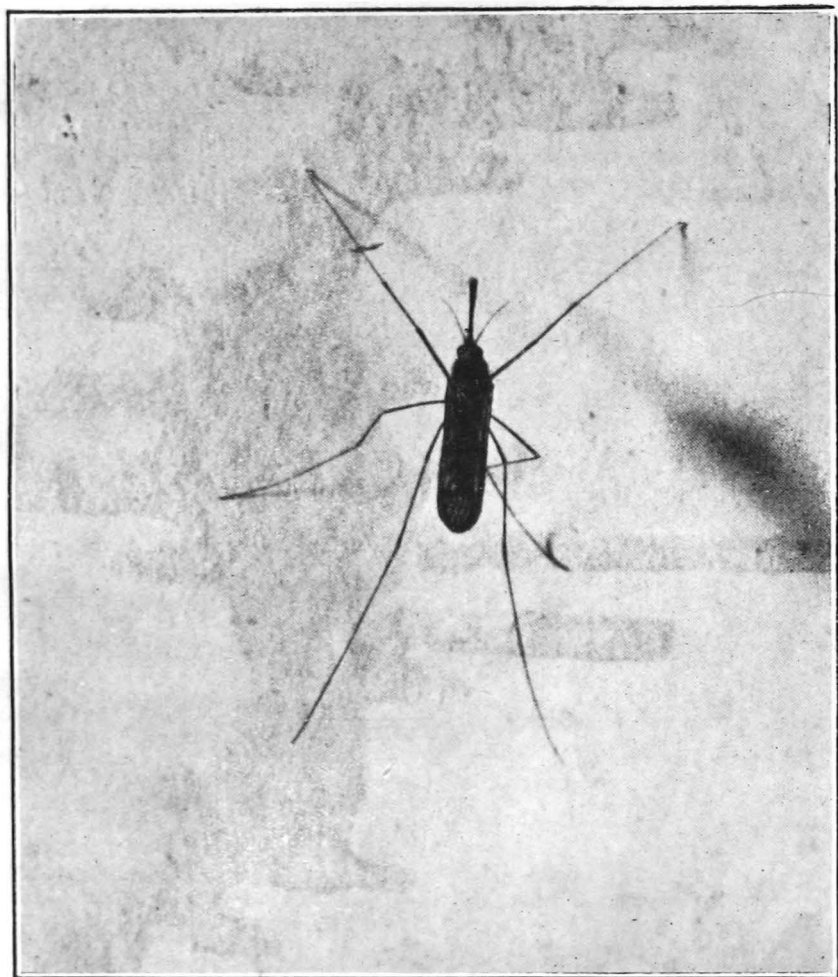
In consideration of the occurrence of malaria indigenous in various parts of England during 1917, it was determined by the War Office to schedule as " dangerous areas " those districts in which cases had arisen, the chief of which were embraced in Romney Marsh, Sandwich, Sheppey, and Isle of Grain

For reasons of prevention, special attention was from the first directed to these " dangerous areas," although the provisional instructions for the treatment of " carriers," and, later, such part as was deemed fit of the provisions specially adopted for control in dangerous areas, were in operation throughout all Commands on all units having malaria " carriers."

The special provisions for control in " dangerous areas " were —

- (a) Supervision by a medical officer with experience of malaria
- (b) Examination of blood films of all cases of doubtful pyrexia

Plate I.



A. maculipennis photographed on a wall in a bedroom in Kent.

To face page 178.

- (c) Keeping of a nominal roll of all men who had been in any war area beyond France, and the weekly medical inspection of these men.
- (d) Screening of huts for accommodation of "carriers."
- (e) Instruction of medical officers, and direction of carrier treatment.
- (f) Treatment of malaria cases and carriers in accordance with provisional instructions.

From these provisions it is evident that concern has been for (1) the wise and efficient treatment of men and their refitting, and (2) the safety of other troops and of the civilian populations.

A list is here given of the main orders and instructions issued during 1917 and 1918, concerned with the control of malaria in England, and brief detail is made of the action taken during inspection and the results attained.

- 24/Gen No /5500/A.M.D. 2 Dealing with malaria centres
31.1.17
- 24/Gen No /5500/A.M.D. 2 Provisional instructions for treatment
April, 1917 of malaria.
- A.C.I. 1322 of 1917 25 8 17. Cancels 1
- 24/Gen. No /5500/A.M.D. 2. Instructions for treatment of malaria
August, 1917 in supersession of 1.
- 24/Gen No /5500/A.M.D. 2. Notification of indigenous malaria
7 11.17
- A.C.I. 293 of 1918 19 3 18. Disposal of malaria cases (Y group men)
returning from Salonika Grants 30
days furlough
- A.C.I. 334 of 1918 29 3 18. Disposal of officers and men sent home
from abroad suffering from malaria.
Documents to be endorsed.—"Malaria
case—not available for theatre
of war where malaria is prevalent."
- 29/Gen No /6307/A.M.D. 2 General direction to all instructions.
5 4 18.
- 24/Eastern/1686/A.G. 1. Removal of carriers from certain areas.
9 7 18.
- A.C.I. 390 of 1918. 13 4 18 Disposal of malaria cases (Y group
officers) returning from Salonika
13 4 18
- 24/Gen No /6198/A.M.D. 2 Concerning treatment in accordance
20 4 18 with Provisional Instructions
- A.C.I. 577 of 1918. 22, 5 18 Provisions of A.C.I. 334 of 1918 not
applicable to officers and men belong-
ing to seven special African regi-
ments.
- 24/Gen No /6198/A.M.D. 2 Calling general attention of Commands
3 6 18 to Provisions for Dangerous Areas
- A.C.I. 844 of 1918 30 7 18 Discharge of soldiers suffering from
malaria
No soldier to be discharged for malaria
except at special malaria centres
- A.C.I. 1125 of 1918. Disposal of malaria cases (Y group
11 10 18. men)
Cancels paras 3 and 5 of 4 (above),
and gives 10 days furlough.

- Urgent Postal Telegram, 4808 A.G. 1 1 8 18. Concentration of personnel affected with malaria, for treatment in France. Men from Salonika, Mesopotamia and Egypt included Draft leave allowing 48 hours at home to be given
- Urgent Postal Telegram. A M D 2 22 8 18 Explains and amplifies 4808
- 24/Gen No /6307/A M D. 2 5 4 18. Regulations for dealing with Y group men posted to units in commands Treatment described in 3 (above) to be carried out Men not to be sent to special malaria hospitals unless definitely ill Old cases of malaria not to be invahded until after treatment in special hospitals Reports called for
- 4876 A G. 1. 14 8 18. 4808 A G 1 does not apply to men of Overseas contingents
- 4890 A G. 1. 16 8 18. Men serving on anti-aircraft guns and searchlights not to be sent to concentration centres till all other personnel sent overseas
- 4917 A G. 1. 22 8 18 Personnel of certain specified infantry regiments to be ready by 19 18 Other infantry by 15 9 18
- 4865 A G. 1 2 9 18. Men employed on agriculture not to be sent to concentration centres at present
- 5007 A G 1 10 9 18. Personnel of A S C (M T) and Supply not to be sent to concentration centres till further notice
- 5028 A G. 1. 12 9 18. Cases of malaria coming from German East Africa to be sent to concentration centres unless belonging to Corps specially excepted in A C I 577 of 1918, as modified by A C I 840 of 1918
- 5060 A G. 1. 20 9 18. Concentration centres to report numbers available for dispatch to "Refilling" in the case of infantry and to Secretary W O incase of other arms
- 5113 A.G. 1. 30 9 18 Cases being drafted to France need not be put through a gas course, but must be equipped with small box respirators
- 5119 A.G 1. 30 9 18 Nominal rolls of drafts of men of other arms than infantry to be marked "Malarial, Y-Scheme."
- 5137 A G. 1. 3 10 18. Concentration orders applicable to malarial personnel sent home from all theatres of war
- 5193 A G. 1. 16 10 18. 4 days' draft leave to be given prior to despatch to concentration centre "Y" group men on completion of 10 days' furlough to be sent to malaria concentration centre of their command No further draft leave to be given Men from hospital, on completion of 10 days' hospital leave, to be posted direct to concentration centre

5194 A G. 1.	16 10 18.	Box respirators not to be issued to men who would not receive them if being sent as an ordinary draft
5236 A G 1.	25 10 18.	Malaria subjects of Irish units to be sent direct from Ireland to concentration centre of the command in which their unit is stationed.
5240 A G 1	28 10 18.	Men of R D C to be re-transferred to their original corps when passed fit for overseas at the malaria centre
5262 A G 1	6 11 18	Infantry need not be shown in two classes in returns called for in (below), but total of infantry only 4,970 required
5265 A G 1	7 11 17	Malaria cases eligible for release for coal mining will not be sent to concentration centres
4970 A G 1.	3 9 18	Forwards form of bi-weekly return to be sent in so as to arrive on Wednesday and Saturday in each week
5041 A G 1	14 9 18	Return ordered in 4970 to be sent in once a week only to A G 1 B
5221 A G 1	23 10 18	Amends the form of return in 4970.
5276 A G 1	13 11 18	Drafting to France to be discontinued Drafts available to be sent to concentration centres up to maximum accommodation

While the conduct of affairs necessitated the pursuit of a variety of courses, no doubt depending on the individual interpretation of the situation, in order to attain the ends aimed at, the record may briefly be limited to a general statement, in harmony with the provisions, dealing with three periods

These periods extend from the inception of the Y-group Scheme, in January, 1918, to the order for the clearance of "dangerous areas" in July, 1918. Thence to the order of August 1st, 1918, for concentration of "carriers" and their removal to France, and finally to the order of November 13th, 1918, discontinuing the drafting to France

All malaria cases, from all seats of war, yielding "carriers" of malaria, have been under control, although the Y-group Scheme aroused special attention, and throughout the year has demanded the greater statistical intromissions. The Y-group Scheme applied to malaria carriers considered in Salonika to be especially debilitated, who were returned to England during 1918, commencing in January

Actually the same operations had to be conducted throughout the year, as, on account of the continued movements, from and to, amongst the expeditionary forces, the order of July, 1918, while securing early transfer of "carriers" on the current roll, did not prevent arrival and re-accumulation of "carriers" on units in "dangerous areas."

(a) SUPERVISION BY A MEDICAL OFFICER WITH EXPERIENCE IN MALARIA.

While every unit in dangerous areas could not be supplied with officers of malaria experience, many units in Sheppey, Isle of Grain, and Sandwich were so supplied. Sandwich, Sheppey, Isle of Grain, and Romney Marsh have been under my supervision from the War Office. Captain O'Connor also represented the War Office in the supervision of the Romney Marsh area up to March, 1918, and after his return from illness in July he has dealt specially in Romney Marsh area for the Eastern Command.

It may be said to the credit of the different Sanitary Officers of Commands and Districts that they have enthusiastically taken the opportunity to make themselves conversant with malaria in its varied aspects, and have greatly facilitated control by personal pursuit of the administrative and executive career of the various Orders and Instructions.

(b) EXAMINATION OF BLOOD FILMS OF ALL CASES OF DOUBTFUL PYREXIA.

That the F.c.c. (*Febris continua communis*) of the Crimea should be reborn as P.U.O. (*Pyrexia* of unknown origin) in another century may not be matter for surprise. But that, with the pathological facilities so generally and generously supplied by the War Office, cases of malaria still may escape detection is regrettable.

Instruction in blood film-making has been given very generally during the year on units, in hospitals, to medical officers, nurses, orderlies, and I have to acknowledge the assistance of all, chiefly of the elderly medical officers, who took up with enthusiasm and success the handling of the microscope and the performance of pathological work, which had ceased to be a practical part of their scheme of life for some twenty or thirty years.

Nevertheless, emphasis should be repeatedly issued on the importance of early and repeated blood examination in all doubtful pyrexias and cachexias.

(c) KEEPING OF A NOMINAL ROLL OF ALL MEN WHO HAD BEEN IN ANY WAR AREA BEYOND FRANCE, AND THE WEEKLY MEDICAL INSPECTION OF THESE MEN.

The value of such a nominal roll lay in that it kept possible malaria "carriers" more definitely under observation, and, in the event of obscure illness in any, the medical officer would recognise the necessity at once of eliminating or establishing malaria. This roll also furnished the source of accurate determination of the cases which should be segregated for treatment and screening.

(d) SCREENING OF HUTS.

In some areas, as at Aldershot and in Sheppey, huts had been screened in 1917. This was done inexpensively with "butter muslin," wrapped round strips of cardboard, which were then tacked down, forming a screened frame around the opening of the window, in position appropriate to the case in hand—for windows of huts, hospitals and barracks are of very varied construction. Correctly affixed these answered well. Wrongly constructed, they are quickly, at the mercy of the elements. Wire netting makes a more satisfactory screen for permanent use.

Considerable time was spent and much interviewing of all sorts and conditions of authorities took place in the course of bringing about the necessary screening on different Camps. Much has been done satisfactorily, but some work as yet insufficient and imperfect. Before another season specific instructions should be issued as to what is to be done, who is to do it, and how, where and when it is to be carried out and completed.

(e) INSTRUCTION OF MEDICAL OFFICERS AND DIRECTION OF CARRIER TREATMENT

This took the form of personal discussion of the whole aspect of malaria with medical officers; special study along with them of the provisional instructions and of the various letters, orders and instructions as issued; and lectures, with practical demonstrations, on malaria in different Commands.

(f) TREATMENT OF MALARIA CASE AND "CARRIER," IN ACCORDANCE WITH PROVISIONAL INSTRUCTIONS.

Treatment has been faithfully carried out in accordance with provisional instructions. Exception to this statement was fairly general in the early part of the year, on account of ignorance of the instructions, owing to (1) frequent changes in the medical personnel on units and in hospitals, (2) misreading or misinterpretation of the instructions; and (3) the natural inclination of officers, general practitioners in civilian life, to treat on the lines of their own experience. These difficulties were quickly got over, with a fuller knowledge of malaria and conditions in general.

From the beginning of the year to the month of June, when 24/Gen No 6198/A.M.D.2 of June 3rd, 1918, called the general attention of Commands to these provisions, the attention of War Office inspectors was confined principally to the "dangerous areas," although visits were paid to different places whence indigenous malaria was reported in 1918 or had occurred in 1917.

After June 3rd the Commands were visited on invitation and similar procedure was carried out on the different units

visited, depending on the estimation of the necessity for the more or less complete adoption of the provisions.

The order 24/Gen. No./1680/A.G.I. of July 9th, 1918, arose out of a visit of Colonel Sir Ronald Ross to the "dangerous areas," at a time when the development and increasing domesticity of the *Anopheles* were in strong evidence, and when segregation and screening of carriers was still not complete.

Before the end of July most known "carriers" were removed from the "dangerous areas." In Sheppey mosquito infection had successfully resulted before this was effected, and 31 indigenous cases are recorded amongst the troops in Sheppey in August and later.

Although "carriers" were removed from Sandwich, the difficulties of administration in the Stonar Camps led to the rapid accumulation of "carriers," and to the maintenance of about the same number of active malaria cases month by month.

At Lydd similar conditions caused similar "carrier" complexity. Yet at Sandwich only six cases and at Lydd only two cases of indigenous malaria occurred throughout the year. The table compares the "carrier" population of these three areas over five probably potentially infective months.

"CARRIERS" OF MALARIA UNDER TREATMENT DURING MAY TO SEPTEMBER, 1918, AT

1918.	Sheppey.		Lydd		Sandwich.	
	In Hospital	Not in Hospital	In Hospital	Not in Hospital	In Hospital	Not in Hospital.
May ..	—	491	12	74	13	7
June ..	—	552	7	84	14	18
July ..	—	550	None	24	10	47
August ..	—	349	1	23	8	17
September	—	46	1	33	6	32

With the Order 4808 A.G.I of August 1st, 1918, came the more radical measure of removal of actual "carriers" to France, as a result of the recommendation of Colonel Sir Ronald Ross, after a visit to certain malaria-infected battalions in France. These battalions had gone direct to France from Salonika, and were so situated that the malaria treatment and their general control were concentrated. The resulting improvement in the men was more evident than the improvement generally throughout the Commands at home. Here concentration had been considered impracticable, and cases of malaria were necessarily scattered on units and

detachments throughout the whole country, so that uniformity and efficacy of treatment was difficult of attainment

Visits have been paid to the Concentration Centres in the various Commands by different officers, to advise in the classification and treatment of the malaria cases brought together for transfer to France

On the conclusion of the armistice on November 11th, 1918, reconsideration of the malaria situation resulted in Order 5276 A.G.I of November 13th, 1918, intimating the discontinuance of drafting malaria personnel to France.

Considering the result of "carrier" control in this country from the points of view of —

- (1) Cure and refitting, and
- (2) Prevention of indigenous malaria,

it may be asserted that, with an increase of the "carrier" population considerably over that of 1917, and with probably equal meteorological and *Anopheline* conditions, the lessened output of indigenous malaria (61 cases against 163) indicates a certain degree of efficacy of preventive measures

In so far as cure depended on the efficiency of the control of the method of treatment ordained, evidence to demonstrate results is not readily presentable. As for refitting, it has certainly been retarded in this country by various influences. Chief among these may be enumerated changes in medical personnel, inexperience in malaria, and institutional delay.

The changes in personnel were to some extent inevitable to the situation, but the differences observed in different Commands indicate other factors.

The malaria inexperience led to a facile acceptance of verbal statements of men, with the consequent crowding of "light duty" ranks on units and the too ready transference of cases to hospital

Institutions have retained cases admitted as malaria while investigation as to authenticity of diagnosis went on, and many cases meanwhile departed on a tour of hospitals. Quinine treatment was thus interrupted, relapse naturally occurred, and the stay in hospital became unduly prolonged.

III. INDIGENOUS MALARIA AMONGST TROOPS IN ENGLAND IN 1918

The record presented of 61 cases of indigenous malaria occurring amongst troops in England in the year 1918 contains brief detail in tabulated form of the points essential to the determination of the infection and of indigenous origin. With the exception of eight, the cases have all been personally investigated by the recorder, the others by the Sanitary Adviser of the Command in which they occurred or by Captain Parsons, R.A.M.C.

Some consideration is offered of these indigenous cases and of the factors of endemicity in England.

INDIGENOUS
CASES REPORTED

(1) No.	(2) Reg. No.	(3) Rank	(4) Name	(5) Unit	(6) Location at Date of Onset of Malaria and Date.	(7) Location of Infection and Date.
1	57623	Rfm	Andrews, S	6 K R R C	Sheppey, 29 Aug, 1918	Lr Camp Halfway Houses, Aug, 1918
2	57583	Rfm	Armstrong	6 K R R C	Sheppey, 8 Sept., 1918	Tile Works, Queen- boro, July, 1918
3		A C. 2.	Booth, R	R. A. F.	Isle of Grain, 1 Sept, 1918	I of G Aerodrome, Aug, 1918
4	32092	Rfm.	Bramson, L.	6 R B.	Sheerness, 2 Sept., 1918	Lr Camp Halfway Houses, Aug, 1918
5		Boy	Buller	R. I. Fus.	Bawdsey, Suffolk, 19 Sept, 1918	Bawdsey, Suffolk, Aug, 1918
6	13125	Cpl.	Bush, H H	No 2 Bell, Sch Lydd	Lydd, 20 May, 1918	Balloon Sch Lydd, May, 1918
7	47264	Rfm.	Chalfield, L. J	6 K R R C	Sheppey, 22 Aug, 1918	Holm Place Lr Camp, Sheppey, Aug, 1918
8	34784	Pte.	Clarke, A G.	68 Co., R.D.C.	I, of Grain, 22 Oct., 1918	Naval Oil Tanks, Port Victoria, Aug to Oct, 1918
9	208068	Spr.	Cottrell, H E	R.C.T.D., R.E.	Longmoor, Hants, 13 Sept, 1918	Apple Camp, Long- moor, Hants, Aug 1918
10	22359	Gnr.	Crooks, J	40 A Coy	Sheppey, 28 Aug, 1918	Neats Court, A Gun Station, Aug, 1918
11	1896	Rfm	Dabben	5 K R R C	Sheppey, 22 Aug, 1918	Halfway Houses, Upper Camp, Aug, 1918
12	3170	L-Cpl.	Dignum,	1st Res. Cav Regt	Curragh, 11 Sept., 1918	Borden, Hants, Aug 1918
13	305469	Spr.	Downing, W	I W & D, R.E	Sandwich, 27 Aug, 1918	Kitchener Camp, Sandwich, Aug, 1918
14	W R. 325159	2/Cpl.	Fendon	I W & D, R.E	Sandwich, 27 Sept, 1918	Halg Camp, Sand- wich, Sept., 1918
15		2/Lt	Hall, F D	13 Fire Cmd R G A	Fort Grain, 30 Sept, 1918	Warden Court, Shep- pey, Aug, 1918
16	12447	Cpl.	Higgs, E	6 K R R C	Sheppey, 3 Sept, 1918	Upper Camp, Holm Place, Aug, 1918
17	27702	Pte	Hill, E H.	3 K O R L R.	Parkeston, Essex, Sept, 1918	Ray Farm, Park- stone, Essex, Aug, 1918
18	204588	Rfm	Howett	5 K R R C	Sheppey, 21 Aug, 1918	Upper Camp, Half- way House, Aug, 1918
19	2930	Spr	Hunder, F. A	A R O D, R E	Longmore, 13 Sept, 1918	Longmore, Aug, 1918
20	157085	Boy, Mech	Jackson, F	R A F	Eastchurch, Shep- pey, 29 Sept, 1918	Eastchurch, Sept, 1918
21	552179	Spr	Jacobs, A	C Dep, 20 Coy, R E	Thetford, May, 1918	Command Depot, Thetford, April, 1918
22	60176	Rfm.	King, C.	4 Coy, 6 K R R C.	Sheppey, 30 Sept., 1918	Lower Camp, Holm Place, Sept, 1918
23	22936	C. 2 MS	McGoldrich	R. I. Fus.	Bawdsey, 19 Sept, 1918	Bawdsey, Aug, 1918
24		2/Lt.	Mallett	R. A. F.	Northley Down, Winchester, 12 Aug, 1918	Soocles, July, 1918, Sheppey
25	314494	Spr.	Menney, E. J.	I W and D R E	Gravesend, 31 Aug, 1918	Kitchener Camp, Sandwich, Aug, 1918
26		Lt.	Miller	Att. R A F	Duxford, 5 Sept, 1918	Thetford, Aug, 1918
27	19560	Pte	Munro	6 Worcs	Dovercourt, 15 Sept, 1918	Crab Knowe Spit, Dovercourt, Aug, 1918
28	323256	Spr	Heale, J W	I. W and D. R E	Sandwich, 22 Aug, 1918	Halg Camp, Sand- wich, Aug, 1918
29	11629	Sgt	Oakley	6 K R R 's	Sheppey, 29 Aug, 1918	Upr Camp, Aug, 1918, Holm Place

MALARIA
INFECTED, 1918

(8) Residential History	(9) Malaria History	(10) Evidence of Infection	(11) Infection Factors		
			(a) "Carriers"	(b) Mosquito	(c) Larvæ and Breeding Places
Never Abroad	Nil	<i>P. vivax</i> found	Present	<i>A. maculipennis</i> Present in huts	<i>Anopheles</i> Larvæ close at hand
Never abroad	"	"	"	"	"
Never abroad	"	"	"	"	"
Africa, 1899 to 1901	"	"	"	"	"
Never abroad	"	"	"	"	"
Never abroad	"	"	"	"	"
France, 1915	"	"	"	"	"
Never abroad	"	"	"	"	"
Never abroad	"	"	"	"	"
Never abroad	"	"	"	"	600 yds. from breed- ing place
Never abroad	"	"	"	"	Larvæ close at hand.
France, 1914 to 1917	"	"	"	"	"
Never abroad	"	"	"	"	"
S Africa, 1901 & 1902, France, 1915 & 1916	"	"	"	"	"
Never abroad	"	"	"	"	"
Never abroad	"	"	"	"	"
Never abroad	"	"	"	"	"
Gallipoli, 1916	"	"	"	"	"
Australia	"	"	"	"	"
Never abroad	"	"	"	"	"
France	"	"	"	"	"
Fiji, 1914 to 1917	"	"	"	"	"
Never abroad	"	"	"	"	"
France, 1917 to 1918	"	"	"	"	"
Dover to Calais Service	"	"	"	"	"
France, 1917	"	"	"	"	"
France, 1915 to 1917	"	"	"	"	"
Never abroad	"	"	"	"	"
France	"	"	"	"	"

CASES REPORTED

(1)	(2)	(3)	(4)	(5)	(6)	(7)
No.	Reg No	Rank.	Name	Unit.	Location at Date of Onset of Malaria and Date	Location of Infection and Date
30		Cdt	Paton	R G A	Maresfield Pk, Uck- field, 20 June, 1918	Maresfield Park, June, 1918
31	81369	Pte.	Percival, J	A S C, M T	Crystal Palace, 29 Aug, 1918	R D Bn Camp, Pur- fleet, Aug, 1918
32	326774	Spr.	Pinkstone, T.	I W and D, R E	Sandwich, 28 Aug, 1918	Kitchener Camp, Sandwich, Aug, 1918
33	82925	Pte	Preuss, L	68 R D C	Port Victoria, 28 Oct, 1918	Old Tanks, Oct, 1918, Port Victoria
34	3849	Cpl	Price	6 K R R 's	Sheppey, 3 Sept, 1918	Holm Pl Lr Camp, Aug, 1918
35	66555	Cpl	Privett	5 K R R 's	Sheppey, 22 Aug, 1918	Upr Camp, Halfway Houses, Aug, 1918
36	57596	Rfm	Rice, G R	6 K R R 's	Sheppey, 2 Sept, 1918	Upr Camp, Holme Pl, Aug, 1918
37	13457	Rfm	Richardson	5 K R R 's	Sheppey, 18 Aug, 1918	Upr Camp, Holm Pl, Aug, 1918
38		Rfm	Rimmel, A	6 K R R C	Sheppey, 22 Aug, 1918	Tile Works, Aug, 1918, Queenboro
39	353149	Gnr	Roberts, A	35 A C, R G A	Dovercourt, 23 Aug, 1918	Gt Oakley, Aug, 1918, Dovercourt
40	50437	Pte	Roberts, H D	Coy, 4 M/er	Tetney Locks, Lincs 1 Sept, 1918	Tetney Locks, Aug, 1918
41	60009	Pte.	Rudge, P	6 K R R C	Sheppey, 31 Aug, 1918	Upr Camp, Aug, 1918, Holm Place
42		Lt	Simpson, J T	204 T D S, R A F	Eastchurch, 10 Sept, 1918	Eastchurch, Aug, 1918
43	185137	Dr.	Smart, H	R F A	Leicester, 17 Julv, 1918	Military Hospital, Leicester, June or July, 1918
44	6095	Pte	Smith, E	Guards, M G Rgt	Purbright, Aug, 1918	Purbright, Aug, 1918
45	47009	Rfm	Smith, G I	6 K R R C	Sheppey, 3 Sept, 1918	Holm Place, Upper Camp, Aug, 1918
46	C/290	A/Sgt.	Smith, W	6 K R R C	Sheppey, 9 Sept, 1918	Lower Camp, Holm Place, Aug, 1918
47	202063	Rfm	Smith, W	6 K R R C	Sheppey 3 Oct, 1918	Lower Camp, Holm Place, Sept, 1918
48	114018	2/A M	Steele	R A F	Liverpool, 18 May, 1918	London Colney, May, 1918
49	60192	Rfm	Terry, A J	6 K R R C	Sheppey, 9 Oct, 1918	Lower Camp, Holm Place, Sept, 1918
50	266355	Sgt	Tinley	1 S R R B, R G A	Shoreham-on-Sea, 13 June, 1918	R G A Camp, Lydd, May, 1918
51	2199	R S M	Twain	6 K R R C	Sheppey, 16 Aug, 1918	Tile Works, Queen- boro, Aug, 1918
52	57590	Rfm	Twiggs	6 K R R C	Sheppey, 31 Aug, 1918	Tile Works, Queen- boro, Aug, 1918
53	60031	Rfm	Walsh	6 K R R C	Sheppey, 23 Sept, 1918	Tile Works, Queen- boro, Aug or Sept, 1918
54	R/18129	L-Cpl	White, R W	6 K R R C	Sheppey, 13 Aug, 1918	Lower Camp, Holm Place, Aug, 1918
55	46025	Rfm	Whiteley, W	6 K R R C	Sheppey, 29 Aug, 1918	Tile Works, Queen- boro, Aug, 1918
56	323576	Spr	Williams	I W and D R E	Sandwich, 13 Aug, 1918	Halg Camp, Sand- wich, Aug, 1918
57	245495	A M 3	Wood, W R	58 Wing, R A F	Eastchurch, 23 Sept, 1918	Eastchurch, Aug or Sept, 1918
58	6662	Rfm	Woodman, T F	5 K R R C	Sheerness	Lower Camp, Half- way House, Aug, 1918
59	M/2 019885	Pte	Wright, H E	700 Coy, A S C, M T	Sheffield, 10 Aug, 1918	Chilwell, Notts, July, 1918
60	46797	Pte	Wright, I	6 Worcs	Dovercourt, 27 Sept, 1918	Crabknowe Spitt, Do- vercourt, Aug or Sept, 1918
61	24190	Pte	Yenn	3 R I Fus,	Bawdsey, Suffolk, 20 Sept, 1918	Bawdsey, Aug. or Sept, 1918

INSPECTED, 1918—continued.

(8) Residential History	(9) Malaria History	(10) Evidence of Infection	(11) Infection Factors		
			(a) "Carriers"	(b) Mosquito.	(c) Larvæ and Breeding Places
France, 1917	Nil	<i>P. vivax</i> found	Present	<i>A. maculipennis</i> Present in huts	<i>Anopheles</i> . Larvæ close at hand
Never abroad	"	"	"	"	"
Never abroad	"	"	"	"	"
France, 3 years	"	"	"	"	"
France	"	"	"	"	"
France	"	"	"	"	"
Never abroad	"	"	"	"	"
France	"	"	"	"	"
Never abroad	"	"	"	"	"
France	"	"	"	"	"
Never abroad	"	"	"	"	"
Never abroad	"	"	"	"	Breeding places near by Larvæ close at hand
France and various	"	"	"	"	Breeding places near by.
France	"	"	"	Within 400 yd	Larvæ within 600 yd.
Never abroad	"	"	"	Present in huts	Breeding places near by.
Never abroad	"	"	"	"	"
France	"	"	"	"	"
France	"	"	"	"	"
Never abroad	"	"	"	"	"
Fiji	"	"	"	"	"
France	"	"	"	"	"
Africa and France	"	"	"	"	"
Never abroad	"	"	"	"	"
Never abroad	"	"	"	"	"
France	"	"	"	"	"
Never abroad	"	"	"	"	"
Never abroad	"	"	"	"	"
Never abroad	"	"	"	Within 400 yd	Larvæ within 600 yds.
—	—	—	—	—	—
In childhood, Egypt and France	"	"	"	"	Breeding place within 20 yds
France	"	"	"	"	Larvæ close at hand.
Never abroad	"	"	"	"	"

EVIDENCE OF MALARIA.

The existence of malaria infection has been established for each case by the recognition and identification by a reliable pathologist of the parasite in the blood of the patient. Most cases also were verified by a specialist officer from the War Office.

EVIDENCE OF INDIGENOUS INFECTION.

(a) Absence of all evidence or history of illness which might be attributed to malaria, whether or not the patient had lived for life in the British Isles or had resided abroad.

(b) The presence of mosquitoes to convey infection. *Anopheles* female imagines have been found in intimate contact with each case; and *Anopheles* larvæ in most situations or always potential breeding-places have been located within valid range.

(c) The presence, at or near the place of infection, of carriers of malaria to infect the mosquitoes.

This was established in all cases, and in most there was a history of a carrier suffering from relapse at the time of mosquito infection.

(d) Season of onset.

The pertinence to the date of infection of the date of onset is indisputable, but the invasion of malaria is so varied in manifestation that there may be wide ranges in time of onset in different individuals infected at the same date.

INFECTIVE FOCI.

While the fact of malaria has been established in each case and the fact that the malaria is of indigenous origin so far as ratiocinative assumption justifies, failing absolute scientific demonstration, the actual situation where infection was received is asserted with less certainty.

Of many cases there is no doubt; but in some there was a plurality of possible infective situations.

NUMBER OF INFECTIVE FOCI 29

This number is a minimum. Where several cases occur in one situation it is not under ordinary conditions evident whether to saddle the onus of infection on one or to extend it to several occasions. The situation alone has for convenience been taken as a single infective focus, in the absence of clearer indication.

DISTRIBUTION OF FOCI

Situation.	Place of Infection	Number of Cases	Situation Number.
Sheppey, 31 cases	Holm Place—		
	Upper Camp	6	1
	Lower Camp	7	2
	Halfway Houses—		
	Upper Camp	3	3
	Lower Camp	3	4
	Queenboro', Tile Works	6	5
	Eastchurch, Aerodrome	3	6
	Scocles Camp	1	7
Neats Court Anti-Aircraft Station	1	8	
Warden Court	1	9	
Isle of Gram, 3 cases	Gram, Aerodrome	1	10
	Port Victoria, Oil Tanks	2	11
Sandwich, 6 cases	Stonar Camps—		
	Haig Camp	3	12
	Kitchener Camp	3	13
Lydd, 2 cases	Artillery Camp	1	14
	Air Balloon School Camp	1	15
Aldershot, 4 cases	Longmoor Camp	2	16
	Borden Camp	1	17
	Pirbright Camp	1	18
Bawdsey, Suffolk	Bawdsey Camp	3	19
Dovercourt, Suffolk	Crabknowe Spit	2	20
	Great Oakley	1	21
Thetford, Norfolk	Command Depot Camp	2	22
Parkeston, Essex	Ray Farm	1	23
Leicester	Military Hospital	1	24
Chilwell, Notts	Tents (A S C), near Grange Farm, Toton	1	25
Tetney Lock, Lincs	R.D.C. Detachment, Tetney Lock.	1	26
London Colney, Herts	London Colney, Aerodrome	1	27
Purfleet, Essex	Camps of R.D. Bn, Purfleet	1	28
	Uckfield, Sussex	Maresfield Park, Uckfield	1	29
	Total	61	—
	Foci of infection	—	29

Distribution has followed on the lines of expectancy—that is, in areas where there is historical record of malaria in time past.

The incidence in these same areas, however, has demonstrated more than that, by clearly pointing out that the chances of infection are localised and intimate. In Sheppey, for instance, *Anophele* conditions are, in general, intimately mixed up with camp conditions. In Lydd, which on the map appears to lie in the midst of excessive *Anophele* conditions, the intimacy of these conditions with camp life (except at the Balloon School to some extent) are minimal as compared with Sheppey.

The distribution and incidence are indications that conditions suitable for the occurrence of indigenous malaria have existed in 1918. The number of infective foci is extended, the number of cases outside definitely controlled areas is about the same as in 1917, and reduction of cases has taken place in specially controlled districts.

COMPARISON OF INCIDENCE AND DISTRIBUTION IN 1917
AND 1918.

Situation.	1917, Number of Cases	1918, Number of Cases.
Sheppey	68	31
Isle of Gram	3	3
Sandwich	69	6
Lydd	1	2
Aldershot	4	4
Elsewhere	18	15
Total	163	61

In 1918 measures of control were in operation, which were not in 1917, and which ensured the recognition of most cases arising, as well as diminished the occurrences.

The outstanding feature in the comparison is the record for Sandwich of six cases in 1918, as compared with 69 in 1917. The factors concerned are elsewhere discussed.

SEASON OF OCCURRENCE.

In the consideration, after investigation, of cases reported as indigenous, many cases were rejected as not being indigenous on account of facts in the personal history pointing to previous malaria abroad; others as not being indigenous in 1918, from indication of previous (usually in 1917) infection in this country.

The season of occurrence naturally influenced one's credence of indigenous origin.

SEASONAL DISTRIBUTION OF MALARIA OCCURRENCE AND INFECTION.

Occurrence.		Infection.	
Date, 1918.	Number of Cases.	(Probable) Date	Number of Cases
May	3	May	4
June	2	June	2
July	1	July	3
August	22	August	47
September	29	September	4
October	4	October	1
Total	61	Total	61

It is here assumed that infection took place in May. There is evidence within my personal observation that *A. bifurcatus* was abroad in March and April; that *A. maculipennis* was taken in a military hut on March 20th; that well-grown larvae of *A. maculipennis* were found on May 26th, so that *A. maculipennis* were abroad laying about the end of April.

Sufficient evidence has not yet been accumulated to determine the temperature at which in this country protozoal development will take place within the mosquito, making infectivity possible; but meteorological records may not necessarily determine the process in a mosquito which may harbour in a heated military hut during the necessary period. This was probable in the four situations assumed to be the seats of infection of the May cases, and *A. maculipennis* is, from its domestic habits, the more likely transmitter amongst the British *Anophelines*.

Extracts from reports on two of these May cases give in more detail the grounds for conclusions:—

Extract from Report on the Investigation of Indigenous Malaria at the Aerodrome, London Colney, St Albans.

MALARIA CONDITIONS.

Human—The documents of 20 E.F. men, all on the camp, were presented, and of these I find one (No. 19330 Airman Humberstone) has been invalided with malaria. From the medical records he is shown to have been treated for malaria since May 16th inst, but had been without treatment since returning to this country from Salonika in January, 1918.

No. 32535 Airman Ravell says he has had malaria, has occasional chills, but has never reported sick with malaria. His documents state he suffered from dysentery in Salonika. Lieut. Arnott states he had malaria in India and in Africa over the past 12 years; had an attack a month ago, and is treating himself with quinine 10 grains daily.

Blood smears were taken, of Lieut. Arnott and Airmen Humberstone and Ravell (at date not examined) (later "no parasites found").

At the War Hospital, Napsbury, I interviewed the medical officers, and was informed that malaria patients are not received there, and that if any had been discovered they would have probably been sent to Epsom. Also the Registrar reports that P.U.O. is a not infrequent diagnosis in the Institution, and though there is a visiting pathologist I cannot ascertain that blood smears have been taken to aid diagnosis.

The Medical Officer of Health of St. Albans and the rural district covering London Colney, whom I met and informed of malaria possibilities and instructed in blood examination, has no knowledge of malaria or the tradition thereof in the district. At All Saints Convent no unknown illness or malaria is recognised, but the Sisters complain of a seasonal plague of mosquitoes.

Anopheles—On the camp there are no *Anopheles* conditions. The sullage effluent in the adjacent cornfield is questionably a potential *maculipennis* breeding-place. No larvæ were found in the effluent.

In the duck pond on Shenleybury Farm numerous pupæ and larvæ of *Chironomidae* were found, but no *Anopheles*.

No adult mosquitoes were taken here.

In the pond of All Saints Convent *practically full-grown larvæ of Anopheles maculipennis were collected. Seven recently fed female Anopheles maculipennis were taken in a cubicle at the end of the cow-house of All Saints Convent, settled on a low ceiling over a parturient cow. This cow-house was remarkably clean, having had a thorough coating of whitewash on walls and ceilings less than three weeks ago—the first week in May.*

Neither larvæ nor adults of *Anopheles* were found at the War Hospital. Larvæ of *Culex pipiens* and of *Ochlerotatus* (?) were found here.

The country around was not explored to great extent. Chance dippings in backwaters of the Colne yielded no *Anopheles* larvæ. The swamps and backwaters recorded are, however, essentially *Anopheles* in character.

CONSIDERATION AND CONCLUSIONS.

The Aerodrome Camp at London Colney is within striking distance of *Anopheles maculipennis*.

With regard to the case in hand, I find that Steele—the infected—works in the fitters' shed. In the technical store, five yards off, Humberstone—the malaria carrier—works. Their sleeping huts are 200 or 300 yards apart. The huts were examined carefully, and no *Anopheles* were found.

The technical store is lofty, with timber rafters and joists, and lined with Uralite, between the different sheets of which are open cob-webbed spaces. It is fitted with tiers of shelves, and has dark corners at shelves and ceiling. It is heated by a stove. There is an inner room in the store, where an orderly sleeps. In this inner room is another stove, and the appearance of the room suggests that company sometimes meets here. No *Anopheles* were found after an exhaustive search.

Anopheles must have been wandering nearly a month ago to account for the maturity of the larvæ found, and the whitewashing of the Convent cow-house must have driven out many *Anopheles* at that time. It is legitimate assumption that a *maculipennis* might find its way into the store, have fed off Humberstone, who worked there in the evenings, rested on some dark corner or ceiling or shelves, and later have infected Steele, who is known to have visited here occasionally.

Infection in the sleeping hut is, owing to their wide separation, less probable, and infection by an over-winter transmitter is not considered. *Steele may have been within range of infection last year, notably, perhaps, in Colchester in August, 1917, but the absence of any history of illness then, or over the succeeding nine months, rules out that possibility, in face of the more probable assumption of the route of infection at London Colney. Steele has not been out of this country, has malaria, and the conditions for infection exist at London Colney.*

He may be assumed to have been infected there early this month.

Extract from Report on the Investigation of Indigenous Malaria at Shoreham-on-Sea.

HISTORY OF CASE.

No. 266355, Sergeant Bertram Tinley, age, 30 years Service, 3½ years.

Served in France from October 15th, 1915, to August 17th, 1917, where he had no illness; has been nowhere else out of the United Kingdom; was at Lydd from April 10th, 1918 to May 6th, 1918, quartered in Bricktown near the Military Hospital; has no knowledge of having been bitten by mosquitoes at Lydd; one Staff-Sergeant Johnson, from

(14557)

East Africa was in the same hut, but was not known to have a malaria record; Tinley arrived at Shoreham from Lydd, on May 6th, 1918; left Shoreham May 9th, 1918, on 48 hours leave, returning to Shoreham May 12th, 1918, his address when on leave being 24, Hartley Road, Nottingham; he has no knowledge of being bitten by mosquitoes at Nottingham or at Shoreham; he says now he had a slight cold while at home, although the Medical Officer, Captain Higg, is of opinion that the original report he gave of the illness at Nottingham was suggestive of a malaria attack. He definitely reported sick on May 21st, 1918, and was the same day removed to 2nd Eastern General Hospital, Stamford Road, Brighton, where the first record of blood examination is on June 16th, 1918, when Captain Dickson reported an infection by *P. falciparum*; blood examinations made on July 20th, 1918, and August 9th, 1918, record "no parasites found": no relative blood count has been made.

Bertram at date seems in fair condition; his sclerotic and skin are ashy in colour and he looks worried. His clinical record, apart from the pathological findings, and his present appearance, are suggestive of a malaria infection

MALARIA CONDITIONS.

LOCATION.

The camps of the I.S.A.R.B., R.G.A.; the London Command Depôt; and the Eastern Command Depôt lie on the seaward slopes of the South Downs above the town and village of Shoreham-on-Sea and Old Shoreham, at an elevation of from 100 to 400 feet. In general the slope of the chalk hills is steep, and storm water is readily carried off without accumulation. The Lower Camp, however, of the I.S.A.R.B., situated to the east in a dip of the hills known as Happy Valley, is, owing to the contour, subject to swampy collection in rainy weather. With a view to lessening nuisance on this account, four pits have been dug, having each on an average some 6 square yards of surface, into which storm water is drained from the valley bottom.

At date August 12th, 1918, two of these were covered with kerosene, one was being emptied into the sullage sewer, and one was dry.

Sullage from different parts of the Camp is carried by pipe and open wooden trough to irrigation ground on the level to the south-east of the Camps.

Between the base of the downs and the sea is a shelf of shingle alluvium, from one-half to three-quarters of a mile in width, extending eastward from Old Shoreham for some miles towards Hove. On this are situated the towns and

villages of Old Shoreham, Shoreham, Southwick and Portslade, as well as farm steadings

The river Adur coming from the north turns abruptly eastward at Old Shoreham, and until entering the sea at Southwick flows parallel to the coast, and with but a bed of shingle intervening

On this alluvial flat conditions are non-malarial in the main, though on the right bank of the Adur, under Lancing and extending westward thereof, there is flat land drained by dykes and sewers, obviously potentially *Anopheline*.

MAN

Enquiry from residents fails to elicit any knowledge of local malaria or ague in recent or bygone time. Mrs. Norman, Old Shoreham, states that her husband came home from abroad eight years ago with malaria, which remained on him about a year. She has heard of no other case in the neighbourhood

Captain Rigg, R A M C, produced the nominal roll of malaria "carriers" who are under treatment according to Provisional Instructions which showed 40 "carriers" on Camp in April and May, 1918 (There would be others on the Command Depôts) These were scattered through all batteries. Two were in No 2 Battery with Tinley—No 99988 Gunner Curtis and Bombardier Harley No. 25531. Neither is known to have had acute malaria in April or May.

Harley for a time in April slept in Hut 15 adjacent to Hut 23 slept in by Tinley Curtis occupied Hut 9 some distance away.

Mosquito

In farm stables, cowsheds and pigstyes examined at Old Shoreham, *Anopheles maculipennis*, male and female, was present in hundreds. In the farm house at Old Shoreham nine male and 2 female *maculipennis* were taken in four bedrooms

In huts and tents inspected on the camps at Shoreham; in tents of the Demolition Camp R M E on the low ground at Shoreham; and in the farm steading near Happy Valley, no *Anophelines* were found

The irrigation ground below Happy Valley is so tended as to prevent stagnant water; the irrigation troughs and channels are devoid of breeding possibilities. In the collecting sumps at Happy Valley culicine larvae have been found by Captain Dickson, R A M C. At date no larvae were found in them. They are unlikely to harbour *Anophelines*.

CONSIDERATION AND CONCLUSIONS.

These camps are well situated, sanitarily well administered, and free from *Anophele* conditions.

Anophele conditions, however, exist within 600 yards of the Main Camp, which are practically negligible owing to the situation and elevation of the Camps

It is not impossible for a wandering mosquito to have transmitted infection from a "carrier" to Tinley in the next hut. Lydd, from the known conditions there, might be more readily suspected. Fifteen days elapsed between leaving Lydd and the definite malaria attack. At the date presumed of infection, *maculipennis* was abroad laying, and though the record of finds in huts was practically nil at Lydd, in April, a stray transmitter is highly probable. At Lydd, however, malaria "carriers" were segregated in screened huts.

The facts ascertained justify the admission of indigenous malaria in this case; but leave it doubtful whether the infection was transmitted at Lydd or at Shoreham-on-Sea. The situation at Lydd is already under control, the limited and remote *Anophele* conditions at Shoreham do not call for urgent administrative interference."

A small number of cases is attributed to infection in June and July, and the month of August gives the most cases. In the month of July *A maculipennis* was increasingly found in military huts and in civilian dwelling houses. It is, therefore, evident that the natural temperature conditions now permitted parasite development within the mosquito.

The mean temperatures for the months of May, June, July and August at Stations A and B, which are representative of East Coast and Midlands, are here given.

1918	Station A, East Coast			Station B, Midlands		
	Max	Min	Mean	Max	Min	Mean
May	60.9	47.2	54.0	63.7	43.9	53.8
June	63.9	48.4	56.0	64.9	44.6	54.7
July	66.8	53.7	60.2	67.7	50.7	59.2
August	68.0	55.1	61.5	69.3	51.9	60.6

The mean maxima and minima and the approximate mean of these are also recorded for 13 periods of 16 days over which the parasite development in the mosquito may have taken place to account for the May infections, without postulating the adventitious incubation in heated barrack room.

MEAN TEMPERATURES OF 13 16-DAY PERIODS.

Station A—East Coast				Station B—Midlands			
Period.	Maximum	Minimum	Approx. mean.	Period	Maximum	Minimum.	Approx. mean
1918 April 19 to May 4 ..	50	41	45	1918 April 19 to May 4 .	52	37	44
.. 20 5 .. .	51	42	46	.. 20 5 ..	53	38	45
.. 21 6 ..	52	42	47	.. 21 6 ..	54	39	46
.. 22 7 . ..	52	43	48	.. 22 7 ..	55	40	47
.. 23 8 .. .	52	43	48	.. 23 8 .	55	40	48
.. 24 9	53	43	48	.. 24 9 ..	56	40	48
.. 25 10	53	43	48	.. 25 10 ..	56	40	48
.. 26 11	53	43	48	.. 26 11 ..	56	40	48
.. 27 12 .. .	53	43	48	.. 27 12 ..	56	40	48
.. 28 13	53	43	48	.. 28 13 ..	56	40	48
.. 29 14 .. .	54	43	49	.. 29 14 ..	57	40	49
.. 30 15	55	44	50	.. 30 15 ..	58	41	50
May 1 16 - ...	56	45	51	May 1 16 -	59	42	51

It is shown by these records that *Anophele* incubation in August at natural temperature is compatible with a mean temperature of about 60° Fahr.; while an assumption of infection has been made to account for cases in the month of May, when the possible mean ranged from 44° Fahr. to 51° Fahr. at natural temperature, but where conditions allowed artificial heating of huts to be an influencing factor.

It is significant that most of the recorded cases amongst the civilian population seem to point to August infection.

The September and October possible infections recorded in the military cases for 1918 may be of earlier date.

It has been assumed that infection from a wintered *Anophele* infected the previous year is not proven.

RESIDENTIAL HISTORY.

Fifty-three per cent. of the recorded cases had not been out of this country; 34 per cent had been in France during the two previous years; 13 per cent had been in other parts of the world on military service or before the present war.

PARASITE.

In all cases the infection recorded was with *Plasmodium vivax*. Three cases were recorded with *Plasmodium falciparum*. Of these one was due to clerical error, one was corrected by the pathologist, and the third was of a case not indigenous.

THE VEHICLE OF TRANSMISSION.

In the absence, at date, of evidence of any other vehicle of transmission, the presence, in biting proximity to the case, of *Anophele* mosquitoes has been accepted as proof of the means of infection. And while infection by *A. bifurcatus* and by *A. plumbeus* may be possible, the ready demonstration of the known malaria carrier of domestic habits, *A. maculipennis*, has obviated further search for *bifurcatus* and *plumbeus* as actual transmitters in any case investigated.

ACCIDENTAL INFECTION.

The possibility of accidental infection by transfusion of blood of a malaria carrier has in all cases been eliminated.

ENDEMICITY OF MALARIA IN ENGLAND

In discussing briefly, as appears incumbent, the probabilities of endemic malaria in England, in time past or to come, I have made free use of the classical work of Nuttall, assisted by Shipley, Cobbett and Strangeways-Pigg, in the

"Journal of Hygiene," work of which this country may feel justly proud. The wonderful perspicacity, the suggestion of almost uncanny prescience, and the careful collection of records under difficulties and with limited means, leave nothing vital to be added by others.

From an inside experience of the occurrence of indigenous malaria amongst troops in England in 1917 and 1918, and from the study of other records and traditions or personal narration, the inferential emphasis here laid on certain of the factors considered already by Nuttall is offered as a respectful tribute to his work.

The demonstration of malaria indigenous in England is a simple matter of recording ascertained facts in the light of present day knowledge.

To assert endemicity, in England, of malaria to-day or in past time, is unwarranted of the present and may be a misinterpretation of the facts of the past.

Consideration of these aspects of malaria, however, requires first a clearing of the course by exact definition of terms used. *Indigenous* simply implies origin in the country. *Endemic* means belonging to the country; and as regards disease the term, precisely used, postulates that all factors causative are always and can be naturally present.

Plague and malaria may occur indigenous in England, as the result of the importation of rodent and human carriers of infection. Neither may be endemic, owing to natural conditions in the country making it impossible for the carrier infective factor to be continuously present.

Further, either may become *epidemic*, given a sufficiently intense and wide distribution of all necessary factors of infectivity—for the epidemic is merely a wide incidence, in a point of time, of (infectious) disease.

Another term, sometimes hazarded to describe malaria in England, is *autochthonous*. This is distinctly out of place in reference to the disease, though, for all we know, it may legitimately be applied to *Anopheles maculipennis* as being, from the first of insect time, a native of the soil.

The main factors which in combination determine the indigenous origin and, in their continuous presence, the endemic persistence of malaria, are.—

- (1) The necessary vehicle of transmission, the *Anopheline* mosquito;
- (2) The carrier of the *Plasmodium*—the infected human;
- (3) The temperature suitable for the sexual development of the *Plasmodium* within the mosquito; and
- (4) The victim for infection, man.

Of these factors the first and fourth are in varying intensity distributed, if disproportionately, over the British Isles

Of the third, it is impossible to say, without much more observation and experimentation in this country, whether it is continuously operative. Judged from the indigenous occurrences in the years 1917 and 1918, it is probably annually operative under natural conditions, over a seasonal period, within certain latitudes if not throughout the whole of the British Isles. The observed habits of *A maculipennis*, moreover, make it remotely possible that the factor might be occasionally active under domestic conditions, natural in civilisation, over the whole year—*vide* possible explanation of a case of indigenous malaria at London Colney in May.

The second factor, it may be admitted, is notably affected in this country by importation. Facts are adduced to support the statement that previous to 1917 and 1918 the last real epidemic, or extension if you will, of ague in England occurred in 1858 to 1860, especially in 1859, and that in those years importation took place of ague amongst troops from Eastern Europe after the Crimean War. That there is no obvious record of the observation of the significance of this event in those years is not to be wondered at, but we owe it to the discoveries of Ross that the possibility was foreseen of epidemic in England resulting from the return of ague-drenched troops from almost the same seat of war in 1917 and 1918.

There is no doubt that ague was greatly in excess in 1859, and there is evidence that ague in time beyond that was clearly recognised in England.

The mortality records of ague, however, are probably almost valueless, because though a baneful debilitating disease, malaria is not accompanied by a mortality that will strikingly affect the figures; and because before 1860, about which time Murchison's Commission paved the way to a purifying of statistics, ague, typhus, typhoid, remittent and intermittent fevers, and possibly influenza, were vaguely homologated.

The assistance that may be legitimately extracted from the mortality record of ague, lies in the assumption that an increase of the returns of deaths from ague implies a definite recognition of increased occurrence of ague, to which naturally deaths from undetermined fevers would concurrently be attributed.

It is suggested here that the factor definitely determining the occurrence of malaria in England is the *importation of carriers*; that at the present day there is no evidence to support the belief that malaria is endemic (as defined) in England; that the evidence accepted to demonstrate that malaria at one time was endemic in England, may equally be taken to prove that it depended for its reappearance on

the importation of carriers; and that while excessive importation of carriers may from time to time give rise to an outbreak of indigenous malaria, the absence from continuous operation of one of the infective factors will prevent the establishment of malaria endemic in England. To say this, however, is not to deny that indigenous cases may not in their turn be actual infective agents. Records of indigenous malaria amongst troops in England, and records obtained by the Local Government Board of malaria amongst civilians, indicate that cases infected in 1917 had relapse of malaria in 1918 during the infective season. But what proportion of cases infected in one year will, treated or untreated, be infective in the following year there is no sufficient evidence to say. At present, for any practical assumption, reliance has to be placed on clinical observation.

For the English indigenous cases of the civil population the Local Government Board record two cases in whose blood parasites were found in 1918 who were presumed to have been infected in 1917, and nine cases known to have been infected in 1917 who still carried parasites in 1918, being 11 out of 35 recorded or 31 per cent.—the others being noted as having no parasites, left the district, &c. At date figures have not been obtained of recurrence of malaria in 1918, in respect of the indigenous cases amongst troops in 1917. In the case of malaria in truly endemic country, clinical evidence points to a recovery from infection and an acquisition of a certain immunity, which may be measured in months or in years; and of the malaria-infected troops returned to England it is interesting to find that of those now under treatment the record shows that most of them belong to the Y group of cases, who have returned since January, 1918. The many of previous date have mostly disappeared, recovered.

In England, again, and in other temperate countries where malaria occurs or has occurred the month of August is definitely recorded as the month of greatest infection. The suggestion earlier made that spring (or May) cases may require the adventitious heat of indoor incubation, while autumn (August) cases are the result of incubation at natural temperature would account for this recognised occurrence in temperate countries and elsewhere, where extremes of temperature or of seasonal humidity produce similar seasonal outbreaks. It would naturally follow, on the numerical standard alone, that the May cases would be fewer than the August cases. As to the intervening months of June and July, in which few cases are recorded or are supposed to occur, it may be pointed out, in regard to this country, that these months lie between the adventitious period of heated

rooms in April and early May and the natural temperature of the July-August period. Artificial heat would be gone from living rooms in dwelling houses and in military huts, while yet the temperature may not have risen in nature to the necessary incubation range. While infection in April to cause May attacks is probably to be admitted, observation shows that *Anopheles maculipennis* wanders but in small number to dwelling houses at this season, and is found with frequency there in July. The infectivity necessary, therefore, to maintain a perennial supply of *plasmodia* for the mosquito must mainly be that which persists from August-September to July-August of the following year. That a large proportion of those infected in one year will have become infectively inert, treated or untreated, by recovery, emigration, or incidental local protection, before 11 or 12 months have passed, may be granted.

On the assumption, then, that the carrier volume brought forward from year to year is insufficient in this country to maintain endemicity, may be explained the immunity enjoyed by this country from malaria during the past 60 years. It may also justify the further assumption that the traditional and recorded history of malaria in England may be a history, not of endemicity, but of outbreaks, from the earliest times, of malaria of indigenous origin occurring as the result of repeated importations of carriers.

To credit the advent of quinine in its notoriously casual method of administration in the hands of the people as well as of the medical practitioner, with the disappearance of malaria, assumptively once endemic, from England, requires critical fortitude.

Nor, from the evidence obtained, can climatic change or agricultural reorganisation, be credited with the achievement.

Evidence, however, indicates that abnormal elevation of temperature, extended over the summer, may be coincident with carrier importation in years of wide malaria incidence.

The importation of carriers determines the *fact* of indigenous occurrence in the presence of anopheles, and the seasonal temperature elevation of abnormal range and extent in time, determines the rate of *incidence*. It is obvious, also, that there will be an optimum of coincidence, where amount and continuity of heat, amount and continuity of rainfall, consequent superabundance of anophelines with extended period for plasmodium incubation, importation and appropriate distribution in space and time of carriers, all combine to cause the occurrence of a sufficiency of indigenous cases to justify the recognition of an epidemic.

In the years 1857 to 1859 the records indicate an approximation to such a coincident optimum amongst the vital factors of endemicity.

In the years 1917 and 1918, while there have been slight differences in temperature and rainfall, the mean has varied little from normal in both years. The carrier importation, however, has probably far exceeded any previous historical occurrence. That 163 known indigenous cases are recorded of 1917, and 61 under more effective control in 1918, establishes the reality of the danger of a malaria outbreak and as well, at the same time, the powers of prevention.

There is no evidence to show that, in the areas dealt with, 1918 was favoured meteorologically over 1917; the importation of carriers and their aggregation in this country caused excess in 1918 over 1917; the measures for control were further perfected, and the indigenous occurrences, now more certainly recorded, are less in 1918.

The control of the War Office is the obvious *ab extra* factor determining this freedom from epidemic occurrence of malaria in England; and for some years the continuance of similar measures of control are demanded, if the population from the Humber to the Solent is to be saved from much misery and distress.

The establishment of malaria endemic is, from the evidence, an impossibility of latitude; but that a few years of acute disaster might result, in the absence of wisely directed control, is likewise historically indicated.

REFERENCES.

1. *Studies in relation to Malaria* By Nuttall, Cobbett, Strangeways-Pigg and Shipley—in extenso.
2. *History of the Crimean War.* Kinglake.

(Extracts)

Note —“ Writing from his Headquarters at Varna on 14th August, 1855, Lord Raglan says ‘ It is curious that where no great fatigues have been endured, the effects of the climate, independent of the cholera, should have proved so serious; and from the officers having suffered so much, it is clear that illness has not been induced by privation. One month ago every Commanding Officer would have volunteered to say that he had fewer sick than he would have had in the United Kingdom. Now they would one and all state that *no man in the ranks*, though not on the sick list, feels well or is capable of the exertion he would display at home.’ ”

Hospital Returns —From hospitals receiving invalided troops of the Crimean Army—from 1st October, 1854, to 31st March, 1855:—

	Admissions	Deaths
Wounded	3,806	373
Sick	48,742	4,986
Total ..	52,548	5,359
Cause of illness—		
Scurvy	1,678	92
Cholera	2,167	297
Diarrhoea	13,708	1,303
Dysentery	4,441	696
Fevers	9,185	1,137

3. *Notes on Matters affecting the Health, Efficiency, and Hospital Administration of the British Army—Florence Nightingale.*

(a) *Appendix, p. xxx, Table 1.*—Number of invalids from Home and Foreign stations discharged the Service at Chatham in each year (from 1st April, 1835, to 1st April, 1857), excerpt :

Cause.	Year							
	1850	1851	1852	1853	1854	1855	1856	1857.
Cachexy	91	133	77	88	108	71	73	342
Weakly constitution, and upon reduction ..	—	—	—	—	—	—	—	289
Total ..	—	—	—	—	—	—	—	631
Total from all causes ..	1,746	2,037	1,500	2,066	1,862	1,198	3,670	5,907

(b) Quotation from Clarke's "History of the War," Vol. II, pp. 168-74, in relation to the Walcheren Expedition of 1809.

"About the middle of August the effects of the baneful atmosphere began to appear, and 3,000 men were already on the sick list; 8,000 men were on the sick list when Lord Chatham embarked for England." (September 14th)

Sir John Pringle had already, in 1747, told of the Walcheren epidemics and says "The epidemics of the country generally appear at the end of July or the beginning of August, under the canicular heats, and end when the frost begins." The whole island is intersected with ditches, &c." "The effects

of such a country are visible in the natives, though counteracted by the Dutch habit of high feeding, by the use of ardent spirits, and by the practice of smoking. It is computed that nearly a third of the inhabitants are attacked with fever every sickly season "

"The water which our men drank was said to contain numerous insects "

"So local were the causes of disease that vessels stationed only a few yards from the land continued perfectly healthy."

"The total of the sick and wounded sent from Walcheren to England in 97 days amounted to 12,863 men." October-December, 1809 "Between 1st January, 1810, and 1st June, 1810, 36,500 patients from the corps at Walcheren were admitted into the hospitals (at-home). This statement includes relapses "

4 *List of Indigenous Cases of Malaria amongst the civil population in Kent and Essex, received from Local Government Board, October, 1918.*

5. *Records of the Registrar-General from 1837 to 1860, and to date.*

(a) The Royal College of Surgeons circulated in 1837 a memorandum relating to a uniform Statistical Nomenclature, with a view to increase the probability of correctness of Death Certification.

In regard to *ague—febris intermittens*—it must be stated whether the *ague* is quotidian, tertian or quartan; and the complications, *without which it would be rarely fatal*, should be added

Remittent fever—febris remittens—is not to be applied to cases sometimes called infantile remittent fever nor to any but the genuine remittent fever so prevalent in the tropics and rare in England.

(b) In 1841 the deaths from cholera, diarrhoea, influenza and *ague* increased to a considerable extent.

(c) 1855—Scarlatina and "fever" prevailed in Cambridge.

(d) 1857—Many districts still suffer from marsh malaria, Maldon.

Ague very prevalent in Tollesbury, Goldenhanger, Tolleshunt D'Arcy and neighbourhood. The lower levels of the basin of the Thames as high up the stream as Oxford and as low as Hoo and Sheppey suffer from malarious diseases in spring and autumn

Sheppey may be taken as a type of these (malarious) districts. The inhabitants have that pallid blue aspect which characterises *agueish* districts. They frequently suffer from *ague*, and sometimes from typhoid fever.

"It is evident that a large portion of our naval reserve may be paralysed by *ague* and fever at the very time when

called on to fight"—(Lord Harris, statistical document of Rayham Farm)

Registrar of Strood, Kent—"This district being marshy in a great part, the poor have suffered during the last winter from agues in a greater degree than has been experienced during a great number of years. . . . An unusually hot summer has operated still more to make the marshes and adjacent districts intensely unhealthy. Many deaths have been registered from intermittent fever, directly or indirectly. The disease is rarely fatal (under favourable circumstances). The chief mortality is amongst indigent and debilitated persons and their families, who have fallen an easy prey to diseases of a general character in consequence of their reduced condition.

"Other districts of Kent on the marshy banks of the Thames and Medway have also experienced a mortality above their average"

Registrar of King's Lynn is quoted—Diarrhoea may be almost said to be universal. The high temperature has continued longer than usual. The illness is now accompanied by the usual remittent fever, which is the prevailing disease here. He speaks also of typhoid or some of the other forms of continued fever.

(e) 1858: Winter cold—June very hot—July cold—September warm

(f) 1859: High death-rate of Cambridge is a matter for comment.

Registrar of Great Wakering—"In the island of Foulness many ditches are in a very filthy state, and the effluvia from some is intolerably offensive. Ague also has been more prevalent, more severe and obstinate during the last two years than I have ever known it in a period of 35 years"

King's Lynn.—"Ague prevalent." Excessive heat in July—during 10 successive days the mean temperature of day and night exceeded 70°.

In New Romney, remittent fever was prevalent and fatal (g) 1860: Mortality low Cold weather from January till end of June. July, August and September also cold—frequent rain—very severe cold in December.

In Cambridge Fens ague and typhoid fever prevailed "Ague was very prevalent at Sutton, in Cambridgeshire."

It is stated that ague has probably never been so prevalent at Wenhaston (Blything) as in 1860. Able-bodied men were the class most subject to it

At Gedney Hill there was ague

In the Northern Counties at Little Chilton (Stockton) marshy ground bred much ague of a virulent character.

"The deaths in Wells, Walsingham, were raised by diphtheria, ague and remittent fever, assuming occasionally

the typhoid form Ague and rheumatism are not now frequently fatal in this country, but they occasion an incalculable amount of suffering, disability and secondary diseases, which will disappear when the soil of England is effectively drained."

(h) *Soldiers Serving Abroad* :—

Year	All Ranks.
1855 .. .	115,256.
1856	101,164
1857 . . .	77,676
1858 .. .	111,730.
1859	123,709
1860	128,391

(i) DEATHS FROM CERTAIN DISEASES IN SELECTED YEARS FROM 1847 TO 1900.

ENGLAND AND WALES.

(*Extracted from the Annual Reports of the Registrar-General.*)

Years.	Popula- tion	Causes of Death			
		In- fluenza	Ague	Remit- tent Fever	Typhus Fever
1847	17,150,018	4,881	228	683	30,320
1848	17,356,882	7,963	228	614	21,406
1849	17,564,656	1,618	171	603	17,896
1850	17,773,324	1,380	154	549	14,296
1851	17,982,849	2,152	167	607	17,122
1852	18,193,206	1,359	152	666	17,845
1853	18,404,368	1,789	183	709	18,015
1854	18,616,310	1,061	192	646	18,332
1855	18,829,000	3,568	149	575	16,032
1856	19,042,412	1,034	124	163	15,428
1857	19,256,516	1,393	195	270	18,249
1858	19,471,291	1,794	207	569	17,883
1859	19,686,701	1,112	233	400	15,877
1860	19,902,713	1,130	203	314	13,012
1861	20,119,314	746	149	208	15,440
1862	20,371,013	915	150	233	18,721
1863	20,625,855	919	141	186	18,017
1864	20,883,889	804	112	183	20,106
1865	21,145,151	596	117	113	23,034
1866	21,409,684	651	135	131	21,104
1867	21,577,535	607	121	107	168,624
1868	21,948,713	306	94	80	19,701
1869	22,228,293	704	118	119	—
1870	22,501,316	615	120	156	—
1871	22,788,594	348	131	142	—
1881	26,046,142	99	113	249	—
1891	29,085,819	16,866	93	40	—
1900	32,249,187	16,245	105	4	—

From 1869.

Year.	Fever				Total
	Simple Continued and Ill-Defined	Enteric	Relapsing Fever and Other Miasmatic Diseases, &c	Typhus	
1869 ..	5,310	8,660	139	4,281	18,390
1870 ..	5,254	8,731	628	3,297	17,910
1871 ..	4,238	8,461	327	2,754	15,790
1881 ..	1,159	5,529	15	552	7,255
1890 ..	325	4,875	30	137	5,367
1900 ..	113	5,591	27	29	5,760

(14557)

6(a) Extracts from Records Supplied by the Courtesy of the Director, Meteorological Office, South Kensington.
(Mean Temperatures at Greenwich, 1853-1862)

Years	April		May		June		July		August		September		October	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1853..	54 0	39 8	63 1	41 9	68 9	50 2	70 5	53 4	70 9	51 8	65 2	47 2	59 1	43 9
1854 .	61 9	38 2	63 7	42 4	67 5	48 3	73 1	51 5	73 1	52 4	72 2	46 5	59 6	42 1
1855..	57 6	36 7	59 9	40 5	68 5	45 7	73 3	54 1	72 9	53 7	68 5	47 7	58 7	45 2
1856..	57 4	38 3	59 1	42 6	70 8	50 0	73 3	52 4	75 9	54 7	65 5	47 6	59 8	46 1
1857 .	55 8	38 8	67 1	44 0	75 9	50 5	77 8	54 3	78 1	56 4	70 2	52 1	61 6	47 1
1858 .	57 6	38 0	63 7	42 7	79 5	53 9	73 8	51 8	75 6	52 1	70 9	52 6	59 9	43 9
1859..	56 9	39 1	64 9	43 9	73 9	53 0	81 8	57 2	76 1	54 3	67 1	49 0	59 0	45 0
1860..	53 7	35 6	65 5	44 6	65 0	48 5	69 2	50 1	67 2	51 8	63 4	45 8	58 6	44 5
1861..	55 0	36 0	63 5	43 0	70 8	51 3	72 3	53 4	75 6	53 8	68 3	48 2	64 1	47 7
1862..	57 5	41 7	66 4	47 9	67 1	49 3	70 8	50 8	71 0	51 4	67 6	50 8	60 5	45 6

211

02

(b) RAINFALL AT GREENWICH (IN INCHES) FOR YEARS 1857, 1858, 1859

(By the Courtesy of the Director of the Meteorological Office.)

Month	1857	1858	1859
January .. .	2 6	0 8	0 8
February .. .	0 2	1 7	0 9
March	1 0	0 8	1 4
April	1 4	2 3	2 2
May	0 6	2 0	2 3
June	2 1	1 2	1 4
July	1 3	3 0	3 3
August	2 7	1 5	1 1
September .. .	3 9	0 9	3 8
October	3 9	1 4	3 6
November .. .	1 3	0 5	2 9
December .. .	0 4	1 7	2 2

(c) RAINFALL FOR 1917 AND 1918 ON EAST COAST AND AT INLAND STATION—RAMSGATE AND HEMEL HEMPSTEAD

Month	Ramsgate		Hemel Hempstead	
	1917	1918	1917	1918
January	2 67	2 68	1 93	2 95
February	0 46	0 61	0 97	1 18
March	1 49	0 95	1 80	0 95
April	1 50	1 32	2 09	4 70
May	0 57	1 73	1 93	2 37
June	1 78	0 87	2 39	0 96
July	3 70	3 59	4 37	2 91
August	6 48	0 78	6 15	1 24
September .. .	0 67	—	1 87	—
October	2 78	—	4 89	—
November	1 37	—	1 21	—
December	2 09	—	0 16	—

7 *Medical and Surgical History of the British Army which Served in Turkey and the Crimea during the War against Russia in the Years 1854, 1855, 1856.**(Compiled and Presented by ANDREW SMITH, M D)*

(a) *Remarks and Extracts*—Febris intermittens, ague, malaria, periodic fever, fevers of tertian, quartan, and quotidian type are generally recognised in Bulgaria, Rumelia and Crimea.

The incidence of malaria on the Army is remarked upon—especially the August rise.

“ Febris intermittens reigns dominant in the Danubian provinces in spring and autumn ”

“ There are intermittents (tertian) where no marshes exist.”

“ Fevers ” account for from 10 to 30 per cent. of admissions to hospital from different corps from 1854 to 1856. Fevers include :—

Febris intermittens
 „ communis continua.
 „ remittens.
 „ typhus.
 „ typhoides.

The July-August rise in “ fevers ” is marked and is variously accounted for :—

April	} Fever rare and of ephemeral type.
May	
June	
July	
August	In the army in Bulgaria “ fever ” became a much more prominent affection—admissions increased from 366 to 1,099
	Still greater prevalence of fever admissions, 2,558.

Sudden subsidence of “ fever ” on transfer of troops to Crimea in September is noted. Fever was almost gone in November

(b) *Treatment* —“ Quinine seems to have been most resorted to, but its exhibition required much caution, on account of the irritable state of the bowels ” (cholera, dysentery and diarrhoea were frequent complications) “ and, except in cases of intermittent fever, the efficacy of this drug does not seem to have come up to the expectations formed regarding it ” .

(c) The belief in the greater prevalence of mosquito-borne diseases (malaria and yellow fever, at any rate) amongst cavalry than amongst infantry has a local explanation at Varna.

June	July August
Periodic fevers, intermittent and remittent from paludial conditions	Continued fevers—common continued and typhus,
Relatively excessive amongst cavalry	At minimum relatively amongst cavalry
Equal incidence on 1st and light division	Equal incidence on 1st and light division
Relative minimum on 2nd and 3rd division	In excess relatively on 2nd and 3rd division.

Explanation—Cavalry and First and Light Division on distinctly malarious situation.

Cavalrymen exposed for longer time in the care of their horses (special *Anopheline* exposure). Second and Third Division not on specially malarious site.

(d) *Return of Troops Invalided to England* = 9,544.
 • From "fevers" = 1,784

(e) *Admissions from June 12th, 1854, to June 30th, 1856, to General Hospitals on the Bosphorus:—*

Fevers	8,409
Febris Quot Int	702
" Comm Cont.	7,216
" Remitt	349
" Typhus	136
" Typhoides	6
Wounds	4,943
Total admissions	43,288

8. *Despatches and Papers relative to the Campaign in Turkey, Asia Minor and the Crimea during the War with Russia in 1854, 1855, 1856*

9. *Encyclopædia Britannica*

Occasions of special association of malaria with armies, and with colonising:—

Darien	1,701	Cartagena	1,741
Achin (French)	1,873	Walcheren	1,810
Tunis (French)	1,881	Rangoon	1,824

10. *Personal Narration*

(a) *Mr. G. C. Solley, Richborough, Sandwich*, Expenditor for the Levels Commissioners for 16 years (a position held by his father 58 years and his grandfather 40; altogether for the last 114 years in this family) has placed his unique knowledge of the east of Kent and its marshes repeatedly and freely at my disposal.

He is of opinion there has been no alteration of the system during 400 years. The last drainage scheme was the formation of Stonar Cut in 1770, meant to benefit the land between Grove Ferry and Canterbury, and which, perhaps, benefited the land lower down.

The last case of ague he has any knowledge of in this district was at a cottage on the border of the marsh, 40 years ago. He has heard of it being common 60 years ago. Houses on the border of the marsh were reputed to have ague more severely than cottages actually in the marsh. I learn that stock was housed in the steadings of the border, while the cottages on the marsh were occupied by the "looker" or stock tender, and cattle were not wintered on these.

(b) *Mr. S. Masters, 92 years of age, Providence Cottage, Sandwich*, remembers a large outbreak of ague in 1859. He is a shipbuilder by trade, and was at Chatham in 1858; he got ague there; from there went to Rye, where there were many cases, he had ague for 12 months then, there was little ague at Sandwich.

(c) *Mr Chas Jeffery, brewery worker, Kennington, Ashford, 70 years of age*, has not worked in the marsh country, but he remembers talk of young men from Sellinge, who went to service in the marshes round by Newchurch, always coming back with ague

(d) *Mr Stewart, of Bloors, Rainham, Kent*, has not heard of ague locally during the 30 years he has been at Bloors. His brother had ague at Northfleet in 1878. The Hundred of Hoo had the reputation of being malarious; its people used to come to Rochester for quinine, reference to which was made in the *Daily Telegraph* of the day when the railway in that district was opened

The county of Kent and the country around Chatham, particularly, used to be a favourite field for discharged soldiers—every farm used to have them tramping for work in the harvest seasons

(e) *Captain Blanc, R E, Sheppey*, informs me that in the hot year, 1911, while residing at Bushwood Road, Kew, within 50 yards of the river, he had an illness which his medical attendant, Dr Paine, said was "very like malaria"; and he "would not hesitate to call it malaria if it were not in England."

(f) *Dr Proctor, Lydd*, says that his father in Lydd district used to carry quinine to give to patients for ague. His records of ague refer to coastguardsmen, a possible carrier source.

(g) *Mr Hammond, Rushenden Farm, Sheppey, aged 76 years*, says ague followed by fever was common in Sheppey when he was a child. He says the land is not now so well cultivated and the ditches are less well attended than then. The land used to be worked corduroy pattern with many drainage furrows kept clear of growth.

(h) *Mr Root, South Shoebury Hall, Essex*, says about 50 years ago ague was prevalent. At Great Wakering Brickfield many men were laid up with ague. Much water lay about, and was kept collected. The master of the brickfield, however, said "we may as well be without water as without men"—cut the ditches, let the water off, and sank wells. Ague disappeared and the brickworks continued

(i) *Mr. Holman, Reculver, Kent, aged 70 years*, had ague in 1860, when 12 years of age. It lasted for 12 weeks or more,

during which time he took regular large doses of quinine powder. Nearly every one had it. It was recognised then as a regular thing. There was little heard of it after that year. The coming of the railway "in 1862," causing a stirring and circulation of the stagnated air of the marshes is the only reason he has heard to account for the disappearance of ague

(j) *Mr. Harold Collard, Brook Farm, Chislet, Kent*, says he had always heard it said that the coming of the railway "about 1845" with its sulphurous fumes and noise and draught caused the disappearance of the ague—and of mosquitoes.

(k) Several farmers around *Rainham, Upchurch, Halstow and Otterham Quay, near Chatham*, stated that the disappearance of ague in that part of the country is attributed to the cutting down of elm trees, which is said to have been extensively done about 1860.

(l) At *Gravesend, Tilbury and other places* frequent statement is made that the erection of cement works caused the disappearance of ague

(m) *Dr. Charles Pinching, of Gravesend*, kindly writes as follows :—

" I am sorry I can't get you the exact number of cases of ague at Gravesend Hospital. I went to-day to find the old records but found that the secretary in an access of patriotism had sold all the old books for waste paper only two months ago. I have seen my father who was on the staff of the Hospital over 40 years ago, and he tells me that even then quite 30 per cent of cases were ague, and that nearly every one in the town at that time suffered from attacks of ague. I had it myself as an infant. I have made out a short report on the district if it is any good to you "

" GRAVESEND.

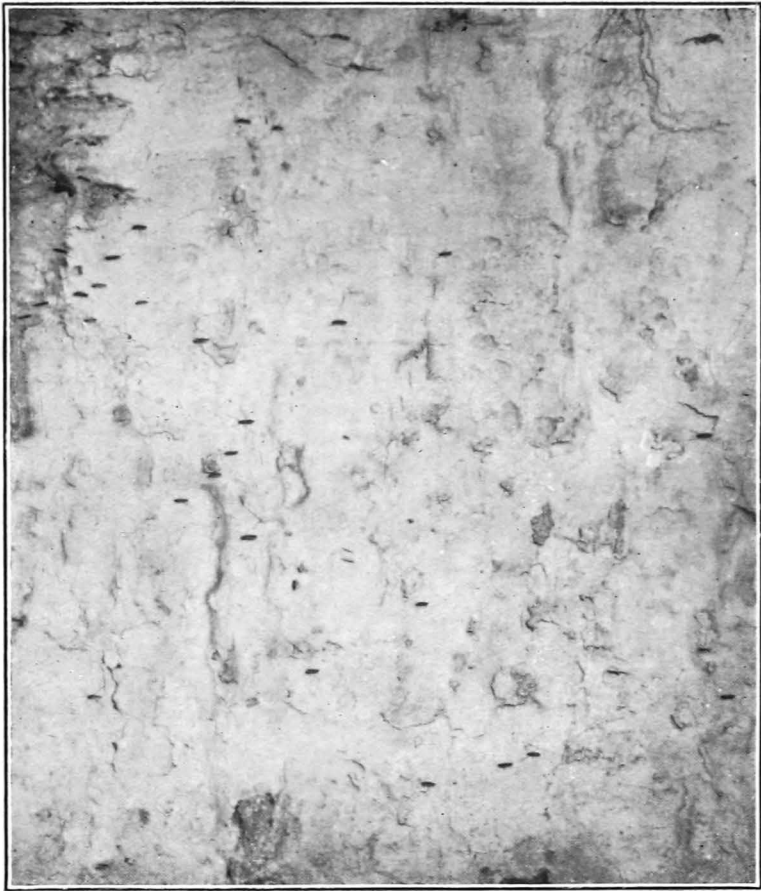
" *Report on Malaria in Thames District.*

" The Thames District, Thames and Medway Defences extends from Gravesend on south side and Tilbury on north side of river to the mouth of the Thames

" This district lies on the banks of the river among marshes drained by open ditches in many cases stagnant, with frequent ponds and pools. These marshes extend from a mile to three miles inland, after which the land rises to wooded hills

" About 60 years ago malaria was endemic in the district. The Out-patient Records of Gravesend Hospital of that time show that at least 30 per cent. of all cases

Plate II.



C. pipiens. Photographed on cellar wall in Kent.

To face page 217.

treated were 'ague.' My father and grandfather who were both on the staff of the Hospital, have told me that these cases were undoubtedly malaria, and think that nearly every person in the district suffered to a greater or less degree.

"The cement industry began about 40 years ago. Many large factories being built above Gravesend. From that time the incidence of malaria became very much less. It has been suggested that this was due to the cement smoke continually blowing across the marshes, the prevailing wind being south-west.

"There are still a fair proportion of scattered cases of malaria among the riverside population, who have never left the district, and mosquitoes are very numerous: *Anopheles* has been found practically all over the district this year and I have myself seen them every year. I would suggest that many of these are imported in ships landing at Tilbury Dock, and that suitable *pabulum* is provided by the seafaring population, many of whom have contracted malaria abroad. During the last two years there have been many malaria cases in the district in drafts of returned Indian troops and men from Salonica, and Egyptian Expeditionary Forces. I cannot, however, say that the incidence of malaria among the civil population has increased and only in a few cases has malaria arisen among home service units in the district."

IV. SUMMARY OF ENTOMOLOGICAL OBSERVATIONS.

GENERAL.

Observations were made chiefly with reference to the *Anophelinae* and have been but a part of general epidemiological investigation.

The areas under observation varied from marsh and estuarine to inland agricultural and alluvial.

The period over which observations extended was February to December, 1918 (notes are added to March, 1919).

Identification of equivocal or unknown specimens was determined by officers of the British Museum, through Dr. Marshall and Mr. W. D. Lang.

Larvæ were identified from imagines produced in captivity.

.CHRONOLOGICAL ENTOMOLOGICAL RECORD, 1918.

Date.	Situation.	Imagines		Larvæ.	
		Identification, Sex, Numbers and Remarks	Habitat.	Identification.	Habitat.
23 2 18	Lydd, Kent Town and all steadings examined in surrounding country.	<i>A. maculipennis</i> ♀ ♀ ♀ numerous fed females	Occupied stables, byres, pigstyes— are in cellars and there in warm corner	<i>A. bifurcatus</i> ..	Sheep pond in pasture land
28 2 18	New Romney, Kent Town and steadings in district	<i>A. maculipennis</i> ♀ ♀ ♀ in fair numbers	Occupied stables and byres	<i>A. bifurcatus</i> ..	Grass grown ditch— taken here all through winter by Dr Hick, M O H.
4 3 18	Sheppey, Kent, Isle of Gram, Kent	<i>A. maculipennis</i> ♀ ♀ ♀ numerous in most places—	Occupied stables, byres, pigstyes	<i>Ochlerotatus salinus</i> and <i>diversus</i> numerous	Backwaters of ditches, grass grown with algae, duckweed, &c., with bottom of black debris, emitting stench on being stirred.
8 3 18	Queenboro, Minster, Sheerness Farms on Isle of Gram—and farms all over Sheppey	"myriads" at Warden Court "One feeding on horse's rump 3 30 p m in shaded stable at Leysdown"	None found in dwelling houses		
11 3 18	Gillingham, Kent, Rainham, Kent	<i>A. maculipennis</i> ♀ ♀ numerous	Occupied stables, &c.	<i>C pipiens</i>	Foul ditch on Gillingham Corporation Dump
12 3 18	Sheppey, Farms ..	<i>A. maculipennis</i> ♀ ♀ abundant	Occupied stables, &c	<i>O salinus</i>	Pools behind Tileworks, Queenboro.

13 3 18	Tilbury, Essex	<i>C pipiens</i> , ♀ ♀ few <i>T annulata</i> , ♀ one	Walls and ceiling of cold dug-outs at Tilbury Fort	<i>O salinus</i> and <i>nemorals</i> abundant	Cut off pools and backwaters north of Tilbury Fort, shallow with grass and rushes
14 3 18	Shoeburyness, Essex	<i>A. maculipennis</i> , ♀, one Many stables, &c examined One ♀, <i>T annulata</i> taken in military hospital in February by Capt Linton, SSO	At Shoebury Court Farm in occupied cowshed	<i>O salinus</i> , <i>C pipiens</i> both abundant	Ditches between stables and gantry at barracks Ditches by railway near barracks
18 3 18	Sheppey, Kent Farms at Minster and throughout Sheppey	<i>A maculipennis</i> , ♀ ♀ ♀, abundant In a stable at Kingsferry "numbers" feeding vigorously, some excreting bright blood, on dark brown horse None on grey horse the grey had just come in	Occupied stables, &c	<i>A bifurcatus</i>	"Fire-trench" at Warden Court A water collection, 4 to 8 inches deep—fine algæ—larvæ seen to burrow in yellow ochreous flocculent clayey bottom
19 3 18	Chatham district	♀, <i>T annulata</i> , one, 1 ♀, <i>A maculipennis</i> . "The horse above whose head on the rafters the <i>maculipennis</i> was taken had come in that morning from a night journey in the marsh country"	Occupied stable at Luton	—	

CHRONOLOGICAL ENTOMOLOGICAL RECORD, 1918—continued.

Date.	Situation.	Imagines.		Larvæ.	
		Identification, Sex, Numbers and Remarks	Habitat.	Identification.	Habitat.
20.3 18	Chatham to Faversham, farmsteadings in flat country between Watling Street and the Medway — East Court, Otterham Quay, Upchurch, Wetham Green, Bayford, Halstow, Cambray, Luddenham, Oare On the same date numerous farms south of Watling Street were examined and no <i>Anopheles</i> were taken	<p><i>A maculipennis</i>, ♀ ♀ ♀ abundant in every farm examined 1 ♀, <i>T annulata</i> at Luddenham "full of blood" 1 ♀, <i>A maculipennis</i>, in Officers' Quarters, R D C Camp, Oare — "the first <i>maculipennis</i> taken in a dwelling this year"</p> <p><i>C pipiens</i> ♀ ♀ ♀ in large number on walls and ceiling of cold cellar at Otterham Quay—and in duckhouse No ♂ was taken</p>	Occupied stables, cowsheds, pigstyes One ♀, <i>A. maculipennis</i> , in wooden hut occupied by officers at Oare, taken by Lieut. Robertson, an experienced Entomologist		
21 3 18	Sheppey, Queenboro' Minster and farms throughout	<i>A maculipennis</i> , ♀ ♀ abundant	Occupied stables, &c		

36. <i>Bovington</i> ..	Hospital (huts and marquees) serving large huttled camp of Tank Corps on rising ground facing Wool Heath	July 1918	29,	No adults seen and no larvæ noticed nearer than meadows adjoining Wool Station 2 miles away	..	
37. <i>Blandford</i> ..	Large camp on Monkton Down; huts and tents. Site is high up on chalky treeless downs. Accommodation for 18,000 troops, R.A.F.	July 1918	30,	No evidence of any mosquito life at all in the camp	..	Conditions on the Downs unfavourable for mosquitos.
38. <i>Swanage</i> ..	Five camps (huts and tents) situated on south slope of Ballard Downs, close to the sea. Occupied chiefly by No. 3 "C" Reserve Brigade, R.F.A.	July 1918	31,	Only two adults found in the camps. Breeding place few and chiefly situated at the western end of the site	..	A relatively large number of the troops are malaria subjects from Salonika.
39. <i>Lulworth</i> ..	Small camp (tents) of 500 (circ.) men of the Tank Corps—situated on cliff overlooking sea near Lulworth Cove	Aug. 8, 1918		No evidence of any <i>Anopheles</i> condition	..	

CHRONOLOGICAL ENTOMOLOGICAL RECORD, 1918—continued.

Date.	Situation	Imagines		Larvæ.	
		Identification, Sex, Numbers and Remarks	Habitat.	Identification	Habitat.
28.3 1918	Sandwich Town ..	<i>A. maculipennis</i> ♀ ♀	A few in most of the stables in the town—in some none Nearly all the stables in town were in occupation by the military, and had been recently cleaned and lime-washed		
8 4 1918	Sheppey, Little Murston and Chatham district	<i>A. maculipennis</i> ♀ ♀, numerous Still in hundreds at Warden Court, where sweeping out has been adopted	Occupied stables, &c.	<i>A. bifurcatus</i> , <i>O. Salinus</i>	Trench at Warden Court Wayside ditch at Little Murston.
12 4 1918	Sandwich Town and District, Ash, Richborough, Guston, &c	<i>A. maculipennis</i> ♀ ♀ numerous	Occupied stables, &c 12 ♀ taken in dwelling house of Guston Farm in bedrooms	<i>Anopheles</i> larvæ numerous—not identified <i>A. maculipennis</i> taken here later Pit dried up in June, again held	Sheep pond in field beside Railway Station Wayside ditches, reed

				water in October.	grown, near farm on Golf Course road
				<i>A bifurcatus</i>	<i>Remarks</i>
21.4 1918	Sheppey throughout	<i>A maculipennis</i> ♀♀, numerous	In same situations In farms near camps sweeping operations have been going on, and <i>Anopheles</i> is scarce, but still present		For the first time it was noted that in test tubes in which ♀ <i>Anopheles maculipennis</i> were taken, eggs were laid on the glass in large numbers. They varied in colour from white or grey, through yellow and brown to almost black. Out of many hundred eggs from these placed in tap water a good many larvæ hatched out—some under the observation of myself, some of Mr Lang, British Museum, and some of Dr Ashworth, at Edinburgh University
to					
26.4 1918	Sheppey throughout	<i>A maculipennis</i> ♀♀	As before	<i>A bifurcatus</i>	Trench at Warden Court.
28.4 1918	Lydd and New Romney and Lympne (Pedding Farm)	<i>A maculipennis</i> ♀♀	As before	<i>A bifurcatus</i>	As before at New Romney.
			2 ♀♀, <i>A maculipennis</i> at Lympne in stable		
		<i>A bifurcatus</i> ♀♂, in house by Dr Hick, M O H, New Romney	Dwelling house		
7.5 1918	Ashford, Kent	<i>A maculipennis</i> ♀♀	Stables at Kennington and Willesborough		
8.5 1918	At Lydd				
			"On evening of bright day before sundown on Priors Farm, near Lydd, in a stable were hundreds of <i>A maculipennis</i> —they were active, and numbers were flying out and in"		
		<i>A bifurcatus</i> ♀	Taken in Lydd Hospital 10.5.1918, by Capt. Rugg, R A M C.		

CHRONOLOGICAL ENTOMOLOGICAL RECORD, 1918—continued.

Date.	Situation.	Imagines.		Larvae.	
		Identification, Sex, Numbers and Remarks.	Habitat.	Identification.	Habitat.
12 5 1918	Danson Park, near Bexley Heath	<i>C. pipiens</i> ♀ ♀, few fed	Cold stables.		
16.5.1918	Sandwich and District	<i>A. maculipennis</i> ♀ ♀	Same situations ..	<i>A. bifurcatus</i> ..	Same situations.
17 5.1918	Lydd and New Romney	<i>A. maculipennis</i> ♀ ♀, ♂ 1 <i>A. maculipennis</i> The first ♂ taken this season	Same situations ..	<i>A. maculipennis</i> ..	Weed-covered dykes near Air Balloon Station."
19 5 1918	Sandwich	<i>A. maculipennis</i> ..	Usual situations ..	<i>A. maculipennis</i> ..	Weed-covered dykes
23 5 1918	Sheppey District ..	<i>A. maculipennis</i> ♂ ♂ and ♀ ♀	In smaller number in usual situations—a few to be found in military huts	<i>A. maculipennis</i> ..	Grass-grown and ulva-covered dykes
26 5 1918	London Colney, Hertfordshire	<i>A. maculipennis</i> ♂ ♂ and ♀ ♀	Cowshed	<i>A. maculipennis</i> ..	Pond amongst rushes, grass and algæ
6 6.1918	Sandwich	<i>A. maculipennis</i> ♀ ♀ and ♂ ♂	In rather smaller number in same situations. Rarely found in huts and latrines on Stonar Camps	<i>A. maculipennis</i> ..	Dykes generally. Seen and taken on surface amongst <i>Enteromorpha</i> which covers the water—collect especially at holes caused by rat

(14557)

						runs, &c. Also taken amongst duckweed.
					<i>C. pipiens</i>	Stagnant pools, e.g., sheep-dipping wells.
					<i>T. annulata</i>	Wayside reed-grown ditch
11 6 1918	Aldershot, Longmoor and Borden and Pirbright	<i>A. maculipennis</i> ♀♀ and ♂♂	A few in huts at Longmoor Camp.			
12 6 1918	Isle of Grain ..	<i>A. maculipennis</i> ♀♀♀ and ♂♂	In usual numbers in stables, &c In fair numbers in R A F Quarters			
13 6 1918	Tilbury, Kyncochs Town, Thames Haven, Shoeburyness	<i>A. maculipennis</i> ♀♀♀ and ♂♂	None at date at Shoeburyness and Tilbury Numerous in military huts and blockhouses	<i>A. maculipennis</i> .		Weed-covered dykes at Thames Haven.
15 6.1918	Lydd .. .	<i>A. maculipennis</i> ♂♂ and ♀♀♀	In about the same numbers in winter habitat In bell tents on camp near Lydd Railway Station A few in huts at Air Balloon School	<i>A. maculipennis</i> ..		In dykes around Air Balloon Camp—amongst algæ, enteromorpha and duckweed.
17 6 1918	Sandwich .. .	<i>A. maculipennis</i> ♀♀ and ♂♂	Usual situations, also a few in huts and in bell tents	<i>A. maculipennis</i> ..		Dykes generally Always where the dykes are grass-grown or covered with weed— <i>not</i> found in dykes kept trained and scrupulously free of weed.

225

CHRONOLOGICAL ENTOMOLOGICAL RECORD, 1918—continued.

Date	Situation.	Imagines.		Larvæ.	
		Identification, Sex, Numbers and Remarks.	Habitat.	Identification.	Habitat.
2.7.1918	Grantham, Belton Park and Harrowby	<i>A. maculispennis</i> ♂ ♂ and ♀ ♀	Stables and pigstyes near Belton Park and in cowshed at Harrowby	"Reported to me that <i>A. maculispennis</i> larvæ were found at Harrowby and Belton Park in August, 1917, by Col Stephens"	
3.7.1918	Lincolnshire (District round Ancaster, Sleaford, Heckington, Swineshead, Donnington, Gosperton, Surfleet, Pinchbeck and Moston)	<i>A. maculispennis</i> ♂ ♂ and ♀ ♀	A few in stables, &c, on farms in districts named	<i>A. maculispennis</i> .. <i>C. pipiens</i>	Grass-grown pond and ditches Foul ditch at Heckington
9.7.1918	Cambridge and District	<i>A. maculispennis</i> ♀ ♀ and ♂ ♂	Stables in the city (Cox's stables and Stetchworth Dairy, near Cam and Bin)—and at Grange Farm; also at Wilbraham	<i>A. maculispennis</i> ..	In great numbers in backwater of and in the river Cam near Waterbeach, chiefly amongst algæ

		<i>A. bifurcatus</i> ♀, 1 on pond at Wilbraham.		<i>T. annulata</i> ..	Earthy ditch with bottom of decaying leafage shadowed by trees, at Cottenham Rectory.
147 1918	Sandwich ..	<i>A. maculipennis</i> , <i>C. pipiens</i> , <i>T. annulata</i>	A few houses in Sandwich Small numbers in military huts, Stonar Camp Usual numbers in stables and similar numbers in unoccupied outhouses	<i>A. maculipennis</i> .	Abundant in weed-covered dykes Rare and not found in cleaned and trained dykes
177 1918	Wantsum Valley, Kent, along the Stour and canal from Sandwich to Reculver	<i>A. maculipennis</i> ♂ ♂ and ♀ ♀	In small numbers in all farms examined along the edge of the marshes—in bell tents at Military Camp, St. Nicholas at Wade	<i>A. maculipennis</i> .	Ulva-covered dykes.
		<i>A. bifurcatus</i> ♀ ♀ 2.	On wing—evening—Sandwich and Richborough		
187 1918 197 1918	Sheppey and Chatham District	<i>A. maculipennis</i> ♂ ♂ and ♀ ♀	In about usual number in stables and unoccupied cowsheds In the case of the stable at Warden Court where were myriads in March now only one or two found after prolonged search The stable has been unoccupied since end of May		

CHRONOLOGICAL AND ENTOMOLOGICAL RECORD, 1918—continued.

Date.	Situation.	Imagines.		Larvæ.	
		Identification Sex, Numbers and Remarks	Habitat	Identification.	Habitat.
24 7 1918	Oxford and District	<i>A. maculipennis</i> ♂ ♂ and ♀ ♀	Stables in city near river—stables at Littlemore, Wolvercote, and Port Meadows	<i>A. maculipennis</i> . <i>C. pipiens</i>	Canal in town—in rushy edges of canal at Port Meadows Stagnant pools in Port Meadows
31 7 1918	Sheppey (East Church)	<i>A. maculipennis</i> ♀ ♀ and ♂ ♂	Huts at Eastchurch Aerodrome		
1 8 1918	Felixstowe . . .	<i>A. maculipennis</i> ♂ ♂ and ♀ ♀	Huts at Station of Royal Air Force	<i>A. maculipennis</i> .	Numerous in grass-grown ponds and weed-covered dykes
9 8 1918	Sheppey and around Chatham	<i>A. maculipennis</i> ♂ ♂ and ♀ ♀	Dwelling houses at Holm Place Military huts at Holm Place Dwelling houses at Leysdown and Shellbeach Bell tents at Leysdown Usual numbers in stables, &c	<i>A. bifurcatus</i> ..	Grass-grown ditch near Moat Farm, Iwade
12 8.1918	Shoreham - by - Sea, Sussex	<i>A. maculipennis</i> ♂ ♂ and ♀ ♀	Cowsheds at Old Shoreham.		

228

14 8 1918	Leicester	..	<i>A. maculipennis</i> ♀ ♀ a few	Cowsheds at Knighton	<i>A. maculipennis</i>	..	Grass-grown stream at Knighton.
21.8.1918	Essex and Suffolk (Ingatestone, St Osyth, Great Bentley, Bawdsey Manor, Aldeburgh, Henham Park, Halesworth, Bungay, Beccles)	..	<i>A. maculipennis</i> ♂ ♂ and ♀ ♀ <i>T. annulata</i> ♂ ♂ and ♀ ♀ at Aldeburgh <i>T. annulata</i> ♀ ♀ and ♂ ♂ <i>C. pipiens</i> ♀ ♀ and ♂ ♂	Stables and cowsheds in all districts named Huts at Bawdsey, tents at St Osyth, Bell tents at Aldeburgh Tents and huts at Beccles	<i>A. maculipennis</i>	..	Ditches with algae and grass at Great Bentley, Bawdsey, Beccles.
25.8 1918	Kew Gardens	..			<i>A. maculipennis</i>	..	Among algae and grass in pond near "Flagstaff."
27 8 1918	Sandwich and District	..	<i>A. maculipennis</i>	Stables, &c, occupied military huts and tents. Dwelling-houses in fair abundance Males indoors are more frequent than earlier	<i>A. maculipennis</i>	..	Weed-covered dykes,
		..	<i>A. bifurcatus</i>	♀ ♀ 2 on the wing (evening)	<i>A. bifurcatus</i>	..	Sedgy ditches
		..	<i>T. annulata</i>	Similar situations to <i>A. maculipennis</i> but in small numbers or rare in stables, and in about equal numbers in huts	<i>T. annulata</i>	..	Sedgy ditches Dead ends of dykes with broken weed surface.
		..	<i>C. pipiens</i>	In huts, barns, &c Frequent in "bush" near breeding places	<i>C. pipiens</i>	..	Dead ends of dykes; foul casual water, various.

CHRONOLOGICAL ENTOMOLOGICAL RECORD, 1918—continued.

Date	Situation.	Imagines.		Larva.	
		Identification, Sex, Numbers and Remarks	Habitat	Identification.	Habitat.
4 9 1918	Chatham and Sheppey	<i>A. maculipennis</i> ..	Stables, &c Huts and tents and dwelling houses	<i>A. maculipennis</i> .. <i>A. bifurcatus</i>	Weed-covered dykes. Alga-growing pools, with flocculent clayey bottom.
13 9 1918	Bishops Stortford and district Harlow to Birchanger The Hadhams to the Rodings	No <i>Anopheles</i> found in districts around Bishops Stortford, where they are already recorded as found in British Museum records. Ditches generally dried up No larvæ found in backwaters of Stort. Algæ practically absent from these waters—bottom of stream sandy and gravelly			
18 9 1918	Tilbury and Purfleet	At Tilbury casual water, which in March carried abundance of <i>Ochlerotatus</i> larvæ, disappeared in May, and has not yet reappeared			
29 9 1918	Sandwich	<i>A. maculipennis</i> ♀ ♀ and ♂ ♂, <i>A. bifurcatus</i> , <i>T. annulata</i> , <i>C. pipiens</i>	Stables on farms near Purfleet	Perhaps the male and female <i>maculipennis</i> population in stables is in excess of the number of females alone there in winter months.	
5.10 1918	Sheppey and District	<i>A. maculipennis</i> ♀ ♀	In huts, a few found	<i>A. bifurcatus</i> ..	Grass-grown ditch Moat Farm, Iwade
9 10 1918	Great Baddow, Essex	Careful search around Great Baddow failed to discover <i>maculipennis</i> , where it is previously recorded, many watercourses were still dried up.			

10.10.1918	Maresfield Park, Uckfield	<i>A. maculipennis</i> ♀♀	Stables	<i>A. maculipennis</i>	Ponds, taken in September by Capt. Dickson, R.A.M.C.
14 10.1918	Sheppey	<i>A. maculipennis</i> ♀♀ <i>A. bifurcatus</i> ♀ and ♀ taken in open near larvæ	Stables	<i>A. bifurcatus</i>	Alga-grown pools.
18 10-1918	Sandwich and District	<i>A. maculipennis</i> ♀♀ <i>C. pipiens</i> ♂ and ♀ <i>Theobaldia annulata</i> ♂ and ♀	30 taken in dwelling house at Guston Farm, Richborough Many in cellar where in March were thousands Taken in dwelling house	<i>A. bifurcatus</i> <i>C. pipiens</i> <i>T. annulata</i>	Sedgely ditch. Stagnant ditch. Sedgely ditch.
29-10 1918	Lincolnshire, Tetney Lock, near Grimsby	<i>A. maculipennis</i> ♀♀ 2 <i>T. annulata</i> ♂ one	Stable Taken in open.		
30 10 1918	Nottinghamshire, Grange Farm, Toton	<i>A. maculipennis</i> ♀♀♀ fair number	Stables, pigstyes, &c.		
28 11 1918	Sandwich and Wantsum Valley	<i>A. maculipennis</i> ♀♀♀ found in same haunts as in March-April, and in about the same or smaller numbers <i>A. maculipennis</i> ♀ one found on 29 11.1918 in military hut. <i>T. annulata</i> ♀ ♂ and <i>C. pipiens</i> ♀ ♂ are still taken in military huts and latrines		<i>A. bifurcatus</i> , <i>T. annulata</i>	Dead end of weed-covered ditch.
30.11 1918	Sheppey and District	<i>A. maculipennis</i> ♀ is in the same haunts as in March, and in smaller numbers ♀ ♂ were taken in the open near their larvæ <i>A. bifurcatus</i> larvæ collected in abundance from algæ-grown pool at Warden Court At Little Murston no water has yet collected in ditch where in March were <i>Ochlerotatus</i> larvæ.			

ANOPHELES MACULIPENNIS.

IMAGINES

Situation and Season.

Stables, cowsheds, pigstyes, occupied by stock—throughout the year.

Unoccupied stables, cowsheds, barns, cellars, dwelling-houses, military huts, barracks, tents—with frequency, from July to September, and rarely earlier and later

Extreme dates are —Military hut at Oare, near Faversham, ♀ 1 on March 20th (Mr Robertson), military hut, Stonar Camp, Sandwich, ♀ 1 on November 29th (Mr. Edwardes), ♀ ♀ 30 in bedrooms and passages, first floor, at Guston Farm, near Sandwich, on October 20th; ♀ ♀ 2 in cellar at Otterham Quay, Kent, amongst hundreds of *C. pipiens*, on March 20th, ♀ ♀ 2 amongst *C. pipiens*, in a cellar at Lydd, on February 24th, and there in a warm corner.

March, 1919 A single record of *A. maculipennis* ♀ has been received for each month, December, 1918, to March, 1919, in military huts at Sandwich

Position.

Most frequently on ceilings, on rafters, on woodwork, or cobwebs, sometimes under mangers and shelves; on walls, generally near ceilings, away from draught, generally in darkest situation, though where cattle are present the ceiling over the cattle, even if in the line of light, carried most rarely suspended from tilework, slate or iron roofing. In dwelling-houses usually in draughtless parts of ceilings or walls, and preferably where sheltered by a wardrobe, cupboard, &c. In bell tents usually in the cone at apex of tent, not frequently amongst clothes and packages

Numbers.

Variable. At Warden Court, Sheppey, in March, "myriads" over pony in low-ceilinged draughtless shaded stable. Later in the year, after the stable had been a couple of months empty, none were found in the same situation. Usually to be counted by tens in stables, cowsheds, pigstyes. In high-ceilinged stables, amongst cobwebs, they are scantily dispersed. In dwelling-houses they have been taken in from ones to twenty in a room. Numbers increased in stables in September.

Time of Day

Observations have been made from 8 a. m. to 10 p. m. at different seasons, and the records are similar at all hours.

Plate III.

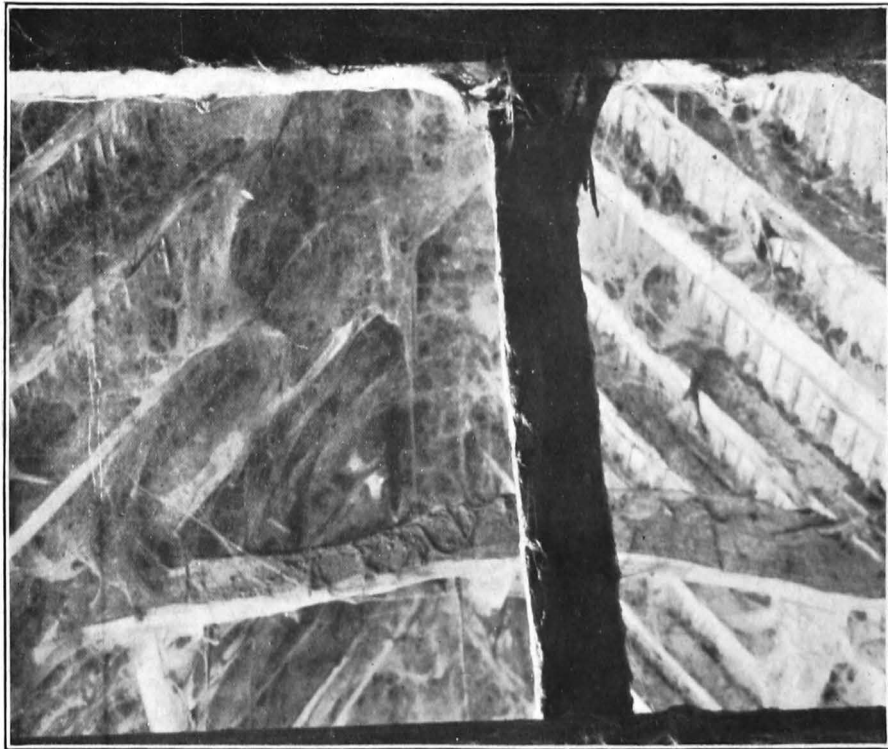


Cobwebbed ceiling of stable where *A. maculipennis* harbours.

To face page 232.

Plate IV.

To face page 233.



Cobwebbed ceiling of stable harbouring *A. maculipennis*.

Condition.

Females in stables, &c, are generally filled with blood. In March, at Leysdown and Kingsferry (on a warm, sunny day) they were seen feeding on horses.

During the later part of September it was remarked that a larger proportion than usual of females was unfed.

In houses, huts and bell tents they were always found filled with blood. Some of 30 taken at Guston Farm in October appeared to have fed. (In September, 1917, 160 males and females were taken by me at Holywood Barracks, Belfast, in latrines and barrack rooms, and not a single female could be said with certainty to be fed. The weather at the time was cold.)

Sex.

Females are found all the year round. The first male taken by me was taken on May 17th. Soon after, males were regularly observed, few compared to the number of females. In early September it was noted that the proportion of males amongst mosquitos resting in stables, &c, was considerably increased. The last male taken by me was on September 24th, and the last recorded taken in huts at Sandwich was on September 25th.

Pairing

No observations have been made.

Swarming in Open.

No observation. Except as recorded on May 8th, 1918, at Lydd, no *maculipennis* has been taken by me in the open.

Egg Laying.

No observation. Captain Davidson, making captive observations at Sandwich, records that eggs were laid between 9 p m and 9 a m.

Distance from Breeding-places.

Except in the case of a presumably carried mosquito in a stable at Luton (recorded above, March 19th, 1918), all *maculipennis* found have been within 600 yards of actual or potential breeding-places, usually much nearer.

LARVÆ.

Situation.

Dykes, sewers, ditches, service ponds in fields, tanks (in field conditions), lakes and ponds, natural and artificial; casual water of long standing, from excavations, hoofmarks,

wallows, &c. ; rivers, canals, backwaters—all in typical marshland, such as Romney, Sandwich, Sheppey, Lincoln, as well as in inland pasture land, where typical waters are present, as London Colney, Chilwell, Leicester, Grantham, Cambridge, Oxford, &c.

Nature of Watercourses.

For larval existence the presence of "cover" at banks, or growing up through the water in its stretch, is necessary. Larvæ of *A. maculipennis* have not been found by me in clear water with depth sufficient to prevent subaqueous vegetation reaching the surface, and with banks devoid of vegetation. What may be called typical *maculipennis* conditions are associated with growth on and in the water, and vary from littoral to inland.

The marsh country dyke, such as may be studied at Sandwich, in which *maculipennis* larvæ abound, is a watercourse of practically stagnant water during the breeding season, with edges overhung by grasses, rushes, and other vegetation dipping in the water, with *Enteromorpha intestinalis* ("Bladder weed") growing from the bottom and floating in a dense carpet all over the surface, with *myriophyllum* and *algæ* growing to the surface, with a clear depth of 9 to 19 inches, and with a bottom of deep silt of blue-black clayey, limey deposit mixed with decaying vegetation, from which the gases given off on stirring are strongly odorous.

Maculipennis larvæ may be dipped from among the surface weed with readiness; but more especially at any hole or opening in the carpet. Small "stone" holes of about 2 inches diameter, and ragged rat runs of about the same width are common, and here, if present at all, larvæ are to be found.

In inland waters, such as the Cam and backwaters, *maculipennis* larvæ may be found in great numbers in the clear water of the river, where masses of *algæ* are growing up and streaming on the surface near the banks, whose vegetation is usually dipping in the stream, and in the stagnant backwater where banks are overhung and vegetation, *algæ* and other, grows from bottom to surface all over. In this type of breeding-place, also, the bottom is of soft alluvium as a rule. Having examined many miles of streams with hard sandy and gravelly bottom, such as are around Bishop's Stortford, and in elevated parts of Essex and Suffolk without finding *maculipennis* larvæ throughout 1918, even in waters whose growth and gradient were otherwise suggestively *Anopheline*, I consider the nature of the bottom important. Its importance may lie in water retention; as watercourses with the deep silt bottom will retain water and permit breeding in seasons when those of hard and porous bottom will be dried up.



Plate V.

Untrained dyke with surface of water covered with *Algæ* and *Ulvæ*. Sheppey.

To face page 235.



Plate VI.

Untrained dyke; breeding place of *A. maculipennis*. Sandwich.

Between the Cambridge and Sandwich types of *maculipennis* breeding waters there are many modifications, although the main desiderata of comparative shallowness, overhanging and upgrowing vegetation, and surface protection of living (and partly dead) vegetation are ever present.

Duckweed (*Lemna vulgaris* and *trisulca*), *Azola carolinensis* (a lovely pink coralline growth, which mixes with and in parts entirely displaces duckweed), *Ulva lactuca*, brooklime, water-cress, and other vegetation afford cover for *maculipennis* larvæ. I have rarely found *maculipennis* larvæ in ditches with a thick growth of tall reeds and sedges.

In ponds, cisterns and small collections of water, larvæ are found; but invariably these are under field conditions, and contain *algæ* and floating vegetation *débris*.

In muddy hoofmarks, wallows and other small shallow collections of casual water, without surface *débris* or vegetation, *maculipennis* larvæ are to be found, but I look upon these as chance breeding in proximity to typical breeding-places, and have found them tenanted only in the height and near the close of the season.

Casual water of any duration in England in 1918 was rare. In fact, most wayside ditches and casual flooding dried up in May, and were still dry in October.

In the common farmyard pond, close to the steading, *maculipennis* is rarely found. These ponds are usually free from upgrowing and overhanging vegetation, are tenanted by fowl, and only in rare cases in their overgrown backwaters have I found larvæ. Not infrequently, however, and especially if siltage contaminates the duckpond, larvæ of *Culex* and of allied insects will be found in great numbers.

The agricultural ponds, weed-grown and overhung, and surrounded by hoofmarks, are breeding-places of *maculipennis*, as well as are agricultural dykes and sewers of all sorts in similar condition as regards vegetation.

Presence of Fish and other Natural Enemies.

Given the conditions of vegetation above described as appertaining to the "typical" *Anophele* breeding-place, a due proportion of *maculipennis* larvæ, fish and predatory larvæ, living together, no doubt in mutual interdependence, is the natural condition.

Perhaps the most valuable enemy of *maculipennis* in the estuarine dykes is the stickleback.

The stickleback has been taken the whole year round in these dykes, and is especially abundant in late spring, when also elvers swarm. Eels are seen all the year round, and roach, dace and chubb are said to be caught. In the more brackish dykes small flatfish and shrimps are common.

Feeding Habits.

Maculipennis larvæ are so readily seen with the naked eye, and taken by surface dipping, as to suggest they are surface feeders. As a rule they take colour from the vegetation amongst which they are found; but even in the same situation they vary widely in colour and in the patterns their bodies present to the eye

Effect on Presence of Larvæ of Dyke Training

The aim of anti-malaria measures directed to the water-courses from the beginning of the year has been to have clean-cut banks, free from vegetation in contact with the water surface, and to have the courses throughout free of vegetation.

When this is accomplished, *maculipennis* larvæ are not found. With the collection of *enteromorpha*, *algæ* or any vegetation on the surface, larvæ are again found. It cannot be said that the female *maculipennis* does not lay on the open water; but, if she does, the larvæ are easy prey to all enemies. If she will only lay on or about vegetable growth, the necessity, for preventive purposes, of clean dykes is obvious.

Effect of Chemical Agents and Oils

The action of oil in preventing larvæ from having access to air is, *in vitro*, very open to demonstration. In the field the use of oil acts similarly where it can, and larvæ under summer conditions are found in the treated situations within a week.

Experiments have been made with sulphate of copper, which destroys *algæ*. Larvæ are not found within certain periods in treated dykes, but they ceased to be found in control dykes at the same time. Observation is being continued.

Salinity and General State of Waters

Maculipennis larvæ frequent clean, fresh water, or less often foul water, flowing river water, and stagnant pool and ditch, and in the marsh and estuarine dykes, they are found in waters with a salinity ranging from 16.5 to 339.0 parts of chlorine per 100,000.

The salinity of the water in six different dykes at Sandwich, in all of which *maculipennis* larvæ have been found, analysed in June, 1918, by Major Foulerton, R A M College, is given:—

Plate VII.



Weed-covered dyke, showing rat runs. Sandwich.

To face page 236.

Sample Labelled.	Parts of Chlorine per 100,000.
Taken from dyke between Depot parade ground and officers' mess, Stonar Camp, 20 June, 1918	339
Taken from small channel leading off narrow end of South Lake, 20 June, 1918.	292
Taken from dyke between sports field and R D C old camp and river, close to bridge leading to prisoners of war camp, 20 June, 1918.	165.5
Taken from dyke by R D C destructor and between new W A A C 's camp and River, Stonar Camp, No 2, 20 June, 1918	166
Taken from dyke near Red Lion Inn and Richboro' level crossing, 20 June, 1918.	30.5
Taken from dyke by level crossing at far side of Saltpans Camp, 20 June, 1918	16.5

Distance from Adults.

Larvæ of *maculipennis* have not been found beyond a few hundred yards of dwelling-houses or of occupied stables and cowsheds

Season.

Larvæ of *maculipennis* have been taken from May 17th to September—possibly from April 12th. They were most abundant throughout August.

PUPÆ.

Pupæ are not taken so frequently or in such numbers as larvæ. They may be found on chance dipping, but more often after stirring up the vegetation and mud of the bottom. Their visits to the surface, as observed, are of brief duration.

In September pupæ are found more abundantly and in excess of larvæ

Ova have not been found in position in dykes

ANOPHELES BIFURCATUS.

IMAGINES.

Situation, Numbers, Season, &c.

Dwelling-house—New Romney ♂ ♀ taken by Dr. Hick in March and other months.

Stable—♀ one amongst hundreds of *maculipennis* at Sandwich in June. At Goss Hall, Sandwich, by Captain Davidson, in stable near water butt with *bifurcatus* larvæ in September.

Twice on wing at Sandwich, just after sundown in July.

In numbers in grass and brushwood overhanging a "fire trench" at Warden Court, Sheppey, in which were numerous larvæ, in October, 1918.

A. bifurcatus has been found, male and female, from March to October.

It is rarely found in dwelling-houses or in stables.

Contrasted with *maculipennis*, it is essentially an undomesticated or wild mosquito. At the same time, it has not been found away many hundred yards from the homes of men and haunts of cattle. Its natural feeding habits have not been observed.

LARVÆ

Situation and Season, &c.

Agricultural ditches, especially growing reeds and sedges; ponds in the same condition of overgrowth of rank vegetation, and with bottom of deep loamy silt and vegetable debris; grass-grown ditches; agricultural ponds with deep flocculent, ochreous bottom; artificial trench with similar bottom, in which larvæ were seen to burrow; in a water butt (Captain Davidson) along with *T. annulata* and other *Culicine* larvæ, with silt of dead leaves, straw, and algæ growth

Bifurcatus larvæ have not been found in the brackish estuarine dykes, which bear *maculipennis* larvæ, nor in water overgrown with surface vegetation, such as the ulvæ and duckweeds.

It might be said that *maculipennis* larvæ are found in all similar situations to those in which *bifurcatus* larvæ are found, and that the homes of *bifurcatus* larvæ are less diverse.

Bifurcatus larvæ are more readily found after stirring up the bottom silt. They are not so consistently found at the surface, which suggests that they may be bottom feeders, and that they may be able to maintain their aeration from air contained within and around the vegetable silt. From immersion experiments in captivity Captain Davidson found that they existed submerged for a longer time than *maculipennis* larvæ. They are not readily distinguishable by the eye from *maculipennis* larvæ. With the hand lens the characters of the clypeal hairs of the *Anophele* larvæ may be detected.

(Larvæ have been found by me in every month of the year, March, 1918, to March, 1919, at Warden Court, Sheppey; in February, 1919, under two inches of ice)

PUPÆ.

Pupæ were frequent and in excess of larvæ in March and September. During the rest of the year pupæ were not so readily obtainable.

OVA.

Ova have not been obtained in nature.

Plate VIII.



Firetrench; a breeding-place of *A. bifurcatus*. Warden Court, Sheppey.

To face page 238

ANOPHELES PLUMBEUS.

No specimen of *Anopheles plumbeus* has been found within the extent of the districts under my observation.

At Maresfield Park, Uckfield, where the occurrence of a case of malaria of indigenous origin is recorded, there is the suggestion of *plumbeus* on account of the extent of well-grown beech trees with numerous tree holes.

In the presence of *maculipennis*, adults and larvæ, search for *plumbeus* was not made at the time of investigation of the indigenous case; but observations are being made.

Female imagines and larvæ of *plumbeus* have been sent me by my son, taken by him (Angus Macdonald, Junr) at Culross, Kincardineshire. The adults were feeding on human blood, indoors and outdoors, within a few hundred yards of a wood, where, in a hole 9 feet off the ground, in a beech tree, larvæ were found.

At date, November 19th, 1918, I quote from Mr. W. D. Lang, of the British Museum, the history of seven *plumbeus* larvæ sent to him in August, 1918 —

“ November 19th, 1918.

“ I think that originally there were seven *A. plumbeus* from Culross. I slew two or three—one died about a month ago and three are alive, and, apparently, flourishing. They have all moulted once or twice, and are in the last or last but one instar.”

CULEX PIPIENS.

IMAGINES

These have been found all the year round—in February and March in enormous numbers in cellars, on ceilings, and chiefly on walls, head usually upwards, scattered irregularly, or sometimes massed as if in battalions in echelon. In the same cellars, visited in late October, the numbers seen were much less.

Throughout the year they are found in dwelling-houses, in living rooms and passages, in outhouses, *eg.* duck-house, barns, &c, rarely in stables and cowsheds occupied by cattle; in offices and latrines; in cellars and dugouts; in urban and rural dwellings.

They do not seem to shun light in general, though often found in dark places, and make for window panes when in windowed rooms.

They have been swept from grass and bush in many situations, especially after dark.

LARVÆ.

Larvæ of *C. pipiens* are widespread, and are more often in foul than clean water. They are generally in myriads, pupæ and larvæ, when found—in any stagnant water, fouled with stable or domestic sulliage, drainings from distillery refuse, &c; foul dead ends of weed-covered dykes, “dipping” tanks with high-coloured liquid, ponds especially if fouled with slops; both remote from and near human dwellings, and in urban and rural parts. Cover and vegetation are unnecessary, and the water may be stagnant or the backwaters of flowing streams.

THEOBALDIA ANNULATA.

IMAGINES.

This *Theobaldia* adult female has been found throughout the year. She frequents much the same situations as *A. maculipennis*. In March, when found in numbers in a cowshed, the mosquitos came in numbers from under or within wisps of straw, which were dragged out of ventilation apertures under the eaves. With *maculipennis* they flew to situation sheltered from the eastern draught which was now established in the byre.

Males have been found from March to November. During the summer this mosquito has been credited with much biting. I have no personal experience to go on; but have taken *Theobaldia annulata* in much smaller numbers than *Anopheles maculipennis* in tents, huts, dwelling-houses, stables and the usual haunts of *maculipennis*.

LARVÆ AND PUPÆ.

Larvæ and pupæ have been found from March to November. Adults hatched out in April and May from pupæ taken in April, along with *Anopheles bifurcatus* larvæ and pupæ.

They have been taken in grass-grown cut-off ditches and pools along with *bifurcatus*; in sedgy pools with *bifurcatus*; in grass-grown pools with *ochlerotatus*; in a water butt with *A. bifurcatus*; in dead ends of estuarine dykes with *C. pipiens*; in rush-grown and overhung pools with *A. maculipennis*—all in rural habitat.

Ova have not been found.

OCHLEROTATUS.

IMAGINES.

Only one male *ochlerotatus* (not identified) has been taken by me during the year, and that was taken within military quarters in October.



Barrel in farmyard containing larvæ of *A. bifurcatus*.



Breeding-place of *A. bifurcatus*. Moat Farm, Iwade.

Numbers have been hatched from larvæ collected in the early part of the year (March to May).

They have been identified mostly as *O. salinus*, a few *diversus* and *nemoralis*.

LARVÆ AND PUPÆ.

Larvæ have been found from March to May in cut-off rush-grown and grass-grown pools, which have been dried up from June to October; also in March in wayside ditches with leafy (elm) bottom, which were dried up later

CONCLUSIONS.

1 Of British mosquitoes, *Culex pipiens*, *Theobaldia annulata*, and *Anopheles maculipennis* are found frequently under domestic conditions, and of these *A. maculipennis* most frequently, in the rural areas under observation.

2 Judged from reports of biting in the districts where these abound, their blood-sucking habits are but to a small extent exercised on man.

3 Of the three British *Anophelinae* reported on, *A. maculipennis* is found both as larva and adult with greatest frequency, in greatest numbers, and in most intimate acquaintance with man.

4 *A. maculipennis*, female, passes the winter in such conditions of temperature, shade, freedom from disturbance and draught, and of feeding possibilities, as are to be found especially in stables, byres, pigsties.

5 *A. maculipennis*, male and female, frequent the same situations, in slightly varying proportion and slightly varying numbers, throughout the rest of the year. In the warmer months they extend their habitat to dwelling-houses, huts, tents, &c, and to unoccupied buildings, where now all the conditions named in (4) may be attained

6 *A. maculipennis*, male, disappears in the winter months and reappears in spring.

7. Egg-laying of the wintered *A. maculipennis* females takes place extensively in spring months, and may range in time according to temperature, and the egg-laying is fertile to a certain degree

8. *A. maculipennis*, adult females, and their larvæ or potential breeding-places, have been found in immediate association with the quarters of all cases of malaria of indigenous origin, investigated amongst troops, in this country during 1918. *A. bifurcatus* and *plumbeus* have not been similarly found. *A. maculipennis* may be looked on as the chief vehicle of transmission of malaria in England.

9 Larvæ of *A. maculipennis* have not been found in all months throughout the year.

10. Larvæ of *A. bifurcatus* have been found in all months throughout the year. Adult *bifurcatus*, male and female, have been recorded from March to October.

11. From present knowledge of the habits and history of these three British *Anopheles*, that chiefly dangerous to man, *A. maculipennis*, though most obviously numerous, is at the same time most readily limited by inexpensive operations under expert administration.

NOTE ON THE RELATION OF SHADE TO MOSQUITO BREEDING.

Unlike the *argyrotarsus* of the West Indies, the larvæ of *maculipennis* and *bifurcatus* in this country are not so definitely baskers in the sun. The shady side of a dyke as often yields them as the sunny side. While frequent at the banks, they may as frequently be dipped from mid dyke. It has been noted that along one bank none was found, while along another they were abundant. The suggested difference on the occasion was the presence of cattle and horses, coming often to drink, on the bank barren of larvæ, and the absence of cattle on the other.

The shade of tree, hedge, wall or bridge, in isolated occurrence, is no hindrance to the presence of *Anopheles* larvæ, provided the condition of the water, *qua* depth and vegetation, &c., is suitable. But shade in general is not favourable; on the whole the larvæ may be said to be the frequenters of open, weed-grown water.

In ditches shaded by thickets of sloe, quick, and myrobalum, and overlooked by thick-planted elms, *ochlerotatus* and *theobaldia* larvæ have been found in abundance. In these situations the ditches have a bottom of recent leafage, not silt of decomposition, and no up-growing vegetation. Such shaded waters are familiar throughout the country, and in none such have I found *Anopheles*. *Culex pipiens* larvæ have been found in perfect darkness in water under a hut at Queenboro', Sheppey. *Culex* imagines flew out and larvæ were dipped from a manhole raised in the flooring.

NOTE ON THE COMPARATIVE FREQUENCY OF *Anopheles Maculipennis* IN 1917 AND 1918.

In assessing the value of the factors of prevention which may have operated in reducing the output of indigenous malaria in 1918 from the numbers reached in 1917, it is of importance to arrive, if possible, at an estimate of the abundance of *Anopheles maculipennis* in 1917 and 1918.

To face page 243.

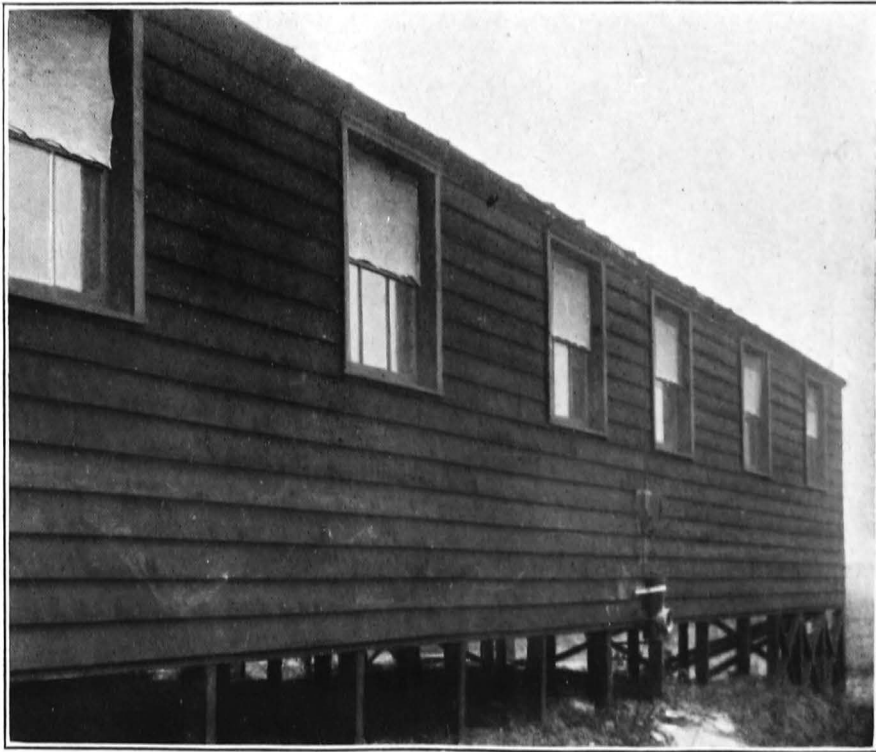


Plate XI.

Defectively fixed muslin screening.

Reasons have been given above for accepting *maculipennis* as the practical infective vehicle, and its presence or absence as the criterion of infective possibility. The records of the *Journal of Hygiene* and of the British Museum are records, for past years, of the fact of distribution, and not being the record of any organised observations, they are no assistance in the estimate of relative abundance from year to year.

But for 1917 and 1918, in both of which years indigenous malaria occurred, the records of Captains Parsons and O'Connor for the War Office, for part of 1917, and of Mr. Grove and Mrs. A. Macdonald for the Local Government Board, have been available, as well as the assistance of personal comparison of observation. In the result it may be said that in areas under observation there has been little difference in the *maculipennis* frequency and abundance in the two years.

There is suggestion, however, that in the year 1918, in which the months of spring and early summer were dry, there was limitation of the *maculipennis* output in certain districts. Drought will naturally limit breeding in districts where streams and ditches, with sandy or gravelly bottoms, dry up completely. But in marsh areas like Sheppey, Sandwich, Romney and Lydd, the effect of moderate drought would at first tend to increase breeding by shallowing ditches and enhancing the conditions described as typical for *Anopheles*. In these areas extreme summer drought would be necessary to limit *Anopheles* breeding. At the same time, hot, dry summers are popularly credited as causing noteworthy mosquito years, though that does not necessarily imply *Anopheles* prevalence.

In these few conclusions, which are mainly a re-statement of facts observed, it is attempted to indicate probabilities for present guidance without making generalisations.

In respect of the bionomics of the British *Anopheles*, much has to be learned by continued observation in different areas throughout the year, and through a succession of years. Completion of the present record of observations, by re-visitation of situations throughout December and January, has been prevented by the necessity for earlier closing this report.

V. SANITARY OPERATIONS.

The record of sanitary operations under my supervision deals with Sandwich, Sheppey, and Lydd. These districts are embraced within typical marsh areas, which all to some extent differ in geological formation from each other. They possess, also, varying degrees of malaria potentiality, depending mainly on the intimacy of mosquito-harbouring with the population concerned—troops and civilians.

In order of menace, under ordinary conditions, the Isle of Sheppey readily takes first rank, on account of the situation of breeding-places and winter haunts in such places as Minster, Queenboro', and around Sheerness, being closely associated with the homes of people and the people being of a class amongst whom malaria carriers from abroad are likely to be many and frequent.

Sandwich and Lydd are surrounded by *Anophele* dykes, and contain many stables and byres which are the winter home of *maculipennis*; but the general nature of their populations militates against the chances of malaria. At Lydd, also, is a permanent camp of artillery, on which, I have been assured by the adjutant, there have been, during all the years of its existence, malaria carriers encamped in fair numbers. This will be considered in a separate place.

Under the conditions of warfare, however, the concentration of troops at Sandwich places, I believe, the Stonar Camp area in the first place for malaria potentiality.

The conditions in Sheppey are also full of possibilities on account of the location of troops throughout the isle on and around the farms, which are the regular haunt of *Anopheles maculipennis*.

The Romney Marsh area, too, is affected by the presence of stations of the Royal Air Force, one near Lydd and another near New Romney. It has been possible, however, for the Air Force to keep known carriers from these stations; so that the added danger at Lydd and Romney has been negligible.

The detail of operations will best be considered by dealing separately with these three "dangerous areas."

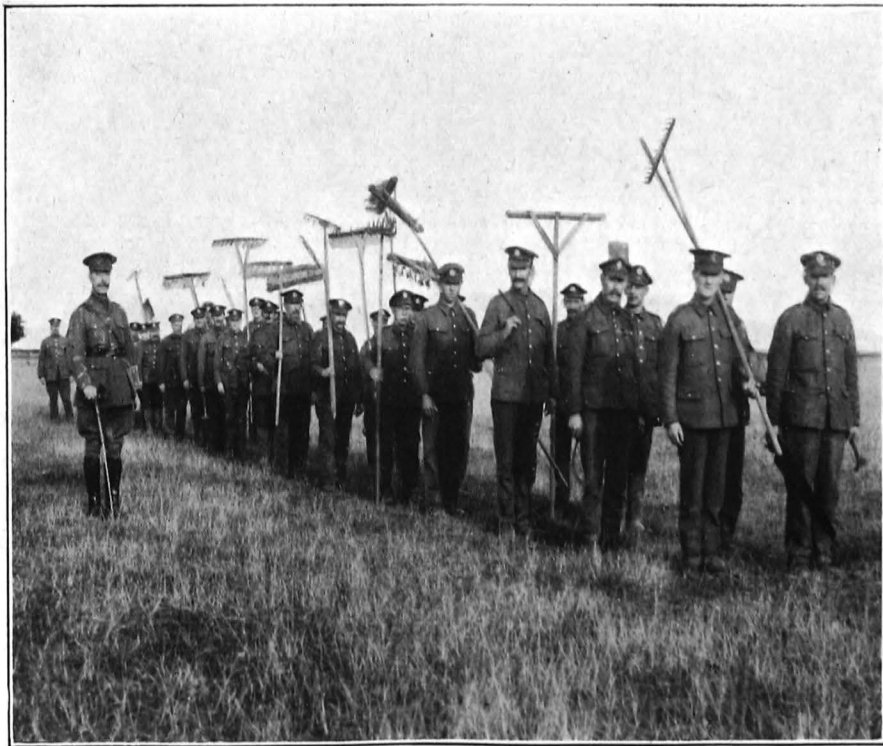
I. SANDWICH

There was in 1917 a minimum record of 69 cases of indigenous malaria to justify the scheduling of Sandwich as a "dangerous area."

At a conference between War Office and Local Government Board officers at which I was present, in February, 1918, the idea was mooted of demonstrating the value of sanitary measures in some one area, and it was remarked that at Sandwich it should be possible to obtain the necessary labour.

Arriving at Sandwich in the last week of March, I was impressed at once with the menace of malaria to a population of nearly 30,000 troops encamped in immediate association with proved malarial conditions.

The specific recommendations made in report dated March 30th, 1918, that deliberate co-ordinated anti-malaria operations, strictly sanitary in nature, should be undertaken in addition to the measures defined in the agreed provisions



Anti-malaria detachment setting out. Sandwich.

for defence, were at once supported. It was recognised that an epidemic of malaria in the Stonar Camps would have disastrous effects on the labour efficiency for which they existed

Earlier Procedure.

The occurrence in 1917 of indigenous malaria in these camps had caused special inspection to be made, and various reports, containing pertinent recommendations of different officers, were presented.

Mosquito observations had been carefully made throughout the winter months by the local Sanitary Section; blood examination and the care of malaria cases were in the hands of a medical practitioner with malaria experience, and a special sanitary officer was in charge of the sanitation of the camps.

The engineering authorities had a large scheme in hand for dealing with the dykes, which included most part of the *Anopheles* dangerous area, and a considerable length of dykes had at date been cleansed, adding thereby to the general salubrity of the camps

Description of the Camp Area

Reference to the map attached may assist the understanding of this brief description. The camps of the I.W. and D., R.E., are situated on the alluvial and estuarine flats extending some three miles within the long southward loop of the river Stour from Munster Brook, near Pegwell Bay, to the Barbican at Sandwich town. The highway from Sandwich to the Isle of Thanet runs through the camps, and in the main, except for Stonar Camp, east of the roadway on the south, the accommodation of troops is on the west side amongst a maze of intersecting dykes, while the workshops are placed on the east side, along the river reach to Pegwell Bay. The troops are accommodated in different collections of huts, wooden and concrete, which are all in varying degree of intimacy with the dyke system. In summer a considerable number of troops was accommodated in bell tents on the flats west of the river at the north end of the camp.

Anopheles Conditions.

Anopheles maculipennis in numbers, *Anopheles bifurcatus* occasionally, and *Theobaldia annulata* and *Culex pipiens* with frequency, were taken in huts throughout the camp area in the summer and autumn of 1917. A collection of all these, not strictly identified, was taken locally during the winter months. During 1918 careful observation has been systematically pursued of mosquito prevalence in selected huts throughout the camps.

Evidence was obtained, after the event, of the presence of mosquitoes on board a train-ferry at its berth in Pegwell Bay, to which location the infection of indigenous case No. 25 may be attributable.

In the month of March, 1918, *Anopheles maculipennis*, in numbers recorded as "few" to "very many," was taken in stables and cowsheds throughout the town of Sandwich, and on farms around the camp area from Minster and Richborough, to the Grange and Downs.

Anopheline larvæ (*A. bifurcatus*, March to November), *A. maculipennis* (April to September [October (?)]), have been taken from March to November within 600 yards of camp premises. On dykes within the camp area they were most abundant in July and August.

Nature of Dykes.

While absolving him from errors which may be mine in repetition, I take the opportunity of attributing to Mr. G. C. Solley, Richborough, Expenditor of the Levels Commissioners, this brief description of the nature and purpose of the dykes of the Wantsum Valley area.

The present scheme of drainage of the marsh lands in the valley of the Stour, from Canterbury to Reculver, Sandwich, and Deal, is much as it was 400 years ago. In 1770, in the reign of George III, the Stonar Cut was made, which was intended to benefit the land between Grove Ferry and Canterbury, and perhaps benefited the lower lands.

The ditches are designed to drain the land by being allowed to run out in winter time, and in summer they are used to check and let in, so as to form fences and supply drinking water for stock. The aim is to keep the water at a constant level. Water is let in from the river at high tide in such situation as will ensure its being fresh, though this is not always attained, and in August and September the water in the river is apt to be brackish.

The main streams, sewers and lead dykes are maintained, under the supervision of the Expenditor, by the Levels Commissioners, and a scot (tax) is levied—the district is "scotted"—to provide the funds.

The owner is responsible for the common dykes, and tenancy agreements make the tenant responsible for certain dyke-cleaning operations.

The chief work of dyke-cleaning lies in the operations of fletting, trowsing and casting. "Fletting" (past participle, "flett") consists in cutting the reeds off just above the roots and drawing to the sides. "Brushing the shores," that is, cutting growth on the banks above water-level, usually accompanies this. The work is performed yearly, and observa-

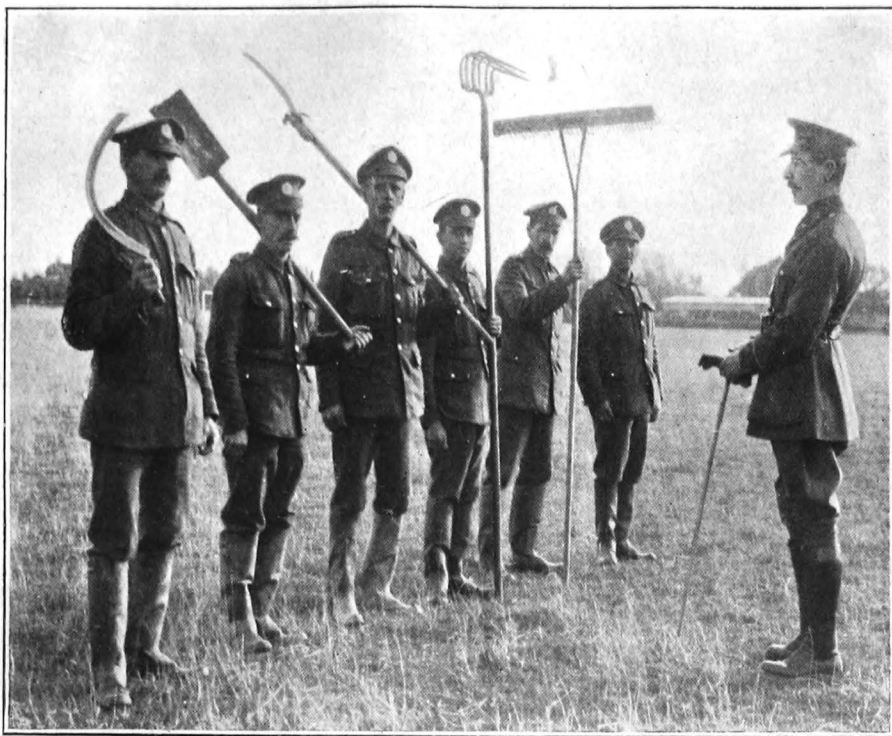


Plate XIII.

Shows a variety of tools used in anti-malaria work at Sandwich.

To face page 247.



Plate XIV.

Tenants' operations—part of work of "fleeting."

tion during 1918 suggests that it is done in September and October, after the dykes have given of their best to promote *Anopheles* development. The rate of pay on recent scales is one penny per rod. "Trowsing" consists of cutting out the roots of the reeds when the water is low, and throwing them on the banks or shores. This is done once in six or seven years, at a cost of eightpence to a shilling a rod for a whole dyke, and is evidently also done in autumn.

"Casting" necessitates the damming of the portions of the dyke to be operated on, baling out the stretch dammed, and throwing out the accumulated mud and silt upon the shores. This may be done only once in twenty years, or less often, and happens only where mud deposits in the streams from the taking in of fresh water from the river.

Casual water and sunken ground is joined up to dykes by the formation of narrow earth channels by the process known as "gripping."

The dykes contain fish. Roach are let in from the river at different times, and also tench, perch and jack enter the streams, although in the Lydden Valley, between Deal and Sandwich, fish are stated to be absent or very rare. Eels and stickleback are seen all the year round in varying frequency, and in spring months elvers and stickleback are to be seen in shoals.

The main streams and sewers are said to be flett in May, July, August and October, and observation throughout 1918 confirms that those in the Sandwich-area have been clear of growth, with well-trimmed edges, throughout the year.

The common dykes, however, have within and without the camp area been overgrown with weeds, in dyke and on bank, throughout the year till September and October, with small exception observed. It is optional on tenant and owner to attend to these. They are the immediate sufferers; in water-logged land, ruined fences, and lost drinking-places, and the Commissioners presumably can only compel operations on proof of transmission of obstruction to main streams or to the common dykes of others.

These dykes all throughout the district become overgrown with algæ and ulvæ, duckweed and *Azola*, grass and reeds, and various plant life, and form typical homes for the larvæ of *Anopheles maculipennis*.

It has been amply demonstrated that larvæ are found in vast numbers in the weed-covered dykes, and are not to be found in the clear and drained dykes.

The survey thus, briefly described—the nature and purposes of the dyke system, the character of the dyke; the malarial potentiality; the methods of keeping them clean for agricultural as well as anti-malaria reasons; the

local cost of operations—is the necessary preliminary of administrative and executive action. Proof is demanded to justify expenditure. Nine-tenths of cure lies in diagnosis.

To put into operation the machinery necessary to obtain the ends aimed at is simplicity itself, when conditions and aims are understood. And at Sandwich the major work of the Engineers and the so-named petty anti-malaria measures of the labour detailed under the local direction of Lieut. Edwardes, R.A.M.C., have been pursued on these principles and have secured excellent results.

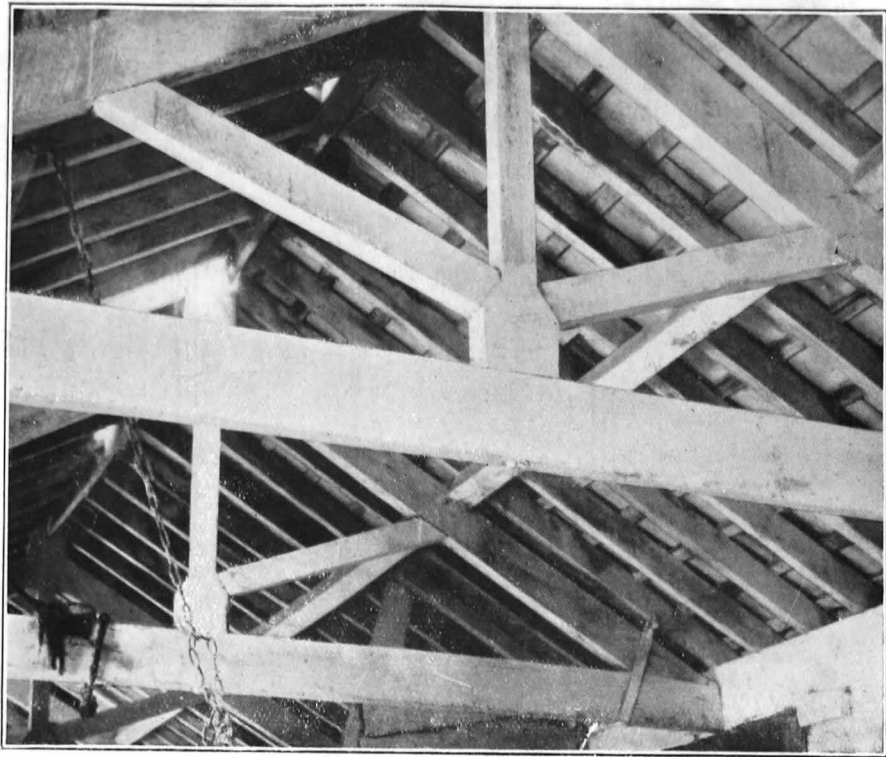
Anti-malaria Measures.

Major Operations of the I W and D. R E—These may be said to have been performed partly in the course of necessary engineering operations; partly with the design of improving by more efficient drainage the general salubrity of the camps, and also with direct anti-malaria intent. Extensive "casting" and deepening of lengths of dyke was undertaken; dykes were filled up and new drainage effected; a sewerage system was installed; low-lying ground was filled in, other parts were drained. In some cases the "casting" of dykes was carried out as a preliminary to the oversight of the anti-malaria detachment, and filling in, partially or wholly, of dykes considered unnecessary for drainage was carried out in the case of *Anopheles*-bearing dykes in central positions.

Petty Anti-malaria Measures

Mosquitos—There were practically no situations within the camp area which might be set down as the winter haunts of *maculipennis*, but observation of the presence of *Anopheles* throughout the winter in camp had been undertaken by the Sanitary Section. In the month of March, as a result of personal interview with farmers, dairymen, the civic authorities in Sandwich, and the officers in charge of stables in the town, attack was made on the adult *maculipennis* then sheltering in stables and cowsheds within recognised flight range of the camp area. Nearly all the stables in the town were in occupation by the military, and these were all lime-washed in the early months of the year. The presence of mosquitos was demonstrated in varying numbers in practically every situation inspected, to justify the request for action to be taken.

In the month of November, again, the labour staff working under Lieut. Edwardes is lending help to destroy mosquitos in the stables, cowsheds and other winter quarters around the camp area.



Stable ceiling cleared of cobwebs and limewashed. Sheppey.

Plate XVI.



Dyke drained and partly trained, 1918. In 1917 it was a quagmire of vegetation, and probably the chief breeding-place of local *maculipennis*.
Holm Place, Sheppey.

To face page 249.

Throughout the year persistent attack on mosquitoes in camp premises has been maintained, and careful record of their numbers, sex and distribution has been kept

Larvæ

The attack on larvæ has been a matter of systematised treatment of all breeding-places within the camp area and certain danger spots outside

To simplify control, and in view of the inevitable changes of sanitary officers rendered necessary by the demand for medical officers for service overseas, Lieut Edwardes, R A M C., was attached to the I W and D, R E, in charge of a special labour detachment supplied from the I W and D, R.E.

The main principles laid down for *Anopheline* limitation by the treating of breeding-places are here briefly outlined, and to their faithful carrying out may in great part be ascribed the comparative immunity from malaria infection evidenced in the Sandwich area

Principles

- 1 Reduction of open water to a minimum

Method.

- (a) Drainage of dykes and swampy areas to river at low water.
 - (b) Maintenance of dykes, &c, in dry condition by attention to sluices as water collects
 - (c) Partial filling of emptied dykes by planting of turf removed in agricultural work.
 - (d) Complete filling of all watercourses, backwaters, swamps and slack ground available
 - (e) Connection, by narrow earth channels, of swamps and slack ground to existing watercourses.
- 2 Conversion of still existing watercourses from being breeding-places or potential breeding-places to impossible or unlikely breeding-places

Method

- (a) Removal of vegetation from the bed of the watercourses and from the banks at water level, and leaving banks and bottom trained with earth surface.
- (b) Opening out, clearing of vegetation, deepening, training edges, and training banks of all backwaters, lakes, swamps, and slack ground not eligible for filling up
- (c) Maintenance of conditions attained under 2 (a) and (b)

The specific application of principles and methods to the Stonar Camps area was fully considered with the local authorities

Under (1) the drainage of dykes and their maintenance in dry condition was considered not practicable in general, but certain lengths were so treated by the R.E.

For some part of the year tidal flushing of a section of the dykes was controlled by the R.E., which aided the prevention of growth of vegetation in their channels. Filling up and drainage were part of the assistance of the R.E. in addition to the extensive casting of dykes already referred to.

The principle and methods suggested under (2) cover most of the petty anti-malaria work.

Roughly, about 20 miles of dyke, of an average of 5 or 6 ft. in width, have been under constant supervision. Originally it was estimated that one man per mile might be sufficient labour to set aside for this work, but experience has shown that, with the low-category men available and the width of water surface to be dealt with, two men per mile were found necessary. Forty men on the average have been occupied on the work, and other labour was from time to time provided to carry out drainage of low-lying ground, to perform partial fillings in, and to deal with ditches of the civil authorities outside the camp area.

While no limit was set to the extent of operations, provided labour was obtained, the main scheme of work was guided by the principle, first of all, of apportioning the labour to those areas where larvæ were actually found and of working out from the centres of population. On the map will be seen the chief centres in Stonar, Haig, Kitchener and Construction Camps, and the lengths of dyke coloured red indicate at the same time those actually incriminated by the finding of larvæ and under continued treatment and maintenance.

Some detail of the actual work done may be excused, considering the vital importance of it. And here it may be emphasised that frequently the simplicity and common sense of operations leads in conventional administration to their undoing. In anti-malaria work the reward for thoroughness is instant and almost magical.

Reference to the indigenous cases at Sandwich shows that the infection in all six is referred to Haig and Kitchener Camps, though No. 25 was probably infected on board a train ferry.

The area around Haig and Kitchener Camps was at first kept clear up to the Monks' Wall, and dykes by the Monks' Wall, being later found to be heavily infested with *Anopheles* larvæ, were then also kept under treatment.

The train-ferry berth lies within 400 yards of the Munster Brook, which was also only late in the season taken under treatment.

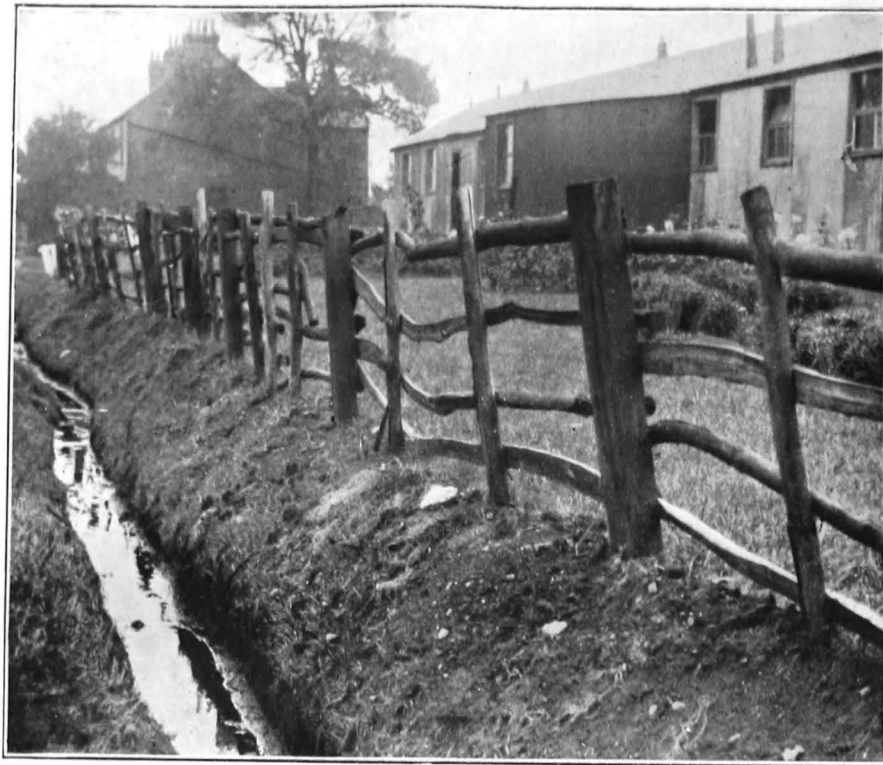


Plate XVII.

Roadside ditch cleaned and trained. Holm Place Camp, Sheppey.

To face page 250

Plate XVIII.



Cleared and trained dyke. In this condition larvæ of *A. maculipennis* are not found. Sandwich.

To face page 251.

Detail of Operations

The whole area was *mapped out*; ditches, ponds, swamps and all known or possible breeding-places were *numbered or named*, *districts were allotted* to labour squads under *responsible supervision*, the whole were under regular direction, and a *weekly report* of observations made and work accomplished was duly forwarded

Dykes were kept free from all plant growth, by cutting down, digging out and throwing on the bank, their edges were kept free of overhanging vegetation, margins broken by the treading of cattle were levelled and, where necessary, banked with shingle, earth sides and bottom were obtained, and free access of fish thus secured for edges and surface

Floating weed was swept up with net and basket, labourers in gum boots waded to perform this work, and incidentally removed many larvæ in throwing out the weed. An interesting variety of improvised tools was employed

Backwaters were filled in, and the continuity of the edges of streams was thus secured, others were cleared of vegetation and made part of the stream, with clean mud bottom and sides

Casual water was removed by filling in, other swampy ground was drained by channels, sometimes duplicate, which allowed one to be in use while the other dried up.

Reed-grown ditches were in some instances cleared and made into open-water channels, afterwards kept free of weed. (In wayside ditches containing no fish it was observed that *bifurcatus* larvæ were found in abundance after this operation, but always around the least collection of floating debris) -

Drainage channels were systematically swept, being gone over thoroughly once a week

Oiling was not resorted to. The efficacy of oil in destroying larvæ, by robbing them of the power of respiration, is open to ready demonstration both in the laboratory and in the field. In the field, however, under any meteorological and regional conditions, its practical utility demands its almost continuous usage. Under the agricultural conditions of the areas treated, its use was negatived. Nor was it of any avail on the weed-covered dykes in hand, until the same amount of labour had been expended in giving an unbroken surface, as was expended in demonstrating the disappearance of larvæ without oil

Chemical larvacides were used in rare situations on cut-off pools, such as sheep-dipping wells, &c.

Cupric sulphate was experimented with in order to have authoritative evidence of its value in destroying the vegetation in the dykes. Its destructive power was demonstrated under certain conditions in fenced-off waters, but, on account of

the lateness of the season, no conclusion is derivable until the observations are pursued throughout the winter and the coming summer.

Entomological Research.

To enhance the value of field observations, an experimental entomological laboratory has been carrying on work at Sandwich.

Many points in the bionomics of the *Anopheles* have to be cleared up to enlarge knowledge and justify administrative recommendations.

The results capable of attainment in this situation should prove of value, not merely in this country, but wherever malaria exists. Sufficient progress has not been made to allow any publication of results.

Screening of Huts.

Seven huts and a part of the hospital were screened with substantial wire screening on windows and with wired double doors. The huts were located throughout the camp area, and, besides accommodating actual known malaria carriers, they were sufficient to allow of segregation of returned Expeditionary Force men who had previously suffered with malaria and amongst whom carriers might still exist.

Pathological Work.

Of distinct value in the prevention of malaria is the early recognition of the case.

Blood examination of all cases of pyrexia of doubtful origin was carried out locally by Dr. Day, C.M.P., and the prompt recognition of case and carrier aided the consequent investigation, segregation and action generally, which brought about the total results of prevention.

2. SHEPPEY AND ISLE OF GRAIN.

The conformation of Sheppey presents a different condition of marsh area from that described of Sandwich. In the main the London clays and recent deposits of more sandy consistence constitute soil and subsoil. The Isle is bounded on the north by the River Thames and is surrounded on east, south and west by the Swale and Medway, connecting with the mainland by rail and road by Queen's Bridge at Kingsferry. A ridge of clayey-land, elevated some 200 ft., runs through the Isle from near Sheerness and Queenboro, on the west, to terminate in high land on the Thames at Swanley and Warden Point, and in marsh land at Leysdown on the east. To the south and west of the ridge there is an extensive area of monotonous flat land, which stretches from Sheerness and Scrapsgate on the north and west, along the



Plate XIX.

To face page 252.

Cleared and trained dyke. In this condition larvæ of *A. maculipennis* are not found. Sandwich.

Medway and Swale to Leysdown on the east. On the north by the river there is for the most part raised land, with cliffs of clay in a state of continuous disintegration by storm and tide.

The chief population of Sheppey is centred in Sheerness, Half-way Houses, West Minster and Queenborough, which lie on flat marshland.

The communities of Minster and Eastchurch and scattered farms and private houses are situated on the elevated ground. Over the marshland south and east there is little population except at Kingsferry, Kingshill, Elmley, Harty and Leysdown, where there are scattered farms and cottages, chiefly along the edge of the marsh. On the mainland, south from Medway and Swale, marshland extends from near Whitstable on the east to Gillingham and Chatham on the west, reaching on the south almost to Watling Street, which runs in a straight line, east by south, in its course from Chatham to Faversham.

The dyke system of Sheppey differs from that described of Sandwich area in that there is no fresh water supply by stream or river. The dykes are therefore practically stagnant the whole year round. Rain alone has to be depended on for maintaining the level of the dykes in summer, and I learn that drying up is not unusual. During the present year observation showed extensive stretches considerably lowered in level and some lengths quite dry.

Weed of similar description to that of Sandwich dykes covers the water surface throughout the year—ulvæ and algæ principally. The long streaming *enteromorpha intestinalis* was not so much in evidence, the surface ulva being of a more broken-up type. Clearing of the dykes by the tenants was not observed to any great extent. The salinity of the dykes was not investigated, nor was anything learned of their official custody. They seemed for the most part to be left untended, except where, on the larger farms, they extended through agricultural land.

The Isle of Grain is a small area of marshland, with trifling central elevation, lying west of the Medway opposite Sheerness, jutting into the Thames, and cut off by the Yantlet Creek and channel stretching from Thames to Medway.

Its population is settled along the highway, at Wallend and Grain, and by the railway terminus at Port Victoria. Its dykes are similar to and distributed relatively as those of Sheppey, and, in addition, there are extensive flat swamps and pools around Port Victoria.

Mosquito.

Adults.—*Anopheles maculipennis* has been found throughout Sheppey from February to December, in winter months in stables, &c., and from June to September in military huts

and bell tents, dwelling-houses, and in the usual winter situations. In the elevated area of the isle it is as widely distributed as in the marshland. The numbers found in Sheppey in the usual haunts exceeded those observed in any other part of the country. In December in certain situations there were fewer than in February and March, while in others the numbers were roughly the same at the end of 1918 as were found at the beginning. Around the situation of reduction measures of limitation had been in progress; elsewhere not. This estimate of their numbers, at beginning and end of the year in its winter quarters, may justify the assumption that *maculipennis* was practically as abundant in 1918 as in 1917.

Anopheles bifurcatus, male and female adults, were taken in the open at Warden Point in October, 1918.

In Isle of Grain *maculipennis* was taken in the usual winter haunts from March to November, and in military huts, barracks, and in dwelling-houses in summer months.

Larvæ—*Maculipennis* larvæ were taken in April, June and September. Larvæ of *bifurcatus* were taken from March to December.

In Isle of Grain *maculipennis* larvæ were taken in May and August.

Extensive and systematic continued search for *Anopheline* larvæ has not been made in Sheppey and Isle of Grain.

Man.

A military population has been distributed throughout Sheppey and Isle of Grain, equally on the elevated part of Sheppey and in the marshland on the west, and at outposts. The camps throughout have been in intimate association in varying degree with *Anopheline* conditions, and most camps have had a farm steading in close proximity or have been surrounded by farm buildings at no great distance.

Known malarial carriers were chiefly concentrated at Holm Place, Eastchurch, Warden Point and Leysdown, where screened huts were provided. At the stations of the Air Ministry at Leysdown and Standford Hill, Sheppey, and in Isle of Grain, known carriers were not retained.

The distribution of occurrence of indigenous malaria was at Holm Place, 13; Half-way Houses, 6; Tile Works, Queenborough, 6; Aerodrome, Eastchurch, 3; Scoles, 1; Neats Court, 1; Warden Court, 1; Aerodrome, Grain, 1; and Oil Tanks, Port Victoria, 2; being 31 cases in Sheppey and 3 in Isle of Grain.

It is elsewhere contended that on account of the concentration of troops at Sandwich in closely contiguous camps the danger of wholesale infection was real. In Sheppey the troops were scattered throughout the Isle on camps and



Plate XX.

To face page 254.

Cleared and trained dyke. In this condition larvæ of *A. maculipennis* are not found. Sandwich.

detachments, and while the same extensive infection was not to be feared, there was considerable danger on each camp in the presence of carriers. The minimum number of infective foci in Sandwich was probably three, in Sheppey probably eleven.

The known carrier distribution throughout the potentially infective months in Sheppey is reported to have been:—

Month.	Location.					
	Sheerness	Minster	Leysdown, East- church & Warden.	Queen- boro'	Isle of Grain	Holm Place
1918—						
May ..	94	3	134	40	11	209
June ..	115	1	170	35	13	218
July ..	159	1	170	7	17	196
August ..	125	—	166	—	16	42
September ..	—	—	4	—	12	30

Screening.

Screened huts were provided on all locations of danger where known malaria carriers were accommodated. Screening had been adopted at Holm Place Camp in 1917. It cannot be said that screening was perfect, as weather conditions repeatedly disturbed the muslin screening, and *Anopheles* mosquitoes were on different dates taken within screened huts.

Mosquito Destruction.

Captain Linton, R.A.M.C., S.S.O., Chatham District, directed anti-malaria measures, which were carried out locally with faithfulness and enthusiasm by Captain Clark, R.A.M.C., then M.O. 1/c Troops, Holm Place. Destruction of mosquitoes in their winter haunts was commenced in March, 1918. A detachment of R.A.M.C. men was specially given for anti-malaria operations. The farm steadings around the camps were variously treated; mosquitoes were swept and driven out in the cold weather, fumigation by smoke was resorted to, and extensive limewashing of stables, &c., by hand and by sprayer has been carried out.

The assistance of Dr Wigglesworth, M.O.H. for Sheppey, was of great advantage in influencing the farmers to have work done on the premises.

Larvæ.

The same principles as were advocated for adoption in dealing with the Sandwich area were accepted and pursued in Sheppey. Owing, however, to the scattered distribution

of camps, to the varied authority, and to changes in R A M C personnel, continuity, concentration and precision of sanitary operations were not attained

Around Holm Place and the Tile Works, Queenboro', ditches were cleared and trained; ponds were drained and filled in; dykes were drained and cleared; and a considerable length of dangerous roadside ditches was kept in safe condition.

At Warden Court, Eastchurch, the stations of the Air Ministry and on other camps and detachments, as Kingsferry, good anti-malaria work was done, under the direction of the officers in charge

3 LYDD AND ROMNEY

The picture of Lydd and Romney on the map, standing in the midst of Romney Marsh, with intersecting dykes in apparently intimate connection with town and camp, makes facile suggestion of extreme malaria danger. *Anopheles maculipennis* is abundant, and *Anopheles bifurcatus* is found with frequency; but the absence of occurrence of malaria amongst the civilian population and the discovery of only two indigenous cases in 1918 and in 1917 one, probably attributable to local infection, indicates the need for precision of observation before either specific administrative action is undertaken or its hopelessness is asserted.

In Romney Marsh the dyke system has originated, beyond historical record, in the reclamation of extensive estuarine deposit, rendered practically lacustrine as a result of the drifting up south and east of shingle banks or "ripes" and the alterations of outflow of the river Rother. There is interesting historical record of phases of reclamation, of shifting of populations and of commercial rearrangements, as well as of recession of sea.

The nature and distribution of dykes prevents the same control over their level by inlet of river water as is attained in the Sandwich system. The result is that, as in Sheppey, the level of the dykes is determined by direct rainfall, and in dry summer seasons the whole system may be dry back to the military canal and in the flats higher up the Rother. This absence of river control, perhaps, also accounts for the evident absence of continuity in the dyke system, especially observable around Lydd. Stagnant dykes with dead ends are not infrequent, and tracts of pasture land show evidence of filling up of lengths of dyke artificially or by long-time neglect and overgrowth.

The depth of alluvium is less and its consistence less retentive of moisture than at Sandwich; so that as there is usually in summer no need to lower the water level, and in many parts not much necessity to do so in winter, the concern