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HOW TO LIVE

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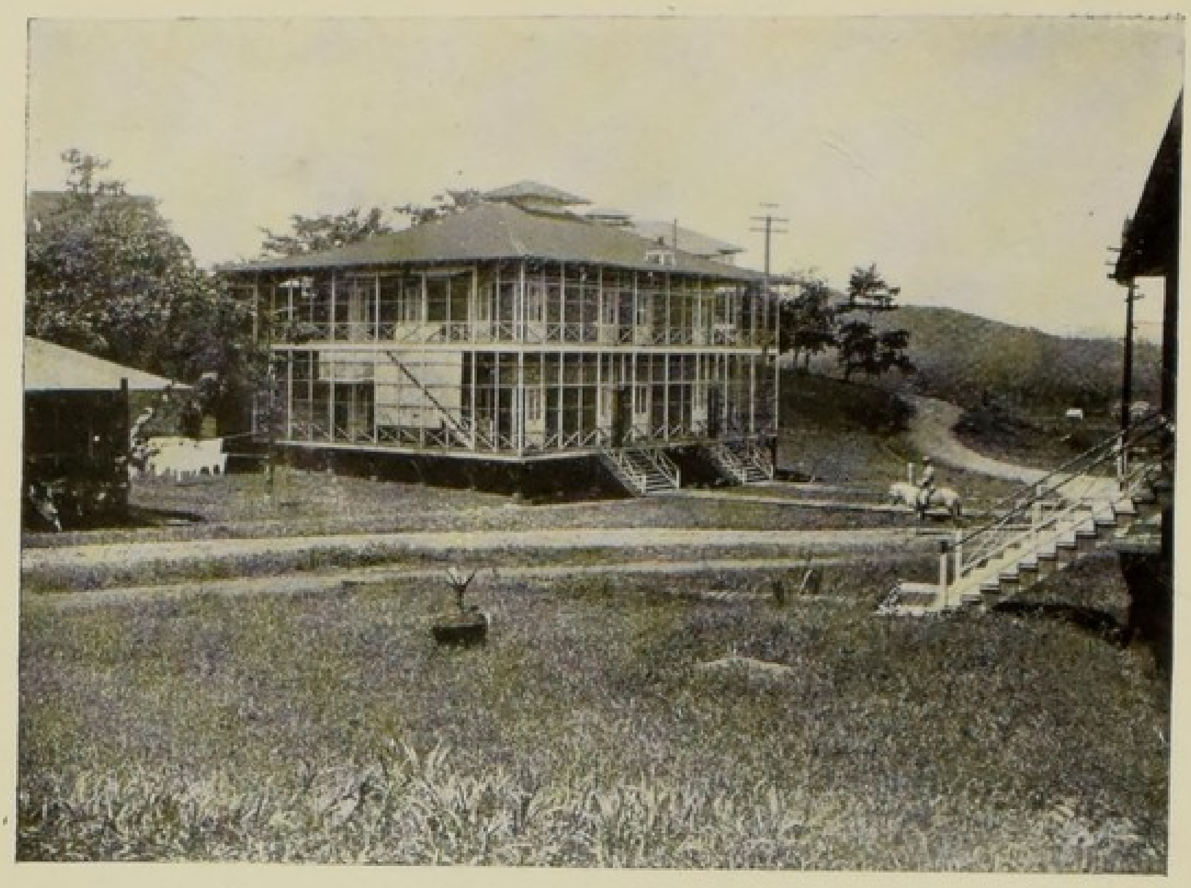

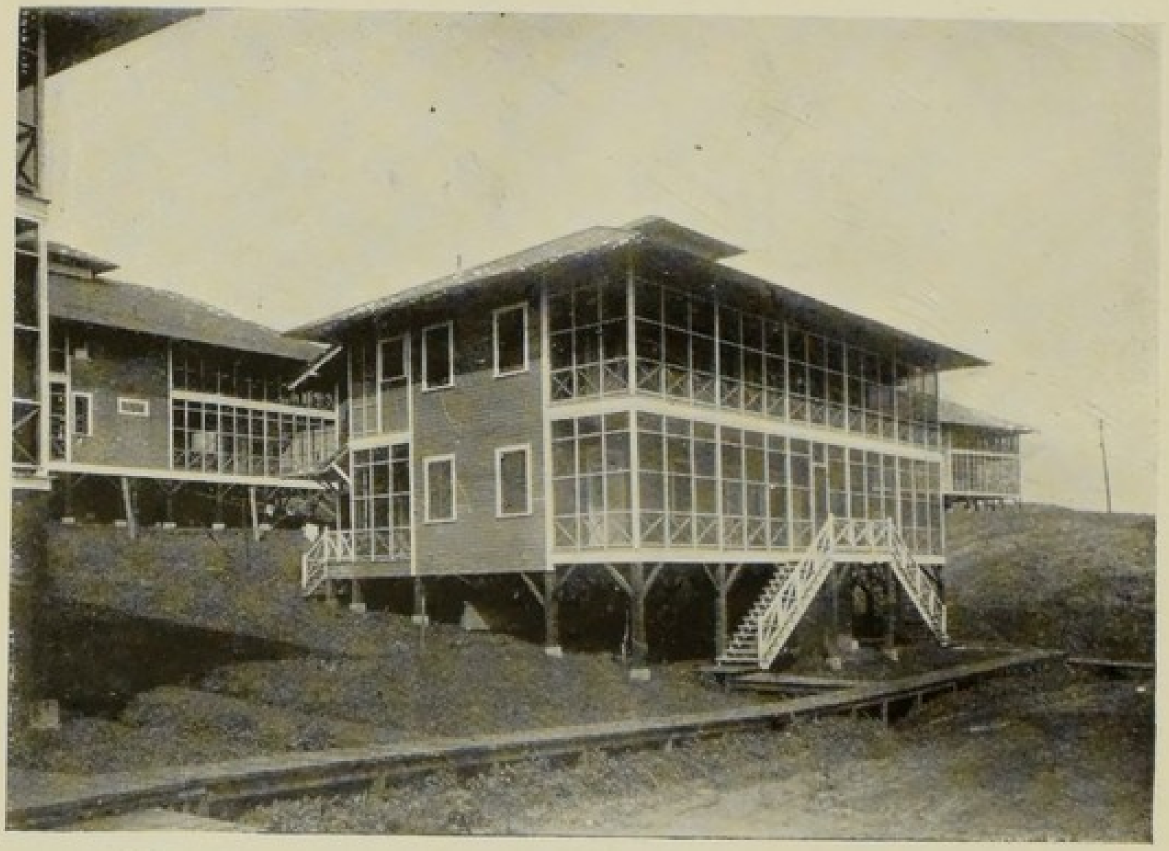

THE NEW TYPE OF MOSQUITO-PROOF HOUSE AS NOW IN USE IN THE PANAMA CANAL ZONE.

For these photographs of two types of screened houses in the Panama Canal Zone, I am indebted to the courtesy of Mr. Joseph Bucklin Bishop, Secretary Isthmian Canal Commission, Ancon-Panama Canal Zone.

HOW TO LIVE

IN

TROPICAL AFRICA

A GUIDE TO TROPICAL HYGIENE AND SANITATION.

The Malaria Problem: The Cause, Prevention, and Cure of Malarial Fever.

BY

J. MURRAY, M.D.

Maps and Climatological Memoranda by E. G. Ravenstein, F.R.G.S.

EDITED BY

LEO WEINTHAL, F.R.G.S.,

Chief Editor of THE AFRICAN WORLD, London.

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[1912]

This Book is

Respectfully Dedicated to

the Memory of

Sir Alfred Jones,

Founder of the

Liverpool School of Tropical Medicine.

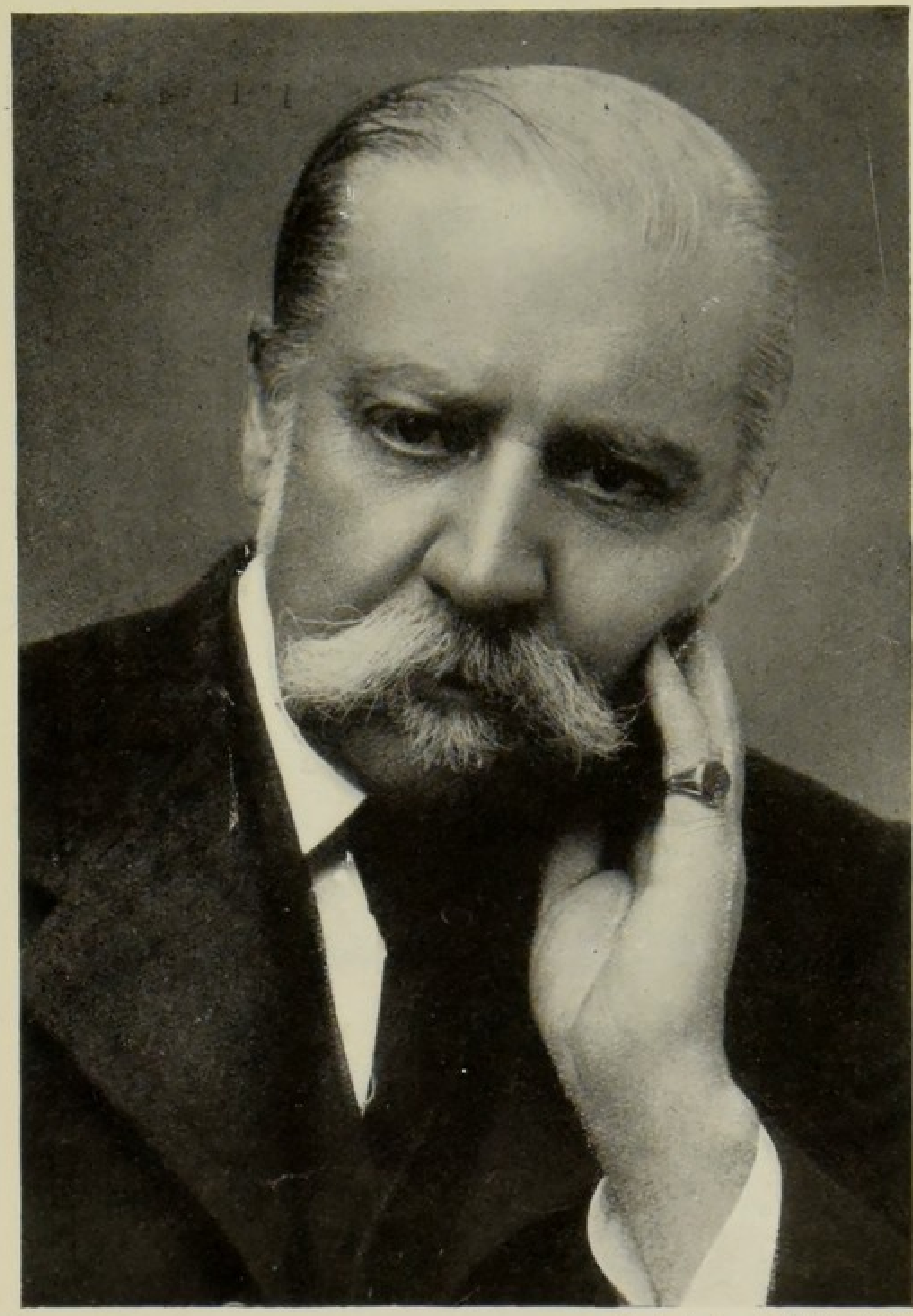


Photo by Leo. Weinthal, 1910.

The Late SIR ALFRED JONES, K.C.M.G.

(Founder of the Liverpool School of Tropical Medicine).

Si monumentum quæris, circumspice.

A brief reference to his work appears on page 199.

INTRODUCTORY NOTICE.

The aim of this Book is to deal with the problem of "How to Live in Tropical Africa" on the following system:—

I.—To sketch in broad outline, from the sanitary view-point, the geography of Tropical Africa, including the climates, physical features, and other conditions of the territories, especially those under the British Crown.

II.—To deduce from the present state of our knowledge concerning these matters the sanitary and hygienic principles and practice suitable for these regions, and,

III.—To lay down, with proofs and observations in support of the conclusions arrived at, the best scheme of life, physical, intellectual and moral, also the best diet, clothing, dwelling and work for the preservation of health and vigour.

IV.—To describe the symptoms, etiology, and pathology of malaria chiefly, and of a few other lethal diseases, that effectively closed the door of Africa through the ages against European civilization.

V.—To indicate the present-day scientific treatment of malaria and other insect-borne diseases, especially the sanitary and medicinal methods found most effective for their prevention.

VI.—To take into account from the foregoing points of view the conditions of existence of Europeans in different regions of Tropical Africa with a view to their amelioration.

Conscious that in proportion to the scope, high aim and difficulty of the subject so is the fallibility of its treatment, I have taken the greatest pains to select and weigh every fact and statement in this book, and to test them by reference to the highest authorities.

I have courted Truth in all ways, and tried to impart valuable information in every page, so I humbly trust that, despite its defects and deficiencies, this little book will prove a reliable and useful guide to "HOW TO LIVE IN TROPICAL AFRICA."

J. MURRAY.

January, 1912.

A FOREWORD

BY

SIR HARRY JOHNSTON, G.C.M.G.

Some years ago I contributed a Prefatory Note to an earlier work by Dr. J. Murray, on the difficulties attending life in Tropical Africa for men and women of European origin, and on the ways by which in some measure these difficulties might be overcome.

The book which is now being published by the *African World* is a much more extended study by Dr. Murray on "How to Live in Tropical Africa." Since Dr. Murray's first work saw the light great changes and developments have taken place in all the tropical regions of the globe. New diseases, like sleeping sickness, have come under our notice, forced on our attention, as it were, by the penetration of the white man into the farthest recesses of Congo, Liberian, Central American, and Malaysian jungles and forests. The vast area of the Bahr-al-Ghazal swamps, the lagoons of the West African coast, the mangrove rivers of the Niger Delta, the immense and dreary deserts of the northern Sudan and of S.W. Africa, have been penetrated, traversed, and lived in by the white man with results both good and bad: good for the world's commerce and the trade of the natives, bad for "free trade in disease." Sixteen or seventeen years ago Africa was still divided up into water-tight compartments, semi-civilised states or native communities separated from each other by dangerous wildernesses, and by various forms of human hatred and enmity of man to man. The lack of easy and frequent intercommunication did much to keep at bay the epidemics of disease in man and beast.

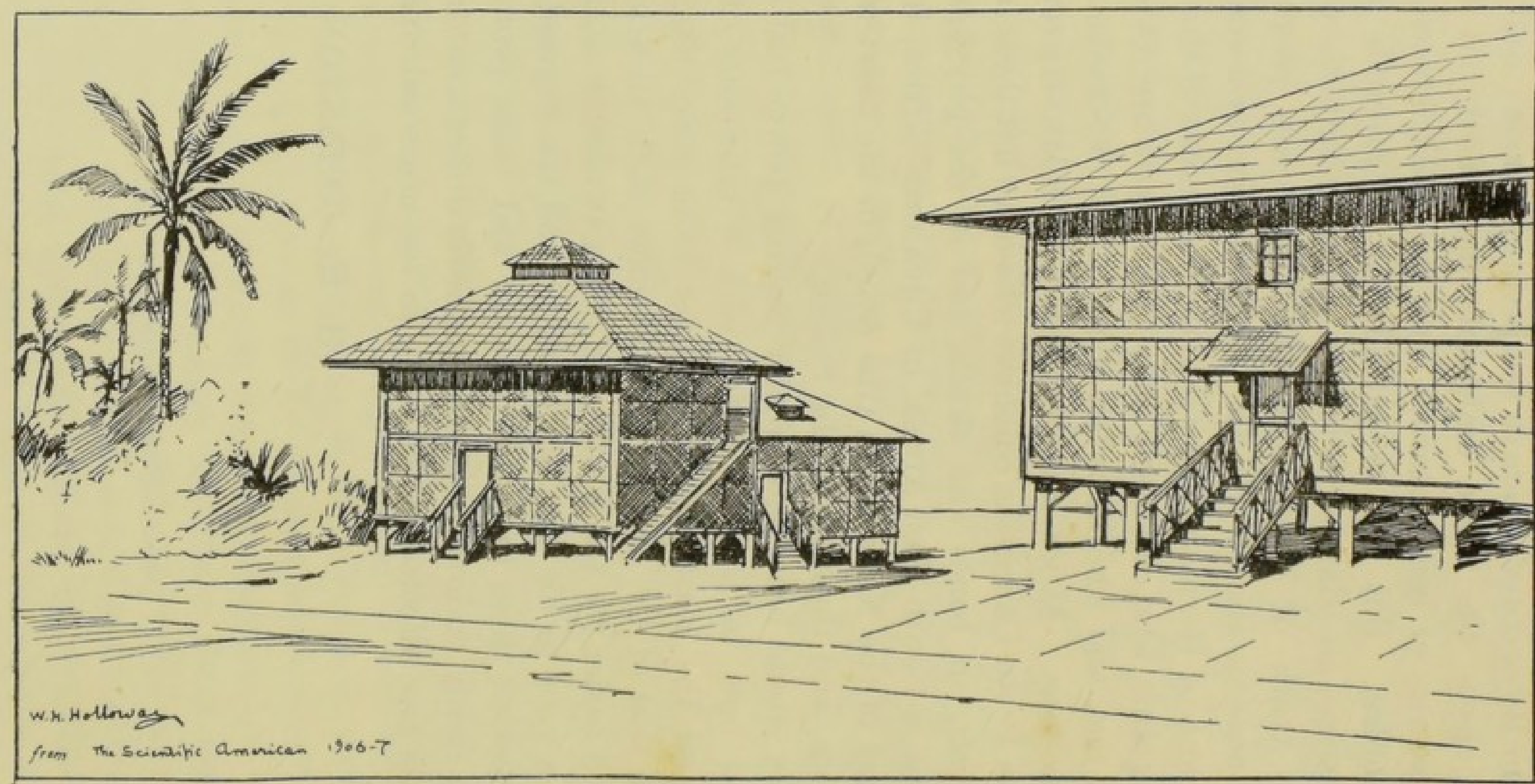
All this is altered now. On the whole the ratio of health among white men has greatly improved in Tropical Africa, and their death rate has diminished. The health of the native has probably been temporarily worsened, by the throwing open of all routes and the mixing of one negro or negroid type with another. There are still all-too-numerous insects and ticks in all parts of Africa ready to act as the transmitting agencies of germ disease from one naked, careless negro to another. But although books like that of Dr. Murray will go far to enlighten the white man on how he may order his mode of life in Africa so as to fulfil his work there and not leave his bones in the Dark Continent, books on African hygiene are of still greater importance to the educated negro and negroid. For, with a few rare exceptions, there are but scant proportions of Tropical Africa, between the Zambesi on the south and the 25th degree of N. latitude on the north, wherein the white race may hope to plant permanent colonies of its descendants who will become as much people of the soil as the Boers and Afrikanders of South Africa, and the Berbers, French, Italians, Spaniards, and Maltese of North Africa. The combined heat of the sun and moisture of the rains will in Tropical Africa, as in Tropical Asia and America, long prevail against the science of the white man to prevent the latter from colonising the tropics and completely displacing the races of coloured skin.

But the rôle of the white man in the tropics is nevertheless one of arch-importance in the world's development. He must come—unconsciously as much as consciously—among the coloured races as a missionary to induce them ever and again to resume the struggle against the blind and brute forces of nature. We think that this is a new movement of the white man, most active and evident in the nineteenth century; as a matter of fact, it began in the remote ages of pre-history. Over and over again the white or Caucasian race has penetrated into the equatorial regions of the Old

World from its original home in temperate Eurasia ; and over and over again the white emigrants have died out from tropical diseases, or been absorbed into the black, brown, and yellow peoples. But not so entirely as to preclude their leaving vestiges on islands, in forests, or on mountains which attest the truth of these theories. There are people of remote Caucasian ancestry in the islands off the west coast of Sumatra, and of German New Guinea : remnants of the bold white emigrants who colonised parts of Malaysia and Oceania long, long ago, and who have left their mixed descendants in the Polynesians. Africa was permeated, in relatively remote times, with Proto-Caucasian colonists who have left their traces in handicraft, in bones and skulls, and in the physique of living races in South-East Africa, in Equatorial Africa, in the eastern part of the Niger Delta (the Aros), in the heart of the Congo basin, and throughout the Sudan.

But they would have had greater staying power had they understood how to live in Africa with a minimum of discomfort and the least possible danger from germ diseases. Books like that of Dr. Murray should make such an achievement much easier for the white man of the twentieth century. Not with a view to his ousting the negro and the negroid, but to his educating them to make the best and most profitable use of the richly endowed but confoundedly difficult continent which Fate has allotted in the main to the negro sub-species.

H. H. JOHNSTON.



TYPE OF SCREENED HOUSES AS USED IN THE PANAMA CANAL ZONE.

AFRICA, 1909-1910.

From "The Statesman's Year Book, 1911."

Africa.	Area, Sq. Miles.	Population.
Ascension	34	120
St. Helena	47	3,558
West Africa—		
N. Nigeria	256,400	7,614,751
S. Nigeria and Protectorate	77,260	6,500,000
Gold Coast and Protectorate	119,260	1,697,000
Sierra Leone Protectorate...	30,000	1,252,000
Gambino Protectorate ...	3,619	154,330
Total W. Africa ...	486,539	17,218,081
Mauritius and Dependency	835	380,144
Seychelles	156	21,982
Somaliland...	68,000	348,086
E. African Protectorate ...	175,518	4,000,000
Uganda Protectorate ...	223,500	2,764,086
Zanzibar	1,020	250,000
Nyasaland	43,608	997,217
Union of S. Africa—		
Cape of Good Hope ...	276,995	2,507,500
Natal	35,371	1,206,386
Transvaal	110,426	1,269,951
Orange Free State... ...	50,392	466,380
Total Union... ..	473,184	5,450,217
Rhodesia	439,575	1,604,875
Swaziland	6,536	85,491
Basutoland...	10,293	348,848
Bechuanaland	275,000	134,000
Total Africa... ...	**2,203,915**	**33,606,805**

BOOK THE FIRST.

GEOGRAPHY.

CHAPTERS I. TO IV.

CONTENTS.

Book the First.

Chapter I.

Chapter II.

CHAPTER I.

The Physical Geography of Tropical Africa.

Looking on the Relief Map of Africa (p. 10) we are struck by the massiveness of the continent and its unindented contour; its coastline measuring 15,000 miles only, against 19,000 of European seaboard, notwithstanding that the area of Africa is thrice as great.

The average altitude of Africa, whose sea-level is also greater than that of Europe.

Again we notice that seven-tenths of the whole continent lies within the torrid zone and that it is cut through near the middle by the Equator, and is unique in being the only continent which extends unbroken from north to south tropics, and therefore shows the largest hot surface of any country on the globe.

If we were able to view the whole vast continent lying beneath us, we should observe its contour of low-lying littoral, in places a few miles, in others over a hundred in width, here a strip of sandy beach backed by woods, and again a swamp, jungle, or russet, scrubby plain. Sometimes it widens, as on the east coast, into savannas, rising slowly from the sea and extending monotonously inland—a dreary region to be painted in sober greens, umbers, and sepia, as befits the abode of the wild beast, reptile, and mosquito, and the true home of malaria. At Benguella, this strip is only a few miles wide, and generally from the Cameroons to th Cape ranges of mountains and tablelands, forming the subsidiary axis of the continent, there is but a narrow margin between their bases and the sea.

From such a coastline, we observe, rising on the eastern side of Africa, the great mountain chains which constitute the main axis of the continent, and which extend from the northernmost point of the Abyssinian Highlands and the Horn of Africa, N. lat. 17°, to the southern foothills of the Drakensberg, S. lat. 32°.

This axial range is not continuous from N. to S.S.W., like the unbroken wall of the Rockies. At the Equatorial region it opens out like the strands of a half-untwisted rope, upon which, to continue the simile, the lofty peaks of Kilima-Njaro (19,700 ft.), Kenia (18,370 ft.), and Ruwenzori (18,000 ft.), covered with eternal snow, stand out like knots amidst the tangle of lofty ranges, separated by deep fissure valleys trending north and south from the Equator. Of these great "Rift Valleys," formed, as Sir Harry Johnston observes,* by a mighty wrinkling of the earth in some remote geological age, Lakes Baringo, Naivasha, and Ayasi, which extend due north to Lake Rudolf and the valley of the Omo River, are the most noticeable, separating Kenia and Kilima-Njaro from the Western Highlands and the Victoria Nyanza, a lake 3,608 ft. above sea level. The great fissures to the south of the Victoria Nyanza give origin to Lake Nyasa (1,300 ft. above the sea) and Tanganyika (2,756 ft.), and on the west to the Albert Edward Nyanza (3,307 ft.), and Albert Nyanza (2,400 ft.), and on the north to the proximal end of the valley of the White Nile (Bahr-el-Jebel).

Although the littoral lowland ends more abruptly on the west than on the east coast in plateaux of 3,000 to 4,000 ft. elevation, the highest land level is throughout nearer the east coast. All over the southern interior heights of from 3,000 to 5,000 ft. are the prevailing feature, while plateaux of 6,000 ft. and upwards are rare, save in the Equatorial zone already

* *The Nile Quest*, by Sir Harry Johnston (1903).

referred to, and the highlands of Abyssinia and the Drakensberg. The interior of Africa, in short, presents every variety of feature, from elevated savannas to deep wooded valleys and lands of moderate altitude.* Everything is on a colossal scale, from its mournful, silent deserts to its forests and savannas teeming with life and exuberant fertility. Desolate wildernesses of rock, gravel, and sand, clays and marls, bearing stunted and prickly vegetation; boundless prairies, illimitable forests, sea-like lakes, mighty rivers, sunny park lands, and weird kopjes alternate with valleys of ravishing beauty and mountain scenery sublime in its stupendous and desolate severity.

The Niger, the Congo, the Nile, and the Zambesi form the four great river systems of the continent, and it is remarkable that all four approximate at their source, and that they are so linked by numerous lakes and navigable reaches as to form water highways all over the habitable regions of the continent.

South of the two million square miles of the Sahara Desert lies the green band of "pastoral" or steppe country, called the Sudan, extending right across Africa from Senegambia to Abyssinia, and including the Lake Tchad region. From the Sudan the country merges (about North lat. 10°) into the great central plateaux region. The great catchment basin of the Congo falls from these plateaux to 1,000 ft. altitude about its middle, where the Aruwimi and many other affluents join it. The great forest of the Congo, large as the whole of France and the Iberian Peninsula—as Stanley has told us—here occupies an area of from 5° to 10° of latitude N. and S. of the Equator. Other chains of lofty mountains, culminating in Cameroon peaks (13,000 ft.), run along the west coast, showing gaps for the outflow of the Congo, Niger, Benue and smaller rivers, while north of the Guinea coast the Kong and many other chains of mountains run parallel to the coast, or

* *Ency. Americana.* Art., *Africa.* I am greatly indebted to this book for valuable information of all kinds.

trend across Nigeria into Senegambia, between which steppes from 5,000 to 7,000 ft. high are interspersed. The Guinea coast ranges are generally densely wooded.

Mountain ranges continue all along the coast from Cape Lopez to a little north of Cape Town, with a large gap for outflow of the Orange River.

The fertile uplands of tropical Rhodesia mostly preserve the characteristics of the southern veldt country, but in other areas they are robed in rich tropical vegetation.

Lastly comes the temperate veldt, including part of Bechuanaland and all of the Transvaal and Orange States, now happily united under the beneficent ægis of the British flag—a region renowned for its pastoral and mineral riches, extending like an ocean of verdure from the tropics to the cool and fruitful regions of the Cape Colony.

Geology.

Much of the catchment areas of the Congo and Zambesi belongs to the Mesozoic or Secondary Period, when clays predominated. The same geological feature prevails along the east coast, from Cape Guardafui to the Drakensberg, and bending in at the rivers, covers most of the low-lying marginal zone and river bottoms, where the clays blend with decaying vegetable matter, making a rich soil and *humus*, which, when uncultivated, is very unhealthy for European settlement.

Archæan and eruptive rocks form the main and subsidiary axes of the continent, and also a considerable part of the central plateaux.

The sandstones and limestones of the plateaux, produced from disintegration of primary rocks, are healthy if the drainage be good. A dry, healthy soil is the general characteristic of limestone country, which readily absorbs moisture and also neutralises the products of vegetable decomposition.*

The Palæozoic areas, in which limestone abounds, form a considerable part of the plateaux of moderate elevation in Central Africa.

The tertiary formations which form the coast line in places need not be considered here, as they possess no marked influence on its salubrity.

This brief glance at the geology of Africa tends to strengthen the opinion of Silva White,† that "the highland countries along the main axes of the continent and the central plateaux are the most favourable regions, both from climatic and political reasons, for European settlement, and for effectively controlling the destinies of Africa."

Clays and clayey loams are bad sites for building upon, even in elevated positions, because all clays are an absorbent of, and contain and retain, large quantities of water; also it takes much sunshine to warm them, and they part with their heat so slowly that they are cold in sunless weather. Puddles suitable for the Anopheles mosquitos to breed in are sure to be left on clayey soil after rain, and this above all else renders such soils dangerous in Tropical Africa.

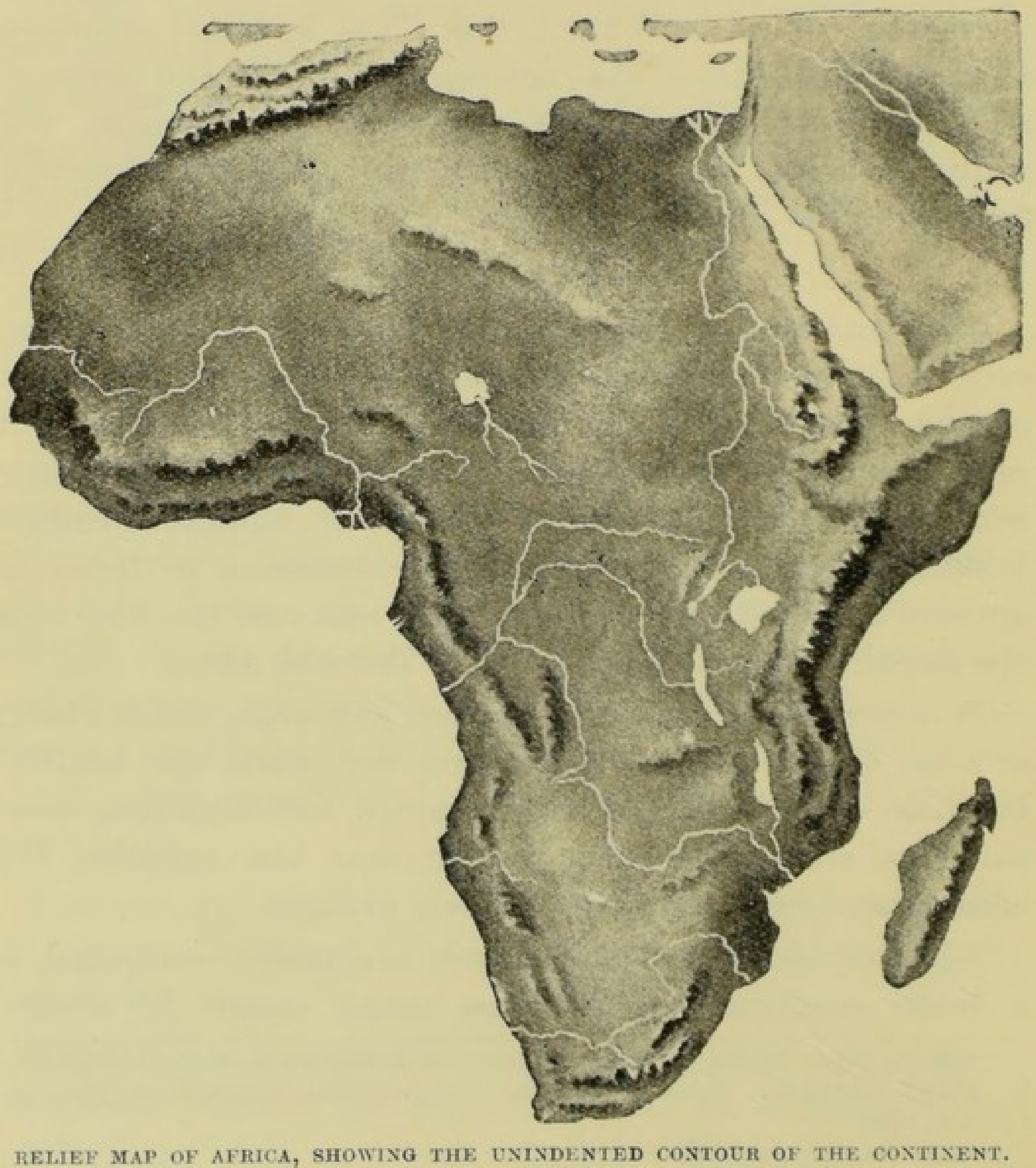
Porous soils, on the contrary, such as gravels, sands, chalk, or other porous subsoil rocks, form dry, warm and healthy building sites, being naturally drained, and admitting sunshine and air with more or less freedom, also radiating the accumulated heat of day quite freely at night.

Silica, of which sand and gravels are mainly composed, is a better conductor of heat than many metals (Tyndall);

* See a paper *On the Influence of Clays and Limestones on Medical Geography* by Alfred Haviland. Read before the International Congress of Hygiene, London, 1891.

† *The Development of Africa.*

hence sandy and pebbly soils are easily raised to a high temperature by solar heat, and so thoroughly dried that pools of surface water occurring after rains are very quickly evaporated or absorbed. This is the essential point, as it tends to limit the propagation of the disease-bearing mosquitos. The quick and high heating of such soil by day and its equally quick cooling by night tend also to prevent certain fungoid growths in the soil which are inimical to health.



RELIEF MAP OF AFRICA, SHOWING THE UNINDENTED CONTOUR OF THE CONTINENT.

CHAPTER II.

General Medical Climatology of Tropical Africa.

PART I.

"*Climate affects the health and happiness of people more than any other condition that goes to making up environment.*"

—*Ency. Americana.*

If this be so, a careful study of African Climates should possess a vital interest for all who visit or reside in that country.

DEFINITION.

By CLIMATE is now understood the solar, telluric, atmospheric and electric phenomena which combine to produce certain conditions on a given portion of the earth's surface. It implies *records* extending over a long period of time, whereas *Weather* is the physical conditions observed for a brief period only—we talk of to-day's "Weather"; of the "Climate" of Britain.*

FACTORS OF CLIMATE.

The factors which constitute Climate are very numerous, and should be understood to enable us to form at least *prima facie* knowledge of the healthiness or otherwise of a country or locality. Dr. W. Hale White enumerates the essential factors of climate as follows: †

(1) Latitude, (2) Temperature, (3) Sunlight, (4) Humidity,

---

* *Ency. Americana.*

† *A Text Book of General Therapeutics.* By W. Hale White, M.D.

(5) Rainfall, (6) Elevation, (7) Cold and Purity of Atmosphere, including Rarefaction, (8) Wind and Ozone, (9) Electricity, (10) Soil, (11) Aspect, (12) Vegetation.

Of Latitude, Temperature, Sunlight, Heat, as Affecting Climate.

THE PHILOSOPHY OF CLIMATE.

The slope (κλίμα) or aspect of any land, as of a mountain side, or the position of a house, determines the amount of daily and yearly sunshine it receives, and thus becomes an important factor in its climate. Even the opposite sides of a wall may in this respect have different climates; on one side we may have well-ripened wall-fruit, on the other nothing will grow to maturity.

In Africa the highest temperature is not found, as might be theoretically expected, under the Equator, but near the tropics ($23\frac{1}{2}°$ N. and S.), which is chiefly accounted for by the lengthening of daylight as we recede from the Line, and also by "the lagging of the sun in this part of the ecliptic."

After his passage of the Equinox he travels through 12° of latitude during the first month, 8° during the second, and only $3\frac{1}{2}°$ during the third month, when 20° distant from the Equator; and as he recedes at the same rate, the zones of Cancer and Capricorn are exposed to about three months' almost vertical sunshine during their summer Solstice.

Also the Solar energy is 7 per cent. greater in the southern than in the northern hemisphere at perihelion, which occurs in December, but owing to the narrowing of the southern end of the African continent, and the influence of the ocean on either side, seasonal extremes are modified.

TEMPERATURE.

Temperature is materially influenced by proximity or otherwise to the sea or to large bodies of inland water, which affects climate by its specific heat, which is five times that of land. Water, therefore, heats and cools much more slowly than land, and therefore seaside places, fanned by cooled sea breezes in summer, and warm sea breezes in winter, have their climate equalised.

The temperature of the prevailing winds, and their force and frequency, also the shelter of hills, and many other atmospheric and physical causes affect climate.

A moist, cloudy atmosphere, as we find on the Gold Coast and in the "Doldrum" latitudes generally, by screening the earth from direct sunshine for much of the year, also by the saturated atmosphere being more or less opaque to the heat rays of the sun, produces an equable, muggy climate, quite different to the inland steppe climate of similar latitudes. This cloudy and moisture-laden atmosphere, in addition to its comparatively low altitude (1,000 ft.), is the cause of the mild, equable, muggy climate of the Great Forest of the Congo. Terrestrial radiation is also diminished in this forest zone by the leafy shade.

But on the elevated tropical table-lands of Africa, as elsewhere, the nights are usually clear and cool, sometimes frosty, from the rapid radiation of heat from the earth into a cloudless sky.

PART II.

Climates of Numerous Places in Tropical Africa.

Ravenstein,* in his paper read at the Oxford meeting of the British Association, 1894, has adopted the isothermal of 72° F., mean annual temperature, as a practical thermal boundary between the hot and temperate regions of south tropical and sub-tropical Africa.

This line begins at St. Lucia Bay in Zululand, and reaches the Atlantic at Cape Negro, to the north of the Kunene River. In the centre of the continent, influenced by the elevation of the land, it extends far into the basin of the Congo. It skirts the plateau of Mashonaland, ascends the Zambesi River to within a short distance of the Victoria Falls, encircles Lakes Nyasa and Bangweolo, and near San Salvador (mean temperature 73°) it approaches close to the lower Congo River.

All to the south of this line the mean temperature is lower than 72° F., and in the highlands, coloured black on the accompanying map, it descends even below 57° F.†

At the Cape we have a mean annual temperature of 60° to 63° F., an average maximum temperature of 80° to 85° F., and a mean humidity of 70 per cent. On its coasts the mean summer heat is 68° F., and the winter mean temperature 56° F. Cape Town has a mean temperature of 61° F.

In the Orange Free State and Transvaal, with elevations of over 4,000 ft., the average maximum temperature is 82° F.,

* See *Mean Temperature* map at the end of this chapter. All these maps are based on the most recent observations, and some of the information embodied in *Maps* and *Tables* is new.

† See Mr. Ravenstein's *Mean Temperature* map.

minimum 55° F., and humidity 55 per cent; but the exposed thermometer frequently rises to above 100° F. in the summer, and falls below freezing, on these elevated plains, in winter. Bloemfontein, at 4,535 ft. elevation, has a mean temperature of 59° F., and Pretoria 67°.

At Durban we have a maximum temperature of 78° F., a mean temperature of 69°, an annual range of 12°, and a daily range of 14°, the relative humidity being 74 per cent.

In the Upper Karroo and Kalahari Desert, and neighbourhood, with an elevation of 2,000 to 3,000 ft. above the sea, we have the extreme of South African dryness; a rainfall in places under 10, and in others under 5 ins. This is the land of drought and thunderstorm, with a summer maximum temperature of over 100° F. in shade, while frost is at certain seasons registered in the starry stillness of the winter nights.

Bechuanaland, with less altitude, possesses a climate somewhat similar to, but drier and warmer than, that of the United States of South Africa.

At Lake Ngami (3,000 feet) July is cold, and the mean temperature under 72°. October and November are the unhealthy months in Khama's Country.

Tati (2,630 ft.); Mangwee, Lees Castle (3,700 ft.); Matoppo Hills, by Bulawayo (3,800 ft.); Fort Victoria, by Zimbabye (3,670 ft.); Fort Charter (4,750 ft.); Fort Salisbury (4,960—or by others 5,050 ft.); all enjoy a mean annual temperature of about 65° F.

Colonel Goold-Adams says of Bulawayo:—"It is a very healthy country. We had over 600 men in this country for eight months, and during the whole time lost not a single man from sickness, though they slept out on the veldt." The rest of the immortal little British force had like experience.

The hilly parts of German South-West Africa are described as exceptionally favourable to European constitutions. At Rehoboth (4,550 ft.) the mean temperature is 67°, with an annual range of 28°, and a rainfall of about 11 inches.

In the Balonda Country, Livingstone found the shade thermometer to register from 42° to 52° F. in the early morning, and 94° to 96° at noon, a mean difference of 48° between sunrise and mid-day.

In the interior of the Gold Coast (500 ft.), in forest clearing in an unsheltered board-house, the range on certain days was from 85° and upwards at mid-day, to 50° and under towards early morning.

"We were struck by the fact that, as soon as we came between the range of hills which flanked the Zambesi, the rains felt warm. At sundown the thermometer stood at 82° to 86° F. At mid-day, in coolest shade—namely, my tent—under a shady tree, at 96° to 98°. At sunset, 86°. This is very different from anything we had experienced in the interior. At Zumbo, the temperature of the nights never fell below 80°, and it was at 91° at sunset. One cannot cool the water by wet towels round vessel."—Livingstone's *Travels*.

Elmina, a place not far from where I lived, has an annual range of only 7° F., and a daily range of 10° F. Such facts are illustrative of the fallibility of general statements in climatology.

In Ravenstein's *Mean Temperature* map he includes the whole coast from Kosseir to St. Lucia Bay as having a mean temperature exceeding 72°, and a similar temperature is found along the West Coast littoral, from 100 miles north of Rio de Oro, or the Tropic of Cancer, to Cape Negro.

Right across Africa, between these two coast lines, the open shading of the map indicates vast regions with a mean temperature of over 72° F., checkered here and there with irregular areas, where it falls to 57° F. and under.

In the *tables* accompanying this chapter many other interesting details of the climate will be found.

Speaking generally, the climate of Central Africa appears to vary from that of the Transvaal to one purely tropical.

Stanley, writing of this equatorial region in *Darkest Africa*, mentions that at Gaviras village, which is about a third of the way across from the Great Forest to the Albert Nyanza, on the Balegga plateau, 4,657 ft. elevation, the temperature fell to 60° F. at midnight, December 12, 1887. He writes:—"The cold is very great on this high land. Each night since we have entered the grass country we have been driven indoors near sunset by the raw, misty weather of the evenings, and we shivered, with chattering teeth, in the extreme chilliness of the young day. One morning the temperature was at 59° F. . . . . We no longer wonder at the tardiness shown by the inhabitants to venture out before nine o'clock ; and, indeed, it would have been manifest wisdom for us to have adopted their example, had our task permitted it.

"Hail fell here December 20th, with a fall of temperature from 75° to 52° F.

"At N'Saba, Lake Albert Nyanza, May 14, we found (he says) the following meteorological record :—

9 a.m.,	breeze from S.E.	...	Temp.	86° F.
10.30 a.m.,	,,	...	,,	88·30° F.
1.30 p.m.,	,,	...	,,	88·30° F.
7 p.m.,	,,	...	,,	76° F.
Midnight	,,	...	,,	73° F.
6 a.m. 15th	,,	...	,,	73° F."

Elevation.

Elevation is perhaps the most determinative and important factor of climate in Tropical Africa. As a general rule, altitude diminishes temperature at the rate of 1° F. for every

350 ft. above sea level, but Ravenstein puts it 1° F. for every 364 feet on the lowlands, and 1° F. for every 313 feet of altitude on the highlands of Africa.

Rainfall and Winds.

Tyndall, Reclus, and other authorities* thus summarise the philosophy of the tropical rainy season :—

"The rains follow the sun in the tropics. As the sun advances through successive zones of latitude, the whirling earth beneath becomes greatly heated and the rarefied air ascends *en masse*, while the cool moist air from the ocean rushes in to fill the void so created. This saturated air has its vapour rapidly condensed, and the result is torrential rains, which follow the sun like a sweeping garment through the tropics. The cause of the quick condensation of the vapour of the inrushing sea air is not due merely to the expansion of its volume, but from the radiation of heat from the vapour itself. A column of saturated air ascends from the equatorial ocean, and rushing inwards, passes at first through air almost as fully saturated.

"Beginning to expand and ascend, it also begins to radiate at first into the surrounding vapour, but this proves very opaque to such radiation. When it ascends higher the quantity of aqueous vapour in the local air rapidly diminishes, so that the newly-arrived column is able to pour out its heat into space very quickly—in other words, its vapour is condensed into torrential rains, often accompanied with tremendous electrical disturbance."*

To understand the rainfall of Africa, in broad outline, we may map the continent into zones.†

* Tyndall's *Heat a Mode of Motion*; *Ency. Americana*—Art, *Climate*; *Chambers' Ency.*; Reclus' *Universal Geography*; *Longman's Geography*; and other authorities.

† See map of *Rainfall* by Ravenstein at end of this chapter.

The *first zone*, left white on the map, is included by an irregular line drawn from Cape Negro S.S.W. to the Tropic of Capricorn. It then bends to the N.E., and, sweeping round, includes the Kalahari Desert, crosses the Orange River, and ends at St. Helena Bay, its base being the coast-line between this bay and Cape Negro. This is a region of exceptional dryness, with a mean annual rainfall of under 10 inches.

With this line as boundary, we include a *second zone* (shaded slantingly on map), by a line drawn from a point 150 miles N. of the mouth of the Congo, southward to opposite Cape Negro, then almost due W. to Mashonaland, and then S. in undulations along the western foot hills of the Drakensberg to Port Elizabeth. From 10 to 25 inches of rain falls over this zone.

With this line for S.W. boundary, we include a *third zone*, by drawing a line from a point 200 miles below Cape Lopez, in the irregular manner shown on map. This line comes south to opposite Cape Negro, then due E., then N., and then due W., finally ending south of the Gambia River. The other boundary of this area starts from an equi-distant point north of the Gambia, runs along the northern boundaries of Western and Central Sudan, and curving round the southern boundary of Eastern Sudan, includes the Abyssinian Highlands, and dropping S., then W., then S. again, and finally S.E., ends at the mouth of the Tana River.

For base it has the coast-line between this point and Port Elizabeth. This very extensive area has a rainfall of 25 to 50 inches.

The *fourth zone*, distinguished by the darkest shade on the map, is included by the western boundary of the last-named region, and has for base the outlines of the African coast from S. lat. 3° to N. lat. 13°. In this zone there is a rainfall of 50 to 100 inches.

It will be noticed that an arid zone (under 10 inches) also mainly occupies the whole of the north of the continent, a thin rim along the western shore, and a triangular area S.W. of the Red Sea; and, likewise, three-fourths of the Horn of Africa.

Again, a curious belt of moderate rainfall (10 to 25 inches) appears to intersect the continent from W. to E. along its horizontal axis, and for 5,000 miles there is an irregular fairly watered zone bordering the south of the deserts, from main to main.

The areas of sufficient rain in oases; the curious mottling of the Mediterranean and North Atlantic sea-board zones; and the dark patches visited by torrential downpour (over 100 inches), though full of interest, must be reluctantly neglected in this brief description.

Every place has its own rainy and dry season; thus, on the Congo, it is dry weather from the middle of May to the middle of October, and the rainy season lasts from mid-October to May.

Again, in East Equatorial Africa there are two rainy seasons, the lesser beginning in the middle of October or early in November, and lasting four to six weeks; the greater beginning in the middle of March, and lasting two months. Stanley says:—"Over the Equator the rain belt discharges its rains for ten months of the year, and as we recede from the equatorial line, either north or south, the dry periods are of longer duration. At S. lat. 4° the long dry season lasts four months, from the middle of May to the middle of September; the short season lasts six weeks, from the middle of January to the end of February. At S. lat. 6°, the dry season is about three weeks longer."

On the Gold Coast the rainy season begins in April and ends in September.

In Mashonaland, in the months of January and February, we find the climax of the rains.

Speaking generally :—" The great feature is that the rains follow the sun, and begin soon after the sun passes the zenith of each place.

" Thus, under the Equator, it rains in every month.

" North and south of it there are two distinct rainy seasons, the intervals between which depend on the intervals between the zenith passages. As we approach the tropics, the interval between the two rainy seasons becomes less and less, until ultimately they merge into *one ;* and under the tropics themselves practically there is only *one* rainy season, followed by a period of continued dryness."*

Winds.

The character of the prevailing winds powerfully affects climate.

Dove classifies winds into *Permanent*, *Periodical* and *Variable.* In Africa, the *Permanent* are the N.E. and S.E. trade winds blowing in North and South Atlantic respectively.

The *Periodical* winds are chiefly the *Monsoons* and the *Harmattan* wind, the latter blowing from N. and N.E. from January to March or April, direct from the desert of Sahara.

The *Variable* winds are those the direction of which varies, yet generally blow more from one quarter than from another.

Local breezes are chiefly sea or mountain winds. About noon a wind sets in from the cooler sea to the heated land to fill the void caused by ascent of rarefied air. They begin from 11 a.m. to noon to blow from sea to land, and they die away at sunset. About 11 p.m. or midnight the land breeze, now cooler than the ocean, begins to blow from the

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* Ravenstein *Memoranda.*

land to the sea, and continues until sunrise, when there is a calm, *i.e.*, an atmospheric equilibrium. The sea breeze is damp, the land breeze dry, in some places so dry as to be prejudicial to health, as in the Sudan, India and Brazil.

Respecting winds, we have those depending on *cosmical, continental*, and *local causes*.

Of the first kind are the S.E. trade winds, blowing from the South Atlantic and Indian Oceans, and the N.E. trades of the North Atlantic.

These winds, impinging on the African coasts, materially help to modify local climates, and in this they are aided by cold and warm ocean currents.

The monsoons are also winds of cosmical origin, following the annual progress of the sun. They visit, at fixed seasons, all the coasts of tropical Africa,* and ensure free circulation of air through the marginal malarial zone, where it is most needed.

On the West Coast the S.W. monsoons blow into the Gulf of Guinea, forming the prevailing winds of these regions. So we find on the Congo that 90 per cent. of the winds are westerly, generally S.W. or W.S.W. and S.S.W. throughout the year.

Tornadoes of extreme violence are seen in the monsoon regions.

In the Indian Ocean the monsoons blow from S.W. by S. to S.E., from April to October, and from N.E. during the other months of the year; so, it will be observed, following the apparent course of the sun.

The conformation of the East African Coast, and its elevation especially, largely deflect these aerial currents.

Of continental causes, the rarefactions of the lower strata of air over this continent, so blessed and scourged by sunshine, is a main factor of local winds; the cooler air rushing in to fill up the void left by the ascending columns.

* *The Development of Africa.*

S.E. winds prevail over many parts of the central plateaux; but in the mountain regions, especially over the great lakes, local winds of great force and suddenness are encountered, blowing from all points of the compass.

Table of African Climatology.

The following table is based upon a *Paper* read by Mr. E. G. Ravenstein, F.R.G.S., F.R. Met. Soc., &c., at the Oxford Meeting of the British Association.

The meteorological data for Greenwich, Rome, and Cape Town are given for sake of comparison.

The first group includes only *coast stations*. At these the mean annual temperature is high, the exception in the case of Walfisch Bay being due to a cold ascending ocean current. The *annual range*, that is the difference between the coldest and the hottest month of the year, and the *daily range*, are inconsiderable; the relative humidity is in most instances considerable. The climate, in fact, is damp.

The *hot inland stations* fall into two classes, namely, places like Kuka and Khartum, the climate of which is influenced by surrounding deserts, and places in the wooded regions of tropical Africa. The former has a dry climate and a considerable annual and daily range; while the latter are characterised by a small annual, but a very considerable daily range.

Lastly, there are what may be called *Temperate Inland Stations*. The temperature of these varies, as a matter of course, with elevation above sea level, and may sink below freezing point; but their true characteristic, as of all tropical inland stations, is a very considerable daily range.

The four maps which illustrate this chapter are based upon very inadequate materials; but it is believed that they convey a correct notion of the climatological features of Africa.

TABLE specially prepared for this book by E. G. Ravenstein.

	Latitude.	Altitude.	Mean Temp.	Annual Range.	Daily Range.	Relative Humidity.	Rainfall.	
							In.	Days
Greenwich	51° 29′ N.	—	49	24	11	82	25	108
Rome	41 54 N.	—	59	32	15	67	30	114
Coast Stations.								
Freetown (Sierra Leone)	8 30 N.	250	80	7	12	76	133	135
Elmina	5 30 N.	60	79	7	10	85	31	74
Akasa (Niger mouth)	4 15 N.	—	78	5	10	84	141	213
Sibange (Gaboon)	0 42 N.	300	76	5	13	88	90	141
Banana (Congo mouth)	6 30 S.	7	78	10	14	81	40	40
Loanda	6 18 S.	—	82	6	8	85	12	29
Walfisch Bay	22 54 S.	10	62	9	17	83	0·3	4
Cape Town	33 50 S.	40	61	15	19	74	25	88
East London	33 0 S.	30	65	12	13	76	28	94
Durban	29 48 S.	150	69	12	14	74	39	126
Lorenzo Marquez	26 0 S.	—	74	15	—	—	26	82
Kilwa	9 0 S.	—	79	2	13	85	46	91
Zanzibar	6 10 S.	—	80	5	8	80	61	114
Mombasa	4 4 S.	—	82	6	7	80	51	108
Massawa (Red Sea)	16 0 N.	—	86	17	10	68	4	29
Suakin	19 2 N.	80	76	19	—	56	2	7
Hot Inland Stations.								
Bismarckburg (Guinea)	8 2 N.	2,320	75	9	20	76	59	132
San Salvador (Congo)	6 18 S.	1,900	73	8	31	75	40	111
Bolobo (Congo)	2 12 S.	1,080	79	3	15	80	58	92
Luluaburg (Congo)	5 54 S.	2,000	75	1	22	78	58	108
Khartum	15 36 N.	1,270	82	25	20	58	—	—
Lado (Upper Nile)	5 2 N.	1,526	81	9	24	66	38	147
Mengo (Uganda)	0 20 N.	4,100	71	5	21	—	48	114
Kuka (Bornu)	12 54 N.	800	79	20	20	50	21	53
Kakoma (Unyamwezi)	5 47 S.	3,600	72	16	27	62	39	95
Tete (Zambesi)	16 12 S.	220	80	11	—	62	32	—
Temperate Inland Stations.								
Baliburg (Cameroons)	6 42 N.	4,400	66	2	21	88	110	210
Caconda (Angola)	13 42 S.	5,500	69	7	11	76	69	135
Rehoboth (German S.-W. Africa).	23 18 S.	4,550	67	28	—	—	13	40
Fraserburg	31 54 S.	3,900	57	28	27	63	9	39
Graaf Reinet	32 16 S.	2,500	62	23	27	56	15	52
Calvinia (Cape Colony) .. .	31 30 S.	3,100	58	33	—	63	8	31
Kimberley (Cape Colony)	28 47 S.	4,040	64	26	30	58	14	44
Bloemfontein	28 54 S.	4,540	59	15	30	51	26	63
Pretoria	25 48 S.	4,300	67	15	31	—	24	67
Molopolole's	24 25 S.	3,300	68	21	—	61	21	—
Tati	21 30 S.	2,800	67	20	26	—	22	—
Fort Salisbury	17 30 S.	5,050	65	13	25	—	34	75
Blantyre (Shiré Highlands) .	15 48 S.	3,320	65	16	24?	68	54	109
Fwambo (Stevenson Road) ..	8 53 S.	5,320	67	13	—	63	35	94
Fort Smith (Kikuyu)	1 14 S.	6,400	61	9	—	79	53	117
Gondar (Abyssinia)	12 30 N.	6,200	67	13	35?	—	34	122
Murzuk (Fezzan)	26 0 N.	1,470	69	25	—	42	—	6

Sunshine, Ozone, and Electricity.

The action of sunshine and soil upon the health will be dealt with later on. It suffices to say here that moderate sunshine is most beneficial to the health of the body and mind. But there is risk of sunstroke in Africa from incautious exposure, especially *standing* under the vertical rays. Sunshine is a powerful sanitary agent, destroying morbific germs of all kinds, and in many other ways depurating air and soil.

Ozone and Electricity.

The influence of ozone and electricity on health is not fully known. *Ozone* is a very powerful oxidising agent, and is more plentiful on the sea-shore and in the country than in towns; on mountains and plateaux than on low lands. It is produced, or much augmented, by rains, intense sunshine and electrical phenomena, and may produce that glow of health often felt after storms. It is certainly a great purifier and sweetener of the atmosphere.

Electricity produces headache and lassitude in some people, as felt before storms, when the air is charged positively. The cold polar winds, which temper tropical heat at certain seasons, are highly charged with electricity, which may contribute to their invigorating effects on the body.

The Soil has many and various well-recognised influences upon the health, an account of which, as I said above, will be given in subsequent chapters.

Vegetation.

Trees hasten the melting of snow upon mountain slopes, and by ensuring its slow liquefaction, prevent sudden floods, and so conserve hillside soil which would otherwise be washed away.

Woods also act as lightning-conductors and cloud-accumulators; these they condense and give back to the thirsty lowlands in gentle rains.

On the other hand, where there is undue humidity of soil, trees return, by evaporation, the surplus water to the atmosphere, and so become cloud-producers; and such clouds being blown away, subsequently supply the treeless areas with rain.

"Woods are, in fact, a factor in atmospheric equilibrium—rendering rainfall more frequent, less heavy, and less violent—a function which is all too painfully realised when it is impaired or annihilated by their destruction, and when the gentle and never long absent shower is exchanged for the comparatively rare, but torrential downpour which sweeps away the products of months of toil."*

The hygienic influence of forest growth is lucidly set forth in the *Lancet* article.

Not only do trees in general give shade, but special woods, as of pine and laurel, are "perennial sources of grateful and salutary effluvia."

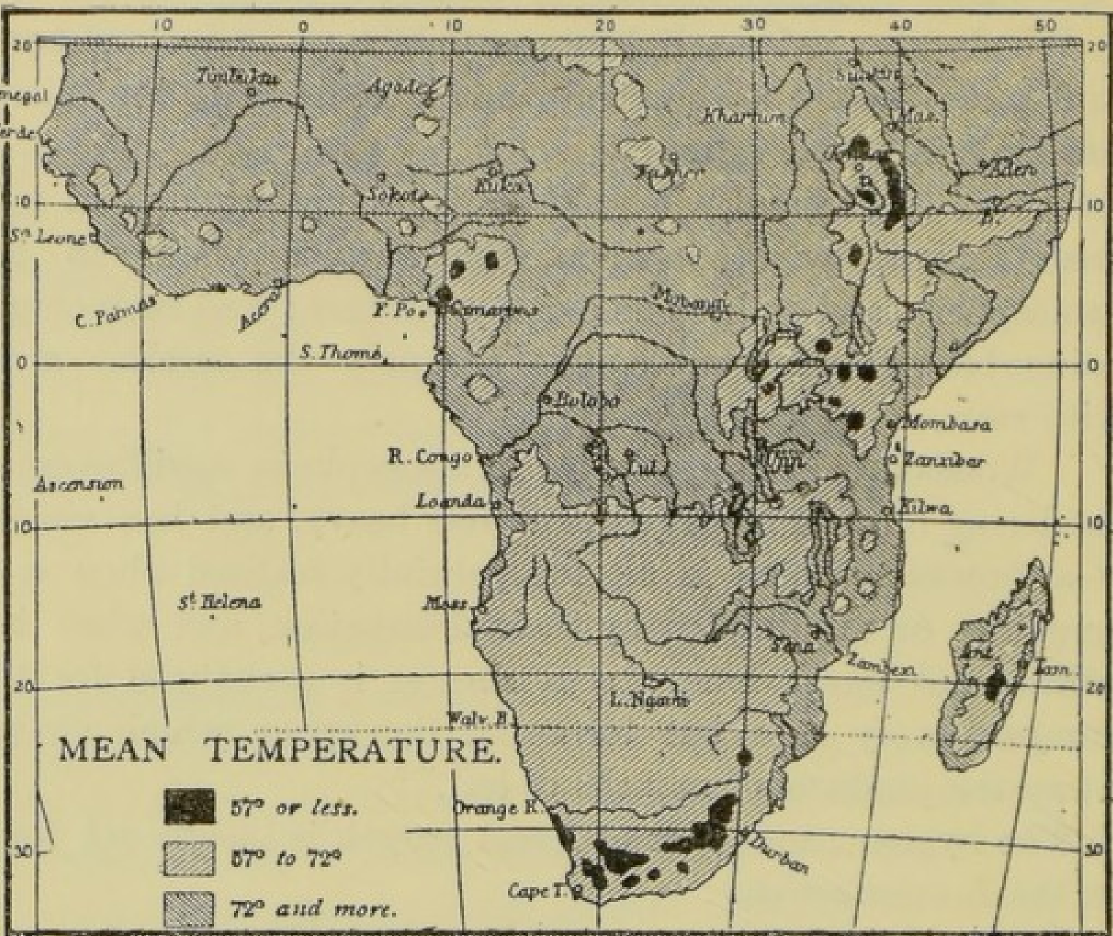
The reclamation of waste lands haunted by malaria, by the planting of eucalyptus, is declared to be, on this high authority, *un fait accompli*, mainly as a consequence of its power to drain and depurate soil.†

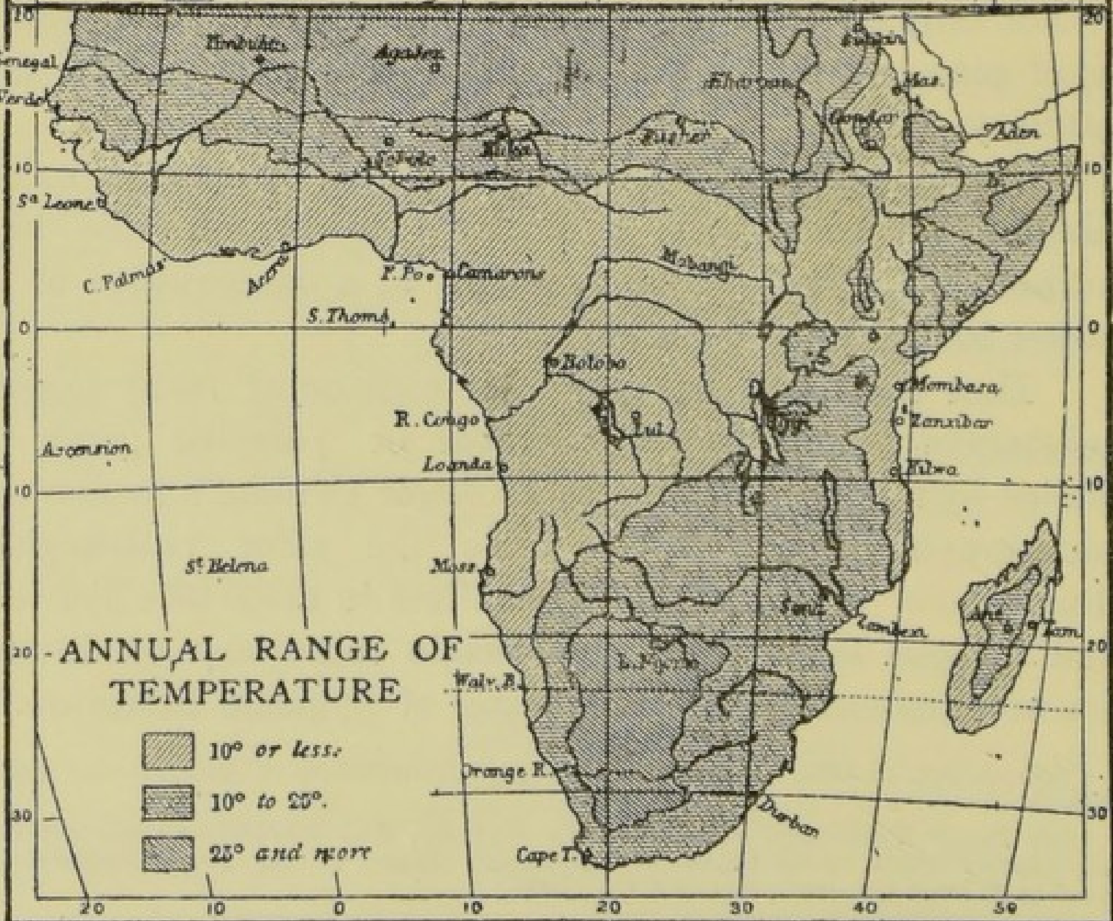
"That the forest has power of consuming many organic substances which favour microbes or parasitic germs is denied by no one after the late Professor Cantani's memorable monograph, '*Pro Silvis*'; while the same pathologist's illustrations of the effects of conifers in malarious districts, and in soils labouring under certain insanitary conditions are now amongst the *loci communes* of hygienic literature."‡

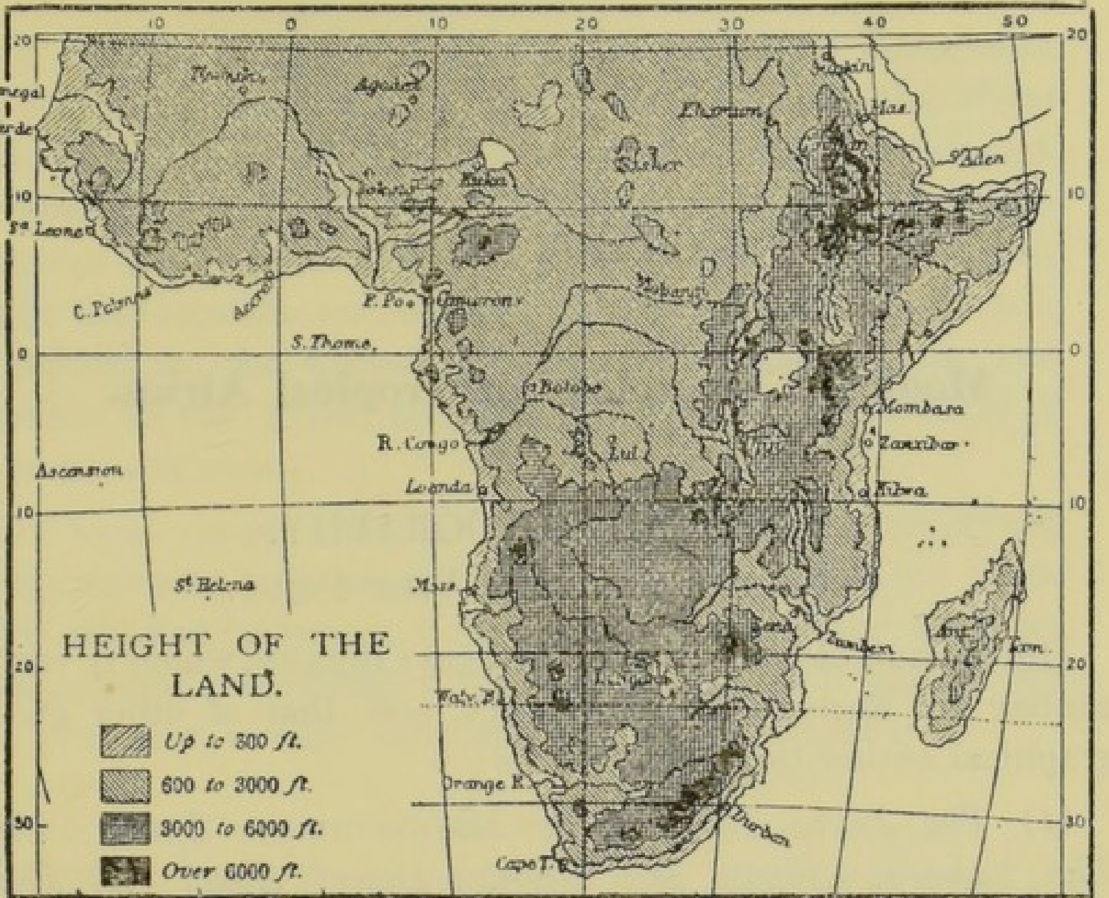
* *Lancet*, Oct. 13, 1894. Editorial on *Unequal Distribution of Rainfall and Forest Growth.*

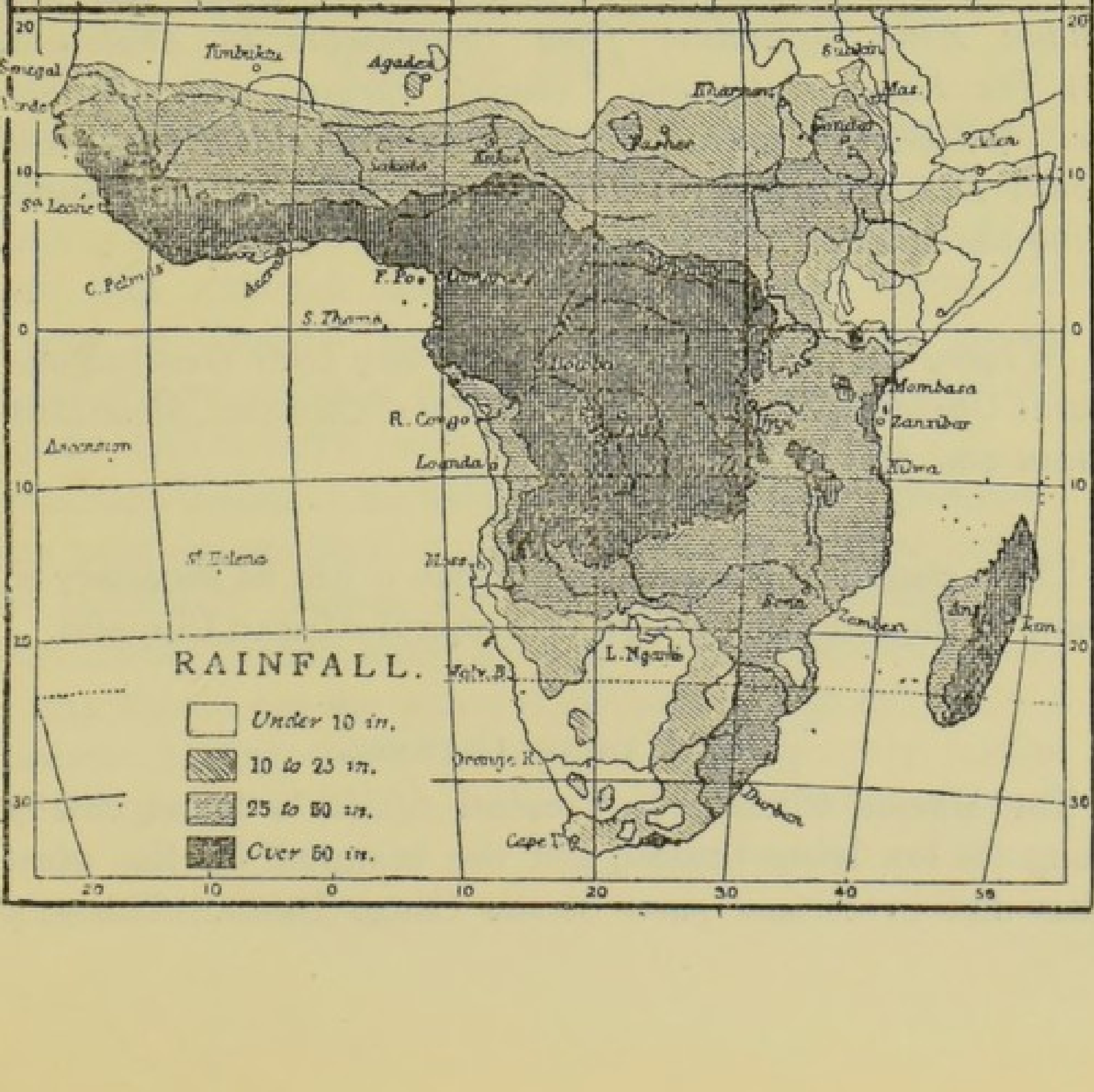
† See Baron Ferdinand Von Mueller's (C.M.G., &c.) *Eucalypographia* on this important subject. Also Baron Von Mueller's *Repcrt on the Forest Resources of Western Australia* (Lovell, Reeve & Co., 1908).

‡ *Lancet, ib*


MEAN TEMPERATURE.
57° or less.
57° to 72°
72° and more.
Senegal
C. Verde
Timbuktu
Agades
Khartum
Aden
Sokoto
Kuka
Sa Leone
C. Palmas
Accra
F. Po
Camarons
Mobangi
S. Thomé
Bolobo
Mombasa
R. Congo
Zanzibar
Ascension
Loanda
Kilwa
St Helena
Moss.
Zambesi
L. Ngami
Walv. B.
Orange R.
Durban
Cape T.


ANNUAL RANGE OF TEMPERATURE
10° or less.
10° to 25°.
25° and more
Senegal
C. Verde
Timbuktu
Agades
Khartum
Aden
Sa Leone
C. Palmas
Accra
F. Po
Camarons
Mobangi
S. Thomé
Bolobo
Mombasa
R. Congo
Zanzibar
Ascension
Loanda
Kilwa
St Helena
Moss.
Zambesi
Walv. B.
Orange R.
Durban
Cape T.


HEIGHT OF THE LAND.
Up to 300 ft.
600 to 3000 ft.
3000 to 6000 ft.
Over 6000 ft.
Senegal
C. Verde
Sa Leone
C. Palmas
Accra
Agades
Sokoto
Kuka
Khartum
Fasher
Aden
F. Po
Cameroons
S. Thome
Mobangi
Bolobo
R. Congo
Loanda
Mombasa
Zanzibar
Kilwa
Ascension
St Helena
Moss
Walv. B.
Orange R.
Cape T.
Durban
Zambezi


RAINFALL.
Under 10 in.
10 to 25 in.
25 to 50 in.
Over 50 in.
Senegal
Timbuktu
Agades
Suakin
Khartum
Mas.
Fasher
Gondar
Sokoto
Kuka
Sa Leone
C. Palmas
Accra
F. Po
S. Thome
Bolobo
Mombasa
Zanzibar
R. Congo
Loanda
Kilwa
Ascension
St Helena
Moss
Zamben
Tan
L. Ngami
Walv. B.
Orange R.
Cape T.
Durban

CHAPTER III.

Medical Climatology of Tropical Africa.

TROPICAL TOPOGRAPHY.

FROM THE SANITARY VIEW-POINT.

Dutroulau's classification of African Climates, which is very similar to Reclus's, Silva White's, and that of other geographical authorities, is as follows:—

(1) *The Juxta Tropical, or Mediterranean Zone.* (2) *The Sahara, Libyan and Nubian Desert Zone.* (3) *The Sudan Zone, extending from Senegambia to Abyssinia.* (4) *The Equatorial Zone; climate varying with altitude, etc.* (5) *South Central, or Savanna or Veldt Zone; and South Desert Zone.* (6) *The Cape Zone, somewhat resembling the Mediterranean Zone.*

In every one of the above zones we may have General and Local Climates, Marine and Continental Climates, Mountain, Plain and Steppe Climates.

These classifications include all that it will be necessary to know in the following review of Tropical African Climates.

THE MARINE CLIMATE.

The Marine Climate of Tropical Africa is found chiefly along its low-lying littoral, and the margins of the great lakes and in certain parts of the Congo Basin. This is a damp, equable, muggy climate, very enervating for Europeans, and very malarious. But all places near the sea and Great Lakes partake of both the marine and continental climates, the predominating one being determined by such local conditions as the trend of the coast in reference to the prevailing winds, the elevation and wooded condition of the coastlands, the nature of the hinterland, the force, temperature and humidity of the winds, and the rainfall and temperature of the ocean currents.

The axial ranges that border the east and west coasts are mostly densely wooded and of considerable altitude; these collect the watery vapour from the sea breezes and by their coolness rapidly condense it into heavy rains, or if too low for this, produce a muggy, hazy and saturated atmosphere.

The Continental or Steppe Climate of Tropical Africa.

This climate differs materially from the maritime, especially as being more suitable for European settlement, and less subject to the scourge of malaria. Yet a wide experience has shown that although altitude is an important factor of salubrity in Tropical Africa, it does not, *per se*, confer immunity from malarial affections, so long as the *Anopheles mosquito and infected persons are associated.*

While the theory of the telluric origin of malaria prevailed, it was most reasonable to suppose that altitude and immunity were intimately related, for at 10,000 ft. elevation on Mount Blanc, Tyndall found a perfectly germ-free atmosphere, and why should not the germs of malaria be also left below? Experience has proved, however, that other sanitary factors must be present which, so far as we know, are unconnected with the aerial diffusion of morbific germs, or with poisonous exhalations from the soil. Cabul, in India, is built on an open elevated plateau, twenty miles across, and 5,700 ft. above sea level. It is also surrounded by lofty mountains. Nevertheless, being a water-logged country, it is unhealthy. The clayey soil around the city is dried to the depth of a few feet in summer and caked hard, but in its fissures and the casual puddles left by rains on the surface are found most favourable conditions for the breeding of the *Anopheles* mosquito. One is not surprised, therefore, to learn that the remittent type of malarial fever is endemic here, and not imported.*

A. Silva White, in his useful book, *The Development of Africa*, discusses "the immunity level of malaria" in Africa and India, believing it to be lower in the former, but he adduces no facts to support this theory.

Surgeon-Major Parke† found the lofty mountain regions and plateau intervening between the Great Lakes and the East Coast, along Stanley's route, via Albert Edward Nyanza, south of Victoria Nyanza, through Unyamwezi, then east to Bagamoyo, through the present German East Africa, all very malarious country, judging by the sickness which overtook the worn-out followers of Stanley, and also the fresh contingents of Emin Pasha, from Wadelai.‡ In this case, however, the infection may have been imported by the new arrivals.

In Uganda, Katanga, and adjoining regions malaria is known to prevail in many places, but Uganda is, nevertheless, a promising field for British emigration in the future. Staff-Surgeon Brahme reports in the *Mitteilungen das Deutschen Schulzebicten* (1894) that the station in Kilima-Njaro, 5,600 ft. above sea level, is not free from endemic malaria, and he is careful to differentiate imported from

* Dr. J. A. Grey's paper *On the Sanitary Condition of Cabul*. *Lancet*, April 28, 1894. Dr. Grey of course, at this date, ascribed the infection to telluric causes, but his facts are most useful.

† *Guide to Health in Africa*, 1893.

‡ *Emin Pasha Relief Expedition*.

endemic cases, the former of which may be introduced by infected people coming from the lowlands into any healthy locality in which the *Anopheles* mosquito is found.

On the healthy uplands of British Central Africa severe cases of malaria occasionally occur from a like cause, namely, the influx of infected people from the lowlands. This is a country where Europeans can live healthily by the careful practice of the rules of sanitation and hygiene, which will be fully explained in this book.

If we take that part of British East Africa which is dominated by Kenia (18,370 ft.) in the north, and Kilima-Njaro (19,700 ft.) in the south, and the Mau plateaux (5,000 to 7,000 ft.) in the west, as roughly typical of steppe country in Tropical Africa, we find the following climatic conditions:—

At Kikuyu (7,000 ft.) where much of the forest has been cleared and the land cultivated by the natives, and also on the rolling savannas of Masai Land to the south, we find, according to Lugard and missionary station records, a cool, healthy climate right on the Equator (lat. 0° to south lat. 6°). In this eastern equatorial plateau region the mean annual temperature, at 6,400 ft. elevation (Fort Smith, Kikuyu) is 61° F., the annual range 9° F., and the daily range 79°. The relative humidity 79, and the rainfall 53 inches. (See Ravenstein's *Table*, chap. II., p. 25.)

Lugard, speaking of this region, says: "The nights are cold, at times even frosty. Blackberry, forget-me-not, clematis, jessamine, trefoil, clover, nightshade, thistle, and other English plants abound. The country is well watered and game plentiful."* Again, he says: "Speaking generally, of all this vast continent, there is probably no part, with the exception of the extreme south, and possibly the highlands north of the Zambesi, which enjoys such natural advantages consequent on high altitude. The eastern plateaux begin

* *Rise of our East African Empire.*

about 150 miles from the coast, and on the higher portions even frost is not unknown, and the air is bracing and healthy like Europe." Of the climate of the more inland districts, as of Uganda, Lugard says that it is praised by the missionaries and other settlers, which account is borne out by Sir Harry Johnston.* Speke also found the climate of the regions north of the Victoria Nyanza and the upper Nile, "cool, rainy, and very salubrious. The winds blow refreshingly, and I was able to do my marching over very rough country clad in woollen clothing."†

Stanley found the "pasture lands" lying between Lake Albert and the Great Forest of the Congo, where cattle, kept by the natives, were quite numerous, and milk formed part of the people's diet (north lat. 1° 30′ about), "an agreeable climate," of which he writes:—

"Five hours work per day can be performed, even outdoor, without discomfort from excessive heat, and three days of the week work can be performed during the whole of the daylight, because of the frequently clouded state of the sky. When, however, the sky is cloudless, or exposed in rifts, the sun shines with burning fervour that makes men seek shelter in their cool huts. The higher portion of the grass-land, as around Kavallis (Lake Albert), and in the Balegga Hills, range from 4,000 to 5,000 ft. above sea level. Large areas of Toro and Southern Unyoro are 10,000 ft. high, and all these regions promise an agreeable land for European settlement."‡ The natives, he adds, are friendly and peaceable, "like unto those blameless people with whom the gods deigned to banquet once a year upon the heights of Ethiopia."

The climate of Rhodesia, with an average elevation of 4,000 to 5,000 ft., forms a fair example of the plain or lower plateaux climate of Tropical Africa.

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* See *The Uganda Protectorate*, by Sir Harry Johnston, G.C.M.G., &c., &c.

† *Source of the Nile.*

‡ *Darkest Africa.*

It has a mean annual temperature of 65° F., and is in many places healthy and suitable for European settlement; in others it is malarious, but not markedly so, and needing only cultivation to become salubrious.

The climate of the Congo State has special characteristics of its own. It will suffice to say here, on the authority of Stanley, Sir Harry Johnston, and other authorities, that although the Lower Congo is unhealthy for Europeans, chiefly owing to the prevalence of funnel winds blowing through it from the Atlantic, the Middle and Upper Congo possess equable and generally healthy climates for the tropics. The mean highest temperature of the Congo is 90° F.; the mean lowest 67° F., but the mercury on certain sunny days rises to 100° and even 115° F. in the shade.*

Sir Harry Johnston says:—"The climate of the western Congo varies in temperature and healthiness according to the regions through which it passes, but on the whole is infinitely superior to that of the Niger or Gold Coast. There is not much marsh land along its banks, and the regular cool breeze from the Atlantic much reduces its heat."†

The Great Forest of the Congo is, however, the rainiest region on the earth, scarcely a day passing without a torrential downpour. This is partly owing to the enormous evaporation constantly taking place from the great ocean of forest foliage which almost equals that from the Indian Ocean or the Atlantic. It is also caused partly by the meeting of the moist monsoons of the former with the trade winds of the latter, just over this forest zone, and consequent equilibrium and stasis of atmosphere, rapid radiation into ether, and torrential precipitation.

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* *The Congo and Founding of its Free State.*—Stanley.

† *The River Congo from its Mouth to Bolobo.* By Sir H. Johnston, F.R.G.S. F.Z.S., etc., etc.

The Tse-tse Fly.

The tse-tse fly, so fatal to domestic animals and the carrier of sleeping sickness, is rare in British East Africa, at the present time being confined to a few well-known localities, but it has unfortunately a much wider range in German East Africa, and the risk of the infection spreading, owing to the influx of infected natives into our possessions, is steadily increasing. Yet much has been done by the Government medical staff on the spot, and by the expeditions despatched by the Liverpool School of Tropical Medicine, to control the spread of this lethal disease.

European Settlement.

The problem of European settlement in these regions is one which, as Keltie remarks, can be solved by experience only.* At Blantyre, Shiré Highlands, altitude 3,320 ft., English and Scottish missionaries, both male and female, and many Scotch planters and settlers have lived healthily for years. Yet fever is by no means unknown there. During my short stay of a few days at Blantyre, I saw two severe cases of malaria in Europeans, but whether contracted on the spot, or imported, could not be ascertained. Constant inter-communication between the low-lying and highly malarious surrounding districts cannot be avoided, so that infected persons, both natives and Europeans, are constantly present in most parts of the Shiré Highlands, and it therefore needs only the presence of the *Anopheles* mosquito to disseminate the infection. I saw very few mosquitos during my brief stay, and no pools, puddles, or other collections of water, yet after rains such must occur. It will, however, be a comparatively easy matter to absolutely exterminate the insects in the Blantyre and Zomba district by the sanitary and hygienic measures hereinafter to be described.

* *Partition of Africa.*

It is also satisfactory to know that both male and female missionaries and settlers in the Kikuyu, Ulu, Kikumbuli, and Masai regions, and those living on the slopes of Kenia and Kilima-Njaro have for some years past been enjoying good health.

In this connection it is instructive to compare the meteorological records of Blantyre and Kikuyu,* and to notice their close correspondence both in climate and in salubrity. But the sanitary record of the Lake Nyasa district, as seen in the records of the Universities' Missions, has been very bad, and many valuable lives have been lost there. This was paralleled by the mortality amongst the early missionaries on the Gold Coast, which for over fifty years checked missionary enterprise, but is now happily a thing of the past, because of the progress of sanitary enlightenment, and the more careful selection of those who are sent out as missionaries.

The Railway as an Agent of Sanitation.

The opening of the Mombasa and Lake Victoria Railway, by which travellers will henceforth be conveyed in a few hours, and in perfect safety, across the pestiferous 150 miles of low-lying coast land to the salubrious central plateau, will prove as useful in sanitary as in commercial and developmental interests. In all parts of tropical Africa the old careless style of living, chiefly on tinned provisions, is also rapidly giving place to a fresh meat and vegetable dietary, and the rude, native-built hut to the well-constructed house, which needs only the addition of wire gauze screening to become thoroughly sanitary and safe for European habitation.

Stores are now numerous in the chief coastal towns of both east and west Tropical Africa, where wheaten bread, butchers'

* See Ravenstein's *Table*, Chap. II.

meat and all kinds of European provisions can be purchased. Similar stores are also springing up along the railway lines, and more or less good hotel accommodation is now obtainable almost everywhere.

Above all, Europeans are now being properly equipped for the tropics, with suitable clothing and mosquito nets, and with a general knowledge of the chief precautionary measures necessary for the preservation of health in Tropical Africa.

A similar development of railways is seen on the West Coast, whereby the rich mineral hinterland is being opened up, and the influences of civilisation extended to Europeans and natives alike.

The great Cape to Cairo Railway is also working out the development of the centre of the continent. Good hotels and stores are found even at the Victoria Falls, and the Cook's excursionist, book in hand, the artist at his easel sketching the mighty cataract, the botanist with his vasculum, and the geologist with bag and hammer, are commonly seen where the Zulu impis only a few years ago desolated the land.

TABLE OF TEMPERATURES, RAINS, &c., IN BRITISH EAST AFRICA.

Place.	Altitude in ft.	Mean Annual Temp.	Annual Range.	Diurnal Range.	Rainfall in inches.
Mombasa	50	78°	7°	9°	28
Moshi ...	5,500	65°	9°	16°	—
Kakoma...	3,600	72°	16°	24°	—
Natete ...	4,000	71°	6°	27°	—
Lado ...	1,500	50°	9°	24°	—
Uganda ...	—	—	—	—	41 to 55
Malindi ...	—	—	—	—	46

From *Rise of Our East African Empire*.—Lugard.

CHAPTER IV.

On the Effects of Tropical Climates on Europeans.

The Outlook of the Anglo-Saxon Colonisation of Tropical Africa.

The excessive heat of certain parts of Tropical Africa is a source of perennial discomfort, if not of danger, to Europeans, which, so far, they have not resolutely attempted to modify, after the example of their fellow countrymen in India.

At sea level especially the extreme heat and humidity are very enervating, and Miss Kingsley justly remarks of the West Coast climate generally, and the same applies to all the tropical littoral—"All the vital powers are required to resist this depressing climate. If the European is seriously weakened in any way, death is liable to ensue."*

On the Gold Coast the average temperature is from 75° to 80°, rising at times to 96° in the evening, and again falling to 60° or 70° at midnight or early morning, and the atmosphere is generally saturated.

One of the most noticeable effects of such climates is to throw the body into copious perspiration, the system thus endeavouring to maintain its normal temperature of 98·4° F. But the sweat being unable to evaporate into the saturated atmosphere, remains mostly in liquid form, bathing and

* *West African Studies*, by Miss H. M Kingsley, 1899.

soddening, or macerating the skin all day long, and so greatly modifying its protective functions, and leaving the body open at all times to being chilled.

In the steppe and plateau regions of Tropical Africa slight exertion also causes free perspiration, but this is immediately carried off as vapour into the dry atmosphere, and so the body is kept cool and vigorous.

Werner puts the matter thus :—" A European is naturally out of his element in tropical countries, so it follows, as a matter of course, he cannot expect his health to be as good as in more northern latitudes. For the rest, a great deal depends on a man's constitution and habits."* Not only are the functions of the skin, but those of the liver and spleen, extremely active in the tropics, which exposes these organs, and through them the whole body, to many serious diseases.

The digestive organs are especially liable to derangement; the appetite grows sluggish, and if stimulated by condiments and alcoholic liquors tends to go from bad to worse; the bowels also act irregularly, constipation and diarrhœa alternating, and frequently amœboid, or other form of dysentery completing the mischief.

The circulatory and nervous systems are especially prone to suffer from heat in the tropics, both having alternate excitation and depression of function. The depression, moodiness, and acerbity of temper so characteristic of the tropics, the very bane of tropical life, is mainly owing to the enervating influences of heat and fever.

Terrestrial Radiation as a Factor of Disease.

The effects of terrestrial radiation of the long heat rays upon the body has not received the attention due to so

* *A Visit to Stanley's Rearguard*, by R. J. Werner.

important a morbific agency. We know that the atmosphere is heated more by convection than by the direct passage of sunshine, the hot earth heating, and consequently expanding, the lowermost stratum of air, precisely as a fire under a kettle heats water. We are, therefore, placed between two dangerous sources of heat, the direct, short heat and actinic rays of sunshine from above, and the long rays of heat reflected from the earth's surface, the latter being readily absorbed by the ascending air.

The sanitary application of this fact, which is so little understood, is that insolation, or heat stroke, may come from the ground as well as from the sky. A man may be properly clothed and helmeted, and yet if he stands for any time on ground which may be reflecting not only solar heat, but radiating heat from the slow, midden-like combustion of decaying vegetation, he may suffer from insolation. Stanley, with his usual sagacity, recognised this fact, and warns us against the dunghill temperature of certain African soils, and above all of the danger of standing still upon such, beneath a vertical sun. This important subject will receive further consideration in the chapter on clothing.

The *sensation* of temperature depends not only on the degree of heat as shown by the height of the mercury, but on the dryness or humidity of the air, and upon the velocity and temperature of the wind. Sitting in a room or verandah through which a sea-breeze is blowing gives the body a refreshing sense of coolness, even when the glass registers 90° F., whereas the same heat in a closed room would be stifling. A wet-and-dry bulb thermometer approximately shows by its wet bulb this sensational temperature, and no resident in Africa should be without one.

The Seasonal Rhythm of the Body.

Here we may pause to consider the craving for seasonal cold weather innate in all northern European races. Whether this be the result of natural selection, of the hereditary transmission of acquired adaptation to a large range of temperature, or to both and other inscrutable causes, certain it is that, for the Anglo-Saxon at least, the constitutional necessity for spring, summer, autumn, and winter is impressed on the race as clearly as that for regularity of meal and sleeping time, and other physiological needs of body. So surely as our forest trees respond in the procession and retrocession of their sap to the seasonal variations of our climate, so do our bodily functions respond to *seasonal rhythm*, which is indeed but an enlargement of that daily physiological rhythm which man shares with all animated nature. If this be a racial law of our being, its disturbance must result in racial degeneration, and, more or less, individual ill health.

The hardy Alpine plant, or the Scotch fir tree, transplanted to the tropics, may for a while struggle for existence, but will ultimately either droop and die or decline into growths bereft of much of their strength and beauty. This is a type of the hardy Northman's fate who makes his home in the tropics.

The child is rightly regarded as the truest physiological index of the healthiness or unhealthiness of a climate or locality, and experience has abundantly proved that European children can be reared with difficulty only, if at all, in India and other tropical countries, where they have all the necessaries and comforts of life, and the fullest advantages of enlightened sanitation. One cannot, therefore, quite agree with Colonel Gorgas, of Havana and Panama Canal zone fame, who holds that "if malaria and yellow fever were eliminated, life in the tropics for the Anglo-Saxon race would become more healthful than in the temperate zone."

Yet in British East Africa, British Central Africa, tropical Rhodesia and the elevated hinterlands of the Gold Coast and Nigeria, taking them in the order of sanitary preference, we have so many factors making for salubriousness, that one is justified in holding a very optimistic view of the possibilities of successful British settlement in those regions, especially in all territories where the wheat crop can be successfully cultivated.

BOOK THE SECOND.

THE MALARIAL PROBLEM.

CHAPTERS V. TO XI.

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Book the Second.

THE MALARIAL PROBLEM.

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CHAPTER V.

The Malarial Problem.

PART I.

Glance at the History of Malaria in England and Elsewhere.

Malaria has been, and is, the most subtle, ubiquitous and deadly foe of man.

In Tropical Africa it has proved the chief barrier to European expansion, and, apart from physiographical difficulties, it has been fever which prevented the civilisation of the continent long ago.

Ague is now almost extinct in England and Holland, but in De Foe's day it ravaged this country as a plague right up to London, which was then surrounded by marshes; and it rendered the fens of Lincolnshire and Cambridgeshire—at that time covered by clouds of cranes, according to Macaulay—quite uninhabitable.*

It slew James I.; it also killed Cromwell.

"The progress of agriculture, the drainage of marsh lands, the general elevation of the average standard of comfort amongst us, have done much to banish it; but it still lingers in Huntingdon, Cambridgeshire, and parts of Kent and Surrey."†

"In northern and temperate climates like our own, it shows itself in various affections of the nervous system, such

* Tanner's *Practice of Medicine*. † *Lancet*, June 11, 1892.

as migraine, or megrim, and other forms of neurosis; in enlarged spleen and liver; in hæmaturia and hæmaglobinuria; and, lastly, in that condition of the constitution which is termed malarious cachexia, characterised by the state of the conjunctivæ, by the greyish-yellow tint of the skin, and by the absence of healthy colour and lack of energy. Besides these forms, we have occasionally, though rarely, examples of intermittent fever. At one time, before the extensive operations of subsoil drainage, ague was comparatively common in Lincolnshire, Essex, and parts of Kent; but now cases are rare, and often only appear after a wet season. . . . . Sir Joseph Fayrer teaches us that in Ceylon, in ten years, 94,821 persons died from ague and remittent fever."*

Dr. Williams goes on to state that the deaths in the Madras Presidency in 1880 from malarial diseases were 209,940, and that the monthly mortality appears to be greater in winter than in summer, increasing apparently with the lowering of the temperature after extreme heat. He shows by some statistics that Europeans in India are not more liable to malarial fever than natives, adding: "Malarious fever prevails extensively in Tropical Africa, but here the natives do not seem to be as liable as Europeans; in fact, Negroes were at one time held to be exempt; but Surgeon Parke proved that the natives of Western and Central Africa, though they might be acclimatised at home, if they remove to another part of the country lost this immunity, and were as liable to contract malarial fevers as Europeans. Therefore, it will be seen that race does not ensure protection."

I have had to treat many cases of fever amongst Krumen working on the Gold Coast. Although coming from Cape Palmas and the Kru Coast, which adjoins the Gold Coast, and possesses similar climate and physiographical features, many suffer from fever on their arrival; but whether this was

* Dr. C. T. Williams, *On Climate in Relation to Health. Lancet*, June 2, 1894.

altogether due to change of country, or partly to the hardships of the passage and change of employment and food, all of which tend to revive old infection, or to the contraction of fresh infection on the Gold Coast, I am unable to say.

The deaths from malarial fever in Italy, according to Dr. Davidson,* amounted in the year 1887 to 21,003; but this appalling mortality is on the decline, in the face of more perfect drainage and agriculture, and also from the practice of enlightened sanitation and hygiene based on the discovery of the true causes of malarial infection.

Dr. Hehir asserts, in short, that "*malarial disease holds the unenviable position of having killed more human beings than any other.*"

The Paludal Theory of Malaria.

The names "ague," "intermittent," and "remittent" applied to the different types of malarial fever are derived from the *sharp*, *broken*, and occasionally *abated*, course they pursue.

It is called "*paludal*," or marsh fever, because of its prevalence in such localities; but in the Roman Campagna, and in many parts of India, Africa, and other tropical countries, malaria is found also where there are no marshes.

Malaria was said to "*lie low*," or keep close to the ground, so that, according to Sir Thomas Watson, "In Italy there is a remark that, as long as the labourers are in the erect position there is little danger, but that fever attacks those who lie or sit down on the ground." The peasants still continue the practice of sleeping upon stages, well raised above the ground, but they have learned that it is the mosquito they are thereby avoiding, that it is the *insect* that lies low.

* *Hygiene and Diseases of Warm Climates*, by Andrew Davidson, M.D., F.R.C.P., Edin. Young J. Pentland, *Edin.* and *London*, 1893.

The true cause and nature of this deadly infection had remained a mystery to our own day. If we consult text-books of Medicine written before 1880, we shall see Malaria described as "an earth-born poison, or miasm, which, emanating or exhaling from certain soils, especially in hot climates, or from marshes in cooler climates, causes those agues and remittent fevers known as malarial."

This appears to have been the popular belief in all parts of Europe, if we may judge by the name given to such fevers in the various European languages.

Malaria had been variously attributed to occult and physical forces of the most extravagant kind ; to paludal and telluric gaseous emanations, connected in some unknown way with seasonal and cosmical influences; with vegetable decomposition and heat, on the one hand, and the turning up of virgin soil, winds, rain and cold, on the other. This ignorance, not untinctured by superstition, was dispelled by the discovery of the micro-organism which is the cause of malarial fever by Laveran in 1880, and its mode of dissemination by Ross, 1899.

The Germ Theory of Disease,

As an introduction to this singularly fascinating subject, we may quote the words of Tyndall :—"The first theory of malaria and like diseases ascribed them to putrefactive emanations, organised matter in motor decay, which, on entering the body, has power to spread there the destroying process by which it has been assailed." He proceeds to explain what he believed to really occur:—"The germs floating in atmosphere enter the body, and produce disturbances by the development within the body of parasitic life. . . . . . Epidemic diseases literally plant their seeds, and grow and shake abroad new germs, which, meeting in the human body their proper food and temperature, finally take possession of whole populations.*

This is the *germ theory of disease*, the discovery of which marks the epoch of a new and more exact science of medicine.

Living organisms, not dead or gaseous matters, were henceforth recognised as the *Contagium vivum* of most diseases.†

It is interesting to notice that the germ origin of malaria was suspected by the agriculturist Varro, who wrote upon the subject in classic times; and that Kircher and Linnæus, also on theoretical grounds, maintained the doctrine of a living ferment in malaria.‡

It was henceforth taken as established that no infectious or contagious disease had ever yet been known to arise *de novo;* all had come from seed, yielded like seed, and bred true. The great Pasteur, whom I had the privilege and honour of knowing personally, sums this matter:—

"*C'est ma conviction, la doctrine des générations spontanées est une chimère.*"§

The names of Crudelli and Klebs, Laveran, Frerichs, and Kelsch are associated with the earliest scientific work upon malaria.

Tommasi Crudelli and Klebs, in 1879, found a parasite, which they named "*schizomêtes bacillaris,*" in the earth and air of malarial districts. With it they inoculated rabbits, and claim to have produced in them "intermittent fever," with enlargement of spleen.

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* *Floating Matter of Air.*

† Of these micro-organisms, the *amœbæ* and *sporozoa* will claim our attention Amœbæ multiply by fission, and may be described as particles of protoplasms, like the colourless corpuscles of human blood (pictured at end of Chap. x.), which exhibit independent contractility. The sporozoa, or that family of them called *micro-cocci*, are single-celled organisms (see Chap. vi.), which multiply by spores or segments, also sexually.

‡ *Il Clima di Roma.*

§ *Pasteur.*

This discovery has not been verified; on the contrary, the negative has so far been established! Ross says: "No one has ever found the germs of malarial fever in water or soil. On the contrary, Calandruccio, Zeri Agenore, Celli, and others have frequently tried to cause infection in healthy persons by water, earth, and air brought from intensely malarious localities, and have always absolutely failed. Besides this, the idea that malarial germs diffuse themselves in the air, earth, or water is contrary to all we know of the habits of animal parasites. It is contradicted by the fact that of two houses, a few yards apart, or even two sides of a barracks or hospital, one may be malarious, the other not."*

The position of scientific belief at this period will be best understood from the then teaching of the Italian School of Medicine, which was briefly as follows:—

1868-1879. Malaria is due to a micro-organism, a living ferment, diffused in the soil, air, and water of infected regions which afford the conditions essential for its growth—moderate heat, moisture, and aeration of soil.

If the temperature should fall for a time below 68° F., or rise for long above 145°, the growth of this fungus will be arrested by what is technically called "*thermic suspension*."

Excessive dryness of soil will produce like results, by "*anhydrous suspension*."

If land is inundated, malaria is held in abeyance by "*hydraulic suspension*," the layer of water preventing aeration essential to its growth, and also the diffusion of its germs in air.

Cementing, trampling, paving, and otherwise sealing up ground, produces "*atmospheric suspension*" of malaria, its necessary air being here also excluded.†

* *Malarial Fever—Ross.*

† "*Il Clima di Roma.*" By Dr. Conrad Tommasi Crudeli. Rome, 1868: Hermann Loescher & Co.

In Tropical Africa malaria is almost universally prevalent, especially in alluvial lands, and in clays and loams full of vegetable matter in process of decay, such as are found in deltas, river bottoms, swamps, lagoons, and flooded flats.

A high British authority thus summarised the conditions of soil and water favourable to the growth of malaria :—

"(1) Alluvial soils, old estuaries, and deltas; (2) sands, if there be impermeable clay or marly subsoil, and old water-courses; (3) the lower parts of chalk, if there be a subsoil of clay or gault; (4) weathered granite trap rocks, if vegetable matter has become intermixed; and (5) rich vegetable soils at the foot of hills. Sir Joseph Fayrer holds that subsoil water or damp is the essential condition of malaria, and especially if the subsoil be impregnated with a certain amount of stagnant moisture, and this is probably present in many of those localities in which the appearance of malaria is so difficult of explanation. Malaria appears to be at its worst in the drying-up season after rains, but during the rains it is less severe. Whilst turning up new soil generally increases the danger of malaria, the cultivation of the same soil afterwards diminished it."*

The spores of these hypothetical fungi were supposed to find entrance to the human system through the medium of the air by breathing, or by drinking water which contained them. All efforts, however, to find them in soil or water proved unavailing, as we shall see presently.

The True Parasite Discovered.

1880. Laveran first discovered the true parasite of malaria in the blood of patients suffering from malarial fever, describing it as a "flagellate organism free in the blood of patients

* Lecture by C. T. Williams, M.D., on "*Climate in its Relation to Health*," 1894.

suffering from malarial fevers."* (See Plate at end of chapter.) Particulars of this discovery are given in the next chapter.

Carboni and Marchiafava next found in malarial blood an organism pathologically resembling Klebs' bacillus.

1883. In 1883, Marchiafava and Celli stained the "amœboid body of the parasite"—which they termed the *plasmodium malariæ*—with methylene blue, thus clearly demonstrating its presence within the blood-corpuscles.

1883-1885. Golgi differentiated the parasite of the *tertian* from that of *quartan* ague, and announced the important law :—*The commencement of paroxysm of the fever is synchronous with the stage of sporulation of the parasite.*

More recently Marchiafava and Bignami describe the microbe as thus summarised by Dr. Charles :—

"The parasite of malaria consists of a minute particle of protoplasm, which, resembling a small amœba, enters into the red blood-corpuscle and there converts the hæmoglobin into melanin. It is often endowed with amœboid movements, which may be very active and produce rapid changes in its shape. It lives in the interior of the red blood-corpuscle, and gathers the pigment it forms into its centre. It then divides into separate fragments, this segmentation taking place within the body of its host, the red-blood corpuscle."†

1894-1897. Guarneri, Bignami, Mannaberg, Councilman, James, Ross, Osler, Carter, Hehir, and Evans, were some of the most distinguished workers upon this subject up to 1894-7.

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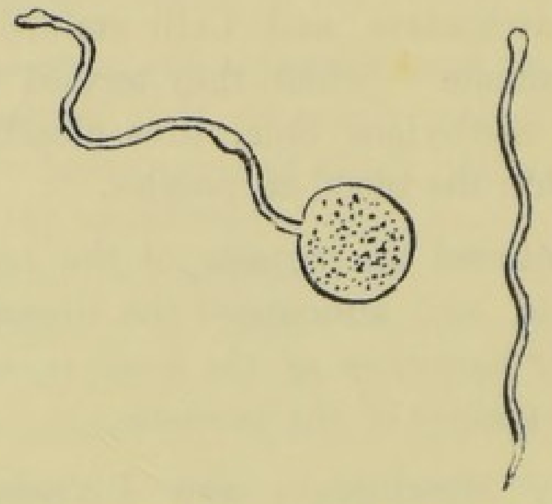
* *Traité des Fièvres Palustres*, Paris, 1884. *Paludism*, by Dr. A. Laveran. Translated by J. W. Martin, M.D., F.R.C.P.E. The New Sydenham Society.

† See *Two Monographs on Malaria and the Parasites of Malarial Fevers.* (1) Marchiafava and Bignami ; (2) Mannaberg. London, the New Sydenham Society, 1894.

The history of the life cycle of the malarial organism in man was now fairly well understood, but it remained for Ross to complete the discovery of its sexual life cycle in the mosquito, and the mode of malarial infection by the bite of a certain species of this insect.



PLASMODIUM MALARIÆ—(after Laveran).

This is known as the flagellated parasite; the tail or whip process at times breaks free from, and moves independently of, head, as shown in illustration. *The true meaning of this form of development and the function of the whip-like process of the parasite will be explained in a future chapter.*

CHAPTER VI.

History of Malarial Discovery—*Continued.*

PART II.—THE MOSQUITO ACCUSED IN ANTIQUITY—THE DAWN OF TRUTH IN EUROPE.

In the last chapter we have seen that a general belief existed, during historic times in Europe, of the telluric origin of malaria, but, strange to say, a still older belief was held in the East, namely, that the mosquito caused it. This appears to have prevailed in China and India from times immemorial, and Sir Rubert Boyce states in *Mosquito or Man* that Sir Henry Blake, speaking at a banquet in connection with the Liverpool School of Tropical Medicine, in **1908**, said that while he was Governor of Ceylon he was shown a book written fourteen hundred years ago, in which flies and mosquitos were stated to be the cause of malaria. Also mechanical protection against mosquitos by the use of pungent oils on the skin, and by the net or other canopy was practised by the ancients, the word "canopy" being derived from κώνωψ, a gnat or mosquito.

1848. This year Dr. Nott, of Alabama, wrote a treatise on the subject of the Mosquito Origin of Yellow Fever.

1853. This year Dr. Beauperthuy, of Guadeloupe, published in the *Gaceta Oficial de Cumana* the results of his observations on Yellow Fever, in which he declares it to be non-contagious, in the ordinary sense, but that it develops itself under conditions which favour the development of mosquitos. He is also very explicit in his description of how the virus is conveyed, and how it affects man. He says: "The mosquito plunges its proboscis into the skin, and introduces a poison which has properties akin to that of snake venom. It softens the red-blood corpuscles, causes their rupture, and facilitates the mixture of their colouring matter with the serum." Further, he states that remittent, intermittent, and pernicious fevers are caused by similar inoculation by mosquitos, and remarks that the expression of "*Winged Serpents*," used by Herodotus is peculiarly applicable to the mosquito and the result of its bite on man. Also, he wholly rejected the marsh origin of yellow fever and malarial infection.

Notwithstanding all this, and the sagacity it displayed, his ideas hovered over telluric infection in another form, and he supposed that the poison conveyed by the mosquito by biting man had been derived from "extraneous decomposing matter," so missing the fact that its true focus was infected man.

In the period from 1852 to 1880 Drs. Blair, Findlay, King, and others contributed to establish Beauperthuy's observations regarding the connection between the mosquito and malaria.

The Second Epoch of Malarial Discovery.

1880. Meanwhile, Laveran had made his great discovery of the life cycle of the malarial parasite in the body of man, so that the two doctrines of intra corporeal propagation of the malarial microbe, and extra corporeal mode of infection by means of the mosquito were rapidly approximating the point of conjunction which would reveal their relationship.

Laveran being a French military surgeon, stationed in Algeria, had ample opportunity of verifying his discovery, which was also confirmed by the leading medical scientists of the day. The malarial parasite was not only visible all over Europe and America, but described and classified in many tongues. Yet the perplexing question remained, how did it gain entrance into the human blood, and to our own countryman, Major Professor Ross, of the Liverpool School of Tropical Medicine, belongs the honour of its discovery.

The Third Epoch of Malarial Discovery.

MANSON'S GREAT DISCOVERY.

1883. We must now look back a few years to consider a memorable discovery, which proved to be the clue to the final solution of the malarial problem.

This was the discovery by Sir Patrick Manson, that *the intermediate host of the blood parasite Filaria was the female mosquito, generally one of the species Culex.* A brief notice of Filariasis will be given later on; it will suffice to say here, that one form of this disease is due to a minute parasite in the blood of the infected known as *Filaria sanguinis hominis.* Manson says it is sometimes very numerous, hundreds in a drop of blood. He concluded that it was the young of some other animal which he, Bancroft, and Lewis afterwards proved, but how this parasite could pass from one human being to another was the question. By a beautiful chain of reasoning, Manson fixed upon the mosquito as the probable carrier, and having allowed hungry mosquitos to feed upon a Chinaman who had the parasites in his blood, he found that on dissecting these mosquitos, the parasites, far from being killed and digested in the juices of the insect's stomach, were full of life and activity therein. Moreover, by a series of patient and beautiful dissections of the mosquitos he was able to trace the *Filaria* parasite, which meanwhile was undergoing a series of developments, first through the stomach walls into the abdominal cavity, thence into the chest muscles, and thence into the proboscis of the mosquito, where it lies in wait to enter a new human host when the mosquito sucks his victim.

This remarkable discovery proved that *both man and mosquito are necessary for the complete development of the Filaria parasite*, and it threw wide open the door to scientific speculation, as to whether the life cycle of the malarial parasite might not also require man and mosquito for the completion of its life cycle. Since Pasteur's day no greater or more epochal medical discovery than this has been made, for as the former gave to science the new world of microbic etiology, so Manson supplied the missing clue to undiscovered territories of research, whereby medical science has been enabled to rescue humanity from ineffable suffering and appalling mortality.

The Final Stage of Malarial Discovery.

1895- During these years Professor Major Ross, by his indefatigable
1899. labours, filled up the last gap in the etiology of malaria, by proving that, "*the parasite of malaria found by Laveran passes a hitherto undiscovered stage of its existence in the mosquito, and is then inoculated into man by the bite of the insect.*"*

There is only space here for the briefest outline of this "Fairy Tale of Science."

Before setting out for India to resume his regimental duties, Professor Ross discussed with Manson the methods

* *Malarial Fever: Its Cause, Prevention, and Treatment.*—Ross.

whereby he should test if the mosquito were the host of the malarial parasite, as Manson had suggested that it might be from his discovery of the insect being the host of the parasite, *Filaria Bancrofti.* Ross says, "In fact, it was proposed that I should adopt exactly the procedure employed by Manson in regard to *Filaria Bancrofti.*"*

Ross on his return to India commenced his arduous task by making an exhaustive survey of all the mosquitos found in the various buildings of the military cantonment, including the officers' quarters, hospital, and numerous small houses of the native soldiers. As a result, he found three kinds of mosquitos, "a brindled, a grey, and a small *pale brown delicate mosquito*, which were in swarms, and *distinguished by resting with the body axis at an angle to the wall and having spotted wings*," a genus distinct from those upon which he had already spent much time and labour in fruitless investigation. These mottled delicate mosquitos, though so numerous, did not appear to bite, and being plentiful in officers' quarters, where they and their families were living free from malaria, he failed at first to suspect maleficence.

Ross, however, determined to prove this, and so he collected and hatched out their larvæ, and when the adult insects appeared, he liberated them within mosquito nets in which malarial patients had been placed.

The insects when gorged were kept for a few days in bottles containing water, and then dissected with the most scrupulous attention to details.

"This work," Ross says, in his account of it, "continued from 8 a.m. to 3 or 4 p.m., with a short interval for breakfast, and was most exhausting, and so blinding that I could scarcely see afterwards." Flies pestered him while at work, and his microscope was old, worn out, and rusted by the sweat of his hands and face, owing to the intense heat of the weather.

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* See *Mosquito or Man*, by the late Sir Rubert Boyce.

No punkah could be used lest the delicate dissections should be spoilt. Worst of all, for weeks the results of his labours were negative.

Aug. 20, 1897. But such labour is seldom or never fruitless, and on August 20, 1897, a day which must be ever memorable in science, just as his hopes were beginning to flag, Ross's labours were crowned with success. On opening an insect's stomach, "I saw," he writes, "a very delicate circular cell, apparently lying amongst the ordinary cells of the organ, and scarcely distinguishable from them. Almost instinctively I felt that here was something new." Then he saw other similar cells, twelve in all, "with minute granules of a black substance inside, exactly like the pigment of the parasite of malaria."

"After mounting the preparation I went home and slept. On waking my first thought was that the problem was solved—and so it was."

Yet there was more hard work before him to complete the chain of evidence, namely, to trace the development of the parasite step by step within the body of the mosquito, up to its final lodgment in the proboscis of the insect, ready to be inoculated when the next victim should be bitten.

This concluding phase of the discovery will be briefly explained in Chapter VII.*

* See Ross's various works on *Malaria*; also Boyce's *Mosquito or Man*.

CHAPTER VII.

The Malarial Problem.
The Life-History of the Malarial Parasite.

All dwellers in Tropical Africa will find it useful to have at least an elementary knowledge of the life-history of the malarial parasite which preys upon the human blood.

But first let us consider what blood is; that wonderful fluid from which the countless cells of which the body is built up derive the pabulum necessary for their growth, development, and functional offices.

Blood consists of a transparent fluid known as the "plasma" or *liquor sanguinis*, containing bodies called corpuscles. Of these, three principal forms may be recognised by the microscope, floating in the colourless plasma, viz., the red blood-corpuscles, or cells (Plate IV., *a*), by far the most numerous, giving the blood its characteristic colour; the white blood-corpuscles, or leucocytes (*b*); and blood plates, called "plaques." We may omit the consideration of the last.

The red blood-corpuscles have no cell membrane, strictly so called, nor power of contraction or movement, such as the leucocytes have.

They are far the most numerous elements, being generally estimated at about 5 millions per cubic millimetre in the blood of a healthy man and 4½ millions in that of a woman.*

The leucocytes, or white corpuscles, number only from 6,000 to 9,000 per cubic millimetre, but they play an important part in the economy as the standing army against parasitic invasion.

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* *The Blood: How to Examine it and Diagnose Disease.* By Alfred C. Colles, M.D. (2nd ed., 1902).

The Malarial Parasite.

WHAT WAS KNOWN TO SCIENCE ABOUT THE MALARIAL PARASITE PRIOR TO ROSS'S DISCOVERY.

PART I.

The parasitic micro-organism which is accepted as the true cause of malarial fever has been variously named from its behaviour under the microscope, and the interpretation of its life-history by scientists.

It has been called the *plasmodium malariæ; hæmaplasmodium malariæ; schizomêtes bacillaris; schizomêtes malariæ; hæmatomomas malariæ; hæmatozoön malariæ; hæmatozoa malariæ;* the *malarial fungus;* and *hæmatophyllum malariæ; hæmamœbe* being its newest name. Golgi said there are two varieties of the malarial parasite, one causing *tertian*, the other *quartan* ague, and he considered *quotidian* fever to be double tertian, or triple quartan.*

Dr. Hehir some years ago held to the doctrine of a single polymorphic parasite, and he thus summarised his views:—The forms assumed by this malarial micro-organism are: Spores, small amœboid organisms, spherical bodies, *hæmatomomas malariæ stellatæ,* intra-corpuscular bodies, hyaline bodies, rosettes, flagellated organisms, and various pigmented

* In this he is supported by Dr. Kaufmann in a communication to the members of the *Institut Egyptien*, who accounts for quotidian ague by supposing that two sets of parasites, the life cycles of which are completed in 48 hours, are maturing in the patient at the same time.—"One set maturing at the conclusion of 48 hours, ending to-day, say, and the other set maturing at the conclusion of 48 hours, ending to-morrow; thus we have double tertian or quotidian ague." See Dr. Manson's *Lecture. Lancet*, January 6th, 1894.

and phagocytic cells. He thus included all the forms described by his predecessors as "*varieties of one polymorphic hæmatozoön.*"*

One of the most common and constant forms of the malarial parasite is the *amœboid*, which has the power of movement and of assuming endless varieties of shape in the microscopic field.

Its quiescent, presporulating, and crescentic phase of development is also commonly seen in the blood of fever patients. The flagellated form is rarer and more evanescent; it possesses the power of active movement, but not of transformation. This curious tail-like process is at first imperceptible, save by the violent disturbances produced by its movements amongst the surrounding red blood-corpuscles, which it also lashes violently.

Soon losing vitality in the microscopic field, and moving more slowly, it ends by becoming still, disconnected from the head, and dissolved in the blood plasma.

The following is the life-history of the malarial parasite in the human blood:—At first it appears as a pearly looking body attached to the outside of the red blood-corpuscle. Entering this it rapidly grows and develops at the expense of the cell contents, while preserving its amœboid movement. By degrees it becomes stationary and "pigmented," or speckled with the colouring matter of the cell contents which

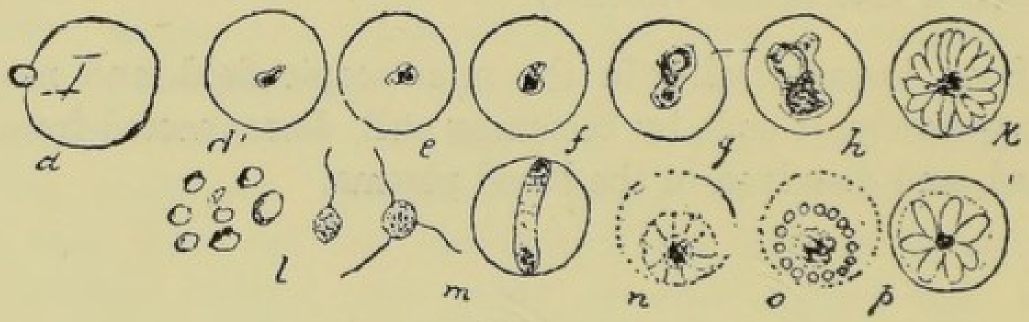
* *Microscopical Observations on the Hæmatozoön of Malaria, with an Appendix containing a series of Plates of Illustrations and Descriptions.* By Surgeon Patrick Hehir, M.D., F.R.C.S.Ed., Lecturer on Pathology and Clinical Medicine to His Highness the Nizam's Medical School and at the Afsul Gunj Hospital, Hyderabad.

ILLUSTRATIONS FOR CHAPTER VII.

PLATE II.

This plate is taken from the paper in the *Canadian Practitioner* (Toronto, Jan. 16th, 1890), by Professor W. Osler, M.D., F.R.C.P., then Prof. of Med., Johns Hopkins University, now of Oxford University.

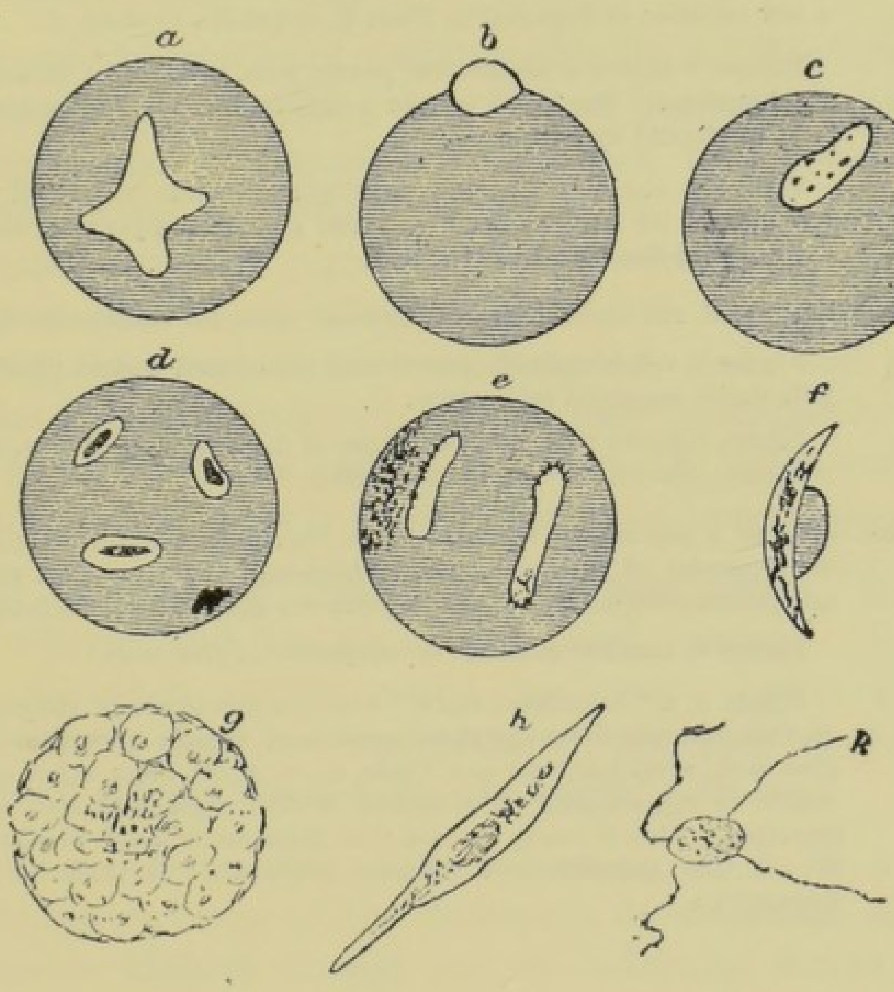
THE ETIOLOGY OF MALARIA.



d-k, successive phases of development of *Plasmodiun malariæ* within human red blood-cells ; *k*, segmentation in the rosette form with central pigment ; *l*, free segments which may be amœboid or flagellate*; *m*, *n*, *o*, plasmodium of tertian, *p*, of quartan ague, according to Golgi.

* The flagellate form has since been discovered to be an *extra corporeal* phase of the parasite's development, also a sexual form within the body of mosquito.

PLATE III.



THE PLASMODIUM MALARIÆ (after Marchiafava and Celli.)

b, Parasite leaving a blood corpuscle.
a, *c*, *d*, *e*, Various developments of parasite in red blood-corpuscle.
g, Sporulating stage just before rupture of blood-cell and escape of spores.
f, *h*, *k*, Sexual forms of parasitic development.

Plate III.

Explanation of figures.*

On 1st line.—Figure *a*, red blood-cell or corpuscle, containing a *plasmodium malariæ*. The parasite possesses power of amœboid movement similar to phagocytes, and will assume as many and varied forms in a few minutes as depicted in Plate B, appendix to chap. x.

Figure *b* shows a motionless pearly *plas. mal.* about to leave the red blood-cell; the blood is from a case immediately after paroxysm and treatment by quinine.

Figure *c* shows *plas. mal.* developing within blood-cell at the expense of its host, as shown by the granules of pigment scattered everywhere through its substance.

On 2nd line.—Figure *d*, red blood-cell, with annular malarial corpuscles inclosed.

Figure *e*, red blood-cell, containing pigmented bodies which have still slight amœboid movement.

Figure *f* shows that peculiar phase of development of *plas. mal.* (or its germ), known as "semi-lunar bodies."

On 3rd line.—Figure *g* shows the sporulating or segmenting stage or phase of development of *plas. mal.* within blood-cell. The pigment granules are scattered or in groups, and spores are seen to have formed.

Figure *h*, another phase of development of *plas. mal.*

Figure *k*, a "flagellated body," which is one phase of the *plas. mal.* In this example there are three processes, *flagellæ* or whips. In the *plas. mal.*, after Laveran (see Plate, ch. v., p. 58), there is but one tail, which is represented as attached to the head, and also another detached. This is really a phase, not then understood, of the *sexual* life of the parasite (see diagram plate iv., "fertilization of the Zygote").

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* For these drawings and description I am indebted to *Papers on the Etiology of Malaria*, by Professor E. Marchiafava and Dr. A. Celli, with a note by C. Friedländer. Translated for private use from the German text by C. H. Eyles L.R.C.P. & S. Edin., Member Path. Society, &c. 1887.

it is digesting.* Having passed through a series of metamorphoses, we find the parasite with the pigment no longer diffused through its substance, but collected into little masses, generally at the centre of the organism. The *plasmodium* has now almost, or quite, filled up the red blood-cell, and digested its contents. At this stage its amœboid movement quite ceases, and it enters upon the second phase of its existence.

The general position of matters within the red blood-corpuscle is now as follows:—There is a central pigmented mass, and a protoplasmic peripheral, which is seen to be breaking up into spores or segments, varying much in size and shape, pigmented and non-pigmented, most commonly the latter. The new broods are being prepared, in short, and, when matured, they rupture the containing cell wall, and are cast into the general circulation. There they immediately invade fresh blood-cells, thus completing their life cycle within the human body by what is known as *asexual* propagation.

But "spores" or "segments" are also found "free," or extra cellular, and floating in the blood plasma.† Some of them are such simple, round, or cystic bodies as have already been described and pictured, adhering to the outer surface of the red blood-cells, like pearly nodules.

Some are crescentic, which is now proved to be a resting or conjugation stage of the parasite's development, in which it remains without change for an indefinite period in the

* The *plasmodium malariæ* becomes loaded with particles of *melanin*, a dark ferruginous pigment resulting from the disintegration of *hæmoglobin*, which is the iron-holding and oxygen-conveying principle of the red blood-corpuscles. Dr. Mannaberg, on this subject, writes: (*Monograph on Malaria*)—"The melanæmia is explained convincingly and indubitably by the fact that the parasites transform the hæmoglobin by which they are nourished by means of their metabolism into melanin. Melanin is, therefore, nothing but the undigested residue of nourishment which the parasites form and heap up in their bodies; the granules and rods can be conveniently termed fæcal matter, notwithstanding that they are not thrown out."

† *Plasma*, "the nearly colourless fluid (of the blood) in which the red corpuscles are suspended."—*Huxley*.

human blood. It was asserted that the conjugation of two semi-lunar parasites, and their fusion, had been actually observed to take place under the microscope, in the blood of cases of pernicious malarial fevers.*

The flagellated, or mobile filaments, or whips, are generally seen attached to round "heads" of clear pigmented protoplasm.†

Marchiafava and Celli described the movement of their whip-like processes as "either continuous or intermittent. They mutually lash and repel each other, and if they happen to get amongst the hæmocytes (red blood-corpuscles), they repel them, lash them hither and thither, and alter their form. They ultimately are set free; entering the plasma with a lively motion, they soon put a distance between themselves and the body to which they were attached, whilst they lash the corpuscles in their way."

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(1) *The time which elapses between the entrance of the malarial parasites into the red blood-corpuscles and their sporulation, determines the type of the resulting fever. And (2), The period of sporulation coincides with the chill, or first stage of malarial pyrexia.*

This is the doctrine of Golgi, which has been substantiated. In quartan ague, for example, he found that the parasite completed its life cycle in exactly three days, during which it enters the red blood-corpuscle, and passes through the various stages of development just described therein. At the end of the third day from that of entrance, coincidently with the chill, or "rigor," or other initiatory symptoms of the new paroxysm, sporulation takes place.

* See Dr. Sheridan Delepine's paper:—*A Few Facts Concerning Psorospermosis and Gregarinosis. Brit. Med. Jour.*, Oct. 14, 1893. See also Dr. Armand Ruffer's paper:—*Recent Researches on Protozoa and Disease. Brit. Med. Jour.*, Oct. 14, 1893.

† See plate of Plasmodium Malariæ, after Laveran. End of Ch. v., p. 58.

In the same manner, *tertian* fever, according to Golgi, is caused by a parasite which completes its life cycle in two days.*

By others, the quotidian is held to be caused by an amœba, with a life cycle of twenty-four hours.

ZOOLOGY OF THE PARASITE OF MALARIA.

Respecting the zoology of the parasite of malaria: the *Plasmodium malariæ*—or, as Dr. Ruffer prefers to call it, the *Hæmatophyllum malariæ*—belongs to the *sporozoa*, a group of simple unicellular organisms, forming part of the sub-kingdom *protozoa*. The cells of certain *sporozoa* are sufficiently large to be seen by the naked eye, but more frequently the pathogenic kinds are quite microscopical.

There are four orders of *sporozoa*,† but we are chiefly concerned with the *gregarinidiæ*, and particularly with one family of them, known as *cocci*, or *coccidiæ*, which Dr. Ramsay Wright‡ describes as "minute intra-cellular parasites, with a short, free, wandering stage, however, permitting the young forms to invade new cells, their hosts."

Neither man nor beast, fowls nor reptiles, insects nor plants, escape from the ravages of some variety of these protozoic pests.

The spores of the *coccidiæ* are oval or round, an example of which is furnished by the pearly-looking bodies of the malarial parasite previously described. They are also cres-

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* See account of Camillo Golgi's work on Malaria, in *Zeitschrift für Hygiene*, vol. x.

† (1) *Gregarinidiæ;* (2) *Sarcosporidiæ;* (3) *Myxosporidiæ;* (4) *Microsporidiæ.*

‡ See Professors Ramsay Wright and William Osler's papers on *The Pathogenic Sporozoa* and *The Etiology of Malaria*,—*The Canadian Practitioner*, January 16, 1890.

centic, flagellate, and other forms, according to their surroundings and the special work they have to perform. Thus they are round when met with in the blood or soft organs, as the liver; crescentic when cell penetration is to be effected; and flagellated when planted on the mucous membranes, as of the throat, where ciliated movement is a condition of their existence.

Before concluding this necessarily brief summary, the valuable investigations of Surgeon Fenton Evans should be noted.

He fully confirms the doctrine of the microbic origin of malarial infection, and in a private letter to me, bearing date May 28, 1891, London, says:—"I regard the organism *(Plasmodium malariæ)* as the cause of malarial infection, but am not at present satisfied that the cycles of change observed in the organism, as studied in the blood by Golgi, have any casual relation with fever incidence. My paper puts on record the first successful attempt to cultivate the organism."

By his method of staining, Evans demonstrated the existence of the malarial parasite not only more effectively in the blood, but also in the tissues. Finally, by the addition of glucose, together with iron or hæmoglobin, or fresh blood, to non-peptonised beef-broth nutrient medium, he found that the organism can pass to a more developed state, *displaying the structure and fructification of a highly organised fungus, but differing in certain important features from any fungus hitherto described.*

"Inoculation of guinea-pigs, monkeys, and rabbits, with the growths in various nutrient media, has produced a frequently fatal disease, which, although not characterised in those animals by the symptoms of classical intermittent fever, yet displayed in a number of instances a definitely intermittent character. . . . accompanied by the appearance of the characteristic organism in the blood, drawn after death from the right ventricle."*

Malarial Parasite viewed as a Fungus.

The *Malaria* parasite is a fungus (Evans). Fungi of all kinds are characterised by extreme rapidity of growth on widely diversified soils. Thus, *yeast* fungus thrives on sugar and water; *mucor*, or mould, on jams, boots, lemons, &c.; *mushrooms*, on decaying animal and vegetable matter; and the malarial fungus on the same, mixed in peats, clays, and loams; also upon the red blood-corpuscles. All fungi have to derive the carbon essential for vegetable existence from some organic matter, and not directly from air.

Professor Naegeli found that the lower order of fungi require food soluble in water, in a solution of low specific gravity; by thickening the solution, *i.e.*, rendering the proportion of nutritious matter excessive, the fungi may be killed. Thus yeast fermentation can be stopped by drawing off some of the water; the putrescence of meat is prevented by its desiccation, its juices are rendered too thick for the septic organisms to live in. Moulds require more drying of their nutrient media than yeast, or the bacteria of putrescence. This is shown in jams, where moderate thickening will check fermentation; but to guard against mildew or mould, the thickening process must be carried much further. As moulds

* Abstract from the Proceedings of the Royal Society, vol. 49, *On the Demonstration by Staining of the Pathogenic Fungus of Malaria, its Artificial Cultivation, and Results of Inoculations of the same.* By Surgeon J. Fenton Evans, M.B., etc., etc.
Evans, in this paper, thus summarises the foreign substances found in the blood during and after attacks of malarial fever:—

Class I.—Cystic bodies or spores, 2 to 11 μ in diameter; round, transparent, encapsulated bodies of various dimensions.

Class II.—Crescentic bodies, 8 to 9 μ long and 3 μ broad.

Class III.—*Plasmodia malariæ*, organisms as variable in size as the cystic bodies or spores, possessing the power of amœboid movement, and so closely associated with the red blood-corpuscle, that hitherto the majority of observers have considered them to be parasites situated within the red blood-cells.

Class IV.—Mobile filaments, 18 to 22 μ long.

grow, they give off ill-smelling gases, familiar to us in the smell of fermenting yeast, mildew, and water cisterns, all caused by micro-organisms.*

The "African smell," which clings to clothing, trunks, etc., is also due to such emanations; so I believe is the nauseating exhalation given off from the body in malarial fever, which, in bad cases, is that of bruised cockroaches.

The foregoing is a brief précis of what was known of the life cycle of the malarial parasite before Ross's discovery, 1895-9.

* See Miss Laurie's paper on *Fungi*, read before the *Cheltenham Natural Science Society*, April, 1892.

PART II.

The most Recent Information concerning the Double Life Cycle in Man and Mosquito of Malarial Parasite.

Ross's discovery, as before observed, has solved the problem of how the malarial parasite enters the human system by the bites of infected mosquitos. Incidentally he has also substantiated almost all the discoveries of his scientific precursors which have been briefly reviewed, and his numerous writings have made the results of his labours easily intelligible to any ordinary reader. Manson's diagrams have also greatly contributed to elucidate and popularise this interesting subject.

Brief Summary of our Present Knowledge of Malarial Infection.

Chiefly Based on Manson's and Ross's Discoveries.

The malarial parasite is now described by scientists as a minute, single celled, yet highly organised animal of the class *Sporozoa*, living within the red blood-corpuscles, and introduced into man by the bite of an infected mosquito. When a mosquito which is infected with malaria from having fed upon a person suffering from the disease bites a healthy person, it not only injects some of its own irritating saliva into the wound, but also some malarial spores, which have been lying in the insect's salivary glands. There are, according to Manson, Ross, and others, at least three kinds of malarial parasite, which are thus introduced into man, and which, breeding true, cause their respective fevers; and each kind of the malarial parasite, generally called by scientists the *Plasmodium malariæ*, has its special span of hours for running its complete life cycle in the human body, *viz.:* in the "benign" forms 24, 48, or 72, producing "*Quotidian,*" "*Tertian,*" *and* "*Quartan*" fever respectively. The "malignant" or *Æstivo-Autumnal* variety, has no definite span of maturation. But, as before stated, some authorities deny the existence of "*Quotidian*" fevers, holding them to be "*double or overlapping Quartan.*" Still they are commonly seen clinically and must therefore be mentioned.

The Life Cycle of the Benign Malarial Parasite.

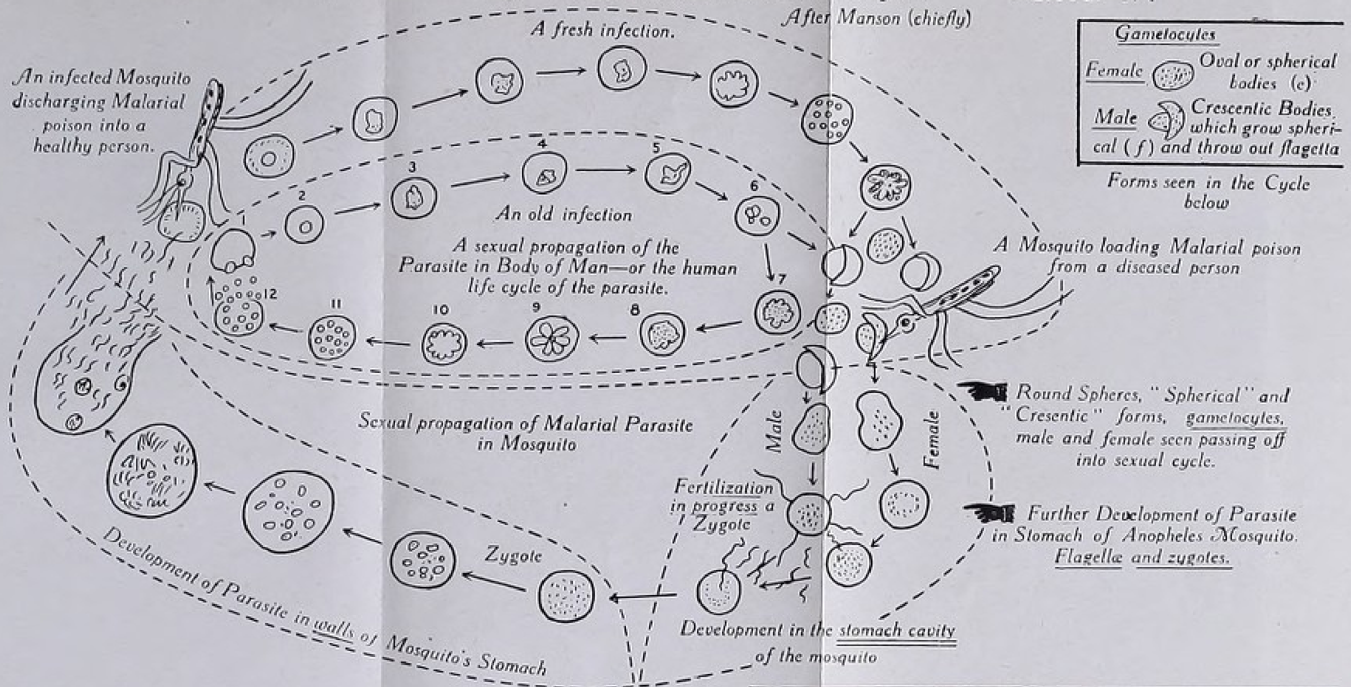
The development of the benign variety of the malarial parasite within the red blood-corpuscles of man, according to the most recent views of scientists, is shown in the accompanying diagram Plate IV.

To understand this diagram we must remember that the *protozoa*, to which the malarial parasite belongs, reproduce themselves both by simple cell division—the asexual method—and by the formation of male and female cells—the sexual method. Take the simplest illustration of this, namely, the reproduction of the *Volvox globator*, to which my son drew my attention. It is found commonly in ponds in England, and is a familiar microscopic object. This produces sexual and asexual spores—the sexual in autumn, the asexual in summer—either kind being capable of reproducing a perfect *volvox* when cast by the rupture of the mother cell into the water. (See Plate IV., *c* and *d*.)

It is noticeable that the sexual spores of the *volvox* are only produced in autumn, and the asexual in summer, a fact which, in the absence of the discovery of more definite scientific

Diagram of Development of the Benign Malarial Parasite in Man and Mosquito. PLATE IV.

After Manson (chiefly)



(a)

(b)

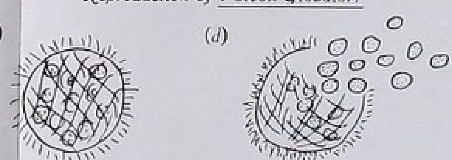
Red blood Corpuscles
Average size, 7.5 mm.

White blood Corpuscles
(leucocytes)
(also called Phagocytes by Metchnikoff)

Reproduction of Volvox Globator.

(c)

(d)



(c) Volvox Globator. Maturing Spores

(d) Rupture of parent cell (Cœnobium) Spores being set free in the water.

causation, suggests to me the possibility of a casual relationship between season and sexual sporulation in the malarial parasite also. Certainly the æstivo-autumnal fevers are those produced by the sexual form of the parasite known as "*Crescentic Bodies*," and these fevers, as the name implies, occur in late summer and autumn.

We can now understand what at first sight might appear to be a very complicated matter, the asexual and sexual life cycle of the malarial parasite in man and mosquito.

PRECIS OF THE LEADING POINTS OF ROSS'S DISCOVERIES.

The ASEXUAL cycle shown in the inner ellipse of diagram (Plate IV.) as occurring in twelve red blood-corpuscles (numbered 1 to 12) corresponds to that described in the preceding part of this chapter (see Plates II. and III.). This form of asexual propagation may go on indefinitely in the human body.

It is, in short, reproduction by simple splitting-up of cells, or cell division, and it is the only mode possible, so long as the parasite remains in man. This is the human life cycle of the malarial parasite.

The SEXUAL propagation of this parasite is shown in the lower half of diagram, Plate IV.

Sooner or later, from a cause not yet discovered, but which I venture to suggest may be connected with the seasons, sexual spores are developed in the hitherto asexual life cycle of the parasite in man, and instead of cells undergoing the breaking-up process referred to, we find some parasites assuming a spherical, others a crescentic form, hence called "*Crescentic Bodies.*"

It was observed when blood from mild and malignant forms of malaria was microscopically examined that in the former there were generally round spheres, and in the latter crescentic bodies found mingled with the ordinary malarial parasites. (See Plate IV.)

As these less numerous and less frequent forms were being observed some of them threw out delicate thread-like processes, which, acting as little whips, lashed the blood-corpuscles, as described on page 72, Part I. of this chapter. This and other phenomena of conjunction suggested to scientists that the malarial parasites had probably an extra corporeal and sexual life. Ross's discoveries, as we know, confirmed this, and proved the completion of the life cycle of the parasite in the body of the mosquito.

Ross's first investigations showed him that the female mosquito, which in the *Culex* and *Anopheles* species are the biters, may feed on patients having the asexual form of parasite without spreading malaria, because these microbes when taken into the stomach of the insect are quickly digested, and so innocuously disappear.

But when by mischance the insect sucks some of the crescentic and spherical bodies a new and wonderful phase of parasitic life begins in the body of the mosquito. Far from being destroyed in the gastric juices of the *Anopheles* mosquito, these parasites have evidently reached congenial soil. They begin to grow rapidly, and the crescentic, or male form becomes differentiated from the spherical, or female, the former being smaller than the latter. In this stage they are known to science as *Gametocytes*. We may remark here that the female form is analogous to the *ovum* or egg, and the male to the *spermatozoa* of higher animal life, *cells performing the functions of organs in the protozoa.*

At a certain point of maturity the male parasites throw out whip-like, very delicate processes, called *flagellæ*, endowed with very active movement, some of which break loose in the stomach of the mosquito, and, finding female parasites, enter, and so fertilize them; they are now called *Zygotes*. The zygotes, or fertilized parasites, now endowed with amœboid movement, promptly burrow into the stomach walls of the mosquito and there quickly grow to thrice or more their original size. They also then proceed to develop, or sub-divide into seed germs, which, as they approach maturity, still further divide, till at last they rupture the containing cell and travel with amœboid activity everywhere through the tissues of the mosquito. Many are drawn by what Ward called "*the chemostatic influence of the salivary glands*," and entering the ducts of these organs, pass with the saliva of the mosquito through the proboscis, into the blood of man.*

To elucidate this, I have introduced a drawing of two mosquitos; that on the right is engaged sucking blood containing "crescentic and spherical bodies," which in a week or ten days will have undergone in the insect the various developments just described. She is then charged for mischief. The mosquito represented on the left hand side of diagram is supposed to be an infected one, now feeding on a healthy person, and so introducing the spores of the malarial parasite which have entered her proboscis and are being discharged, with her acrid saliva, into the blood of the bitten, where they promptly enter the blood-corpuscles, and so start a new infection. (Plate IV.)

The three most fatal varieties of mosquito are:—

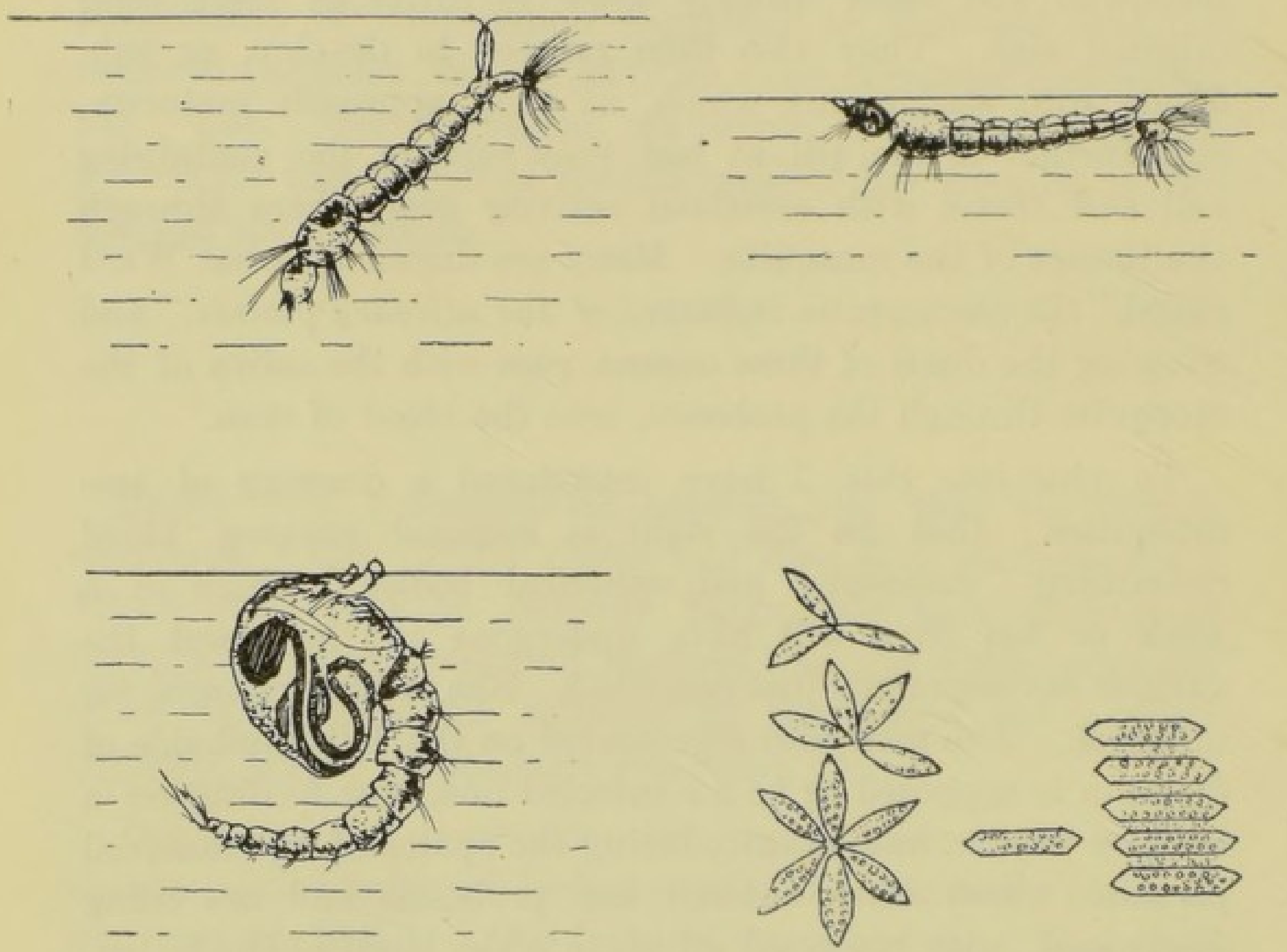
STEGOMYIA FASCIATA.

ANOPHELES MACULIPENSIS, or CLAVINGER.

CULEX FATIGANS, or PUNGENS.

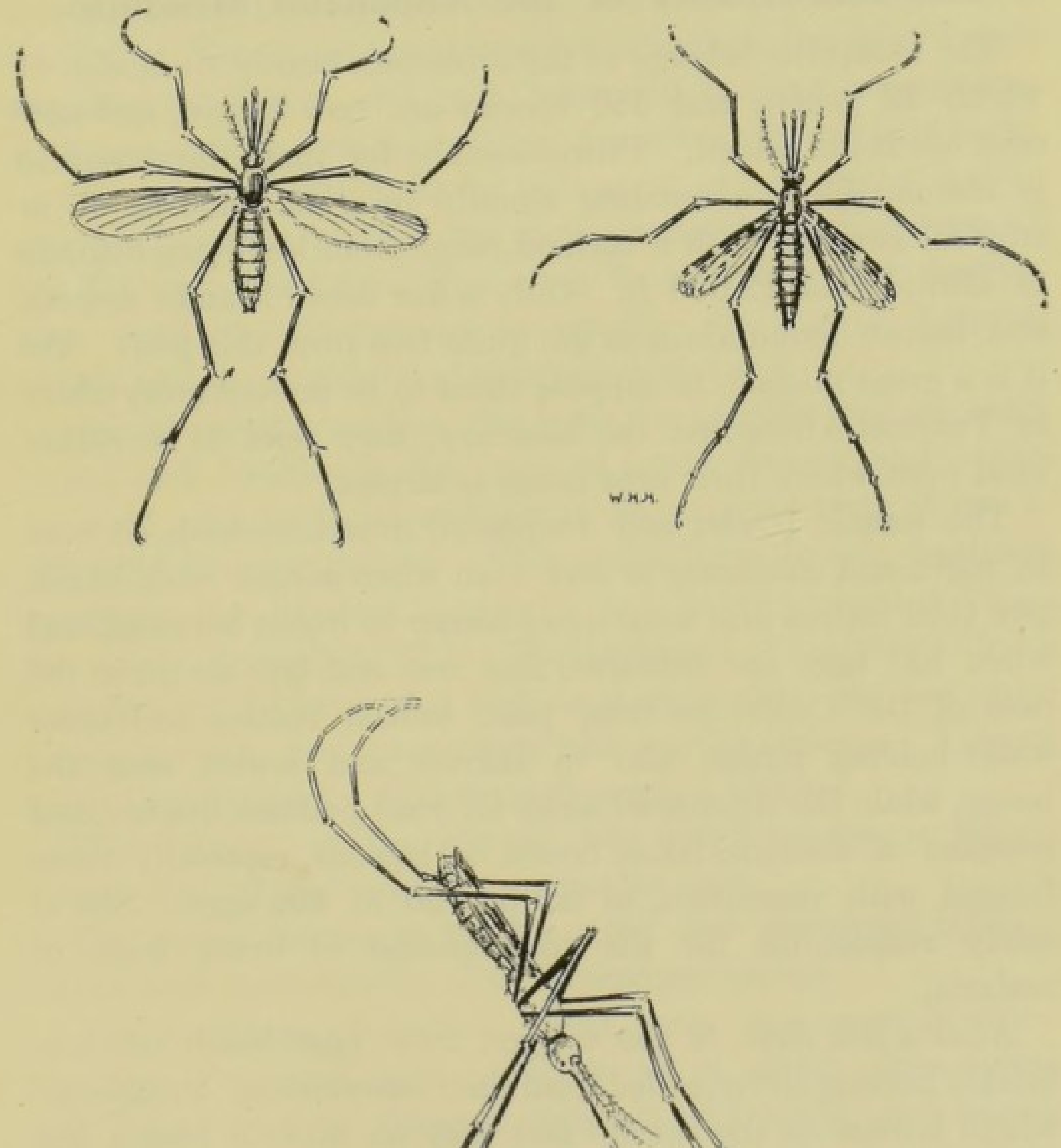
******Scientific American*, 1908, Vol. I., to which I wish to express my indebtedness for valuable material used here and elsewhere.**

PLATE V.



EGGS OF TH[E] ANOPHELES MOSQUITO.

PLATE VI.



CHAPTER VIII.

The Malarial Problem: The Life-History of the Anopheles Mosquito.

The mosquito belongs to the dipterous family *Culicidæ*, of which 22 genera and 350 species are now known, and new ones are being added. Unfortunately for man, the mosquito is cosmopolitan, abounding equally in arctic tundras as in tropical swamps, with a vertical range from low-lying littorals to altitudes of 13,000 ft. Only a few ocean islands, deserts, and barren mountain-tops are quite free from this pest. Yet it is a great mistake to suppose them to be present everywhere in Tropical Africa; on the contrary, they tend to be rather local even where their area range is largest.

The female (*Culex* and *Anopheles*) mosquito feeds on man by night and continues to suck even when gorged with blood. She then retires into some quiet corner to digest her meal, and when her eggs are matured, flies out and lays them, in the case of the *Culex*, in tubs, pots, broken bottles and other water-holding refuse, also in barrels and sewers near the house, while the *Anopheles* seeks for road puddles, ditches, and margins of streams, lakes, rivers, or lagoons, especially those fringed with vegetation, to lay her 50 to 400 eggs. She is solely responsible for the transmission of every form of malaria.

After a few days, in the tropics, these eggs hatch out into briskly moving *larvæ*, called from their movements, "wrigglers," which browse on the bottom and prey on minute plants and animals in the water, and also have many enemies that prey upon them. The larvæ have a swollen head and thorax, and a body of nine segments. (See Plate V.)

The *Culex* larvæ swim head downwards, the *Anopheles* larvæ along the surface of water, by which we may distinguish one kind from another. Larvæ are obliged to swim thus, being unable to breathe like fishes under water, so they must thrust their breathing tubes, situated in *Anopheles* in the eighth segment, in *Culex* in the tail, into the air.

After a short time, one to a few weeks generally, the larvæ are transformed into *pupæ*, which resemble the larvæ with a hood on. The pupæ are also active wrigglers, but more buoyant than the larvæ, and seen generally floating on surface, with two ear-like breathing tubes projecting from their back.

After another brief interval the *imago*, or full-grown insect, emerges from the hood of the pupa, pauses for a short time to dry his wings, and then flies away to discipline and destroy man until he has learned to practise the simple laws of health and the necessity of cultivating the soil.

Male mosquitos seldom bite, and the natural food of both males and females is the juice of fruits, flowers, and other parts of plants; blood-sucking is an acquired taste, if not a necessity for propagation. The males have broad, feathery *antennæ*, the females simply a few hairs projecting from the head. (See Plate VI.). The proboscis of the mosquito is simply a little lancet case, and its sharp stylets can not only pierce the skin, but even cotton and woollen fabrics. I have often been bitten by mosquitos through a blanket.

The "song" of the *Cicada* has found an echo in Greek lyrics; that of the mosquito awaits its poet.

The *Culex* appears to be the piper, the *Anopheles* being a silent, and consequently more dangerous, enemy.

The *Anopheles* abound in forest, bush, and even in open country if covered with scrub, in all of which, Ross points out, "they feed on villagers, animals, and birds, and attack travellers in camps or rest houses." This is an important point, especially as in and near villages *Anopheles* are often infected from children containing the malarial parasites.

Note also that winter may be passed by the mosquito in any stage, from egg to adult, and the full-grown insect may be found hibernating in corners, cellars, and other sheltered places all the year round, and may become active on warm days, when the female *Anopheles* will most likely begin biting.

The *Anopheles* mosquito is a weak flier and never goes far from its birthplace. Far from being disseminated by strong winds, they carefully hide themselves from them in sheltered places. Ships, railway trains, and waggons prove, unfortunately, very effective in introducing them into new localities or countries.*

Most of the species of mosquito are active by night, but the *Stegomyia fasciata* (the carrier of yellow fever), in which both sexes bite, are most vicious in the early afternoon. The use of their salivary secretion appears to be to stimulate by irritation the flow of blood into the bitten part, and so to facilitate their feeding.

Ammonia and glycerine allays the irritation of mosquito bites.

The eggs of the *Anopheles*, or swamp mosquito, are boat-shaped and float sometimes singly and sometimes in little rafts.

The bottom of the floating egg is marked in a raised net-like pattern. The top is smooth, black, and partly covered by a fine transparent membrane which holds air and so buoys the egg.

The *Anopheles* mosquito being a weak flier, and naturally lying low, we may to some degree avoid it by living in upstairs rooms, sleeping on raised stages, as the Italian peasants do, or camping a few hundred yards to windward of its breeding haunts, but the use of the net must never be neglected.

The *Culex*, on the other hand, is a strong flier, and must be fended by nets for safety.†

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* See *Report on the Prevention of Malaria in Mauritius*. By Professor Major Roland Ross.

† See article *Mosquito*, *Encyclopædia Americana*, Vol. X., by Quitman Kohnke M.D., etc., Health Officer, New Orleans, La.

CHAPTER IX.

The Malarial Problem—*continued.*
Malarial Fever.

Classification of Fevers.

Selecting from many classifications what appears to be the simplest and best, that of Manson and Ross—

African malarial fevers are :—
Intermittent, or Remittent, in period ;
Benign, or Malignant, in character.

The Intermittents include :—

Benign.

Fevers occurring every	24	hrs.,	called	Quotidian	}	No *crescents* in blood.
,, ,, ,,	48	,,	,,	Tertian		
,, ,, ,,	72	,,	,,	Quartan		

The Malignant Group includes :—

Malignant.

Quotidian and Tertian Remittent and Continuous fevers	} *Crescents* and *spheres* in blood.

General Information respecting Malarial Fevers.

Fevers are often of a very mixed nature, too variable to classify. Thus the first fever of new arrivals is generally remittent, *i.e.*, lasting for days with various rises and falls of temperature, hence called "remittent." Later it generally breaks into isolated attacks lasting from a few hours to a day or two, and tending to recur at regular intervals with fever-free times between; in this phase the fever may be called "intermittent"; evidently both are but phases of the one disease, generally modified by the use of quinine.

"Benign" Remittent and Intermittent Fevers.

The parasites of the different fevers are clearly distinguishable under the microscope. The "benign" types do not form "crescents," the malignant do.

It is now almost an anachronism to speak of remittents as distinct from intermittents, for the remittent type may be produced by quotidian, tertian, and quartan parasites by the concurrent development of separate swarms of parasites maturing at different periods in the blood. In other words, the resulting type will depend practically on whether the patient has been once or many times infected during a certain period.

The following case which came under my personal observation will best elucidate this matter.

A strong, healthy young man, for the first time in the tropics, was placed in a very malarious locality where mosquitos were very numerous and vicious biters, and native villages near ensured their being infected with malaria. The man shared a roughly made native hut with another European, but preferred sleeping in a hammock in the open air. He had no mosquito net and was also unprovided with quinine. In short, he ignorantly satisfied every condition requisite for contracting in the briefest time and most severe form malarial infection. Fresh swarms of mosquitos fed upon his defenceless body every night for three or four weeks, thus ensuring successive infections by each new swarm. Towards the end of the third week his fevers began, gentle at first, but with steadily increasing malignity, and when he was relieved about the seventh week it was a dangerous remittent, or rather —as the fever-free breaks were infrequent—a severe continuous fever.

No quinine had been given in this case, which quickly developed into black water fever, with jaundice, vomiting, occasional delirium, and other bad symptoms.

Curiously enough, this case, which had all the appearance of ending fatally, recovered without the aid of quinine or other drugs, apparently by natural recuperative process, when the patient was removed to a healthy tropical locality where he was well nursed and cared for, had good and suitable food, and a little champagne and other suitable stimulants.

The history of this case appears to indicate that the types of malarial fever are intrinsically identical and transmutable by the conditions of infection. Also that the more bites of infected mosquitos, which, of course, means the more malarial parasites injected into the patient's blood, the prompter, stronger, and more perilous the resulting fever, whether it assume an intermittent, remittent, continuous, or black water type.

Thus, a single or a few brief exposures to probably but few bites from infected mosquitos may cause one or other form of typical intermittent; while exposure for a week or over to many bites from infected mosquitos will most likely cause remittent or continuous, and, if infection still goes on and is severe, black water fever.

All a matter of *quantity* and *quality* of parasite as of any other poison, the æstivo-autumnal being worst, and this is the common African fever.

Microscopic examination of the blood is the only reliable means of determining the type of fever from which the patient is suffering.

Quinine, now in universal use, also modifies the symptoms of malarial fever, rendering classification doubtful. A large dose will cut short the succession of attacks, a moderate dose will shorten them and prolong the fever-free intervals. Quinine will also ward off moderate infection.

Black Water Fever

was first described by a French naval surgeon, stationed at Nossibé, Madagascar. Its etiology is still not well understood. No *special* parasite has been found in it, but all the common parasites of malaria are present in the blood. The disease, however, appears to kill out these parasites, and so tends to spontaneous cure (Manson). The foregoing narrative will confirm this, and Manson also tells us that the fever is very fatal, one of every three attacked dying. The "black water" is really owing to the hæmoglobin of the red blood-cells being set free in the blood, and so becoming useless, it is in a dark and somewhat altered form excreted from the blood as waste material by the kidneys. Some also goes to the liver and spleen, disordering the functions of both organs and causing jaundice. The empty corpuscles may be seen floating about in the blood plasma like little sponges.*

I believe those of a hæmorrhagic temperament, whose trifling cuts or scratches bleed freely, whose skin bruises by the slightest impact, are most prone to black water fever. Such people should not go to Tropical Africa.

In 1857 Pasteur made his great discovery of the lactic acid microbe, and he showed that although it could produce

* See *The Diseases of the Blood.* By A. C. Colles, M.D.

lactic acid, it was interfered with by an excess of this acid. So when sugar in solution is being transformed into lactic acid it is useful to add some chalk, as otherwise the fermentation stops before the greater part of the sugar is transformed.

Again, when the action of lactic acid is continued too long it not only arrests fermentation, but kills the microbe; that is to say, the lactic acid microbe is killed by the products of its own physiological activity while yet associated with nutrient material—a true case of auto-intoxication. The microbe which causes butyric acid fermentation is also killed in the same way by an excess of its own secretions. Yeast, which is the microbe producing alcoholic fermentation, is also interfered with, and at a certain point of alcoholic strength stopped, and killed, especially if the fermenting fluid should be poor in sugar and rich in nitrogen, when it forms salts of ammonia and quickly dies of auto-intoxication.*

The malarial parasite being also a fungus, like yeast or mould (but with certain sexual and other developments which cause its inclusion under the animal kingdom), there is a strong probability that its growth in the human body is attended with the production of one or more toxic products. It is generally accepted that it is owing to the sudden pouring out of such poisons from a quarter of a billion spores, at the period of their maturity and synchronous liberation from the red blood-cells in which they had lived, which causes the paroxysm of malarial fever—the shiver of shock, the fire of reaction and rally, the sweat of purgation.

In the case of "black water fever," it seems to me probable that the poison has been poured out in such abundance from overwhelming numbers of parasites—in the blood—that they are killed in the manner of other ferments in the presence of excess of their own physiological productions or secretions. This would appear to be a reasonable explanation of the fact

* Duclaux—*Microbiologie*—quoted by Metchnikoff, o.a.c.

that the malarial parasite is not generally found in any numbers in such patients' blood, that they tend to disappear altogether, and of the paradox that the most lethal form of malaria alone presents the phenomenon of spontaneous cure.

The Malignant Type of Fevers.

This type is characterised by persistently high temperature (hyperpyrexia), mounting to 108° F. and upwards to stem of thermometer. There are other symptoms of lethal malarial poisoning, persistent vomiting, convulsions, muttering delirium, and general abolition of function. Many symptoms closely resemble yellow fever, and nothing but efficient medical treatment can give such patients a fair chance of recovery.

True yellow fever also is reported as occurring in sporadic cases on the West African coast.

Latent or Hatching Period of Malarial Fever

is from 20 to 40 days, which is really the period of *immunity* enjoyed by persons coming fresh from home. As a fact, the malarial parasites "hatch out," as we have seen, in the human blood in from 24 to 72 hours, but the powers of parasitic destruction of the human body limit their accumulation to the fever point, a quarter of a billion (Ross) for 20 to 40 days—then the parasites prevail.

Relapses and Rallies in Fever.

These mark the course of all malarial fevers if quinine is not regularly given, or if its use is abandoned too soon.

The cause is that the fever germs lie hidden for years in the tissues, organs, and even the marrow of patients, despite treatment and homecoming. They may remain latent indefinitely, but are often called into activity by chill, fatigue, excesses, and so forth, as seen in preceding chapters.

A full course of quinine for three or four months, as prescribed by Ross and Manson, will ward such relapses.

Stages of Fever in Typical Intermittents.

1st —The Cold Stage, or "Rigor," often missing in African fevers—lasting from ...	1 to 3 hours.
2nd—The Hot Stage	3 to 5 ,,
3rd—The Sweating Stage (rather indefinite)...	2 to 4 ,,

Quotidian attack generally occurs in the morning.
Tertian ,, ,, ,, at noon.
Quartan ,, ,, ,, in the evening.

A Typical Malaria (Manson).

Often seen in Africa—deceptive and dangerous. It presents few of the ordinary symptoms just described, merely slight chilliness or shivering, head or back ache, and slight rise of temperature, perhaps to 103° or 104°. Patient goes about his ordinary work, says he "will shake it off," when suddenly, like a bolt from the blue, pernicious symptoms set in and he may lie for weeks in peril of death. Young men going to Africa should bear this stamp of insidious fever well in mind.[*]

Advice to Laymen Concerning Fever.

The foregoing account of African fevers must suffice to warn lay readers of the difficulty and complexity of the

* See *Tropical Diseases*, by Sir Patrick Manson, from which work I have derived much valuable information for the preparation of this chapter.

subject, and the necessity for calling in medical aid when available.

The layman's strength should be directed towards *prevention*, where he may hope for perfect success, rather than *cure*, where he is as likely to mar as to mend matters. In short, in this as in all art and science, "*a little learning is a dangerous thing.*"

Description of an Attack of Typical Malarial Fever.

I will now depict a typical attack of malarial fever occurring in a newcomer, who has not been taking quinine and who has received a large dose of a benign intermittent malaria from numerous bites of infected *Anopheles* mosquitos.

For days preceding the attack, the poison appears to exhilarate its victim. He boasts of superb health; body and mind rejoicing in the sense of unwonted vigour. He talks loudly and dogmatically, perhaps sings or laughs uproariously; yet he is irritable, impatient of contradiction, and prone to fits of anger.

One morning he awakes languid and depressed after a restless night, troubled by frightful dreams.

He is very cross with everybody; the head aches, the mouth is clammy, he yawns frequently, and suffers from nausea and sinking in the region of the stomach.

By-and-by he vomits, and feels utterly prostrated.

His very surroundings appear altered for the worse; their commonplace rudeness oppresses his spirits; he grows more and more despondent.

Movement, even thought, grows distressing as he vainly tries, with what strength and courage remain, to pull himself together.

Now to increasing, distracting headache, is added pains in knees, thighs and loins.

The extremities are cold as ice; the head burns.

Later, the whole surface becomes goose-skinned, and the body shudders with cold; the patient covers himself with blankets, and drinks hot fluids eagerly. Thirst is rapidly developing, and with it nausea, retching, and vomiting, to complete his agony. The native noise and chatter become unendurable, and, like some stricken heifer, he seeks repose and solitude.

At last pyrexia sets in, with the usual burning skin and bounding pulse; headache gives way to dizziness or delirium; the tongue is now parched and furred, the throat dry, and thirst excessive.

Misery culminates in a state of numbness and semi-insensibility to suffering. The heart now beats as if it would burst the chest, and the body is shaken by its throbs as by flail thumps; but the patient no longer feels or cares for anything—he is fully intoxicated by the poison.

The urine, dark and scanty from the first, is now suppressed, and the temperature, which has been rapidly mounting, reaches the pinnacle of fever; when, as in all storms, after climax comes defervescence.

Great sweating ensues, bringing instant relief, followed by refreshing sleep, which restores the patient.

On awakening, his tongue and throat feel moist, and, instead of thirst, there is a wholesome craving for food. Some dizziness and weakness may remain, but a bath and breakfast dispel them, and he resumes his accustomed work in good spirits, well disposed to review his fever experience as some hideous nightmare.

To-day dying, the next day stalking game: such is a phase of African fever.

This attack is but one of many like depletions, each leaving the patient more unfitted to withstand the next, until cure, or prompt removal to some healthy country, becomes the last alternative.

CHAPTER X.

The Malarial Problem—*continued.*

PART I.—Latent Malaria.

DISCOVERY BY KOCH AND OTHERS OF HUMAN "RESERVOIRS."
SEGREGATION AND SCREENING OF THE INFECTED.

PART II.—Pseudo-Malaria.

PART III.—The Heat-Regulating Mechanism of the Body.

SANITARY EPISODE OF STANLEY'S RELIEF EXPEDITION.
THE TERRITORIAL ARMY OF THE BODY IN PEACE AND WAR-TIME.

Professor Koch's Discoveries.

The world is much indebted to Professor Koch.

In 1882 he isolated the *tubercle bacillus*, the cause of consumption.

In 1884 he discovered the *cholera spirillum*, or *comma bacillus*, which causes cholera.

DISCOVERY OF HUMAN RESERVOIRS OR FOCI OF MALARIA.

Somewhat later, being sent to Africa by the German Government, he made another great discovery, that 80 to 90 per cent. of native children, most of whom were apparently in good health, were carrying malarial germs in their blood. In such children the crescent parasite predominated, but all varieties of parasites were represented.

This discovery, which was fully confirmed and extended in widely separated regions of Africa by the labours of Daniels, Stephens, Christophers and others, is of vital importance to all dwellers in Tropical Africa.

Report on Sanitary Condition of Liberia.

In the Report on the Sanitary Condition of Liberia, by Dr. Captain C. B. Wallis, British Consul at Monrovia, he states that nearly every native child in Liberia has malarial parasites in the blood, and that *Anopheles* mosquitos, which were generally found to be infected, were plentiful in all the villages, so that malarial diseases spread very rapidly all over the country. He also pointed out " the deadly practice of every European house being surrounded by, or in close vicinity to native huts, full of infected native children."

Latent Malaria.

This form of infection is called *latent malaria,* because it exists without producing symptoms sufficiently intense to attract attention, and apparently without affecting the health of the affected individuals.

It is obviously of the greatest importance to recognise its presence, because even a few cases, or, to use the term now in vogue, *reservoirs,* may infect a whole community, if the carrying mosquitos happen to live in the locality.

Nor is the danger confined to Tropical Africa. A large number of the American soldiers who returned from the Philippines were found to have in their blood the crescent, or æstivo-autumnal parasite of malaria, which we have seen causes dangerous remittent fever, and is destined to complete the sexual cycle of the *Plasmodium malariæ* in the mosquito.

A most important point was observed in these cases, and I have noted the same in African cases also, that while *fever* was often in abeyance, the men were suffering from chronic diarrhœa, chronic dysentery, amœbic dysentery, tuberculosis, or chronic gastritis, so disguising the true nature of the case and misleading even doctors in their treatment. In all, or nearly all, such cases, treatment with quinine, by removing the malarial infection, produced marked improvement, or recovery.

How Malaria was Introduced into the Mauritius.

In this connection the outbreak of malaria in the Mauritius is very instructive.

Lord Elgin, H.M. Secretary of State, sent out Professor Major Ross in 1907 to inquire into the plague of malaria which had suddenly broken out in the Mauritius, a country in which this disease had been hitherto unknown. This inquiry extended over three months.

It was found by Ross that although the islands were suitable both in soil and climate and humidity for its development, no outbreak took place until 1865-1866, when the *Pyrotophorus costalis* mosquito, a native of East Africa, was first imported. Then in 1867 coolies began to come from India to work the estates, and most of those men were suffering from *latent malaria*, although apparently healthy. The two necessary conditions being now associated, the fly and the infected man, or "reservoir," malaria was rapidly disseminated amongst all the inhabitants of the islands, with a resulting mortality of about 60,000 out of a population of 330,000. Ross and his companion, Fowler, made the origin of the outbreak quite clear, and they promptly organised the necessary sanitary and hygienic measures for its suppression, which will be described in another chapter.*

* *Report on the Prevention of Malaria in Mauritius*, by Roland Ross, C.B.

More about "Reservoirs" Black and White.

It is a remarkable fact that the malarial parasites appear to diminish in numbers in the blood of natives as they advance towards puberty, after which they either disappear altogether, or more frequently remain in small numbers, seldom causing fever, or, if at all, very mild attacks.

All old residents in Africa have also a variable number of malarial parasites in their system, and both they and, above all, the native children, are therefore to be reckoned as "*reservoirs*," the latter being specially dangerous. A relapse now and then will convince the oldest European resident that he is by no means fever-proof; and it often happens that those who have kept in fairly good health for years succumb to a fatal attack, it may be even after returning from furlough in England, as in Governor Rowe's case.

Again, the new comer arriving in an infected zone, where every one around appears to be in good health, may find himself struck down by fever, a perfect bolt from the blue, coming he knows not whence. He looks out from his sick bed upon native children playing under his window, little thinking that from one or other of them, or even the old colonist who sits smoking in the next room, he may have received the infection. Or it may be he was bitten in some hotel, or friend's house, or native rest-hut by one or more infected mosquitos.

One Bite Causing Fever.

A single mosquito bite, of an insect which had fed on a case of tertian fever in Italy, and had then been brought to England for the purpose of this experiment, proved sufficient to cause a sharp attack of this disease in Dr. Manson's son, who had never been out of England, and who had bravely volunteered to submit himself to the test.

Negroes not Immune.

It is a curious fact that adult natives who are practically immune in their own country readily contract malaria when they move into another part of Africa, a fact I observed amongst Kru labourers who came to work in the Gold Coast's mines.

The negroes from the United States who emigrated to Liberia suffered such a sick and death rate in that country that this emigration has practically ceased.*

Segregation must be Practical.

Europeans should live as far away from native houses as possible, and their native servants and other employees should be obliged to take a daily preventive dose of quinine. The same rule should be enforced upon all whites and blacks working on plantations, and segregation of all sick folks should be rigorously enforced.

But the practice of segregation should hold good not only for numbers, but for individuals.

Any person in a house who is suffering from malaria should be carefully screened off from the other inmates, if possible in a mosquito-proof room, or at least by a very careful use of the mosquito net around the patient's bed. The various means of prevention of the spread of malaria under these and other conditions will be carefully considered in a subsequent chapter.

Additional Information about Malarial Fevers.

From the foregoing we must see that there is a perpetual struggle being waged in the blood of all tropical residents, between the parasites of malaria chiefly and all other morbific microbes and the protective agencies of the body. Of these

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* *Mosquito and Man.*

the white corpuscles or phagocytes are predominant. One may compare them to our Territorials, ever ready and efficient to fight against invaders.

But malarial parasites, despite quinine and phagocytes appear to hide in the system of some people "like rats in a ship," as Ross puts it, and to seize the opportunities that present from time to time to sally forth and commit depredation, in other words, cause or help to cause a relapse.

In Stanley's ascent of the Congo, while moving with the wind which constantly sweeps up the river from the Atlantic, neither himself nor party suffered from fever; but on his return journey, travelling against this cool wind, fever was never absent from them.

A somewhat similar experience occurs to homeward-bound West Coasters, who embark apparently in fair health, but are sent down in fever the moment they exchange the warm shelter of the African coast for the cool north-east trade winds.

Pseudo-Malarial Fever and Its Causes.

The cause of this curious phenomenon is *shock*, and it is of practical utility to inquire the causes. These may include any of the following :—

Cold current of air, as draughts upon the sweating body ; getting drenched by rain ; not changing clothes when wet from any cause, sweating included; a fall into a river (which caused the death of my successor on Gold Coast, a strong young man) ; passing when sweating from hot sunshine to cool shade of verandah or room ; drinking cold water when perspiring ; excesses of many kinds as in drink, food, venery, anger, grief, anxiety, fear, indigestible food, insolation, lack of proper food, or missing meals. Surgeon Parke's addition to this list :—" A single hour's chill, a couple of hours' unshaded exposure to the vertical sun, the swimming of a river, the wading of a swamp and the quiet inhalation of vapour arising from rank, moist, decomposing vegetation were all followed by fever."*

The question naturally arises, How can such causes all at once produce malarial fever?

How can the parasites, until this moment lying dormant, suddenly sporulate *en masse*, and thus only can they cause fever (Golgi)?

I think we must look elsewhere for explanation—namely, to the effect of *shock* upon the heat-regulating mechanism of the body, throwing it out of gear, with the consequent disturbance known as fever. Doubtless the malarial parasite lends its aid later on to intensify and prolong the fever started by shock.

The close analogy between such fevers and those caused by such poisons as belladonna, fish and mushroom poisoning, cannot be overlooked, in which the shock comes to the nervous regulating apparatus also from within. Also the physiological experiments of C. Bernard, Pasteur and other scientists appear to throw light here. Claud Bernard placed animals in a hot medium, 104° to 105° F., their normal temperature kept level for a short time, then, resistance being suddenly overcome, their temperature rose to 113° F., and the animals died.

Pasteur made somewhat similar experiments in a cold chamber, and so overcame the natural resisting powers of the animals that they easily succumbed to disease they had hitherto resisted.†

We may take it, then, for granted that any violent oscillation of the bodily temperature from whatever cause arising, or

* *Notes on African Fever.* By Surgeon-Major F. H. Parke (of Stanley's Emin Pasha Relief Expedition), 1893.

† *An Address on the Part Played by Nervous Debility in the Production of Fever.* By Professor Bouchard of Paris, delivered before the eleventh International Medical Congress, held in Rome, 1894.

the sudden lowering of the vital powers of resistance, will excite fever in Africa and elsewhere in the tropics in persons whose nervous system is more or less debilitated from malaria or other causes.

This enervated state of system is a common result of tropical residence combined with fever, and in such weakened people we can see, as with a magnifying glass, effects which are scarcely if at all visible in the normally healthy.*

* Address *On the Personal Factor in Disease*, delivered at the Annual Meeting of the Metropolitan Counties Branch, B.M.A., by L. W. Sedwick, M.D.

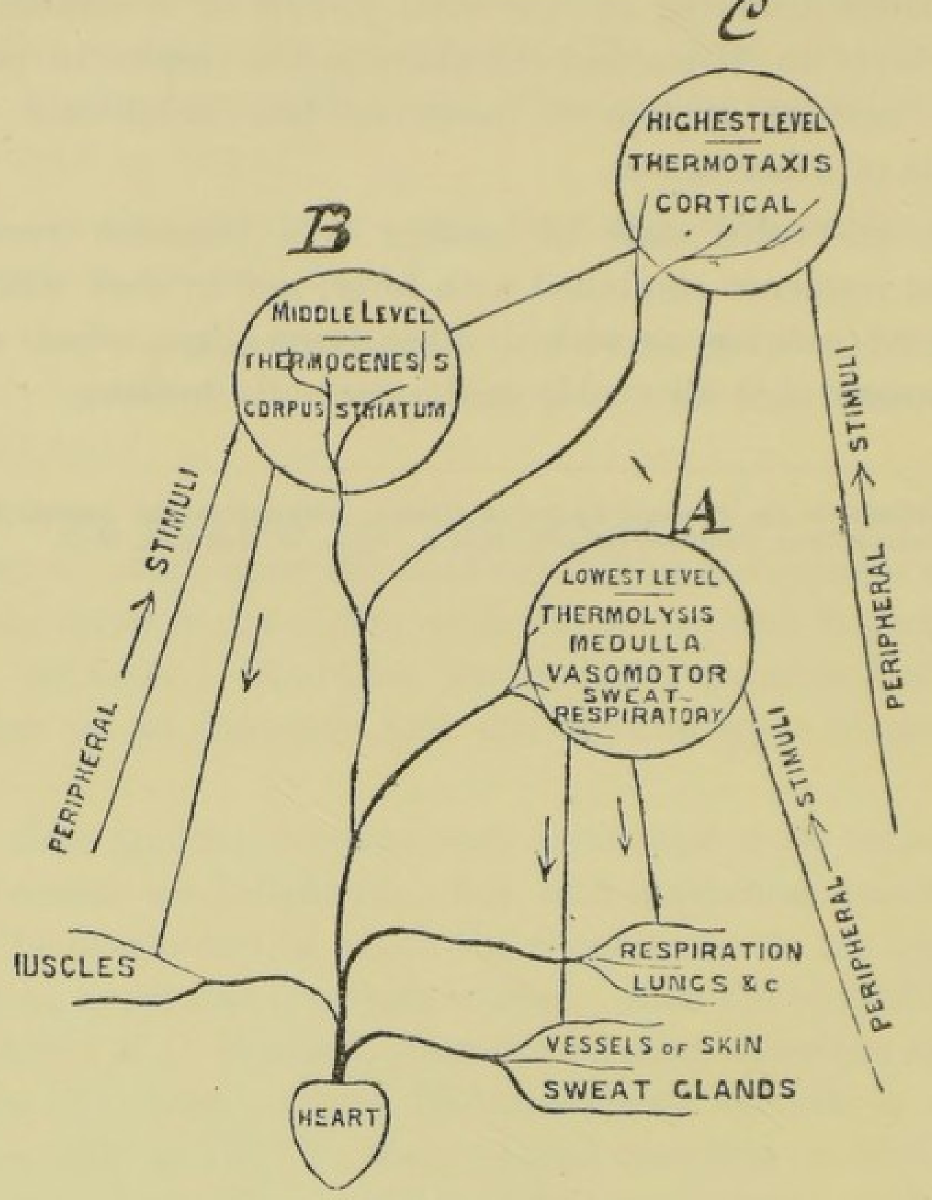

PLATE A.

DR. W. H. WHITE'S DIAGRAM OF THE HEAT MECHANISM OF THE BODY.

*The accompanying diagram is intended to show that the thermolytic mechanism acts chiefly through the lungs and skin, and the thermogenetic chiefly through the muscles: that the thermotaxic maintains a balance between the two; that either centre can be affected reflexly; and that all parts of the mechanism can be influenced by the quality of the blood circulating through them.**

* From "*Huglings Jackson's Three Levels.*" By W. Hale White, M.D., F.R.C.P.; *British Medical Journal*, April 26, 1890; also *Theory of Pyrexia*, American Journal of Medical Science.

The Heat-Regulating Mechanism of the Body.

Explanation of Diagram.

A B C represent

The low (spinal marrow or medulla)	A
The middle (central part of brain)	B
The upper (cortical or outer grey layer of brain)	C

A represents the centre which governs *heat-losing* or *cooling* apparatus of the body, which includes blood vessels, sweat glands, and, to a small degree, the lungs. Sweat evaporation is the most important cooling agency of man, acting as porous earthenware cooler on water. By insensible perspiration also the temperature is chiefly maintained at normal 98.4° F. In fever the sweat glands cease to act, so skin becomes hot and dry, radiation from its burning surface being wholly inadequate to cool the fire which is consuming the body. Even the lung vapour is cut off, little or no exhalation being given off from the parched mucous membranes.

B represents the heat-producing mechanism of body, the consumption of muscles being the chief source of heat; hence muscles waste away quickly in fever, and patient is soon reduced to skin and bone.

C represents the *heat-regulating* nervous apparatus. Its action is like that of the governor of a steam engine, which equalises speed by opening the throttle valve. Under normal conditions it maintains an almost constant temperature of body 98.4° or ½ or 1° over or under. Its power of control varies with the individual's health and strength; it is easiest of all three put out of gear when the other two then run riot.

In all three cases we have to deal with some outside or inside body stimulus, as cold or heat, or a poison or parasite which the nerve-endings in skin, or internal organs, instantly transmit to their respective centres, *e.g.*,

A cold shower bath acts strongly ... on A.
A poison or parasite in blood ...... on B.
And stimuli of all kinds .... on C.

These centres, being roused to action, transmit nerve energy to their respective organs, throwing them into action somewhat as heat applied to the corner of a lump of coal sets up molecular vibrations leading to the ignition of the mass.

C also receives the stimuli from without and from within, but its motor influence is exercised upon A and B, and is chiefly inhibitive or restraining. It has a skittish team to handle, very prone to take the bit in teeth and run away with the body to its destruction.

In Memoriam: Stanley and his Men.

Surgeon Parke states that the officers of Stanley's Relief Expedition often put in a hard day's marching over difficult ground, and other heavy work, and constant attention to worrying duties besides, with temperature up to 105°-106° F., and that they did not appear to suffer hurt, adding that "all our worst cases of fever occurred while we were in standing camps."

This remarkably high temperature cannot have been caused by malaria *per se*, although this must have contributed to its production.

The heat-regulating mechanism of these brave young men must have been thoroughly put out of gear by protracted physical and mental suffering. Half starved at times, they supplemented their exhausted stores of food by the wretched harvest of such roots and fungi as their fast-dying but faithful black followers, despite their own pangs of hunger, humbly laid at their tent doors. Yet despite their hardships, sickness, and want, these noble young officers unflinchingly discharged their duty, calling up all the reserves of their youthful vigour to the task.

"QUIT YE LIKE MEN, BE STRONG!"

was the voice they ever heard behind them, when exhausted nature turned to the right hand for comfort, to the left hand for repose. True, their heroic leader, the great Stone-breaker,* had ever ready a helping hand and a cheering word for all his companions. He would remind them that "the paths that lead to victory and success have ever been like mine own, steep, thorny, and rugged." Or by the camp fire he might read them extracts from Shakespeare, or from other of his favourite poets, not forgetting the delightful favourite couplet :—

"*Joy's soul lies in the doing,*
And the rapture of pursuing is the prize."

But though their drooping spirits might be uplifted and briefly buoyed upon this sea of troubles, the flesh was weak, and the enfeebled officers, yea, and their great leader also, were often, by fever and other diseases, brought nigh to death.

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* *Bula Matari*, the "Stone-breaker," was the native name given to the "Great Chief," to whom nothing seemed impossible, who never failed.

See *Autobiography of Henry Stanley*. (Sampson Low, Marston and Co., 1909.) A superb book, which no one connected with Africa should fail to read, still better to keep. A veritable British Odyssey.

HEAR THE BUGLE-CALL WITH WHICH STANLEY ENDS "IN DARKEST AFRICA."

In bidding his companions, Stairs, Jephson, Nelson, Parke, and Bonny, "a long good-night," he discloses the heroic motive of his life.

You who never turned your backs,
   But marched breast forward,
Never doubted clouds would break,
Never dreamed, though right were worsted,
   Wrong would triumph.
Held we fall to rise, are buffed to
   Fight better,
Sleep to wake. * * * *
Greet the UNSEEN with a cheer!
"Strive and thrive!" Cry, "Speed, fight
   On, for ever
There as here."

"THE THANKS BE TO GOD FOR EVER AND EVER. AMEN."

APPENDIX TO CHAPTER X.

PART III.

THE TERRITORIALS OF THE BODY IN PEACE, WAR-TIME AND VICTORY.

DIAGRAM OF WHITE BLOOD-CORPUSCLES, OR PHAGOCYTES.

THE "TERRITORIALS" OF THE HUMAN BODY IN PEACE AND IN ACTION.

PLATE B.

Peace-time.

Successive forms assumed by colourless human blood-corpuscles, or leucocytes, called by Metchnikoff "phagocytes," in the space of five minutes. Magnified about 1,000 diameters.—After Huxley (*Physiology*).

MALARIAL INVASION.

PLATE C.

War-time.

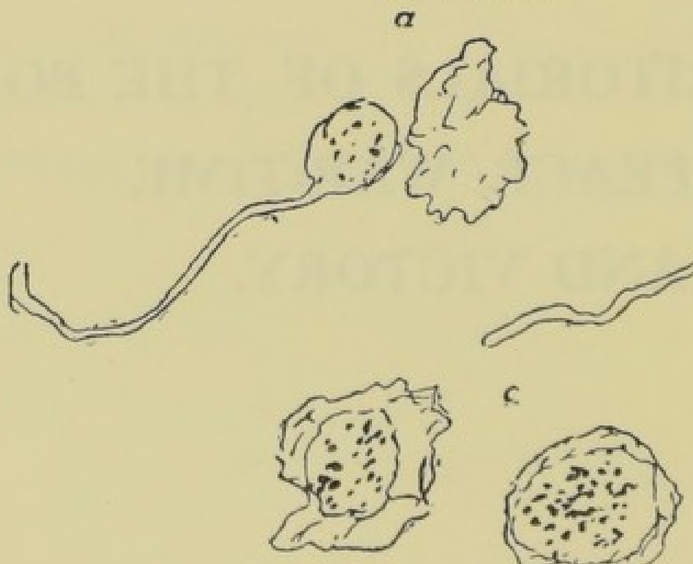

PLATE C.—Illustrating phagocytosis in malarial poisoning.

(*a*) Plasmodium malariæ and phagocyte just coming into contact.

(*b*) Plas. mal. half enveloped in phagocyte.

(*c*) Plas. mal. fully incorporated in phagocyte, in which state of being digested it is conveyed to the spleen, brain, bone-marrow, or liver.

Phagocytes Enjoying the Fruits of Victory.

Plate D.

Active Service.

Further illustration of the phenomena of phagocytosis, after Dr. T. Lauder Brunton. Croonian Lectures, *Brit. Med. Jour.*, June 8, 1889.

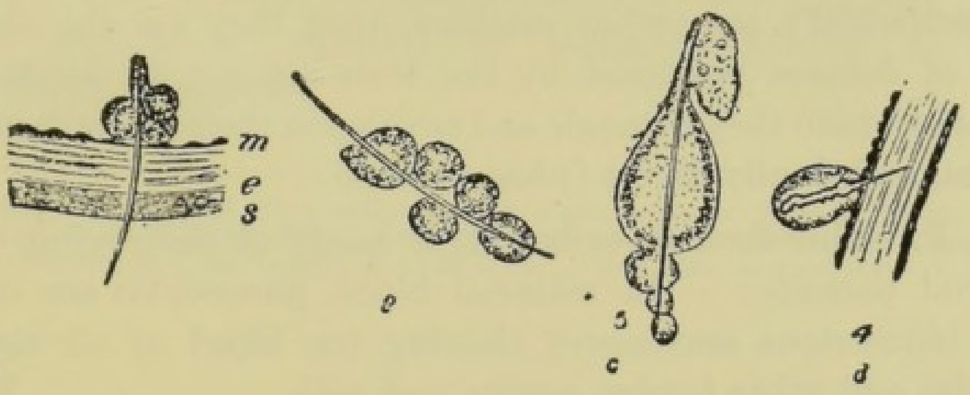

Fig. 1.

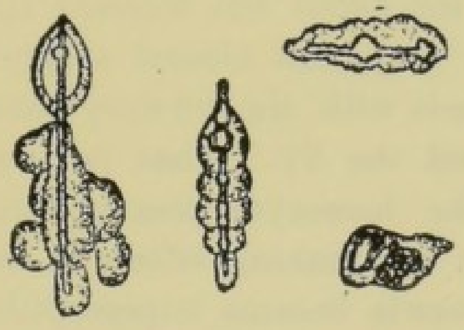

Fig. 2.

Fig. 1.—A spore which has penetrated the intestinal wall and entered the abdominal cavity, where four leucocytes have surrounded its end. *b.* and *c.* Spores surrounded by leucocytes, which have become confluent in *c.* *d.* A spore, one end of which is being digested by a leucocyte.

Fig. 2.—Different stages of the digestion of spores by phagocytes.

Part II.—On Phagocytosis.

Mannaberg and other authorities hold that when malarial fever gets well without the use of quinine, the result is chiefly due to *phagocytosis*. Phagocytes—so called by Metchnikoff from their cell-devouring function—are those microscopical particles of protoplasm found in vast quantities in the blood and tissues, until recently called white blood-corpuscles, or leucocytes.

Metchnikoff's researches establish that they are the chief agent of defence possessed by the body against all kinds of microbes, which they entangle and envelop in their protoplasmic meshes, and finally digest (*phagocytosis*).

Dr. P. Hehir thus describes their mode of destroying the malarial parasite:—"In malarial blood, phagocytes are very often industrious scavengers, clearing the blood of all stray particles and other foreign agents met with. . . . . The rapidity with which they eat up the malarial organisms sometimes prevents the process being properly studied. . . . . The phagocyte at first advanced towards its victim, and then for about ten seconds appeared inactive, barely touching its prey, and almost suggesting that it was come to make friends with the unwary parasite—reminding one of the spider and the fly. That portion of the parasite in contact with the leucocyte was apparently stationary, whilst the free part was making efforts to set itself free; but gradually its movements became imperceptible. The phagocyte continued to draw nearer, and to enwrap its prey; until, within the space of a minute, it completely incorporated the amœboid parasite within its protoplasmic web, whence there was no exit. The pigment, and sometimes an entire parasite even, is devoured by the ever-watchful phagocyte, and is carried by it to the spleen, brain, bone-marrow, or liver, where it is deposited, and becomes the pigment so characteristic of those organisms in all malarial cadavera."

Space forbids pursuing this subject; it must suffice to observe that the body maintains immunity, and cures disease, not only by phagocytosis, but by the action of protective substances in the blood chiefly, and also in the tissues. That in the blood serum, called *alexin* by Buchmer, kills bacteria and other micro-organisms.

Hankin, Nissen, and Lubarsch consider the defensive substance to be *cell globulin.*

Glycogen, a sweet substance found in liver, spleen, and other organs, is regarded by some authorities as the paramount protector.*

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* See *Microscopical Observations on the Hæmatozoön of Malaria*, by Surgeon P. Hehir, M.D., F.R.C.S. Edin. Also, *Report on the Conflict between the Organism and the Microbe*, by E. H. Hankin, B.A., M.D., &c.—*Brit. Med. Journal*, July 12, 1890.

CHAPTER XI.

Other Diseases of Tropical Africa.

Bilharzia: What is Known of this Disease.

1. It is caused by a parasite which exists in the waters of rivers, streams and ponds in many parts of tropical Africa.

2. It enters the body *directly* from the water by the penis (urethra), or by the anus, during long immersion.

3. The longer the immersion the greater the danger.

4. Brief bathing in infected water, either at home or in a river, followed by thorough drying, is perfectly safe.

5. The prepuce materially assists invasion of urinary tracts.

6. Circumcision gives almost complete protection.

7. The parasite cannot reproduce itself within the human body, so if precautions are taken against further entry the disease will die out naturally.*

Recent investigations respecting Bilharzia have proved that the eggs of this worm are found in the fæces and urine of infected persons in Egypt. The disease materially reduces the number of red corpuscles in the blood, sometimes to half of normal, anæmia and general ill-health resulting. It was very prevalent in Egypt during 1910.

Guinea Worm.

This is what is called a Nematode worm *(Filaria medinensis)*, the female of which may grow to three feet in length and when not full of eggs is somewhat thicker than a knitting needle.

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* *Bilharziosis and How to Prevent It.* By James Allen, M.D.—*Lancet*, August 6, 1910.

This disease was known to the Greeks as "*dracontiasis;*" it is now known medically as "*filariasis.*" It is a disease of Africa, Arabia, and India chiefly, and especially prevalent on the Guinea Coast. Like most parasites it has an intra and extra corporeal life to complete its cycle of development, and propagate its species.

The embryo of the worm is a very small worm-shaped parasite, and if we begin at this part of the life cycle, we find it swimming briskly in water and finally entering the body of the "water flea" (*Cyclops*, a small fresh-water crustacean, which is its "intermediary host"). Here it loses its tail and undergoes further developments fitting it for its transfer into the stomach of man when he drinks the flea in contaminated water. In man it develops after a time into a worm with a somewhat complicated life history; the female form of it works its way through the body, preferably towards the feet, where it becomes discovered first as a slight swelling, next as a blister, which, when it bursts, discloses the head of the worm lying at bottom of a little hole. From this, what looks like a milky juice exudes if we drop water on it, and this contains the embryo worms in vast numbers which can only be seen under the microscope. These young worms being discharged into water of brooks, ponds, etc., as by the infected natives walking in same, bring us back to our starting point in the animal's life cycle.

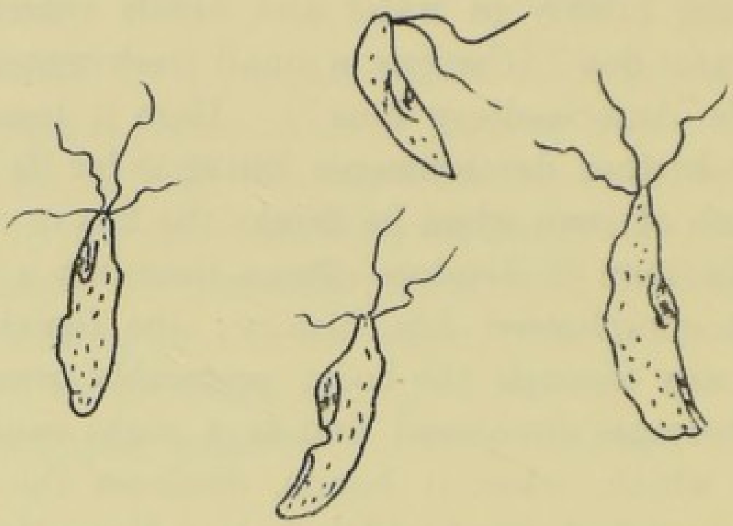
This female worm must be extracted from the leg very slowly. When its head emerges beyond level of skin it should be gently caught and wound round a split match or some such thing, a very little at a time, as by breaking the worm we scatter its young under the skin and cause serious inflammation.

The natives are experts at this little operation—and more to be trusted than inexperienced Europeans. They seldom break the worm and generally extract it whole, despite the prehensile hook on its tail.

Plate VII.

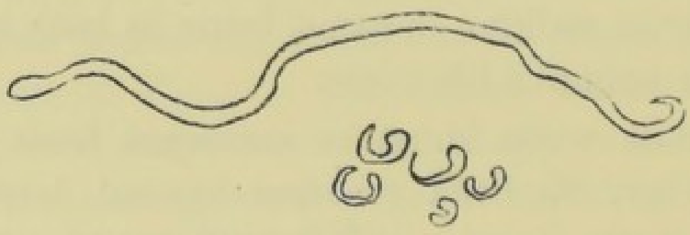
SOME DANGEROUS AFRICAN PARASITES.

For drawing of the embryo of the Bilharzia Hæmatobia, see Chapter xxii., p. 258.



Trypanosoma.

The protozoon parasite of Sleeping Sickness.
Transmitted by the Tse-tse Fly—*Glossina palpalis*



Guinea Worm.

Filaria Medinensis and Embryos.
Transmitted by the water-flea, *Cyclops*

Sleeping Sickness.

This disease is caused by a protozoon parasite which was known to exist in the blood of natives of Africa long before its connection with sleeping sickness had been traced. It is fusiform in shape and has flagellated (or delicate whip-like) ends. (See Plate VII.)

Bruce found it in 75 *per cent.* of the natives of Uganda whom he had examined, and the disease is spreading rapidly over the continent. This is owing to the development of native intercommunication between hitherto almost isolated areas of infection, and healthy countries.

It is a widely distributed disease also amongst cattle due to the bite of the tse-tse fly, and we find an account of it in the works of Livingstone and other travellers. Negro and white are equally affected; the latter more rarely, owing merely to his clothing and sanitation.

1869 The minute parasite called the *trypanosoma* has been known as a blood parasite in many of the lower animals since 1869,
1901 but the credit of its discovery in man belongs to Dr. Dutton, of the Liverpool School of Tropical Medicine (1901), who found it in the blood of a patient in Gambia, for which reason he named the parasite *Trypanosoma Gambiense*.

1902 In this year Bruce and Castellani showed the casual relationship between this parasite and the lethal sleeping sickness.

We can but touch upon the fringe of this important subject, which has already a large and highly scientific literature. The Sleeping Sickness Bureau of London has been issuing a most valuable series of bulletins on the subject to the medical profession during the past few years, and the Liverpool School of Tropical Medicine has sent out several expeditions to Africa to investigate sleeping sickness. International action has also been taken in Africa to limit the ravages and if possible to stamp out the disease, which is said to have depopulated parts of the Uganda Protectorate and the Congo.

Wherever the tse-tse fly, especially that known to science as the *Glossina palpalis,* exists in presence of an affected person, that is, one having the parasite *trypanosoma* in his blood, we have all the conditions necessary for the spread of sleeping sickness. This species is known as the "river fly," but it is probable that other species may also be capable of transmitting the disease.

The mode of dissemination of sleeping sickness is therefore similar to that by which malaria and yellow fever are propagated, that is, through the bite of an infected fly, which has become infected by feeding on an infected person, the fly being a true host of the parasite in this case also.

It was the bite of the tse-tse fly, in this case of the *Glossina Morsitans* species, that destroyed our horses in the South African war. A species of the same fly also causes "*Surra*," a very fatal disease amongst animals in India, sometimes destroying all the live stock in a district.

Plan of Campaign against the Sleeping Sickness Pest.

What chiefly concerns us in a book of sanitation is to learn how to exterminate the fly which carries the disease, and the plan of campaign differs but little in principle from that which will be described in full detail as waged against the mosquito carriers of malaria and yellow fever.

The breeding-ground of the fly has now been ascertained to be a strip about 30 yards wide along the margins of rivers, lakes, or other waters, even sea-beaches where a dense moist scrub is found, for the larvæ require humidity and shade from direct sunshine to develop.

Therefore the first step is to clear and burn this marginal scrub in the vicinity of human habitations.

The direct sunshine and desiccation of ground soon destroy the larvæ of the tse-tse, and so the plague is stopped in the locality.

But where this cannot be effectively accomplished, as in certain districts of the Victoria Nyanza shore and islands, the native population has been removed by Government to more inland and fly-free country. Sessi Island has thus been cleared of 200,000 inhabitants, amongst whom the mortality from sleeping sickness had been appalling. By these and othei measures, chiefly by segregation of the infected, the mortality has fallen in Uganda from 20,000 to 30,000 yearly in 1900 to only 2,000 yearly in 1909.

The natives have also been educated how to destroy the larvæ and pupæ of the fly. No Europeans have been infected since 1906.

Briefly, then, clearing of scrub, segregation of all infected cases, removal from the dangerous zone, destruction of fly, larvæ and pupæ, and education of natives and Europeans are the remedies against sleeping sickness.

The mosquito net, especially of the *Vade mecum* pattern, should also be used day and night.

The House Fly.

(Musca domestica.)

The ordinary house fly is one of the commonest yet least regarded carriers of infection in all climates, and is especially dangerous in the tropics. It breeds in collections of fermenting matter, fæcal matter especially, which appears to exercise for the insect an overwhelming attraction. This forms one of many strong reasons for the careful disposal of night soil, as the flies load their legs, feet, and proboscides very quickly with dejections from such diseases as dysentery, diarrhœa, and typhoid fever, also with the discharges from ulcers, phthisical expectoration, and various catarrhs, and convey them directly to foods, bodies and clothing.

The house fly is especially dangerous as a conveyor of the microbe of typhoid fever, but cholera, tuberculosis, and dysentery or diarrhœa are also directly transmitted by it.

Where there are flies there is filth close at hand, so the cure of this plague is above all the perfect scavenging of the town and back yards, the removal or burning of all garbage, the careful disposal of night soil, general cleanliness of house and premises. The cleaner the house and surroundings, the fewer the flies. Not a fly should be seen in a sickroom, and all food should be carefully screened from them, if the house should be unprovided with gauze wire screening.

Filarial Disease.

Manson's great discovery of the casual relationship of the *Culex* species of mosquito to the propagation of the disease known as *filariasis* has already been referred to (Chapter VI.). This important malady can be only referred to here to further enforce the rigorous use of the mosquito net upon all European dwellers in the tropics, for here again we have the fly as the host of the parasite *Filaria Bancrofti*, *F. Nocturna*, *F. Perstans*, and other species of the parasite, which produce *elephantiasis* and other morbid conditions in Europeans and negroes alike. The history of these parasites cannot be gone into, but it somewhat resembles the life cycle of the malarial parasite, requiring both man and mosquito to complete its development.* Therefore the destruction of the *Culex* larvæ and full-grown insect is almost as important in the tropics as the destruction of the malaria or yellow-fever-carrying insects and of the tse-tse larvæ and fly.

The guiding principle in all insect-born disease is

DESTROY THE INSECT AND YOU REMOVE THE DISEASE.

* See *Lessons on Elementary Hygiene and Sanitation*, by W. T. Prout, C.M.G., M.B., C.M., &c., to which I am indebted for some useful information. It has good plates of many parasites.

BOOK THE THIRD.

QUININE.

HAPTERS XII. TO XV.

CONTENTS.

Book the Third.

Chapter XII.

Chapter XIII.

Chapter XIV.

CHAPTER XII.

On Quinine.

PART I.

THE CINCHONA TREE, FROM WHICH QUININE IS OBTAINED—BRIEF HISTORY OF THE USE OF CINCHONA BARK IN MEDICAL PRACTICE.

The original habitat of the cinchona tree, of which there are at least 36 species, is South America, on the eastern slopes of the Andes and of the Cordilleras, in a zone of forest from 3,000 to 12,000 feet above sea level. Roughly, the cinchona region forms a great, but comparatively narrow, circle or arc, with its convexity towards the west, with its centre at Loxa, where it approaches the sea. The northern extremity of this arc reaches nearly to Caracas, about 10° of N. lat., while the southern extremity reaches to near Santa Cruz de la Sierra, in Bolivia, about 19° S. lat.* The climate of this region is characterised by a prolonged rainy season, the rains occurring chiefly by night, and bright sunshine or fog prevailing by day. There is also a sharp winter fall of temperature, often to freezing, for a few months, so reducing the mean annual temperature to about 62° F. The cinchona tree here grows naturally to various sizes, according to species and local conditions. It is an evergreen and of laurel-like appearance, with entire and opposite leaves, and it bears panicles of flowers somewhat like lilac or privet, which are either white, pink, or purple.

* Royle's *Manual of Materia Medica and Therapeutics.* Art. *Cinchona.*

The accompanying plate out of Royle's *Materia Medica* will give a better idea of the tree than a long description.

Cinchona Calisaya.

Fructiferous branch. (From a specimen collected by Weddell in the province of Carabaya, in Peru.) B. Flowers. C. Corolla laid open (magnified in proportion). D. Capsule (magnified in proportion). E. Seed (magnified in proportion). F. Leaf of var. *Josephiana*. (From a specimen gathered in the province of Yungas, in Bolivia.)

One species of the cinchona from which quinine is obtained.

From Royle's *Manual of Materia Medica and Therapeutics*, which contains an excellent account of this subject.

The bark of the tree contains the medicinal properties, and this used to be, and is still harvested by the Indians, who spend the dry season, which lasts about three months, in the forests collecting it by the wasteful method of felling the trees and stripping off the bark, which they then carefully dry and bring to market.

This bark is known to commerce under many names—*Cinchona bark*, *Peruvian bark*, *Jesuits' bark*, and *China bark*, the latter being a corruption of the Indian name Guina or Kina, which means "*the bark.*"*

Of course in plantations the bark is collected by methods which preserve the life of the trees.

To Mr. (now Sir) Clements R. Markham is due the credit of having introduced its cultivation into India, where it now forms a flourishing industry in the Neilgherry Hills, Sikkim, at the foot of the Himalayas, British Burma, Ceylon and other places.

There is little doubt that many parts of Africa will prove excellently adapted for its cultivation, especially the escarpments of its lofty table lands, and the elevated forest region of the Ruwenzori and Kenia ranges, where the conditions of climate should closely resemble those of its native habitat.

The History of the Introduction of Peruvian Bark into Europe Contains the Element of Romance.

According to one account, Linnæus, while in Peru, was cured of fever by the bark administered to him by the Countess of Cinchona, wife of the Viceroy of Peru, and in gratitude he gave it her name. According to another story it was the Countess who was cured of a severe intermittent fever by the bark, and she it was who first brought it to Europe, in 1639, and there caused it to be distributed

* *Stillé and Maisch.*

gratuitously to those suffering from ague. In either case her memory as a great benefactress of humanity will live as long as cinchona bark or its active principle, quinine, continues to be the most powerful remedy known for the prevention and cure of malarial fevers. Here as elsewhere:—

"*The memory of the just is blessed.*"—*Prov. x. 7.*

Later the Jesuit missionaries brought the bark to Rome, and from their several stations at first distributed it gratuitously to the poor, but subsequently began to sell it at fabulous prices as an infallible remedy. Hence one of its names was "Jesuits' bark." But physicians and Protestants looked coldly on its employment by this religious order, so in time it fell out of use in Europe.

Revival of Use of Bark in Europe and France.

Its revival was due to one Robert Talbot, or Talbor, an English apothecary, who about the year 1678 acquired great celebrity by curing by its use intermittent fever, then very prevalent in England. Having cured Charles II. of a severe attack, Talbot was appointed physician to the king. After this he cured the Dauphin of France of the same disease, and finally sold his secret to the great Louis XIV., who gave it to the French nation.

Yet the *Odium medicum* pursued the cure in England until the illustrious Sydenham and Morton, by example and precept, won over the hard heart of professional prejudice and firmly established its therapeutic value.*

As this drug has saved the lives of millions, and will ever prove the best friend of man against the malarial parasite, I will quote another authority on its medical history, which is full of interest and instruction.

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* I wish to express my indebtedness to *Chambers's Encyclopædia* for many of the above historical facts.

"A knowledge of the curative power of Peruvian bark was not due to sagacious prescience, or scientific investigations, but to the simple fact that in the early part of the seventeenth century the Spanish conquerors of Peru learned its virtues from the native Indians. Carried to Europe, learned bigotry condemned what unenlightened savages had discovered, and one religious body zealously spurned a priceless boon that had been introduced by another, whose form of faith they derided.

"About the middle of the seventeenth century a large quantity of bark was brought from America, and at a great Council of the Jesuits at Rome was distributed to the members, who afterwards carried it all over Europe; hence it was called 'Jesuits' bark.'

"But it had still to encounter the sneers of the learned and the hate of bigotry, and it was not until an English quack succeeded in curing by its means men of high rank that fashion broke down the prejudices which reason could not remove.

"Thenceforth cinchona was everywhere applied to the cure of malarial fevers and fevers of a typhoid type, as well as for various other diseases.

"The discovery of the active principle of cinchona, imperfectly made by Duncan in 1803, was perfected by Pelletier and Caventou in 1820, as far as regards *quinine* and *cinchonine*; *quinidine* was discovered partially in 1833, but perfectly isolated in 1852.

"The introduction into practice of quinine and cinchonine dates from 1820-21."*

We may neglect in this work the alkaloids cinchonine and quinidine, and in Part II. confine our attention to quinine as being the predominant curative agent contained in Peruvian bark.

* *The National Dispensatory*, by Alfred Stillé, M.D., LL.D., Professor of Medicine, University of Pennsylvania, and John M. Maisch, Phar. D., Professor of Materia Medica and Botany, Philadelphia College of Pharmacy. London: J. & A. Churchill. One of the richest mines of Materia Medica and Pharmacy in the English language.

CHAPTER XIII.

On Quinine.

PART II.

The Physiological Action of Quinine.

Action of Quinine on lowest forms of both Animal and Vegetable Life.

How Quinine acts in Malarial Fever.

Sulphate of quinine, known popularly as quinine, is the one specific and perfect remedy for malarial fever.

It has power not only to cure, but also to prevent malarial poisoning. "*Quinine* in ague," says Osler, "*did not fail to check the paroxysms in a single instance amongst the several thousand cases of intermittent fever which I have had under observation during the past seven years.*" *

If, as Dr. Hehir holds, malaria kills more human beings than any other single disease, the drug which has power both to prevent and to cure its attacks should be reckoned amongst the best gifts of God to man.

Quinine is obtained mostly from the yellow cinchona, called *Cinchona calisaya or Cinchona flava*, or Peruvian bark ; its physical characters are too well known to need description. (See plate, chap. XII.) It is the most active ingredient in Warburg's Tincture and other well-known remedies for malarial fever.

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* *The Principles and Practice of Medicine.* By W. Osler, M.D., F.R.C.P., &c. London : Young J. Pentland.

Everyone going to Africa should make himself sufficiently acquainted with the physiological and medicinal action of this drug to enable him to use it intelligently; for quinine is a weapon of precision, powerful for offence and defence in competent hands, and equally dangerous when ignorantly administered.

Quinism.

The first thing to be learnt in practice is the difference between the *physiological action* and the *remedial power* of quinine, applied to the prevention and cure of malarial fevers.

Its most obvious physiological action, alike to patient and observer, is *quinism*, a form of intoxication quickly produced by one or more sufficiently large doses.

Its remedial action, in malarial fever, is more slowly produced than quinism, and chiefly seen in arrest of paroxysm and fall of temperature.

It is quite possible to produce quinism in a case and yet fail to cure the fever.

It is also possible to cure intermittent or remittent attacks by quinine without once producing the physiological effects of the drug.

Quinism may be roughly recognised by headache, heaviness, tinnitus and buzzing in the ears, confusion of vision and thought; by volubility and nervous excitement, suffusion of face, brilliancy of eye and unsteadiness of gait—manifestly a true intoxication. These and other symptoms point to the incidence of the drug—which is poisonous in large doses—upon the nerve centres. They may last for two or more hours, according to constitution and dose, and are followed by some degree of nervous exhaustion, muscular debility and drowsiness, ending in sleep.

Quinism may be produced in the susceptible by a single dose of 4 to 6 grains; or by two such doses given with an hour's interval between—the effects beginning in two to three hours.

6 to 10 grains can generally produce quinism in one to two hours.

15 grains will produce strong quinism in from a quarter to half an hour.

Larger doses, while not acting much quicker, will maintain the physiological action proportionately longer, say from four to five hours.

These figures represent the mean of experiments on healthy men unaccustomed to the use of quinine; they can only be approximately correct, as sex, age and the personal equation and other things influence results. The drug is more operative on females than on males, and most operative on children, to whom it must be given very cautiously and in small doses. Its action is very decided and prolonged in age, and is then apt to seriously affect the heart's functions and so become a dangerous remedy.

The accepted cause of quinism is the directly poisonous action of the drug upon brain, spinal cord, and ganglionic nerve centres, and through them upon the heart and organs of circulation generally: there is affinity between the drug and nerve tissue.

Quinine is essentially a cell poison, less fatal to the cells of the body than to the cellular parasites (as the *Plasmodium malariæ) which invade it; but poisonous, save in moderate doses, to both.*

Under moderate doses of 2 to 4 grains of quinine the pulse rises, but falls in strength and frequency under full doses of 8 to 15 grains, with marked lowering of temperature.

Doses of from 8 to 20 grains act as a sedative to the heart and nervous system, causing muscular, nervous, and cardiac debility; and if the dose be further increased or unduly repeated, death may result, with coma and other symptoms indicative of nerve-poisoning.

The appearance of quinism in a case of fever under treatment should be taken as a warning that the limit of toleration has been passed, and further administration of the drug should be suspended until the symptoms of intoxication have disappeared. Cure is retarded, and not accelerated, by the production of quinism.[*]

While quinism may occur from a quarter of an hour to two or more hours after dose, the remedial action of quinine upon malarial fever, when given by mouth in ordinary doses, may not become apparent for eight or twelve hours after administration; indeed it is sometimes not manifested for days. These facts should be kept well in view when treating the disease.

Quinine is absorbed into the blood, and retained there in solution.[†] It appears unchanged as quinine in all the secretions, and "is slowly eliminated by the kidneys, slightly or not at all changed, excepting that it is in an amorphous condition."[‡]

The Bactericidal and Globulicidal Action of Quinine.

Quinine has a directly poisonous action upon the lowest forms of both animal and vegetable life, or, as Prof. Binz puts it, "it is a powerful antizymotic."

Stillé and Maisch say:—"One part of quinine dissolved in 20,000 parts of water will, in a few minutes, begin to

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* *The National Dispensatory.* (Churchill, London.)

† Kerner, Pflüger's *Archiv. für Physiol.*

‡ Royle's *Manual of Materia Medica and Therapeutics.*

enfeeble the *Parameciæ*, in two hours destroying their vitality, and in a few hours more causing their disintegration."

It kills in the same way such vigorous fungi as the *Penicillium* and *Torula cerevisiæ*, or yeast plant. A solution of 1 part of quinine in 800 of water stops the movement of *vibrios* and bacteria, and arrests putrefaction.

A solution of 1 part in 300 of water checks alcoholic fermentation, and preserves flesh and urine for a considerable time, probably until the quinine itself is decomposed.*

As the digestive process is known to depend in part at least upon the action of certain micro-organisms, the protracted or excessive use of quinine, by arresting this, will cause dyspepsia and mal-assimilation of food. This argues for the periodical suspension or intermission of the drug, or for its hypodermic or anal administration.

How Quinine acts in Malarial Fever.

As late as 1884 Husemann held the opinion that "no amount of quinine, capable of destroying micro-organisms in the blood of man, could be taken by him without endangering life."†

Professor Binz, of Bonn, about this time took a different view, and foreshadowed what is now the established doctrine of its action :—"Quinine," he said, "cures malaria by acting directly upon the central cause of its manifestations, whether this be an organised germ or some albuminoid material in the state of change. *Its curative action is not exerted through the nerves.* Tinnitus, vertigo, drowsiness and other symptoms of quinism in man may possibly be due to partial anæmia of the brain. Quinine paralyses the irritant miasm by virtue of its antiseptic quality."

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* Royle, *o.a.c.*

† *Die Pflanzenstoffe.* Baxter and other authorities shared this opinion.

He goes on to give his theory why quinine causes the spleen to shrink, one of its useful actions in malarial poisoning being the removal of the ague cake. Binz says that this results from the drug acting upon the internal nervous system of the spleen, checking its normal function of aiding in the production of the white blood-corpuscles.

Subsequent to the writing of the foregoing, Laveran, Marchiafava and Celli, and other scientists, established that *quinine cures malarial poisoning, of which fever is a frequent but unessential phenomenon, by its directly poisonous action upon the malarial parasites circulating in the blood or lodged in the tissues.*

In short, its action on the *Plasmodium malariæ* in the blood differs in no way from that of its solution upon *infusoriæ.*

Whether quinine fails to destroy the *Plasmodium malariæ* at one phase of its life, according to Marchiafava and Bignami,* or at all periods is of small practical importance in view of its established power to kill the parasite sooner or later in the blood and tissues.

Marchiafava and Celli† took blood from cases of pernicious malarial fever (*Perniciosa comatosa*) immediately before, and also during paroxysm, and found it "*rich in active plasmodia malariæ, which became few and motionless or entirely absent after a paroxysm or after the hypodermic administration of quinine.*" The dose injected beneath the skin in these cases was 1½ grammes, equal to 23·6 grains.

Quinine retards the oxidation of the blood, in other words, lessens the oxygen-conveying function of the red corpuscles,

* "Quinine acts on the amœba of malaria in those phases of its life which are occupied in nutrition and development; when, however, the transformation of hæmoglobin into black pigment is arrested, and in consequence the nutritive activity ceases and the reproductive phase begins, then against this latter process quinine is of no avail."—*Two Monographs on Malaria and the Parasite of Malarial Fever*, previously referred to.

† *Paper on the Etiology of Malaria*, previously referred to. A Monograph, translated by my friend Dr. C. H. Eyles, for private use only. See p. 69, chap. vii.

and so far tends to produce anæmia when given in large doses.

Quinine also slows or arrests the amœboid movements of the white corpuscles, now known as phagocytes, from one of their functions. According to Mannaberg, it materially hinders phagocytosis while circulating in the blood, but, fortunately, it proves more effective than the white blood corpuscles (phagocytes) in destroying the malarial parasites.

The phagocytes can only fight as it were hand to hand in single combat with the enemy, whereas quinine, like our modern weapons of precision, kills at all ranges and annihilates the foe everywhere its influence reaches.

Of the after effects of quinine, given over long periods or in excessive doses, deafness is the most common. Partial or complete blindness sometimes ensues. Distressing ringing in the ears (tinnitus), buzzing and pulsating sounds; gastric disturbances of various kinds; cardiac, nervous, and muscular debility, are not unusual sequences. Some of these symptoms have been known to last for months, years, or permanently, after discontinuing the use of drug and returning to Europe.

The sequelæ of malarial fever may be easily confounded with those of quinine poisoning. Time tends to cure both.

CHAPTER XIV.

The Most Approved Present-Day Methods of Treating Malarial Fevers.

AFTER ROSS, MANSON AND THE GERMAN HOSPITAL OF TROPICAL DISEASE, HAMBURG.

QUININE HYDROCHLORATE v. QUININE SULPHATE.

NURSING AND FEEDING IN FEVER.

It will be well for laymen to follow Ross's advice in all severe cases of malaria, viz., to *send for the doctor and to follow his advice.*

Failing this, one or other of the following lines of practice may be safely followed, the layman being duly equipped with a clinical thermometer, without which no one should go to Africa. To use this, first wash the instrument in cold water, then shake down the register by a few sharp jerks till it reaches normal, 98°4 F.; then place it under tongue, close lips, not teeth, upon it, breathing through nose ; hold it so for five minutes, and then read off temperature. (Note.—The instrument is very fragile, and it is well to have two in your outfit.)

Fundamental Principles Underlying the Treatment of Malaria and Cure.

Ross sums them up as follows:—

1. "Malarial fever is caused by multitudes of parasites which live indefinitely in the blood.
2. "The object of treatment is to exterminate these parasites entirely—not merely to reduce their numbers temporarily.
3. "Quinine taken constantly in considerable doses for three or four months generally exterminates the parasites, provided that reinfection does not occur."

The dose of quinine must not be too small to be effective. Quinine should not be left off after fever has ceased, because although large numbers of parasites have been destroyed by its use, the survivors will soon multiply again for another attack, called "a relapse," which with due management need not occur. So Ross gives another invaluable bit of advice:— "*If a person has once become infected with malarial fever, he must continue to take quinine regularly for at least three or four months* WHETHER HE GETS FRESH ATTACKS OF FEVER OR NOT."

Quinine is best taken in solution, say, in a wineglass of water to which a little lemon juice is added, or it may be taken in a little milk. The 5-grain capsule is a handy way of carrying quinine, as it saves the trouble of weighing, but the capsule must be broken and the drug taken in solution as directed above. If a full dose is taken on an empty stomach, as Ross advises, the well-known ringing in the ears begins in about half-an-hour, showing that the drug has been absorbed into the blood. A mouthful of milk or other food will remove the bitter taste.

SUMMARY OF ROSS'S TREATMENT.

1. *For first week give quinine*	...	*5 grains daily and twice weekly 10 grains*
2. *For first fortnight*	... ...	*15 to 20 grains daily*
3. *For second fortnight*	... ...	*15 ,, ,,*
4. *For second month*	... ...	*10 ,, ,,*
5. *For third month*	... ...	*5 ,, ,,*

Half taken before breakfast, half before dinner or afternoon tea.

6. *For fourth month*	... ...	*10 grains once a week and two 5-grain doses in between, making 20 grains weekly in all.*

"If during above treatment a relapse should occur, start treatment again from the beginning."—Ross. Should such drastic treatment fail, call medical aid or send patient home to England.

Ross gives quinine at all periods of fever, cold, hot, or sweating stage; Manson approves of it at sweating time only. Ross gives the drug even during vomiting, "Even if patient be vomiting do not wait; it is bad policy." And, again, "Commence his treatment whether he has high fever or not."

Manson says, "During an ordinary intermittent, wait until the cold and hot stages are over and give the drug when patient begins to perspire." He thinks that fever once begun cannot be cut short by quinine, which rather tends then to aggravate the headache and general distress. He therefore gives 10 grains in solution at the beginning of sweating, and afterwards 5 grains every 6 or 8 hours for the next two or three days, which generally cures the fever, at least on this occasion.

Ross's treatment is heroic and radical if the patient can only bear it; Manson's prudent, in view of the risks to some of large doses. Both agree as to amount of daily dose required, 20 grains, but Manson prefers more subdivided administration than Ross.

In all cases the rigor, or cold stage, of fever should be helped out by warm drinks, heavy bedclothes, and, if there be signs of collapse, some form of hot alcohol stimulant very carefully given.

Ross treats old cases, *i.e.*—those who have had many attacks and are more or less anæmic and run down—with smaller doses, but in view of the necessity of killing out the parasites in the blood, he insists on a modified four months' course.

Summary of Manson's Mode of Treatment.

1. Quinine to be always given in solution — milk, however, may be used as vehicle.

2. Give from 15 to 20 grains daily in remittent and continued fevers, but divided into 5-grain doses every six or eight hours; if an initial stage of sweating can be caught, he then begins with a 10-grain dose.

3. In ordinary intermittents await beginning of sweating stage for giving the first 10-grain dose of quinine, then give 5 grains every six or eight hours afterwards; 30 grains spread over two or three days "is usually ample to check such intermittents."

4. He prefers to begin all treatment of fever with an aperient—strong or mild as required.

5. He believes that in cases of bad vomiting the administration of quinine by rectum (injection) is good practice, the bowels having been first well evacuated by aperient or warm water injection.

6. Manson's course runs "from six weeks to two months or longer," according to symptoms.

7. He introduces the use of arsenic and iron tonics into intervals of this course, which are no doubt of great utility if well tolerated.

8. Manson warns against the poisonous action of quinine upon the heart in certain cases, especially in oldish people, "cardiac depression, even death from syncope and serious gastric and intestinal derangements may arise from its incautious use."

9. The dose for children must be very small, say, ½ grain under a year, and so on upwards; they stand it badly.*

Present-Day Treatment of Malarial Fevers in the German Hospital of Tropical Diseases, Hamburg.

It will be well to give one more example of how the highest scientific authorities are treating malarial fever in Germany.

Malaria is treated in the above hospital as follows:—

1. Three grains of hydrochlorate of quinine is given five times daily for eight days.
2. It is then intermitted for two days, and then given another eight days in the same doses.
3. This treatment is repeated with successive intervals of three, four, five, and six days, until the end of *two months*, when the patient is generally cured.

The quinine is given in oval capsules pleated together along an equator, which quickly dissolve when placed in water, and so when swallowed the quinine hydrochlorate is quickly exposed to the action of the gastric juice.†

Quinine Hydrochlorate v. Quinine Sulphate.

To avoid confusion, I have confined myself so far to the form of quinine, *i.e.*, sulphate of quinine, in almost universal use in England, America, India, and our Dominions.

* *Tropical Diseases.*

† From *Lancet*, August 20, 1910.

The Germans, however, appear to favour the hydrochlorate of quinine, which is said to contain more of the active principle (the alkaloid *quina*) than the sulphate, in the proportion of 100 parts by weight of the hydrochlorate, being equal to 121 parts by weight of the sulphate (our ordinary quinine).

Although the hydrochlorate appears to possess certain advantages over the sulphate for hypodermic injection, it is by no means so suitable for tropical use, especially by non-professional persons, as it is easily decomposed when exposed to a damp and warm atmosphere, and much more expensive than the sulphate, a few grains extra of which for dose equalises its slight comparative deficiency in *quina*.

Nursing and Feeding in Fever.

Careful Nursing and proper feeding are paramount matters in the treatment of fever. *It should be the exclusive business of some one who can be trusted to nurse the sick man. He must not, emphatically, be left to the general care when suffering from fever, for here more than elsewhere—everybody's is nobody's business.*

Intelligent blacks make excellent nurses.

Feeding in Fever.—Over-feeding and under-feeding are both dangerous in fever, and the popular formula, "Feed a Fever," must be taken with reservation.

Thirst, which is always present, must not be treated as if it were hunger, by giving draughts of milk, however diluted, or of animal broths, however weak. These are fluid *foods*, and if taken in excess will overload the stomach and quite upset digestion. Milk curds will give rise to flatulent distension, nausea, and vomiting. Dr. Broadbent recommends, as the average amount of food in typhoid fever: Two pints of milk and one of broth or beef tea in the 24 hours, to be given in small teacupfuls (say, 4 to 5 ozs.) at 2½ to 3 hour intervals by day; 3½ to 4 hours by night, to avoid interruption of sleep.* This, as a kind of general standard of the necessary alimentation in continuous fever, is useful; but the conditions of typhoid and malarial fevers are dissimilar, and of the latter every case must be dealt with somewhat differently, so that no fixed rule can be laid down. I have known fresh milk to disagree with people in Africa, so that it could not be given, while preserved milk suited them fairly well. There are others who cannot take milk in any form, not even sour, as it is used by the blacks; such will have to depend on broths, beef tea, and farinaceous food.

Again, if only a small quantity of nourishment can be taken at a time in very bad fevers, say, one tablespoonful, it must be frequently repeated, say every half hour, so that the average quantity of 4 to 5 ozs. every 2½ to 3 hours may be duly administered. Sometimes, as pointed out by Father Kneipp†, milk taken thus in tablespoonful doses will agree perfectly, while in larger quantities it will disagree.

As the case progresses, and the patient grows weaker, the intervals for giving food should be always shortened.

To test how food is agreeing, it is well to examine the *dejecta* daily; if its smell is particularly offensive, or colour unnatural, some article of food is disagreeing, which should be sought out and something else given in its stead. Perhaps it may be too much animal broth or beef tea which occasions the bad smell, or too much milk, the curds of which may be seen; in such cases give less milk and broth, and more farinaceous food.

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* See the *Cavendish Lecture—Lancet*, August 25, 1894—*On Some Points in the Treatment of Typhoid Fever*, by Sir William H. Broadbent, Bart., M.D., &c.

† *Thus Shalt Thou Live*, by Sebastian Kneipp. Trans. from 19th German Edition.

As a rule, milk is best given with some form of gruel, by which means its curds are finely divided in the stomach and made easier of digestion. The custom of giving it in soda-water or lime-water does not commend itself; a little mixes well with plain boiled and filtered water, or "averina," for a food-drink.

The essentials for a fever diet in Africa include the fresh milk of cows, goats, or sheep, or preserved milk; beef tea, mutton, kid, game, or fish broth; chicken tea; sago, rice, tapioca, arrowroot, cornflour in gruel, to which a little milk may be added. Plaintain and manioc gruel; banana gruel with milk, which saved Stanley's life; vegetable broths, of various native garden produce, some of which, as made by the natives, are palatable and nourishing.

To the above list may be added certain wholesome fruits, as ripe melons, papaws, and bananas, kept over night in a cool room, and eaten very moderately.

Weak tea, coffee, and cocoa, as nerve stimulants, are occasionally very useful.

Water which has been boiled, filtered, and allowed to go cold is nature's fever drink, which nothing else can equal. Next to this, and when some little nourishment and support are needed, comes "averina," thin and thick, and, still more rarely, a draught of sherbet, not highly sweetened; but to give acid drink all day, as I have known to be done, is a great physiological blunder.

Milk and rolled oatmeal gruel, the latter and chicken tea, may be mixed in various ways to please the palate.* Biscuit pap and also some good wine must be given. Later, some form of fresh meat stew with suitable vegetables boiled in it will strengthen the heart, especially if a little champagne or good Madeira, or a little diluted brandy or whisky, be added to the evening meal.

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* *Light Diet*, by Dr. H. W. Seager, gives concise directions for the preparation of food for all kinds of invalids.

CHAPTER XV.

Quinine.

PART IV.

The Medical Action and Uses of Quinine and Warburg's Tincture in Malaria.

Quinine may be taken as the type of vegetable tonics.—*Royle.* It is useful in debility, whether general or local, when it acts as a stimulant of the nervous and circulatory systems.

"On the digestive organs small doses of quinine, as of all pure bitters, stimulate appetite and digestion; but in large and continued doses it irritates the stomach and confines the bowels at first, although it may afterwards cause diarrhœa."—*Stillé and Maisch.*

"Dose as a tonic, 1 grain three times daily. More than this is likely to act as a sedative rather than as a tonic."—*Royle.*

Quinine as a Preventive of Malaria.

As a preventive of malarial fever, quinine should be taken in doses of 2½ to 5 grains at 6 a.m. and 6 p.m. daily.

The prophylactic value of quinine and other salts of cinchona is thus spoken of by Stillé and Maisch:—"*Their powers have been tested in all parts of the world, and it is now certain that a person under the impression of a dose of quinine or cinchonine, even within the limits of sensible cinchonism, may be exposed to malarial infection without danger.*"

Surgeon Parke says:—"Experience unmistakably indicates the great value of quinine as a prophylactic. . . . . . For that purpose it is always desirable, on entering a malarial district, to take a 5-grain quinine tabloid twice a day."* Again, writing to the *Lancet*,† he says:—"For a period of about ten days before entering the Congo each of the white officers of the E.P.R. Expedition took about 4 grains of quinine twice daily, and the results were satisfactory, as could well have been anticipated. . . . We had but a couple of cases of slight intermittent fever until we reached Stanley Pool, a distance of 350 miles, through one of the most unhealthy regions in Africa, from March 18th till April 22, 1887."‡

The dose must not be sufficiently large to produce the physiological effects of the drug. Surgeon Parke and Stanley recommend 4 or 5 grains twice daily, but I have found 2 or 2½ twice daily quite sufficient if steadily persevered with, this being the condition of its success. *To assure safety, begin use of quinine a week before entering a malarious region, and regulate the dose within the limits of 2½ and 5 grains daily* (that is, 1¼ to 2½ grs. in the morning and same in the evening) *according to health, tolerance of drug, season, environment, and exposure to infection.*

Malarial fever may be contracted on shipboard while sailing along a malarious coast, especially if lying off the mouths of rivers, where mosquitos frequently fly on board.

Going ashore at unhealthy ports is a dangerous recreation, especially at the hours of sunrise and sunset; large prophylactic 5-grain doses may in such cases be necessary to prevent infection.

The way in which small doses of quinine, taken at twelve-hour intervals, prevents malarial fever is shown, I think, in

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* *Guide to Health in Africa.* † *Lancet*, May 28, 1892.

‡ This corresponds to the initial period of immunity, and so confuses the issue of prophylaxis by quinine.

Tyndall's experiments with micro-organisms in nutrient media. He found that germs which resisted a heat of 212° F. (ordinary boiling) for eight consecutive hours, *readily succumbed to the moderate heat of* 150° *F., applied for a few minutes at intervals of twelve hours—"whereby the softened germs, then approaching the phase of final development, would be killed—at each time, more and more until all the germs were killed off.*"* The life cycle of many of the organisms upon which he experimented was completed in two or three days, agreeing herein with that of the malarial parasite. The blood and Tyndall's culture tubes, in this experiment, differ, however, in this important particular, that whereas the former is ever open to receive fresh germs from mosquitos, the tubes were perfectly guarded against such occurrence. This rendered the destruction of germs in Tyndall's experiment easier and quicker than of those in the blood.

Experience shows that a moderate dose of quinine given every twelfth hour will prevent fever in the presence of ordinary malarial infection, and it is difficult to explain this otherwise than by the directly destructive action of the drug upon the parasites, or, more probably, upon such of them as are sporulating; that final soft stage of development which coincides, according to Golgi, with the commencement of a fever outburst.

Experimental proof has established the fact that the young spores rapidly disappear from the blood when a large dose of quinine has been given. It is therefore practicable to annihilate all the parasites by repeated adequate doses of quinine, given as Ross prescribes, if the patient has returned to England or can guard against fresh infection during his stay in Africa — a matter quite possible by using the protective measures taught by science.

* *Floating Matter of Air.*

Rule for Giving Large Doses of Quinine.

*To give large doses of quinine with greatest effect, divide it into smaller doses of 6 or 8 grains, and give one of them every hour until all has been administered.**

Not only is the antidotal action of quinine best secured by this method, but the danger of inducing quinism is lessened.

When and How Quinine should be Administered.

No doubt *rapid* and *energetic* absorption of quinine is best obtained by giving quinine in a watery solution when fasting, but *gradual* and *prolonged* absorption is best obtained by giving the drug with or soon after meals.

Herein lies the clue to its scientific administration in malaria, which when regularly periodical requires the dose to be given during fasting, dissolved in water, and if possible a short time before the expected paroxysms; while, on the other hand, in such irregular fevers as those of the remittent and continuous type it is best to give the watery solution of quinine in the needful doses every six or eight hours, and *with* food, or at meals, until the required daily quantity has been administered. Thus given the quinine is certain to meet the swarms of young parasites at their various sporulating periods and, meeting, to destroy them.†

Should Aperients be given or not before a Course of Quinine?

Quinine given in pill, powder, tabloid, or capsule, or too frequently administered upon the empty stomach, is apt to produce, by its concentrated action on the mucous surfaces, dyspepsia and bowel derangements.

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* See chap. xii.

† See Summary of Dr. H. C. MacGilchrist's, I.M.S., Paper on *Quinine: Its Administration and Its Dangers.—Lancet*, May 6th, 1911.

Simply mixing the dose in a wineglassful of water, which has been both boiled and filtered, will prevent such untoward results; but if a bottleful for steady use is required, sufficient aromatic sulphuric acid to make a clear solution, with a little tincture of orange peel or extract of liquorice, should be added for flavouring.

Quinine may be given in simple intermittent and remittent fever without preliminary medication.

This being controverted, I quote Stillé and Maisch in support:—"Formerly the notion prevailed that in order to render the treatment of simple periodical fever effective, the gastro-intestinal tube should be thoroughly cleansed by emetics and cathartics, and that sometimes mercury should be exhibited; experience proved that these methods, founded upon theory for the most part, are generally unnecessary, and sometimes injurious, the condition they are intended to remove depending mainly upon the malarial poisoning for which quinine is the specific cure."

Livingstone, on the other hand, always commenced the treatment of fever by his "rousers," of which Dr. Maclean, of Netley Hospital, says:—"No better combination of a purgative with quinine can be given to begin the treatment of the fever than Livingstone's rousers." But he warns us in another place against active purgation "in those who have suffered from dysentery or other forms of bowel complaint."

Some experienced men recommend a dose of calomel, on the principle of causing a flow of bile, and so flushing out the intestinal tube before beginning specific treatment. Dr. Laws, quoted by Mr. Waller, advocates purgatives thus:—"We find nature getting rid of the poison by all possible channels; the lungs, the skin, the kidneys, and the bowels: therefore, in our treatment we must follow her guidance, and endeavour to keep all the doors of escape open for throwing out the poison. By purgatives we act on the bowels, by weak tea assuage the thirst and furnish a diluent acting on the skin also, and relieving the kidneys; . . . and by careful ventilation we provide fresh air for the lungs."

But probably this discrepancy is more apparent than real, for all authorities agree that the congestive and bilious types of fever need evacuant treatment to begin with, while few will be found to insist upon its necessity in simple fevers save in view of some special requirement.

We should regulate the dose of quinine by the type, phase, and severity of the fever.

Until recently periodicity was viewed as the essential condition of the remedial action of quinine.* Now this is determined with greater precision by microscopical examination of the blood for the *Plasmodium malariæ*. This is rightly insisted upon by Dr. Manson in all grave and doubtful cases, and he gives the following rule:—

"*If you see Plasmodium malariæ in the blood, give quinine freely and very likely you will save your patient.*"†

He was here specially alluding to pernicious cases with coma and rapidly rising temperature, and to certain forms of malarial dysentery with plum-coloured stools containing "blood and mucus"—but the rule holds good for general application.

If microscopical examination of the blood is impracticable, the following rule may be found useful in fevers and other cases of doubtful malarial origin:—

If fever or disease is slight or chronic, give quinine sparingly at first in 4 to 8 grain doses every 12 hours (night and morning). If fever or disease is severe or acute, give 8 to 12 grain doses every 12 hours. In either

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* See *The National Dispensatory* of 1886.

† A Clinical Lecture on *The Parasite of Malaria and its Development.* By Patrick Manson, M.D.Aberd., M.R.C.P.L.—*Lancet*, Jan. 6, 1894.

case watch results : if beneficial, pursue full quinine treatment by rules laid down in next chapter. If no benefit or if hurt accrue, suspend quinine. Women require smaller doses of quinine than men ; children are especially sensitive to its action in the smallest quantities.

Quinine by Rectum.

Warburg's Tincture and its Mode of Administration.

"*Sulphate of quinine may be exhibited in same dose, and with nearly same effect, by rectum as by mouth, provided it be given in watery solution.*"—*Stillé and Maisch.*

This fact should be borne in mind in view of the very common intolerance of quinine given in the ordinary way. With some this intolerance is innate ; more generally it is acquired from the excessive or protracted use of the drug.

As a rule, quinine should not be administered by mouth or rectum during paroxysm or exacerbation of fever.—Manson.

Quinine given by mouth or rectum is ordinarily slow to act, and during pyrexia absorption is in partial abeyance, so that but little of the drug could arrive in the blood and tissues in time to avail against the parasites. On the other hand, it would be quite possible to produce quinism by large doses, and so add to the risk and sufferings of the patient without mitigating the disease.

The intravenous or hypodermic administration of quinine may be practised with highest benefit and promptest effect during paroxysm and exacerbation : because, by either mode, the immediate entrance into the circulation of full doses of the drug in state of minimum dilution is secured, but as this can be done only by a skilful physician, it is held to be a dangerous mode of use by some doctors.

Warburg's Tincture is a safe and effective remedy for all types of malarial fever, especially for simple and congestive remittents.

Dr. Maclean, of Netley, well expresses the consensus of medical opinion of its merits as follows:—"I have treated remittent fevers of every degree of severity in the jungles of Deccan and Mysore, and at the base of the mountain ranges of India; on the Coromandel Coast, in the pestilential highlands of the northern division of the Madras Presidency; on the malarial rivers of China, and in men brought to Netley Hospital from the swamps of the Gold Coast; and I affirm that I have never seen quinine, when given alone, act in the manner characteristic of this tincture. And although I yield to no one in my opinion of the inestimable value of quinine, I have never seen a single dose of it given alone, to the extent of 9½ grains, sufficient to arrest an exacerbation of remittent fever, much less prevent its recurrence; while nothing is more common than to see the same quantity of the alkaloid in Warburg's Tincture bring about such results."*

Exacerbation or paroxysm is no bar, but rather the opportunity, for the administration of Warburg's Tincture. It is an ideal remedy for laymen in ordinary simple cases of malaria.

Treatment by Warburg's Tincture.

This has some advantages over treatment by quinine alone; one is that the administration of Warburg is always safe and beneficial at any stage of the fever. If given during exacerbation, it generally subdues it; if during remission, it generally prevents exacerbation.

* *Medical Times and Gazette*, Nov. 1875.

Mode of administration of Warburg:—

Rule 3: "*The bowels having been thoroughly evacuated by some suitable purgative, all drink being withheld, give one tablespoonful* ($\frac{1}{2}$ *oz.*) *of tincture alone, without dilution; give a similar dose in similar manner in* 3 *hours.*"—*Stillé and Maisch.*

Profuse perspiration, with defervescence, will ensue after second dose of the drug, if given during the exacerbation. Similar but less intense action, if given through the remission, with good prospect of cutting short the disease in either case by two doses. Should the fever continue, it will be necessary to give two more extra doses at three-hour intervals, in the same way precisely that the first two doses were administered, save that the purgative should not be repeated.

This tincture may be given at any time upon recrudescence of fever, because it is void of noxious properties; and after extinguishing the fever, instead of producing quinism, its surplus energy will be expended in depurating the system from the products (*toxines*) of the malarial microbe.

The composition of this medicine is given on page 156.

Summary of Facts about Quinine and Warburg.

Quinine is the specific for malarial fever. Warburg is the best form to administer it in certain types of the disease.

Quinine is distinctly a prophylactic of highest value. Warburg cannot be conveniently used for this purpose.

Quinine acts as an antidote, directly destroying the malarial parasite. Warburg, while possessing antidotal properties, acts chiefly as an eliminative and depurative, quickly removing the toxines of malaria by setting all the emunctories in action.

Quinine should be administered before paroxysm, and after exacerbation. Warburg's best opportunity is during pyrexia.

Quinine is held by some authorities to be unsuitable for hæmaturic fever. Warburg is a good and safe remedy in this affection.

Quinine is poisonous to all cells, those of the body inclusive; but it is usually more poisonous to parasitic micro-organisms in the blood than to cells of blood or tissues. Warburg is in no sense a cell poison to the body, but its quinine appears to have some toxic effect on the *Plasmodium malariæ* in the blood and tissues.

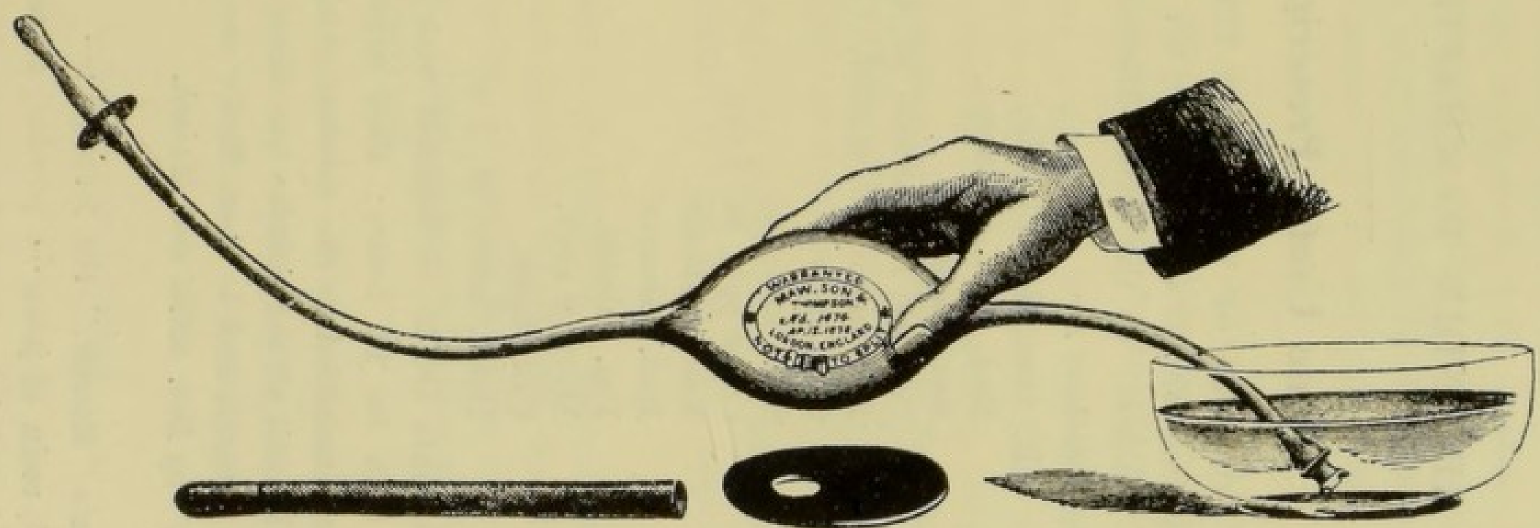
Quinine, in certain doses, produces intoxication, called quinism, due to its incidence upon nerve tissue. Warburg has not been noticed to produce quinism.

Quinine, administered as below :—

(1) by intravenous injection, } **Methods 1 and 2 can be employed by skilled physicians only.**
(2) by subcutaneous injection,
(3) by mouth,
(4) by rectum,
(5) by skin—by "salting," which is helped by friction and the solution of drug in lime-juice, and sweat,

is, in this order, efficacious in treatment of malarial fevers.

The best form of injection instrument for use in Tropical Africa. It is simple in construction and does not get out of order. Its mode of use is shown in drawing below, taken from Maw, Son, and Sons' Catalogue. The short nozzle, as seen in drawing, does for ordinary injections; the long one may be used in cases of greater difficulty. It answers excellently for all forms of injection.



349—Seamless, Ingram's Patent. Makers, Maw, Son, and Sons, Surgical Instrument Makers, 7 to 12, Aldersgate Street, London.

APPENDIX TO CHAPTER XV.

Some Useful Prescriptions.

ORIGINAL FORMULA OF WARBURG'S TINCTURE.—This tincture was for a long time famous as a nostrum, till its secret was obtained by Professor Maclean, of the Army Medical School, Netley. Its composition is as follows:—

R. Aloes (Socot.), 1 lb.
Rad. rhœi. (Chinens).
Sem. angelicæ.
Confect. Damocratis, āā, 4 ozs.
Rad. helenii (S. enulæ).
Croci sativi.
Sem. fœniculi.
Cretæ ppt., āā, 2 ozs.
Rad. gentianæ.
Rad. zedoariæ.
Pip. cubebæ.
Myrrhæ elect.
Camphoræ.
Bolet. larisis, āā, 1 oz.

These ingredients are to be digested with 500 ozs. of proof spirit in a water bath for 12 hours; then expressed, and 10 ozs. of sulphate of quinine added to the mixture, which is then replaced in the water bath until all the quinine has dissolved. The liquor, when cool, is to be filtered, and is then fit for use.—*From "The National Dispensatory," by Drs. Stillé and Maisch.*

Livingstone's "Rouser," the formula:—

R. Calomel, resin of jalap in powder, of each 8 grains; powdered China rhubarb, quinine, of each 6 grains. Mix carefully, and make a powder. Dose, from 6 to 12 grains.

The best general aperient for the tropics is the following :—

R. Glauber salts (in crystals), 1 oz.

Epsom salts, 2 ozs. Mix them together. Pour upon them 1 pint of boiling water, stir briskly ; add, when cool, bicarbonate of soda, 10 grains ; tinct. of rhubarb, ½ oz. Bottle. Dose, a wineglassful first thing in the morning, fasting, in cases of chronic constipation. The same dose every two hours will soon cause a flow of bile and healthy alvine discharges. A few drops of essence of ginger may be added to this mixture.

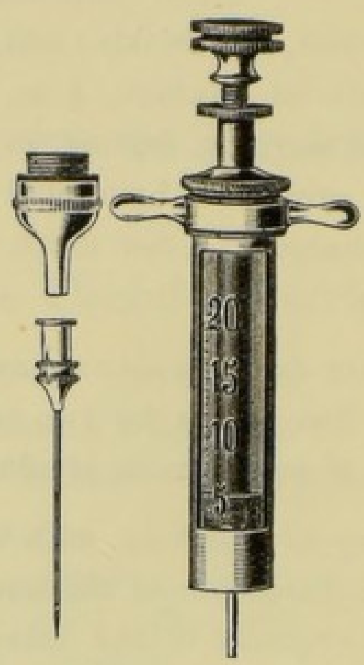
Calomel, in 2 or 3-grain doses, is also an excellent remedy in fever to initiate treatment. Two grains for two succesive days, according to the German practice, is a good mode of administration.

If there be a tendency to diarrhœa, with very offensive stools and tympanitis, or flatulent distension of abdomen, facts which point to septic processes in the contents of the intestine, there is no better treatment than that recommended by Sir W. H. Broadbent, of ⅓-grain tabloids of calomel every three hours, until the stools become normal in character, then suspend use of this drug.

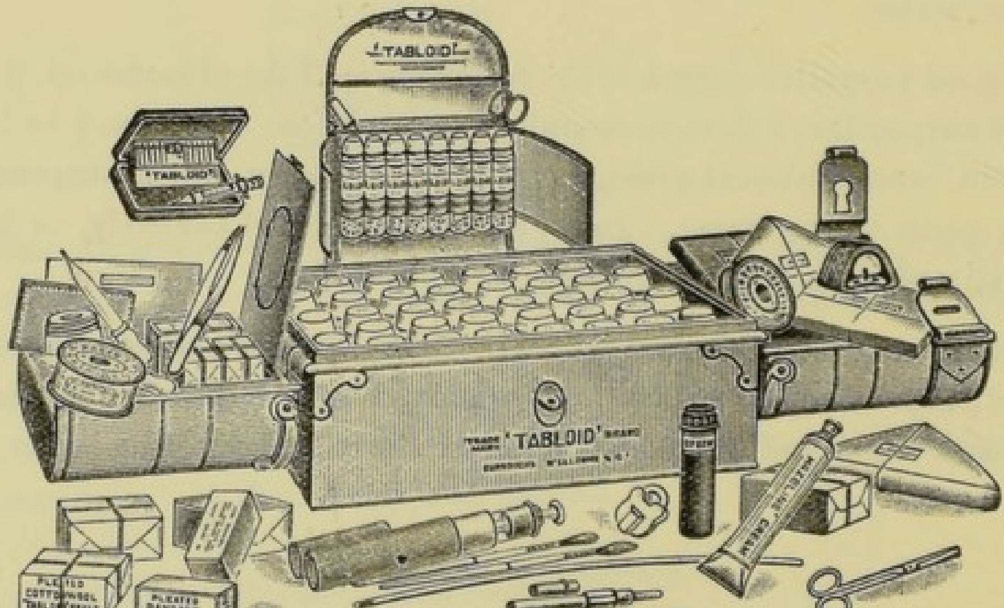
A safe emetic is mustard and warm water, or warm salt and waters or 15 grains of ipecacuanha powder, followed by copious draughts of warm water.

A good purgative enema is the following :—Take of castor oil, 2 ozs. ; oil of turpentine, 1 dessert-spoonful ; for excipient use, from ½ to 1 pint of thin, warm oatmeal gruel, or mutton broth, or warm soapsuds, or even plain warm water. Inject at temperature of the body, or hotter if a stimulant action is required.

For a useful stimulating enema :—Take of tinct. of asafœtida, 1 oz. ; oil of turpentine, 1 teaspoonful ; brandy, 1 oz. ; mix in 2 wineglassful, of warm water and inject. The hotter it can be borne the better.



A USEFUL FORM OF HYPODERMIC SYRINGE FOR AFRICA, SUPPLIED BY BURROUGHS, WELLCOME & CO.



"TABLOID" BRAND MEDICINE CHEST.

BOOK THE FOURTH.

PREVENTION OF DISEASE:

A Treatise on African SANITATION AND HYGIENE.

CHAPTERS XVI. TO XX.

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Book the Fourth.

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PREFACE

TO

Book the Fourth.

Medical science has at last thrown open the closed or half-shut door of Tropical Africa to European immigration.

But let no one venture therein who is not personally satisfied, and medically assured, of his fitness to possess the Land.

The vital equipment for everyone going to tropical Africa is the possession of

MENS SANA IN CORPORE SANO.

If a man is not sound in wind and limb; if he has previously suffered from malarial fever so badly as to have needed sick furlough; if there is latent dyscrasia of blood or tissue, especially any tendency to nervous debility, epilepsy, insanity, or other neuroses; finally, if he be weak blooded, scorbutic, or anæmic, or has suffered from rheumatism, gout, or hæmorrhage, or is past the meridian of life, *in God's name let him not go to Tropical Africa.*

Hear what a high authority says on this subject :—" *Some who go there are, under the most favourable conditions, foredoomed to death. It would be well if no man went to Tropical Africa without having undergone a searching examination in not only his own health-history, but that of his family as well. Even temperament, which is a more* *deep-rooted thing than many of us know, may seriously affect his chances of health."* *

If one is conscious of weakness or unsoundness at home, how can he hope for better health under far more trying conditions of life abroad?

> "*If thou hast run with the footmen, and they have wearied thee, then how canst thou contend with the horses? And if in the land of peace, wherein thou trustedst, they wearied thee, then how wilt thou do in the swelling of Jordan?"—Jer. xii. 5.*

Therefore we have taken for the motto of this book, and commend it to the notice of our readers:—

ERST WÄGEN, DANN WAGEN.
FIRST WEIGH, THEN WAGE.

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* *The Hospital.*

CHAPTER XVI.

Hygiene and Sanitation in Tropical Africa.

Definition of Terms.

Hygiene relates to the preservation and improvement of health, both in individuals and communities.

Sanitation relates to the devising and applying of measures for preserving and promoting both public and private health, such as the removal or neutralization of things injurious to health, and the practice of what promotes health.

Sanitary Science, or the science of health, includes both. It will be seen that the terms somewhat overlap, but the tendency is to apply *Hygiene* to the medical and physiological aspects, and *Sanitation* to the engineering, commissariat, inspection and administrative aspects generally of the science of health.*

"*Health* may be defined as the normal operation of the human mechanism—*Disease* as its abnormal."—*Huxley*.

Health consists (1) with the *control of the individual*, and (2) with the control of *environment*.

(1) Some diseases may be wholly warded by increasing the efficiency of the bodily mechanism, as by good food, air, location, temperance, and so forth; also by appropriate drugs, as by the use of small doses of quinine as a preventive measure in malarial countries.

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* *Ency. Americana*: Art. *Sanitation*.

Every Man that striveth for the mastery is temperate in all things.—I. Cor. ix. 25.

And "*Self-knowledge, self-reverence, self-control*" (*Tennyson*) are fundamental principles of bodily as well as psychic health. This is *Hygiene.*

(2) Other diseases may be warded by adequate *control of environment*, as by drainage, good water supply, site of buildings, good scavenging, and so forth, which deal directly with environment, indirectly with the individual. This is *Sanitation.*

Both hygiene and sanitation must be unremittingly, perseveringly, and strenuously practised in Tropical Africa to maintain health.

General Sanitation in Tropical Africa.

On the Selection of Healthy Lands and Building Sites, and other Precautionary Measures Against Malaria.

The selection of healthy lands for settlement and sanitary building sites requires a careful study of the climate and topography of a district.

As a rule, *the higher the altitude in the tropics—other things being equal—the healthier the locality, and the less danger from malaria.*

Surface water, subject to constant change of level, renders a place unhealthy; hence the margins of rivers, lakes, lagoons, and swamps, especially on the lee side, should not be built on. But if it becomes a necessity to live near such places, fix your house to windward, on the highest tree-screened ground available. I lived on the West Coast, in a camp, on a hill 100 feet above and to the lee of a lagoon, the waters of which were constantly changing level and exposing fresh mud banks. Malaria was endemic amongst us, owing, as I have since learned (but did not then know), to the fact that the conditions were most favourable for the breeding of *Anopheles* mosquitos, which were constantly conveying infection to us by their bites.

Bowl-like depressions, deep gullies with water at bottom, flats and plains subject to inundation, or with retentive bottom, should never be selected for towns or homesteads, being the haunts of the mosquito.

Rivers, narrow lakes, gorges, valleys, and similar features, by acting as funnels, cause draughts, which Stanley found to be, at Vivi and elsewhere, surely provocative of malarial fever. At some seasons such places will be healthy, and at others unhealthy, which will cause perplexity until the topography and prevailing winds are studied.

On the other hand, a place may benefit by mountain and sea-air being led to it through similar channels, provided it is not exposed, like Vivi, to strong draughts.

Rule :—*Note direction, strength and character of prevailing winds, especially local ones, and learn from the natives what winds are considered good and bad before founding settlement or building house.*

On Drainage.

The best fruits of civilization cannot be had without considerable expenditure of money and labour, and areas cannot be properly drained in a new and sparsely populated country without overtaxing the young communities.

On the other hand, to attempt, yet fail, to drain properly is to invite malarial infection, as nothing is more fraught with danger in the tropics than the upturning of soil, which creates, especially in clayey ground, numerous puddles after rains, well suited to serve as breeding grounds for the *Anopheles* mosquito.

On this question of upturned earth causing malaria Dr. Atkinson writes as follows :—

" There can be no doubt that freshly upturned earth is here (China), as in other parts of the world, a point of considerable importance in relation to the causation of this disease. It may seem superfluous to produce proof in evidence of this, but as some still dissent from this view, I will here introduce some facts bearing out this theory, Dr. Young, one of my predecessors at the hospital, wrote to me in 1888 concerning an outbreak of malarial fever at Kowloon Point, which, in his opinion, was caused *by the extensive earth-cutting necessitated in the preparation* of the site for the new water police-station at Tsim-tsa-tsui. This occurred in the summer months, during the S.W. monsoon, *and the houses in which the people were attacked by this fever lay right in the course of the prevailing winds.* In 1888, during the time foundations were being made for the new Chinese barracks at our own hospital, we had an outbreak of malarial fever amongst the officers and attendants, which I could only account for by this earth-cutting theory. Out of a staff of forty, no less than fifteen were invalided from this cause during one week, in which the earth-cutting and filling in of this space were taking place—a ratio of 34 per cent. (remittent fever).

. . . .

"Lastly, there is the severe outbreak which occurred in the latter half of 1889, after the great rain-storm in May of that year. *That enormous downpour*—namely, 33·11 inches from 3 a.m. on the 29th to 5 p.m. on the 30th (thirty-eight hours)—*washed down great quantities of alluvial soil from the many landslips on the hillside*, and undoubtedly must have set free the malarial poison to an abnormally great extent. There were no less than nine deaths from remittent fever at the hospital during that year, eight of these occurring after the rain-storm; four of the eight were members of the European police force, men who from the very nature of their calling are more exposed to this poison."*

This subject is at the present moment (1911) being investigated by Italian scientists, but the history of the sanitation of

* *The Malarial Fevers of Hong Kong.* By J. M. Atkinson, M.B., Lond. *Lancet*, April 28, 1894.

the Panama Canal zone would appear to negative Dr. Atkinson's theory of malarial infection *in toto.*

Tree Planting.

Tree planting is a mode of drainage for tropical countries full of excellent promise.

The Trefontine Convent at Rome had become uninhabitable from malarial fever before the Trappist monks took it and planted the estate with eucalyptus, which had the effect of suppressing malaria, save in one cloister. When this was also planted, fever disappeared. The trees drained the soil, and so curtailed the breeding of *Anopheles.*

Mr. J. W. Rowlands, in his paper,* supports Sir Joseph Fayrer and other authorities in the doctrine of subsoil water propagating malaria. He considers want of shade another factor of its production.

Lagos (1892) has little or no shade, and the underground water lies from 6 to 12 ft. below the surface in the highest, while frequently overflowing in the lowest parts of the town.

Mr. Rowlands attributes the permanent unhealthiness of the town to these causes, and for remedy recommends the planting of quick-growing trees, which, while furnishing shade, will also drain the soil.

Professor Pettenkofer, of Munich, calculated that an ordinary oak tree has 751,592 leaves, and that such a tree loses, from May to October, 212 ins. of water by evaporation; while the rainfall over the area covered by trees was only 25.6 ins. In other words evaporation exceeded rainfall over area covered by tree 81.3 times, and this great loss was supplied through the roots. The eucalyptus, in Algeria, has been calculated to evaporate 12 times its area of rainfall.†

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* *Report on the Sanitary Condition of Lagos.*

† See Baron Von Mueller's *Eucalyptographia.*

Pettenkofer was one of the first to establish that underground water can contain and transport the germs of disease from place to place.

Naegeli proved that "underground water lying not too far from the surface, with alternate rise and subsidence of level, has a great effect in producing malaria."*

Naegeli has also shown that underground, vitiated air, and doubtless the poisonous microbes it holds, may be drawn into houses by the suction of fires.

From the foregoing we draw these useful sanitary rules :—

Rule I.—*Cement basements, floors, cellars, passages, yards, in short, the whole area occupied by dwelling-houses in tropical countries, to cut off sub-soil emanation and damp.*

Sir Charles Cameron, Health Officer for Dublin, recommended the cementing of cellars and casing of foundations to remedy the unhealthy underground dampness of houses in that city.

Rule II.—*Reject for building sites localities where the subsoil water rises within 20 feet of the surface at climax of the rainy season. Should it be necessary to build on such sites, plant ground with quick-growing, deep-rooted trees and shrubs, and never remove a native tree without supplying its place by another.*

Dr. Léon Colin has pointed out that the danger from "malarial exhalations" is least at noon, although there is then greatest evaporation. Morning and evening are the most dangerous times, because the difference of temperature between earth and air causes upward currents, which waft malaria from the soil.

This is another example of most excellent practice based on most erroneous theory. It teaches us also that we must

* Quoted by Dr. Jaeger in his *Health Culture*.

never despise the lessons of experience while yielding to the modes of learning.—*Bacon.*

Morning and evening are certainly the most dangerous times, for the malarial mosquitos are then in strongest evidence, and the uprising air currents help their feeble up-flight in search of food.

Rule III.—*Keep your house in the tropics during the fatal hours of sunrise and sunset.*

The Standardisation of Disinfectants.

In the November 20, 1909, issue of the *Lancet* there appeared a report on the bacteriological examination of disinfectants commonly sold to the public. The following summary of Bacteriological Experiments was published :—" The disinfectants which we have tested may be classified as follows :—

List of Coefficients (Pure Phenol).

——		Coefficients.	
	At 2½ minutes.	At 30 minutes.	Mean.
A. Coal-tar disinfectants forming emulsions with water :—			
1. Cofectant	7·7	11·9	9·8
1. Sanitas-Bactox	6·1	12·9	9·5
1. Sanitas-Okol	7·7	10·2	8·9
1. Cyllin (from bulk)	6·6	11·1	8·8
1. McDougall's M.O.H. Fluid	7·0	8·8	7·9
1. Kerol	5·5	10·0	7·7
1. Izal	7·0	7·8	7·4
1. Cyllin (Medical)	6·0	6·8	6·4
2. Pearson's Antiseptic Fluid	1·8	2·7	2·2
2. Jeyes' (Chemists')	1·1	2·3	1·7
2. Lawes Fluid	1·4	1·9	1·6
2. Zotal	1·1	1·9	1·5
2. Krysyl	1·2	1·5	1·3
2. Jeyes' No. 2 (Grocers')	0·55	0·94	0·75
B. Coal-tar disinfectants forming clear solutions with water :—			
Crude Carbolic Acid	4·0	4·4	4·2
Calvert's No. 5 Carbolic..	2·7	2·4	2·5
Trikresol	2·5	2·5	2·5
Lysol	1·5	1·9	1·7
Sanitas Disinfecting Fluid	8·018	0·032	0·025

". . . It must be borne in mind that this order is in terms of an artificial set of conditions, but we believe that it may be regarded as giving a rough indication of the value of these disinfectants in destroying the germs of disease under the conditions of natural disinfection."

In reproducing these tables from *The Lancet*, an error has been made. The last line should read:

	At $2\frac{1}{2}$ Minutes.	At 30 Mean.	Mean.
"Sanitas Disinfectant Fluid	0.018	0.032	0.025."

The 8.018 in column 1 being obviously a printer's error.

PART II.

Sanitary Aspects of Clearing and Tree Planting in Tropical Africa.

The question of clearing native timber and scrub for some distance around European dwellings or settlements has to be carefully considered from many view-points, as it is a subject of some controversy amongst authorities.

Some would have the clearing of all vegetation, even of native grasses; others are for retention of some trees and not stripping the earth of its grassy mantle; all appear to approve of some form of planting on the denuded area.

If we seek guidance in this matter from native usage, which is often a prudent course, we find that all large, well-established villages are surrounded by native plantations, as far as the conditions of the locality permit.

If the village is situated on the borders of the primeval forest, which is a favourite site, because of the great fertility of the forest soil, the clearing includes removal of all scrub and the felling of many large trees, which are burned and the crops sown amongst the ashes. Some of the largest umbrageous trees are left in every compound and field, and generally one or two are retained in every village, under whose shade people sit in the evenings, as our village folk used, in the bucolic days of "Merrie England," to assemble under

> "*The hawthorn bush, with seats beneath the shade,*
> *For talking age and whispering lovers made.*"

In Axim, Gold Coast, the main street is avenued with shady Ganian, or Umbrella-fig trees, which adorn the dingy little town with a necklace of beauty.

Burton remarks that a boulevard of Bread-fruit trees would give more shade, besides yielding nutritious food, and it is a pity that this beautiful and useful tree has not been more generally introduced into Tropical Africa.

Grass is grown in the vacant spaces of most African towns, but the plots are little cared for, save in European quarters. The boulevard style of planting should be universally adopted in Africa, where a bountiful Nature will grow almost any kind of tropical tree to perfection, as witness the flamboyant *Acaciæ*, which stand like gigantic bouquets in the streets of Quilimane, Portuguese East Africa.

When a healthy and otherwise suitable site for a house or station has been found, the ground must be thoroughly cleared of weeds, scrub, and rubbish for as large an area as possible around site. It must then be cultivated and planted. A few shady trees should be retained in plantation and near house, around which some carefully selected shrubs, such as will not shelter mosquitos—as cactus, aloes, pyrethrums—and flowers also should be planted. All trees and plants holding water should be avoided; a eucalyptus avenue will be ornamental and sanitary.

Some plants are said to repel mosquitos, *e.g.*, the "mosquito plant," *Ocymum viride*, a species of basil, the leaves of which yield a volatile oil which contains 32 per cent. of thymol, the volatile oil of the thyme (*Thymus vulgaris*). Major H. D. Larymore, R.A., considers that the planting of the mosquito plant round his house in West Africa protected himself and family from malaria. The eucalyptus, castor oil plant, and the humble garlic, known in Southern Europe as "the poor man's quinine," are also believed to possess mosquito-repelling properties.* Doubtless all plants giving forth pungent volatile emanations will more or less repel mosquitos.

* See *Lancet*, April 22, 1911.

Grasses for Africa

THAT CAN HOLD THE FIELD AGAINST ALL NATIVE GROWTHS.

The introduction of sward grasses into Africa is a very interesting matter which has not so far received due attention. My son and I have studied the question, and on my return from Brazil in 1910 I submitted some specimens of grass which I had collected at Rio and Santos to the Curator of the Royal Botanical Gardens, Kew. My son favours me with the following memorandum on the subject:—

"Respecting the grass you brought home from Santos, named by the Curator R. B. G., Kew, *Chloris pycnothrix*, it much resembles in its dried state Bermuda grass. The Curator states that it could probably be raised from seed, provided sufficient quantity could be obtained.* No doubt its seed or the young plants of *C. pycnothrix* could be imported from Brazil should no native African variety exist. In Rio, Santos, and all Brazilian towns it is cultivated as an ornamental grass in the public gardens, and is delightfully green and refreshing to look upon. Its mode of cultivation, which I witnessed, is to put in young plants separately about three inches asunder, and these grow and propagate by stolons, very quickly covering the bed in matted vegetation and needing no special care save mowing down when too high.

"It is very difficult to obtain good close sward, such as we see in England, in the tropics, yet some of our English grasses, or, more correctly, grasses introduced into and now thriving in England, might be tried.

* Private memorandum from Mr. V. E. Murray.

"One of the most likely is the Bermuda grass, also called 'Bahama' and 'Dog's-tooth grass,' *Cynodon dactylon*, which, extends into the tropics, should do well in them if properly cultivated; it is the grass which Burton advised for the Gold Coast.

"Though rare in England, it has established itself along the coasts of Cornwall, Devonshire and Dorsetshire. It is also to be found along the European shores of the Mediterranean, and on the northern coasts of Africa.

"In India a variety of the *C. dactylon*, *C. linearis*, is highly prized by the Hindu people as pasture grass, under the name of 'dura' or 'durra.' A large variety of this grass has been also found in Jamaica, and it may probably grow along the coasts of Africa. Seed of *Cynodon dactylon* can be obtained in England, but the ground must be very carefully prepared for all grass crops."

I have enlarged upon lawn cultivation because some authorities advocate, I think erroneously, the total abolition of vegetation around the house, lest it should harbour mosquitos. Such people forget the harvest of the eye, which should never be neglected in Africa. Have they forgotten the beautiful lines commencing—

> "*With sweet solicitation thou, O Nature,*
> *Healeth thy wandering and distracted children.*"

Spare a few stately old-world trees for shade, and spread a green carpet of sward with flowers for pattern before your door, if only in memory of England and the days of "auld lang syne."

CHAPTER XVII.

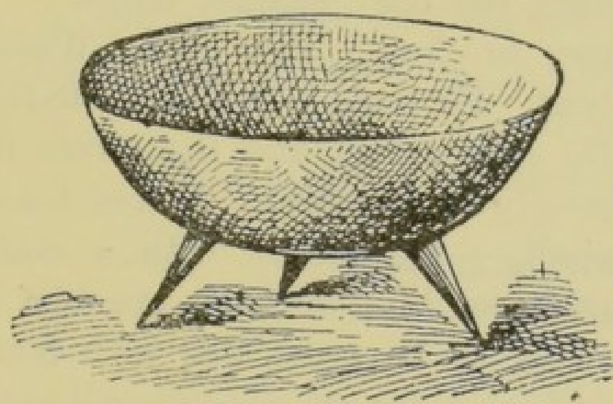
Hygiene and Sanitation in Tropical Africa (continued).

FURTHER PRECAUTIONARY MEASURES AGAINST MALARIA.

PART I.

The employment of fires as disinfecting agents in the streets and squares of plague-stricken towns dates from remote antiquity, having been employed by Hippocrates.

Fires, judiciously and persistently used, both within and without dwellings in Tropical Africa, during the two rainy seasons are of highest sanitary value.


The Brazier, or simple portable stove for the tropics.

For internal use the ordinary brazier, which resembles the lower section of an iron pot, with ventilating holes at the bottom, answers excellently well, as I have proved by long personal experience. Of course, other stoves may be used with equal or greater advantage.

A fire of this kind should be kept smouldering all day and night during damp, cold weather, to maintain an equable temperature in chamber, keep things dry, and expel mosquitos.

Whenever the temperature falls sufficiently to make a fire tolerable, it should be used by day and night.

The natives of Africa burn small fires in their huts day and night during the rains.

Burning large logs or bonfires all night before houses during the rainy season and foggy weather is also most useful, as I have proved by personal experience on the Gold Coast.

In short—*Fire is a very useful disinfectant in the tropics, being cheaper, safer, more effective, and handier than chemical agents. Neither mould, fog, damp, nor mosquitos can permanently abide in a chamber where it is judiciously and perseveringly burned. Smouldering, smoky fires act best against mosquitos.*

I owe twelve months' immunity in a sickly camp in no small degree to fires.

Dryness and absence of mould upon boots, walls, furniture, and books readily indicate that the house or chamber is in good sanitary condition in the tropics, and vice versa.

Fires by night also protect the body against chills. "A man turns into his tent or hut," says Mr. Waller, "thoroughly tired by the heat. He finds it impossible to bear the blanket over him. He falls asleep, and the cooler the night becomes the more soundly he slumbers. Before 4 a.m. the thermometer falls rapidly ; he awakes with a chilly feeling ; he pulls his blanket over him, but the mischief is done. In 24 hours he is likely to be prostrated with fever. *To obviate this it is wise to have a fire smouldering all night in the room or hut.*" *

Mosquito Nets.

Mosquito nets are absolutely necessary in Tropical Africa. All authorities on African travel recommended their use long before the infecting power of the mosquito had been discovered.

* *Health Hints for Central Afri a.* By Horace Waller. John Murray, London, 1893.

Mr. Waller rightly considered the mosquito net utterly indispensable, and pointed out as one of its recommendations that "it can be set up in forest, in fields, amongst reeds, in a boat or canoe, or on the deck or bridge of a steamer; in short, anywhere, and with a little care it will stand a great deal of wear and tear."

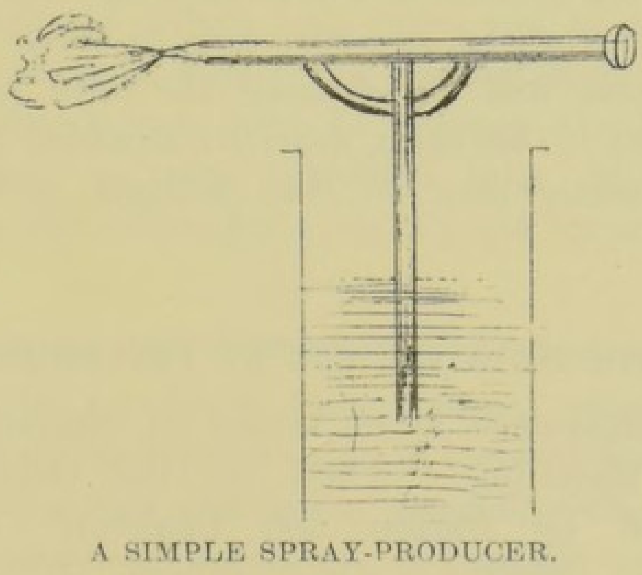
The nets must be made after some approved pattern, and rendered uninflammable by steeping in the following solution:—

Take—Of ammonia sulphate, 1 part by weight; water (boiled and filtered), 5 parts by weight. Dissolve.

Steep netting for several hours in this solution; hang out to dry, and iron before using. Every pound of netting will require 20 to 24 ozs. (about a pint) of this solution.* It is cheap and inoffensive, and the ease with which it may be used is a great recommendation. Two nets at least should be taken—one with wider meshes than the other, as mosquitos vary much in size in different localities.

A special article on nets and description of the "*Vade Mecum*" net will be found in Chap. XIX.

SPRAYING AS A MODE OF DISINFECTION.



A SIMPLE SPRAY-PRODUCER.

* *Medical Record.*

Spraying is a handy way of using disinfectants, as solutions of nitrate of silver (lunar caustic), Condy's Fluid, eucalyptus oil, and so forth. The simplest and best shape is the T sprayer shown in plate, made of vulcanite or glass. This will do for all kinds of work, as for disinfecting ulcers, bad throats, wounds, clothing and the like.

A solution of ordinary borax in boiled and filtered water, to which a few drops of eucalyptus oil has been added, will prove a valuable simple disinfectant. The vertical stem is immersed, and by blowing through the horizontal, spraying is effected.

Hammocks.

Hammocks are excellent safeguards against damp and malaria.

Of all kinds made, the South American grass hammock is the best; and this, with a good rug, hair pillow, and two Austrian blankets, is an excellent sleeping outfit for travellers in the tropics.

As pointed out elsewhere, the hammock should be slung as high as possible above the ground.

To sleep on the ground in the tropics, howsoever carefully the bed may be prepared, is a sure way to invite the attacks of the mosquito, and by chilling the body to lessen its resisting powers. Diarrhœa, digestive troubles, rheumatism, and other diseases may be thus brought on the careless traveller.

Native Huts for use by Travellers.

My own experience is in favour of sleeping in native huts when travelling. Those on the Gold Coast are well described by Burton and Cameron* as bamboo

* *To the Gold Coast for Gold.*

bird-cages of large size, many of them being quite open to the weather, save for a lining of mats on the inner walls: the roofs are of palm thatch. Yet I never contracted fever while sleeping in these huts, even in notoriously unhealthy localities. This was a great puzzle to me, until I discovered that excellent sanitation was being quite unconsciously practised by the inhabitants.

Thus, the floors of the huts, the passages between them, and, in short, the whole area of the village compound, is generally covered with a thick layer of ant-hill clay, or stiff yellow clay, which is thoroughly tempered and trodden in firmly and smoothly by the natives' feet. In time this becomes saturated with grease and oil, thus forming a perfect cement. The houses of such villages nestle closely together often under the shade of trees, and are surrounded by plantations. Fires are kept constantly burning in the huts by night, and sometimes by day, on the floors of the huts during the cold and rainy months, besides which there are numerous fires lighted under cooking-sheds, so that the atmosphere in and out of doors is at times as reeky and healthy as that of an Irish cabin. The greasy, warm, smoky air of such villages is antiseptic, and appears to afford protection from mosquitos, which I seldom or never found under such conditions. This applies to *inhabited* village huts only, not to empty guest-houses, which are cold, damp, and uncomfortable, and often contain mosquitos; such must be severely avoided. But in the Gold Coast, at least, inhabited huts can be always obtained from the natives for a night's use by travellers.

Bathing and Personal Cleanliness.

There can be no doubt that personal cleanliness is a hygienic agent of the highest value in tropical countries. But bathing in cold rivers and lakes, especially when travelling and at early morning, is strongly deprecated as a cause of fever.

These remarks do not apply to the use of the ordinary cold tub by new-comers, so long as it can be tolerated.

During my first year in Tropical Africa I never missed the morning cold tub, followed by brisk rubbing and "quinine salting" of the whole body; this and steady quinine taking prevented malaria, until, growing careless, I slept in a boat one night without mosquito net, was severely bitten, got sharp fever, and had henceforth to partly discontinue cold baths.

The Shower Bath.

The shower bath is pre-eminently the best form of cold bathing in the tropics, being quickly used, handy, stimulating and a tonic beyond other baths. No house in Tropical Africa should be without one, and every European should take this bath immediately upon leaving bed, and while still warm—an essential point, for if one is cool before bath it may do hurt. Brisk towel rubbing should follow to promote vigorous reaction, which is aided by a quick walk in the cool of the morning.

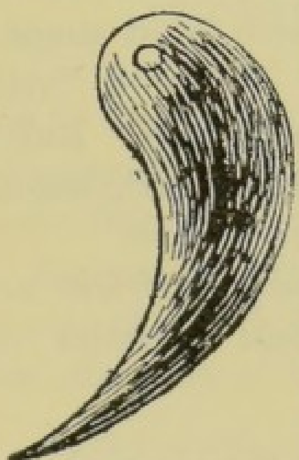
The mode of action of the shower bath is, the blood is first driven in a wave from the surface of the body, while a wholesome stimulus is also given to the superficial nerves, and conveyed thence to all the nerve centres. The wave of blood quickly flows back to the skin, and the nervous system radiates to all the organs the nerve impulse it has received, waking them up, as it were, to vigorous work. This ebb and flow of blood and discharge of nervous force have the highest possible tonic effect on the system. But this bath is only serviceable to those in health—if there be little or no reaction, harm, not good, will be done.

The Indian "pitcher-bath"—given by pouring a pitcher of water, which has been cooling all night outside, over head neck, and spine, the bather's head and body being slightly bent forward—is a most excellent bath, second only to the shower in its splendid stimulating and tonic effects. It acts on the same principle as the shower, upon nerves, brain, spinal cord, heart, blood-vessels and other organs of the body. It can be taken wherever water is available, and the colder the better.

For information concerning simple domestic baths, many of which would prove most useful in Tropical Africa, consult "*My Water Cure*," by Father Sebastian Kneipp. Translation of 36th German edition. Publisher: Jos. Kœsel, Kempten, Bavaria. This philanthropist takes for motto:—"*Go and wash in Jordan seven times, and thy flesh shall come again to thee, and thou shalt be clean.*"—*II. Kings, v. 10.* No one should be without this book in Africa.

The native practice of rubbing the body briskly over with freshly-cut limes after a bath is excellent, as the acid together with the friction acts as a good tonic and astringent of the skin.

The lime-juice also destroys certain microbes that find lodgment on or in the skin, and which, according to Professor Schenk, enter the system through the hair-bulb sheaths.



THE ROMAN STRIGIL. (¼ real size.)

The acid continues to act as above for some time after every application.

Naegeli found that a weak acid solution rather favoured the growth of moulds, but that if the strength is over 5 per cent. it kills them.

The *Strigil*, or metal skin-scraper, used by the ancient Romans at the bath, might be serviceable in Africa. When the skin had been scraped it was anointed with fragrant oil, if a rich man; if poor, with lentil flour.* The utility of this practice

* *Encyc. Brit.*: Art. *Baths.*

has been established by the discovery of microbes in the normal healthy skin, chiefly embedded in the fat glands, from which they cannot be removed by ordinary washing.

On the Zambesi, the natives use skin-scrapers of bone and ivory.

THE ZAMBESIAN SKIN-SCRAPER. (½ real size.)

An old Makololo chief on the Shiré—one of the last survivors of Livingstone's faithfuls, now lord of wide lands and many wives—presented me with the one here pictured. It measures 6½ inches in length, and somewhat resembles a marrow spoon, the hollow part being long as the handle, and the convex side artistically scroll-marked in black. It is carried in the hair or behind the ear, and constantly used to scrape perspiration off the face, being, in short, a kind of African pocket-handkerchief.

Anointing-Oil for the Tropics.

The following prescription will be of use for this purpose :—

Take—of oil of eucalyptus ½ oz.; oil of lavender, bergamot, and cajeput, of each ¼ oz.; oil of roses, 15 drops. Fill up with finest almond or olive oil to 20 ozs. Mix. Keep in well-stoppered bottle, enclosed in wooden case. Rub a little briskly into skin after bath and strigilation, as a fragrant and antiseptic agent.

Scents, scented oils, soaps and dentifrices are recommended for use in tropical climates on hygienic principles.

The perfume of flowers is known to keep the air cool and to expel noxious odours. Many scents are known to be beneficial to health, and their use in the East dates back to remote antiquity.

Quinine Salting as a Prophylactic Against Malaria.

This is a Spanish practice of great utility.

The operation consists in thoroughly rubbing dry quinine into the skin of the whole body, especially down the spine, much after the manner of rubbing salt into meat to preserve it. It should be done after a bath, and its efficacy is increased by first scraping or lime-rubbing the skin.

Quinine so applied, especially when partially dissolved in the sweat or lime-juice, will instantly destroy all micro-organisms in the skin, and render it proof against mosquito-bites for many hours. Dr. Dobson has shown* that disease germs may be deposited in the clefts and folds of the skin from washing in African water, so that the quinine should be most carefully rubbed into such parts to ensure their destruction.

In view of the recent researches of Vanni and Guiccardi upon its analogues, it would be unsafe to deny that some of the partially dissolved quinine is not absorbed, and thus able to produce its medical effects upon the system.†

Medicated Soaps and Tooth Powders.

Carbolic, coal-tar, eucalyptus, and other medicated soaps are in the market for use as disinfectants, but their odour is oftentimes unpleasant, and personally I prefer the use of some fragrant soap of finest quality.

Respecting *antiseptic tooth-powders:* To persevere in a course of mouth disinfection may do serious hurt by altering the character of the saliva, and so causing dyspepsia. I have

* See *Medical Hints*, by Dr. Dobson, in *Hints to Travellers*. Published by R. G. S., London, 1889.

† Sodium salicylate and morphine hydrochlorate were shown by Vanni and Guiccardi to be easily and rapidly absorbed when applied to the skin, dissolved in human saliva, and the question of using this excipient, or something possessing similar properties, is now engaging medical attention. So far the absorption of quinine by the skin has been denied, but I believe that I have experienced its medical effects when applied by "salting."

known ulcerations of the root of the tongue to be caused by the prolonged use of disinfecting mouth-washes.

Plain boiled water, to which a little common salt or a few drops of Condy's Fluid has been added, is a safe and good mouth wash and gargle.

From the Zulus we learn the following useful rule :—*Rinse the mouth out most carefully, and use the toothpick—or, better still, the tooth-brush—after every meal, else the teeth will rapidly decay in the tropics.*

Ordinary water will do for mouth rinsing, but boiled and filtered water is safer and better than river or creek water especially.

Prepared chalk, camphorated chalk, or good soap make excellent dentifrices; but I like the following prescription for personal use :—

R.	Quinæ sulph : 3 drachms. Ol : Eucalypti, 2 drachms. Ol : Rosæ, 10 drops. Armenian bole, 1 oz. Camphorated chalk, 5 ozs.	Triturate well together and make a powder. Keep in stoppered bottles or closed tin tooth-powder boxes containing 1 or 2 ozs.

Use this tooth powder morning and night in the tropics.

Chills and Wetting.

Rule :—*When wet, from any cause, change every article of clothing as soon as possible—this is of paramount importance. But if some delay must occur, wrap the body well up in overcoat or macintosh, to retain the vapour, by which means chill will be avoided.*

Fogs to be Avoided.

Europeans must certainly avoid foggy localities, as river bottoms and, above all, sleeping in boats on tropical rivers. They should also avoid going out before the morning fog has lifted, or after the night fog has come on.

Undisturbed Rest.

One of the earliest symptoms of malarial poisoning is disturbed and unrefreshing sleep; and this want of rest reacts on the nervous system, lowering its tone, and predisposing to fever. This is an example of *acquired predisposition* analogous to that produced in fowls, ordinarily immune to anthrax, by immersing them in water for three days, when they readily took the disease.—*Pasteur*. Here cold had suspended the power of resistance.

Again, frogs—animals also immune by nature to anthrax—readily contracted it after their temperature had been raised many degrees for several days; an example of the natural power of resistance being overcome by heat.—*Pasteur*.

In man acquired predisposition to malaria and other diseases may be induced by all manner of depressing agencies acting upon the body from without and from within.

PART II.

Subjective Precautions Against Malarial Disease.

These include everything which promotes health and strength —as bodily and mental activity ; suitable diet, clothing, and dwellings ; baths ; uniform temperature ; pleasant society and occupation ; due indoor and outdoor recreation, and so forth.

Also the avoidance of physical and mental fatigue and strain, and such enervating agencies as grief, fear, anger, licentiousness, intemperance ; or such physical depressants as cold, wet, isolation, and disturbed rest.

Activity of mind and body is of the utmost importance in hot climates, where the temperature disposes to indolence. During hot weather less oxygen is inhaled, and less carbonic acid exhaled, two things that contribute to liver engorgement, anæmia, and tropical cachexia—diseases that may result from high temperature alone, but more readily from heat, malaria and indolence combined. The same causes are answerable for exhausting perspiration, nervous and muscular debility, diminution in number and force of respirations, fæcal accumulations alternating with diarrhœa, impoverishment of blood and visceral congestions. Such symptoms point to the urgent need of regular daily exercise, or work, and mental exertion also.

Hobby is a good horse to ride in all tropical countries.

Exercise.

If exercise be not taken, the observance of all the other laws of health will not avail.

People may appear to get on fairly well for a time without it, because the organs, being vicarious, struggle to help each other out of difficulties. Thus, skin helps lungs and kidneys, and does much of their work in hot climates; and so the balance of a fictitious and precarious health may be maintained under quiescent conditions. But if such weakened organs sustain a shock or strain, as by chill, sudden travail, or unaccustomed work of any kind—especially under altered climatic conditions—a breakdown is inevitable.

Prove all things, hold fast that which is good (*I. Thess. v. 21*) is a good motto for the tropics. Test your condition by your daily walk or ride during the cool hours. Busy yourself with hunting, shooting, fishing, gardening, carpentering; be mason and blacksmith by turns, like Livingstone, and keep well. Even foils, single-stick, gloves, billiards, and skittles—without beer—are better than lounging and drowsing in the tropics.

Heat, especially when moist, tends to raise the bodily temperature half a degree or more above the normal (98·4° F.), which is an additional menace to health, and a warning not to push exercise too far.

To do this is inevitably to kindle fever.

For this reason, also, exercise must not be taken during the hottest hours of the day, the suitable times being from 6 to 8 a.m. and from 4.30 to 6 p.m., decided preference being given to the morning hours.

Of course, this is a camp rule which must be broken in travelling, and while engaged in hunting or necessary work.

A liberal supply of cool, nourishing liquid food, and rest in cool shade, should follow any extraordinary exertion in the tropics, and at sundown a light meal should be taken, with a glass of good wine, or half a glass of whisky or brandy in well-sweetened punch, or in a cup of tea or coffee. Later a sponge over with very hot water and brisk towel rubbing and to bed.

Books—Conduct.

Lord Bacon recommends a pleasant book as a good means of promoting health. Certainly plenty of wholesome, elevating light literature should fill the shelves of the settler's library, and a little should be read daily during rest hours, as one of the best mental tonics and antidotes available against ennui, vapours, home-sickness, and the depressing influence of monotonous commonplace and barbaric contiguity. Of course, if good music were available it would be the paramount uplifter, but remember *La poésie c'est la musique de l'âme,* and available for all.

Facilis Descensus.

If a man begins to barter his glorious heritage of a thousand years' civilization for a life of ease and sensual enjoyment in Tropical Africa, no material successes will compensate for his eventual moral degradation.

The wholesome glass of wine, taken at his evening dinner, will quickly become "pick-me-ups" all through the day. The "country wife" will become the wife indeed, "of one flesh" with him, having strength to drag him down to her own semi-brutal level.

Temper.

The relationship between temper and health is thus emphasized by the great Duke of Wellington, writing from India :—"I know of but one receipt for good health in this country, and that is *to live moderately ;* to drink little or no wine ; to exercise ; to keep body and mind employed ; and, if possible, *to keep in good humour with the world.* This is the most difficult, for, as you have often observed, there is scarcely a good-tempered man in India."

My lamented friend, Dr. C. S. Grant, whose kindness and hospitality to me on the Gold Coast I shall never forget, writes in his excellent little book, now, alas! passing Letheward, upon this subject:—"The cultivation of an impassive and philosophical temper in Tropical Africa is necessary, as irritability is a very usual product of the African climate, and has undoubtedly a bad influence on the general health."*

He that is slow to anger is better than the mighty, and he that ruleth his spirit than he that taketh a city.—Prov. xvi. 32.

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* *West African Hygiene*, by C. S. Grant, B.A., L.R.C.S.I., &c. London, 1882.

PART III.

Religion.

Its Uplifting and Sustaining Power in Africa.

"*As sunlight is to the flower, so is the religion of Christ to my soul.*"—*Tennyson.*

"*More things are wrought by prayer*
Than this world dreams of. . . .
For what are men better than sheep or goats
That nourish a blind life within the brain,
If, knowing God, they lift not hands of prayer? . . .
For so the whole round earth is every way
Bound by gold chains about the feet of God."
—"*The Passing of Arthur.*"

The paramount advantages of religion, practised without cant and fruitful in good deeds, and distinguished by unselfishness, need not be insisted upon here by me. But the words of the greatest African explorer, part, as it were, of his last will and testament, will awaken a reverent feeling in the coldest breast, strengthen the faith of the wavering, and silence the scoffer.

What Stanley writes in His Autobiography on Religion.*

"On starting an expedition, take an honest, open-eyed view of your surroundings, with as much faith as possible in the God above you, who knows your heart better than you know it yourself. Consider that you cannot perish unless it is His will; that a man's heart need not be oppressed by fear as long

* Sampson Low and Co., 1910.—A veritable British Odyssey that al interested in Africa should read, or, better, buy and keep.

as his motives are righteous, his endeavours honest, his actions just, his mind free from sordid and selfish passions, his whole aim to be workmanlike and duteous. Thus equipped he is fit for heaven and for the world."

Once again the venerable voice is raised, and the indomitable heart uplifted: "Civilised society rejoices in the protection afforded by the strong arm of the law.

"Those in whom FAITH IN GOD is strong feel the same sense of security in the deepest wilds.

"An invisible GOOD INFLUENCE surrounds them, to whom they appeal in distress. An INFLUENCE which inspires noble thoughts, comfort in grief, and resolution when weakened by misfortune. . . . I know that when I have called on GOD I have been answered, strengthened, assisted."

Again he testifies: "Religion is my invisible shield against moral evil, against the corruption of the mind, against the defilement of the soul. . . . Religion is an invaluable curb on the inner nature of man, which longest remains barbarous and uncivilised."

Again he confesses the power of prayer: "I, for one, must not dare to say that prayers are inefficacious. WHERE I HAVE BEEN EARNEST, I HAVE BEEN ANSWERED."

Again he says:—

"When I have prayed for light to guide my followers wisely through perils which beset them, a ray of light has come upon the perplexed mind and a clear road to deliverance has been pointed out. I have evidence satisfactory to myself that prayers are granted."

"*You may know when prayer is answered by the glow of content which fills one who has flung his cause before GOD.*"

If these extracts cannot move the reader's heart, neither could John Bright's peroration that awed the Commons:— "*To the Upright there ariseth Light in the Darkness.*"—*Ps. cxii. 4.*

CHAPTER XVIII.

The Prevention of Malaria.

Part I.—Drainage, or Topographical Prevention—Municipal Sanitary Administration to Prevent Malaria—List of Malarial Expeditions sent out to Africa by the Liverpool School of Tropical Medicine.

Of all measures to effect the extermination of the mosquito Drainage is pre-eminently the best. Whatever tends to desiccate the soil of a locality, or site of a town, village, or habitation, will *pari passu* mitigate malaria. This fact was well known to antiquity, as evidenced by the drainage of the Roman marshes under the Emperors.

The sanitary history of our own country sufficiently attests the value of drainage, for Lincolnshire, Essex, parts of Kent, Surrey, and Cambridgeshire were very malarious before they were thoroughly drained. The revival of drainage operations in Italy and other parts of Europe, also in the United States of America, in the full light of present-day scientific knowledge of malaria, confirms its paramount utility in every malarial campaign.

The latest malarial news from India shows that there also drainage is now recognised as the most effective remedy against malaria. The Malabar Hills at Bombay city, which have long been a focus of the disease, are now being extensively drained, with the best sanitary results. Under the able direction of Dr. J. A. Turner, Bombay city is also being drained in many places, and all hollow ground is being filled and levelled. He contends that until the island on which Bombay stands is made *waterless, well-less, and perfectly drained nothing will prevent the breeding of mosquitos and consequent malaria.**

The spade, in short, is beginning once more to occupy its predominant position in malarial sanitation.

Drainage includes not only subsoil drains, but graded surface drains, if possible of masonry and cemented; such are imperative in towns. But in rural districts, where from cost such works are impracticable, the surface drainage must be in all possible ways improved; all stagnant water freed, and all depressions filled. The edges of canals, ponds, streams, lagoons, and artificial drains and ditches must be kept sharply cut and free from weeds, which are the favourite breeding places of *Anopheles*. Concrete or stone, cemented brick gutters should be made in the streets, and all puddles filled in as they occur. Flushing of drains is also useful when practicable, and, of course, scavenging work should be daily done in all streets, and repairs of roads promptly effected. "Both in villages and towns the lowering of a high subsoil water level when practicable is an anti-malarial measure of primary importance. It must be drained off as much as practicable."†

Medical opinion in Italy, India, and elsewhere is gradually coming round to the belief that oiling of ponds and other surface waters is already an anachronism, more expensive and less useful than some form of drainage. Still there can be no doubt that oiling is very useful for small collections of water, such as are constantly occurring during the rains, or as a temporary expedient until filling and drainage can be

* *Lancet*, May 7, 1910.

† See *Report* of recent *Imperial Malarial Conference* in Simla, held October, 1909, *Lancet*, March 12, 1910.

effected; for insignificant puddles, lasting for a week or less, often enable the *Anopheles* to breed in unsuspected places. This is especially the case in jungle, and is one of the arguments for clearing land.

It also points to the many advantages of cultivation around towns, villages, and houses. In all countries the great *foci* of malaria are uncultivated—that is to say, undrained—tracts, whether inland, marsh, or derelict; or degenerate, or imperfectly cultivated lands. Obviously the last is as bad as the first, if stagnant drains and ditches or hollows containing water with unweeded edges are found in places, and the general soil is imperfectly drained.

Sir Rubert Boyce, in his *Mosquito or Man?* gives many instances of the beneficial effects of drainage upon hitherto malarial localities. Thus in Sumatra, with its notoriously malarial coast line, and a region once a malarious, marshy jungle, the cultivation of tobacco, which is only possible in well-drained ground, has gradually caused the swamps, and with them the malaria, to disappear on the estate. The uncultivated jungle remains everywhere as malarious as before.

In Grenada, where cocoa planting has replaced sugar-cane, malaria has also disappeared, simply because cocoa requires a very well-drained soil for cultivation. This is relevant to the sanitary advantages of cocoa planting in West Africa. Wherever the grape-vine is cultivated in Algeria, malaria disappears, because careful drainage has to be employed for the grape.

The effect of tree planting, especially of the eucalyptus, as an effective mode of desiccating swampy soil has been referred to, and planting should always accompany spade work and clearing in Africa.

PART II.

The Anti-Malarial Campaign.

Ross considers this under three headings:—

I.—Personal Precautions Against Malaria—viz.: Use of mosquito net; of quinine; of punkahs or electric fans; and keeping aloof from native quarters.

II.—Domestic Precautions—viz.: Removal or screening of all surface waters near dwellings; use of wire gauze screening of houses; and segregation.

III.—Municipal Precautions—viz.: Employment of mosquito brigades; enforcement of sanitary regulations; employment of an effective sanitary service and sale of cheap quinine to people, also treatment of malarial cases; lecturing or otherwise educating the people; and publishing malarial statistics.*

Mosquito Brigades.

1901. These were first instituted by Ross in Free Town, Sierra Leone, July, 1901. Thirty-two natives under headmen were employed, and duly equipped with carts and utensils. They were divided into two gangs—the *Culex* gang, for clearing back-yards of rubbish, and the *Anopheles* gang, for sanitary street scavenging, drainage, and general sanitary work about town and suburbs. The inhabitants were duly warned of the danger of harbouring larvæ. The drains were kept well cleared out, and the roads repaired. A marked diminution in mosquitos resulted from these measures.

* *Malarial Fever: Its Cause, Prevention, and Treatment.* By Ronald Ross, F.R.C.S., D.P.H., F.R.S., &c. An indispensable book to take to Tropical Africa.

1905. In 1905 it was made a nuisance under the Public Health Ordinance of Sierra Leone, through the efforts of Mr. Prout, C.M.G., to have any collection of water, in any well, pool, channel, barrel, tub, bucket, or other vessel, found by the sanitary authorities to contain mosquito larvæ. Even the holes and hollows in trees which contain water, and any clefts or cavities in rocks, were, on Major Ross's suggestion, filled up with concrete. All water receptacles were henceforth to be kept covered, to effectively prevent the breeding of mosquito larvæ, and fines varying from £1 to £10 were recoverable from those who disobeyed these ordinances.

Sanitary Expeditions to Africa.

1899. In 1899 the Liverpool School of Tropical Medicine sent a second malarial expedition to the Gold Coast under Dr. R. F. Ould.

1900. In 1900 a third malarial expedition, under Drs. Annett, Dutton, and Elliot, was sent to Northern and Southern Nigeria.

1901. In 1901 the Liverpool School of Tropical Medicine sent a *fourth*, malarial and generally sanitary, expedition to Sierra Leone, under Major Ross and Dr. L. Taylor.

Also in 1901 a *fifth* malarial expedition was sent to the Gold Coast under Dr. C. Balfour Stewart.

1902. In 1902 Major Ross was again despatched to Sierra Leone on a malarial and sanitary expedition.

In 1902 a *sixth* malarial expedition was sent to Ismailia, composed of Major Ross and Sir William MacGregor, K.C.M.G., Governor of Lagos.

In 1902 was also sent a *seventh* expedition from Sierra Leone to Cape Coast Castle, under Dr. Logan Taylor, to inquire into the causes of the unsatisfactory state of health in that town and district.

1904. In 1904 an *eighth* malarial and general sanitary expedition was sent to Bathurst, Conakry, and Freetown to report on the sanitation and anti-malarial measures in practice at the towns visited. This expedition consisted of Professor Sir Rubert Boyce, M.D., F.R.S., Dr. Arthur Evans, M.R.C.S., Dr. Herbert H. Clarke, M.A., B.Sc. (Cantab).

Also in 1904 a *ninth* malarial expedition was despatched to the Gold Coast, consisting of Lieut.-Col. G. M. Giles, M.B., and Dr. R. E. McConnell, M.D.

1907. In 1907 the *tenth* malarial Black-water fever expedition was despatched to Nyasaland under Dr. I. O. W. Barratt, M.D., D.Sc. (Lond.), and Dr. W. Yorke, M.D.*

It will be seen by the foregoing list that Africa has received its due share of attention from the great Liverpool School of Tropical Medicine, which will ever remain as the noblest monument of its founder, the late Sir Alfred Jones. *Si monumentum quœris, circumspice*, assuredly applies here, for this noble institution has at last opened up Africa, not only to our people, but to all Europe, an achievement which all the knowledge, valour, and experience of bygone ages failed to accomplish—a work so great that its due proportions will be more and more justly appreciated in the retrospect of coming centuries.

* Boyce, *o.a.c.*

PART III.

Domestic Precautions.

The following are amongst the most essential domestic precautions for preventing malaria. :—

I.—Wire gauze screening of house, or verandah, or both, including windows, doors, ventilators, and all other openings by which mosquitos can find entrance.

This matter will be thoroughly treated in a subsequent chapter. All that need be said here is that for those who cannot afford wire gauze, rhea fibre mosquito net of thick thread will answer fairly well if carefully put up. Iron wire gauze, tinned over, as is now extensively used on the Gold Coast, is quite cheap, and, of course, more durable, and useful for this purpose. Netting or cheese cloth may, however, answer for covering water barrels and other vessels in poor localities.

II.—Segregation is another most important safeguard.

Europeans should, if at all possible, exclusively occupy a different quarter of town, or village, a suburb for preference, and never have their houses situated amongst the native huts, as is too commonly seen in African towns. European houses should stand singly in their own gardens, however small, and on as high an elevation as available.

But although this form of segregation may be impracticable save for the well-to-do classes, there is another, possible for all, namely, the segregation of every person suffering from malarial fever from all others living in the same home, or establishment, by the screening of his room, or at least by the strictest use of the mosquito net on his bed, and the killing of all mosquitos found in his chamber. Of course, if the patient can be moved for a few hours into another room, the best plan would be to fumigate his own chamber with sulphur fumes, first carefully stopping up all crevices and openings with sheets of stout paper or newspapers pasted over them.

Fumigation.

Pyrethrum powder is commonly used in the United States for fumigation, in quantities of 3 lbs. to every 1,000 cubic feet of space in a room, applied for 3 hours. The pots containing the powder should be placed in pans standing in a little water, as a precaution against fire.

Sulphur, 2 lbs. to 1,000 cubic feet of room space, may be used in the same way.

Punkahs and Electric Fans.

Either punkahs or electric fans should be placed in all rooms of private houses, factories, hospital, barracks and other places which persons have to occupy for any length of time. They should be regarded as indispensable household furniture. Ross attributes the superior health of Europeans in India largely to the use of punkahs. He says, "Englishmen in India dress, eat, work and sleep under punkahs, which not only drive off mosquitos, but other flies, and keep the body cool and comfortable. This has the double effect of warding off malarial infection and of retaining the natural energy. *In Africa people sit, sweat, feed mosquitos and die.*"

The preventive use of quinine is fully considered in the chapters on this remedy. It will suffice to say here that the consensus of medical opinion sanctions, or recommends, its judicious use as the only reliable medicine for preventing malarial fever, or, at least, for modifying its attacks.

Ross, personally, however, uses but little quinine as a prophylactic; he pins his faith of escaping infection mainly upon the constant and careful use of the mosquito net, an anti-malarial agent of such importance that the following chapter will be devoted to its consideration.

PART IV.

Summary of Boyce's Plan of Campaign against the Mosquito.

I.—MEASURES TO AVOID HUMAN RESERVOIRS, OR PERSONS INFECTED WITH MALARIA.

(*a*) By means of segregation.

(*b*) By screening with nets those suffering from malaria.

II.—MEASURES TO AVOID ANOPHELES.

(*a*) Choice of suitable locality when possible.

(*b*) Screening houses, windows, and verandahs with wire gauze.

(*c*) Sleeping under mosquito nets.

III.—MEASURES TO EXTERMINATE THE ANOPHELES.

(*a*) Use of natural enemies of the mosquito.

(*b*) Use of culicides, as oil poured on water, to kill their larvæ.

(*c*) By drainage and scavenging to get rid of breeding places.

(*d*) Enforcement of penalties for harbouring mosquito larvæ, or keeping stagnant water uncovered.

(*e*) By educational methods.*

IV.—MEASURES TO KILL THE PARASITE IN THE BLOOD OF INFECTED MAN, BY QUININE—THAT IS, "QUINISATION."

The natural enemies of the mosquito include certain species of small fish, as the *Girardinus pœciloides*, or "*Millions*," of the Barbados—a kind of carnivorous minnow—which abound in all the shallow waters of the island, and are believed to be the chief cause of the absence of malaria from the Barbados, as they devour all the mosquito larvæ before they hatch out. The natives in other islands of the West Indies often keep goldfish in their water barrels, and in such Sir Rubert Boyce never found larvæ, while they abounded in others where no fish were kept.

There are many other natural enemies of the mosquito larvæ, but the minnow or other kinds of fish appear to be best suited for introduction into Africa. Possibly suitable native fish abound there.

* *Mosquito or Man?*

Of course, every means should be also taken to destroy the mature insects in every room of every house in a malarial country. It is well-spent money to employ a boy for this purpose to go round the rooms carefully directly after sunrise and before dusk with a fly-flapper and stool—the latter to enable him to get near the ceiling and to examine nooks and corners high up on walls where these insects usually lie hidden. All mosquito nets over beds should be daily carefully examined for rents, and to see if any insects are inside. When proved sound and free they should be tucked carefully under mattress or mats, and never allowed to hang down upon the ground as is the common careless custom, whereby mosquitos often find entrance.

The curtains must have no rents, for the mosquito will make a careful examination of every part of them during the night, and will be sure to find out the smallest opening. The beds also should be wide enough to prevent any part of the body coming in contact with the net during sleep, an accident which has frequently nullified all other protective measures.

Tobacco.

Tobacco-smoking is held by some to be a protection against malaria; and when we consider how poisonous tobacco is to vegetable and insect life, and that its smoke contains nicotine and empyreumatic products, there appear to be some grounds for this belief. During the influenza epidemic, employées in tobacco manufactories and others working amongst tobacco were singularly free from the disease, probably due to the pungent exhalation from the leaves and fine tobacco dust in the air repelling the mosquito.

Tobacco smoke must act as an antiseptic on the mouth and nasal mucous membranes and their secretions, however prejudicial it may be in other ways. My advice is therefore:—*To those who have always smoked, do not stop; to those who have never smoked, do not begin in Tropical Africa.*

INDIAN HEMP is said to be a febrifuge, and this may account for its general use all over the East and in many parts of Africa.

The following extract from my paper, *On the Cultivation of Fibre-bearing Plants in Zambesia*, which appeared in *South Africa*, Nov. 11, 1893, throws a curious side-light on this subject, and may prove interesting, at least to smokers:—

"I will conclude this paper by a brief description of 'Insangu,' or Indian hemp smoking, witnessed by me upon the Zambesi.

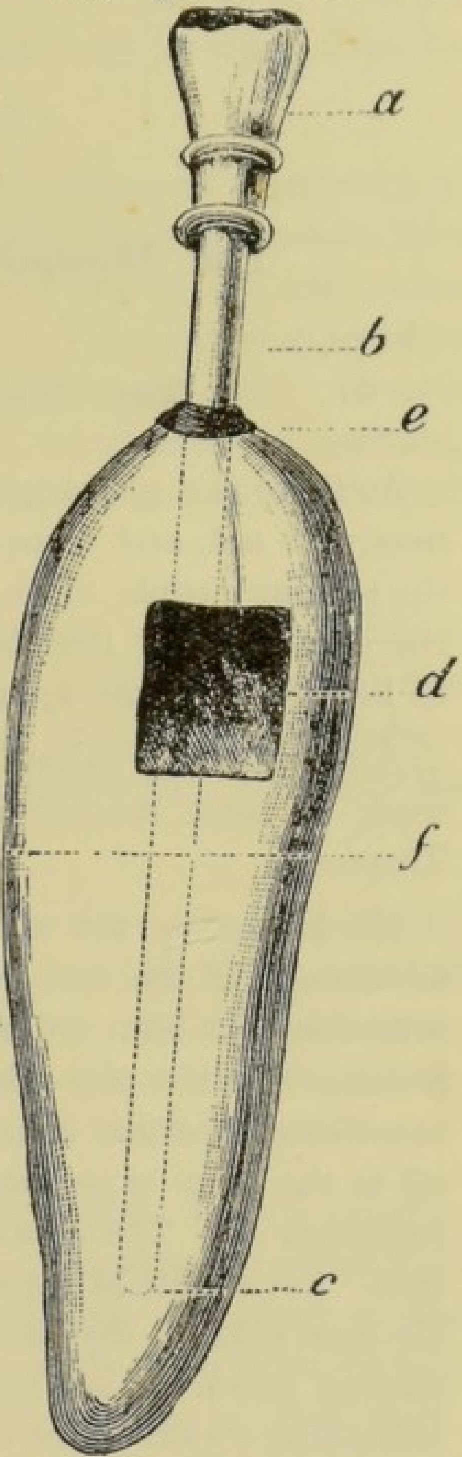
"A coarse powder, consisting of the dried leaves, stalks, and fruit of this plant, and also its resin, is well known throughout the East as *Bhang* or *Siddi*, and the resin as *Charas* or *Churrus* in India. The Arabs know it as *hashish*, and probably introduced its use into Africa.

"I was surprised to find this *Cannabis*, or 'Insangu,' or *hashish*, smoked by the natives along the banks of the lower Zambesi, of course for its intoxicating properties.

"Smokers are found in every village, but still they are few in number, and regarded, I believe, somewhat in the light of drunkards, with a mixture of amusement and contempt.

"The pipe used is a very curious one, consisting of three separate parts, the head (*a*) being a rude earthenware ring or bowl with hole at bottom, into which a bamboo or reed stem (*b*) is inserted in the usual pipe-stem fashion. This stem passes down into a gourd about 1½ ft. long by 6 or 8 ins. round its widest part, being carefully cemented to it by resin above at *e*, and continued (as indicated by dotted line) to very nearly the bottom of the gourd (*c*). At *d* a rough aperture is made in the shell of the gourd, 1½ in. long by 1 in. wide. This constitutes the pipe.

"The powdered 'Insangu' is introduced into (*a*), which is stuffed full and ignited by a coal. The stem (*b*) is then inserted, and the smoker, holding the pipe in a vertical position in one hand, draws the smoke out by applying his mouth to the aperture (*d*). The gourd has been previously filled with water up to the level (*f*), so that the poisonous smoke passes through 6 or 8 ins. of water before reaching the smoker's mouth.



"This smoking is generally done after nightfall, the man sitting on the ground or on a low stool before his house, surrounded by a giggling crowd of villagers, who witness the performance as a good play. He inhales the fumes at intervals by deep and laboured inspirations, and their extreme pungency throws him into paroxysms of coughing and choking, audible for a considerable distance around, and in the stillness of the night startling the stranger into the belief that someone is in the throes of mortal agony.

"Soon, however, the narcotic influence becomes manifest, and the victim of this hideous vice sinks upon the ground, where he lies for hours dreaming or unconscious.

"I had difficulty in purchasing the pipe, of which I send this sketch. During the stage of exhilaration I had pleaded in vain with the smoker, who would on no account sell it; but at grey morning—which is said to be a bad quarter of an hour for even civilised debauchees—he sold me his treasure for a yard of calico, and we parted mutually satisfied."

CHAPTER XIX.

The Mosquito Curtain or Canopy.

The Philosophy of the Net.

As there is a philosophy of clothing,* so is there one of the mosquito net, and whoever will take the trouble of reading the leading article in the *Lancet* of September 3, 1910, will rise convinced of this fact, and also of how much there is to be learned about an apparently simple "secret known to all."

A commentary alone is possible on this article, which is the work of some master of the art of "How to Live in the Tropics."

He begins by the statement that notwithstanding all the advantages of the net, which since the problem of malarial infection has been solved is acknowledged to be a hygienic necessary, it has grave drawbacks, and that its use involves a sacrifice of personal comfort. This will be acknowledged by all as the clear expression of what they have long been dimly conscious of. The reason furnished is also undeniable—viz., that "hot countries require a much more active circulation of air than cold, *to dispose of the surplus animal heat.*" The cooling power of air increases with its velocity, hence the refreshing action of the moderate sea breeze—"the Doctor," in all tropical countries.

Tropical nights are cooler than the days, but humidity is increased, and this, as shown in a previous chapter, lessens the

* See *Sartor Resartus* (Carlyle).

vapourising of sweat, whereby heat is rapidly withdrawn from the body, so that a person, especially in the still air of a room, often suffers more from surplus animal heat by night than by day.

As the writer justly points out, the misuse of mattresses in the tropics makes matters worse ; being good non-conductors of heat, they help to keep the sleeper hot below, and hence more in need of air to cool him above. "He is thus exposed to *irregular cooling*, which is very likely to cause chill." Here is a constant source of danger to health, which few have realised, for chill in the tropics, from any cause, means fever, and digestive and nervous troubles.

The *Lancet* writer's advice is to reduce the under bedding, so that the body may cool, as far as possible, at an equal rate below and above, and he points out that, if this be done, a very moderate current of air will produce and maintain the desired comfort.

This is fine advice, but the writer does not suggest any substitute for the highly objectionable mattress, which, amongst its other faults, absorbs the sweat, the saline hygroscopic nature of which causes the mattress afterwards to remain more or less damp, especially during the rainy season.

The best bed, according to my experience, for all possible uses in the tropics is some form of wire mattress covered with native matting of greater or less thickness according to the heat of the weather. This matting, made from palm-fronds, has a delightfully smooth and cool surface to rest upon, and a woven wire pillow covered over with a layer or two of such will be much cooler and softer than pillows stuffed with feathers, hair, wool, grass, or other heat-retaining materials. Of course, a *linen* sheet may be thrown over all the matting and pillow if desired.

Best Fibre for Netting.

The *Lancet* writer next takes up the question of fibre, and calculates that the threads of the ordinary net occupy 39 per cent. of the total area in a net covering the whole of bed, and, in addition, "numerous cotton fibres project into the openings, offering friction and resistance to the passage of air."

If the net have a calico roof there is a reduction of 25 per cent. more of aerial ingress in that area. "A calico roof on a double bed would represent a loss of one-fifth of the whole area for ventilation."

The writer draws attention to small currents of air, arising from the small increase of temperature due to the human body, and shows, by the simple experiment of smoking under a net, and marking the course taken by the ascending smoke, how such currents tend to escape vertically, thus proving how greatly lateral ventilation is interfered with by the curtain. The resistance of net to light horizontal currents of air he calculates at 60 per cent., which means that in ordinary rooms (without punkah or fans) the air is practically stagnant beneath an ordinary mosquito net, a state of matters which is bad for comfort and health.

Nothing tends more to sound sleep and refreshment of body than free circulation of air, and where nets are unnecessary, as in the Indian hill stations, this greatly aids the recuperation of health.

One of the next points dealt with is the substitution of the rhea *(Bœhmeria nivea)* fibre for cotton in the manufacture of mosquito nets.

In the chapter on clothing the "grass cloth," made from this beautiful fibre, is recommended for European clothing in the tropics, and now its excellent suitability for nets is established as being "conspicuous for *strength*, *fineness* and *durability*. It is at least three times stronger than cotton, so permitting nets to be made of finer thread, and thus offering less resistance to the passage of air." Also, as its fibre resembles linen in smoothness, the meshes of the net would be clear of straggling fibres, which help to check the passage of air.

Such nets will bear rough native washing and handling much better than cotton, which is very liable to tear, and so for all our care admit the mosquito.

Punkahs and Electric Fans.

Punkahs.—Part of this valuable *Lancet* article is devoted to punkahs and electric fans, the use of which is so strongly advised by Major Ross.

It is clear that the punkah—which is "a board or framework covered with canvas and provided with a fringe and hung by ropes from the ceiling, and operated by ropes which pass over a pulley, and through a hole in the wall" (*Ross*)—swinging in a room will greatly help to produce an artificial ventilation. It is therefore a real necessary of tropical life; but the coolie puller, or *punkah walla*, is a grave nuisance.

Self-Acting Portable Fans.—These are extensively used in India. They resemble the electric fans, which have replaced them in Calcutta, Bombay, Madras and other large cities, and are operated by a hot air engine heated by spirit or kerosene. But all the products of combustion remain in the room, and tend to warm and vitiate its air.

A small portable machine free from such objections is much needed in the tropics.

"Such a machine driving a fan made on more scientific principles than those now in use would command an immense sale."

The objection to the present make of fan is that "the propelling angle of the blade has no variation from top to root, and so it tends to produce mixed currents that mar due circulation of air. The top of blade forms an angle of 9° to 10° with the plane of rotation."

This fine article, which I trust I may be the humble means of making more widely known, ends with an aphorism well worth remembering :—"*The chief art of living healthily in the tropics consists in the means of procuring sound sleep at night, so as to rise refreshed in the morning.*"

Dr. Murray's "Vade Mecum" Mosquito Net.

Although this is a very simple invention, it will be found to possess a combination of qualities which fit it excellently for general use everywhere in Tropical Africa.

It is light, portable, and very strong, being made of medium rhea thread, and also rendered fireproof.

It can be promptly and most easily adjusted anywhere by the aid of its own cords, in the European house or verandah, the native hut, or rest house, the bed-room of an hotel, or the usual "Egerton" tent.

It can also be put up in the bush when travelling, and on boat or steamer. To adjust it in a house or verandah, it needs nothing more than a few nails or hooks in the wall, or other points of attachment for its cords; in the tent, a few reef points or rings; in the field, a frame of light bamboo rods, which are carried, and can be put up in five minutes by being simply lashed together; on boat or steamer, under awning or in cabin, it can be put up anywhere by its cords, for attachment points are always to be found.

The full-sized net can be used equally well on a large double bedstead as on a small cot, for the net admits of being adjusted to cover different areas, over which it forms an insect-proof chamber, where work can be done in comfort by day and refreshing sleep obtained by night.

Ross, when engaged upon his mosquito dissections, which resulted in his great discovery, declares that he "was plagued by swarms of flies, and by the great heat, which could not be modified by punkah lest his delicate dissections should be disturbed." Had his work been done under a Vade Mecum net or canopy he would have had perfect freedom from the fly, and also the punkah could have worked, as the net would have fended draughts and currents of air.

When travelling a comfortable insect-proof room can be set up anywhere, which, if a macintosh or canvas floor-cloth be used, will be insect-proof both above and below.

CHAPTER XX.

How the Panama Canal Difficulty was Solved.—An Object Lesson in Sanitary Administration.

Unquestionably the Medical Administration of the Panama Canal zone, from first to last, forms the most remarkable object lesson in practical sanitation and hygiene on a large scale which the world has ever seen.

When President Roosevelt officially visited the zone in November, 1906, and spent three days there, making a most painstaking and minute investigation of all the details of this work, his message to the two Houses of Congress of the United States amounted to an assurance that "*the Panama Difficulty had been solved.*"*

To understand the magnitude of this problem we must remember that the French, after spending vast sums of money and losing what has been estimated at 50,000 men by malaria and yellow fever chiefly, "*one man for every sleeper*," had to abandon the work and sold their excellent engineering plant and betterments, including the Panama Railway, to the United States for $40,000,000. Utterly routed by disease, they had to make the best terms they could and beat a retreat.

The vast, abandoned equipment lay silent and scattered through the tropical jungle for months, a veritable αἱ τριήρεες νεκραὶ ανδρων.

The United States, as Roosevelt observes, never made a better purchase, but they were keenly alive to the dangers and responsibilities of the task. "The first great problem to

* See full account of President Theodore Roosevelt's Report, White House, December 17, 1906, in The *Scientific American*, Vol. II., 1906, and Vol. I., 1907.

be solved, upon the solution of which the success of the rest of the work depended, was the problem of sanitation."—*Roosevelt.* This was, fortunately, from the outset, placed under the direction of Colonel W. C. Gorgas, M.D., who has accomplished the task in a manner unparalleled in the annals of practical sanitation.

In 1904 the United States took possession, and appointed a Special Commission for the administration of the canal zone, of which Dr. Gorgas was made chief sanitary officer, with a well-trained staff of 2,000 men under him.

To enforce and carry out the anti-malarial measures in the 45 miles of the canal zone, which is 6 miles wide, it was divided into seven districts, each in charge of an inspector, with a chief inspector over all. The staff includes naturalists well acquainted with the life history of the mosquito; also experts in drainage, tillage, and clearing of timber; chemists, microscopists, carpenters, builders, and physicians and surgeons. There are also special dispensers of quinine.

The medical officer of each district has to report monthly to the central office all cases of disease occurring in his section, and if there be an increase in the sick rate an inquiry is made into its cause, and prompt measures taken for its reduction.

In his address, delivered at a meeting of the American Medical Association, Colonel W. C. Gorgas, M.D., President and Chief Sanitary Officer of the Panama Canal Commission, gave the following summary of his work on the zone:—*

"Aside from securing the ordinary conditions necessary to health, as cleanliness, good food, protection from exposure to the elements, temperance in all things, the entire energy of the sanitary squad was directed to the destruction of one species of mosquito, the *Anopheles*, the life history of which

* See *Lancet*, July 10, 1909, for fuller particulars.

insect is now well known, viz.:—The female lays her eggs on the surface of fresh water in which grass or algæ are abundant. The eggs float until they are hatched out, when the larvæ seek the grass and algæ for protection. In about eight days they are developed into full-grown mosquitos.

"The *Anopheles* is weak on the wing and 100 yards is its ordinary flight. The adult avoids the wind and seeks the grass and plants near the ground for shelter."

"These facts explain the methods employed, viz.:—DRAINAGE when practicable; *sulphate of copper* for killing algæ; *petroleum* for killing larvæ floating on water; *phinotas oil* as a direct poison for larvæ. These measures also destroy the *Culex* and *Stegomyia*, or yellow-fever bearing mosquito.

"The *Culex*, however, is strong of wing."

Gorgas then points to the sanitary records of Colon, with a population of 15,000, built on an island just above sea level which used to be infested with mosquitos of every kind, and having formerly a high malarial sick and death rate. "It is now almost entirely free from mosquitos, and consequently of malarial diseases." This result was obtained by cutting away all the bush, half a mile around the town, intersecting the cleared space with small canals, which drained away the fresh water and allowed the incoming tides to fill them daily with sea water, and treating all water retainers with petroleum.

The death rate of the canal zone was	31·60	per 1,000
Sick rate 1910 was reduced to	23·01	,,
It is now reduced to	18·95	,,
The death rate amongst the Government canal employees in 1906 was	41·37	,,
In 1908 it was reduced to	13·01	,,
In 1910 ,, ,, ...	10.84	,,

Colonel Gorgas concluded his address by the remark that:—

"The white man can live in the tropics and enjoy as good health as in the temperate zone. The returns for labour are manifoldly greater in the tropics than the temperate zone, hence during the next few centuries the tendency will be for the white man to migrate to the tropics." He predicted that "after the lapse of a period equal to that which now separated 1909 from the period of the Norman Conquest of England, the tropics will show centres of as powerful and cultured a white civilisation as any that will then exist in the temperate zone."

Theodore P. Shonts, writing in the *Scientific American*, December 16th, 1905, gives a very complete and succinct account of how the Panama zone and City of Panama were rendered healthy under the following heads:—

1. By providing suitable habitations for all European employees of the Isthmian Canal Commission. This subject will be presently enlarged on and a plate of the approved dwellings given.

2. By providing a system of food supply which affords to all employees opportunities for obtaining wholesome food at reasonable cost.

3. By a thorough sanitary system being enforced on all.

When the United States began this work there was no system of *waterworks*, or of *sewerage*, or of *drainage* of the Isthmus.

The people drew their water from unprotected cisterns filled during the rains, or from barrels filled from neighbouring streams, all breeding-places for mosquitos, all sources liable to contamination.

The filth of ages had accumulated around the dwellings and in the streets, undisturbed save by the scour of torrential rains.

Pools of stagnant water were everywhere near dwellings; insect-breeding swamps adjacent to cities and villages.

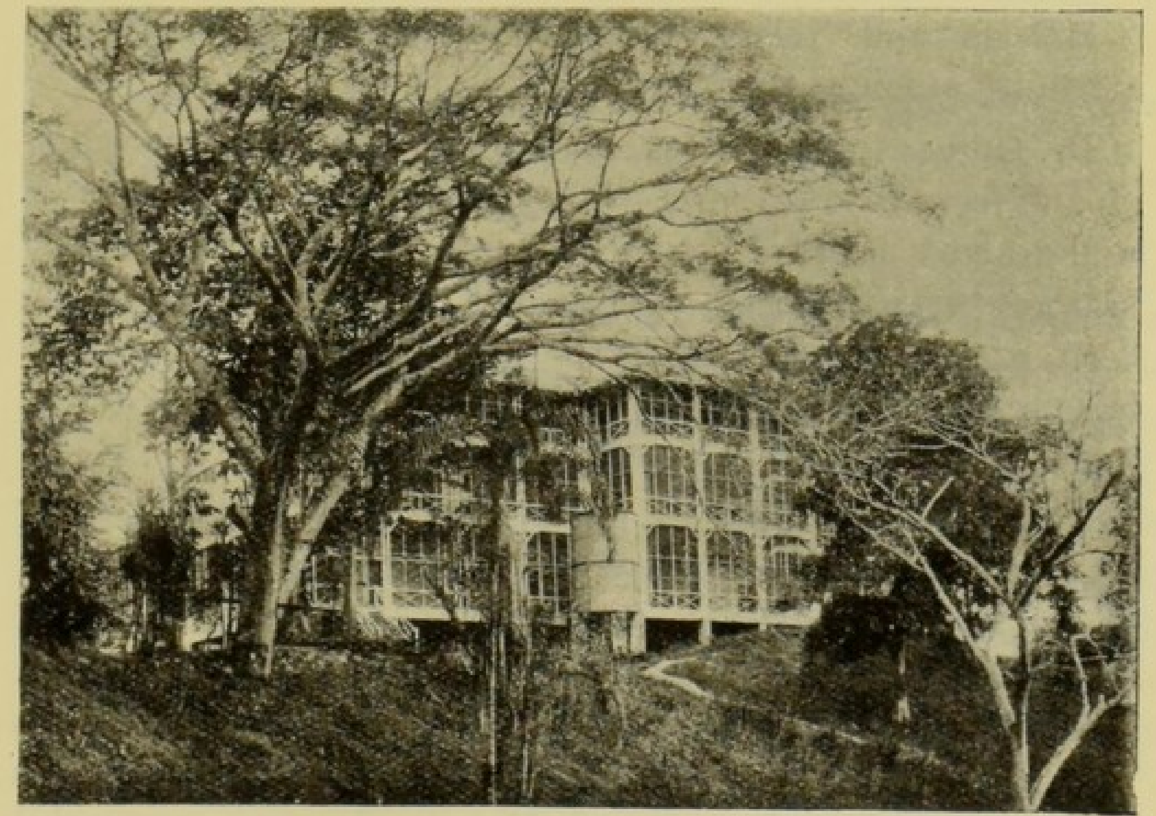
Now 70 per cent. of Panama is supplied with pure water from mountains, out of a reservoir large enough to supply 60 gallons a day to every inhabitant.

A complete modern sewerage system has been installed and is being pushed towards completion.

The streets are being paved with brick. The whole city of Panama has been fumigated again and again; that is, every house in the city done at the one time.

A large scavenging force is employed to clean and keep clean the city, and Governor Magoon, who has done all this work, is going to raze the worst huts and replace them with proper sanitary buildings.

Panama is now well watered, well sewered, clean and healthy.*



A WIRE SCREENED HOSPITAL IN THE CANAL ZONE.

* *Scientific American*, 1905, Vol. II.

Further Information about the Panama Canal Sanitation.

From memoranda by Colonel Gorgas we glean further knowledge of his sanitary practice in the Canal zone.

The zone as a whole is well drained and hilly, and follows generally the line of the Chagres River.

Owing to the warm climate and heavy rainfall the mosquitos can find, all the year round, abundant breeding-places. In all previous attempts at canal-making the death rate has been frightful, but this has been generally the case when unacclimatised Europeans have been thrown into tropical countries.

Malaria and yellow fever accounted for most of the mortality amongst the French.

Dr. Gorgas fixed his first camp of Marines on an elevation of 200 feet above sea level, where he found about an acre of well-drained land. Yet in four months 170 out of 450 Marines became affected with malaria, although they had not been exposed to the sun or weather or to severe work as labourers, which would have doubtless raised sickness and mortality to the French record.

At the foot of the Camp hill there was a native village of 400 people. Dr. Gorgas goes on to say :—" I examined all the children, and found enlarged spleens in plenty of them, if not all—*therefore there was chronic (latent) malaria present.* All the adults spoken to had also chills and fever within the last six months. In short, the native population was thoroughly infected, and probably the Marines contracted malaria from the natives, as they used to spend their leisure hours in the village." Every time a Marine went to the village he was probably bitten by mosquitos, and some of these *Anopheles* were infected from having bitten infected natives. Dr. Gorgas therefore concluded that the natives were the cause of the spread of malaria in his camp. If the village were removed, his men, he believed, would soon recover under medical treatment.

As this removal was impracticable, Dr. Gorgas did the next best thing—he put the villagers under systematic medical inspection, caused all water barrels to be covered, the streets to be cleaned, and night soil to be disposed of. Also all the population suffering from fever, or having the malarial parasites in their blood, were put under treatment with quinine, *thus to eliminate the human being as a source of infection*, so that at the end of a year an unacclimated person might live safely in the village. These measures proved successful, and the further spread of malaria was arrested in this camp.

After this, all villages along the Panama Canal strip have been dealt with on the same plan.

This subject has been enlarged upon because the success of the sanitary administration of the Panama Canal zone is an example for every other country to follow as closely as conditions admit. Dr. Gorgas had previously, availing himself of Dr. Finlay's discovery in 1881 of the *Stegomyia* mosquito being the carrier of yellow fever, and by using similar sanitary and hygienic methods to those described, conquered that disease in Havana, and then, confident of victory, commenced his victorious sanitary campaign in Panama.

When writing in 1908 he was able to say: "It is now more than three years since a case of yellow fever has developed in the Isthmus. The death and sick rates will compare favourably with most parts of the United States."

The total number of employees of the Isthmian Canal Commission is computed at about 40,000. The 6,000 Americans who occupy all the official and overseeing posts have wives and children in many cases, so raising the number of American citizens to 12,000. All the rest are either negro workmen from the West Indies or Spanish or Italian labourers.

The Screened Houses of the Panama Canal Zone.

A writer in the *Pall Mall Gazette* who has lately visited the Isthmus describes the screened houses in which the employees of the I.C. Commission live, in Cristobal, a suburb of Colon, as looking "dark and blind, like a row of gigantic meat-safes, on the top of rising ground backed by groves of palm trees."

These screened houses are universally used by all the white employees of the I.C.C. in zone, Colon, and Panama.

By the courtesy of Mr. Joseph Bucklin Bishop, Secretary I.C.C., Ancon, Canal zone, who kindly presented me with four fine photographs of types of screened houses in the zone; and also by the kindness of my friend, Ferdinand Siegel, M.D., of Brooklyn, N.Y., I am able to give my readers up-to-date illustrations of this remarkable development of applied sanitation.

One soon becomes reconciled to the ugliness of these structures and learns to appreciate their utility.

The writer goes on to say: "The verandahs are enclosed in an impervious veil of wire gauze, and this covering is also used to screen all water receptacles. The houses are well built and spacious, containing a fine hall, with dining and drawing room on either hand opening out of it. The verandah is very spacious, affording what is equivalent to another suite of rooms. These houses are cool and airy as heart can desire, and from within the screens are scarcely noticeable, save by tending slightly to modify glare.

Thorough ventilation is secured by a central air shaft, terminating above the roof in a large louvred, square turret, protected by a pyramidal roof with broad eaves, which, like the wide eaves of main roof, gives ample shade and protection from rain.

This mode of ventilation is well worth imitating in African houses; indeed the whole house, in all its details, is a perfect model of scientific tropical architecture.

The great hospital buildings at Ancon and at Colon are also screened and ventilated on the same principle.

"These fine houses are in Colon and other places surrounded by swamp and jungle country; they look out upon a very pestiferous region and a blood-red river. It is said that the railway built by the French cost a life for every sleeper." "Round Colon there was no native cultivation, no peasantry; all swamps, with here and there some of the abandoned impedimenta of Mons. de Lesseps's Moscow. The French knew nothing of malaria and tropical hygiene, so malaria and yellow fever had their way with them."

"*Monotony* is dreaded as much as climate and mosquitos, therefore, as you cannot get good work out of people who are homesick, or even retain them in service, the I.C.C. have organised amusements and opened a fine Club House, which cost £7,000, with gymnasium, bowling alley, billiard tables and other popular games. There are also Commissary Stores, where the employees can purchase all they require at New York prices. Cold storage for meats, fruits and vegetables are also established and excellently handled."*

* *The Panama Canal*, by William Archer, *Pall Mall Gazette*, July, 1909.

Some Further Information re Canal Zone which may Prove Useful in Tropical Africa.

President Roosevelt's visit to the Canal was during the rainy season, which the unfortunate French found to be the most unhealthy. He says, "The rains varied from torrential downpour to fine drizzle. In 15 minutes 1.5 ins. fell at Cristobal. On November 10th, from 1 to 3 a.m., 3.2 ins. fell. On November 16th, 10.24 ins. fell, and the Chagres river flooded." It would be hard to find any record like this in all Tropical Africa.

Bath-houses and water-closets form an important factor in the zone sanitation, and they were carefully inspected by Roosevelt, and found in almost every case "well kept and in good working order."

While no pains are spared to give the employees good and cheap food, very strenuous and successful efforts are being made to minimise and control the sale of liquors.

"Drainage ditches have been made everywhere, which, while removing the water, have removed the breeding-places of the mosquitos. The whole jungle is cut down around the little towns and villages which have sprung up for black and white employees, and the utmost care is taken to keep them healthy."—*Roosevelt.*

The cutting down of jungle for a considerable space around the habitations destroys the places where the mosquitos take shelter and discloses the pools in which they used to breed.

"The drainage ditches and clearings are in evidence everywhere in the zone, and, together with the presence of invariably screened piazzas and of mosquito doors to the houses, not to speak of the careful fumigation that has gone on in all infected houses, explain the extraordinary absence of mosquitos."

"As a matter of fact, but a single mosquito, and this not of the dangerous species, was seen by any member of the party during my three days' stay on the Isthmus."

"Equal care is taken by the inspectors to secure cleanliness in the houses and proper hygienic conditions."

"Inspected between 20 and 30 water-closets, both those used by the white employees and by coloured labourers, and in almost every case I found the conditions perfect."

"The health of the Isthmus was remarkably good, better than in most sections of the United States.

"Only one Spanish labourer out of 700 brought over to work on the Canal had died of disease during the past year. Pneumonia has so far been the most fatal disease on the Isthmus.

"Amongst the 6,000 white Americans, including women and children, not a single death has occurred during the past three months, whereas in the same time thirty would have died in the United States.

"Pneumonia killed 86 of 19,000 negroes in October; they are less careful and harder to control than the whites, hence the greater mortality, although they have been used to similar climatic conditions."—*Roosevelt.*

The negro workers come chiefly from Jamaica and other West India Islands, and not, as might have been expected, from the United States.

In the Culebra cutting, where mosquitos used to abound, only two were found in rooms of all the houses, and neither of the fatal species. Roosevelt attributes this to *Inspection*, *Drainage*, *Disinfecting*, and *Clearing of Bush.*

Corozal (four miles from La Boca) was the most insanitary place on the Isthmus, with a marsh and pond in the middle. Dr. Gorgas had both drained and the scrub cleared off, so now a meadow is seen between the drainage channels, and the town shows the best sick rate on the zone, employees and their wives and children living there healthily.

Conclusion.

We must conclude from the foregoing brief extracts from the bulky, up-to-date literature on tropical sanitation and hygiene that under intelligent sanitary administration, which includes vigilant inspection and power to enforce penalties, drainage, sewerage, guttering, and paving of streets, the clearing of adjacent scrub, and the screening of houses or verandahs, together with the observance of the domestic and personal practice of hygiene, it is possible to banish insect-borne disease, and to render town, village, compound and dwelling in the tropics healthy for European residence.

BOOK THE FIFTH.

MISCELLANEOUS PROBLEMS
Connected with
AFRICAN SANITATION and HYGIENE.

Chapters XXI. to XXIV.

CONTENTS.

Book the Fifth.

NOTICE.—*For type of screened houses at present in use in the Panama Canal zone—probably the best-equipped sanitary buildings in the world—see illustrations from official photographs received direct from the offices of the Isthmian Canal Commission, Ancon, Panama.*

CHAPTER XXI.

The Victualling Problem in Tropical Africa.

PART I.

The Science of Dietary.

"*Good health consists with temperance alone.*"—*Pope.*

"*One fourth of what we eat keeps us, and the other three-fourths we keep at the peril of our lives.*"—
Dr. Abercrombie.

"*The cause of death of so many exploring parties in Tropical Africa is improper food. Feed your European on good provisions, to be had in the preserved form; pet and care for him, and he will live; give him native food and let him rough it, and he will die—just a matter of commissariat, you see.*"—*Stanley.*

The victualling problem includes the consideration of *quantity* and *quality* of foods; *cooking*, *menu*, and *meal time routine.*

In matters of commissariat, above others, nothing must be left to chance, and some experienced person should have charge of the victualling department, with a good cook under him, in every party, camp, and establishment.

Quantity of Food Required.

As an example of an approved dietary, I select, out of many, the scale of victualling used in H.M. Navy.

Scale of Victualling in H.M. Navy.

WHEN ISSUED	ARTICLE.	WEIGHT.	FULL ALLOWANCE.
1 Daily	Biscuit or	lb.	1¼
2 Daily	Soft bread	,,	1½
3 Daily	Spirit (Rum)	pint	⅛ Half a gill.
4 Daily	Sugar	oz.	2
5 Daily	Chocolate, ordinary	,,	1
6 ,,	Or ,, soluble	,,	1.2
6 ,,	Tea	,,	¼
7 Weekly	Oatmeal	oz.	3
8 Weekly	Pepper	,,	¼
9 Weekly	Mustard	,,	½
10 Weekly	Vinegar	pint	¼
11 Daily when procurable.	Fresh meat	lb.	1
12 Daily when procurable.	Vegetables	,,	½
Table of Equivalents.			
	Coffee	oz.	1
	Cocoa	,,	1
	Chocolate, ordinary	,,	1
	,, soluble	,,	1.2
	Tea	,,	¼ Are to be considered equal to each other.
The following, when issued with meat rations, are to be considered equal to each other.			
1	Split peas	lb.	⅓
1	Peas, whole	pint	½
1	Flour	lb.	¾
1	Calavances	pint	⅓
1	Dhall	,,	½
1	Rice	lb.	¾
2	Vegetables	lb.	½
2	Compressed mixed vegetables	oz.	1
2	Preserved potatoes	,,	2
3	Oatmeal	oz.	2 or ⅛ pint.
3	Split peas	lb.	⅔
3	Flour for biscuit	,,	¼ if men desire the exchange.
1	Tea	oz.	¼
1	Soluble Chocolate	,,	½
1	Sugar	,,	1¼
or			
2	Tea	oz.	¼
2	Sugar	,,	2¾
or			
3	Soluble Chocolate	oz.	¾
3	Sugar	,,	2

Scale of Victualling in H.M. Navy—*continued.*

In cases where men have been or are exposed to unusually severe weather, or in cases of heavy extra work or other exceptional circumstances, an additional ration of :—

ARTICLE.	WEIGHT	FULL ALLOWANCE	
1 { Soluble Chocolate	oz.	$\frac{1}{2}$	May be ordered.
Sugar	,,	$\frac{1}{2}$	
or			
2 { Tea	oz.	$\frac{1}{8}$	
Sugar	,,	$\frac{1}{4}$	
or			
3 { Coffee	oz.	$\frac{1}{2}$	
Sugar	,,	$\frac{1}{4}$	

The Navy dietary given above may be assumed to be best for purposes required. It contains :—

Of dry nutritious matter daily ... ... oz.—31 to 35½

Of this the vegetable part amounts to... oz.—26
,, ,, animal ,, ,, ... ,, 5 to 9½

Which, reduced to its physiological equivalents, gives :
Carbon ... ... oz.—10
Nitrogenous compounds ... ... ,, 5

In the latter respect (amount of carbon and nitrogen) it is the same as the dietary of the British soldier.

The proper quantity of food which a man weighing 134 lbs., and taking full exercise in the open air, will require in the 24 hours amounts to about 6 lbs. avoirdupois—equal to 42,000 grains. Three lbs. of this is so-called solid or dry food, and 3 lbs. water.

Quality of Food.

The general leading indication as regards quality is, that food should be of as mixed and varied a kind as possible, while containing, in due proportion and quantity, the elements essential for nutrition.

These elements may be classified as follows:—

(1) *Proteids* or *nitrogenous* elements of foods, equivalent to 14 or 16 ozs. of lean beef daily.

(2) *Amyloid* or *carbonaceous* elements, equivalent to about 1 lb. of bread daily.

(3) *Fatty* or *oily* elements, equivalent to about 3 ozs. of butter daily.

(4) *Mixed* elements of food, as common salt, potash, &c., which are found in potatoes and other vegetables and meats, about 1 oz. daily.

(5) *Water*, about 3 lbs. daily.*

The chief food in Scotland used to be oatmeal; in Ireland, potatoes. The races of Northern India live upon barley, wheat, millet, and rice; those of Southern India, on peas, beans and rice. The African's staples are maize, rice, and millet. The Roman soldier conquered the world on a diet of hand-ground corn, boiled into a kind of furmety (or frumenty); while the gladiator trained chiefly upon barley.

It appears, therefore, that a man can live upon any kind of food—provided he digests it—if he consumes about 6 lbs. daily, and if it contains in weight and due proportion, as above set down, the elements essential for bodily nutrition.

To illustrate: We may substitute for lean beef in (1) mutton, venison, or other kinds of flesh; fish, poultry; cheese, eggs, oatmeal, peas, rice, millet, wheaten flour, maize meal, and other farinaceous and leguminous food.

* Huxley's *Physiology*.

For bread, in (2), may be substituted many kinds of vegetables, sugars, and starchy foods.

Any oil or fat, or 1 lb. of milk, which contains sufficient butter for a man's daily use, may be substituted as equivalent to 3 ozs. of butter in (3).

The necessary quantity of (4) will be found in various vegetables—say in $\frac{1}{2}$ lb. of potatoes.

The quantity of water, although put down at 3 lbs. daily, must necessarily vary greatly according to work, temperature, and kind and quantity of other food consumed.

The foregoing is the physiological principle upon which all proper dietaries must be constructed.

PART II.

Cooking, Menu, and Meal-Time Routine in Tropical Africa.

Blacks make fair cooks, and some native dishes are wholesome and delicious; so there should be little difficulty in teaching the negro how to prepare European food.

Of course, the question of menu must rest with the white man in charge of the commissariat; but this need not present insuperable difficulties to anyone who has a good cookery-book to refer to, and who has once mastered the principles upon which a "square meal" is planned.

In its simplest form, a *dinner* should consist of the following elements, served in this sequence:—(1) A soup; (2) a piece of fish; (3) a *relevé*, the joint or principal item of repast; (4) an *entrée*, as roast bird; (5) an *entremet de légume*, or plate of vegetables; (6) a sweet *entremet*, or side dish; (7) a savoury morsel of some kind of cheese; (8) dessert.

This menu is the type to be followed as closely as circumstances permit; it is also a standing protest against "rough-and-ready" feeding, which must be emphatically condemned in the tropics. Far from being an arbitrary or capricious selection and arrangement of food, it is really a valuable gastronomic formula, based upon experience and sanctioned by physiology.

Thus, a soup at the beginning of a meal acts as a quick restorative of gastric force and stimulus of digestive action.

Fish, yielding its soft tissue to easy chymification, continues and augments the sustaining action of soup, without taxing the energies of the stomach, which is thus fortified to cope with the joint. Game and vegetables possess peptic with nutritive properties; while the digestive power of a little sugar, followed by a particle of ripe cheese, is well known. The gustatory nerves—not yet cloyed—can respond to the pure stimulant of a little wholesome fruit, so that the dessert should deliciously and fragrantly crown the meal.

Meal-Time Routine.

Rise at 5 a.m. if travelling; 5.30 if camped, or living the settler's life.

At 5.30, if travelling—otherwise at 6—take the first breakfast. This should consist of coffee, tea, or cocoa, with fresh or preserved milk, a roll and butter, or biscuits. One or two eggs, or a few sardines, may be advantageously added to this meal. Biscuits, although useful as substitutes, are not so wholesome, digestible, or palatable as well-made bread, which should be always used when procurable.

Dr. Grant says:—"*It is highly improvident to expose oneself, or to commence work in Tropical Africa, without previously taking a light repast.*"* This is very true; the body needs warmth, the nerves bracing, the blood refreshing at this time, especially to compensate for the long night fast, and as four or five hours of exhausting heat and work must follow.

Breakfast or Déjeuner à la Fourchette.

This should be taken at 11 to 11.30 a.m. Begin with soup, then fish, game and meat of some kind, then vegetables (fresh if possible, if not, preserved), then a mere taste of some sweet, followed by a morsel of cheese. Parmesan or Dutch cheese

* *West African Hygiene.*

keeps best in the tropics, and one or other, with macaroni, may be used for a change. Cheese should be avoided, however, if the digestion is weak or deranged. A little sound fruit for dessert. The peel and woody fibre of fruit are hurtful in Africa, and the strong acid of the pineapple renders it dangerous except in very small quantities.

Déjeuner may be finished by a cup of *café noir*, which must be well made, and drunk with a teaspoonful of brandy, or a liqueur.

Stanley, speaking of this meal, recommends weak black tea with condensed milk, dry bread, lean meat—he strongly insists upon absence of all fat—fish, and vegetables. Sherbet, or plain boiled and filtered water, to quench thirst.

Of course, apollinaris may be used, as monotony is to be avoided in food and drink.

Averina,* which I hope to be the means of introducing into Africa, will be suitable here as elsewhere; it appears to fulfil Stanley's requirements of a perfect drink for the tropics:—"We want to find," he says, "some harmless, mild liquid, which is agreeable and palatable; uninebriating as tea, and as inoffensive to the stomach as milk; which affects neither the nerves nor the kidneys, and is a portable food and easily assimilated by the digestive organs."†

Wines and all other alcoholic beverages are quite unsuitable at déjeuner in the tropics, but the *petit verre* of cognac at the finish has physiological sanction as a promoter of digestion, without acting as a general stimulant.

Dinner.

The proper time for this in the tropics is 6.30 p.m.

Menu.—The standard menu should be followed closely as possible. If soups or entrées are impracticable at déjeuner, they should now at all events be forthcoming, for the hour

* For an account of *Averina*, and how to make it, see chap. xxii.

† *The Congo, and Founding of Its Free State.*

[Photo by Leo Weinthal.

A NATIVE IDYLL IN THE SPELONKEN.

"Home, sweet home" in Bawendaland.

has arrived when commissariat and cuisine are on trial, with irritable, if not hungry, men as judges of capacity and skill.

This is also the only safe hour in the twenty-four when alcoholic beverages, in moderate quantity, may be used with advantage. Champagne, sauterne, chablis, burgundy, and claret are all suitable wines; but only one or two wineglassfuls should be used, plain or diluted with mineral water, as apollinaris, or with plain water which has been boiled and filtered.

No tea, coffee, or cocoa should accompany this meal; nor should it be followed by *café noir* or the *petit verre* of cognac. Digestion may be marred by infringing this rule.

SUPPER *should* NOT *be taken in the tropics.*

From dinner to bedtime, at 9 or 9.30 p.m., is the social period of the day, when care should be cast aside, and heart and mind freely opened to mirth, sympathy, and the cordial interchange of happy thought. It is the hour for music, poetry, recitation, and narrative. Dickens may be in the camp, and the gentle spirit of sweetest humour of Cervantes and Swift may set the ruddy circle in a roar.

It is also the hour for smoking the peace pipe, for the home sigh, and for thoughts of GOD.

The accompanying photograph, reproduced by the kind permission of the Editor of the *African World*, admirably illustrates the ménage of the Bantu negro in all parts of Africa. The hut is built of bamboo-palm, *Raphia vinifera.*

The woman is seen pounding maize, plantains or yams in the large wooden mortar used everywhere in Africa, a work which sounds the *reveille* in African villages every morning before dawn. The large pots are for palm wine or water. The husband is obviously a good hunter, as seen by his necklace of trophies, but at home he is the loafing owner of as many slave-wives as he can buy or support.*

* See *The Bawenda of Spelonken.* By R. Wessmann. Translated by Leo Weinthal, F.R.G.S., Editor of *The African World.* A most interesting study of an unsophisticated branch of the great Bantu race.

PART III.

Fresh Native Provisions and Native Cuisine.

Although fairly good wheaten bread, made from imported flour by native bakers, is now obtainable in all the large towns and many of the villages of Tropical Africa, not only on its littoral, but far into its hinterlands, where reached by steamer and rail, yet the natives prefer to use maize, millet, rice, yams, plantains and other native produce for their ordinary food.

Thus on the Gold Coast "kankie" is still the staple food. The maize, of which it is made, is first boiled soft and then pounded in large wooden mortars by the women, with the occasional addition of water, into a rough dough. It is then wrapped in plantain leaves and exposed in large lumps for sale. Owing to the silicious coating of the maize, kankie disagrees with Europeans, and causes them diseases of the digestive organs; but natives readily digest and thrive on it, and with the addition of some dried fish and palm oil it forms the daily food of the labouring classes all along the West Coast.

I have often been astonished to see what work a crew of Elmina "boys" will do on such fare. They will paddle a heavy surf-boat from sunrise to late afternoon under a blazing sun with no other sustenance save an occasional drink of palm-wine,* so bearing out what George Eliot says in

* This home-brew of the native, dear to him as the Englishman's beer, is made either from the sap of the bamboo palm (*Raphia vinifera*), or the oil palm (*Elais Guineënsis*), the latter being far the best. The natives drink palm wine at different hours of the day, according to taste. The beverage is mild as milk in the morning, before fermentation sets in; in the afternoon it develops much alcohol, and is intoxicating and rough as the sourest cider.—*Burton*. Taken in moderation it appears to be a help to native digestion. Few Europeans have the courage to drink such a nauseous and disgusting beverage.

one of her perfect works—"All the hardest work of the world is done on the poorest food." The yam and cassava, boiled or roast, and also the sweet potato are all use in native cookery. "Fou-fou" is the name given to plantains pounded into a tenacious dough, which forms a palatable addition to native soups and stews of meat, chicken, fish, snail or vegetables, to which native pepper is freely added. Sun-dried fish with detestable odour (hence called "stink-fish") is the poor man's bacon on the Gold Coast; it also forms an important article of trade with the natives of the interior, who use it as the caviare of their feasts.

But the epicurean dish of the Gold Coast is "Palm-oil Chop," which consists of meat or fowl mixed with a little freshly made palm-oil, well peppered, and served with yams, fou-fou, or rice. "Ground Nut Soup" is another dainty dish to set before king or prince; it is somewhat similarly made to palm-oil chop, but has ground nuts for basis, and is often preferred by Gold Coast gourmets.

Soured and Fresh Milk in Native Diet.

The chief food of many natives of Tropical Africa consists of soured milk. The staple diet of the Mpeseni is a curdled milk, almost solidified. Meat is eaten only on ceremonial occasions. According to Foà, a tribe of the Nyasa-Tanganyika plateau, like the Zulus, take milk only in the form of raw cheese mixed with salt and pepper.

Dr. Lima, of Mossamedes, in West Africa, stated to Metchnikoff that the natives of regions lying south of Angola live almost entirely on milk, which, soured and curdled, is their staple food. They use the cream to anoint the skin. They are a long-lived and healthy people. Soured milk has been used by the Egyptians from remote antiquity. The wandering Arabs of the Sahara live almost wholly on camel's milk, fresh or soured, and on this diet enjoy excellent health, display great vigour, and reach advanced ages.*

Milk in its sour or curdled state forms an important part of the diet of all the Bantu tribes of Central Africa. On the rugged Balegga plateau, and elsewhere between the Great Forest of the Congo and the Great Lakes, Stanley found the natives keeping large herds of cattle and living on their milk.† All the Zulu tribes kept herds and used their soured milk, and a recent writer‡ mentions that the Bawenda people of the Northern Transvaal, who are practically vegetarians, have milking herds, and doubtless use their produce in the soured state.

In short, milk and maize form the staple food of most of these Central African Bantus, but they are omnivorous when flesh and other foods are obtainable.

Cold Storage.

Commissariat difficulties in the old days greatly retarded European settlement in Tropical Africa, checked mining and other industries, and helped to swell the appalling mortality which prevailed.

But now all this has been changed, chiefly by *cold storage*, in many of the large towns, and the supply of frozen fresh foodstuffs brought out by steamers. To this must be added the larger production of native provisions and the importation of live stock from the interior, aided by the facilities afforded for distribution of foodstuffs by railways and river steamers.

* See *The Prolongation of Life*, by Elie Metchnikoff. English translation by P. C. Mitchell, M.A., D.Sc., &c. London: W. Heinemann, 1907.

† *In Darkest Africa.*

‡ See *The Bawenda of the Spelonken*. By R. Wessmann, translated by Leo Weinthal, F.R.G.S., Editor of *The African World*, 1908.

Almost all kinds of fresh foods necessary for health are now obtainable from steamers, and the *régime* of canned and other kinds of preserved provisions is drawing to a close.

By the courtesy of Mr. R. D. Graham, Secretary, *The African World*, I am enabled to lay before my readers the following Memorandum and Appendix, obtained directly by him from Elder, Dempster and Co.'s office, giving most useful information respecting the cold storage operations of this company along the West African Coast.

Memorandum on Cold Storage in West Africa

From Office of the British and African Steam Navigation Co., Ltd. Elder, Dempster and Co., Managers, 1911.

Cold storage in West Africa was seriously taken up on board our steamers about the year 1904. We had previously realised what an important factor towards health ice and fresh provisions would be, but had not sufficient refrigerator accommodation.

The late Sir Alfred Jones was very energetic indeed in promoting the scheme, which has been a great success. Nearly all the West African steamers now carry large quantities of ice and fresh provisions for sale to residents at all West African ports, for which we charge a very reasonable price, as per circular enclosed.*

The steamers carry meat, etc., frozen in the refrigerating chambers.

Cold storage has made enormous progress in West Africa, the sales in three months amounting to £4,250, against about £1,000 six years ago.

We have a special cold storage plant at Seccondee for supplying the mining districts. This, however, has not been a financial success owing to local difficulties.

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* See appendix for prices of cold storage provisions.

At Lagos, where the main line steamers cannot cross the bar, we are assisted by the Colonial Government, who rent us two chambers of their large refrigerators. We do a big business in this port. At Calabar the African Association own a cold storage on shore which is stocked by the steamers. All the other ports are supplied direct from the steamers.

We are now extending the refrigerator plants and fitting more steamers.

The above remarks apply to West Africa only.

PART IV.

Further Information Respecting Native Foodstuffs.

Every effort should be made to keep up a good supply of fresh provisions. Expeditions should take live stock with them when practicable, and no settler should fail to surround himself with flocks and herds. The goat is a specially useful animal for travellers and families, furnishing both milk and meat, hardy and requiring little care, and immune from malaria and the tse-tse fly.*

The foods possibly obtainable from the natives certain countries of Tropical Africa, and during plentiful seasons, include poultry, game, beef, goat-flesh, eggs, milk, millet, maize, rice, sorghum, yams, sweet potatoes, eddoes (*Arum esculentum*), pumpkins, beans, cassava or manioc, sugar-cane, bananas, plantains, papaws, guavas, limes, ground-nuts, cocoa-nuts, melons, oranges, cucumbers, capsicum, and many other fruits and vegetables.

MILLET.

Dr. Pruen speaks highly of the millet :—"Millet seed (*ungali*), is much more sustaining than Indian corn, and the latter than rice. With their *ungali* the natives eat, as a relish, either dried half-cooked fowl, or beef or mutton treated in a similar way."† I found that maize and rice were more highly esteemed for food on the Zambesi, although the millet for some reason was more generally cultivated along the river, where I saw splendid fields of it ready for the harvest, which looked just like our home wheat fields.

* It is not improbable that goats' milk and flesh possess, in some degree, the properties of the serum, and so act as a mild preventive against malarial infection.

† *Arab and African.*

MAIZE MEAL, which is universally used by the natives of Africa, is not very suitable for Europeans, owing to the silicious coating of the grain, and the quantity of stone dust which it contains, derived from their primitive grist mills, which resemble the ancient British quern. If this meal is freely used by new arrivals in porridge or cakes, it is very likely, as Dr. Pruen points out, to cause serious stomach and bowel disorders.*

RICE is good food everywhere and specially useful in the tropics.

MANIOC, when properly prepared, by careful washing and roasting, is a palatable and nourishing article of diet.†

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* The roughest meals may be rendered serviceable for invalids by using malt extract, made as follows :—" Take 3 ozs. (or piled-up tablespoonfuls) of crushed malt, mix them thoroughly in a suitable vessel with half a pint of cold water. This mixture is allowed to stand overnight—from 8 to 15 hours, according to temperature of air. It is then filtered through until it becomes perfectly bright. The above quantities yield about 7 ozs. of product, of a sherry-brown colour and a faint, sweetish taste. It is nearly neutral, and its sp. gr. about 1·025. Its chief solid constituent is maltose, and it is rich in diastase. . . . It is very prone to fermentation, and ought to be prepared fresh every day."—Roberts, *Practitioner*, xxiii. 405. A tablespoonful of this fluid added to half a pint of gruel, prepared from wheat or other flour, or from oatmeal, groats, pearl barley, arrowroot, maize, millet, or other farinæ, *at a temperature not too high for being eaten*, will immediately transform the starchy ingredients into a mixture of sugar and dextrine. In this manner food may be formed which will save or prolong life of patients affected with tubercle, marasmus, fever, or wasting disease, in which all other forms of nutriment are either vomited or passed at stool." —*The National Dispensatory*. Malt may be carried in air-tight tins, like any other form of preserved food ; and, failing this, it may be easily made from different kinds of grain by simply soaking them in water, placing them in heaps, or otherwise promoting germination. When the germs have attained the desired length, the grain is rapidly dried, and constitutes malt. The roughest native maize-meal gruel treated with this infusion yields a nutritious fluid, all husks and other impurities settling at the bottom.

† The fleshy, tuberous roots of this plant (*Manioc*, *Jatropha manihot*) contain a milky juice, which is poisonous, from the presence of prussic acid. On grating the roots, expressing and washing out the poisonous juice, drying or roasting the remainder, and grinding it, a meal is obtained which, when baked in thin cakes, furnishes cassava or manioc bread. From the expressed juice, and by washing the meal in water, on standing the starch is deposited. On drying this starch while still moist, on heated plates, tapioca is obtained.—*The National Dispensatory*. See also *In Darkest Africa*, vol. ii., chap. xxi.

Soured Milk.

If Europeans are living where milk can be obtained, I strongly advise its plentiful use, but chiefly in the soured or curdled form approved by the natives.

Metchnikoff, Sub-Director of the Pasteur Institute, Paris, lays great stress on the nutritive and therapeutic properties of sour milk, the use of which appears to have extended into remote antiquity in Egypt, Syria, and the East.*

He also shows the wide range of the use of soured milk, under a variety of names and variously prepared, in Europe, Asia, and Africa of the present day, the *koumiss* made from mare's milk and used by the Tartars, Kirghises, and Kalmucks being that form best known in England.

Metchnikoff ascribes the value of these preparations of soured milk to the lactic acid which they contain, which has a double action—first, it softens and dissolves the casein of the milk, so rendering it much easier of digestion, and thereby also aiding the digestive acids of the stomach; secondly, it renders great aid in preventing intestinal putrefaction, which is a common occurrence in the large intestine and a fruitfu cause of disease everywhere, but especially in the tropics, where absorption of the poisonous products of such putrefaction is a very frequent cause of ill-health, by "anti-intoxication" as it is technically called. In brief, the bacilli which produce lactic acid from the sugar of milk, aiding the acid so produced, help to destroy the microbes which produce putrefaction—and so favour life and health.†

Of course, diet which favours intestinal putrefaction and butyric acid fermentation in intestines must be avoided, and

* According to Ebstein in his work on *The Medicines of the Old Testament*, soured milk is spoken of in many places in the Bible, which in our authorised version is wrongly translated "butter." See. Gen. xviii. 8: "And he [Abraham] took 'butter' and milk," &c.; here "butter" is used instead of "soured milk," and "fresh milk." Also Deut. xxxii. 14: "Butter of kine" should have been translated "soured milk of kine," &c.

† Metchnikoff, *o.q.c.*

conformity to the rules of rational hygiene must accompany dietetic regulation.

On the whole I support Metchnikoff in believing that soured milk diet would be most useful in Africa, where the digestive functions of most people are so weakened and disordered that all are more or less dyspeptic, and for many forms of this disease in temperate climates, soured milk has proved remedial when other treatment has failed. I know of one case in which it saved a young lady's life and made her grow up a strong and healthy woman. Personally I could never digest *fresh* milk in Africa.

BUTTER is rarely met with, and it is generally used by the natives to anoint their bodies.

BANANAS AND PLANTAINS are of equal food value to white and black.

Stanley says of the former :—" For infants, persons of delicate digestion, dyspeptics, and others suffering from temporary derangement of the stomach, the flour, properly prepared, would be of universal demand."—*Darkest Africa.*

During his two attacks of gastritis, a thin gruel made of banana flour, mixed with preserved milk, was the only food Stanley could digest, *and it saved his life.*

It is odd, as he remarks, that in banana lands the valuable properties of the banana and plantain, as the most nourishing and easily digestible of foods, should be overlooked by Europeans. Banana fritters are one of the delicacies of the tropics.

PLANTAINS are also splendid food, and admit of being cooked in a variety of ways as vegetable and fruit. They are as palatable and wholesome as parsnips, which they somewhat resemble in taste.

The Garden.

It behoves every settler to bestir himself and plant a garden the moment he has finished building his house. On this subject Burton writes:—"Gardening should be encouraged. The vegetables would be occus (*Hibiscus*) and bringalls, lettuce, tomatoes and marrow, yams, sweet potatoes, pumpkins, peppers, and cucumbers. The fruits are grapes, pineapples, limes, mangoes, melons, oranges, papaws, and a long list of native growth.

"The land fenced in, for privacy, would produce abundant holcus, millet, rice, and lucerne for beasts. There would be breeding ground for black cattle, sheep, and goats and pigs, and poultry-yard protected against wild cats."*

* Burton and Cameron's *To the Gold Coast for Gold.*

The Victualling Problem in Tropical Africa—
(Continued).

PART V.

Preserved Provisions.—Information for Travellers and Others Living Out of Touch of Ordinary Fresh Food Markets.

Native supplies of food are precarious for many reasons, above all, on account of the mode of savage warfare, which lays waste the conquered territories.

Stanley's Aruwimi experiences are classical; and Captain Stairs when he reached Katanga, after a record march, found the country desolated by war, and so void of food that half his caravan perished of famine.

Every year will alter this state of matters for the better; but for a long time to come it will be prudent for travellers, and settlers pushing into new regions, to victual and otherwise provide against contingencies, after the manner of a ship navigating unknown seas.

This means that preserved provisions must be taken; and the following list, which I had once to prepare for a large African expedition, may prove useful for similar victualling. It will enable small parties, or individuals, to select such food-stuffs as they may think necessary.

List.

Coffee, green beans (for roasting as required), finest quality; tea, fine black blend, with 1 per cent. admixture of green; tea, ditto, all black; cocoa, Cadbury's preferred, in small tins;

chocolate, soluble; chocolate, ordinary; sugar, best cane loaf; preserved milk, Swiss, sweetened, condensed preferred; butter, Sussex, Somerset, or Danish, in 1-lb. tins; bacon, Harris's Wiltshire, smoked, in tin; flour, best kiln-dried Hungarian, in 5-lb. tins; oatmeal, fine ground Scotch, and Quaker or rolled oats, kiln-dried, in 2-lb. tins; biscuits, best captain's in 5-lb. tins, Huntley and Palmer's for preference; wines, champagne, Chablis, Sauterne, Burgundy, claret, Madeira, a little of each kind; rice, finest Carolina; potatoes, preserved, in 4-lb. tins; compressed desiccated French vegetables, mixed, Chollet and Co.; cheese, Parmesan and Dutch; Apollinaris water; spirits, finest Scotch whisky, five years old; pepper, white and black; mustard, Colman's in 2-oz. tins; vinegar, finest malt; suet, mixed beef and mutton kidney, in 1-lb. tins; raisins, best sultanas; chutney, finest Indian; curry powder, ditto; corn flour, Brown and Polson's; apples, dried American rings; dates; figs, finest Levant; lard, in 1-lb. tins; macaroni, round Italian; vermicelli, ditto; mushrooms, Leicester black; hominy, finest; golden syrup; wheatmeal, kiln-dried, in 2-lb. tins; onions, in brown vinegar; sardines, in oil, Philippe and Canaud; pearl barley, in 1-lb. tins; ginger; cloves; nutmeg; mixed spices; tapioca and sago, finest; ground rice, Erbswurst, in 1-lb. tins; herrings, à la sardine; roast beef; roast mutton; roast fowl; soup and bouilli; tripe and onions; preserved beef; army rations; ox-tail and other soups; brandy, best Cognac, Chartreuse; haricot beans; French beans; pease, preserved; pease, dry, split, for soup; lentils, for soup; malt, amber, in 1-lb. tins. Well-prepared beef, biltong, or jerked beef, such as the Boers formerly used in trekking, is a valuable food reserve for travellers in Tropical Africa.

Preserved Provisions, their Uses and Drawbacks.

Preserved provisions, although essential, can never equal fresh food. The meats suffer impairment by the heat and other processes employed in their preparation. Osmazome, a volatile principle which distinguishes meat from vegetables and one meat from another, is almost wholly lost; molecular disintegration has proceeded to the point of partly separating the gelatine and other coloids from the muscular fibre, while the salts and extractive matter run into the gravy, the whole forming a somewhat unpalatable food, prone to rapid decomposition when exposed to the air.

Osmazome is produced by the action of heat upon animal tissues. It is dissipated by excessive heat and also by cooling, and its loss is the chief reason why cold is less palatable and digestible than hot meat.

How to produce and to retain this fragant principle is one of the arts of good cooking:—"Every kind of animal and vegetable nitrogenous food will be thoroughly well cooked if allowed to remain long enough in water of 180° Fahr. The French never boil any good or wholesome food, because they are aware that this process tends to disintegration, loss of weight and flavour."*

Canned provisions of bad brands are rendered still more unwholesome by the addition of chemicals, all of which, if we accept common salt in small quantities, have been proved injurious to health.

A third danger lies in the mode of soldering the tins to make them air-tight.

The best qualities of solder are composed of equal parts of tin and lead, but larger proportions of lead are frequently present; and a flux composed of chloride of zinc, containing

* *Health in the House*, by Catherine M. Bucton (Longmans, Green and Co. London.)

free hydrochl ric acid, is applied to the surfaces to be soldered, which are, as a rule, inside, instead of being outside the tins.* Provisions out of such tins must necessarily contain lead and perhaps other poisons in solution. Our only hope is that on this side of the Atlantic a totally different mode of soldering is employed.

Extract from a Report by Dr. Murray upon certain preserved provisions submitted to him for examination, in view of victualling a large party for Central Africa:—

"All the preserved provisions supplied by Moir and Son, purveyors, 9-10, Gt. Tower Street, London, were of the best quality, and in excellent condition. Not a single tin was bad or damaged, owing to the careful way the packing had been done—a point of great importance."

Biltong, or "Jerked" Beef.

Excellent, reliable, and most nutritious food; to my mind, superior to all other forms of preserved meat.

It is easily prepared in the bush by cutting beef or other flesh into thin strips, stringing them on rods which have been previously soaked in boiling brine, and then submitting them to hot sunshine upon frames until quite dry. The strips can be also strung on cords, which have been previously soaked in boiling brine, stretched between upright posts. Some sprinkle a little salt on the meat, but this is a mistake, as it renders it hygroscropic.

The inspissation of the animal juices by solar heat—which in this process should be carried to the point of converting it into sticks almost hard as glue—is of all others

* *Report on the Provisions Preserved in Tins for Exportation from the United States.* By Capt. Segrave, H.B.M. Consul, Baltimore.

the best means of preserving meat; and by taking ordinary precautions against wet and damp, biltong will keep good for years.

In one journey I used this food as the only form of preserved meat with perfectly satisfactory results. It was carried in canvas bags, and got damp; yet the only result was the growth of a little mould on the surface, while the inside of the meat kept sweet and good as ever after a year's travelling. This biltong not only retained its nourishing and sustaining powers, but it was palatable to the last, even when it became too hard for chewing after long boiling, and had to be pounded into dust for soup. Biltong is lighter and more portable than other forms of preserved meat. You can carry a good week's supply (2 lbs.) in your pocket, and a month's in your knapsack; and with a tin or earthenware pot, and a few native or preserved vegetables, a nourishing meal may be prepared at shortest notice. I therefore say to travellers:—*Take well-prepared biltong in preference to all other preserved meats, and in liberal quantity.*

Preserved Milk.

The samples I examined—supplied by Moir and Son, and others—were of various kinds, from "pure milk in can" to "milk in powder." The Anglo-Swiss Company's sweetened condensed milk gave greatest satisfaction.

The result of analysis of 10 different kinds of condensed milk by Mr. Thomas Maben, of Hanwick, N.B.—seven sweetened and three unsweetened—is as follows:—In all the unsweetened the water amounted to 30 per cent. only; in all the sweetened to 64 or 69 per cent., some of the water being due to the sugar used. Thus the unsweetened milk is concentrated to rather less than one-third of its original volume, but different brands are of different strength. To bring this to the ordinary standard of strength, from two to three volumes of water can be added, but no more.

The sweetened milk appears to contain about the same percentage of casein, milk-sugar and salts; but it may be more diluted, insomuch as the cane sugar is a valuable element of food.

As condensed milk sometimes suits infants when ordinary milk disagrees, we may conclude that it will suit the squeamish stomach of the adult in Africa—at least, fairly well. I selected the sweetened kind, which is almost universally used on shipboard, and my experience with it in Africa was very favourable.

Bacon.

The tinned Wiltshire smoked bacon of Moir and Son is good and palatable. It is largely exported to India, and I found that it kept well in Africa.

Potatoes Preserved Whole.

Moir's "potatoes whole, No. 122" on their list, proved unsatisfactory and unpalatable. I could not recommend them, especially as they are a bulky preparation.

Desiccated Potatoes.

King's preserved desiccated potatoes, such as are commonly used on ship-board, answered fairly well, although never very palatable food.

Moir knew of no other kind in the market, and said there was no great sale for this brand. I tried to find a French preparation, but failed. As this vegetable is essential for supplying potash and other useful salts to the blood, and so strengthening it and preventing scurvy, I decided to take a good supply of King's potatoes.

French Desiccated Vegetables.

I tested in many ways in England, and afterwards used for a time in Africa, the vegetables prepared by Chollet and Co. (now Ch. Prevet et Cie., 55, Leadenhall Street, London). The samples were in assorted tins, containing 10 cakes of 5 rations each, including onions and garlic.

They are in compressed and desiccated form, and of highest quality.

They maintained their condition excellently in the tropics, and in flavour and appearance I found them almost equal to fresh vegetables. *In short, they are as near perfection as such preparations can be, and travellers and settlers should not fail to take liberal supplies of them.*

Desiccated Beef with Vegetables.

Moir's No. 77.—This did not commend itself to me, owing, I believe, to the mixing of meat and vegetables together, which I hold to be wrong in principle, for the heat required to preserve the one will disintegrate the other. Besides, the flavour of meat and vegetable extractives mixed together in a common gravy is unpalatable.

Erbswurst (*Moir and Son*).

This is the very perfect combination of legumes and fat which stood the Germans in such good stead during the campaign of 1870-1, when it formed the staple food of the victorious army. Essentially it is a form of pea-soup, containing a due proportion of bacon or lard; the whole dried down, so as to be portable and stable.

It is a splendid food for sustaining muscular expenditure during sudden and extraordinary strain; while as a supporter of bodily heat it has no equal. Erbswurst answers instead of flesh meat, because 1 lb. of pease contains as much nitrogenous or flesh-forming food as 3 lbs. of lean beef, always provided that the pease are presented to the stomach in a form easily digested, a result secured by this excellent combination.

*Erbswurst is, in short, a complete food in itself; "the nutriment it contains is readily accessible and easy of digestion. It was relished cold, and could be converted in a few minutes into good soup with boiling water."**

A large supply of this should be taken to Africa. I found by experience that the ordinary Erbswurst is better than the dry kind, although, of course, more bulky. Both may be profitably taken.

American Dried Apples, or Apple Rings, and Dried Apricots.

I can recommend both strongly, from long experience, as reliable, palatable, and wholesome preparations.

A number of other foods were examined with varying results, but space forbids me pursuing this subject.

Conclusion.

Henceforth the commissariat of Europeans in Tropical Africa will draw its supplies of food from the following sources:—

I. From native local produce, animal, fruit and vegetable.

II. From imported cattle, sheep or goats, from the grass lands of the interior.

III. From imported frozen meats supplied by steamers calling at various ports, and

IV. From cold storage depôts now being opened in many large African towns.

V. From canned or other forms of preserved provisions for special or emergency uses, or to supplement other supplies.

Of course, all groceries, flour, biscuits, tea, coffee, sugar and other necessaries, also all sorts of alcoholic liquors, mineral waters, and such like will continue to be imported into Africa from home.

* *Food and Feeding.* By Sir Henry Thompson, F.R.C.S., &c., &c.

APPENDIX

TO

CHAPTER XXI.

THE BRITISH AND AFRICAN STEAM NAVIGATION CO., LIMITED, AND AFRICAN STEAMSHIP COMPANY, ELDER DEMPSTER AND CO., LIMITED, *Managers.*

WEST AFRICAN COLD STORAGE DEPARTMENT.

List of fresh provisions for sale placed on board all our refrigerator steamers :—

Beef and Mutton (average 8-lb. joints)...	9d. per. lb.
Beef Steak (,, 3-lb pieces)...	1/- ,,
Canterbury Lamb (,, 6-lb. joints)...	11d. ,,
Pork (,, 8-lb. ,,)...	1/- ,,
Sheep Kidneys	4d. each.
Game (assorted, as may be in season)...	5/6 per brace.
Pheasants	7/6 ,,
Cases of Apples (three to four dozen) ...	5/6 each.
Boxes of Aberdeen Haddies (about 7 lbs. weight each)	4/6 per box.
,, Bloaters (say 30 in each box) ...	3/6 ,,
,, Kippers (,, 30 ,,) ...	3/6 ,,
Butter in 1-lb. jars	1/9 per lb.
Salmon	1/6 ,,
Sausages (Palethorpe's Royal Cambridge)	1/- ,,
Cheese (MacLaren's Imperial) in small jars	1/3 per jar.
Eggs (in salt) in boxes of 50	7/6 per box.
Ice (block of 56-lbs.) packed in matting	2/- per block.
Carrots and Turnips (boxes 14 lbs. each)	1/6 per box.
Sterilized Milk	10d. per qt. bottle.

CHAPTER XXII.

The Drink Problem in Tropical Africa.

The fact that Africans drink large quantities of water recommends its use ; but Europeans used to look upon this fluid from most native sources with prejudice, believing it to be a medium of conveying malarial infection.

This has not been substantiated by the experiments of Marchiafava and Celli. They failed altogether to induce malarial fever by liberal and protracted drinking of water from malarial lands.* Nor is it borne out by the experience of the inhabitants of malarious regions in Africa, who drink river, creek, lagoon, and lake water upon all occasions with apparent impunity.

On the other hand, I lived in two camps where extraordinary precautions were taken by boiling, and filtering through Pasteur's filters, every drop of water used, yet malarial fever was ever present.

This is not an argument for the careless drinking of water in Africa ; I wish to enforce the very opposite, and with this view give the accompanying illustration of one of the many parasites that infest African lakes, rivers, creeks, and wells, and find entrance to the human body not only by drinking, but also by bathing in such waters.

The embryo of the *trematode*, or *Bilharzia hæmatobia*, invariably passes through the kidneys, where it gives rise to *hæmaturia*, or bloody urine. It usually attacks males under 30, those over that age not being so susceptible.†

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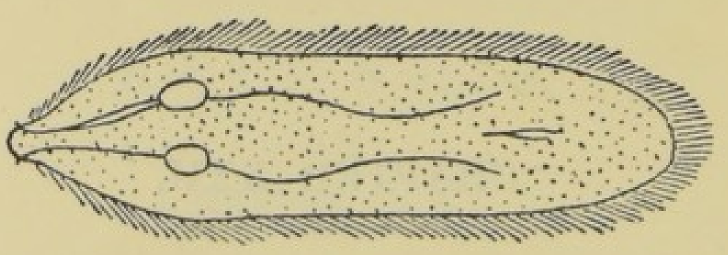
* *o.a.c.*

† See a very important notice of this disease and its connection with bathing in African waters, Chap. XI.



Free swimming embryo of the *Bilharzia hæmatobia*, as seen with magnifying power of 500 diameters.

Another common organism found in African waters is the guinea-worm embryo, which is the cause of a very wide-spread and loathsome disease.*

Space forbids me multiplying examples.

Filters and Sterilizers.

The Pasteur-Chamberland filter is perfect, but very slow in action. I gave it a long trial in Africa, and prefer it to all others.

While it is recognised that filters provide protection against the communication of infective disease and that by their employment the impurities that convey the germs of typhoid, cholera and diarrhœa are removed, yet it is an additional precaution that all water to be used for drinking and cooking purposes should be boiled before being passed through the filtrate. All the better-known makes may be relied upon to serve for ordinary use, but unless special care be taken a large amount of suspended matter in course of time becomes disseminated. In the advertising section of this work will be found particulars of the "Macnair" automatic water sterilizer. Briefly, this contrivance consists of two cisterns, fitted one on the top of the other. The lower is used as a boiler and the upper as a locked reservoir. These are connected by a pipe up the centre. The apparatus

* See notice respecting guinea worm in Chap. XI., with account of its remarkable mode of transmission to man through the "water-flea," or *Cyclops*.

is filled with water, placed on a fire, and when the water boils, the steam generated forces the sterilized water up into the reservoir, from whence after cooling it can be drawn off by the tap.

Alcohol.

It is certain that some of the best work of our best explorers, travellers, huntsmen, and missionaries has been accomplished without the aid of alcohol, although it does not appear that they were mostly teetotalers. Livingstone speaks of the benefit he derived from thimblefuls of spirit.* Burton, Cameron, and Baker never "shirked their liquor"; and Stanley in his monumental work,† which contains the best précis of African hygiene I ever read, allows a man at least a glass of light wine in the four-and-twenty hours.

If my opinion upon this question were asked by a free liver, I should reply:—"*Good health consists with temperance alone.*" If by a teetotaler: "*Drink no longer water, but use a little wine for thy stomach's sake and thine often infirmities.*"‡

As it appears that Africa has its alcoholic question, I will cite a few authorities on ther side.

In Parkes's Manual of Fractical Hygiene it is laid down: "*From 1 to $1\frac{1}{2}$ oz. of alcohol daily is the limit of toleration in the human body.*"

We find that the daily allowance of rum served out to the men during the Ashantee Campaign was $2\frac{1}{2}$ to $3\frac{1}{2}$ ozs.—roughly, rom one to two wineglassfuls.§

When the ration was given on the march, its first effect was to revive, but this passed off after two or three miles, and was succeeded by feelings of languor and depression.

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* *Travels.* † *The Congo, and Founding of Its Free State.*

‡ I. *Timothy* v.

§ See *Report on the Issue of Spirit Ration during the Ashantee Campaign of 1874*, by Professor arkes, of Netley.

When, however, the march or day's work was ended, and exhaustion from heat and fatigue had ensued—a very common occurrence—the spirit ration mentioned above, *given hot and with food*, proved very effective as a restorative of cardiac force, while soothing and promoting sleep.

Professor Parkes found that extracts of meat and coffee were far better strengtheners and supporters during a march than any kind of alcoholic beverage. The dose of a good meat extract, as Liebig's, was from ½ to 1 oz., taken in warm water for a single issue, its action both during and after marching being described as "powerfully reviving and stimulating."

It must not be supposed from this that Liebig's or any other meat extract is *food*, in the strict sense, or good or suitable for general use. The very opposite is the fact. Thus, if a dog is fed on nothing but Liebig's extract, he dies sooner than if not fed at all; which is explained by Foster,* to result "from the potash salts of the extract exerting their deleterious influences in the absence of foods whose metabolism their function is to direct."

It follows from the foregoing that :—

Meat extracts must be classed as nerve foods along with tea, coffee, and alcohol, and that, although capable of increasing the number and strength of the heart's pulsations and so rendering great aid in collapse, they should be administered with the same caution, and in much the same manner, as alcohol. They appear to differ from alcohol in this important point: that their moderate use during the heat and work of the day is not followed by languor and depression.

Regarding spirituous beverages, it appears from the foregoing that the safe quantity for daily use should be gauged by the amount of alcohol they contain, and that this should not exceed 1 to 1½ oz. of rectified spirit, the specific gravity of which ranges from 0·830 to 0·834.

* *Physiology.*

French clarets, Burgundies, Rhine wines, Sauterne, Chablis, and champagne contain from 7 to 14 per cent. of rectified spirits, so that, according to Dr. Parkes's doctrine, they may be safely taken in daily quantities of ½ to 1 pint, or 10 to 20 ozs., according to strength.

Professor Parkes's opinion, on the whole, does not appear to be favourable to the use of alcohol in health in the tropics.

Moleschott, on the other hand, recommends it:—"Alcohol is the savings bank of the tissues. He who eats little and drinks alcohol in moderation retains as much in his blood and tissues as he who eats more and drinks no alcohol."

The opinion of Prof. Carl Binz, of Bonn, upon the use of alcohol in health and disease is as follows:—*

"Alcohol.—Synon: Ethyl-Alcohol; Vinic Alcohol; Spirit of Wine C_2H_6O.

. . . .

"Physiological effects:— . . . . Alcohol is a powerful *antiseptic*, probably from the fact that it is capable, even when diluted, of preventing the development of septic germs, such as vibrios and bacteria, as well as of paralysing the activity of those formed. There is scarcely any other therapeutical agent, the *internal action* of which varies so much according to the dose given. In *small quantity*, and slightly diluted with water, alcohol promotes the functional activity of the stomach, the heart, and the brain; whilst a like quantity largely diluted exerts but a limited influence upon those organs; if, however, the dose of alcohol be often repeated, it is readily assimilated, and, becoming diffused throughout the system, undergoes combustion within the

* See article on alcohol in *A Dictionary of Medicine, including General Pathology, General Therapeutics, Hygiene, and the Diseases of Women and Children.* Edited by Richard Quain, Bart., M.D. Lond., LL.D. Edin., F.R.S., assisted by Frederick Thomas, M.D. Lond., B.Sc., and J. Mitchell Bruce, M.A. Abdn., M.D. Lond. London: Longmans, Green and Co. 1894.

tissues of the body, imparts warmth to them, and yields vital force for the performance of their various functions."

Binz admits that "a healthy individual, well supplied with sufficient food of suitable quality, can get on without alcohol or any specially combustible material;" but he is careful to point out that the case is quite different in sickness; "while the metamorphosis of tissue goes on with its usual activity, or with increased energy, as happens in many diseases, the stomach refusing to accept or to digest ordinary food, fails to supply material to compensate for this waste. Here it is, then, that a material which can be most readily assimilated by the system, and which, by its superior combustibility, spares the sacrifice of animal tissue, is especially called for, and such a material we have in alcohol. . . . In this sense alcohol is a *food*, for we must regard as food not only the building material, but all substances which, by their combustion in its tissues, afford warmth to the animal organism, and, by so doing, contribute towards the production of vital force, and keep up the powers of endurance. . . . In such cases it is certainly not sufficient to call alcohol merely a *stimulant*. . . . To take a familiar illustration, alcohol thus given stimulates no more than does the readily combustible coal which we put in small quantities upon a languid fire, to prevent its going entirely out."

Coffee.

Coffee in the Ashantee expedition yielded somewhat disappointing results, attributable, perhaps, to inferior quality of berry, or to using coffee long ground; or else to errors in preparation of infusion.

Good coffee requires, of course, good berries, which should be roasted on the spot, and then ground, or otherwise powdered coarsely, and, while hot, submitted to the action of boiling water. A moment's boiling is a safe precaution to ensure good results. By this process only can the full flavour, due to volatile aromatic principles, be preserved, and their tonic and stimulating powers added to those of the staple alkaloid caffeine.

French coffee excels because made in this manner.

The Arabs do likewise, roasting the berries on metal plates, pounding them into coarse powder while hot, and then using such a large quantity, aided by a slight boil, that the resulting beverage is too strong for Europeans, although it appears to suit those abstemious nomads to whom the use of all alcohol is forbidden.

I obtained this account of Arab coffee making from Cameron, who, when offered the beverage by the ever-hospitable Arabs whom he met in his great journey, could not drink it owing to its extraordinary strength.

It will be remembered that Captain Verney Lovett Cameron, R.N., C.B., &c., was the first European who ever crossed Africa from east to west, a journey he did alone, and which, if we consider his inadequate equipment, and the difficulties and dangers he had to encounter, must ever rank in the forefront of African explorations.* His patriotism is best told by the following stanza from his elegy, which records a striking episode in his journey :—

A thousand leagues in toil and pain,
He bore The Flag, before by day,
At night beneath its folds he lay,
From Main to Main.

The Arabs also use coffee freshly prepared as above, mixed with butter, upon their predatory expeditions, and a mass the size of a billiard ball is said to keep them in health and spirits during a whole day's fatigue.

* See *Across Africa*, by Verney Lovett Cameron, Commander R.N., C.B., &c.

To sum up:—*Coffee is of high value as a supporter of nerve force, and a useful adjunct to solid food. It may be used in moderate quantity during, as after, work, without causing languor and depression. Caffeine is one of the best known cardiac stimulants.*

Oatmeal Water.

Professor Parkes thought highly of oatmeal, and cites the following in proof of its value:—Owing to exceptional pressure upon the Great Western Railway, large gangs of men had to work 18 hours daily, stopping only for meals and sleep.

Their diet was bread, cocoa, coffee, sugar, bacon, cheese, and meat. Their only drink at and between meals was oatmeal water, the use of wines, beer, and spirits being strictly prohibited.

The daily ration of oatmeal and sugar served for drink, in addition to their solid rations, was 1lb. of the former, and ½ lb. of the latter, per man; and so important did the matter appear, that one in every squad of 20 was told off to attend to its preparation and distribution.

It was thus prepared:—A potful of water was set boiling, and then the oatmeal was carefully sprinkled in, with brisk stirring until a thin gruel was made. When this was thoroughly boiled, sufficient sugar to sweeten was added, and it was then removed from the fire as ready for use.

The men soon became very fond of this drink, and not one case of drunkenness or illness occurred amongst the 1,500, working from daybreak till dark, for many consecutive weeks.*

* Extract from *Report J. W. Armstrong* (1872), and *Henry Voss* (1874), *Divisional Engineers, G.W.R. Co.* Quoted by Dr. Parkes in his *Issue of Spirit Rations during the Ashantee Campaign.* A few men took beer at night after work, but it was strictly prohibited during working hours.

Stokers in steamers navigating tropical seas, iron-puddlers and furnace-men, glass workers, and others exposed to intense heat, prefer oatmeal water—roughly made by mixing the meal in cold water—to any other drink, from its thirst-assuaging, cooling, and supporting properties.

In the tropics the uncooked meal would in time produce irritation of the stomach, and so mar the good effects of the drink.

AVERINA.

This is the drink for tropical countries already referred to as fulfilling Stanley's requirements, "uninebriating as tea; inoffensive to the stomach, nerves, and kidneys as milk; with all palatable food easy of assimilation; and portable."

RECEIPT FOR MAKING AVERINA.

Bring a gallon of the best water procurable—filtered if possible—to which the outside rind only of a lime or lemon has been added,* to the boil. Take from one to two tablespoonfuls (1 oz. to 2 ozs.) of best, finely ground kiln-dried Scotch oatmeal, and having blended it in a little cold water to avoid lumps, slowly add it to the boiling pot with constant stirring. When all has been added, boil for 20 minutes on a slow fire, stirring occasionally. Just at finish add 1 oz. of finest cane loaf sugar reduced to powder; stir quickly in, and remove from fire. When cool it is ready for use.

Thus made, the drink is perfect; yet, occasionally, from one to two dessert-spoonfuls of lemon juice to the gallon may be added, while cooling, for flavouring—but never more, nor do I recommend even this.

To make the drink either sweet or acid, or to give it any marked flavour by adding other ingredients, is utterly to mar

* A few drops of *oil of lemon*, added when the sugar is put in at the last, will answer if fresh lemons are unobtainable.

its beneficial action. Straining is unnecessary, as it soon settles, a pale straw or straw-green coloured liquor remaining on top. The thick parts are serviceable when nourishment is the chief aim.

Tea.

Tea is too well known and appreciated as a universal drink to need lengthened notice.

The Chinese, who should be the best judges of the cup that cheers but not inebriates, hold it to be "cooling, peptic, exhilarating, and stimulating; the drink at once of Chinese scholars and labourers, to stave off the cravings of hunger until a convenient season arrives."

The small amount of tannic acid it contains renders the infusion useful as a weak antiseptic internally, and as an excellent application for sore eyes, ulcers and wounds of all kinds.

Tea relieves the feeling of oppression and nausea after too full a meal; and nothing banishes the sense of fatigue and muscular soreness and exhaustion, after excessive marching, better than copious draughts of this beverage, hot as can be taken.

The effects of tea and coffee upon the system are by no means identical; they both cause wakefulness, but coffee produces a more pleasing insomnia, "not unlike that occasioned by small doses of opium," while tea throws the nervous system into a state of irritative tension highly distressing.

Sealers on the coast of Labrador and Newfoundland, and Australian bushmen alike find tea the most restorative, refreshing and supporting drink under opposite conditions of climate, but parity of severest toil.

Cocoa.

Cocoa is an excellent drink, and, especially in the form of chocolate, more nourishing and supporting than tea or coffee.

While travelling on the Zambesi, our "first breakfast" invariably consisted of sardines, biscuits, and half a pint or more of strong Cadbury's cocoa, duly sweetened with sugar, and mixed with preserved milk.

This repast enabled us to carry on work until 11 or 12 o'clock, when we had our regular breakfast, without experiencing feelings of emptiness or exhaustion. We took to cocoa at first because handier and less likely to be spoilt in making by our half-awakened cook-boy; but we grew to like it so much, and to find such benefit in its nourishing, warming, and sustaining action, that we never abandoned its morning use for any other beverage.

"Hygiama" is a tonic food-beverage, similar to fine cocoa in flavour but far more nutritious. It is extremely digestible, and is a valuable food in cases of fever and dysentery, as well as being a delicious breakfast beverage. Lieut. Graetz found it invaluable during his famous motor-boat journey across Africa.

Kola.

Kola is the nut or seed of the *Sterculia acuminata*, which is a native of Africa, where it is held in highest repute.

This nut contains, besides, 2.348 per cent. of *caffeine;* 0.028 per cent. of *theobromine*, which is the active principle of cocoa; 25 per cent. of starch; and 2 per cent. of *tannin*. It has also an essential oil, possessing aphrodisiac properties, and this has to be removed before the nut can be used as a drug, or for food.

Mr. Heckel, knowing that the natives of Africa use this nut to sustain them in the absence of regular food upon long journeys and predatory expeditions, thought that it might be utilised as an article of diet for troops and horses in warfare.

His first care was to prepare the nut by drying it, which caused nearly all the oil to disappear. What remained he expelled by steeping for two or three days, according to the season of the year, in water of 16° to 18° C. (60.8° to 64.4° Fahr.), containing 1 per cent. of carbonate of soda; then partly drying and slightly roasting the nuts before they were quite dry.

With nuts so prepared he composed a chocolate powder for the use of soldiers, and an oatcake for horses.

Both have been tried by the French soldiers, manœuvring in the Alps and undergoing exceptional fatigue. It was found to "sustain physical force, and to increase the energy of men and horses." The latter liked kola cake, which M. Sanson, Professor of Agriculture of Grignon, declares to be twice as nourishing as oats.

These hints may not be thrown away upon travellers and settlers in the very home of the kola nut.

Kola Chocolate.

This is said to possess the remarkable power of enabling a man "to do a day's work upon a cupful taken at breakfast." This may be so, but what we tried proved somewhat unpalatable and upsetting to the stomach. Kola is best taken by adding a pinch of well-prepared powder to a cup of ordinary chocolate, cocoa, or coffee. It should not be used in pill or capsule, as its concentrated action on the mucous membrane of the stomach will prove hurtful.

Kola is a powerful drug, and as such should be used on emergencies only. Its general action appears to be to augment force and abolish fatigue, and so furnish temporary strength to a starving person; but only at the expense of his own tissues: to put it technically, by facilitating the combustion of the tertiary elements of oxidation.

To summarise :—We have *tea*, *coffee*, *cocoa*, *hygiama*, and *meat extracts*, as reviving agents, nerve stimulants and heart tonics, which materially help food in sustaining the body. They may be taken with advantage during the hours of work and heat of the day; also when work is done, and in states of fatigue and collapse; in the evening and at night, without injurious consequences in any case.

In *Kola* we have a powerful medicine containing in large quantity the active principles of tea, coffee, and cocoa. It should be used sparingly, on exceptional occasions or emergencies only, and in very diluted form.

In *Alcohol* we have an available, prompt restorative of nerve force, and of the tired heart; also a combustible food of value; but a very dangerous agent, lending itself to abuse and potent for ill as for good. It is quite unsuitable in the tropics during the heat and labour of the day, but serviceable at times in fatigue and collapse after work and heat, especially when given in the evening after sunset. If spirits are used they must be very well diluted with warm water.

Alcohol in all forms should be taken in conjunction with food.

In *Averina* we possess the perfect portable food-drink for the tropics, suitable at all times and under all circumstances.

The great developments in applied food-science in recent years have added enormously to the convenience of travellers in tropical countries. One of the best of up-to-date pocket-foods is known as Hygiama Tablets. These supply complete all-round nourishment in a pure, palatable, compact and digestible form. Instead of temporarily stimulating the system like Kola and other drugs, they rapidly give new energy, owing to their nutritive elements being so easily assimilated. Being practically free from salt and sugar they do not create acidity or unnatural thirst. Particulars will be found in the advertising section of this work.

CHAPTER XXIII.

How, then, comes, may the reflective mind repeat, that the grand Tissue of all Tissues, the only real Tissue, should have been quite overlooked by Science,—the vestural Tissue, namely, of woollen or other cloth; which Man's Soul wears as its outmost wrappage and overall; wherein his whole other Tissues are included and screened, his whole Faculities work, his whole Self lives, moves and has its being?—" Sartor Resartus."

The Clothing Problem in the Tropics.

PART I.

The Philosophy of Clothing.

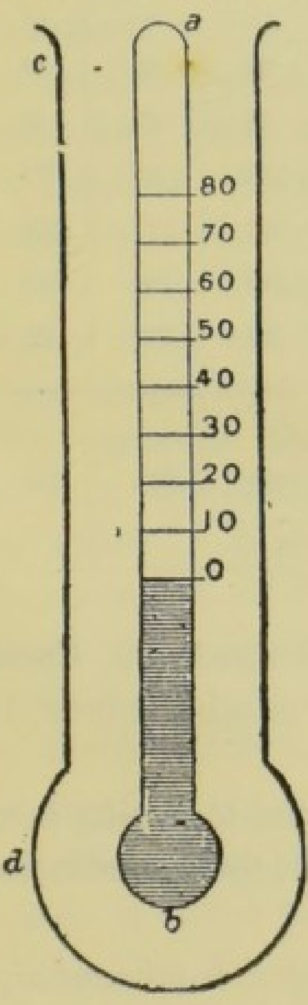
What should be worn in the tropics is an apparently simple question on the surface, yet beset by difficulties.

It includes inquiry into the physical properties of the various fibres or tissues in their raw and diversely manufactured states; the absolute and relative weights—measure for measure—of materials, besides such properties as porousness, smoothness, warmth, and durability. Finally, the type, pattern, fit, ventilation, and colour of clothing, and the proper garments to wear at all times and seasons.

Respecting material, Stanley advocates nothing but wool; Gerhard Rohlf says:—" The best clothing in Africa is no clothing, but if any is worn, let it be cotton;" while Cameron is for a compromise between wool and cotton.

Authority being thus at variance, we have to question science and experience.

Over 150 years ago Benjamin Count Rumford read a remarkable paper on the Philosophy of Clothing,* in which he recorded his experiments upon the physical properties of wool, cotton, and flax fibres and fabrics, with a view to determine their relation and positive value for clothing.



This he accomplished by placing a thermometer, *a b*, inside a glass bulb, *c d*, and packing the space between the two with the substance to be experimented upon, thread or woven fabric being wound round the thermometer bulb. This apparatus, which Count Rumford called his "*passage thermometer*," was, when charged with a substance, plunged into water at 75° Réaumur (80° being the boiling point on this scale). When the thermometer was raised to the requisite temperature, it was plunged into a freezing mixture and permitted to cool down, and the time occupied in cooling from 70° R. was taken, at intervals of 10° R., as registered by a stop-watch, marking half-seconds, held to the ear.

Some of the results of his experiments may be seen by glancing at the table on next page.

* *Essays, Political, Economical, and Philosophical*, by Benjamin Count Rumford, containing *Paper on the Warmth of Substances used in Clothing*, read before the Royal Society, Jan. 19th, 1797. London, 1800.

Heat lost in degrees of R. from 70°.	Air in globe surrounding thermometer.	Sheep's wool 16 grs., surrounding bulb of thermometer.	Woollen thread 16 grs., wound round bulb of thermometer.	Cotton wool 16 grs., surrounding bulb of thermometer.	Cotton thread 16 grs., wound round bulb of thermometer.	Lint finely scraped 16 grs., surrounding bulb of thermometer.	Linen thread 16 grs., wound round bulb of thermometer.	Linen cloth 16 grs., wrapped closely round bulb of thermometer
Réaumur. 70°	" —	" —	" —	" —	" —	" —	" —	" —
60	38	79	46	83	45	80	46	42
50	46	95	63	95	60	93	62	56
40	59	118	89	117	83	115	83	74
30	80	162	126	152	115	150	117	108
20	122	238	200	221	179	218	180	167
10	231	426	410	378	370	376	385	336
Total times to fall from 70° to 10°.	576	1118	934	1046	852	1032	873	783

The "warmth" of a substance, as defined by Count Rumford, is "*its power of confining heat*," in other words, its non-conducting power for heat.

The warmth of the bodies mentioned in the foregoing table are as the times of cooling of the thermometer, their conducting power being inversely as these times.

Count Rumford remarks upon his table :—"*I acknowledge that the differences in warmth of these substances were much less than I expected to have found them.*"

It appears that unwrought material, packed loosely around the thermometer, is warmer at all temperatures between 70° and 10° R. than an equal weight of thread or woven fabric wound or wrapped closely round the bulb.

In another series of experiments he found that while the thickness of the covering of the thermometer remained the same, if the density was increased by forcing twice, thrice, or four times the quantity of wool or other substance into the glass bulb, the non-conducting power rose in proportion to the density. In other words, *the more wool or other substance woven into a cloth of given thickness, the "warmer" it should be.*

We arrive also at the conclusion that, with like weights of substance woven into like measures of cloth, loose, reticular, or cellular weaving tends for warmth; while close twisting of yarn and close weaving tends to produce coolness of fabric. A familiar example of this is the warmth of ladies' "ice-wool" shawls, which contain a very small weight of the tissue woven into loose, reticular fabric. A like quantity of wool, finely spun and woven into the thinnest cloth, would not measure as much by half nor yield a fourth of the warmth. We conclude that:—*Close twisting and fine weaving of tissues, whether animal or vegetable, tends to produce coolness of fabric. Also that the density of a textile, other things being equal, is directly proportionate to its non-conducting power for heat, or, in other words, to its warmth. Finally, that loose reticular or cellular weaving tends to produce warmth of fabric.*

Wool cannot be spun fine as cotton, and the fibre is specifically heavier; so that if we take the thinnest garments made of either tissue, the woollen will be slightly the heavier.

Also, at about the normal temperature of the body—30° R. = 99.5° Fahr.—we see from Rumford's table that the warmth of wool and woollen thread, as compared to cotton wool and cotton thread, is as 162 and 126 to 152 and 115 respectively: a proof that in its raw and manufactured state wool is warmer than cotton.

If we compare finest woollen with finest cotton fabrics, as regards strength and durability, cotton stands superior to wool; it is also very much cheaper wear.

The following physiological facts bear upon the question of suitable clothing for the tropics. The average daily skin loss from the body of a full-grown man of 154 lbs. is, according to Huxley :—

10,000	grains, or over $1\frac{1}{2}$ lbs. of water.	
700	,,	of other matter.
100	,,	of carbon.
10	,,	of nitrogen.

The quantity of solid matter lost by extraordinary sweating does not diminish in proportion to increased secretion, and this accounts for its rapidly enfeebling action.

Great sweating is also locally weakening, the skin, in its sodden and reeking state, being unable to offer effective resistance to microbes, or to accommodate itself to rapid fluctuations of external temperature, or to close its pores against cold suddenly applied in any way.

The true principle of clothing in all countries is that apparel (aided, of course, by food and other necessaries) should maintain the body at its normal temperature, 98·4° F., with greatest possible comfort to wearer and least strain upon all the bodily organs.

A man properly clad is in a state of physiological repose or equilibrium, as regards reactions between his skin and environment.

Clothes which cause avoidable perspiration, and check the issue through the skin of excess of bodily heat, manifestly fail to fulfil the above requirements, while being most uncomfortable and weakening wear.

In parts of Tropical Africa we have a very small annual and high diurnal range of temperature; from over 80° Fahr. by day to under 40° Fahr. by night being not uncommon on the elevated central table-lands. Under such conditions it must be wrong to wear the same weight of clothes by day as by night. Equally wrong to wear the same amount of clothes while working in sun or shade, and burning muscle tissue with rapid evolution of heat, as when the body is engaged in sedentary pursuits or at rest, which means little or no physiological combustion.

A man's sensations interpret the want of lighter clothing in proportion to heat and work.

Theoretically, the amount of clothing required should vary as the temperature. The weight of clothing, say, at 40° F. being so much, that at 80° F. should be expressed by $\frac{40}{80}$, or $\frac{1}{2}$. But such rules are inapplicable in view of the variableness of a man's environment and subjective conditions. In still, dry air, as of a closed room at the temperature from 67° to 77° F., which on that account has been named the "indifferent" temperature, the naked person will neither lose nor gain heat, a fact which explains why the natives of hot countries dispense with all clothing, save what is worn for decency, in their indoor domestic life.

When the natives wear nothing, it appears reasonable that the European should dress in lightest grass-cloth or cotton. When the native wears cotton from a sense of cold, the Europeans may need their woollen clothing.

Précis of Comparative Value of Woollen and Cotton Clothing for Tropical Countries.

Tropical clothing, of whatever material, must be light, loose, porous and ventilated. In the matter of weight I find that, thickness for thickness of material, there is not much difference in the weights of similar woollen and cotton garments (see Part III.). In the matter of porousness, the lightest woollens are more porous than the lightest cotton stuffs, as $1\frac{1}{2} : 1$; but in durability of lightest fabrics, this proportion is reversed, cotton being more durable.

Woollen fabrics prevent radiation and conduction, *i.e.*, passage of heat out of and into body, better than cotton; they also entangle more air and more water; they do not lie so flatly applied to skin as cotton, being separated by an elastic nap, which causes a thin film of air to intervene; consequently wool does not cling like cotton. Woollen fabrics, by their hygroscopic properties, not only impede very rapid evaporation, but permit of some condensation occurring in their substance, whereby the vapour of the body, turning into water, gives back some of its specific heat, and so warms the fabric. This is an additional defence against chills. Cotton fabrics do not possess these properties, and by permitting freer evaporation, conduction, and radiation, more quickly cause chills.

Most flannels—Jaeger's least—irritate the skin, and so promote sweating much more than cotton underwear. Most flannels, especially when stout and subjected to bad washing, shrink and "felt" more and more, thus losing porousness. Cotton stuffs, after first shrinkage, do not alter. As the object of all clothing is mainly the maintenance of the normal temperature of the body, 98·4° F., under all conditions of environment; in temperate climates, where external temperature is almost always below "indifferent," wool is a better buffer than cotton to interpose between the skin and the atmosphere, as it better prevents the passage of heat from the warmer body to the cooler air.

On the other hand, in hot climates, with the atmosphere most frequently above the "indifferent" temperature, 67° to 77° F., and at times heated up to 80°, 90°, and 100° F., the maintenance of normal bodily temperature will depend usually on giving free issue to superfluous caloric, and defending the body against sunshine. Cotton garments especially, made on Arab and Eastern pattern, fulfil both requirements better than woollen. The great difficulty lies in their becoming wet with perspiration, for then they are dangerous if applied flatly to the skin, as in European dress. Not so in flowing robes, which are only wet where they touch; the vapour of the body entangled in their folds parts with its specific heat, and so maintains warmth of body. Against radiant heat and light (both of which it reflects), dust, and dry wind cotton made into flowing robes forms a better defence than wool, which absorbs heat and light rays, holds dust, and lets wind blow through. Woollen garments are unsuitable during physical exertion in the tropics, when the physiological combustion of muscular tissue liberates heat very rapidly, which requires freest issue for comfort and health's sake. Lightest cotton is well adapted under such circumstances.

WOOL.

Woollen fabrics, dry and wet, are more elastic than cotton, the fibres or hairs standing crisp and apart in either condition. Dry and wet they can take in and contain more air, and are in this respect better non-conductors, *i.e.*, warmer.

Wet, they absorb water as a sponge does,—*i.e.*, by elasticity, becoming thick and heavy. Very wet, the elasticity of nap fibres being overcome by weight, close application of fabric to skin takes place, and consequent free conduction and evaporation. Water is squeezed out of and air sucked into fabrics at every movement, and the constant elastic rebound of nap fibres tends to separate them from the skin, so chill is modified.

From foregoing we conclude that close-fitting garments of wool protect the body from chill when wet better than those of cotton.

COTTON.

Cotton fabrics, dry and wet, are inelastic, and the fibrils and fibres tend to clog together when wet, and not to stand apart. Dry and wet they contain less air than fabrics of wool, and to this extent are cooler, or better conductors of heat.

Wet, they take in water not by elastic, spongy action, but by the capillary attraction between their fibrils and fibres, which then tend to coalesce and adhere to the surface of skin, so promoting freest conduction and evaporation.

They thicken when wet, but cannot then contain air, and having no inherent elasticity, they cling to the skin uninfluenced by movements of body.

From foregoing we conclude that cotton garments are serviceable in the tropics in proportion to their looseness or smallness of area of contact between stuff and skin.

PROTECTION OF VITAL ORGANS.

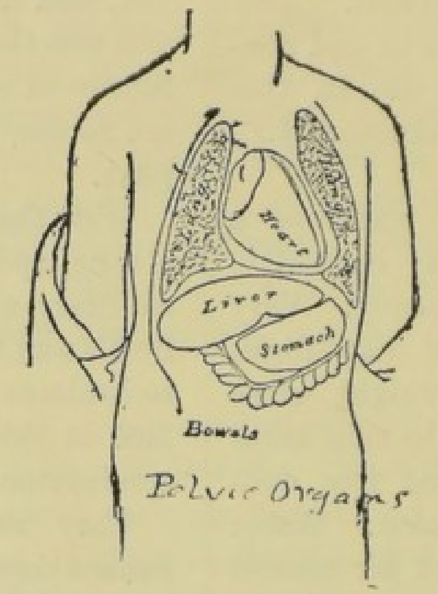


DIAGRAM SHOWING POSITION OF VISCERA AND PELVIC ORGANS THAT NEED SPECIAL PROTECTION.

The Clothing Problem in Tropical Africa.

PART II.

How the Inhabitants of Tropical Africa, India, and China Clothe Themselves.

Cameron says that the Arab wears "a *kittub-shukka*, or loin-cloth, as his sole dress in private life; while lounging he throws a *doti cloth* around his shoulders, and for regular outdoor dress wears the Kanza, a flowing, loose, cotton garment (previously described). The good Mussulman may not wear silk, and knows nothing of flannel."—*Private letter.*

Rohlf, writing on the same subject, says:—"It is not true that the Arabs clothe themselves in wool. A sheik will put on his whole wardrobe of *burnouses*, cloths and turbans when he has occasion to enter a town; but when at home he simply wears shirting.

"The value of cottons imported into Africa is immense, while flannel and woollen materials find no market, and are not asked for by the natives. At the courts of inner Africa the chief persons wear a quantity of cotton clothing, but the apparel is so constructed as to freely admit air to the body."*

Respecting Chinese clothing, Mr. Palm says:—"The Chinaman never wears flannel next his skin. As a rule he wears a cotton jacket and trousers made very loosely. In Canton, in very hot weather, he frequently wears a loose, sleeveless vest next to his skin, made of a sort of bamboo netting, which keeps the jacket from contact with the skin, and so prevents the perspiration showing through. In private life he often sits with nothing on the

* To *Health Culture*, by Dr. Jaeger, I am indebted for these references to Rohlf.

upper part of his body at all. The jacket and trousers are often made of what is called grass-cloth, which is much cooler than cotton, and generally woven in more open texture. Silk is only worn by the better classes. In hot weather he never wears any headdress, save on swell occasions, excepting boatmen and coolies, who wear very large-brimmed straw and bamboo hats when working in the sun. The shoes are generally made with felt soles and silk uppers, but they have waterproof leather boots for wet weather. When there is a change in the atmosphere, and cooler temperature, the Celestials add one or more garments till they think they are sufficiently clothed. These additional garments are put on over the others, and pulled off again as the temperature rises. The foregoing remarks apply to South China; in North China the winters are colder than they are in England."*

The Chinese pattern may be described as funnel or Λ shaped, and the more closely this is followed the less material is needed for the garment, as folding, plaiting, or draping can thereby be dispensed with.

In proper Chinese clothing, no belt being worn, air passes freely under body of coat, also up trousers and sleeves, while vapour and warm air find free escape around neck and at arm-holes, thus thorough ventilation is secured. The coat only comes in contact with the body at the shoulders and upper part of chest, and here, in hot weather, it is fended by the bamboo vest, described in Mr. Palm's letter, which prevents the garment touching touching the skin and so becoming wet with perspiration.

In Arab clothing ventilation and coolness are secured by ample folds and flowing drapery, which, while reflecting solar heat and light, and resisting their passage, permits freest ingress of cool and issue of hot air and vapour from the body. In this case the material is never disposed flatly on the skin,

* Extract from private letter to me from Mr. S. L E. Palm, of the Chinese Government service.

but enwraps the man in a light, fleecy cloud of some thickness, excellent for resisting sun, wind, and dust. With his turban and hood protecting head, neck, and face, we have in the Arab an exemplar of clothing perfectly adapted to a man's condition and environment in nomadic desert life.

The natives of India wear cotton or grass-cloth, the use of wool, hair, and silk being exceptional or forbidden.

The African black wears simply a loin-cloth, some folds of which are passed between the legs. Morning and evening, before and after work, he dons two or more fathoms of calico, which he drapes gracefully, toga fashion, around his person, and this, with sandals, is full dress. The calico also serves him for covering by night.

Gerhard Rohlf raises a warning voice:—"Too heavy clothing and woollen clothing are not suitable for the tropics. The body is weakened by constant perspiration, and the skin becomes more sensitive. This is the main reason why northern people find it so difficult to acclimatise themselves in the tropics. . . . Why are the British, who are the chief advocates for flannel, so unable to bear hot climates? . . . Partly because they indulge in excess of brandy, . . . but still more because they over-stimulate their skins by day and night, and thereby enervate it so that it becomes incapable of the necessary reaction. . . .

"It is all important not to weaken the powers by exhaustive perspiration; especially in damp heat would this be unhealthy, creating a condition similar to the Turkish bath.

"Let us copy the natives, who content themselves with the least possible clothing, and let us not weaken our skins by wearing wool—like the English, who can consequently only endure a tropical climate for a short time, and are compelled to send their children home to Europe that are born there. It is illogical in hot countries to wear clothing which makes one still hotter."

The Clothing Problem in Tropical Africa.

PART III.

How Europeans Clothe and should Clothe in the Tropics.

Europeans are slow to alter their style of dress, generally contenting themselves with producing familiar patterns in lighter material for tropical wear. Most people take out what the outfitter recommends—including the ordinary flannel shirt, weighing 15 to 18 ozs., and, still worse, woven undervests and drawers of wool and cotton. The stout flannel shirt becomes so imporous by constant bad washing* that it has to be worn open in front (so exposing vital organs to danger of chill) to secure ventilation.

Woven underclothes, when dry, cling to the skin and irritate it, so causing profuse sweatings. When wet they cling still more and asphyxiate the skin, also chilling it by permitting rapid loss of heat by conduction and radiation from the open pores.

Reject woven garments of all kinds and of all materials as absolutely unsuitable for tropical wear.

Coming to clothing in detail, we begin with Stanley's travelling suit. "When on the march, the lighter you are clothed the better, because at the halt you will be reminded of your paletot or overcoat. Very light flannel will be

* All flannel should be well shrunk before being made up. To wash flannel properly, dissolve the soap in boiling water, and, when cool enough to be borne by the hand, wash the flannel in this solution. Rinse it out in cool, boiled water; shake, and dry in open air. To wash by rubbing in soap and using cold water, or by boiling, is to spoil the flannel.

sufficient for your dress, owing to the exercise you take. Light russet shoes for the feet, knickerbockers of light flannel, a loose, light flannel shirt, a roll of flannel round the waist, and a Congo cap for your head, will enable you to travel twelve miles per day without distress."*

Rider Haggard says:—"Nearly all our clothing was made of well-shrunk and very strong grey flannel, and excellent wear I found it for travelling in these parts (swampy regions of Tropical Africa), because, though a Norfolk jacket, shirt, and pair of trousers of it only weighed about four pounds, a great consideration in a tropical country, where every ounce tells on the wearer, it was warm, and offered good resistance to the rays of the sun, and, best of all, to chills, which are so apt to result from sudden change of temperature."†

Colonel Tulloch, now Major-General Tulloch, while serving in Natal, seeing the men of his Welsh Regiment suffering from the scarlet kersey and other abominations of uniform as then in use, had the boldness to clothe them in a couple of strong grey flannel shirts apiece, the outside one being worn as a blouse, with great increase of comfort and improvement of the general health of the regiment.

In the foregoing Stanley, with his accustomed sagacity, grasps the essentials of proper tropical clothing—*lightness*; *looseness*, securing *ventilation*; *thinness*, securing *porousness* of fabric; protection of *head, loins, abdomen, lower abdominal* organs *and nerves* from sun and weather; and safe-guarding of *feet*, without unduly sweating them.

If a man can wear flannel at all with comfort in the tropics—which some cannot do—this suit of Stanley's is excellent, especially if the light woollen material is made into the smock-Norfolk and knickerbockers to be afterwards described.

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* *The Congo, and Founding of Its Free State.* † *She.*

THE TYPICAL EXPLORER'S SUIT, of which this illustration shows the most approved pattern, is by the well-known outfitters, Silver and Co.

This is a very neat and becoming style of coat, which will answer, with slight modifications, for both town and country wear. It is a good pattern for tweeds, khaki, grass cloth, Indian silk or drills, and has been adopted by officers in the navy and mercantile marine service. As its collar stands up,

THE TYPICAL EXPLORER'S SUIT OF SILVER AND CO., OUTFITTERS.

and sufficiently covers the neck, it enables the wearer to dispense wholly with white collar and tie, which prove a detestable nuisance in tropical wear.

Also such coats can be worn in very hot weather without any vest or shirt, the upper part unbuttoned.

For bush use grey tweed may be employed, provided it is light and porous. The belt may be dispensed with in hot weather.

A light khaki suit of this kind will also prove cool and durable, but it lacks porosity and must be ventilated in its folds.

In fact, all such coats should be ventilated to permit of the vapour of perspiration escaping, and this may be very simply done without spoiling the appearance of the coat by having slits, opening under the two front and the central back pleats, which can hook and close if desired.

So made, the pattern is very suitable for all kinds of tropical wear.

The same material can be used for trousers or knickerbockers—the latter being far the most suitable for Tropical Africa. They should be loose, and made to wear open or closed at knee.

The choice of material is most important, as we have seen, and the points to bear in mind are *lightness*, *thinness*, *porosity* and *ventilation*.

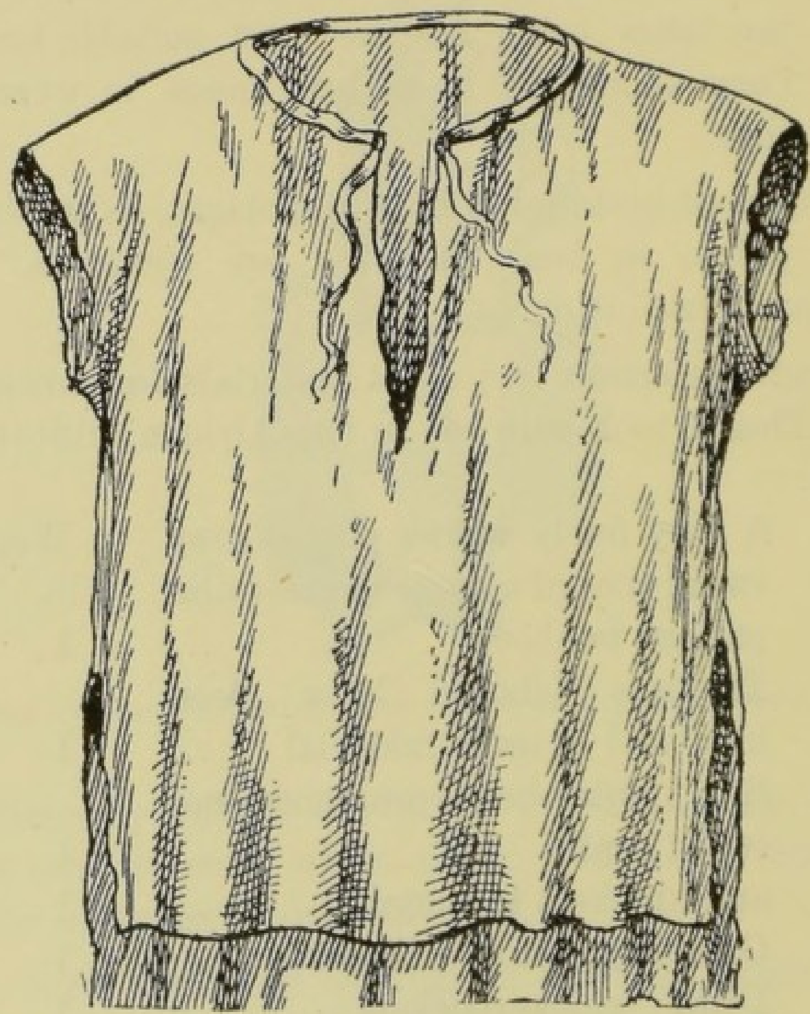
By careful selection very light materials for suiting can be found. Thus I took with me in one African outfit the following suits :—

		Weight. lb.	ozs.
1st.	A very finely woven porous grey tweed coat of a somewhat similar pattern to above	1	15½
	Trousers (should have been knickers) of same material ...	1	7
2nd.	Still lighter but strong gossamer tweed coat	1	7
	and knickers to match	1	0¾
3rd.	Ordinary cotton drill coat ...	1	7
	Ditto knickerbockers	1	0

My frock coat and dress suit were also very light, no lining being used in any of the clothes, save where indispensable. No tropical clothing should be lined. The ordinary cotton drill suits generally sold by outfitters for tropical wear, if very loose fitting, will answer persons who do not wish to go to the trouble and expense of a tailor-made outfit.

PUTTIES are better in all ways for tropical use than leather leggings. As generally supplied they are too thick and clumsy and not porous, and being woollen they sweat the legs all day. A mixed wool and rhea or cotton material would answer better, and if of the proper open texture would prove cool, light, and comfortable wear. They should weigh much less than the ordinary service putties and permit of free ventilation.

UNDERVESTS AND DRAWERS.



PATTERN OF TROPICAL UNDERVEST MATERIAL. JAEGER'S OR OTHER VERY LIGHT UNSHRINKABLE FLANNEL.

UNDERVESTS.—Very light flannel, of Jaeger or other unshrinkable make, will suit best for material. They should be very loose, open freely in front, have wide arm-holes, and skirts deeply "slashed." Half or long and loose sleeved ones of same pattern may be taken for the rainy season.

On no account take woven undervests of wool or cotton to Africa; they cling to body wet with perspiration and are harmful and uncomfortable wear.

Drawers, Pyjamas, and Other Lower Garments.

The protection of the lower parts of the trunk is sadly overlooked by Europeans, who have much to learn in this matter from the natives of hot countries.

People as a rule rest satisfied with protecting the head, chest, and middle trunk. Yet the organs of the lower trunk require equal care and protection against the heat radiating from the ground.

I wish to draw particular attention to this fact, that disease may come from below as well as from above. The protection of the abdomen will be dealt with later on, but the protection of the pelvic organs requires a little loosely made garment of very light flannel, Turkey red, Chinese silk or cotton, made bathing drawers fashion. Its weight will be inconsiderable, yet it will materially help the trousers or knickers to modify the action of radiated heat and that of the hot air and vapours ascending from the ground. The natives of India and other Eastern countries wear gauze or other light material between the legs attached to or forming part of the kummerbund. The native African's loin cloth is used in same way. This should be a hint to Europeans, and teach them the necessity of protecting the genitals and rectum in hot countries.

Of course, a gauze or silk scarf wound round abdomen and then passed between the legs would answer worn *over* trousers or knickers, and might be preferred to the loose drawers.

A flannel pyjama suit is the best sleeping dress in the tropics, and generally sufficient, but in the rains or the chilly hour of dawn a blanket is often indispensable to prevent chill. One should be kept folded at foot of bed for instant use, lest in seeking for it in the night mosquitos be admitted under the net.

Sandals, or felt-soled canvas or linen slippers, worn with bare legs and feet, complete the best camp dress for the tropics.* During the rains, at early morning and after sunset, a light, loose flannel or tweed suit may be worn, and if the feet are chilly, boots and woollen stockings put on. A long, loose, unlined and porous woollen dressing-gown will be of great service after fever, or during the chilly stage of its attack. A similar cotton garment will be useful for lounging in hot weather. It is well to imitate the inhabitants of Southern Europe, who always change their light working clothes, and after a wash or bath, put on a warm woollen suit in the evening after sunset.

Linen and Grass-Cloth.

Linen, Indian and Chinese silk, and rhea grass-cloth are the textiles likely to compete with cotton and wool for African clothing. The former, as every one knows, is the manufactured product of the *Linum usitatissimum;* the latter is a cloth prepared from the *Rhea*, or *Bœhmeria nivea.* This cloth, of which many varieties are used in the East, is not easily procurable save, perhaps, at Indian outfitters' in England, but it is likely to be introduced into Africa by the Indian traders, who are now flocking to the East Coast. In its prepared state the finest fibre is beautifully white, lustrous,

* This advice is only suitable for mosquito-proof houses. If mosquitos are about, the legs and feet must be as carefully guarded as other parts. They make mosquito boots of thin soft leather in Madeira for this purpose, and a pair should be purchased *en route* to Africa.

and silky, and admits of being woven into fabrics finer than cambric and glossy as silk.*

The coarser fabrics, worn by the working classes, are described as being wonderfully light and porous, and might be best suited for tropical wear.

Indian and native tailors can now be found in most large African towns.

LINEN.

The ancient Egyptians, Greeks, Romans, and Israelites† all wore both wool and linen, but the latter was most esteemed, and used for the clothing of kings, priests, and the wealthiest classes. This preference was chiefly owing to the coolness, smoothness, and beauty of linen, and to the fact that it did not cause sweating.

Home-spun linen was once the common wear in Germany and England; and even now the Iberian, Italian and German peasants use a very coarse kind for their working garments, which are immediately changed for woollen when they return home, to prevent chills.

For "warmth," linen thread compares with cotton thread, on Rumford's scale, at a temperature of 30° R.—as 108 : 115.

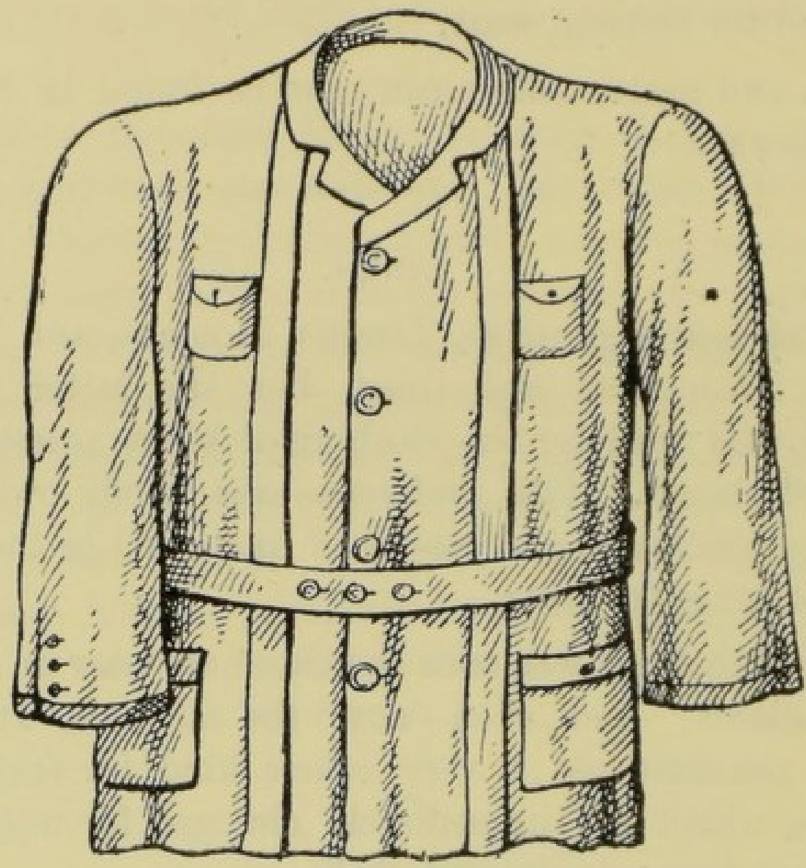
On my Zambesi trip I took under-blouses, smock-frock Norfolk jackets, and knickerbockers made of hand-woven linen, extra long staple, from the looms of J. Harris and Son, Derwent Mills, Cockermouth.

The material used for the under-vests was light, smooth, porous, and even of texture; cool and glossy as cambric; beautiful, strong, and durable. I found it excellent wear in

* I am indebted for specimens of the raw and manufactured fibre to the director of the Kew Royal Gardens; and for a pattern of its clo.h, finer than cambric, to S. L. E. Palm, Esq., of the Chinese Customs.

† See Exodus xxviii., xxxvi., xxxix., also Leviticus and Deuteronomy; and consult Rawlinson's *Ancient Egypt*.

the temperate climate of Natal, but in the tropics, when it became wet with perspiration, it chilled more than wool or cotton.



THE HARRIS LINEN SMOCK-FROCK NORFOLK COAT.

The linen used for the smock-frock Norfolk coat, shown in illustration, and for knickerbockers to match, resembled fine canvas, but was much pleasanter and lighter wear; soft, smooth, cool, porous, and strong. These outer suits gave great satisfaction; and I see no reason why linen should not form a useful part of every tropical outfit. It must be acknowledged that linen has one great drawback for tropical wear: it chills the body quicker by its capacity for conducting heat. It must therefore be regarded as best suited for indoor lounging suits rather than for work-a-day garments. A linen shirt, too, is much cooler than a cotton one.

Silk, and Silk and Wool.

Silk, and a mixture of silk and wool, have been recommended by Surgeon Parke and others for underclothing; but it is not easy to see in what way these expensive fabrics are better than cotton or wool.

The silk kummerbund is soft, warm, and elegant wear, but I prefer, with Stanley, a stout flannel one, say, a strip of ordinary blanket, 14 ins. wide, worn round the abdomen and overlapping in front and fixed by safety-pins, to any other kind of belt or girdle for the tropics. "Cholera" belts and other made belts are not recommended.

Chinese, Indian, or Tussore Silk makes excellent clothing for moderately hot weather, as I know from long experience. Chinese silk is smooth, soft, tough, elastic, strong, and durable, but rather warm wear except in semi-Chinese make of garments. It does not chill the body when wet so much as linen or cotton, less even than wool of the thinnest kind. Some suits of Chinese silk should be found in every outfit.

Boots, Socks, Stockings.

Good boots are of highest importance in Africa. They should be made of well-seasoned russet leather, stitched, a loose fit, with wide "hygienic" soles—that is, cut straight inside. Expansion of the foot from heat must be allowed for; *a close fit in Europe will prove too tight in the tropics.*

Boots of different strengths should be taken, from strong shooters, for travelling and hunting, to light shoes, sandals, and felt-soled canvas slippers for camp use.

Anglers' overall india-rubber knee boots should be taken—they are invaluable during the rains.

Woollen stockings or socks of various strengths are the only proper foot-wear in Africa. Cotton will not do.

Whether it is best to take light, medium, and heavy suits for change, or to follow the Chinese plan of doffing and donning similar garments according to weather and work, I must leave to every one to decide for himself. Personally, I incline to the latter plan.

A light loose top-coat of ordinary make, or a light long sleeveless "Inverness," or paletot of porous tweed, unlined; a first quality stitched North British macintosh of same make, lined, well "hollowed" at armholes for ventilation, are both essential for Africa.

The overcoat, umbrella, and rain-coat should be always instantly available; the former to enwrap the sweating body at every cessation from labour; the latter as defence against sudden showers. Chills and fever will follow the neglect of these precautions.

Head, Neck, and Spine Protection.

The solar topee, or helmet, with *real* Indian puggaree, fly-net, and net-screen, or the Congo hat, with fly-net and neck screen, are best of all wear for hot weather—the Terai, cowboy, or Panama hat, with puggaree, for moderate weather; the travelling cap, or "canoe," for ship, road coach, train, and night-watching.

The Neck Screen.—This is a light fabric, composed of pith and gauze chiefly. It should hang like a curtain, from back of helmet or hat, 6 or 7 ins. down the neck, to guard it against the slanting rays of morning and evening sun, which, by striking under the helmet, often cause sunstroke, as I have known to occur amongst our troops on parade.

The Spine Screen.—This is made like the neck screen, but of somewhat stronger materials. It should measure 3 to 3½ ins. wide and 24 to 28 ins. long. Hook or button to collar, middle, and bottom of coat or shirt, or so protect the whole spine from the sun. It is very useful when there is much exposure and stooping.

Porousness, Ventilation, and Colour.

The *porousness* of a material is easily tested by *blowing* or *breathing* through it.

If it can be *blown* through with difficulty, or not at all, it is, in this respect, unsuitable for tropical clothing. If it can be *breathed* through, it is, in so far, suitable. Between the two extremes we must make the best selection we can.

A material which is not very porous, like cotton drill, may do for tropical wear by having it made into smock-frock Norfolk or Chinese pattern garments, the *free ventilation* so afforded compensating for its want of porousness.

Colour of Clothing.—Light shades of terra-cotta or brown, grey, or cream may be selected, but I prefer pure white.

The ideal garment for the tropics is thin, light, loose, porous, smooth, ventilated, and white.

Suggested Outfit for Tropical Africa for Travellers, Hunters, Missionaries, and Others.

Tent of rot-proof canvas, with fly and ground sheet; valise of same for Parke's African bedstead, folding arm-chair, cork mattress, mosquito curtain, four best Austrian blankets, indiarubber basin and bath, small woven wire or wool pillow, washing linen pillow-covers, rubber hot-water bottle (North British patent).

Canteen, containing nested cook-pots with movable handles, mincer, gridiron, ladles, enamelled plates nested, hot-water plate, knives, forks, spoons, pudding tins nested, teapot and kettle, block-tin pot, enamelled cups and saucers and goblets, salt, pepper, and mustard tins; the whole contained in galvanised iron bucket with lid, both of which are useful.*

Boxes or trunks (number to suit requirements), best American make; dimensions, 16 × 10 × 8 ins. outer measure, aluminium fittings; weight, 50 to 60 lbs. when full; lined with thinnest zinc sheeting is best. Stationery:

* See Parke's *Guide to Health in Africa* for list of drugs, &c.

pens, ink pellets, paper, note-books, drawing-books, rubber, pencils; Bible, Shakespeare, a few other unbound books of light literature and poetry; matches, luminous match-box, camphor tablets, toilet necessaries in leathern case, tooth-brushes, nail-brushes, sponges, sponge-bag, some finest scented soap, musk and attar of roses, waterproof canvas bag (green) for odds and ends, with lock; a "Prana" Sparklet Syphon with bulbs and accessories; water-bottle (vulcanite or aluminium); a Beresford lantern (folding) for oil or candles; leather colonial waist-belt, with strap over right shoulder; sheath for unclasped knife; holster for light nickelled revolver; ammunition pouch; flint, steel, burning glass, alarm whistle; South American grass hammock; pocket filter and other filters; cork-screws, tin-openers, champagne-opener, screwdriver, hammer, gimlet, and other tools; tool-knife. Boots—plentiful stock, strong, medium, and light; shoes and slippers; felt-soled canvas slippers; sandals, spare laces, dubbing; anglers' wading boots, knee high. Abdominal and pelvic protectors, light flannel undershirts, pyjamas, woollen socks and stockings, various suits of clothes as described in text, tweed overcoat, rubber overcoat, solar helmet and tweed cap with earflaps, puggarees, neck and spine screens, flannel dressing gown, light summer ditto, pocket-handkerchiefs, cashmere comforter, towels, brushes and other toilet necessaries, buff gloves, housewife, fishing tackle, hand-bags, cabin pocket and hooks, light woollen jersey, canvas suit, south-wester hat, compass, arms, handbag, medicines, cabin trunk $30 \times 16 \times 4$.

The umbrella must be a strong one with white and red linings, the latter over the white. All head-wear should be lined with red, which stops the dangerous rays of sun.

Above all else, a large-size *Vade Mecum* mosquito net with fittings should be taken—if possible, one made of rhea grass, for strength, durability and ventilation.

A Sunproof Cloth.

One of the dangerous elements of the tropical climate are the actinic rays, and as Nature has protected the native by means of a colour screen analogous to that used by photographers for the preservation of their sensitized plates, attempts have been made to accomplish similar protection for the white man. One of the most successful is that of Dr. Louis N. Sambon, Lecturer to the London School of Tropical Medicine, who has perfected a fabric, under the name of "Solaro," which is impervious to the sun's rays. The fabric is woven in such a way as to present an upper surface of neutral colour, such as khaki, and an under surface of red or orange. "Solaro" cloth has received the unqualified approval of numerous medical men, military officers, and travellers of repute, who have written in highly appreciative terms based upon actual practical experience. The fabrics have been accepted by the Examining Board of the Institute of Hygiene as fulfilling their standard of "Hygienic Merit," and are sealed at the Colonial Office for officers appointed to the tropics.

Major-General Rimington, C.B., in a letter from Deccan, dated 6th September, 1910, writes as follows:—"I used the 'Solaro' cloth habitually, and find it most suitable for the great heat here. I was out tiger shooting this summer, the thermometer about 115° in the shade—and one often has no shade—and I really think it helped to keep me fit." Another letter of recommendation is from Dr. H. G. McKinney, who writes from Southern Nigeria:—"Regarding my experience of 'Solaro' cloth, I have great pleasure in letting you know it is altogether favourable. The riding cloak was quite waterproof in a tropical thunderstorm, with heavy rain falling for over an hour. The tunic, which I always wore open, seemed to me to have prophylactic actions against the effects of the chemical rays of the sun. When I wore it I did not have the backache I nearly always suffered from when wearing the ordinary khaki drill tunic when sitting on horseback for five or six hours daily in a hot sun."

A Tropical Shirting.

A flannel shirting for the Tropics that appears to fulfil many essential requirements is "Soltego," which has recently been brought out by Messrs. Turnbull and Asser, the well-known outfitters, of 71-72, Jermyn Street, London, S.W. Its texture is finely woven, soft and elastic. It is light in weight, and furthermore made of colours that are calculated to resist the rays of the sun. The upper surface shows a neutral colour, while the under is of red—a combination that is well fitted to defend the body against sunshine. The "Indian Field" makes the following comment on "Soltego":—"It is particularly its sun-resisting qualities which commend it to all those using it in tropical climates."

CHAPTER XXIV.

The Tent and House Problem in Tropical Africa.

The essential points of a good tent are roominess, strength, lightness, ventilation, and durability, with highest protective powers against sun, wind, and rain, and fluctuations of temperature.

The military tents of India are made of coarse calico, three plies thick. They are of many patterns; but every kind has a double fly, each three layers thick, so that roof and flies together contain nine layers of calico.

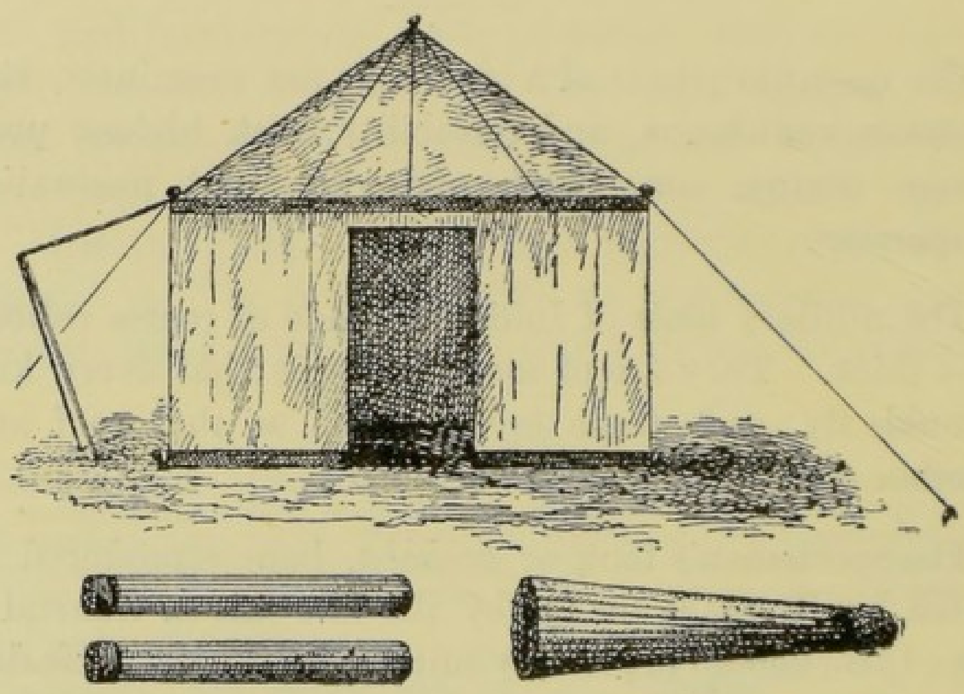
The sportsman's tent, or *bechoba*, here reproduced from a sketch kindly made for me by the late Lieut.-General Wray, R.A., C.B., should prove very suitable for Africa. He describes it as follows:—"The *bechoba* is a splendid tent; I have used it for years. It is without pole, the roof being kept open by resting on the walls, having ribs of light female bamboo sewn into the cloth like wires of an umbrella. It has three pieces of coarse calico *(dungaree)* in both roof and walls, and it may be easily carried on a pony.

"It holds two comfortably, being 10 ft. square. Under a tree it is the best tent in the world, and being stiff in the roof, keeps the rain out well, the cloth not bellying."

General Wray warns us against the use of the "bell tent," of which he had bitter experience during the Crimea War:—"Such tents are toys, and most uncomfortable."

On my Zambesi trip I took with me two tents, made by Benjamin Edgington, Duke Street, London, S.E., of green rot

PLATE I.



THE BECHOBA, OR INDIAN SPORTSMAN'S TENT.

and damp proof canvas,* on a pattern approved by Stanley, Cameron, Wissman, and other authorities.

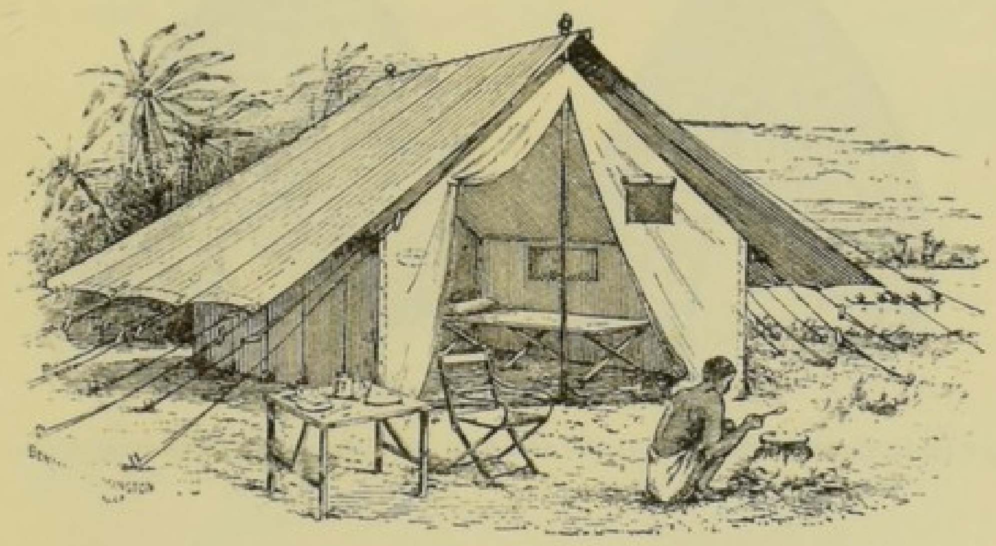
These tents were provided with large flies and ground sheets of same canvas, and, following Dr. Pruen's advice, I

* The canvas now universally used for tropical tents is prepared by steeping ordinary canvas in strong solutions of sulphate of copper, which makes it resistive of wet and rot. I found a sheet which I had thrown over potatoes in a damp cellar just as I had left it after seven months, while cotton fabrics were covered with mould. The Wissman tent of this pattern measures 9×7×7 ft., and weighs 90 lbs.

added ceilings of coarse green baize. I regret not having had the walls similarly lined, and baize screen to draw across the door, as more perfect defence against oscillations of temperature.

The crucial test of the sanitary fitness of house or tent is the range of the indoor protected thermometer. The less the mercury fluctuates by day and by night—other things being equal—the nearer the dwelling approaches perfection for comfort or health.

PLATE II.



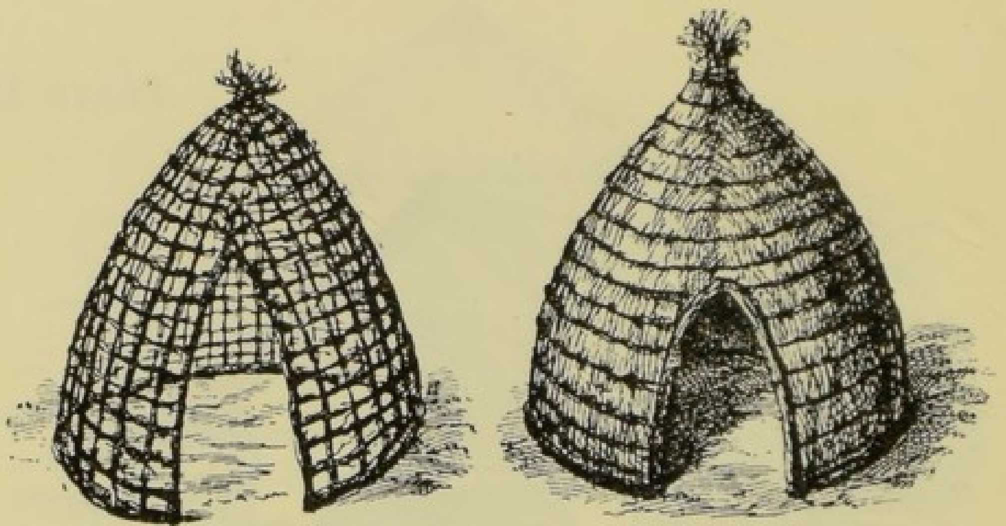
EDGINGTON'S APPROVED TENT FOR TROPICAL AFRICA (9 × 8 × 6 FT.)

The Zulu hut illustrates this cardinal principle. It is bee-hive shaped, and the walls, which are very thick, are substantially built of thatch and wattle. It has no windows, and the door is a mere hole to be crept through. The hut is dark and cool inside even at midday, and *the thermometer hung from the centre of the roof shows only a few degrees of range in the twenty-four hours at any season of year or time of day.*

Dr. Pruen's useful hospital hut for natives, built of boughs crinoline fashion, and afterwards thatched with reeds or grass, is cool and serviceable.

Its door is, however, larger, walls much thinner, and it is smaller in all dimensions than the typical Zulu hut, which it resembles in shape.

PLATE III.



DR. PRUEN'S HOSPITAL HUT FOR NATIVES,

6 to 7 ft. in diameter and about the same in height.—From *Arab and African.*

HOUSE-BUILDING.

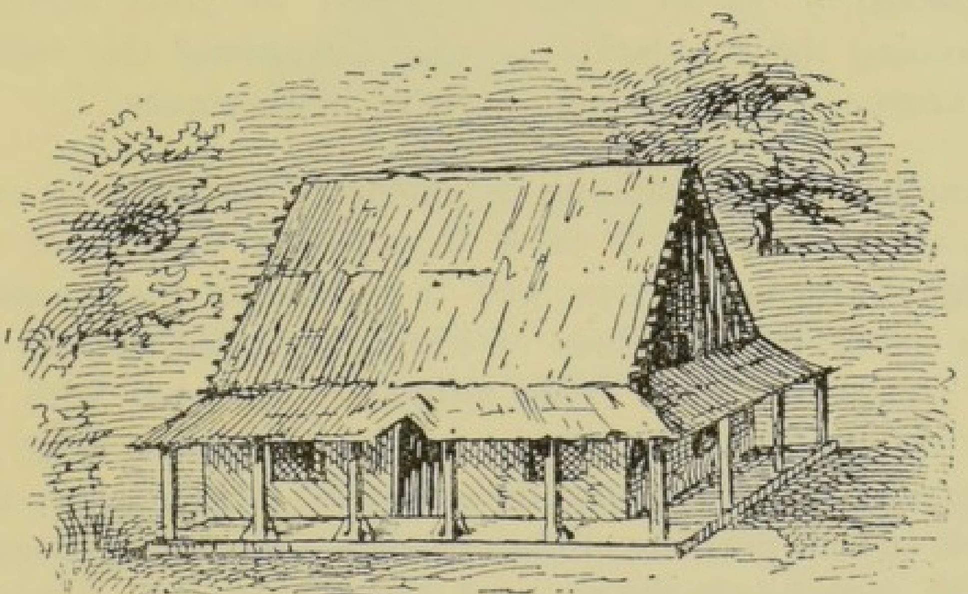
All houses should be built of the best materials procurable, and be constructed upon sanitary principles. *For the tropics they should be planned mainly for coolness, ventilation, exclusion of malaria, and maintenance of equable indoor temperature at all times and seasons.*

On the West Coast I lived in a European-made board-house of excellent appearance, with good verandahs, lofty, well-proportioned rooms, and glazed windows; yet it was neither comfortable nor healthy, owing to the thinness of the walls and roof, and its unshaded position, which occasioned a high range of indoor temperature, at times from over 85° Fahr. by day to under 50° by night.

It was also built on the top of a high hill, so that great perspiration was produced by climbing home. We do not stable a sweating horse, but appear to forget that a perspiring man cannot plunge frequently into the cold air bath of his house without risk of chills and consequent fever.

As a good type of temporary house I select Mr. Arnot's.

Plate IV.



The Arnot Temporary House for Tropical Africa.

He thus tells us how he built it:—

"After measuring out a piece of ground 30 by 15 ft., I began to dig a deep trench for the foundation. The lads found nothing but rock under the surface, so that it was laborious work picking and digging a trench deep enough to well imbed the poles which were to form the walls of the house. Whilst a few of us busied ourselves in digging out this trench, others went to the bush to cut the poles, and for each one brought in I paid them 20 beads. The poles were then cut into equal lengths, and set up in the trench close together, in the same way as the fences of old railway-sleepers we are accustomed to see. Two openings were left for windows, and one large space in the middle for a door. Across the poles the men placed small canes, something like bamboo, which were bound on with cords of bark. These acted as laths in supporting the mud with which the walls were afterwards thickly plastered. The rafters I made of split teak wood, over which transverse slips of cane were bound, and the whole was carefully thatched with grass. A spacious verandah, 6 ft. in width, I found of great service in promoting the circulation of cool air around the walls of the house. The doors were made of hewn planks."*

Another way of building a temporary house is by erecting, at intervals of 2 or 3 ft. apart, a number of 6-in. uprights with forked tops, and then binding them together with wattle, the interstices of which are filled up with mud and stones, the walls being ultimately plastered with mud and whitewashed. In this house the tie-beams, ridge-pole, joists, and rafters are supported upon the forked sticks ; those at the ends of the house, forming gables, will vary, of course, in length, according to the required pitch of the roof. Thatch or bark roofing, or both combined, will suit such houses best.

A dwelling of this kind may be quickly and inexpensively put up, and if provided with wide verandah and double thatch or bark roof, it will prove fairly comfortable and sanitary.

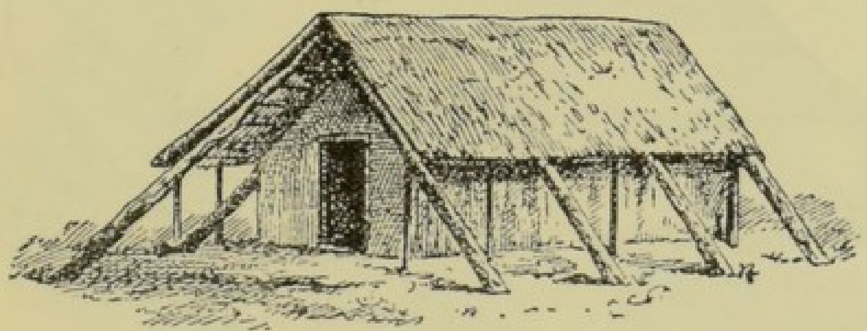
Another way of making the walls is to interpose between the uprights two perpendicular layers of bamboo, with air

* The illustration and description are taken from *Garenganze; or Seven Years Pioneer Missionary Work in Central Africa.* By S. F. Arnot. (James E. Hawkins, London.)

space intervening ; the inside bamboos are then covered with native mats, the outside plastered and whitewashed.

The floor should be of cement, concrete, or trodden ant-hill clay, which Dr. Pruen recommends to be tarred and sanded over as a protection against ants. A calico or baize ceiling may be stretched beneath thatch ; baize curtains behind outer doors, and instead of inner doors the door may be made of

PLATE V.



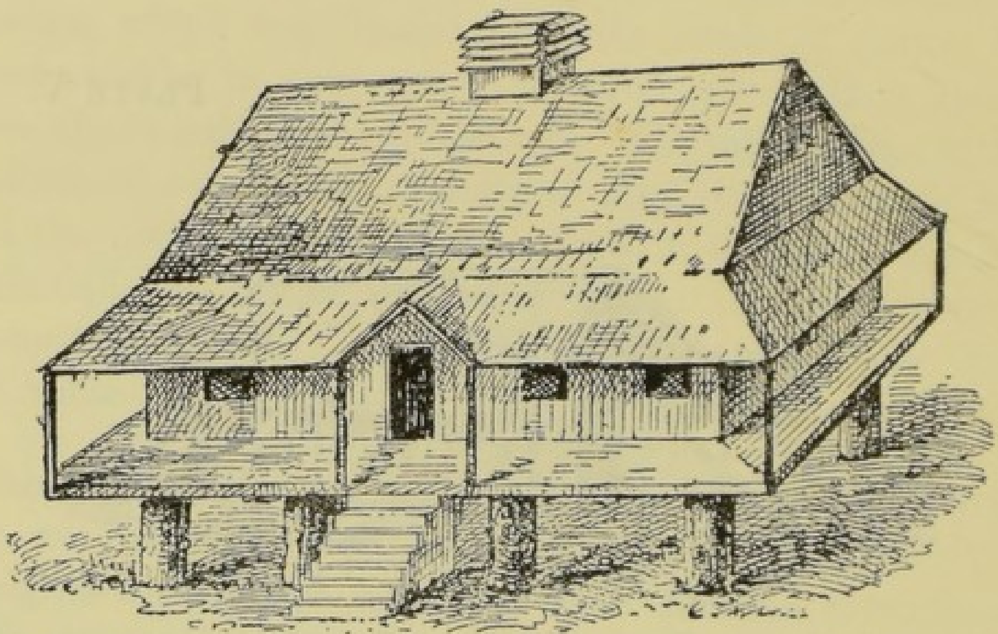
DR. PRUEN'S TYPE OF TEMPORARY HOUSE FOR AFRICA.
(From *Arab and African.*)

canvas nailed on a light frame, while one or two layers of mosquito-netting will serve provisionally for windows.

Another form of temporary house is shown in the illustration, which may be very quickly and cheaply put up. Its walls are composite—wood, wattle, and mud, as before described—but the roof timbers being prolonged down to the ground simplifies the construction.

Plate VI. shows the style of house generally used in the tropical African bush, and hitherto considered the acme of sanitary construction. It has many good points, a wide, well-shaded verandah, lofty, well-ventilated rooms, and the building well raised on piles above the ground. That shown in the plate was built of imported timber and cost some hundreds of

Plate VI.



The Old-Fashioned Type of Unscreened House used in the Tropical African Bush.

(Dr. Murray lived in this house about a year.)

pounds, but generally such bush houses are built of native materials found on the spot, and have no verandahs, the walls being of wattle and thatch palm fronds. There are openings everywhere in such houses, not only for the free admission of air, which was enjoyable, but also for mosquitos, and fever was for ever present in those standing near native habitations.

Yet, by the daily use of quinine, and having a fire in my room all through the night and another burning in front of the house, by which means mosquitos and mould were practically banished, I lived in such a native-built house with no mosquito net for nearly a year without contracting fever.

Description of Diagrammatic Section of Tropical Sanitary Bungalow (Plate VII.)

Such houses may be built of wood, brick, stone, concrete or mud (as in India), the essential point being walls 2 or $2\frac{1}{2}$ feet thick, and some 20 to 25 feet high, and that they should be perforated at proper intervals by ceiling and basement ventilators $E''\ A$ and $E'''\ C$.

A double roof, $RR,'$ is best with air space between. The outer roof may be of thatch (if shingle is not available), the inner of wood, well tarred on both sides to prevent the ravages of insects, or it may be made of a single or double layer of rot-proof green canvas stretched on tarred frames.

The ceiling ventilator, $E''\ A$, is really an open space from 6 to 12 ins. wide, extending around most of the walls beneath the roof, and the basement ventilator, $E'''\ C$, is also an open space in the wall below of the same character ; both can be closed at intervals within by a simple louvre shutter arrangement.

The windows, $E'\ B$, should be of French pattern, opening inward on hinges. The verandahs should be from 9 to 12 ft. wide, and about same height as pillars, being, in fact, regarded as a most useful outdoor suite of apartments.

The floor of the bungalow should be composed of three layers, the lowest broken-up stones or bricks well soaked in tar ; the second of anthill or other clay or clayey earth well beaten and stamped down and tarred ; the third of concrete or cement well smoothed on top.

Such floors are far preferable to boards, which are not only attacked by the white ant and other insects, but also absorb water and noxious emanations.

The platform, of rubble or masonry, on which the house and verandah stands, *PP.*, should be well raised above the ground.

Thin iron pillars are the best for verandahs, but certain African hard woods may be used instead. E E' E'' E''' show the most important feature of these sanitary buildings, the wire gauze screening and the mosquito door or porch.

Generally, it suffices to screen the verandah, but some prefer to screen both house and verandah. Supposing the latter to be the case, we see that all the ventilators must be screened and also the windows, E' B. A wire-gauze frame opening on hinges outwards will suit here. If wire gauze instead of wooden panels is used on all the doors of the house the most thorough ventilation will be obtained. The ceiling, A A, may consist of strips of baize or calico in lengths running on wires, as seen in photographic studios. Such can be drawn back in hot weather, and drawn over in the chilly, rainy season, when a stove may be necessary in some of the rooms.

An Eastern Flat-Roofed Bungalow.

Plate IX. is sketch of a House built for a lady doctor at Camaran, on the Red Sea, and it would be certainly a most suitable type of bungalow for Tropical Africa if only the verandah is securely screened and mosquito-proof doors or porch introduced (Plate VIII.).

The bungalow is built on a masonry, or rubble and clay, platform. It has a wide all-round verandah shaded by a well-made roof resting on pillars below, on wall above. The roof is of the kind called "Tap-tap" in Syria, and consists, first, of stout wooden planks, resting on strong wooden girders and transverse beams.

On the planks is first placed a layer of native matting; this is covered with a thick layer of clay or clayey earth, which is thoroughly beaten with shovels and stamped down ; on top of this comes a layer of shingle, and above all a layer of lime, concrete or cement. It is the beating down and tramping, which goes on for several days, in making this roof which gives it the name of "Tap-tap."

This kind of roof lasts for years without needing repair. It is damp-proof and heat-proof, and greatly lessens the liability of fire.

Being flat, by building a parapet around it, as shown in the picture, and making an outer staircase at the back, where it will not offend the eye, such a roof answers admirably as a raised terrace for use in hot weather, and can be easily covered by awnings, from the posts of which the *Vade Mecum* mosquito net can be suspended when necessary to form an insect-proof room.*

Excreta: Disposal of in Tropics.

This is a difficult subject in all tropics. The use of closets in small places should be confined to earth.

Deposits of fæces near streams, or in tidal rivers, or in privy pits in the vicinity of wells, or communicating with underground water is a grave danger to public health, besides being most unpleasant and unsatisfactory.

In small domestic privies, where the house is away from the town and from all wells, a single dug-out pit, placed to the lee of the house, may suffice as a temporary expedient, provided there is a box of well-dried earth handy, and the use of some is never neglected. Surround pit with a eucalyptus shrubbery.

The soil will absorb the fluid part of the fæces, the solids will also disappear in time, but their presence, if left uncovered, gives risk of propagation of house and other flies, that

* For further particulars, see *Report by the British Delegate on the Constantinople Board of Health, Turkish Lazarets. Lancet*, Vol. I., p. 1,506, 1907.

lay their eggs and develop in them, and subsequently convey on their legs and proboscis the poisonous matters they have been crawling over, to contaminate man's food and body. Therefore, besides earth, some cheap chemical disinfectant should be often used to prevent the breeding of such insects. Natives should be obliged to use earth pits also, and to keep them properly.

Green Wash.

Instead of ordinary whitewash for roofs and walls of houses, I recommend the following green wash for the tropics:—

Take of lime 5 lbs., of sulphate of copper 10 lbs.; mix them in 50 gallons of water, adding 1 lb. of crude carbolic acid to the mixture, and also some size or other fixing ingredient.*

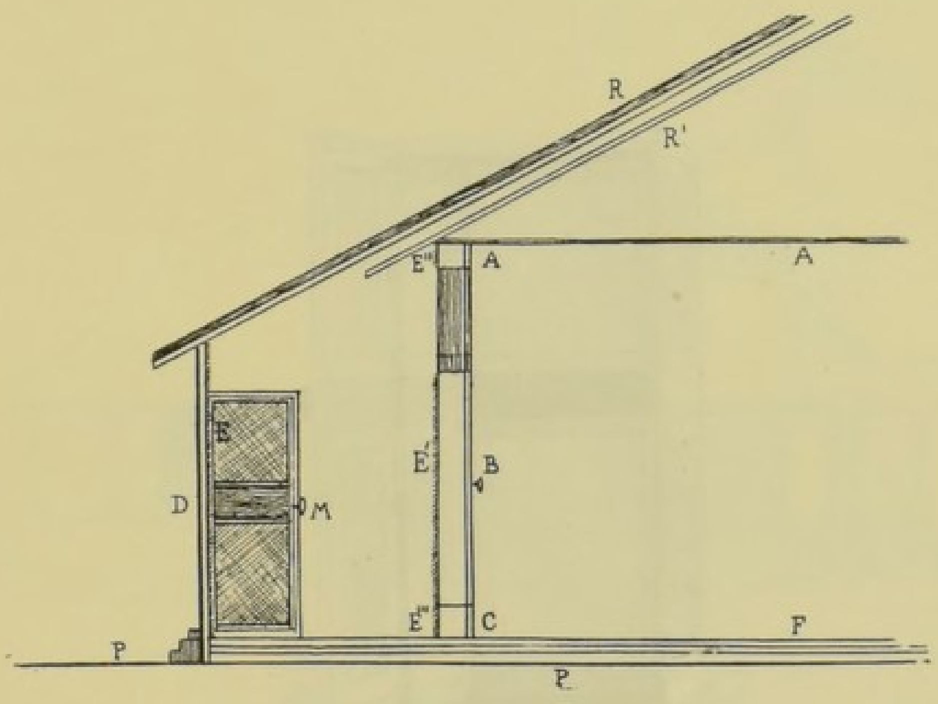
Such a mixture will answer excellently for disinfecting privy pits.

Floor Washing.

The floors and woodwork of houses should be carefully washed daily or at least twice a week with hot water containing washing soda and 5 per cent. of carbolic acid.

* Adhere to above proportions in making smaller quantities of wash.

PLATE VII.



Sectional plan of a modern tropical sanitary bungalow, showing in diagram the principle of its construction and method of wire gauze screening.

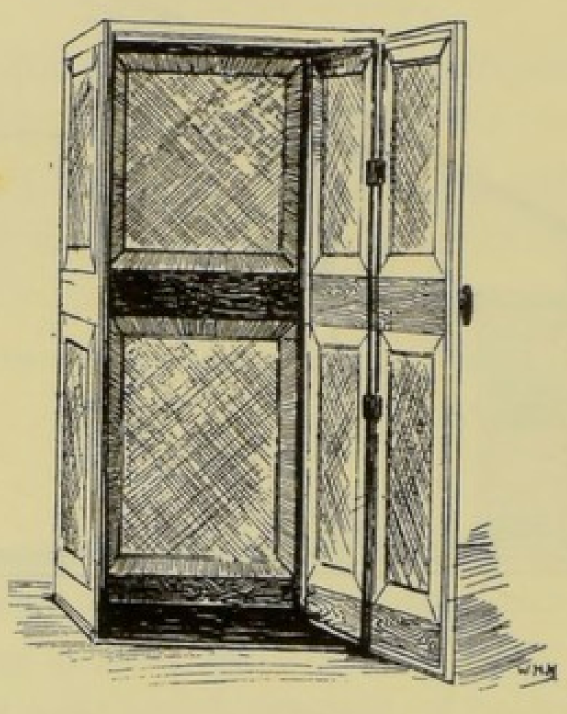
R R', the double roof. *E E' E'' E'''*, wire gauze screens of the verandah, ventilators, doors, and windows.

D M, mosquito door or porch ; a similar one may be used in house. *B*, French window opening on verandah.

P P, raised rubble or masonry platform of bungalow.

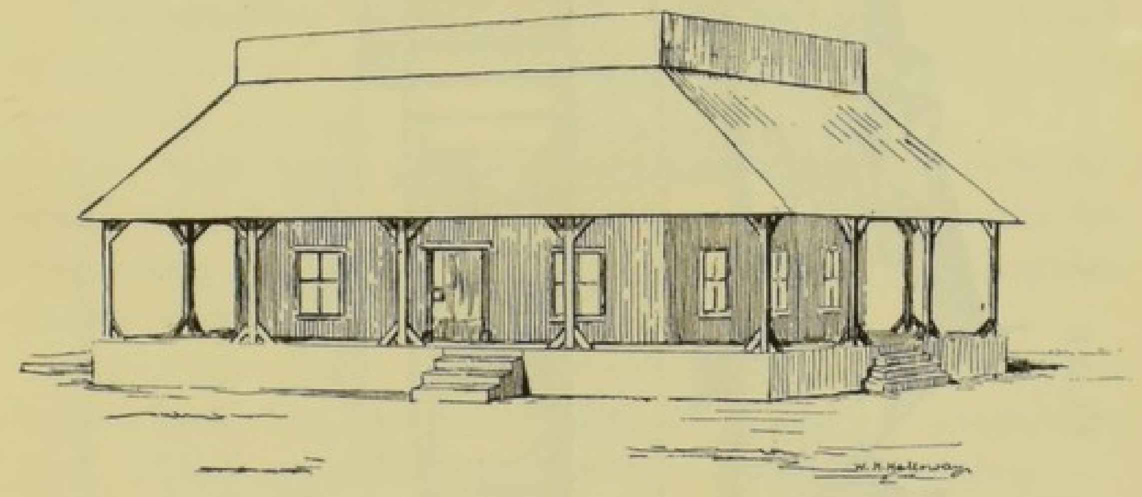
A A, ceiling. *E'' A* and *E''' C*, ventilators.

PLATE VIII.



View of a screened double doorway, or sanitary porch, as used in the screened houses in the Panama Canal zone and elsewhere. Both are spring doors, and the outer is here represented open ; it closes before the inner is opened. Wire gauze fixed in frames form the doors and sides and top of porch.

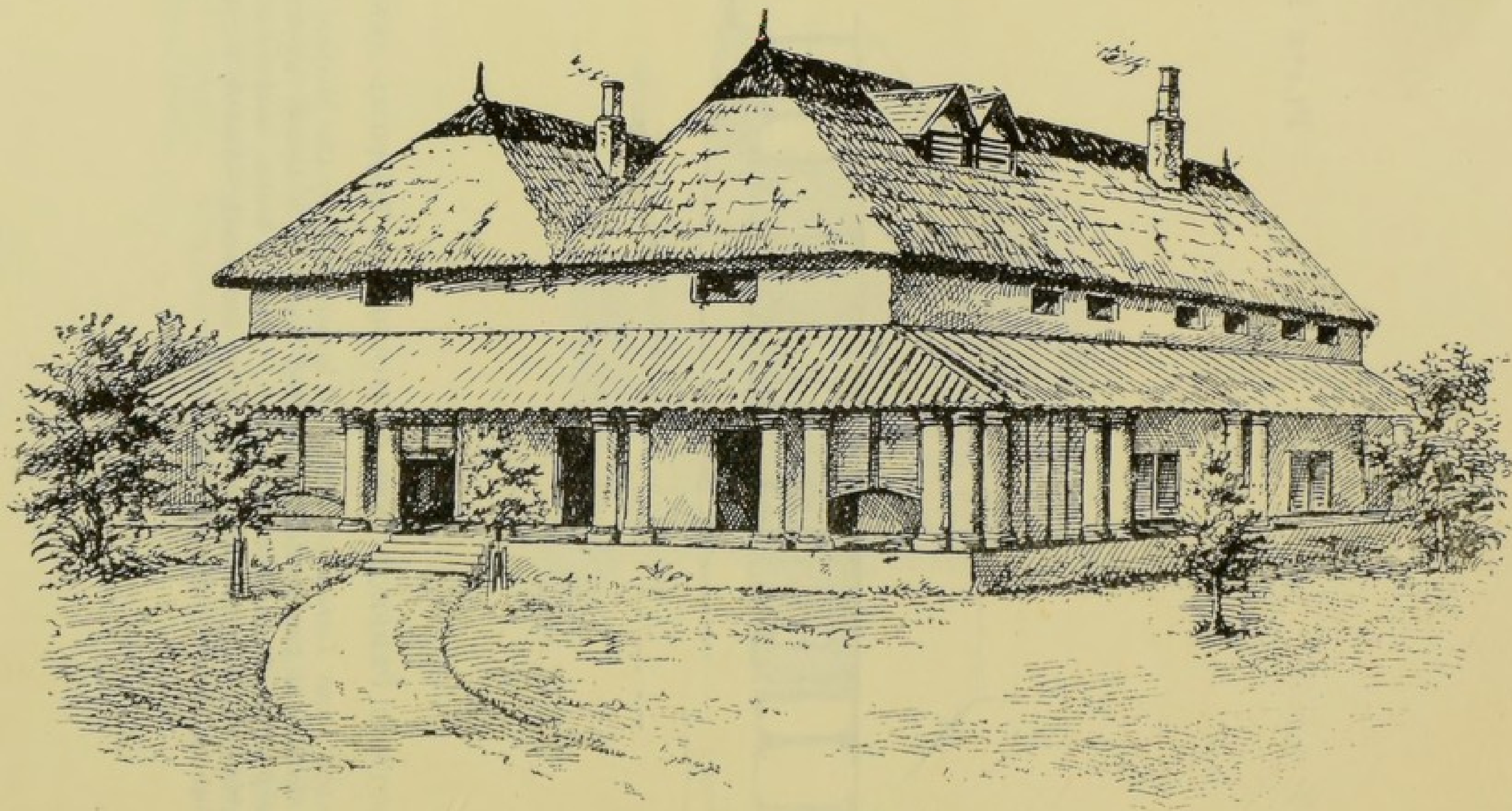
PLATE IX.



ANOTHER PERFECT TYPE OF HOUSE FOR TROPICAL AFRICA.

Sketch from *Lancet* of a typical house used by the Medical Officer of a station at Camaran, on the Red Sea. It is locally known as a *Tap-tap* house, from its construction. Such a house, well screened, or its verandah well screened, would prove excellently suitable in all parts of Tropical Africa. *See page* 306.

Plate X.



INDIAN BUNGALOW.

The Indian Bungalow.

ANOTHER TYPE OF HOUSE VERY SUITABLE FOR TROPICAL AFRICA.

(See Illustration, Plate X.*)*

The sketch is taken from a photograph of one in India. It is built upon a masonry platform raised $2\frac{1}{2}$ ft. above the level of the ground. The platform is beautifully level and smooth on top, where it forms the floor of rooms, passages, and verandah, being covered here and there with native mats. Its many advantages will be apparent to anyone who has lived in the tropics or even perused this book.

The verandah is 9 or 10 ft. wide, and has a tiled roof, which is supported on pillars; it extends almost or quite around the house.

The doors and windows open directly upon the verandah, which is shaded in parts by shrubs, and generally by bamboo sunscreens, or "chics," three of which, wholly or partially drawn down, are represented in the sketch.

The walls of the house are of mud or clay, $2\frac{1}{2}$ ft. thick below, somewhat less above, and 24 ft. high, to junction of roof. They are whitewashed without and tinted within.

The dormer windows seen on the roof are for ventilation merely, as there is no upper storey in these bungalows. The house is thatched with reeds or grass, the roof being about $2\frac{1}{2}$ ft. thick, and rising to a ridge 15 ft. above the top of the walls, which it overhangs some $3\frac{1}{2}$ ft. at eaves.

The roof is perforated by windowed structures for ventilation, and by the necessary number of chimneys.

Venetians, tatties, and glass are used in the windows and doors; two windows, with venetians closed, may be seen in sketch.

It would be quite easy to fit up such a bungalow with wire gauze screening and mosquito-proof doors. But the spacious verandah would present many difficulties if it were to retain its pleasing architectural form. It would be a pity to give such a building the "meat-safe" look of the screened houses of the Panama Canal, nor would it be necessary if gauze were carefully used to close every opening in the house.

The Screened Houses of the Panama Canal Zone.

(See Frontispiece.)

A description of these fine houses has been given already, also reproductions of some of the fine photographs sent to me by the courtesy of the I.C.C., Panama.

These houses contain in perfection every modern sanitary factor, and although the wire screening somewhat mars their appearance, their architectural outlines are fine.

The site of these houses has been carefully selected for their elevation and pleasing prospect and surroundings.

Harmless and beautiful native trees and shrubs have been left standing around the house, and one may feel certain, that other ornamental plants have been put in, and swards and flowers and other details of landscape gardening carefully attended to when possible by a race whose strenuous temper feels the need more than any other people of the soothing solicitations of Nature.

I hope we shall copy America in this, and make the surroundings of our Tropical African homes refreshing to the glare-wearied eyes and healing to the drooping and distracted spirit as possible.

If there be a place in the whole world where the soul needs awakening, uplifting, and sustaining by tender strokes of Art and Nature combined, that place is Tropical Africa. Here especially

A THING OF BEAUTY IS A JOY FOR EVER.

FINIS.

Recipes for Making Oatmeal Water and Barley Water.

Oatmeal Water, as already pointed out in the chapter on "The Drink Problem," which appears in this volume, is highly valuable as a nourishing and sustaining beverage for hot climates.

The readiest and most useful and efficacious mode of preparing Oatmeal Water is by using Robinson's "Patent" Groats according to the following recipe :—

> Mix one dessertspoonful of Robinson's "Patent" Groats with a wineglassful of cold water into a smooth paste. Pour slowly into a stewpan containing one quart of boiling water, and stir over the fire for ten minutes. Allow the mixture to cool; it is then ready for use. A slice of lemon may be added as flavouring, if desired.
>
> If hot water is not available, the "Patent" Groats should be mixed into a smooth paste as directed above, and then stirred into a quart of cold water. This, however, should not be continued for any length of time as the uncooked meal would in time affect the digestion.

Barley Water also has many enthusiastic advocates as a drink of supreme value for tropical countries. From the earliest times, barley has been used to prepare drinks for the sick, and Barley Water is constantly prescribed in fever cases.

A very famous physician, in treating recently a foremost citizen of New York, found that the addition of Robinson's "Patent" Barley to the milk given to his patient worked wonders. He writes that equal parts of milk and Barley Water made with Robinson's "Patent" Barley constitute "the most satisfactory preparation we have in modern times for feeding typhoid fever patients." It is wise to drink largely of Barley Water at all times in fever districts, on the ground that "prevention is better than cure."

It is an excellent variant on Oatmeal Water, and is made with Robinson's "Patent" Barley in precisely the same way.

The superiority of Robinson's "Patent" Barley and Robinson's "Patent" Groats to ordinary pearl barley and oatmeal is partly due to the fact that in this form the full nutritive value of these cereals is more easily obtained. There is the additional advantage of reliability and good keeping qualities.

Robinson's "Patent" Barley and "Patent" Groats are obtainable at leading stores throughout the world. In case of any difficulty, however, write at once to :—

J. & J. COLMAN, LTD.,

With which is incorporated KEEN, ROBINSON & CO., LTD.,

Carrow Works, NORWICH, England.

SEE PAGE 172.