HOW TO LIVE

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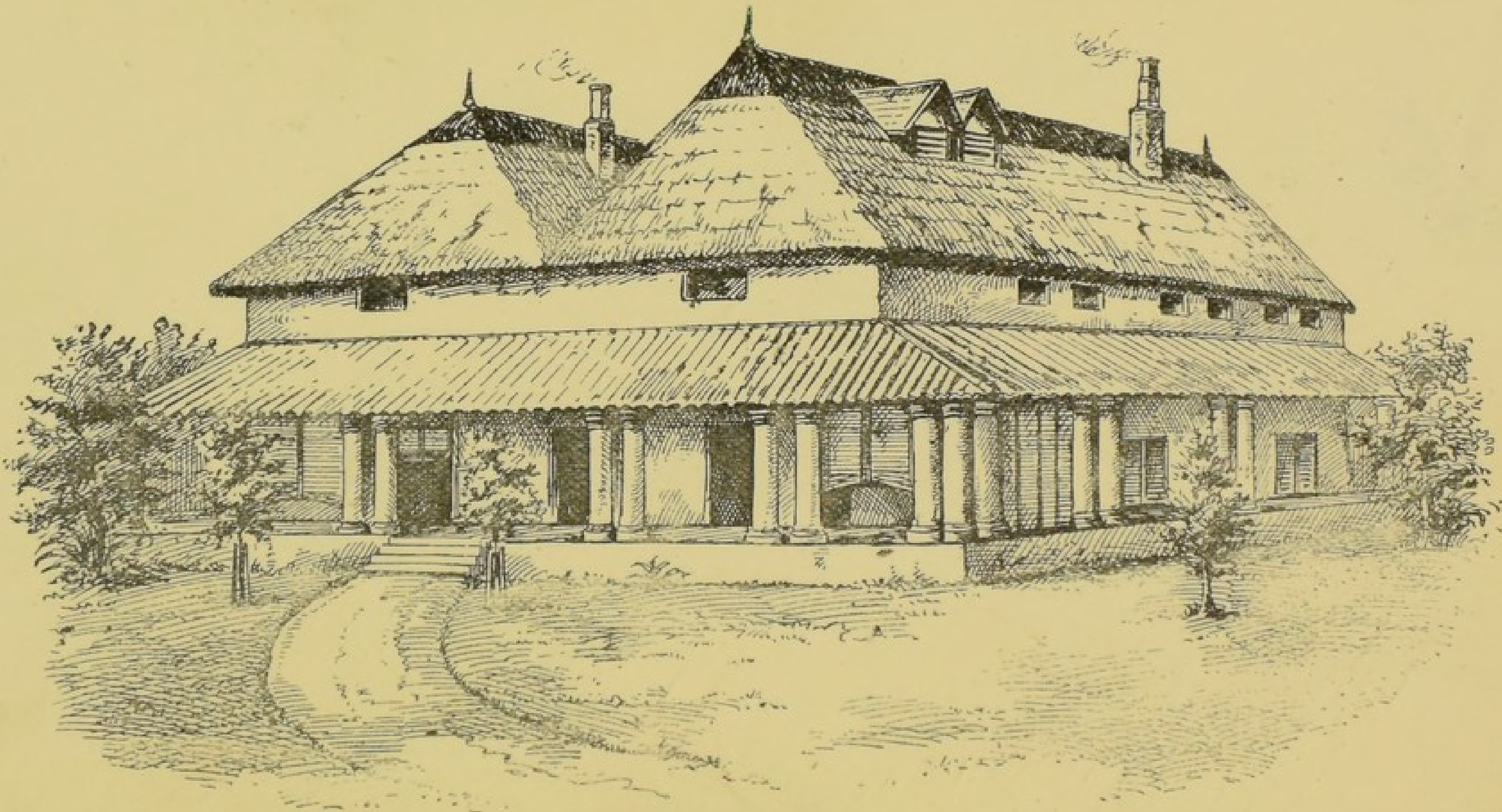

THE INDIAN BUNGALOW, OR PERFECT TYPE OF TROPICAL HOUSE.—*From a Photograph.*
See p. 251.

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TROPICAL AFRICA

A GUIDE TO TROPICAL HYGIENE.

THE MALARIA PROBLEM:
THE CAUSE, PREVENTION, AND CURE OF MALARIAL FEVERS.

BY

J. MURRAY, M.D.

Erst wägen, dann wagen.

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

WITH ILLUSTRATIONS.

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PREFACE.

AFRICA has ceased to be, in a geographical sense, the Dark Continent. It is now known physiographically, and is yearly becoming of increasing importance in the world.

Yet in one true sense darkness prevails, where malaria broods over the land, as a great power for evil.

Fever mainly prevented the civilisation of the continent in the past; will it continue to prevent, or at least retard, civilisation in the future?—That is the question which, in full view of the whole field of enquiry, may be confidently answered in the negative.

"*The thing that hath been, it is that which shall be,*" was not spoken of our NEW AFRICA.

Its pestilential littoral, its higher ague and fly belts—that formed almost insuperable barriers, destroying the lives and marring the health of the few adventurers who laboriously tried to traverse them—are now in process of annihilation by steam.

This means, in short, that a central highland region of singular beauty, richness, and fertility, large as Europe, has been thrown open with unprecedented quickness, not merely as a possible, but an inviting field for European expansion.

Stanley and Rhodes did this work for us.

Yet even under such promising auspices, the colonisation of New Africa cannot be effected without a heavy tribute of sickness and mortality. But while a careful review of the problem enforces this conclusion, it also inspires good hope, by showing that malaria is not unconquerable. We see that it has been expelled from England and Holland; and although Italy, Greece, India, and other old countries still languish in its grasp, there are grounds for the belief that, with improved agriculture, including drainage and tree planting, the elevation of the average standard of the peoples' comfort, and, above all, the free diffusion of knowledge of personal and domestic hygiene, the mortality from malaria in all countries will decline.

It appears reasonable to expect that mitigation of disease and saving of life will result in New Africa, as elsewhere, when people know better *how to live* in their altered environment: mainly in proportion to the extent and accuracy of such knowledge has been and will be the issue of man's health history in all tropical countries.

The ubiquitous, lethal fever should be studied: it is scarcely prudent to reside in a country where this pest is endemic, in utter ignorance of its nature, and unskilled in the art of averting and treating its attacks.

To supply such knowledge in reliable, comprehensive, well digested and accessible form, is the aim of this little

GUIDE TO TROPICAL AFRICA.

MALVERN,

JANUARY 1, 1895.

CONTENTS.

INTRODUCTORY.

NEW AFRICA.

By act of the Berlin Conference of 1884-5, the political partition of Africa was consummated.

Europe may be now said to hold all pagan Africa, but the Mohammedan Soudan still lies to a large extent under the dominion of native sultans.

The subjoined Statistical Summary of this great European annexation shows the area and population, under each flag, in this New Africa, which, viewed from the standpoint of health, forms the main subject of the following pages.

TABLE
of Areas and Populations, in 1894, of New and Old African States and Protectorates, by E. G. Ravenstein, F.R.G.S., &c.

Nationalities.	Square Miles.	Population.
Total Continent of Africa . .	11,276,000	
,, Islands of Africa .	238,800	
British . . .	1,828,000	34,300,000
French	2,740,000	24,000,000
Portuguese	820,000	5,400,000
Germany . . .	888,000	6,000,000
Italy	648,000	6,300,000
Spain	214,000	440,000
Congo State . . .	870,000	15,000,000
Boer States and Swaziland .	177,000	755,000
Remainder	3,329,800	42,000,000
Total of Africa . .	11,514,800	134,195,000

How to Live in Tropical Africa.

CHAPTER I.

CLIMATOLOGY.

Part I.—General Medical Climatology.

Climate is made up of numerous and often inscrutable factors. Briefly, it includes consideration of :—

I. *Purity of Atmosphere.*
II. *Temperature.*
III. *Atmospheric humidity, including rainfall.*
IV. *Sunlight.*
V. *Rarefaction of Atmosphere.*
VI. *Ozone.*
VII. *Wind.*
VIII. *Electricity.*
IX. *Soil and Aspect.*
X. *Vegetation.**

I.—Purity of Atmosphere.

Impurity of atmosphere from excess of carbonic acid, sulphurous acid, and other noxious emanations, save

*See *A Text Book of General Therapeutics*, by W. Hale White, M.D., F.R.C.P., &c. (Macmillan & Co., London and New York, 1889), to which I wish to express my indebtedness in the preparation of Part I.

miasmatic, are not pertinent to this inquiry, and may consequently be neglected.

II.—Temperature.

Temperature is materially influenced in all countries by local conditions, the chief of which are absence or presence of *water*, *wind*, and *elevation*.

Water affects climate by its specific heat, which is five times greater than land; consequently, it parts with heat very slowly, and requires much to raise its temperature. This applies to large inland lakes as well as to the sea, and makes places situated near either, warmer in winter and colder in summer.

The temperature of prevailing winds and the shelter of hills both materially influence the temperature of a place.

Elevation diminishes temperature 1° F. for every 350 feet above sea level,* the diminution being greater the drier the air, for fall of temperature by condensation of moisture sets free latent heat.

Moist, cloudy atmosphere absorbs much of the sun's heat in passing through it; therefore places under the equatorial cloud-belt are comparatively cooler than those at a greater distance from the equator in the tropics, where the atmosphere is freer of moisture. A moist atmosphere and cloudy sky diminishes radiation at night, and, consequently, the earth is warmer on such than on clear nights. On the tropical central tablelands of Africa and other continents the nights are usually clear

* In Africa this general statement must be modified, after Ravenstein, to 364 ft. of altitude for every 1° F. of temp. on the low lands, and 313 ft. for every 1° F. on the highlands.

and cool, and radiation goes on so quickly that ice may be formed artificially, as is done in India.

Range and Mean Temperature.

Range includes the diurnal, monthly, and annual extremes of temperature; *i.e.*, the record of the hottest and coldest hours of the day or months of the year.

Mean temperature includes the daily, monthly, and annual mean of registrations over each period respectively; *e.g.*, the mean annual temperature of Greenwich is 49° F.; of Cape Town, 61° F.

The mean temperature of a place is a more fallible guide than its range; but the factors being complemental, must be associated in arriving at a just estimate of the climate. Thus the mean daily, monthly, or yearly temperature may be excellent, yet the range may be too excessive for prolonged European residence; and this extreme range may be too much or too little.

The fallacy of judging climate by one or more of its factors, disconnected from the remainder, is impressively shown in Ravenstein's table, p. 28; *e.g.*, Bolobo (Congo) has the same mean daily range of temperature, 15° F., as Rome, and Khartum almost the same annual range, 25° F., as Greenwich (28° F.), while the difference of all other factors of these climates is strikingly apparent. Or, to put the matter in another light, as Ravenstein has done in *The Development of Africa;* by ascending 10,000 ft., beneath the equator, we reach a point having the mean annual temperature of Greenwich; to say that, consequently, we had found the climate of London, would be a *reductio ad absurdum.*

Again, the pleasant coolness of the nights of certain places in the tropics has been erroneously put forward as a proof of their suitableness for Europeans, whereas the opposite is the case, unless the houses are so constructed that the range of the indoor thermometer remains small at all times and seasons (see chap. xix.).

To live in badly constructed tents, or single board houses, in a climate which at certain seasons exhibits a range of from 40° F. and under by nights, to 90° F. and over by day, is incompatible with health for permanent residence, save by the enlightened practice of tropical hygiene.

In short, the climates of tropical Africa and Europe are too essentially different to admit of just comparison; and the sooner the vicious mode of describing the former in terms of the latter disappears the better. The tropics of Africa are practically seasonless in the European sense, and their climates are broadly characterised by a lower annual, and higher diurnal, range of temperature than those of Europe, in regions physiographically possible for permanent white settlement.

The range increases, not only from the equator to the poles, but from the coast towards the interior of the continent; and the region of extreme range in Africa, as elsewhere, coincides approximately with that of lowest temperature.

The range is also greater in the Northern than in the Southern hemisphere.

In the mountain districts of the interior the range diminishes with the height above the sea, which depends not only on remoteness from the sea, but on the increased dryness, tenuity, and purity of mountain atmosphere as we ascend.

III.—Atmospheric Humidity, including Rainfall.

Atmospheric humidity is determined by several causes.

(1.) *Elevation.*—The higher the altitude the less atmospheric moisture—half the vapour in the atmosphere being below 6,000 feet.

(2.) *Temperature.*—The higher this is, the greater the absorptive capacity of the air; and under circumstances of copious and free evaporation, the greater absolute quantity of moisture it contains. But in some places, and under like conditions, the humidity is comparatively less at higher than at lower temperatures, because the increased evaporation cannot keep pace with the rise of temperature.

Humidity of wind is a principal cause of moisture in some places—as the English S.W. wind.

The quantity of moisture in the atmosphere greatly affects the temperature, for when the air is very dry, the radiant heat of the sun is very great, and *vice versa.* As the air is drier at high altitudes, high latitudes, and in cold weather generally, radiant heat is greater under such conditions: hence the intense heat of the sun described by Tyndall, in his ascent of Mont Blanc, while it was freezing in the shade; "the great radiant heat at places such as Davos;" and why, "in Arctic regions the pitch will bubble on the side of the ship exposed to the sun, at the same time that water freezes on the side in the shade."* "Mountains," says Tyndall, "are cool, and act as condensers, because above them spread no vapour screen of sufficient density to intercept the heat, which, consequently, gushes into space from the tops when the

* *A Text Book of General Therapeutics.*

sun is withdrawn: also, because the sun cannot warm the air devoid of moisture and other floating matter, so under fierce sunlight the mountain snows may be perpetual."*

The air is said to be *saturated* when it contains the greatest amount possible of watery vapour at a given temperature. If from any cause there is a sudden lowering of temperature, cloud, fog, mist, rain, snow, or hail will result. As all these keep off solar heat, a knowledge of the moisture and cloudiness of a place is necessary to determine its temperature and suitableness for residence.

"Water itself absorbs 80 to 90 per cent. of heat in very thin layers of 0·02 to 0·27 inches, and vapour of water would, could it be examined, do likewise. Also, the absorption is in proportion to *quantity* or *thickness* of moist air. Thus, under pressure of 5 inches, 16 per cent. of heat was absorbed by the moist air in experiment tube, but under a pressure of 30 inches, 98 per cent."†

Local conditions largely determine rainfall and humidity of a place. Mountains, especially when wooded, collect watery vapour on the side exposed to the moist winds. When these are strong, they are forced mechanically to ascend the inclined surface of the range into cooler regions, where they are condensed into clouds, rain, snow, or hail. This effect is most marked in mountains over 1,500 feet high, but it commences with those of 500 feet elevation or under. If the range is over 2,000 feet high, the rain mostly falls on the side exposed to the wind.

Cold winds meeting warm ones can also condense their vapour.

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* *Floating Matter of Air.* † Tyndall—*Heat a Mode of Motion.*

Warm winds passing over cold ground anywhere, suffer condensation of their moisture, and rain ensues.

The importance of knowing the annual rainfall, and still more so, the number of wet days, and the time of year when rain falls at a place, is obvious; and the value of the information given on such matters in Ravenstein's tables—unfortunately limited from paucity of meteorological data—very great.

In tropical Africa, the rainfall varies so widely, according to locality, even in the same latitude, that a hygrometrical chart of each place is necessary.

Tyndall thus summarises the philosophy of the tropical rainy season*:—

"The rains follow the sun in the tropics, in the region of calms, and are due to the condensation of vapour. This chilling has been formerly attributed to the expansion of ascending air laden with vapour, but the radiation from the vapour itself must be influential. A column of saturated air ascends from the equatorial ocean, passes at first through air almost fully saturated. It radiates, as it ascends, at first into surrounding vapour, but the surrounding vapour is very opaque to this radiation, so the radiation of the ascending column is retarded, and even returned by surrounding vapour. But the quantity of aqueous vapour in air diminishes speedily as we ascend . . . . so our vaporous column soon finds itself elevated beyond the protecting screen, and in purer space pours out its heat without stoppage or requital. To this great loss of heat, its condensation in vapour, and its torrential descent to earth, must be in part ascribed."

**Heat a Mode of Motion.*

IV.—Sunlight.

Sunlight, save when it is excessive, acts beneficially upon mind and body, and there can be little doubt that the prevalence of certain diseases is directly owing to the absence of light.

In Africa there need be no uneasiness on this head; on the contrary, the practice of tropical hygiene is much occupied in providing defensive measures whereby the body may be at least partially protected from excessive sunshine.*

The effects of sunshine on climate is attested by the derivation of the latter word, κλιμα, *a slope;* and thus, at a glance, we perceive "how the aspect it presents to the rays of the sun in the earth's revolutions, must affect the 'climate' of a country."†

As a rule, the more vertical the sun is, the hotter the atmosphere, for the rays strike directly upon the earth, which radiates the warmth received, and these rays are, as we know, invisible. The sun, also, is slightly nearer at the zenith than when at the horizon, and in the latter position more rays are absorbed by the atmosphere. The longer the day the greater the heat.‡

The effects of sunshine and heat on bodily health will be noticed in succeeding chapters.

V.—Rarefaction of Atmosphere.

"People who inhabit regions more than 6,500 ft. above the sea level, are said to be pale, sallow, and weak,

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*See chaps. xviii. and xix., besides numerous references scattered through body of this work.

† *The Marvels of Geology and Physical Geography.* (Ward, Lock and Co., London and New York.)

‡ *Ibid.*

with a tranquil and meditative air ; and it is stated that infant mortality is high. . . . . It is difficult to say to what these characteristics may be attributed ; according, however, to Jourdanet, they are due to the diminution of the pressure of the oxygen in the air."*

This would appear to contra-indicate settlement in very high altitudes: elevations of from 3,000 to 5,000 feet appear to be best suited for permanent residence in the tropics.

VI.—Ozone.

Ozone is found more on mountains than on plains ; it is augmented by rainy weather, intense sunlight, and thunderstorms.

VII.—Wind.

The character of prevailing winds powerfully affects the climate of any place. Winds are classified by Dove into *permanent*, *periodical*, and *variable.*

The permanent, or the trade winds, N.E. in the Northern and S.E. in the Southern hemisphere.

The periodical—the monsoons.

The variable, or those the direction of which varies, usually blowing more fully from one quarter than from another.

Local breezes are chiefly sea and mountain breezes. About noon a wind sets in from the sea towards land, and dies away at sunset. A little before midnight the land breeze begins to blow in the opposite direction, and is succeeded by a calm towards sunrise.

The sea breeze is damp, the land breeze dry—in some climates so dry as to be dangerous ; *e.g.*, the Sudan, India, Ceylon, Brazil.

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* Dr. W. Hale White, *o.a.c.*

"In mountain regions, about 9 or 10 A.M., the day wind begins to blow up the valleys, freshens till afternoon, and dies down at sunset. The night wind, blowing down the valleys, is felt between sunset and sunrise."*

The Föhn, Sirocco, Mistral, Simoom, and Harmattan are explained by the forcing of wind, from impinging against mountains or other causes, into such high altitude, or its passage over extensive desiccating tracts of sand, that it loses its water. Such winds, with greatly augmented capacity for absorbing and retaining moisture, in blowing over vegetable and animal organisms, wither and sear them, from the avidity with which they imbibe the water of their tissues.

VIII.—Electricity.

"There is an absence of exact information about the effect of the electrical condition of the atmosphere upon the human body. The air is, as a rule, charged with positive, the earth with negative, electricity."†

IX.—Soil and Aspect.

The question of soil and aspect, in connection with malarial diseases and general hygiene, will be fully treated in subsequent chapters.

X.—Vegetation.

Vegetation of all kinds, but especially trees, are important factors of climate.

Trees afford shelter from winds, and shade from sunshine.

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* Dr. W. Hale White. † *Ibid.*

In temperate latitudes they hasten the melting of snow upon mountain slopes, and by ensuring its slow liquefaction, prevents sudden floods, and so conserves hillside soil which would otherwise be washed away.

Woods 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, they 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*, as a consequence of its power to drain and depurate soil mainly, and possibly in

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

some degree of the virtue ascribed to it in antagonising malarial poison.*

"That the forest, however, 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."†

* This subject is somewhat fully treated in chap. v., *q.v.*

† *Lancet*, *ib.*

CHAPTER II.

CLIMATOLOGY.

PART II. THE CLIMATES OF AFRICA.

To impart what is known to science and experience of the climatology of Africa, in a useful and accessible form for settlers, would require a treatise of the nature of a series of monographs on the climates of its territories.

Generalisation is unpalatable to some, and misleading to all, if not pointed by instance; while, on the other hand, a mass of detail is not only irritating, but often delusive, by wasting on a number of unrelated facts the mental energy which is required for the adequate comprehension of the whole.

An effort will be made to avoid either extreme in conveying what information is possible in the brief compass of this chapter.

For convenience of description of its climates and products, Dutroulau divides Africa into six zones:—

(1.) The Juxta-tropical Zone, inclined towards the north, which is greatly influenced by the prevailing N.W. winds, the climate of which, with the partial exception of the portion next Asia, is greatly moderated by the presence of the Mediterranean Sea, over which these winds have to pass to the land.

(2.) The zone which includes the Deserts of Sahara, and those of Libya and Nubia, which, on account of its inland position, is subject to much greater extremes of temperature than most other regions of the same latitude.

(3.) The Zone of the Sudan, which is wholly intertropical, and possesses a climate fairly similar to that of India.

(4.) The Equatorial Zone proper, which stretches from the maritime regions of Guinea and the Congo on the West, to Mozambique and Zanzibar on the East Coast.

(5.) The Southern Desert Zone, similar in its prominent features to the vast desert zone on the north, but less extensive in area, less arid, and possessed of a climate which displays less extremes of temperature.

(6.) The Cape Zone, which has many features similar to those of the first zone.*

Physiography.

The physiography of the African continent, of course, materially influences its climates.

Its contour is so unindented that, with nearly three times the area, its coast-line measures 15,000 miles only, against 19,000 of European sea-board.

The average elevation of its surface above sea-level is greater than that of Europe; roughly, 3,500 feet in the Southern, and 1,500 feet in the Northern hemisphere.

To convey some adequate comprehension of the physical features of Africa, we should view, in imagination, the whole vast panorama of the continent lying beneath us.

We see its low littoral; a rim of swamp, jungle, russet,

* Quoted by Surgeon-Major T. H. Parke in his *Guide to Health in Africa*. London: Sampson Low, Marston & Co., 1893.

thinly-wooded plain, or undulating savanna, rising slowly from sea-level, and extending monotonously inland—a dreary land, to be painted in dull greens, umbers, and sepia, as befits the abode of the wild beast and reptile, and the home of fever.

This zone is from 50 to 300 miles in width; and may attain an elevation of 600 feet or over.

It is in many places a continual swamp in the rainy season, and a parched, russet-coloured plain in the dries, traversed by comparatively few streams.

On the Atlantic seaboard it is frequently narrowed, as at Benguella, to a few miles; and generally, from the Cameroons to the Cape, ranges of mountains and table-lands, forming the subsidiary axis of the continent, leave but a narrow, low margin between their bases and the sea.

On the eastern side, the mountain chains, which constitute the main axis of Africa, extend from the northernmost point of the Abyssinian Highlands, N. lat. 17°, to the southern foot hills 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. Having reached the equatorial regions, it opens out like the strands of a half-untwisted rope, upon which, to continue the simile, the lofty peaks of Kilimanjaro (19,700 ft.), Kenia (18,400 ft.), and Ruwenzori (18,000 ft.), covered with eternal snows, stand out like knots amidst a tangle of lofty ranges, separated by a network of deep fissure valleys, trending north and south of the equatorial line.

"This highland region of Africa, broadly speaking, extends along the east coast from the southern extremity of the Red Sea to the Cape of Good Hope. It widens out as it recedes from the equator, and almost completely covers the southern extremity of the continent."*

Of the great fissures, one of the most noticeable is the Rift Valley on the east, within which lie the Lakes Baringo, Naivasha, and Ayasi, and which extends due north to Lake Rudolf and the valley of the Omo River, thus separating Kenia and Kilimanjaro from the Western Highlands and the Victoria Nyanza, which is 3,608 feet above sea level.

The greater fissure to the west of this lake gives origin to the Lakes Nyasa (1,300 ft.), Tanganyika (2,756 ft.), Albert Edward Nyanza (3,307 ft.), and Albert Nyanza (2,400 ft.), and forms the proximal end of the valley of the Bahr el Jebel or White Nile.

The marginal low-lying littoral ends more abruptly on the West than on the East Coast, in plateaux of 3,000 to 4,000 feet altitude. The most elevated land is throughout nearer the East than the West Coast; but over all the southern interior of the continent, heights of 3,000 to 5,000 feet above sea level is the prevailing feature, while 6,000 feet and over is rare, save at the equatorial mountains above referred to, the Highlands of Abyssinia, and the Drakensberg.

It has been customary to describe the elevated regions of Central Africa as consisting of two steppes, the central culminating in mountain peaks; but this is too artificial, and tends rather to confusion of thought than clear and just comprehension of the subject.

The interior of Africa presents every possible variety of feature, from elevated plains to deep valleys and lands of moderate altitude.

Everything is on a colossal scale, from its mournful,

* *Guide to Health in Africa, a.c.*

silent deserts, to its regions of exuberant fertility and teeming life.

Desolate wildernesses, boundless savannas, illimitable forests, sea-like lakes, mighty rivers, and glorious sunny park-lands, alternate with valleys of ravishing beauty and mountain scenery, sublime in its desolate severity.

Rivers.

Africa is mainly drained by four great river systems—the Niger and Congo on the west, the Nile on the north, the Zambesi on the east. These approximate at their sources, and are so linked by numerous lakes and navigable reaches, as to form waterways all over the habitable regions of the Continent.

Temperature.

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 Bang-

* 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.

weolo, 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 elevation of over 4,000 feet, the average maximum temperature is 82° F., 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 feet 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 Kalihari Desert, and neighbourhood, with an elevation of 2,000 to 3,000 feet above the sea, we have the extreme of South African dryness; a rainfall in places under 10, and in others under 5 inches. This is the land of drought and thunderstorm, with a summer range of temperature up to 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 some-

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

what similar but dryer and warmer climate than that of the Boer Republics.

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° Fahr.

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 feet) 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.

* See Mather's excellent *Map of Mashonaland and Matabeleland*, also *Zambesia*, by E. P. Mathers, F.R.G.S., &c., a storehouse of useful information for the colonist.

† *South Africa*, Dec. 15th, 1894.

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 range 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.

It is established that the nearer we approach the equator within the tropics, the more the temperature falls, owing to increasing altitude, which in high regions gives a fall of 1° F. of temperature for every 300 or 350 feet of elevation; and, secondly, because of the equatorial cloud-belts, which stretch five or six degrees, according to the time of year, on either side of the line.

To give an instance, 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 Lake Albert Nyanza, on the Balegga plateau, 4,657 feet 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, 20th December, 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 A.M., ,,	- -	,,	88·30° F.
7 A.M., ,,	- -	,,	76° F.
Midnight, ,,	- -	,,	73° F.
6 A.M., 15th ,,	- -	,,	73° F.

Height of post of observation, N'Saba, above sea 2,350 ft.

Also, in Ankori, at 5,750 ft. altitude, frost was observed on the ground in the early morning, and blackberries grew on the road bushes. The winds here in July were E. to S.E., then to N.E.

Stanley's party suffered greatly from sickness, chiefly fever, while traversing this cold, moist region, the reason of which will become apparent in future chapters.

Again, Cameron reports thin ice in the early mornings while traversing certain highlands between Tanganyika and Benguella;* and, if space permitted, other instances of wonderfully low range of temperature within the equatorial region of Africa could be cited.

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* *Across Africa.*

How great the contrast between such a climate and that of the Congo and Zambesi, as registered in the immortal pages of Stanley and Livingstone. One extract must suffice from the latter. "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° Fahr. 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 fall below 80°, and it was at 91° at sunset. One cannot cool the water by wet towels round vessel."—*(Travels.)**

Rainfall and Winds.

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

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 Kalihari 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

* For further details of temperature see annexed *Tables.*

† *See Map of Rainfall.*

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 in.), 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 in.) 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 seaboard zones; and the dark patches visited by torrential downpour (over 100 in.), 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.

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.

* Ravenstein *Memoranda.* † *The Development of Africa.*

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 defluct 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.

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.

Tables 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 recent 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 Walvisch Bay being due to a cold ascending ocean current. The *annual range*, that is, the difference between the coldest and 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.

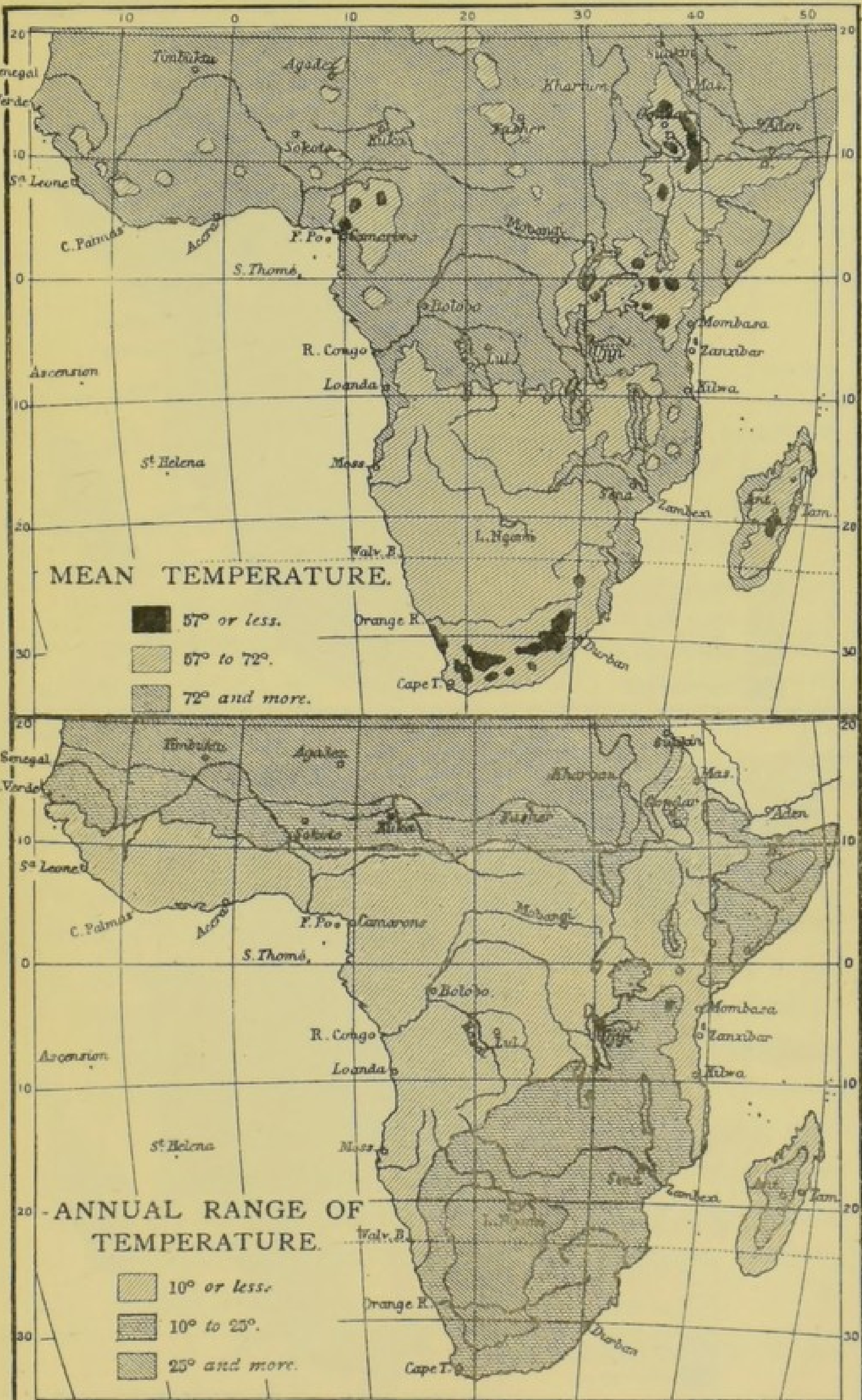
The *hot inland stations* fall into two classes, namely, places like Kuka and Khartum, the climate of which is influenced by surrounding deserts, and places in the wooded regions of tropical Africa. The former has a dry climate and a considerable annual and daily range; while the latter are characterised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

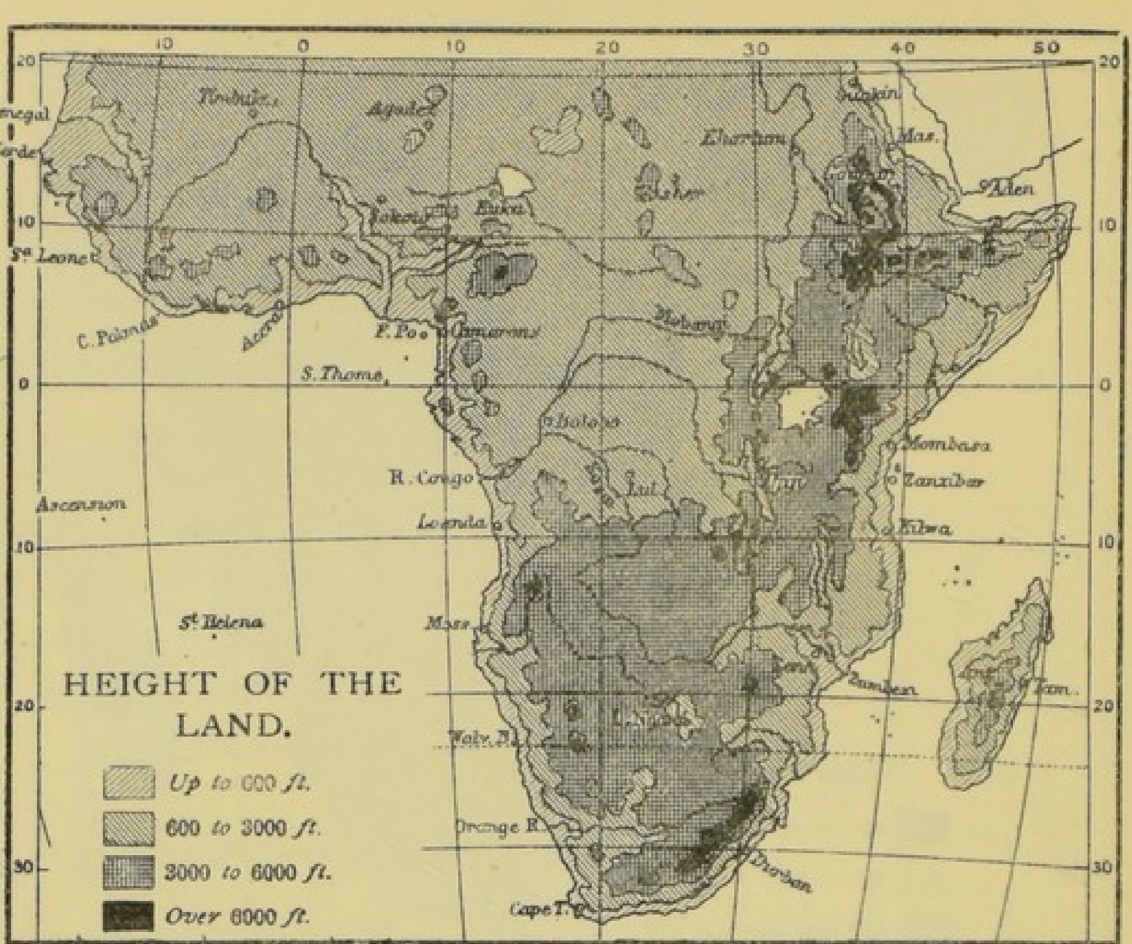
Lastly, there are what may be called *Temperate Inland Stations.* The temperature of these varies, as a matter of course, with elevation above sea level, and may sink below freezing point; but their true characteristic, as of all tropical inland stations, is a very considerable daily range.

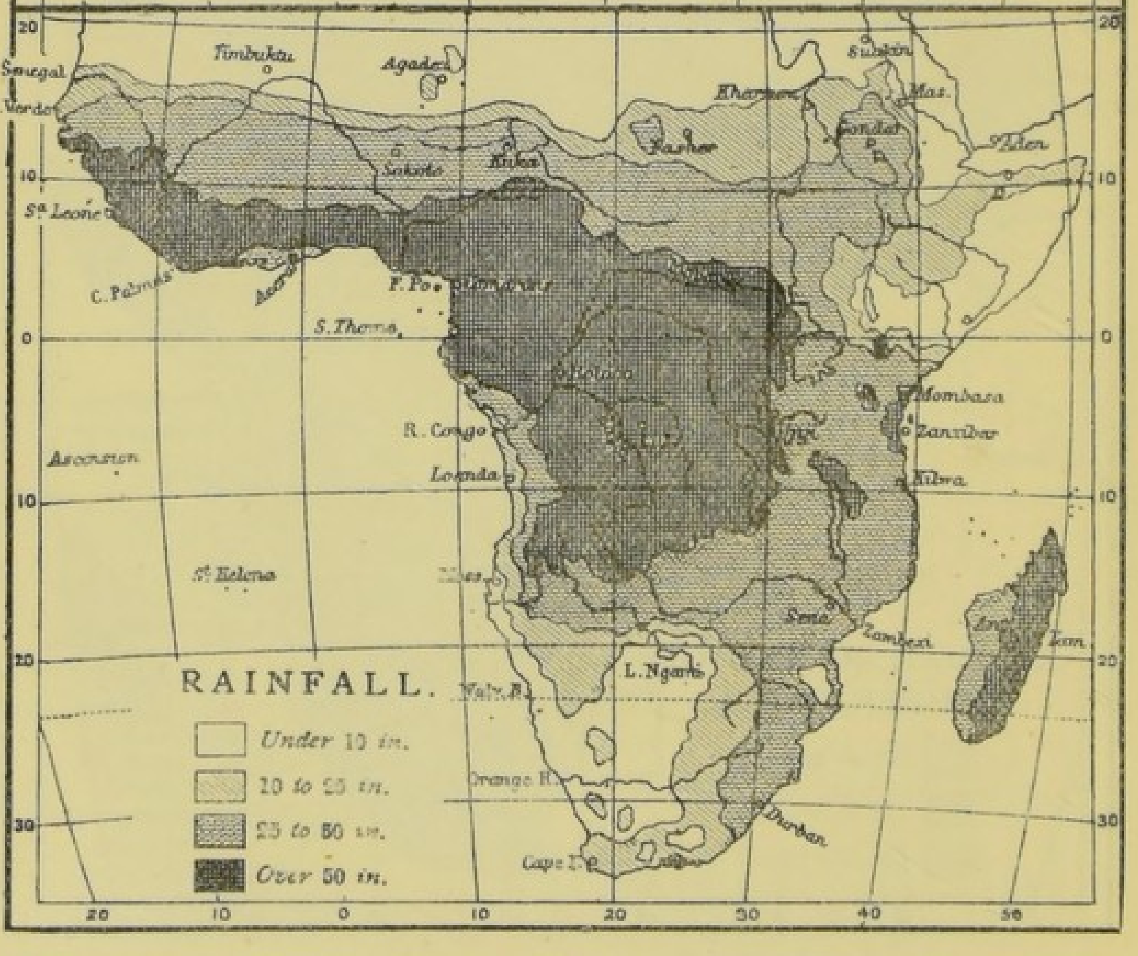
The four maps which illustrate this chapter are based upon very inadequate materials; but it is believed that they convey a correct notion of the climatological features of Africa.

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 (Gabon)	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
Walvisch 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
Sawakin	36 30 N.	80	76	19	—	56	2	7
Hot Inland Stations.								
Bismarckburg (Guinea)	8 2 N.	2,320	75	9	20	76	59	132
S. 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 (Borneo)	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 (Camarons)	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 (Shire 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


MEAN TEMPERATURE.
57° or less.
57° to 72°.
72° and more.
Senegal
C. Verde
Timbuktu
Agades
Khartum
Mas.
Fasher
Kuka
Sokoto
Aden
Sa. Leone
C. Palmas
Accra
F. Po
Camarons
S. Thomé
Mobangi
Bolobo
Mombasa
R. Congo
Zanzibar
Ascension
Loanda
Kilwa
St. Helena
Moss.
Zambesi
Tam.
L. Ngami
Walv. B.
Orange R.
Durban
Cape T.
ANNUAL RANGE OF TEMPERATURE.
10° or less.
10° to 25°.
25° and more.
Suakin
Gondar


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


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

CHAPTER III.

THE HABITAT OF MALARIA: CLIMATE IN RELATION TO MALARIA.

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 æration 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 æration 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.*

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.

* "*Il Clima di Roma.*" By Dr. Conrad Tommasi Crudeli. Rome: Hermann Loescher & Co., 1886.

But while malaria is more concentrated in the low lands, it is also found in the plateaux and mountain regions of Equatorial Africa, where its immunity-level has yet to be determined.

Dr. Felkin fixes this at 4,000 feet, which experience has proved to be too low; and I have attended a case of ordinary, and one of pernicious malarial fever, at a higher elevation in East Central Africa.

A. Silva White, in his very useful book, *The Development of Africa*, expresses his belief, that the immunity-level is lower in Africa than in India, but he adduces no facts in support.

Surgeon Parke found the mountain regions intervening between the Great Lakes and the East Coast very malarious, alike to the weary followers of Stanley as to the fresh contingents of Emin Pasha from Wadelai. In this case, however, it must have been impossible to distinguish endemic from imported cases of fever.

It is established that malaria prevails in the highlands of Uganda, Katanga, and the adjoining regions.

Staff-Surgeon Brahme reports, in the *Mitteilungen aus Deutschen Schulzgebieten*, 1894, that the station on "Kilimanjaro, 5,600 feet above the sea, is not free from endemic malaria. He is careful to distinguish imported from endemic cases. Every time the natives descend to the lowlands they bring malarial fever back with them, and more men appear to die of fever afterwards than at the hands of their enemies."*

Elevated country may in another way wrongly obtain a malarious reputation, by exciting fever, due to the shock of sudden change from a warmer to colder tem-

* Extract from *letter* from E. G. Ravenstein, F.R.G.S.

perature—in those who have already suffered and become debilitated from the disease.

The sanitary condition of the natives inhabiting high altitudes, will no more solve this question than *à priori* reasoning from the effects of climate. Nothing but long European experience of a place can determine its sanitary suitableness for the race.

Cabul in India is built on an open elevated plateau, 20 miles across, and 5,700 feet in height above sea level. It is also surrounded by lofty mountains. Nevertheless, being a water-logged valley, the subsoil is unwholesome. Exposed to the influence of hot sunshine, the soil is dried to the depth of a few feet in summer, and cakes hard; and when this crust is disturbed by man, or fissured, or removed by natural causes, malarial fever generally of the remittent type occurs. It is, in short, prevalent and endemic here, and not imported.*

Tyndall, in his ascent of Mont Blanc, reached an absolutely germ-free atmosphere at 10,000 feet; and there can be no doubt that as we ascend, other things being equal, malaria diminishes.

The modifying influences of elevation upon the action of oxygen and sunshine operating on the body is established, while the comparatively cool, germ-free, and bracing atmosphere, is stimulating, alterative, and strengthening.

But mountain regions, although possessing these sanitary advantages, are subject to sudden changes of weather—funnel winds, gully storms, fogs, rain and cold —all more trying to delicate people and more provocative of fever than the moderate, steady, equable heat of lower country.

* Dr. J. A. Grey's Paper *On the Sanitary Condition of Cabul. Lancet*, April 28th, 1894.

A high authority thus summarises 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 watercourses; (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, draining and cropping the same soil afterwards diminish it."*

Light, sandy, and gravelly soils being porous and dry, readily admit sun† and air more freely than clays, while they are easily washed of adhering moulds by rain. Silica is a better conductor of heat than many metals (Tyndall), and its specific heat is over five times that of water, from which reasons dry sands are easily raised to high temperature by day, and quickly cool down by night. This causes the diurnal range in deserts to be very high, while presenting conditions incompatible with the growth of malaria.

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* A Lecture on *Climate in Relation to Health*. Delivered at the Parkes Museum, May 7, 1894, by C. Theodore Williams, M.D., &c. *Lancet*, June 2, 1894.

† The destructive action of sunshine upon micro-organisms is established.

Stiff clayey loams, and clays even in elevated positions, should be avoided. Clays being hygroscopic, absorb and retain large quantities of water, while apparently dry upon the crust. They are of high specific heat, and consequently cold in sunless weather, because it takes much sun to warm them; but, once warmed, they part with heat very slowly. These conditions are favourable to the growth of malaria, and as a fact it is imprisoned in a concentrated and virulent form in clayey soil, and by its slow or sudden liberation causes endemic malarial fever or sudden epidemics of this disease.

Speaking generally, sandstones, gravels and limestones are good for settlement if the locality is dry, and well drained, and subsoil water at great depth or absent; while clayey soils, or such as have a substratum of clay or rock, and are good holding ground for water from any cause, whether this water be above or below ground, are certain to be malarious.

Tropical forests present meteorological conditions the reverse of what obtains in deserts—cool, saturated atmosphere, and minimum of diurnal range.

The great Central African forest, although full of horrors, and, according to Stanley, "the rainiest zone of the earth," appears not to have been very malarious. In such forests, the soil, being protected from direct sunshine, is never heated by day above the surrounding atmosphere; nor can it lose much heat by night through the screening foliage. From the leafy surface enormous radiation and evaporation goes on constantly, cooling the air beneath and draining the soil of some of its superabundant moisture.

The mild, still, forest atmosphere causes no strong reactions or oscillations of bodily temperature so provocative of fever, and the malarial fungus grows badly, perhaps from over-saturation of soil and air.*

On the other hand, certain tropical forests, as the Terai in India, owing, it is supposed, to infected subsoil water, are amongst the most malarious regions in the world.

Speaking widely, we have two classes of soil—the limestones and the clays. In the former, carbon, oxygen, lime, and water predominate; in the latter, silica, aluminia, and water.

Every geological period, from the Archæan to the Recent, has been characterised by sandstones, clays, or limestones; and it was from the Archæan rocks, by process of decomposition and disintegration, that Cambrian and Silurian grits and sandstones have been made. A dry soil characterises limestone formations; they are, in short, absorbent. But they are more than this;—they neutralise the acids produced by vegetable decomposition, and to this extent render the soil less suitable for the culture of fungi.†

Much of the catchment areas of the Congo and Zambesi belong to the Mesozoic or secondary period, where clays predominate.

The same prevails along the east coast from Cape Guardafui to the Drakensberg, and, bending inwards at the rivers, covers most of the low-lying marginal zone, forming an additional factor of its unhealthiness.

Archæan and eruptive rock forms the axes of the continent and a considerable part of the Central plateaux,

* See chap. i.

† See *A Paper on the Influence of Clays and Limestones on Medical Geography*, by Alfred Haviland. Read before the 7th International Congress of Hygiene and Demography, held in London, 17th August, 1891.

and the sandstones and limestones of these regions should be healthy at elevations of over 5,000 feet, if the drainage is good.

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

Recent deposits forming the coast fringe, and tertiary formations occurring rarely, need not be considered here.

It is, therefore, as A. Silva White points out,† "to the highland countries along the main axis of the continent that we must look for the most favourable districts of Equatorial Africa; it is there that for climate, as well as for political reasons, we have our best chances of personally and effectually controlling the destinies of Africa."

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* Drummond's *Tropical Africa*. † *The Development of Africa*.

CHAPTER IV.

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 in quantity and virulence of 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.*

Bowl-like depressions, deep gullies with water at bottom, flooded flats and plains subject to inundation, or with retentive bottom, should never be selected for towns or homesteads.

Rivers, narrow lakes, gorges, valleys, and similar features, by acting as funnels, cause draughts, whereby the air of a place may become tainted from distant and

* I lived on the West Coast, in a camp, on a hill 250 feet above and to the lee of a lagoon, the waters of which were constantly changing level and exposing fresh mud banks, the malarious emanations from which caused fever to be endemic amongst us.

unsuspected sources of infection. At some seasons this place will be healthy, and at others unhealthy, which will cause perplexity until the topography and prevailing winds have become known.

On the other hand, a place may benefit by mountain and sea-air being led to it through similar channels.

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.*

On Drainage.

The best fruits of civilisation 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 virgin soil.

In attempting to form a new plantation, I contracted pernicious hæmaturic fever in six weeks, with permanent impairment of health.

This subject is of such vital importance that I venture to give the following extract verbatim from a paper by Dr. Atkinson.*

"There can be no doubt that freshly upturned earth is there (China), as in other parts of the world, a point of considerable importance in relation to the causation

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* *The Malarial Fevers of Hong Kong.* By J. M. Atkinson, M.B., Lond. *Lancet*, April 28, 1894.

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."

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 produced "anhydrous suspension" of malaria.

Mr. J. W. Rowlands, in his paper,* supports Sir Joseph Fayrer and other authorities in the doctrine of sub-soil 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 feet below the surface in the highest, while frequently overflowing in the lowest parts of 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 inches of water by evaporation, while the rainfall over the area covered by tree was only 25·6 inches. In other words, evaporation exceeded rainfall over area covered by tree 81·3 times,

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* *Report on the Sanitary Condition of Lagos.*

and this great loss was supplied through the roots. The Eucalyptus, in Algeria, has been calculated to evaporate 12 times its area of rainfall.

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. When the strata of soil are dry, the germs sticking to them are drawn down by the subsiding of the underground water, and so they naturally come to pervade the underground atmosphere; and if there be an issue towards the surface, the air, with the rise of the underground water, will be driven through it into the open air."*

Naegeli has also shown how this underground, vitiated air, may be drawn into houses by the suction of fires.

Such germs cannot rise at all if the strata through which they should be wafted is wet, for they will then stick to the particles of wet soil too firmly to be removed by subterraneous air currents.

From foregoing we draw this rule :—

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 :—*Reject for building sites localities where the sub-soil water rises within 20 feet of the surface at climax*

* Quoted by Dr. Jaeger in his "*Health Culture.*"

of the rainy season. Should it be necessary to build on such sites, plant ground very thickly 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.

Rule: — *Keep your house in the tropics during the fatal hours of sunrise and sunset.*

The inexperienced settler is apt to think that, by removing timber and undergrowth from his compound and its vicinity, and so admitting more air and light, he will improve his sanitary condition. This is a doctrine founded on complete ignorance of the subject. While on the West Coast of Africa, myself and a companion were forced to reside for some months in a very dilapidated, leaky house, built in a gully amongst primeval forest. We suffered discomforts, but maintained our health.

Later, the camp was enlarged, and moved to the top of a hill 200 feet high; and our party having been increased by the addition of other Europeans, we proceeded, on the "sunlight and fresh air" theory, to clear the land of all trees and shrubs for many acres around.

Fever then came, and could not be banished: finally it broke up the camp; five out of six were invalided to England, when one died on his return, while two suffered permanent impairment of health.

In our ignorance we had removed our protecting vegetation, and fell an easy prey to overwhelming doses of malarial poison.

Rule:—*Do not clear for sunlight and air sake. Cut down no shade trees within your compound. Plant shade trees if there be none. Leave native undergrowths intact, or replace them by grasses and herbage, to form a matting of vegetation over the soil.*

One of the most unhealthy camps I remember had the appearance of a well-kept garden around the houses. All native trees and shrubs had of course been carefully cut down, and the land was planted in pine-apple, which, failing to thrive, afforded no covering for the soil. Exposed to sun and rain, this became caked and fissured, thus permitting constant issue of malarial exhalations.

Rule:—*Avoid cultivation within compound. Let the necessary garden and arable land lie to the lee of the dwellings, separated from them by intervening bush or plantation.*

The compound should be enclosed by a boundary screen of scrub or shrubberies, widest to windward. This serves as breakwind and air filter. The leaves having become wet from rain or dew, or even in their dry state, arrest the floating matter of air which adheres to their surfaces. Some remains in the leaf tissue, as dust in a begrimed hedge-row; some is washed into the ground by fresh rains and dews, so that the air is well filtered of microbes before it can reach the houses. A good site for a house is upon a gentle acclivity, 50 to 80 feet above the plain, upon the skirts of open bush. The house should have an aspect towards the East, to receive the morning sun, but it should be sheltered by trees from noon and afternoon glare. The wooded hills behind, running at right angles to prevailing winds, will ensure the necessary shelter, and in other ways promote comfort. (See ch. xix.)

A well known meteorologist* says:—"Protection from winds, either by interjacent woods or by contour of ground, is what mostly renders a situation agreeable. The rainfall upon a particular place is mainly determined by the presence or absence of hills, and their relative positions. Where a moist wind strikes a hill side, while depositing some of its moisture at the point of incidence, it is forced mechanically to rise over the crest, thus leaving the lee side comparatively drier and warmer." From which considerations he lays down, for choice of residence in any climate, this Rule:—"*Select a spot with hills lying to the windward, on the rainy side.*"

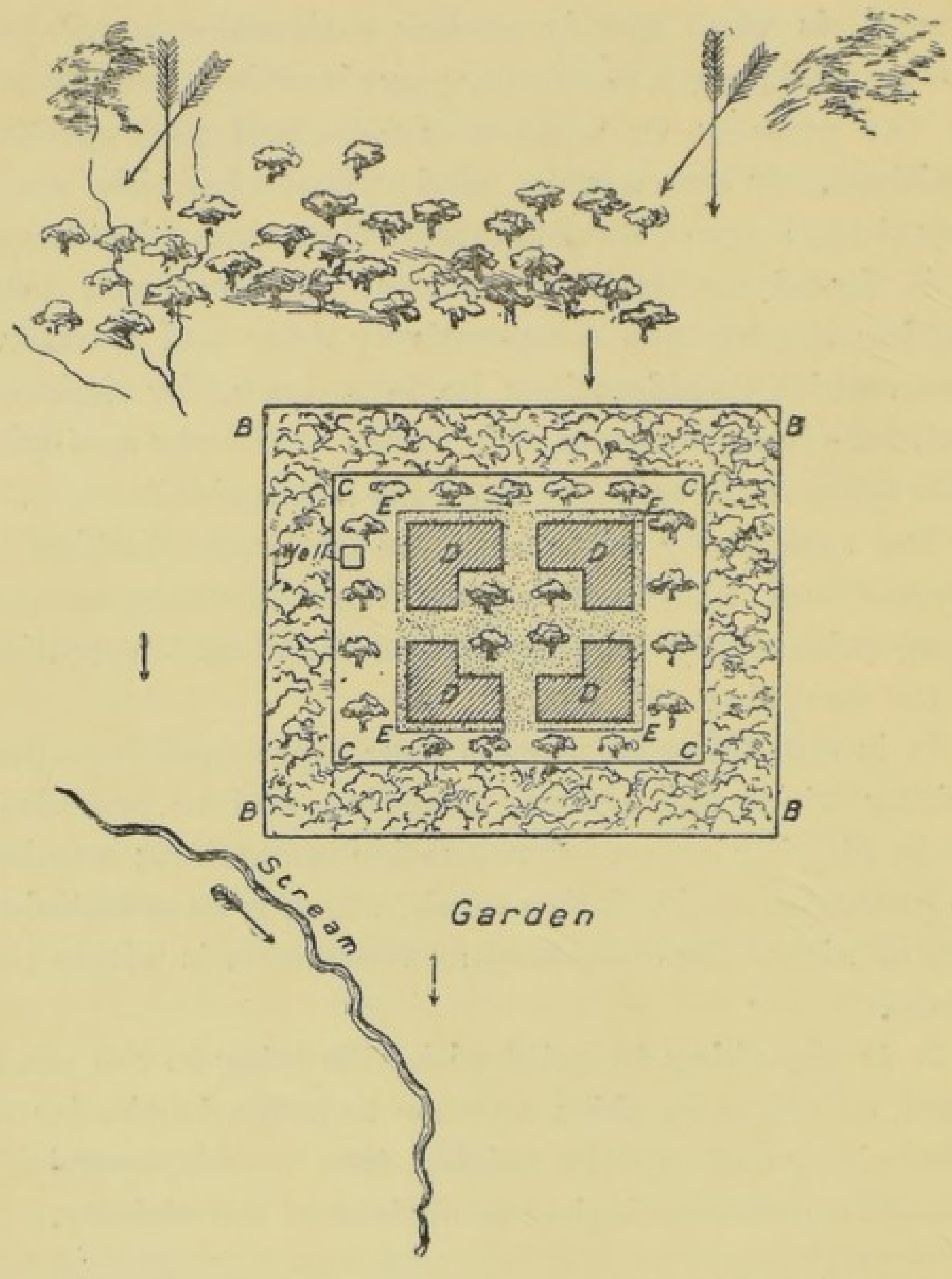
The superiority of the climate of Great Malvern in dryness and temperature over West Malvern—places lying quite closely together—is an excellent illustration of the foregoing.

It is one thing to protect your homestead from prevailing winds and chilling draughts, and to provide a leafy, filtering screen of vegetation around it; another to prevent free circulation of air, which is as essential to health within the compound as ventilation is within the house.

It is one thing to build with hills lying to the windward, on the rainy side; another to settle in the lee of dominating and superior heights, that would perennially disturb the meteorological conditions of the vicinity.

* Mr. R. H. Scott, writing in *Longman's Magazine*, June 1892.

DIAGRAM OF SANITARY CAMP.



B B B B.— Rectangular space, bounded on all sides by a belt of native bush, or plantation, within which, *C C C C*, the compound is laid out, shaded by some native trees left standing, or by those planted. A thick matting of grass or herbage should cover soil.

D D D D.—Dwellings. The blocks look inwards upon a shady courtyard. The unplanted spaces—walks, yards, passages, and basements of houses as far as *E E E E*, some yards all around—should be carefully asphalted, cemented, or covered with trodden ant-hill clay, oiled occasionally.

There is a well within compound.

The Camp stands on a gentle acclivity, sloping from rising wooded ground to windward, down to a stream. The large arrows indicate direction of prevailing winds. The garden and agricultural land lies to the lee of compound.

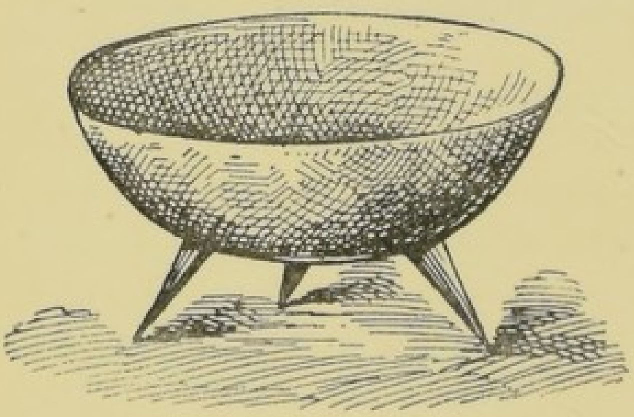
CHAPTER V.

FURTHER PRECAUTIONARY MEASURES AGAINST MALARIAL INFECTION.

PART I.

The employment of fires, as disinfecting agents, in the streets and squares of plague-stricken towns, dates from remote antiquity.

Fires, judiciously and persistently used, both within and without dwellings in tropical Africa, 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 night during damp, cold weather, to maintain an equable temperature in chamber, keep things dry, expel mosquitoes, and destroy the germs of malaria. *Whenever the temperature falls sufficiently to make a fire tolerable, it should be used by day and night as a protection against ever present malaria.*

Fire, of course, consumes all germs that are wafted through it, and, in addition, its pyroligneous and carbonic acids, and other products of combustion, hurt or kill the germs by disturbing the equilibrium of their molecular structure and chemical medium.

Tyndall found that air passed over a spirit-lamp was immediately freed from germs and other floating matter, and Professor Schenk has shewn that micro-organisms in the air of a room move towards the warmest bodies by a vital process initiated by the stimulus of heat. Fire can thus attract and destroy floating microbes.

The natives of Africa burn small fires in their huts day and night, during the rains.

Burning large bonfires all night before houses, during the rainy season and foggy weather, is also most useful, as I have proved by personal experience.

In short—*Fire is the one perfect disinfectant in the tropics, being cheaper, safer, more effective, and handier than any chemical agent, whether powder, fluid, or vapour. Neither malaria, mould, fog, damp, or mosquitoes can permanently abide in a chamber where it is judiciously and perseveringly burned.*

I owe six months' immunity in a sickly camp to fire.

Dryness and absence of mould upon boots, walls, furniture, and books, roughly indicate that the house or chamber is in good sanitary condition in the tropics.

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 few logs smouldering in the hut.*"*

Mosquito Nets.

Mosquito nets are of signal value as protection against malaria, for which they are strongly recommended by all authorities on African travel.

They act as air-filters when dry, and also when wet: when dry, by entangling the floating matter of air after the manner of cotton-wool, which is a perfect air-filter; when wet with dew, damp, or exhalations from the body, by the adhesion of germs to the moist fabric.

Mr. Waller rightly considers the mosquito net utterly indispensable, and points 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."

It is obvious that mosquito nets will need frequent disinfecting, else they may become sources of infection.

This is easily done by putting them in a closed box or press, and fumigating them thoroughly with burning sulphur. *The nets must be made after some approved pattern, and rendered uninflammable by steeping in the following solution:—*

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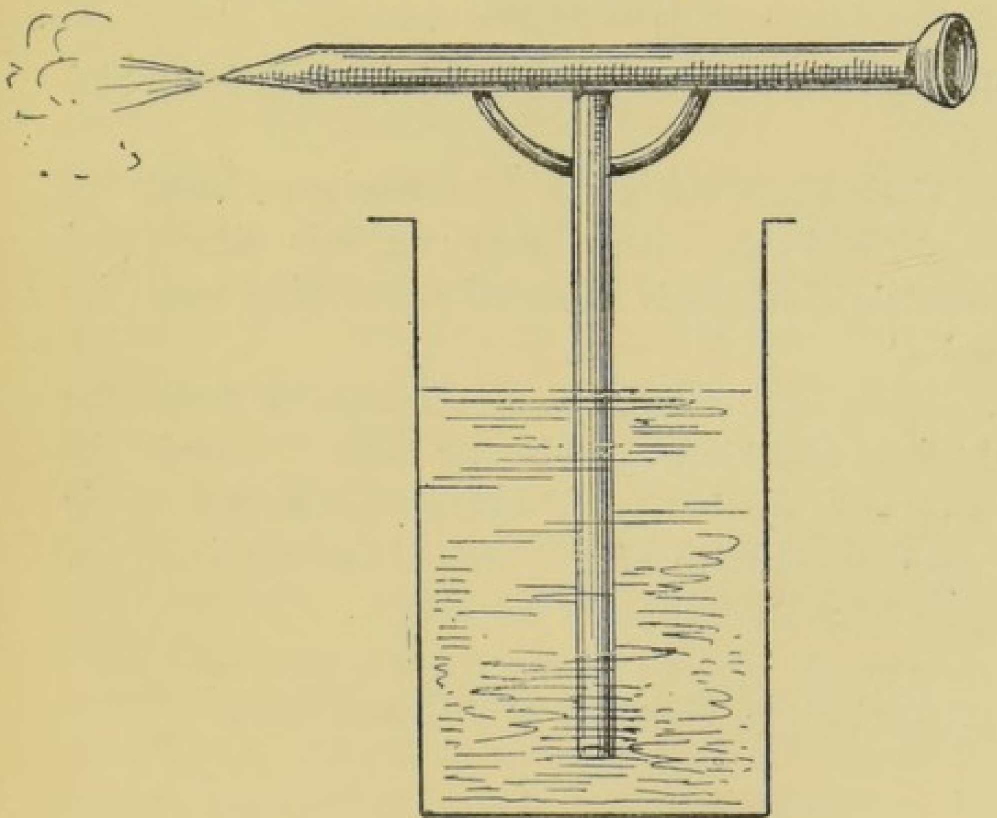
* "*Health Hints for Central Africa.*" By Horace Waller. John Murray, London, 1893.

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 lb. 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 mosquitoes vary much in size in different localities.

Spraying as a Mode of Disinfection.



A SIMPLE SPRAY-PRODUCER.

Spraying is a handy way of using disinfectants, as solutions of nitrate of silver (lunar caustic), Condy's fluid

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* *Medical Record.*

(permanganate of potash), 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 the tropics.

As pointed out elsewhere, the hammock should be slung high as possible, remembering that "*malaria lies low*," and that condensation and sedimentation of air occur near the surface of the ground during the cold, still hours of night and early morning.

To sleep on the ground in the tropics, howsoever carefully the bed may be prepared, is to invite fever.

Native Huts for use by Travellers.

My own experience is strongly in favour of sleeping in native huts when travelling. Those on the Gold Coast are well described by Burton and Cameron as bamboo 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 thatch. Yet we never contracted fever while sleeping in these huts, even in notoriously unhealthy localities. This was a great puzzle to me, until I discovered that the most perfect sanitation was quite unconsciously practised.

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 under the shade of trees, and are surrounded by jungle and plantations, which shield them from rough winds and filter the air. Fires are kept constantly burning 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 very antiseptic, and it appears to afford protection from malaria.

The same thing has been noticed in Rome and other towns with a malarial history: people living in the most densely-packed and reeky slums remaining immune, while the disease is endemic in the good quarters, especially in the suburbs, where houses stand in their own gardens.

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 cold bath by new comers, so long as it can be tolerated.*

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 act as a good tonic and astringent of the skin.

The lime-juice also destroys malarial and other 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.

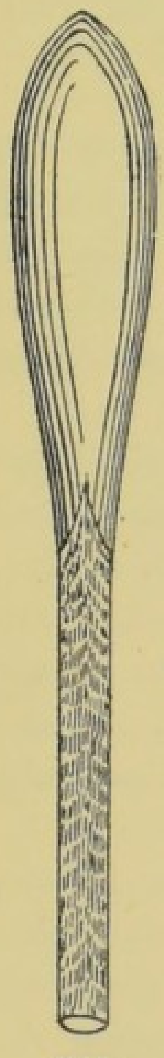
Naegeli found that a weak acid solution rather favoured the growth of moulds, but that if the strength is over 5 per cent. it kills them.

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 has been established by the discovery of microbes in the normal healthy skin, chiefly

* See article on "*Baths*," chap. xiv. † *Encyc. Brit.: Art. Baths.*

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 (¼ 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 Cajuput, 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 them 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 malarial infection 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.†

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* 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."

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 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 tooth-pick—or better still, the tooth brush—after every meal.*

Ordinary water will do for mouth rinsing, but boiled and filtered water is safer and better.

Prepared chalk, camphorated chalk, or good soap, make excellent dentifrices; but I like the following prescription for personal use:—

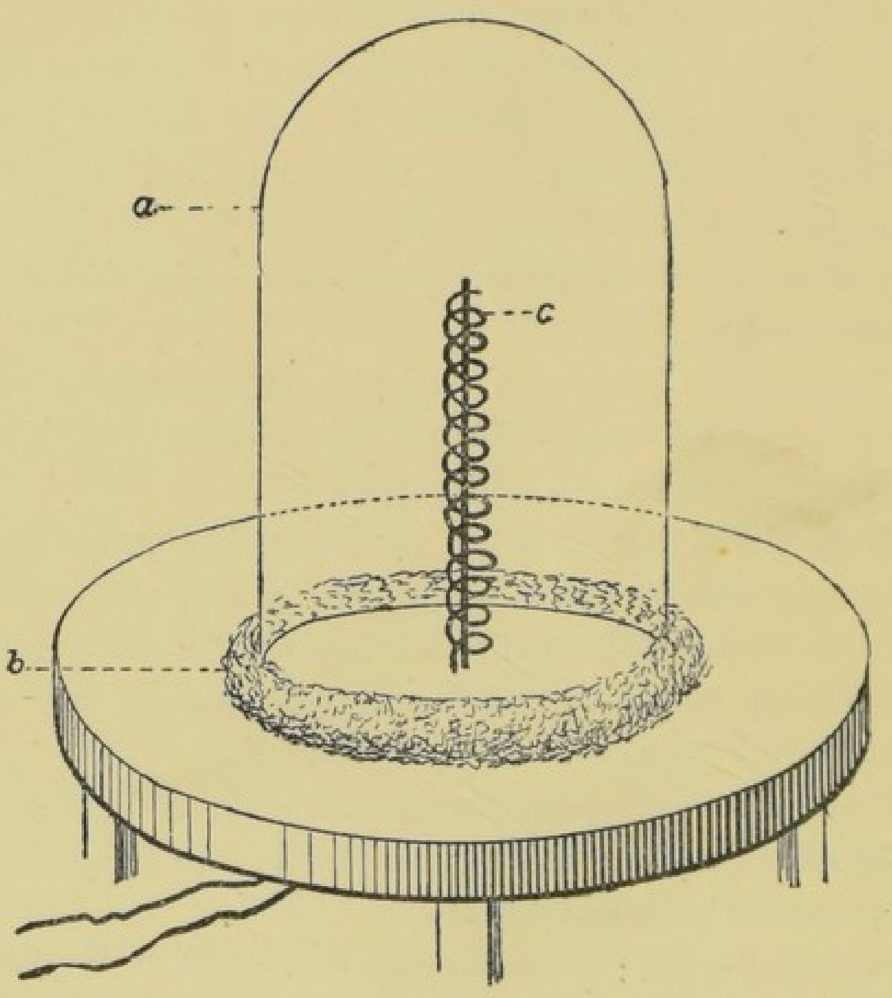
R. Quinæ Sulph: 3 drachms.
Ol: Eucalypti, 2 drachms.
Ol: Rosæ, 10 drops.
Armenian bole, 1 oz.
Camphorated Chalk, 5 ozs.

} Triturate well together and make a powder. Keep in stoppered bottles or closed tin tooth boxes, containing 1 or 2 ozs.

Use this tooth powder morning and night in the tropics.

THE COTTON WOOL NOSE PLUG, OR AIR-FILTER.

This is well known to old West Coasters, and should not be despised from its somewhat ludicrous associations. How excellent cotton wool is as an air-filter, Tyndall illustrates by the following experiment :—



Standing a bell jar *a*, upon a cotton wool collar *b*, so that air can only enter or leave the jar by passing through this collar ; he heated a platinum coil *c*, within, by electricity. The internal air, expanding, was forced out. On ceasing the current, the renewed air of bell jar, which had all passed through the cotton wool collar, was found to be germless — absolutely free from all floating matter—when subjected to tests.*

* "*Floating Matter of Air.*"

The cotton wool nose-plug acts similarly on inhaled air. Its success, of course, depends on keeping the mouth closed—a secret of other successes.

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 mackintosh, 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. Malaria and fog are generally closely associated.

I know of one case where a man who had kept well for a year, contracted malarial fever from sleeping one night on an African river, although he had taken the greatest precautions to protect himself from the fog which enveloped the boat.

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.

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, insolation, 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 and malaria 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.

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. This is why so many die upon the home voyage, or after returning to England from the tropics.

It is also why malaria kills so frequently; the system which can scarcely exist under tropical environments, readily breaking down beneath the added weight of fever.

"*Prove all things*,"* 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 black-smith 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.

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* I. Thess. v. 21.

A liberal supply of proper cool liquid food and rest should follow extraordinary exertion, and then, if at all, a little weak alcoholic stimulant may be taken.

Books.

Lord Bacon recommends a pleasant book as a means of promoting health; and light literature should be available in Africa, as an antidote to the monotonous, commonplace, and frequently barbarous conditions of the daily life.

Religion.

The paramount advantages of religion, practised without cant, and fruitful in good deeds, and forgetfulness of self, need not here be insisted upon.

Temper.

The relationship between temper and health is thus emphasized by the Duke of Wellington. Writing of 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 use exercise; to keep the mind and body 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."

Dr. Grant writes :—" The cultivation of an impassive and philosophical temperament is necessary; as irritability, a very usual product of the African climate, renders a man uncomfortable, and has, undoubtedly, a bad influence on the general health."*

* *West African Hygiene.* By C. S. Grant, B.A., L.R.C.S.I., &c. London, 1882.

CHAPTER VI.

THE MALARIA PROBLEM.

PART I.—GENERAL REVIEW.

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

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

system, such 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.

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

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 altogether due to change of country, or partly to the hardships of the passage, and change of employment and food, 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 preventing the admixture of fresh and salt water in the lagoons of the littoral districts.

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

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 is said to "*lie low*," or keep close to the ground, so that, according to Sir Thomas Watson, "In

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

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 true cause and nature of this deadly infection remained a mystery to our own day.

It 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, has been dispelled within the last fourteen years by the discovery of the micro-organism which is the cause of malarial fever.

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 really occurs:— "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

* *Floating Matter of Air.*

which marks the epoch of a new and more exact science of medicine.

Living organisms, not dead or gaseous matters, are now 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 may be taken as established that no infectious or contagious disease has ever yet been known to arise *de novo;* all have come from seed, yield like seed, and breed true.‡

"*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 produced in them intermittent fever, with enlargement of spleen.

In 1880, Laveran and Richard discovered what they believed to be the true malarial parasite, which they described as a "flagellate organism, free in the blood of

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* 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.

† *Il Clima di Roma.* ‡ Tyndall. § Pasteur.

patients suffering from malarial fevers."* (See Plate at end of chapter.)

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

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.

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.*

Quite 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." †

Guarneri, Bignami, Mannaberg, Councilman, James, Osler, Carter, Hehir, and Evans, are some of the most distinguished workers upon this subject up to date (1894).

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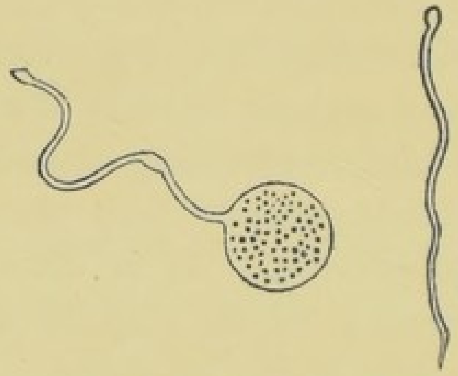
* *Traité des Fièvres Palustres*, Paris, 1884. *Paludism*, by Dr. A. Laveran. Translated by J. W. Martin, M.D., F.R.C.P.E., the New Sydenham Society.

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

In 1890, Evans succeeded, for the first time, in cultivating the malarial parasite outside the human body from germs furnished by malarial blood. With these cultivations he produced in certain of the lower animals a frequently fatal fever, and the characteristic parasite was invariably found in their blood.

The history of the life cycle of the malarial organism was thus completed, and the true cause of malarial fever discovered.



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.

CHAPTER VII.

THE MALARIA PROBLEM.

PART II.

The parasitic micro-organism which is generally 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.

Whether there is but one microbe which assumes many forms, according to the stages of its growth and development, or several, each of which is capable of producing a typical fever—is not finally settled—but the consensus of authority pronounces it to be *a single polymorphic organism.*

This has been variously called the *plasmodium malariæ; hæmaplasmodium malariæ; schizomêtes bacillaris; hæmatomomas malariæ; hæmatozoön malariæ;* the *malarial fungus;* and *hæmatophyllum malariæ.* Golgi says there are two varieties of the malarial parasite, one causing *tertian*, the other *quartan* ague; and he considers *quotidian* fever to be double tertian, or triple quartan; but the proofs he adduces in support of this doctrine, although singularly ingenious, have not gained general acceptance.*

* Golgi, and in this he is supported by Dr. Kaufmann in his recent communication to the members of the *Institut Egyptien*, accounts for quotidian ague by supposing that two sets of parasites, the life cycles

Dr. Hehir thus summarises the forms assumed by the malarial micro-organism :—Spores, small amœboid organisms, spherical bodies, *hæmatomomas malariæ stellatæ*, intra-corpuscular bodies, hyaline bodies, rosettes, flagellated organisms, and various pigmented and phagocytic cells. He thus includes 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, or 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. The 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 life-history of the malarial parasite in the human blood may be briefly told :—At first it appears as a pearly

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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 6, 1894.

* *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.

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 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 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, upon the surface of the enlarged protoplasm of the parasite, 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.

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* 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."

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 appears to be a resting or conjugation stage of the parasite's development, in which it remains without change for an indefinite period. It is asserted that the conjugation of two semi-lunar parasites, and their fusion, has 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 describe 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 hœmocytes (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."

(1) *The time which elapses between the entrance of the malarial parasites into the red blood-corpuscles and their*

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

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

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 gained wide acceptance. 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.

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.

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

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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.*

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 or beast, fowls or reptiles, insects or 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 crescentic, 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, has any casual relation with fever incidence. My paper puts on record the first successful attempt to cultivate the organism."

By his new method of staining, Evans demonstrated

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

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." *

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

* 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., &c., &c.

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.

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 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, &c., 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.

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

ILLUSTRATIONS FOR CHAPTER VII.

Plate I.

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 A, 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. vi.), there is but one tail, which is represented as attached to the head, and also another detached.

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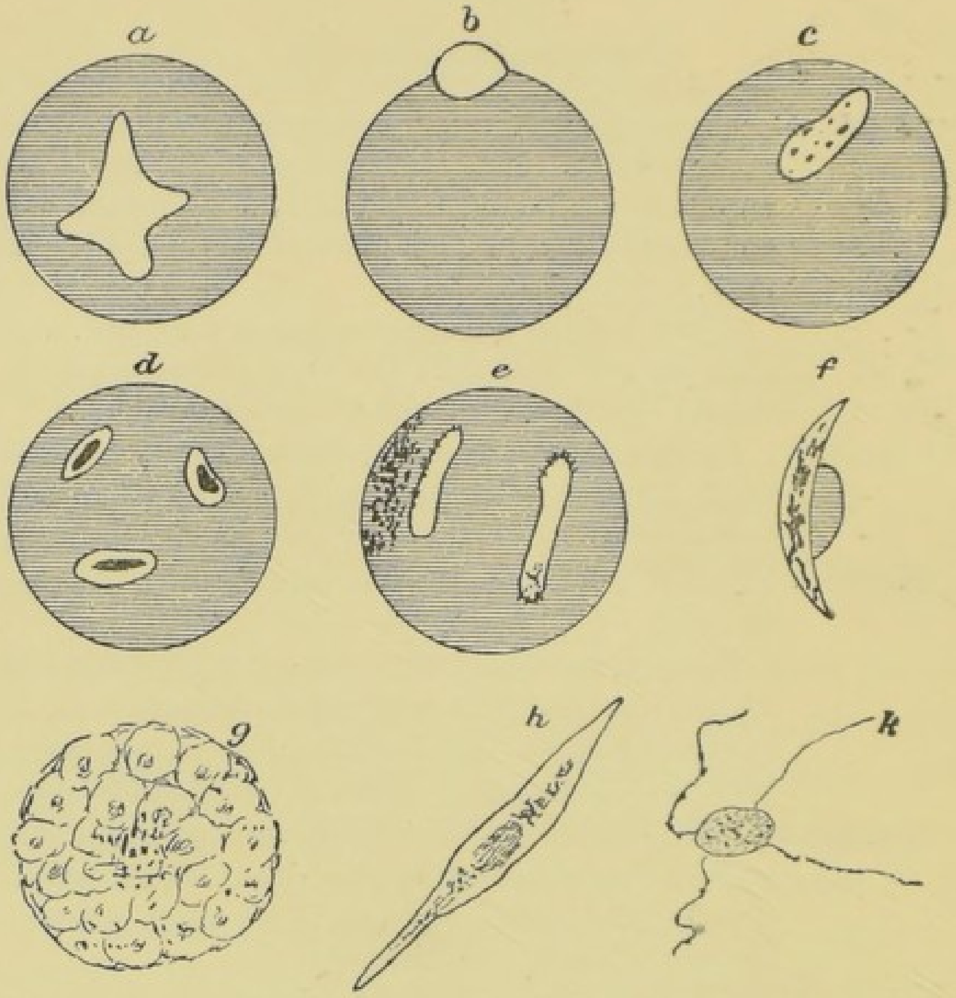
* For these drawings and description I am indebted to *Papers on the Etiology of Malaria*, by Professor E. Marchiafava and Dr. A. Celli, with a note by C. Friedländer. Translated for private use from the German text by C. H. Eyles, L.R.C.P. & S. Edin., Member Path. Society, &c. 1887.



THE PLASMODIUM MALARIÆ (after Marchiafava and Celli.)

Plate II.

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

The Etiology of Malaria.

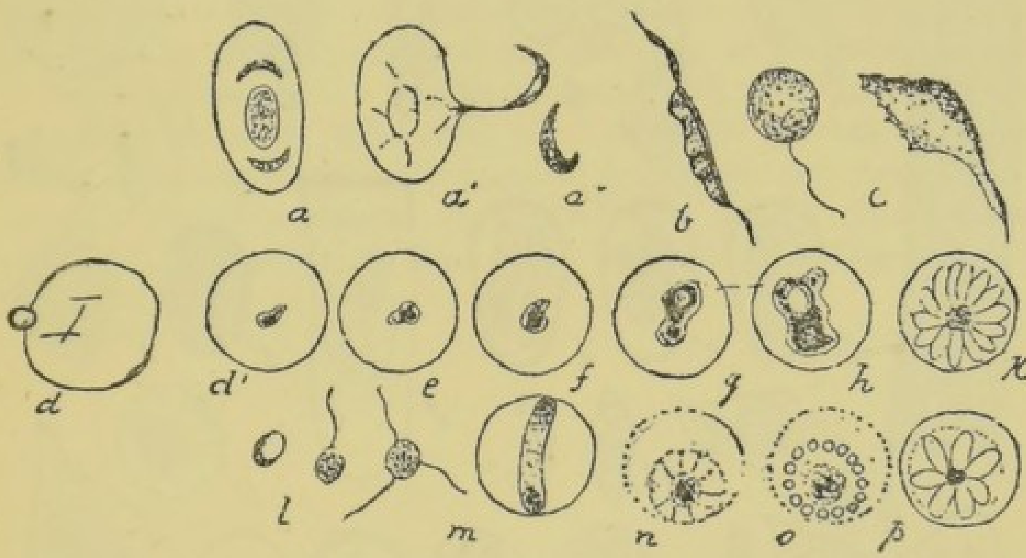


Plate II.—Various Forms of Blood-Cell Parasites.

a, A red blood-cell of frog, containing two crescents of *Crepanidium ranarum*, *a* 1, a crescent escaping, *a* 2, a free crescent; *b*, *Trichomonas* from fish's blood, *c*, from frog's blood—two phases; *d-k*, successive phases of development of *Plasmodium malariæ* within human red blood-cells; *k*, segmentation in the rosette form with central pigment; *l*, free segments which may be amœboid or flagellate; *n o*, plasmodium of tertian, *p*, of quartan ague, according to Golgi.

Plate III.

This plate is also taken from a paper in the *Canadian Practitioner* (Jan. 16, 1890), by Ramsay Wright, M.A., B.Sc., Professor of Biology, University of Toronto, on

The Pathogenic Sporozoa.

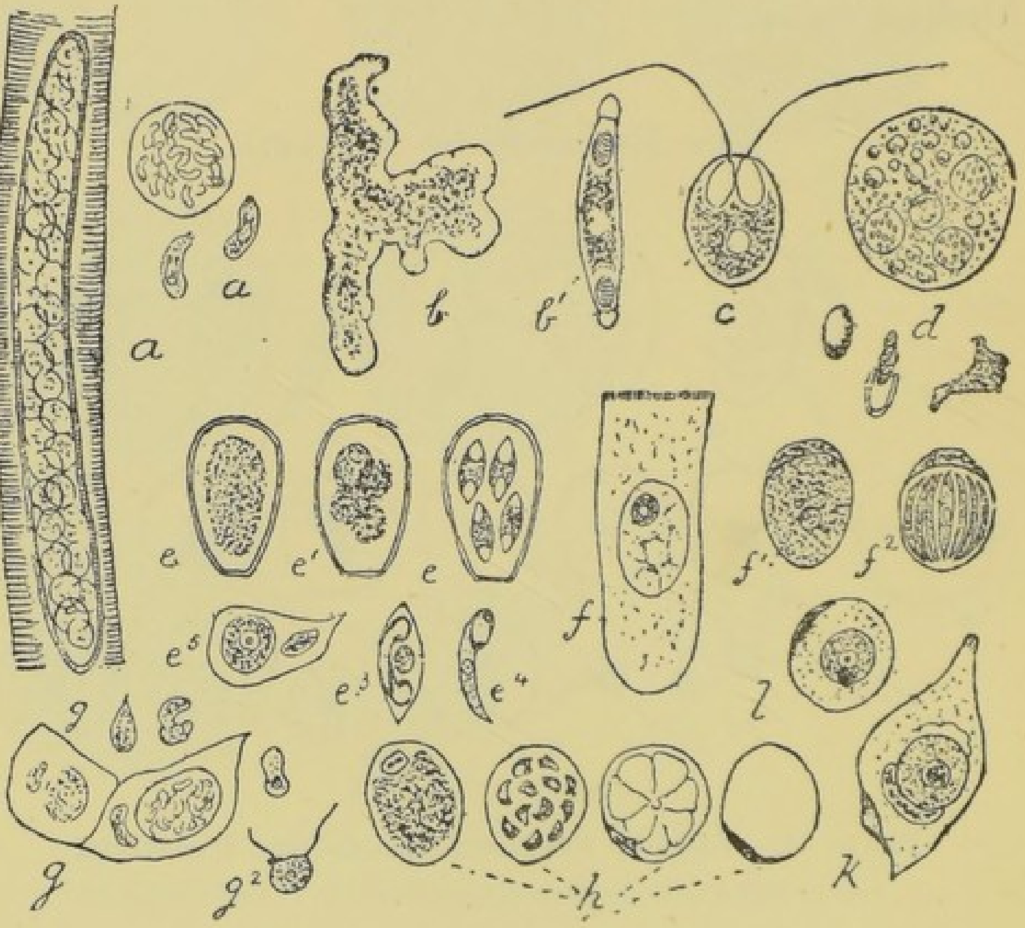


Plate III.—Illustrating Various Pathogenic Sporozoa.

a, A voluntary muscle-fibre from the œsophagus of the sheep containing a tube-like Sarcosporid; within the tubes are cysts in different stages of development, the ripe ones (*a* 1) containing numerous crescentic bodies; *b*, a Myxosporid from the bladder of the pike, (*b* 1) one of its spores with terminal thread-cells: *c*, a spore from another species with projected threads; *d*, yolk-cell from the egg of silk-moth infested with microsporic cysts; below is represented one of the oval spores contained in these and the amœboid germs which emerge from such spores; *e*, *Coccidium oviforme*, from the liver of the rabbit in encysted stage; *e* 1, *e* 2, contents of cysts segmenting into spores, *e* 3, one of the spores enlarged containing two crescentic germs, *e* 4; *e* 5, epithelial cell from a bile-duct invaded by a young coccidium; *f*, intestinal epithelial cell from the salamander, the nucleus of which is invaded by a coccidium (*Karyophagus* of Steinhaus), *f* 1, a similar nucleus almost entirely replaced by the invading coccidium; *f* 2, the coccidium undergoing direct division into segments; *g*, epithelial cells from the mouth of the pigeon, after Pfeiffer, with coccidia in different stages of development, one encysted with contained crescents; *g* 1, crescents showing amœboid movements; *g* 2, adopting "flagellate" form on mucous membrane; *h*, four epidermal cells from *molluscum contagiosum* after Neisser, to the left is a cell, *h* 1, with the contained coccidium in its protoplasmic phase, *h* 2, segmentation into angular refractive bodies follows, which eventually enlarge so as to crowd upon each other, *h* 3, their outlines disappearing and the surrounding cell cornifying give rise to the characteristic "molluscum corpuscle," *h* 4; *k*, epidermal cell from *psorospermosis follicularis* (keratosis follicularis), after Darier, in which a coccidium pushes aside and distorts the nucleus; *l*, epithelial cell from Paget's disease "chronic eczema of the nipple" after Butlin, the contained coccidium interpreted by him as an instance of endogenous cell-formation.

CHAPTER VIII.

CLASSIFICATION AND DESCRIPTION OF MALARIAL FEVERS.

The following classification of malarial fevers, while open to criticism, will serve, at least, as clue for laymen through this mazy subject.

Ordinary Types of Malarial Fever.	*I. Intermittent.* *II. Remittent.* *III. Mixed Intermittent and Remittent.* *IV. Bilious Remittent.* *V. Hæmaturic.*

Each type may be *Simple*, *Congestive*, or *Pernicious* in its clinical manifestations.

In all types, and at all stages of malarial fever, we are dealing with a process of malarial poisoning.

Fever, or pyrexia, although a frequent incident, is not an essential phenomenon of malarial poisoning, which may be variously manifested by diarrhœa, dysentery, stomach, liver, nervous and other disorders, with little or no concurrent fever.

Indeed, much of the sickness prevalent in malarial regions, although apparently unconnected with the fever, is really its cogener, having the malarial parasite, which is seldom absent from the blood, for cause.

Epitomised Description of Malarial Fevers, in the order of their classification.

I. Intermittent Fever. Syn. Fever and Ague, Ague, &c.

In this disease we have fever outbursts, or "*paroxysms*," occurring at regular intervals, with intervening *apyrexia*, or total absence of fever.

When the paroxysms occur at twenty-four hours' interval, the disease is called *quotidian;* when at forty-eight, *tertian;* when at seventy-two, *quartan* ague.

The temperature during paroxysm may range from 103° to 108° F., and over. Each paroxysm has three stages (in the classical disease), namely, *cold*, *hot*, and *sweating;* but in Africa the cold is frequently missing, or trivial.

The cold stage may last from half, to two or three hours; the hot, four to six hours; the sweating is of indefinite duration, varying according to circumstances, but ever ending and rounded off by refreshing sleep.

Quotidian generally has its paroxysm in the morning; tertian, at noon; and quartan in the evening.

II. Remittent Malarial Fever.

In this disease we have increase of violence, technically "*Exacerbation*," with temperature rising from 102° to 108° F., or over, occurring at irregular intervals, with intervening lowering of temperature, or "*remission*," to 102° or 100° F., but seldom total defervescence, or fall of temperature, to the normal 98·4° F.

The exacerbation, having lasted from an hour to several hours, its duration being very variable, ends by remission, which is accompanied by some sweating, diuresis, and other abortive efforts at defervescence ; not ending or rounded off by really refreshing sleep.

A mild form of this fever, lasting from ten to fourteen days, is common on the West Coast of Africa, and known there as "*acclimatisation fever*," a misnomer which should be changed for "*initiatory*," seeing that no immunity is conferred by the attack.

The duration of fevers Class I. and II., if left wholly to nature, is indefinite, long as patient is exposed to fresh infection and other exciting causes of pyrexia.

Intermittent may be likened to a geyser, in which thermal eruptions occur at fixed intervals, succeeded by lulls, during which material is being accumulated for fresh outbreaks.

Remittent rather resembles a live volcano, subject to violent eruptions at irregular times, but also sensibly active during the intervals.

III. Mixed Intermittent and Remittent : Sub-continuous fever.

Of this hybrid disease there are many varieties, but a description of the three most commonly met with in Africa must here suffice.

Var. A. This is a kind of mild remittent, the temperature rising to 101°-2°-3° F., seldom over. There is sometimes intermission, with fall below 100° F., accompanied by moderate—never excessive—sweating. At times there is obscure periodicity for days together, with brief paroxysms, showing a range up to 104° Fahr., followed by more or less defervescence.

Var. B. This is a form of sub-continuous malarial fever. It is neither distinctly intermittent or remittent, and its chief incidence is upon debilitated persons.

After chilliness—seldom shivering in Africa—which lasts from one to many hours, the temperature rises rapidly to 104°-5° or 106° F., and remains at this high plane subsequently all through the attack, while subject to frequent and rapid fluctuations of 2° or more during the course of the 24 hours. This persistently high temperature is characteristic of the fever.

The falls, or partial remissions, are accompanied as a rule by sweating; but, unlike the typical remittent, such sweating does not usually occur in the morning, but at any time of the day, and its occurrence seldom has the effect of materially lowering temperature. Indeed, more or less constant sweating, unaccompanied by marked defervescence, is another symptom of this fever.

Its duration is very variable, lasting, in cases uninfluenced by treatment, from several days to many weeks. Intense muscular and nervous debility follow these attacks.

Var. C. This has marked intermittent characteristics, but the paroxysms occur so frequently and last so long that the disease practically becomes a most dangerous remittent, with scarcely any interval of apyrexia. To explain this reduplication of paroxysm, Golgi assumes the co-existence in the blood of many "sets" of malarial parasites, each set arriving at maturity and sporulating independently.

In this fever, the very high temperature, sometimes up to 108° Fahr. or over—technically, *hyperpyrexia*—renders it extremely dangerous. Wasting and prostration rapidly ensue, and everything indicates acute malarial poisoning.

IV. Bilious Remittent Fever.

This, as the name implies, is remittent fever complicated with severe bilious symptoms.

It is characterised by very high temperature, delirium and coma, jaundice, and the passing of porter-coloured urine. This fever is chiefly prevalent on the tropical African littoral, but it is also met with in the hinterlands amongst those of bilious diathesis; here, as elsewhere, personal equation counting for much in determining the character of fever resulting from malarial infection.

V. Hæmaturic or Blackwater Fever.—Hæmorrhagic and Ictero-hæmaturic Fever.

Hæmaturic, or blackwater fever, according to Easmon, whom the *Lancet* considers to be probably right, is "an ordinary fever of remittent type, complicated by hæmorrhage from kidneys, and deserving no distinctive name."

In this fever there is at times a general hæmorrhagic tendency, with bleeding from nose, mouth, and bowels, and ecchymosis, or bruise marks on legs and other parts, from subcutaneous extravasation of blood.

In *Ictero-hæmaturic* fever, a variety of the foregoing, there is jaundice superadded to hæmorrhage.

The porter-coloured urine of Class IV. is due to the admixture of bile or its pigments, as seen in ordinary jaundice. The discolouration of urine in Class V. is chiefly due to the admixture of pure blood, or of blood and hæmoglobin, derived from destruction of red blood-cells; to which bile is added in the ictero-hæmaturic variety.

All fevers follow a *simple*, *congestive*, or *pernicious* course.

Simple fever presents no serious visceral or other complications.

Congestive fever, as the name implies, is complicated by congestions of one or more organs, as liver, spleen, lungs, kidneys, or brain.

Pernicious, or malignant fever, is characterised upon the surface by persistently and excessively high temperatures *(hyperpyrexia)*, mounting to 108° Fahrenheit and upwards, in fatal cases, to the stem of thermometer. There are also present other symptoms of lethal malarial poisoning, as persistent vomiting, convulsions, muttering delirium, coma, and general abolition of function.

The symptoms of *pernicious* closely resemble those of yellow fever, and nothing but the most prompt and efficient medical treatment can avail to give the patient even a chance of recovery.

True yellow fever is also occasionally met with on the African tropical littoral—never in the interior.

The period of *incubation*, or latency of malarial fever, is put down in medical works at 20 to 40 days, which is really the length of the period of *immunity* enjoyed by those coming fresh from home for the first time into malarial regions.

As a fact, the hatching period of the malarial hæmatozoön in the human body is, as we have seen, from 24 to 72 hours; but the powers of parasitic destruction possessed by the system prevail from 20 to 40 days, which means the suppression of fever over this period. Sooner or later, according to individual strength, idiosyncracy, dose of poison and other causes, the overwhelming and persistent onslaughts of the parasites prevail, and henceforth fever is always with us.

The commencement, and especially the end, of the rainy season are the most dangerous times for malarial infection.

I will now try to depict a typical attack of malarial fever, occurring after the usual period of immunity.

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-bye 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 remains, 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 apidly developing, and with it nausea, retching, and vomiting, to complete his agony. The native noise and chatter become unendurable, and, like some stricken life, 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 semiinsensibility 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 IX.

ON PYREXIA AND PSEUDO-MALARIAL FEVER.

There is a malady in Africa in which increased and persistently high temperature appears to constitute the disease. Cases go on for weeks and even months together, uninfluenced by quinine, arsenic, and other drugs, as long as the patient is exposed to exciting causes while in a state of broken health, and especially while suffering from nervous debility.

This form of continuous pyrexia is due to derangement of the nervous heat mechanism, the balance of which is easily upset.

In the strong, this mechanism prevents a greater diurnal range of bodily temperature than $\frac{1}{2}°$ to $1°$ Fahr., and this chiefly by fall at night and corresponding rise by day. But in the debilitated the range is greater, and pyrexia easily excited.

Amongst the causes which can produce it, acting singly or in conjunction with malaria, are: bodily and mental fatigue, harassing marches, exposure to sun; chill; bad, ill-cooked, unwholesome, or deficient food; disturbed sleep; intemperance in eating or drinking; sexual excesses; shock, grief, anger and fear.

Given the *frequent* and *persistent* incidence of one or more of the above agencies, acting in a malarious country upon persons who have had malarial fever, and become debilitated—and we may produce this form of continued febrile disease, from functional disturbance of the heat-regulating mechanism.

Under similar subjective conditions and environment, we can produce another form of pyrexia, the symptoms of which are undistinguishable from those of typical intermittent or remittent, by the *sudden*, *brief*, and *occasional* incidence of one or more of the above agencies. To this the name *pseudo-malarial fever* might be applied, to distinguish it from the true disease, with which it is so frequently confounded.

It is easy to see how quinine and arsenic fail to cure either of the above types of pyrexia, which are placed, by their nature and origin, outside the range of the specific action of such drugs.

It must have been to a form of this continuous type that Surgeon Parke alludes:—"There was not one of the officers of the Relief Expedition who did not, over and over again, go through a hard day's work, including laborious marching over very difficult ground, and constant attention to a number of worrying duties, while his temperature was all the while above 105° or 106° Fahr., and such exertion did not appear to have any subsequent effect upon his convalescence; indeed, all our worst cases occurred while we were occupying standing camps."*

Pseudo-malaria is most commonly induced by sudden chill, and it may be taken as established that—*violent oscillations of bodily temperature, from whatever cause, is the commonest excitant of fever in the tropics.*

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* *Notes on African Fever*, by Surgeon F. H. Parke. *Lancet*, May 28, 1892.

Thus, getting drenched by a shower, or falling into water; passing from hot sunshine to the cool shade of tree or verandah; standing still in draught, or drinking cold water when perspiring, may originate fever in the susceptible.

Surgeon Parke, in the article quoted, shows that pseudo-malarial fever was of constant occurrence:—"A couple of hours' unshaded exposure to the vertical sun, a single hour's chill, the swimming of a river, the wading of a swamp, and the quiet inhalation of the vapours arising from a quantity of rank and moist decomposing vegetation, were rapidly followed by fever."

To understand how this occurs, it is necessary to glance in passing at

The Heat-regulating Mechanism of the Body.

This consists essentially of three parts:—

1st.—A heat-losing, or *thermolytic*, mechanism, which embraces the cutaneous blood-vessels and sweat-glands, besides the respiratory organs, the chief loss of heat being through the skin: all presided over by the medulla and spinal cord.

2nd.—A heat-producing, or *thermogenetic*, mechanism. The consumption of muscle is the chief source of heat, and this is presided over by that part of the brain called the *corpus striatum*, irritation of which, either artificially or by disease, causes rise of temperature.

3rd.—A heat-balancing, or *thermotaxis*, mechanism, the function of which is to maintain automatically a constant temperature, by adjusting the balance between the other two. This organ is strong in the healthy man, and fairly competent to maintain the bodily heat, with no greater range in the 24 hours than 1° Fahr. It is weaker in women and very weak in children, in whom the slightest causes produce rapid and high fluctuations of temperature. This part of the mechanism is also most easily put out of gear and exhausted, which is seen towards the termination of fatal fever, and even in nervous pyrexia, when a great rise of temperature often occurs.

Bleeding into the *corpus striatum* will also cause a rise of temperature.

"Poisons in the blood may affect any part of the heat mechanism, and most specific fevers are probably an instance of this; and we have a rise of temperature in belladonna and fish poisoning. Lastly, it is possible that severe peripheral stimuli may influence the thermic central nervous system."*

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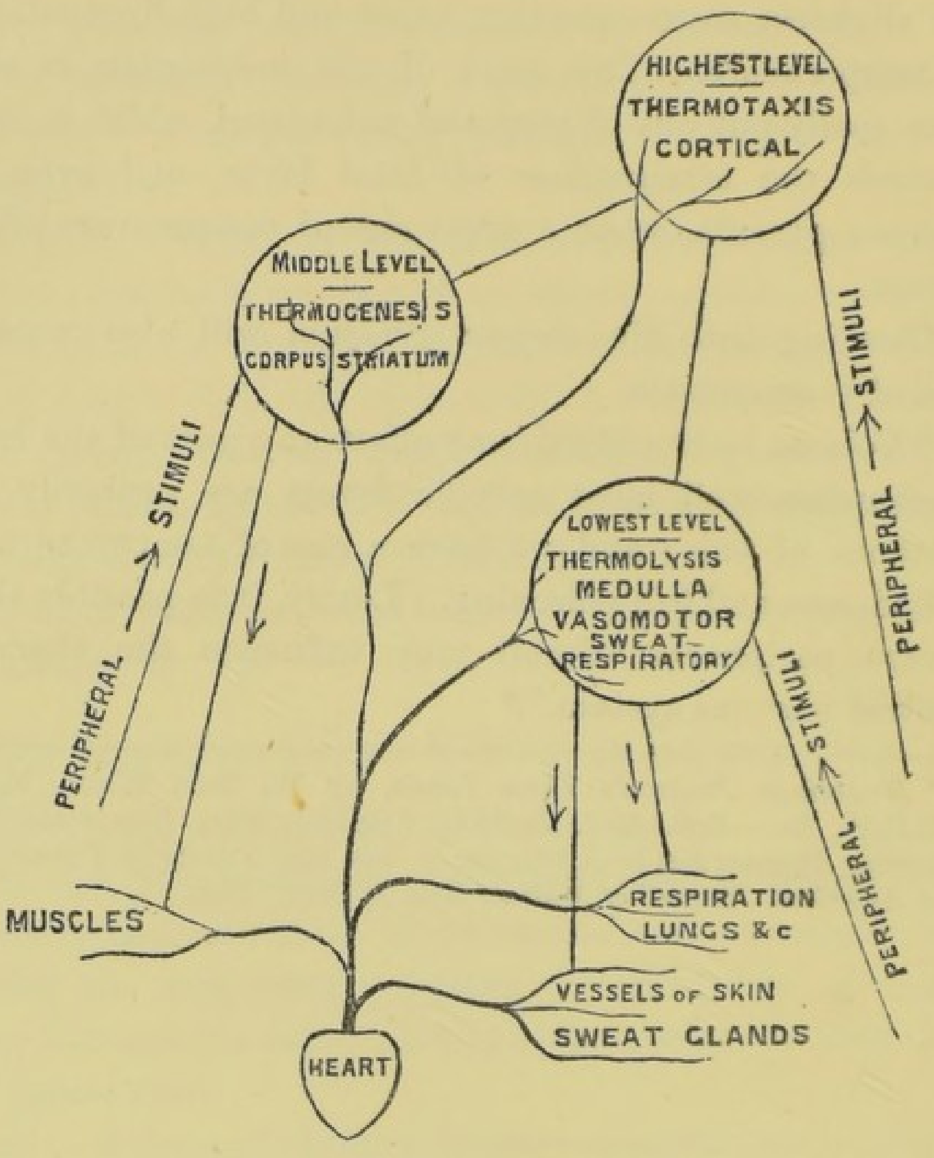
* *Hughlings Jackson's Three Levels*, by W. Hale White, M.D. F.R.C.P., &c.—*Brit. Med. Journal*, April 26, 1890, from which the following diagram has been borrowed. See also *Theory of Pyrexia.—The American Journal of Medical Science*, Nov., 1890.



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.

Dr. White, in his *Address on Pyrexia and its Treatment* at the British Medical Association Meeting (Bristol, August 3, 1894), says:—"Many substances circulating in the blood cause pyrexia—*e.g.*, atropine, strychnine, cocaine, caffeine, pepsin, albumose, &c.; also the products of decomposing food, as ham, mussels, cheese, pork, &c. But the importance of the pyrexia produced by the circulation in the blood of the toxines, produced by the micro-organisms of the specific fevers, overshadows that of all others. The *pyrogenous toxines* of anthrax and diphtheria have been isolated and separated from the toxines which produce the other symptoms, and pyrogenous substances have been separated from cultures of many bacilli. What part of the neuro-muscular thermic apparatus these substances act upon is not known."

The thermotaxis maintains the normal temperature better than it can restore it whence once upset.

For example, an organism may resist disturbing influences for a considerable time, then, becoming exhausted, develop an attack of fever from some trivial shock or chill.

Thus, Bernard found in animals, placed in an overheated medium, that their temperature, after reaching 104°–105° Fahr., kept at this level for a long time; then at once, the resistance being overcome, it rose to 113° Fahr., and the animal died.* Professor Bouchard also shows that muscular exercise, unrest, indigestion, and hysteria may produce fever in the debilitated, "*in whom protection against variations of temperature by the*

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* An Address on *The Part Played by Nervous Debility in the Production of Fever.* Delivered before a General Meeting of the XIth. *International Medical Congress,* held in Rome, 1894. By Professor Bouchard, of Paris.

nervous system is more or less ineffectual." In such people, he says, "*one can see as with a magnifying glass, effects which are but slightly visible in the normal state.*" His conclusion is :—"*The weakened nervous system is a reagent particularly sensitive to the action of the factors which produce fever.*"

The part played by pyrexia, arising from any cause, in rekindling, exaggerating, and simulating true malarial fever, is very remarkable. It is a good example of what has been called "*the unconscious memory of disease,*" inherent in the system. *Or it might be viewed as a morbid habit of body which henceforth casts every pyrexia in the mould of malarial fever.*

This recrudescence of intermittent or remittent febrile process is independent of *fresh* malarial infection, although the malarial parasite, dwelling perennially in the blood in malarial regions, doubtless helps to shape the symptoms.

When assured of the total disappearance of the microbe from the blood, as after months or years of residence in Europe, we see that it is still quite easy to start an attack of pseudo-malarial fever. Sixteen months after leaving the West Coast (not to mention a great number of fevers in the interval), I brought on myself two severe attacks of remittent fever, with complete set of African symptoms, by taking very early train journeys in cold weather.

Speaking on this subject, Dr. Sedgwick says :—"Who can doubt the after influence of an attack of malarial fever? A subsequent catarrh, or a digestive trouble, will be accompanied by rigors and sweating, long years after the original disease has passed away, and will be most effectively dealt with by the help of quinine."*

In my experience I have certainly not found quinine to be of service, but rather the reverse, in attacks of pseudo-malarial fever. It appeared rather to increase the headache and other distressing symptoms, and, save in tonic doses, I fail to see the *rationale* of its use, at all events after returning to Europe.

Pseudo-malarial fever occurring in malarious regions may be very easily mistaken for the genuine disease, and if treated for such with large doses of quinine, its symptoms may be aggravated, and the remedy wrongly discredited. Tonic doses of quinine are, however, indicated in these fevers. "In the weak man," says Professor Bouchard—and all who suffer from pseudo-malarial fever are weak—"the thermic line becomes almost straight, when some temporary energy is restored to his nervous system by the administration of moderate doses of quinine."

As the cruellest characteristic of malarial fever is its tendency to return, often with increased virulence, at each fresh exposure to infection, so does its simulacrum, pseudo-malarial fever, also recur; but in a healthy country the strength and number of its attacks decrease with the elapse of time, and the restoration of health and strength.

Time is the one great remedy for this trouble.

That genuine malarial fever can be imported into England, or into any other healthy country, in the blood of a person who has been suffering from the disease, is impossible. The parasite can only fight successfully by

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* Address on *The Personal Factor in Disease.* Delivered at the Annual Meeting of the Metropolitan Counties Branch, B. M. A., by Leonard W. Sedgwick, M.D.

constantly pouring fresh legions into the blood to take the place of those that have perished, and this is only possible in a malarious country. On leaving it for a healthy one, if the patient survives the change, the protective forces of the body soon gain the upper hand, and exterminate the remaining microbes, while the emunctories quickly clear the system of their toxines.

One important lesson may be learnt from the preceding: the vital necessity of

MENS SANA, IN CORPORE SANO.

for those going to tropical Africa.

If a man is not sound in wind and limb; if he has previously suffered from malarial fever so badly as to have needed 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 Central 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.*" *

Amongst the dangerous maladies, other than fever, resulting from malaria, may be named: diarrhœa, dysen-

* *The Hospital.* May 12, 1893.

tery, cardiac, hepatic, splenic, and kidney diseases, and neuroses of all kinds, for the incidence of the poison is mainly upon the nervous system.

Not only are the nerves shattered by repeated attacks of fever, but even when it has been suppressed, the poison continues to work insidiously in blood and tissues, causing muscular atrophy, anæmia, and cachexia.

CHAPTER X.

ON QUININE.

Part I. The Physiological Action of Quinine. Its Action on the Malarial Parasite and other Low Organisms.

Part II. On Phagocytosis.

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 (*cinchona flava*), or Peruvian bark; its physical characters are too well known to need description. It is the most

* *The Principles and Practice of Medicine.* By W. Osler, M.D., F.R.C.P., &c., &c., &c., 1892. London: Young J. Pentland.

active ingredient in Warburg's Tincture and other well known remedies for malarial fever.

Everyone going to Africa should make himself sufficiently acquainted with the physiological and medical 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.

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 poison—for such it is 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 personal equation and other things influence results.

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 tonic 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."

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* I am under special obligations to the monumental work of Drs. Stillé and Maisch—*The National Dispensatory* (Churchill, London)—for much of the valuable matter of this chapter.

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

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

Stillé and Maisch say:—"One part of quinine dissolved in 20,000 parts of water will, in a few minutes, begin to 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, it is probable that the protracted or excessive use of quinine, by arresting this, may 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

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* Royle, *o.a.c.*

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

doctrine of its action:—"Quinine," he said, "cures malarial cachexia, 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 anœmia of the brain. Quinine paralyses the irritant miasm by virtue of its antiseptic quality."

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 ague cake.

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,* is of small practical importance in view of its established power to kill the parasite sooner or later in the blood and tissues.

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* "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.

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. Possibly this may modify the attraction between the parasite and the corpuscles, as the former, being aërobic, is drawn to the red blood-cell for its supply of oxygen as well as food.

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.

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 of 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 sequalæ of malarial, may be easily confounded with those of quinine poisoning. Time tends to cure both.

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* *Paper on the Etiology of Malaria*, previously referred to.

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 advances 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 substantives 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.

Plate A.

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*).

Plate B.

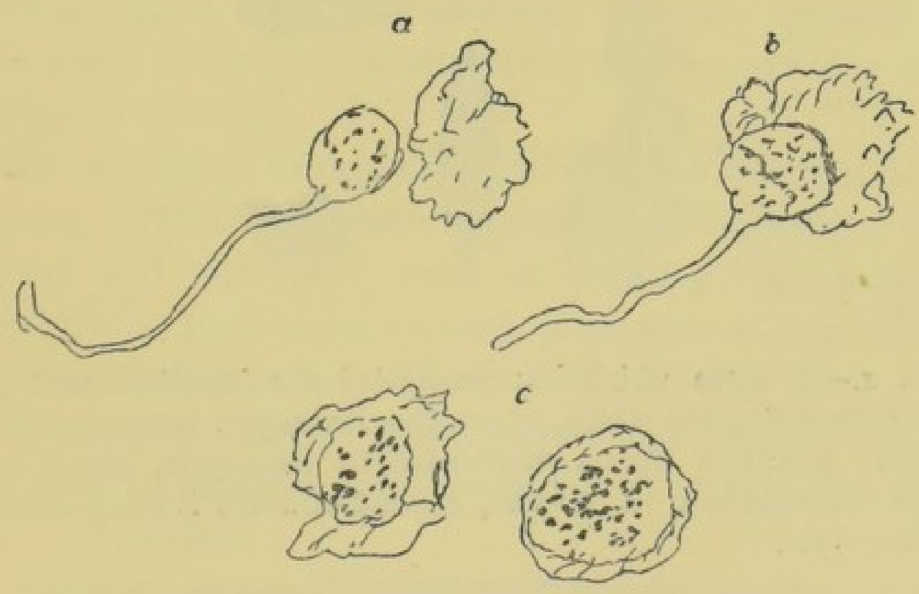
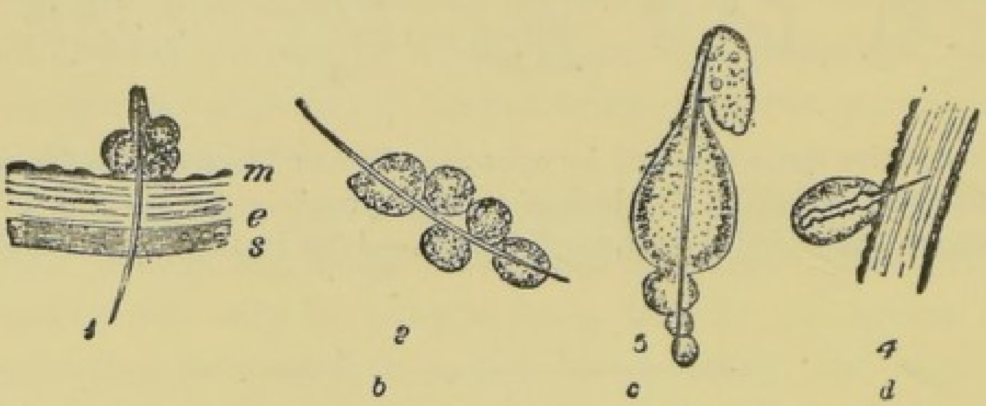


Plate B.—Illustrating phagocytosis in malarial poisoning.

(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 it is conveyed to the spleen, brain, bone-marrow, or liver.

Plate C.

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



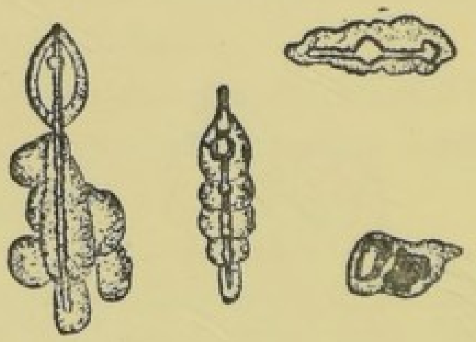


Fig. 1.—A spore which has penetrated the intestinal wall and entered the abdominal cavity, where four leucocytes have surrounded its end. *b.* and *c.* Spores surrounded by leucocytes, which have become confluent in *c.* *d.* A spore, one end of which is being digested by a leucocyte.

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

CHAPTER XI.

QUININE.

PART I.—THE MEDICAL ACTION AND USES OF QUININE AND WARBURG'S TINCTURE IN MALARIAL FEVERS.

PART II.—NURSING AND FEEDING IN FEVER.

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 PROPHYLACTIC.

As a prevention of malarial fever, quinine should be taken in doses of $2\frac{1}{2}$ *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 five-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 recommended 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 twice daily,*

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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.

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.

Going ashore at unhealthy parts 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, prevent malarial fever, is shown, I think, in 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 the air, 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, to which new microbes were being constantly added.

Experience shows that a moderate dose of quinine given every twelfth hour will prevent fever in the pre-

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* *Floating Matter of Air.*

sence 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 approaching sporulation—that final soft stage of development which coincides, according to Golgi, with the commencement of paroxysm or exacerbation.

The successive destruction of ripening malarial crops by quinine, aided by the natural protective agents, prevents the accumulation and sporulation of the parasites in sufficient quantities to cause fever: so establishing a precarious temporary immunity.

It is easily conceivable how such small repeated doses of quinine can quickly annihilate the whole brood of malarial parasites, if no fresh germs find entrance to the blood—as when the patient takes ship for England.

Although quinine is aided in this struggle by all the natural protective forces of the body, yet the battle is unequal, and never doubtful if protracted; because the defensive powers are limited, and tend to diminish, while the microbes are numberless, their supply inexhaustible, and their assaults perpetual.

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.

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* See chap. xii.

Quinine is best administered in solution, and when the stomach contains some food.

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.

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

* 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.

forms of malarial dysentery with plumb-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 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.

"*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.

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.

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.

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

Speaking generally:—*Warburg is the safest of all remedies to employ in doubtful cases, especially of the remittent type, as it does not produce quinism or other hurtful effects, even should it fail to cure the disease.*

It sounds like a truism to say:—*the proper and only safe place for a fever patient is his bed;* yet there is no sanitary maxim more disregarded in the tropics.

Do not suddenly raise up a weak fever patient into sitting or standing posture, lest syncope or death result from failure of the heart's action.

This is another venerable medical saw more honoured in the breach than the observance in Africa.

Part II. 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 four to five 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

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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.

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 four to five ozs. every $2\frac{1}{2}$ 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.

As a rule, milk is best given with some form of gruel, by which means its curds are finely divided in the stomach, and much 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.

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

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, corn-flour in gruel, to which a little milk may be added. Plantain and manioc gruel; banana gruel, with milk, which saved Stanley's life (see chap. xv.). Maize and millet meal gruel, used with malt infusion (see chap. xv.), 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.

The three great staple foods for fever in Africa are milk, finely ground Scotch oatmeal gruel, and chicken tea; given these, and we can get on in the absence of all the rest.

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 is 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 oatmeal gruel, the latter and chicken tea, may be mixed in various ways to please the palate.*

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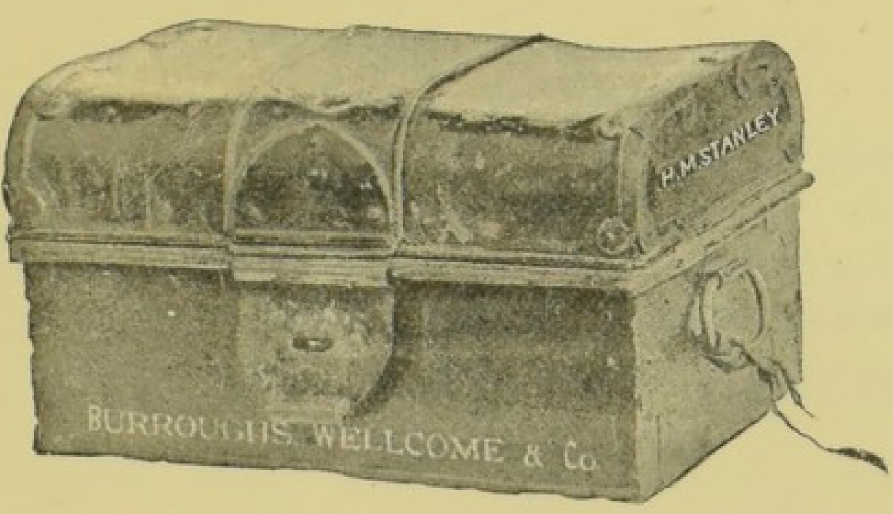
* *Light Diet*, by Dr. H. W. Seager, gives concise directions for the preparation of food for all kinds of invalids.



THE STANLEY MEDICINE CHEST.

One of the Medicine Chests, fitted with tabloids of compressed drugs, supplied to H. M. Stanley by Burroughs, Wellcome & Co., carried throughout his Emin Pasha Relief Expedition, and brought back as a souvenir, the remaining contents unimpaired.

Weight when completely filled, 40 lbs.; dimensions, $15\frac{5}{8} \times 10 \times 8$ inches.

This firm supplied the drugs for my last expedition. Those in tabloid form were perfect.

On a previous expedition I obtained my drugs from the old firm of Burgoyne, Burbridges & Co., 16 Coleman Street, London. They were the ordinary tinctures, oils, powders, &c. (as I did not then use tabloids) of perfect quality, and packed up with such care and skill that nothing was broken or damaged.

CHAPTER XII.

DOSE AND MODE OF ADMINISTRATION OF QUININE AND WARBURG'S TINCTURE IN MALARIAL FEVERS.

WHEN BATHS AND PACKS, PHENACETIN AND ANTIPYRIN, ARE USEFUL.

Class I. Intermittent Fever: its Treatment by Quinine.

Rule: *Without preliminary medication of any kind, in simple cases of intermittent, give* 5 *to* 8 *grains; in severe cases,* 15 *to* 20 *grains; in pernicious,* 30 *to* 60 *grains of quinine. Dose to be given in every instance during intermission, and, if possible, about* 12 *hours before the expected paroxysm.*

When paroxysms have been arrested :—

Rule: "*Suspend the drug until* 24 *or* 36 *hours before the seventh day, reckoning from the beginning of last paroxysm, when it should be repeated again in the original dose.*"—*(Stillé and Maisch.)*

Class II. Remittent Fever: its Treatment by Quinine.

Rule (1): *Give* 12 *to* 18 *grains of quinine in mild cases,* 18 *to* 27 *in severe cases,* 24 *to* 36 *grains in per-*

nicious cases, during the remission, and soon as possible after it has set in.

In mild cases, preliminary purgation is not recommended as a mere routine of treatment.

Rule (2): *As the exacerbations diminish in frequency and force, the doses of quinine should be gradually reduced to ½, ⅓, and ¼ of original, and then cautiously omitted. It is never safe wholly to suspend the use of quinine until the temperature has kept below 100° F. for at least a week.*

Remission usually occurs towards morning; *exacerbation* towards evening, when the fever is permitted to follow its natural course; as when the patient is confined to bed and properly fed and nursed. But, as before observed, numerous causes (physical and emotional), as chill, anger, fright, muscular exertion and the like, may bring on exacerbation at any hour of day or night. This fact is to be remembered.

REMITTENT FEVER: ITS 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.

Mode of administration of Warburg:—

Rule (3): "*The bowels having been thoroughly evacuated by some suitable purgative, all drink being withheld, give one tablespoonful (½ 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 below.*

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* 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 ounces of proof spirit in a water bath for 12 hours; then expressed, and 10 ounces 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.

CLASS III. MIXED INTERMITTENT AND REMITTENT FEVER: TREATMENT BY QUININE AND WARBURG.

Var. A and B.—Rule: *Quinine and Warburg should be administered in these fevers as in ordinary cases of mild remittent. Give 12 to 18 grains of quinine during remission, beginning soon as possible after it has set in. Or give Warburg during the exacerbation in way already prescribed. In Var. B slightly larger doses of the drugs should be used, and the pack or cold bath employed if hyperpyrexia sets in, with temperature of 106° and over.*

Var. C.—Nothing short of the most active and judicious treatment—if possible, by some skilful physician—will avail to cure this disease.

FIRST METHOD.—The most effective remedy is quinine, administered by intravenous or hypodermic injection.

RULE: *From 15 to 30 grains in proper solution should be injected every twelfth hour until the paroxysms are arrested; then 8 to 12 grains, at twelve-hour intervals, to complete the cure. In every case suspend use of drug if quinism should supervene.*

SECOND METHOD.—*If intravenous or hypodermic injection is impracticable, give quinine by mouth or rectum, in solution, in doses of 20 to 36 grains, choosing, if possible, an apyrexial interval for its administration. When the fever has been quelled, complete cure by 8 to 12-grain doses, at 12-hour intervals. In every case suspend use of drug if quinism should supervene.*

General Rule for the Administration of Large Doses of Quinine.

If more than 8 grains of quinine is to be administered for a dose, either by intravenous or hypodermic injection, or by mouth or rectum, safety and efficiency of action are best insured by dividing the whole into parts of not more than 8 grains, and giving one such part every hour until all has been administered. Instantly suspend the drug if quinism should supervene.

Var. C.—Treatment by Warburg's Tincture.

Rule: *Begin by an active purgative or clyster, then give a tablespoonful of Warburg's Tincture every 2 hours until 6 doses have been administered. If defervescence should occur after any dose, suspend the drug for 12 hours. If no favourable effect is produced after 6 doses, extending over 12 hours, stop the medicine as inoperative.*

Although the Warburg treatment for Var. C., Class III., is too mild to be recommended, it is not condemned; and as it has the advantage of being free from danger, it may be used tentatively by the inexperienced.

A few doses will sometimes cure in a most unexpected manner.—*(See article on Cold Baths, Packing, and Affusions in this fever, and other forms of hyperpyrexia).*

Class IV. Bilious Remittent: its Treatment by Quinine and Warburg.

This being a severe form of remittent, complicated with bilious symptoms, treat the case as follows:—

The bowels having been thoroughly evacuated by some *suitable purgative,* give Warburg in tablespoonful doses every 2 or 3 hours. Should this fail, after 6 doses, to cause defervescence or marked relief of symptoms, treat the case as Var. C., Class III. Suspend all drugs for 12 hours on advent of defervescence, when they may be cautiously resumed in ½, ⅓, or ¼ quantity.*

Warburg is, as a rule, the best remedy for this form of malarial fever.—(*See article on Hot Air Baths and Packing*, ch. xiv.)

CLASS V.—HÆMATURIC OR BLACKWATER FEVER: ITS TREATMENT BY QUININE AND WARBURG.

This type of malarial disease presents many points of difficulty and danger. We have to deal with hæmorrhage in addition to intense malarial poisoning, and,

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* In this case there can be no question about suitableness of the Livingstone "rouser," of which this is 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 wine-glassful 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 successive 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.

according to some authorities, to face the issue unaided by quinine, or at least employing it with doubtful mind.

Dr. McDaniel, speaking of the use of quinine in this disease, says :—" Quinine is not only not the effective and reliable remedy, as is now widely believed and practised, but is, on the contrary, an uncertain and even dangerous agent in this hæmaturic disease, and often seems to determine an unfavourable issue."* Pietro-Pucci confirms the hurtful influence of " quinine administered in any form, or in any dose, in cases of the *ictero-hæmaturic* fever described by Tomaselli. In such it induces shivering, vomiting, bloody urine, and jaundice, or bloody urine with subsequent hæmorrhage."†

On the other hand, " The consensus of opinion of practitioners whose experience has been gained in the regions in which the disease occurs, is in favour of the use of quinine."‡

On the Gold Coast this fever is successfully treated by Warburg and quinine, and one should hesitate to abandon the specific without at least a trial.

Treatment recommended :—

The bowels having been gently opened by some mild aperient, § *Warburg should be administered in the usual way in tablespoonful doses every third hour. Should defervescence occur upon the second or third dose of drug, suspend its use. Upon recrudescence of the fever—a thing to be looked for—repeat Warburg, but do not under any circumstances administer more than* 3 *or* 4 *doses in the* 24 *hours.*

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* *Medical News*, xliii. 56. † *Gazz. d. Osp.*, Dec. 7, 1893.

‡ Stillé and Maisch in *The National Dispensatory*.

§ For this purpose nothing is better than a tablespoonful or two of castor oil given in hot brandy or whisky and water.

This is the ordinary safe treatment for inexperienced laymen. In many cases, aided by good nursing, suitable food and packing, it will cure or relieve the disease ; but in others it will fail, and the ominously high temperature will show no decline.

Should such occur, treat the case with full doses of quinine, given by vein or hypodermically, by mouth or rectum, precisely as indicated in treatment of Var. C, Class III.

I believe that when cure is possible, it can be effected only by thus destroying the malarial parasite in blood and tissues, and by removing its toxines from the system ; not by remedies directed to arrest hæmorrhage from kidneys, or to lower temperature, as phenacetin, antipyrin, and ergotin.

Warburg is an excellent remedy to begin with ; the quinine it contains being so cunningly combined with other drugs which act powerfully on the emunctories, that it is eliminated wholly, or chiefly with the malarial toxines, through bowels and skin, kidney function being spared to the utmost, and so the passage of blood through these organs minimised.

As in all cases of continuous hyperpyrexia, the bath should be judiciously administered in connection with quinine and Warburg.*

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* See chap. xiv., *Baths.*

TREATMENT OF SPECIAL PHASES OF FEVER.

THE CONGESTIVE PHASE OF FEVERS: ITS TREATMENT.

Rule: *Always begin the treatment of congestive fevers by brisk evacuants, as the "rouser," calomel, an emetic, or clyster; singly or conjoined.* After the bowels have been thoroughly evacuated, give quinine or Warburg according to the rules laid down for the treatment of severe intermittent and remittent.*

The following remedies are also indicated in congestive fevers:—The hot air bath, hot general and local packs, mustard pack, sinapisms to nape of neck, spine and legs, hot fomentations and affusions; hot poultices, bottles, &c., to abdomen, loins, and legs; hot injections and stimulating enemata. At the same time, ice-cold evaporating cloths or affusions to head, to check cerebral congestion.†

PERNICIOUS OR MALIGNANT FEVERS: HOW TREATED.

Rule: *Begin treatment as above by evacuants. Then administer quinine, by intravenous or hypodermic injection, in doses of* 15 *to* 30 *grains (divided into* 8*-grain doses, given hourly). Repeat such doses, at* 12*-hour inter-*

* A safe emetic is mustard and warm water, or warm salt and water, 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 soap-suds, or even plain warm water. Inject at temperature of the body, or hotter if a stimulant action is required.

† Full details of how to use these *baths* and *applications* will be given in a subsequent chapter.

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

vals, until paroxysm or exacerbation has been arrested, or defervescence occurs. If the first 15 or 30 grains arrest fever, reduce dose to ½, ⅓, and ¼, at successive 12-hour intervals, until all fever manifestations have disappeared. Then give 5-grain doses night and morning, and gradually suspend the medicine.

Bacelli, writing on this fever, says :—

"*The subcutaneous (hypodermic) injection of quinine in cases of pernicious or aggravated malarial fever, yielded a percentage of 17 to 18 failures; the intravenous injection of some salt succeeded in nearly every patient.*"

If, however, this treatment is impracticable, pursue the "*second method*" described under Var. C, Class III., in which large doses of quinine are administered by mouth or rectum.

The general cold bath, or, failing appliances to give this, frequent general cold affusions of the body, and cold compresses over abdomen, are especially useful in this affection. As pointed out by Dr. Hale White, cold does good not merely as an antipyretic or damper of the fever process, but also by diminishing coma and delirium, and other complications not clearly traceable to fever. Cold baths greatly aid the excretion of toxines, or the poisons manufactured by microbes in the system, and in this sense they should be regarded as specifics of highest value in the treatment of hyperpyrexia, viz., fever with a temperature persistently above 106° F.

Dr. White says :—"In conclusion, hyperpyrexia requires prompt treatment by cold baths. The treatment of pyrexia as such is on all grounds unsound. In ague and rheumatic fever we have specific remedies which, as such, improve all the symptoms, and consequently the temperature falls. In some cases of typhoid fever, and perhaps pneumonia, cold externally does good, not as an antipyretic, but probably by aiding the elimination of toxines. The use of ordinary antipyretic drugs is never called for in pyrexia or hyperpyrexia."*

On the other hand, Professor Bouchard† holds that antipyrin may save apparently hopeless cases of fever.

If, then, quinine, and the use of such cold as can be applied, should fail to reduce the temperature of any case of fever when it has reached, let us say, 105° or 106°, with upward tendency, may we not be justified in administering *antipyrin* or *phenacetin?*

Antipyrin or phenacetin are indicated by hyperpyrexia, despite of treatment. They are poisons, but under such circumstances antagonistic or antidotal to other poisons which threaten life.

Dose: From 15 to 30 grains of antipyrin may be administered by mouth, or 30 to 60 grains by rectum. One dose is generally sufficient to lower temperature to a point where other less dangerous treatment becomes effective.

The Subcutaneous and Intravenous Administration of Quinine.

Dr. Tanner's formula *(Practice of Medicine)* for the hypodermic use of quinine:—

R. Quinæ Sulph., 64 grains.
Acid: Sulph: dilut: P.B., 10 drops.
Distilled water, 4 ozs. Make solution.

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* See Address delivered by Dr. W. Hale White, *On Pyrexia and its Treatment*, before the *Brit. Med. Ass.*, August 2nd, 1894.

† See Professor Bouchard's Address at *The International Medical Congress, Rome*, 1894. Also *Medical Record*, xxix. 254. Sir W. H. Broadbent prefers phenacetin to antipyrin for lowering temperature in fever. See *Lancet*, August 25, 1894.

Dose, from 15 to 30 drops, equal to 4 to 8 grains of quinine, for a single injection.

Directions :—Inject slowly into subcutaneous tissue (just under skin), in slanting direction. Only a clear solution must be used, as the quinine must be perfectly dissolved.

The hypodermic syringe must be kept scrupulously clean, and washed in pure spirit or strong solution of quinine before and after use. Passing the needle for a moment through flame of a spirit lamp before use is a good antiseptic precaution.

Professor Binz, of Bonn, prefers *hydrobromate of quinine* to ordinary sulphate for intravenous and subcutaneous injections. It has the great recommendation of being soluble in an equal weight of plain boiled and filtered water, without addition of acid. It is also, he says, less likely than the sulphate to produce inflammation and abscess at the seat of injection.

Quinine : how administered by Rectum.

Rule : *Take of sulphate of quinine the required dose, put it into a wineglassful of water which has been both boiled and filtered; add a few drops of dilute sulphuric acid, or, failing this, enough of lemon juice to secure solution. The bowels having been first thoroughly evacuated, and, if necessary, washed out by an enema of warm water, the solution should be then raised to blood heat, and slowly and carefully injected, the patient lying on the left side, and keeping still for a little time after the operation to ensure retention.*

The enema apparatus must, of course, be kept scrupulously clean by washing it carefully after every injection, and also by steeping it in a 10 per cent. solution of carbolic acid. A nozzle about 4 or 5 inches long is best; it must not be oiled or greased for use.

Treatment of the Continued Pyrexia and Pseudo-Malaria described in Chapter IX.

Both of these forms of pyrexia being uninfluenced by quinine, arsenic, or other drugs, save in tonic doses, so long as the patient remains exposed to the exciting causes of the diseases, the proper course is to return at once to Europe, taking care not to arrive in England during the winter. Should this prove impracticable, some healthy part of Africa, as the Cape Colony, Kalihari, Orange Free State; or the Canary Islands, or Madeira, may be selected for sanatorium.

The following prescription will prove beneficial in such cases, under favourable conditions of environment and regime:—R. Liq.: Arsenicalis (Fowler's); Liquor strychnine: hydro-chlor. P. B. āā, 2 to 3 drops; quinine sulph. 1 to 2 grs. Mix in a wineglassful of water that has been boiled and filtered. Take this draught at 7 A.M. (after breakfast), and 7 P.M. (after dinner).

Tabloids of arsenic, strychnine, and quinine, containing equivalent quantities of these drugs, as above prescribed, may be used advantageously, mixtures not being reliable in the tropics.

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 either 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,
(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.

A useful form of Hypodermic Syringe for Africa. A large Pravaz Syringe, for same purpose, as used on the Continent, should be also taken.

Pyrexia is used in this book, after Dr. W. Hale White, to indicate a temperature exceeding the highest point of its healthy range, viz., 98° to 99° F. in man. By *Hyperpyrexia* is meant a temperature of 106° F., and over.

CHAPTER XIII.

ON OTHER REMEDIES FOR MALARIAL FEVER.

DRUGS.

Stillé and Maisch state the case for other remedies for malarial fever very clearly as follows :—"While we think the antidotal power of quinine cannot be refused the chief place in the cure of periodic fevers, we must not lose sight of the fact that they were cured from the beginning of time, down to the discovery of cinchona, by a great number of agents, and that they continue to be so cured even in cases where quinine has failed of its expected effects."*

African travellers are well aware that the natives possess many valuable remedies for fever; such as that lately brought into Europe from the Gold Coast by Mr. G. A. Krause, the explorer, who travelled alone from Agra to Timbuctoo, a distance of 3,000 miles. Running short of quinine, he was forced to use a native febrifuge, which proved to be an excellent substitute. The nature of this plant is doubtful, as his samples were lost, but it is supposed to be the *Zanthoxylum caribæum.*†

* *The National Dispensatory.*

† *The Monthly Magazine of Pharmacy, Chemistry, and Medicine,* July, 1894. Burgoyne, Burbridges & Co., London.

Again, the drug *Kreat*, indigenous to India, is said "to be to the native physicians of that country and the East, what quinine is to Europe and the West."

Opium.

The consensus of Indian medical opinion is in favour of the use of opium in malarial disease; and prophylactic and curative powers are claimed for it by the inhabitants of malarial regions.

Surgeon-Colonel Hamilton says:—"Perhaps the actual prophylactic value of opium is not as high as that of quinine, but the comfort it confers on the fever-stricken native is immense. Give a man suffering from a severe attack of ague a grain and a half of opium (say 30 drops of laudanum), and what a relief it is. The hot stage comes on quickly; is much shortened; and the sweating stage soon follows, with intense comfort to the patient. The poor fever-stricken native looks on opium as his sheet anchor, his truest friend; and, from my experience, seldom takes it to excess. It is cheap, easily carried, and taken in the form of a pill."

For the insomnia of malarial disease no remedy equals opium, in from 1 to 2 gr. doses, administered at bed time.*

Dr J. M. S. Maynard, in his *Letter* on the subject to *Brit. Med. Journal*, Feb. 24th, 1894, says:—"The probable reason why the opium-eating habit in India serves as a protection against malaria is the composition of Indian opium. It contains less *morphine* (1 to $1{\cdot}868^{1}$) and much more *narcotine* ($3{\cdot}65$ to 1^{1}) than Turkish opium; and therefore a man who eats it regularly is

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* See *Brit. Med. Journal*, Jan. 13th, 1893.

consuming narcotine which—since, if not before, the time when Sir William O'Shaughnessy was opium examiner here, and wrote the *Bengal Dispensatory*, in 1841—has been recognised as a tonic and anti-periodic without any narcotic properties. Sir William indeed called it 'a most important febrifuge remedy,' and stated that its salts were 'capable of arresting the paroxysms of intermittent and remittent fevers.' In the days when quinine was much more expensive than it is now, the Government Medical Store Department in India issued narcotine on indent to the dispensaries."

Arsenic.

Arsenic is a very ancient remedy for malarial disease in China and the East. Its prophylactic and curative powers are unquestionably great, being chiefly manifested in chronic malarial poisoning. It acts also as a nerve tonic; and it increases the number and improves the quality of the red blood-corpuscles.

As the incidence of the malarial poison is markedly upon the nervous system, which it debilitates, and as destruction of the red blood-corpuscles is the most obvious of all its effects, the system should derive great benefit from a drug which militates against nervous debility and blood-cell destruction.

Arsenic as Prophylactic and Tonic; how administered.

Arsenic, in tabloid or Fowler's solution *(Liquor Potasii arsenitis)*, in either form well diluted, may be taken after breakfast and late dinner—7 A.M. and 7 P.M.; as prophylactic and tonic in 1 to 2 tabloids of $\frac{1}{50}$th grain, or

1 or 2 drops of Fowler's solution. The tabloids keep best in hot countries, and are consequently recommended.

Arsenic is unsuitable during an attack of malarial fever; but it may be taken with advantage during convalescence from fever, if found to agree with patient.

It is a very useful remedy *in malarial neuralgia*, especially of the orbital and other facial nerves. It is good also in enlarged liver and spleen; and the indigestion consequent on malarial fever. To summarise its action in malarial disease :—

Arsenic is the specific tonic in malarial regions; in chronic malarial poisoning, and in the cachexia and other sequalæ of malarial disease—as quinine is the specific remedy for malarial fever.

Arsenic must not be given upon an empty stomach, or in concentrated form. From its tendency to accumulate in the system and suddenly develop poisonous action, it can never be considered a very safe remedy in lay hands. The drug must be at once suspended if dryness of throat and mouth, colicky pains and tendency to diarrhœa, with redness of eyes and puffiness of lids, should become manifest.

There is one curious form of malarial poisoning the symptoms of which are slight fall of temperature and coldness of the extremities; this going on daily for months without any marked fever ensuing, and no periodicity. Here quinine has no power for good; but doses of 2 to 5 drops of Fowler's solution (or one or two $\frac{1}{50}$th-grain arsenic tabloids) given twice or thrice daily, after meals, in a wineglassful of water which has been boiled and filtered, quickly cures.*

* See communication from Lieut.-Col. A. Crombie, M.D., in *Lancet*, 9th Sept., 1893.

Rule: *Absence of periodicity and marked pyrexia; chronic nature of infection, and inoperativeness of quinine, are the leading indications for the administration of arsenic in malarial disease.*

The combination of arsenic and quinine, or the concurrent administration of both drugs, is advocated by some authorities; but it appears to be better and safer treatment to give either drug separately in any case of malarial poisoning.

Oil of Eucalyptus, in 1 to 4 drop doses every four hours, given in emulsion, or beaten up with an egg, is recommended in malarial diseases, on the theory of its antiseptic power, said by Dr. Hardwick to exceed that of carbolic acid. This oil will probably be found more useful for spraying and for fumigating than for internal use.

Piperine, the active principle of black pepper *(piper nigrum)*, is recommended in 3 to 5 grain doses, in pill form, every hour. Dr. C. S. Taylor has cured refractory cases with this drug. Black pepper tea may be also used with good results.

Capsicum, or red pepper, fruit of the *Capsicum fastigiatum*, is a popular anti-febrile in Africa, where it is used in wonderfully large doses. It is a very powerful hepatic and general stimulant, and, helped by warm drinks, causes profuse perspiration, diuresis, and purgation. It is best administered in warm infusion, 5 to 10 grains being taken in a cup of hot water.

As an addition to quinine, capsicum is certainly of use in malarial fever.

METHYLENE BLUE, from its singular property of staining the malarial and similar parasites, and, in very weak solutions, arresting their movements, has been proposed as a highly effective remedy for malarial fever. Dose, from 1½ to 4 grains in capsule; or it may be given by intravenous injection.*

CARBOLIC ACID AND PHENOCOLL.

A 1 per cent. solution of the crystallised acid has proved very effective in the hands of Dr. Nazien of Smyrna, in curing cases of intractable quotidian ague.†

PHENOCOLL has lately been extolled as a certain cure for the ictero-hæmorrhagic form of malarial fever.‡

ANTIPYRIN AND PHENACETIN.

These drugs have already been briefly noticed (chap. xii.).

It must suffice to say here that Dr. Potter of Bombay, and many other leading practitioners, have cured cases of malarial fever by antipyrin, which has resisted ordinary treatment.§ They are, however, poisonous and depressing

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* Rosin in *Deut. Med. Woch.*, Nov. 2, 1893. The physiological saline solution of methylene blue is 1 to 20,000.

† For account of cases see *Progrès Medical*, Jan. 30, 1886.

‡ See *Brit. Med. Journal*, Dec. 23, 1893.

§ *Lancet.*

drugs, and tend to prevent the passage of toxines from the system.*

ALCOHOL, in the form of brandy, whisky, or good wine, must always prove useful, when judiciously administered, in malarial affections. Sir Samuel Baker says :—"When I arrived at a place where I could procure potato whisky, I drank hot toddy every day and became strong, and from that time the fever left me."

Dr. Broadbent's teachings upon the administration of alcohol in typhoid fever, apply in some parts to malarial fever also :—

"The part which stimulants take in the treatment of typhoid fever is chiefly to carry the patient through the later stages of the disease, when the nervous system is exhausted, the circulation failing, and digestion all but suspended, or as an accessory to cold bathing. Many cases do not really require stimulants from first to last; in no case should they be given at once as a matter of routine. The indications which tell that they will be of service, and that the time has come for their use, are frequency and low tension of the pulse and dryness of the tongue, together with nervous and muscular prostration and mental confusion. The amount given should be small at first—one and a half, two, or three ounces of brandy—and it should be subdivided and taken with or after the milk or other nourishment.

. . . .

"A change of stimulants often does better than an

* "The antipyretics not only knock down the temperature, but the patient also—sometimes fatally; and I have often, in cases admitted into hospital, diagnosed not only the disease, but the remedy. Roque and Wells have found out that antipyrin arrests the elimination of toxines by the urine without preventing their formation."—*Sir W. H. Broadbent.*

increase in the quantity, such as the substitution of whisky, or port, or old Madeira, or Malmsey, or champagne, for brandy.

. . . .

"When stimulants are really necessary, the good effects are seen in a lowering of the pulse-rate, the volume and tone being improved; usually, also, the temperature is somewhat reduced, the nervous system is steadied, and there is more restful sleep."*

Strychnine.

The strychnine sulphate tabloids, $\frac{1}{150}$, $\frac{1}{100}$, and $\frac{1}{60}$, gr. may be administered hypodermically in cases of sudden failure or collapse occurring at any stage of fever.

Lime or Lemon Juice,

Expressed from the *citrus acidum* or *citrus limonum*, forms a very grateful drink in the form of sherbet. In Italy, hot lemon tea has a high popular reputation as a cure for malarial fever, and the juice is used internally and externally in Africa for the same purpose. The tonic and astringent action of this mild vegetable acid, with its powerfully antiscorbutic properties, makes it a valuable aid to specific treatment.

Next to boiled and filtered water, and "*Averina*," there is no better fever drink than sherbet or lemon

* *Some Points in the Treatment of Typhoid Fever.* The *Cavendish Lecture*, delivered by Sir W. H. Broadbent, M.D., F.R.C.P., Lond.—*Lancet*, August 25, 1894.

tea, made very weak, and little sweetened. It should be always prepared fresh, as needed, by simply pouring boiling water upon the newly sliced fruit, which has been gathered and kept in a cool place over night. *Fruit "with the sun in it" is not wholesome.*

Caffeine is said to have cured intermittent fever, "*as almost everything else has done occasionally.*"—(Stillé and Maisch.)

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.

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.

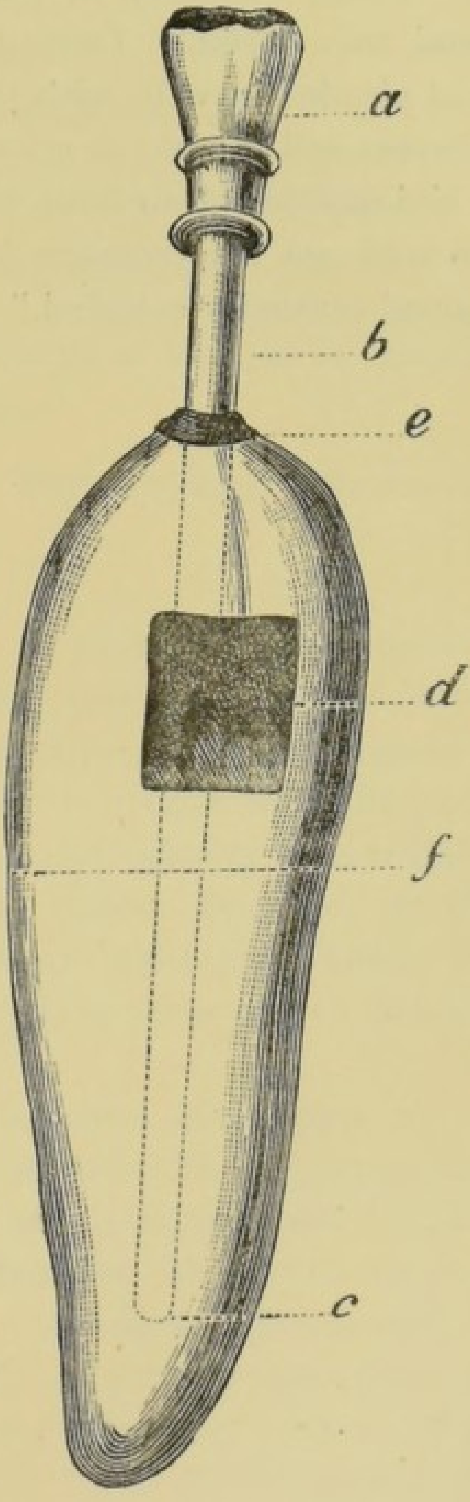
"A coarse powder, consisting of the dried leaves, stalks, and fruit of this plant, and also its resin, is well known throughout the East as *Bhang* or *Siddi*, and the resin as *Charas* or *Churrus* in India. The Arabs know it as *hashish*, and probably introduced its use into Africa.

"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 feet long by 6 or 8 inches 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 inches long by one inch 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 six or eight inches 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 XIV.

OTHER REMEDIES FOR MALARIAL FEVER.

PART I. TREATMENT BY THE SERUM AND BLOOD OF IMMUNE ANIMALS.

PART II. BATHS, PACKS, AND MISCELLANEOUS REMEDIES.

It has been seen in chap. x. that *natural immunity* is held to result from phagocytosis aided by the action of certain protective substances in blood and tissues of the organism. The latter act not only by killing and weakening the microbes, but by neutralising their toxines, and they are helped in this double function by the reaction of the toxines, which are poisonous alike to the cells of the parasites that produce them and to those of the body.

Artificial immunity is conferred sometimes by an attack of the disease, as in smallpox ; in other cases this fails to afford protection, as in malarial fevers. It can be also conferred in certain diseases—the list of which is increasing, and promises to increase—by injecting a specific virus in progressively increasing quantities or virulence, as in Pasteur's inoculations for rabies ; or by the single inoculation of the virus, as in vaccination for smallpox. From Behring and Kitasato we have learnt the properties of the serum of animals rendered thus immune against tetanus and diphtheria.*

Vernicke, Boer, and collaborators have explained how the serum acts upon the toxine of the disease as a preventive and therapeutic agent; and Kossel, Wassermann and others, since 1891, have been employing what is technically called "serum therapeutics" for the cure and prevention of diphtheria in children. This treatment by "antitoxic serum" has been further extended and confirmed by Professor Roux, who says:—"*The animals furnishing the antitoxic serum are rendered immune against diphtheria—that is to say, they are rendered accustomed to the toxines of diphtheria.*"†

The steps in this process are briefly:—(1) to prepare the toxine; (2) to inject it in gradually increasing quantities, from 5 c.c. upwards, under the skin of a healthy horse; (3) when the horse has been rendered immune to enormous doses of this poison, to use 20 c.c. of his serum by hypodermic injection for a child suffering from diphtheria.

It may be added that the preparation of the toxine (1) is simply growing a crop of diphtheria from "virulent diphtherial bacilli," in suitable cultures, as we would grow a crop of potatoes or peas. After three or four weeks it is strong enough for use, and being filtered, yields a clear liquid, which can be kept for a long time without losing its activity, "in well-filled vessels, corked and sheltered from light, at the ordinary temperature."

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*Serum is the watery transparent fluid which forms on the surface of the blood after coagulation.

†See article: *The Serum Therapeutics of Diphtheria*, read before the Eighth International Congress of Hygiene and Demography, Budapest, 1894, by Professor E. Roux.—*Lancet*, September 23, 1894.

One-tenth of a cubic centimetre of the toxine will kill a guinea-pig weighing 500 grammes in from 40 to 60 hours.

"*The serum of the immune horse is said to stimulate the cells of the organism in a manner which enables them to resist or throw off the poison of the microbes.*"

This horse serum is perfectly harmless, but some days after its injection, and during convalescence, an ill-defined eruption resembling urticaria or nettle-rash, a frequent consequence of transfusion of blood, appears. That the serum of the immune horse is an antidote to bacterial toxine is proved by mixing it and toxine together outside of the body, when 40 volumes of toxine to 80 of serum neutralise each other; so that injection of the mixture beneath the skin of a susceptible animal produces no more effect than that of so much pure water.

Serum therapeutics, in diphtheria, rests on a scientific basis. In the hands of Professor Ehrlich and Dr. Wassermann, of Berlin, the result of inoculation has been to reduce the mortality 50 per cent., and it is proposed to make preventive inoculation for diphtheria compulsory in Germany.

Space forbids pursuing this interesting subject, or dwelling on the recent mode of treatment of tuberculosis by ass's serum. It must suffice to say that Dr. A. Viquerat, of Geneva, pupil of Professor Koch, has selected the ass as the most naturally refractory of all animals to the infection of tubercle, and because its serum attains, under certain treatment, very active anti-bacillary properties. The ass tolerates considerable quantities of tuberculous bouillon, injected into the veins as well as subcutaneously. This produces certain effects that need not be dwelt on; but after six weeks the microbe has completely disappeared from the body of the animal, and his serum has become a very potent anti-tuberculizing substance; curing guinea-pigs and other animals artificially infected, and better, giving "magnificent results" in the treatment of consumption in man.

We may therefore conclude, in the words of the report,* that, 1*st*, "*Certain animals have a natural immunity to certain toxic or morbific elements;*" 2*nd*, "*That an acquired immunity is produced in other animals by toxic infection, natural or artificial;*" *and* 3*rd*, "*That the serum of the immunised animal can produce immunity, curative or protective, when introduced into the economy of another*, *even of a totally different species.*"

The existence of these states or conditions is established by ample and reliable observation and experiment, but an explanation of the *modus operandi* is still wanting.

The treatment of consumption by the blood of goats, animals naturally immune to this disease, is based on like principles. Drs. Bernheim, Hayes, and Peltier, in 1891, and Drs. Bertin, Picq, and Roahan, a little later, adopted the practice of transfusion and injection of goats' blood in phthisis, with most encouraging results. Dr. Bernheim's theory of its action is "*that it directly kills the tubercle bacillus, which cannot withstand it long;*" while M. Bourgeois thinks the secret of its power lies in the *fluoride of sodium*, which goats' blood contains.

My object in thus glancing at so large a subject is to draw attention to the possibility of goats' blood and serum proving useful as preventive and therapeutic agents in malarial poisoning. The field is a promising and inviting one, as the goat thrives well in all parts of Africa; and

* See *Lancet*, Sept. 29th, 1894, on *The Results obtained by Dr. Viquerat in his Treatment of Tuberculosis.*

in all parts is immune to malaria, under the severest and most persistent conditions of exposure. His organism cannot fail to be receiving malarial microbes in vast quantities all day from year's end to year's end—what becomes of them; and why is he none the worse? It would appear as if his immunity from consumption is less surprising, and should tax in much less degree the resisting powers of his organism, than his immunity from miasmatic disease while living in the hotbed of malaria. More than this, the goat has proved refractory to large and repeated injections of malarial blood, which, of all modes of infection, is the most intensitive.*

A trial might be made of goats' serum, given hypodermically as a prophylactic remedy, when quinine for any reason cannot be employed.

Also injection of the serum hypodermically given at intervals of 24 hours, might prove a valuable therapeutic agent in malarial fever. The injection, if properly made into the subcutaneous cellular tissues, is not painful, and in a few minutes the serum is absorbed.

Even rectal injections of this serum, the bowel having been thoroughly evacuated and rinsed out with tepid water, might be tried. Klebs has demonstrated that rectal injections of *tuberculocidin* may sometimes be used in preference to subcutaneous injections, with equally good results.†

Even transfusion or injection of goats' blood or ass's

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* *Paper on the Etiology of Malaria*, by Marchiafava and Celli, previously referred to:—" From the animals inoculated (with soil cultures of malaria), viz., an ass, goat, rabbit, and guinea-pig, negative results were obtained; but in these animals no result followed repeated and large injections of malarial blood from pernicious and other severe forms, taken both during the fever and in the apyrexial period immediately before a paroxysm."

† *Brit. Med. Journal*, Oct. 27th, 1894.

blood appears to be well deserving of a trial in cases of constantly recurring malarial fever; especially in persons suffering from malarial cachexia, anæmia, or nervous exhaustion, where all other remedies have lost power to operate for good, failing, as it were, to find leverage in the dilapidated organism.

If goats' blood do nothing else, it will nourish and sustain the system, improve the quality and increase the quantity of the red blood-corpuscles, and act as a powerful nerve tonic and heart restorative.

The treatment has its dangers; but when the alternative is certain death on the one hand, and the small risk with good prospect of recovery on the other, few will hesitate to operate.

Dr. Bernheim performs transfusion thus:—The goat is firmly bound and placed on a table. Its throat is laid bare with a bistoury down to the carotid artery. The patient kneels or sits close to the table with his arm bare, and bandaged above the elbow, as for ordinary bleeding.

A small incision is then made in the largest vein of the arm, and blood begins to flow. The apparatus for transfusion consists of an india-rubber tube, with a canula or fine metal pipe attached to either end, which is inserted into vein and artery respectively. Or it may have a perforated needle at the patient's end, which admits of it being passed into the vein, and so rendering incision unnecessary.

The bandage being now removed and the thumb from compressing the artery, the blood, by the propelling arterial force, augmented by venous indraught, rapidly flows from artery into vein. The india-rubber tubing is kept immersed in water of about 90° Fahr., to prevent cooling and coagulating of the blood in transit.

The chief dangers are the passage of a clot, or entrance of air into the vein; but the canula and needle, being of small calibre, would become blocked if clotting occurred, and so stop the flow; and careful manipulation will prevent ingress of air.

An assistant may rub the arm upward to assist the flow. The progress of the operation may be ascertained by the pulsations of the goat's artery beneath the finger. One minute and a half is sufficient to inject 150 grammes (about 5 ozs.) of blood, and the patient experiences no discomfort, but, on the contrary, "converses calmly during the operation."

Dr. Bernheim denies that any deaths have occurred in his own hands in the practice of transfusion.

Dr. Bertin's operation is very different from foregoing. He takes about 30 grammes (1 oz.) of blood from the jugular vein of the goat by a small syringe, specially made and adapted for the operation. Of this, 15 grammes are injected immediately into the veins of patient, the rest soon afterwards.

The operation is painless, and all patients experienced relief from the treatment.

Its simplicity and apparently greater freedom from danger recommends it in practice, and it is said that any intelligent person can soon learn how to use it.

Of course the most scrupulous antiseptic precautions will be required in either operation, and it is here, especially, that the necessity for medical knowledge and training becomes obvious.*

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* To show the care required in such injections, I quote the following from a monograph of Marchiafava and Celli :—" A Koch's syringe was first heated for some hours at a temperature of 150° C. in a tube stoppered with wadding; immediately before the operation, the hands being

Part II. Baths, Packs, and Miscellaneous Remedies.

The Hot Air Sweating Bath.

This is an excellent remedy in certain types, and at certain stages of malarial fever, and at all times as an agent for removing toxines from the blood.*

The following is a handy way to give the bath in bush practice:—The patient, stripped naked, is placed lying down upon a canvas stretcher, or bamboo couch covered with native mats, the head being supported on a cool pillow.† Blankets are then thrown over the body, and top and bottom of bed, in such a manner that they reach the floor on all sides. One or more spirit lamps of large size, or cups filled with blazing spirits standing in dishes, or a small brazier on iron tray, containing red hot charcoal, should be then introduced beneath the bed. The enclosed air, becoming heated, expands, and ascending under the blankets—all issue being as far as possible

first cleaned in a solution of perchloride of mercury, the syringe was removed from the tube by means of a platinum wire ; then the surface at the bend of the elbow being washed with sublimate, a small quantity of blood was taken from an engorged vein. The operation is very simple and almost painless. The patient to be inoculated is next to the blood giver, the circulation in a vein is stopped, the surface washed with sublimate, and nothing is wanted further but to introduce the blood. In some cases the blood was injected into the subcutanecus cellular tissue instead of into a vein. The greatest quantity introduced at a time was one gramme, and for obvious reasons it was not defibrinated."

* Bolmerstein goes so far as to pronounce such baths "a certain cure for all blood poisoning, however caused."

† A wire or bamboo pillow covered with a clean *linen* cloth is better than a wool, feather, or flock pillow.

prevented—quickly throws the patient into profuse perspiration. Meanwhile the head is kept cool by evaporating cloths wrung out of cold water, and constantly changed.

The duration of this bath varies from 10 to 30 minutes, according to idiosyncrasy of patient and type and phase of fever. Its action must be carefully watched by frequent examination of the pulse; and when copious perspiration has fairly set in, the heat should be modified, and in 10 or 15 minutes the lamps removed. If palpitation or breathlessness supervene, the bath should at once be suspended, the heating agents removed, and free issue afforded to the hot air and vapour.

When the patient has perspired sufficiently, he should be gently lifted—always in the recumbent posture—into a hot, shallow bath of 98° to 100° Fahr., where the body is subjected to brisk washing with soap-suds, and gentle loofah or flesh-brush rubbing; a few minutes should suffice for this immersion.

The patient is then carefully, quickly, and gently dried with warm sheets or bath towels, and removed into a cool sheeted bed, standing in a well-ventilated, shady room. The doors and windows may be left open in hot weather, if due care is taken to shield the body from all draughts of air. A sheet over the patient will suffice for covering, to permit of gradual cooling; a light porous coverlet or blanket being put on when his temperature falls to normal.

As a general Rule: *The hot air sweating bath should only be given in intermittent or remittent fever, at the stage of either disease when the administration of quinine is indicated.*

This, as we have seen, is several hours before paroxysm, and soon after exacerbation. If given 8 or 10 hours before paroxysm, it will materially aid the action of quinine in averting the threatened pyrexia; and in mild cases it will effect this without the aid of the drug.

If given after exacerbation, and while yet the sweating of defervescence is in process, it will materially lighten the labour of the emunctories, and so conserve the bodily energy, by rapid mechanical elimination through skin of the toxines of malaria.

The bath, in short, increases tissue metamorphosis, and aids the elimination of all waste products from the system; results helped by frequent drinks.

In *bilious remittent* and *pernicious* fever this bath is appropriate if given during a remission; but hyper-pyrexia forbids its employment.

Quinine and Warburg may be administered with advantage before the bath, which appears to augment the curative action of the latter. They are less appropriate, being less needed, after the bath.

No sweating bath or pack should be given until the bowels have been well evacuated, else septic absorption may ensue.

While cooling down, fluid nourishment, and if the heart is very weak, a little alcoholic stimulant, should be given to the patient at frequent intervals. His best drink during and after the bath is tepid "averina," or boiled and filtered water, which will increase tissue change and wash out the system.*

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* I learnt the use of this hot-air bath while in charge of a fever hospital in Brazil. We commenced treatment there by very large doses of castor oil given in hot rum punch, followed by clysters, if necessary. When the bowels had been thoroughly evacuated, the bath, as above described, was given in suitable cases, with a large percentage of recovery even in yellow fever.

In mild febrile attacks, when specific treatment is not necessary, small doses of *pyretic saline* may be taken after the sweating bath, or such a simple mixture as the following :—

R. Liquor : Amm : acetatis P.B. $\frac{1}{2}$ oz.
Mag : Sulph : Soda Sulph : āā 1 drachm.
Spirit : Æther : Nit : 2 drachms.
Tinct : Aurant : 1 drachm.
Aquæ Camph : add 8 ozs.—mix.

Dose—a small tablespoonful every two hours.

The Hot Pack.

This is another very useful remedy in malarial fevers complicated by visceral congestions, or intestinal derangements. A handy mode of giving it is as follows :—

A blanket just large enough to envelop the patient is folded lengthwise twice, and then rolled into a moderately tight roll. Two ounces of good soap are boiled until dissolved in two quarts of water, and the boiling solution is poured slowly into the centre of the roll, which is shaken from time to time to facilitate thorough saturation.

The blanket is then placed on a bed, or on a part of the bed, prepared with a waterproof sheet, covered with a dry blanket, and rapidly unrolled. As soon as the blanket has become cool enough to be borne, the patient is wrapped up with the arms enclosed, first in the wet and then in the dry blanket. The dry blanket, which must be double, is then carefully secured around the neck with safety pins, and well tucked in at the feet, to which hot-water bottles may be applied if they tend to be cold.

If the room is cold, the whole body should be covered with a blanket. Cold wet cloths, constantly changed, should be applied to the head. The pack is kept on from one to two hours, according to the temperature and feelings of the patient.*

The effects are to reduce the temperature, to remove delirium and coma, and to induce sleep.

The pack will help to cut short an attack of intermittent or remittent, if given at any stage of the disease.

For remittent it is especially useful, and will be found not only to shorten the attack as a whole, but to reduce the temperature on any particular day to a safe point. Two such packs daily will generally keep the temperature below 101° F., in simple remittent, bilious remittent, and blackwater fever, with little or no aid from quinine or other drugs. Even three baths daily may be given in dangerous congestive and pernicious attacks with marked advantage, and, if aided by Warburg and quinine, a permanent lowering of temperature to 101° F. may be effected in all curable cases.

After the pack bath, the patient must be treated in precisely similar fashion as after the hot-air bath, with hot lathering and loofah or flesh-brush rubbing, finally rinsing with clean, tepid water, then careful drying and removal to fresh bed in cool, shady room. But if very weak, he may be simply washed as he lies, and afterwards rubbed over with cut limes.

All treatment is best conducted without raising the patient from the horizontal position : in protracted cases of fever this becomes of vital importance.

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* *Bremner's New York Medical Journal*, May 28, 1892. I have frequently administered these packs, and can answer personally for their utility.

Baths.

Baths may be conveniently classified into *cold*, *tepid*, *warm*, and *hot*. All baths below 70° are commonly called *cold;* between 70° and 88°, *tepid;* between 88° and 98°, *warm;* over 98°, *hot.*

What are called "warm" are, accurately speaking, *indifferent*, because baths between 88° and 98° F. produce no alteration in the temperature of the body in its normal state, even if they last for an hour or more.*

Cold baths act by abstraction of heat from body, and by shock; they promote decomposition of non-nitrogenous tissue; increase excretion of carbonic acid and urea, and generally quicken reflex action, and the elimination of morbid products, as toxines.

Warm baths raise the temperature of the body by imparting heat to it; cleanse the skin by liquefying fatty secretions; and, by mechanically withdrawing blood to the surface, relieve muscular and nerve fatigue, and promote sleep.

Hot baths act more powerfully than warm in the same direction: they first stimulate, then soothe pain, and relieve soreness of muscle and brain fag.

Cold Baths, *temperature under* 70°.

Cold baths abstract heat quickly from the body, and if they are of short duration, and the bather is in good health, they are succeeded by feelings of exhilaration and warmth, the nervous and muscular systems having gained in tone. Their action appears to depend on salutary shock, and rapid ebb and flow of blood.

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* *A Text Book of General Therapeutics*, by Dr. W. Hale White.

The shock causes contraction of the vessels of the skin, whereby more blood is sent in waves to the inner organs, abstracting waste products from them, and stimulating their functions. With the dilatation of the cutaneous vessels, which follows, comes reflux of blood to the surface, a bright glow and feeling of warmth; this process being technically known as "*reaction.*"

But if from any cause the cold bath fails to contract the superficial vessels; or if, as sometimes happens, they are paralysed by the cold, as manifested by a blue and congested surface; or if, having contracted, they remain spasmodically closed, leaving the skin white and cold as marble; no good, but much hurt, may be expected to follow the bath.

The test, therefore, of the suitableness of cold bathing is reaction, due to the healthy contraction and after dilatation of the superficial vessels; and this, like all other bodily functions, can be cultivated by the judicious habitual use of the bath. Under the ordinary conditions of muscular, vascular, and nervous debility seen in those long resident in the tropics, good reaction is impossible; the shock of cold will cause capillary *stasis*, and, while paralysing the nerves and muscles of the skin, inflict an injurious shock on the nerve centres.

Instead of a warm flow of blood being sent to internal organs, hot blood will be withdrawn from them, their functions suspended, and thermotaxis so unbalanced, that fever may ensue.

Cold baths should therefore be avoided altogether, or used very sparingly, by the average dweller in the tropics.

Stanley says on this subject:—"Do not bathe in cold water unless you are but newly arrived from a temperate climate. The temperature of your bath is not safe below 85° Fahr. Let your bath be in the morning, or before your dinner. The tepid bath is the most suitable."*

The morning *cold tub*, taken as in England, may suit new arrivals of strong, rich, full-blooded habit for a time; and I owe a long spell of good health to its use. It is best taken immediately upon rising, and should be followed by towel-rubbing, and dumb-bell or club exercise, or a brisk walk, to ensure perfect reaction.

The *cold shower* is a useful bath for those whose vigour is unimpaired.

The Indian *pitcher-bath*, given by pouring a vessel of cold water over head and spine directly upon rising, is also excellent if followed by due reaction, which should be ensured by friction and exercise.

Rule: *Cold baths are salutary in the tropics so long only as there is good reaction manifested by red and warm skin. As this lessens, they should be taken more quickly and rarely. When reaction ceases, suspend baths. As a general rule, the more fever, the less cold water can be borne in the tropics.*

THE WET SHEET PACK is given precisely as the pack already described, by substituting for the hot wet blanket a large rough sheet, lightly wrung out of cold water, this being laid on the dry blanket with a mackintosh beneath. The body is then carefully wrapped up in wet sheet, dry blanket, and, lastly, in mackintosh. Warm bottles may be applied to feet and abdomen if there be chilliness; and a light blanket thrown over all if weather be cold, or until perspiration is established. The duration of

* *The Congo and Founding of Its Free State.*

this pack is from 1 to 2 hours. The patient should have his head wrapped in evaporating cloths, wrung frequently out of cold water; and he should drink thin averina freely. The pack removes delirium and coma, and causes speedy defervescence, with copious perspiration and refreshing sleep.

THE WET COMPRESS PACK is a local and limited application of the above, and may be readily given by placing a two or four-fold rough cloth, lightly wrung out of cold water, on affected part. The cloth should be covered by a piece of dry flannel and mackintosh, to retain vapour and prevent evaporation. It acts by dilating the superficial blood-vessels, and drawing blood to the part as the general pack draws it to the whole surface of body.

Both packs act somewhat like poultices, and are of marked benefit in congestion and other visceral disorders, especially of a painful nature.

COLD WATER COMPRESSES.

These are simply cloths wrung out of cold water and laid on the affected part. When dry they are to be replaced by fresh wet cloths, and so a continuous local abstraction of heat is easily and safely effected. They are of great use in abdominal tenderness and tension arising during fever.

COLD SPONGINGS AND BATHING IN FEVERS.

In all fevers the body should be sponged with cold water from 3 to 6 times daily.

A better treatment is for patient to get into, or to be lifted into, a tub of cold water placed alongside of his bed, whenever the fever heat runs high. He should sit or partially lie down in the tub, the water reaching to pit of stomach if possible, and the upper part of his body is to be rapidly washed with a coarse linen towel. The duration of the immersion should not exceed one minute at a time; and from 3 to 6 such baths should be taken daily, according to the rise of temperature. This bath is suitable for all forms of pyrexia where it is safe to sit the patient up; and Father Kneipp assures us that he has cured Typhus and other fevers by this simple remedy.*

Dr. Hale White gives a cold affusion as follows:—"Under the patient a large mackintosh sheet is placed, and it is extended over a bank of pillows on either side; a gutter is made in the mackintosh at the foot of the bed, so that the cold water poured in at the head will run out at the foot, where it is caught in some suitable vessel. The pillows at either side may be so high that the patient lies in a bath of running water."†

The General Cold Bath in Fevers.

Although the foregoing methods of applying cold to the body are useful in mild fevers, when the axillary or rectal temperature does not exceed 103° F. at the utmost, and when the duration of the pyrexia is short; in severe cases, where the temperature mounts to 105°, 106° or over (hyperpyrexia), in spite of ordinary treatment, nothing but the general cold bath will avail to bring it down, or perhaps to save the patient.

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* *My Water Cure*, by Sebastian Kneipp. English Trans. of 36th German Edition.

† *General Therapeutics.*

The result of treatment by the cold bath in typhoid fever has been to reduce the mortality, in the hands of Dr. Brand, from 25 to 9 per cent.

His system was to place the patient in water of 65° to 70° F. for 20 minutes every 3 hours, so long as the temperature in the rectum rose to 103·5° in the intervals; cold water being at the same time applied to the head. He may or may not be thoroughly dried, according to the temperature of the body—and he should be very lightly, if at all, covered after every bath.

Another mode of giving the cold bath in hyperpyrexia is to immerse the patient for 10 minutes at a time in water at a temperature of 58° to 68°, or warmer if the temperature of the patient runs very high. The bath is most conveniently placed at foot of bed, in a line with it, and the patient may be lifted upon a sheet which is lowered into the water, another sheet or blanket covering bath for decency.

Repeated baths of this kind are found to be more potent to reduce hyperpyrexia than fewer and longer immersions—unless the water can be kept continually cool in the latter, either by removing the hot and adding cold, or by the arrangement of a constantly flowing cold bath.*

The Continuous Bath in Fevers.

The continuous bath has yielded good results in the hands of Dr. Barr, of Liverpool, in the treatment of ordinary typhoid fever—not hyperpyrexia. It is given at a temperature of 95° F., never lower than 90°, arrangements being made by which it remains at either point.

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* Dr. W. Hale White in *General Therapeutics.*

At times really cold, or even iced water, may be dashed over patient. The continuous bath may be used for hours, even days at a time, the patient resting comfortably upon a submerged canvas stretcher, with an air pillow under head.

Such a bath might prove serviceable in the continuous pyrexia and pseudo-malaria, spoken of in chap. ix., in which neither quinine or other drugs avail.

The general effects of cold baths in fever are to eliminate toxines by urine and skin, and by cooling the blood and soothing the skin and nerve irritation, to restore thermotaxis. The tongue becomes moist, the pulse slow and regular; delirium, tremor, prostration, headache, and thirst are all relieved, and sleep induced.

Tepid, Warm, and Hot Baths in the Tropics in Health.

The tepid bath (70° to 88° temp.), as before explained, is best for general use in the tropics, as the cold bath (below 70°) is most sanitary for temperate zones.

After a chill, the warm bath (88° to 98° F.) may be better, or even a rapid sponge over with really hot water (above 98° F.) may be advisable as prelude to the tepid bath.

Celsus says:—"I do not consider the hot bath good for persons fatigued, but rather the tepid bath after a short rest. This may be followed by oiling of the skin, and then the *solium* or cold bath taken, after this food and water, or very diluted wine."

In the tropics for the after cold bath should be substituted a mere sprinkling with *cool* water.

The Japanese take an opposite view to the Romans, although living under somewhat similar climatic conditions. Here, after severe fatigue, exposure to sun, and even as a luxury to promote coolness in hot weather, baths of 110° to 115° F. and over are used.

It requires a training to bear them, which consists in gradually augmenting the heat of water; but, tolerance acquired, they are said to be more stimulating, cooling, and refreshing than any other baths.

On the Local Application of Heat.

The stimulating action of heat may be locally attained by applying hot-water bottles, preferably of indiarubber, to abdomen, legs, and feet.

Hot applications to the abdomen, especially during the chilly stage of fever, have a directly stimulating action upon the sympathetic nervous system, the gangliæ of which lie in front and at the sides of the spinal column, and also spreads its network of plexuses behind and upon the stomach, heart, and other viscera.

As the malarial toxics have special incidence upon and tend to paralyse these nerves, any stimulant like heat, which evokes and sustains their action, must prove beneficial.

The impression of heat is also quickly conveyed to the spinal cord, to which the sympathetic system is intimately united; also indirectly to the brain; thus arousing the whole nervous mechanism, as it were, to arms.

Injections.

Another useful mode of applying heat is by hot injections of thin gruel at 100° to 104° F. temperature. To such may be added a teaspoonful of assafœtida tincture, or of brandy or other spirit, in cases of collapse. The single-piece india-rubber enema instrument will answer best for giving such injections, and prove very useful in Africa.*

Sinapisms, *poultices*, and *fomentations* are all valuable at times.

A fomentation may be given by wringing a woollen cloth out of hot water and applying it to affected part when it can be borne; sprinkling it with turpentine increases its action. Such fomentations to abdomen in dysentery, diarrhœa, visceral congestions and inflammations, which frequently occur in malarial poisoning, give great relief.

The troublesome vomiting of fever is often instantly checked by a mustard poultice over stomach.

Sinapisms or blisters to nape of neck, spine, calves of legs or feet, are very powerful revulsives, and of great utility in pernicious-comatose, and other malarial fevers with head symptoms.

* J. G. Ingram and Son, London, E. (Burgoyne, Burbridges and Co., agents), make a good seamless instrument of this kind. Ordinary constipation, a dangerous thing in the tropics, can be relieved by the injection of ½-pint of warm water daily.

CHAPTER XV.

THE VICTUALLING PROBLEM IN TROPICAL AFRICA.

PART I.

"*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		Soft bread	,,	1½	
3		Spirit (Rum)	pint	⅛	Half a gill.
4		Sugar	oz.	2	
5		Chocolate, ordinary	,,	1	
6	,,	Or ,, soluble	,,	1.2	
		Tea	,,	¼	
7	Weekly	Oatmeal	oz.	3	
8		Pepper	,,	¼	
9		Mustard	,,	½	
10		Vinegar	pint	¼	
11	Daily when procurable.	Fresh meat	lb.	1	
12		Vegetables	,,	½	

TABLE OF EQUIVALENTS.

	Article	Weight	Allowance	
	Coffee	oz.	1	Are to be considered equal to each other.
	Cocoa	,,	1	
	Chocolate, ordinary	,,	1	
	,, soluble	,,	1.2	
	Tea	,,	¼	

The following, when issued with meat rations, are to be considered equal to each other.

	Article	Weight	Allowance	
1	Split peas	lb.	½	
	Peas, whole	pint	½	
	Flour	lb.	¾	
	Calavances	pint	½	
	Dhall	,,	½	
	Rice	lb.	¾	
2	Vegetables	lb.	½	
	Compressed mixed vegetables	oz.	1	
	Preserved potatoes	,,	2	
3	Oatmeal	oz.	2 or ⅙ pint.	
	Split peas	lb.	⅜	if men desire the exchange.
	Flour for biscuit	,,	¼	
1	Tea	oz.	¼	
	Soluble Chocolate	,,	½	
	Sugar	,,	1¼	
	or			
2	Tea	oz.	¼	
	Sugar	,,	2¼	
	or			
3	Soluble Chocolate	oz.	¾	
	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 case 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 food, 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 fermerty; 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),

* Huxley's *Physiology.*

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.

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 ½ 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.

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 the 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 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 pine-apple 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.

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* *West African Hygiene.*

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 neither affects the nerves or 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 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

* For an account of *Averina*, and how to make it, see chap. xvi.

† *The Congo, and Founding of Its Free State.*

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.

Part II. Fresh Provisions.

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 in certain countries in Africa, and during plentiful seasons, include poultry, game, beef, mutton, goat-flesh, eggs, milk, butter, 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.

* 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.*

On the West Coast, maize, in the form of *kankie*, a kind of bread made of its roughly ground meal—the grain having first been boiled—was the staple food. On a lump of *kankie* weighing 2 or 3 lbs., with a little "*stink-fish*," a kind of dried herring, and some palm oil to work it down, our Elmina boats' crews could do a hard up-stream day's paddling in good spirits, with no other refreshment save occasional drinks of river water, or rarely a draught of "palm wine."

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.*

* The roughest meals may be rendered serviceable for invalids by using malt extract, made as follows :—"Take 3 ozs. (or piled up table-spoonfuls) of crushed malt, mix them thoroughly in a suitable vessel with ½ pint of cold water. This mixture is allowed to stand over-night —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 ounces 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

RICE is good food everywhere.

MANIOC, when properly prepared, by careful washing and roasting, is a palatable and nourishing article of diet.*

MILK is preferred in its sour state by the natives, and doubtless this is its most digestible form in the tropics.

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

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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.

valuable properties of the banana, as the most nourishing and easily digestible of foods, should be overlooked.

PLANTAINS are also splendid food, and admit of being cooked in a variety of ways as vegetable and fruit.

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, pumpkin, peppers, and cucumbers. The fruits are grapes, pine-apples, 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."*

Our commissariat will therefore draw its supplies of fresh provisions from three sources:—1st, from live stock imported ; 2nd, from native sources ; 3rd, from produce of farm and garden.

* *To the Gold Coast for Gold.* By R. F. Burton and V. L. Cameron. Vol. ii. Chatto & Windus, 1883.

Part III. Preserved Provisions.

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 :—

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, kiln-dried, in 2-lb. tins; biscuits, best captain's, in 5-lb. tins; 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 & Co.; cheese, Parmesan and Dutch; Apollinaris water; spirits, finest Scotch whisky, 5 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 & 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; wheat meal, kiln-dried, in 2-lb. tins; onions, in brown vinegar; sardines, in oil *(Philippe & 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. *Above all, and in preference to all other preserved meats, take an abundance of well-prepared beef, biltong, or jerked flesh, prepared in Africa, and rolled up in green canvas bags.*

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 meats.

How to produce and to retain this fragrant 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 and 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 except 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 free hydrochloric 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

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* *Health in the House*, by Catherine M. Bucton.—(Longman, Green & Co., London.)

† *Report on the Provisions Preserved in Tins for Exportation from the United States.* By Capt. Segrave, H.B.M. Consul, Baltimore.

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 & Son, purveyors, 145 Leadenhall 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 hygroscopic.

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 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 & 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 2 to 3 volumes of water can be added, but no more.

The sweetened milk appears to contain about the same percentage of caseine, milk-sugar and salts; but it may be more diluted, in so much 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 ship-board, and my experience with it in Africa was very favourable.

Bacon.

The tinned Wiltshire smoked bacon of Moir & 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. 20" 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 & Co.* (now *Ch. Prevet et Cie., Paris, Moir & Son*, agents). 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. 7½.—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 & 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.

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* *Food and Feeding.* By Sir Henry Thompson, F.R.C.S., &c., &c.

CHAPTER XVI.

THE DRINK PROBLEM IN TROPICAL AFRICA.

The fact that Africans drink large quantities of water recommends its use; but Europeans 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.

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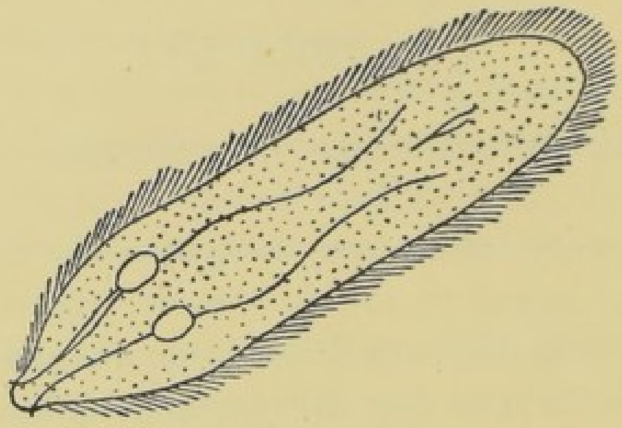
* *o. a. c.*

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.



Free swimming embryo of the *Bilharzia hæmatobia*, as seen with magnifying power of 500 diameters.

Another common organism found in African waters is the *Dracunculus* or guinea-worm, the ova of which, whether taken immediately from water, which is probable, or mediately from contaminated fish,* eaten when freshly caught and imperfectly cooked, is the cause of a wide-spread and loathsome disease.

Space forbids me multiplying examples.

Filters.

The Pasteur-Chamberland filter is perfect; but very slow in action, and fragile. I gave it a long trial in Africa, and prefer it to all others.

The *Filtre-Rapide* may serve for ordinary use, the water having been previously boiled. "Although, as we

* See *Darkest Africa*, vol. ii., p. 381, on this important and interesting subject.

said, these filters *(Filtre-Rapide)* act in a relatively much more perfect fashion than most of those with which we have had to deal, still it cannot be contended that they confer any protection against the communication of infective disease, inasmuch as, although a large proportion of the micro-organisms are undoubtedly retained in the meshes of the filter, yet in course of time, in all probability, these, or at any rate the greater number of them, pass into the filtrate, and are drunk by the consumer. Now, as the manufacturers of these filters state, as among the requisites of a good filter, that it should include the provision to arrest 'the suspended matter, large and small . . . even the spores of cholera and typhoid fever germs, algæ, diatoms, and all other microscopical and ultra-microscopical organisms'—we cannot agree with their statement that this filter possesses these qualities, and is 'a perfect guarantee against disease.'"*

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.

* *An Inquiry into the Relative Efficiency of Water Filters in the Prevention of Infectious Disease.* A special report to the *British Medical Journal*, November 17th, 1894.

† *Travels.* ‡ *The Congo, and Founding of Its Free State*

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 sake and thine oft infirmities.*"*

As it appears that Africa has its alcoholic question, I will cite a few authorities on either side.

In Parkes' Manual of Practical Hygiene it is laid down : "*From* 1 *to* 1½ *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 2½ to 3½ ozs., roughly, from 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.

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

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* I *Timothy* v. 23.

† See "*Report on the issue of Spirit Ration during the Ashantee Campaign of 1874,*" by Professor Parkes, of Netley.

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.

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' doctrine, they may be safely taken in daily quantities of ½ to 1 pint, or 10 to 20 ozs., according to strength.

Professor Parkes' 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:—

* *Physiology.*

"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 already 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 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

* 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 & Co. 1894.

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.

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.

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 1 lb. 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.*

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."

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* Extract from *Report of 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.

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 1 to 2 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 1 to 2 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 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,

* A few drops of *oil of lemon*, added when the sugar is put in at the last, will answer if fresh lemons are unobtainable.

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.

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.

M. 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, manœuvering 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 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*, 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.

CHAPTER XVII.

THE CLOTHING PROBLEM IN THE TROPICS.

PART I. THE PHILOSOPHY OF CLOTHING.

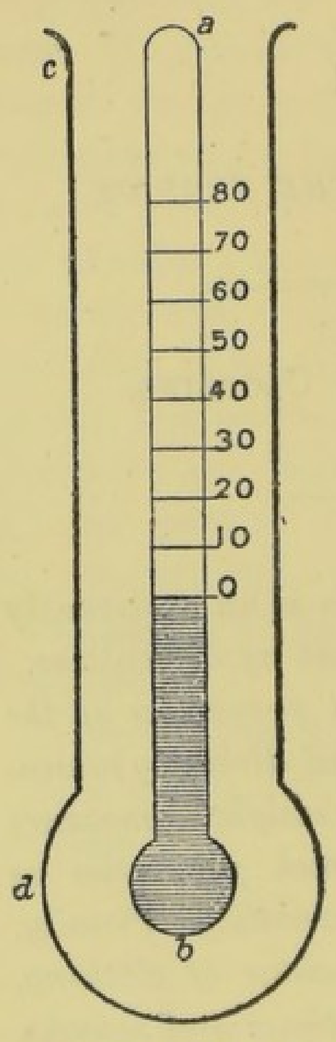
What should be worn in the tropics is an apparently simple question on the surface, yet beset by difficulties.

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 Rholf 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 substances 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 following table :—

* *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, 1729. 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 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 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 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 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 or 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* chap. xviii.). In the matter of porousness, the lightest woollens are more porous than the lightest cotton stuffs, as 1½ : 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 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 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 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 skin, as in European dress. Not so in flowing robes, which are only wet where they touch ; the vapour of 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 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 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 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.

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 out-door 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 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 flannels 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

* To *Health Culture*, by Dr. Jaeger, I am indebted for these references to Rohlf.

with the skin, and so prevents the perspiration showing through. In private life, he often sits with nothing on the 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 head dress, except 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

* Extract from private letter to me from Mr. S. L. E. Palm of the Chinese Government service.

garment 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, 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.

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."

CHAPTER XVIII.

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 reproducing 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 oz., 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

* 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.

chilling it by permitting rapid loss of heat 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 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.

* *The Congo, and Founding of Its Free State.* † *She.*

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.

THE TYPICAL EXPLORER'S SUIT OF SILVER & CO., OUTFITTERS.

THE TYPICAL EXPLORER'S SUIT, of which this illustration shows the most approved pattern by the well-known outfitters, Silver & Co., although smart, becoming, and soldierly wear for parade, and perfect in many details, fails in the essentials of *looseness* and *ventilation*.

Supposing that the material is sufficiently *light* and *porous*, these faults could be remedied by enlarging body and sleeves and "hollowing" arm-holes, cutting down and opening collar, as in next illustration, and draping the body in folds or plaits. Beneath the plaits there should be four slits—one on either side, extending from collar to belt in front; and the same in number and position behind, for ventilation. The sleeves should be looser and shorter than in sketch, and of semi-Chinese pattern.

THE SMOCK-FROCK NORFOLK SUIT is, as the name shows, a combination of two useful types of clothes.

The coat should be loose as possible, compatible with decent fit, and made to hang in folds or plaits around the body, with two ventilating slits—made to button up when required—beneath the folds in front, and two behind, as in explorer's suit.

A belt of same material as coat may be loosely worn or dispensed with at pleasure.

The collar should consist of a linen tape or band merely. It should be cut low and sit loosely, so as to expose the neck freely, and permit of issue of vapour and hot air all around.

By these arrangements thorough ventilation is secured. A novel feature of this garment is the sleeves, which should be of semi-Chinese pattern, slashed at cuff, and shorter and more hollowed under arms than appears in sketch. Knickerbockers of the same light porous material as the coat should be made upon the loosest riding-breeches pattern; they may be occasionally buttoned at the knee, but are preferably worn open.

THE SMOCK-FROCK NORFOLK SUIT.

Tutties of linen, cotton, or canvas, to be used in travelling only, instead of gaiters, and ordinary shoes or boots of russet leather, complete a suit which is excellent for the tropics.

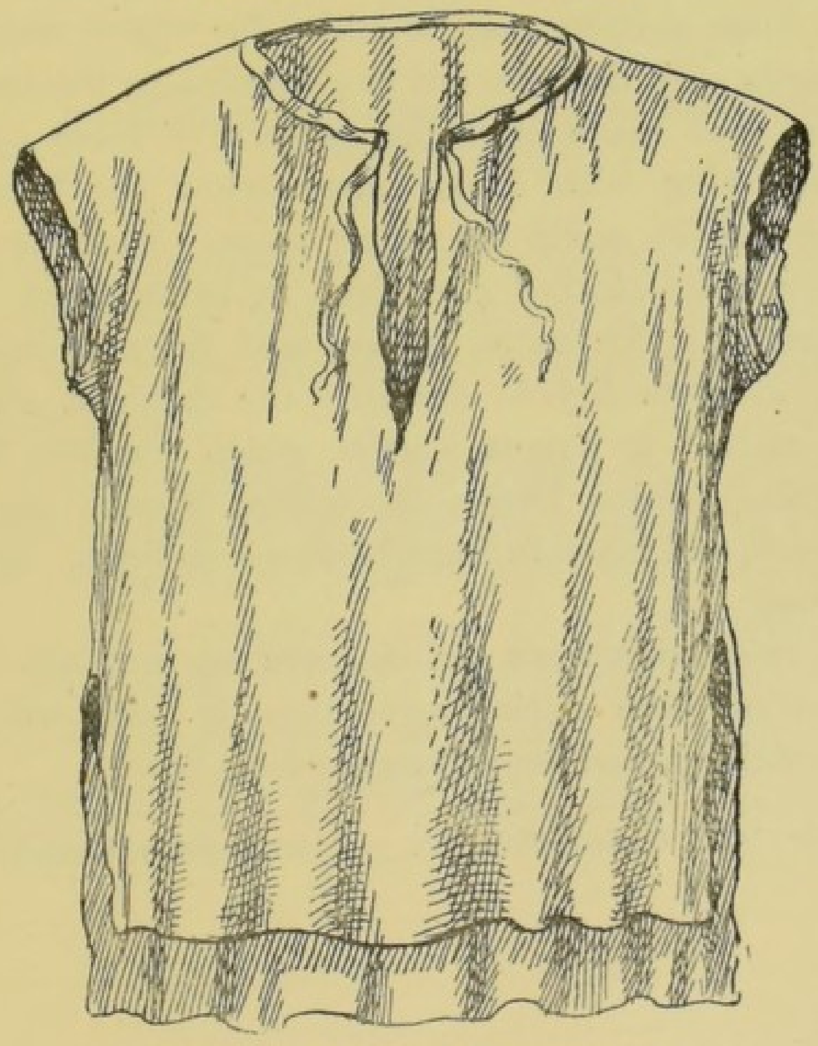
I took out somewhat similar suits of fairly stout very porous tweed, gossamer Indian tweed, cotton drill, calico long-cloth, and Harris's linen, which weighed respectively :—Substantial very porous tweed, Norfolk, with belt and movable collar, 1 lb. 15½ ozs.; very loose trousers of same grey material, 1 lb. 7½ ozs.; smock-frock Norfolk coat, gossamer tweed, 1 lb. 7 ozs.; knickerbockers to match, 1 lb. 0¾ ozs.; Harris's linen smock, Norfolk belt, &c., 1 lb. 12 ozs.; ditto knicks, 1 lb. 1¾ ozs.; cotton drill coat, 1 lb. 7 ozs.; drill knicks, 1 lb.; light smock, Norfolk calico, 1 lb. 4 ozs.; knicks ditto, 1 lb. All clothes taken to Africa should be made to order at some good tailors or outfitters.

Clothing for House or Factory wear.

Very little clothing, and that of the very lightest kind, should be used in house and factory, especially during the dry hot season. A French cambric shirt weighing 11½ ozs., a size too large for wearer, very loose at neck and sleeves; or a calico, cambric, grass-cloth, or Harris's linen smock-frock Norfolk coat; or a blouse of same materials, made on the French *ouvrier* pattern; will all prove comfortable wear.

Knickerbockers to suit, made on the riding-breeches pattern described, slit at knee, where they may be fastened by buttons or strings. Or short semi-Chinese pattern trousers, which should reach only a few inches below knees. 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 stockings of wool or cotton put on. A long, loose, unlined, light and porous woollen dressing-gown will be of great service after fever, or during the chilly stage of its attack. A similar make in cotton will be useful for lounging in hot weather.

Undervests and Drawers.



The Under-Blouse (Sleeveless).

My under-blouses were made on a loose pattern of two widths of stuff, and measured about 36 inches in length. They weighed in cotton long-cloth 8½ ozs., Harris's linen 9½ ozs., stout flannel 11 ozs., light ditto 7½ ozs., cellular cotton cloth 10½ ozs.

The *sleeveless under-blouse*, as shown in sketch, should be the pattern for all tropical underwear of whatever material.

The garment should be loose enough to hang in folds upon the body, and open freely down the front, where it is secured loosely at base of neck by linen running strings. The armholes should be very large or "hollowed," and the skirt deeply slashed. Half sleeves or whole sleeves, of very loose pattern, may be added for winter wear.

Drawers.—If drawers are ever needed in the tropics, they are best made after the pattern of loose pyjama trousers, tying with linen tapes below the knee for summer, and at ankle for winter wear. In either case they should be slashed 4 in. deep at tying place. The best materials for under-blouses and drawers are, for winter, Jaeger's lighest flannel; for summer, cellular cotton cloth,* a patent textile which permits freest ventilation, Indian long-cloth (calico), French cambric, grass-cloth, and Harris's finest hand-woven linen. Weight 7 to 9 ozs.

As a rule, undervests and drawers are not needed in the tropics, save during exceptionally cold weather, night-watching, and convalescence from fever.

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* *Cellular Cotton Underclothing Co.*, 73 Aldermanbury, London, E.C.

PROTECTION OF VITAL ORGANS.

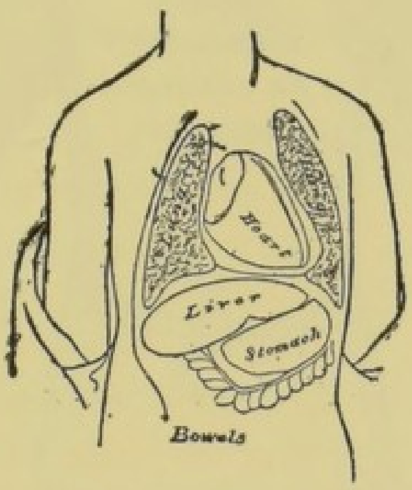
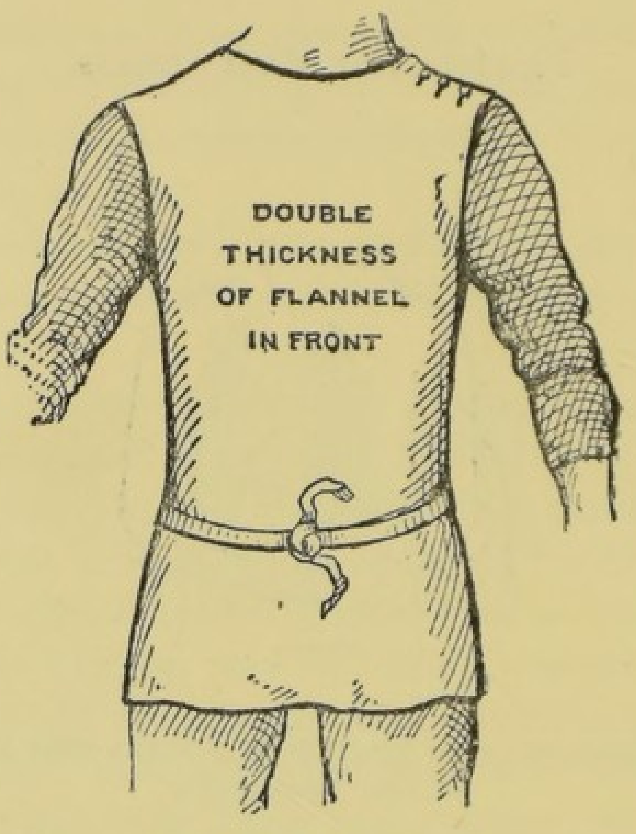


DIAGRAM SHOWING POSITION OF VISCERA THAT NEED SPECIAL PROTECTION.

In Dr. Jaeger's make of underclothing the vital organs are protected by doubling the material in front. The use of this is at once apparent by glancing at the accompanying sketch.

I found it necessary in the tropics to modify Jaeger's pattern, as seen in the Cameron cuirass, which affords equal protection for vital organs, with thorough ventilation, and a delightful sense of looseness and freedom. It may be made of light Jaeger flannel, cellular cotton cloth, or any other warm and porous material, and it is best worn over an under-blouse, with a shirt or smock Norfolk over all.



THE CAMERON CUIRASS.

In make, the Cameron is the same as an ordinary Jaeger undervest, slit down under the arms at either side. Wide linen tapes are then stitched to the back piece, which are brought forward and tied in front, as shown in illustration; the sides are open save where garment overlaps.

LINEN AND GRASS-CLOTH.

Linen and grass-cloth are the only two 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 procurable at present (1893) in England; but it is likely to be introduced into Africa by the Banian traders, who are now flocking to the East Coast. In its prepared state the finest fibre is beautifully white, lustrous, 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.

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.

Linen was once the common wear in Germany and England; and even now the Iberian and Italian peasants use it for their working garments, which are 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.

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* 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 cloth, 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 HARRIS'S LINEN SMOCK-FROCK NORFOLK COAT.

The material used for the under-blouses was light, smooth, porous, and even of texture; cool and glossy as cambric; beautiful, strong, and durable. I found it excellent wear in the temperate climate of Natal, but in the tropics, when it became wet with perspiration, it chilled more than wool or cotton.

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.

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 *kamarband* is soft, warm, and elegant wear, but I prefer, with Stanley, a stout flannel one, say, a strip of ordinary blanket, 14 in. wide, overlapping in front, to any other kind of belt or girdle for the tropics.

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 thinnest kind. Some suits of Chinese silk should be found in every outfit.

BOOTS.

Good boots are of highest importance in Africa. They should be made to order 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.

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, long, sleeveless "Inverness" or paletot, with large removable cape and hood, made of lightest and most porous tweed, unlined; a first quality, stitched, North British mackintosh of same make, well "hollowed" at armholes for ventilation, are both essential for Africa.

The Inverness and mackintosh 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.

All tropical clothing should be unlined.

Head, Neck, and Spine Protection.

The solar topee or helmet, with *real* Indian puggaree, fly-net, and neck 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 in. down neck, to guard it against the slanting rays of morning and evening sun, which, by striking under the helmet, often cause sunstroke.

The spine screen.—This is made like the neck screen, but of somewhat stronger materials. It should measure 3 to 3½ in. wide, and 24 to 28 in. long. Hook or button to collar, middle, and bottom of coat or shirt, and 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.

Suggestive Outfit List for Tropical Africa.

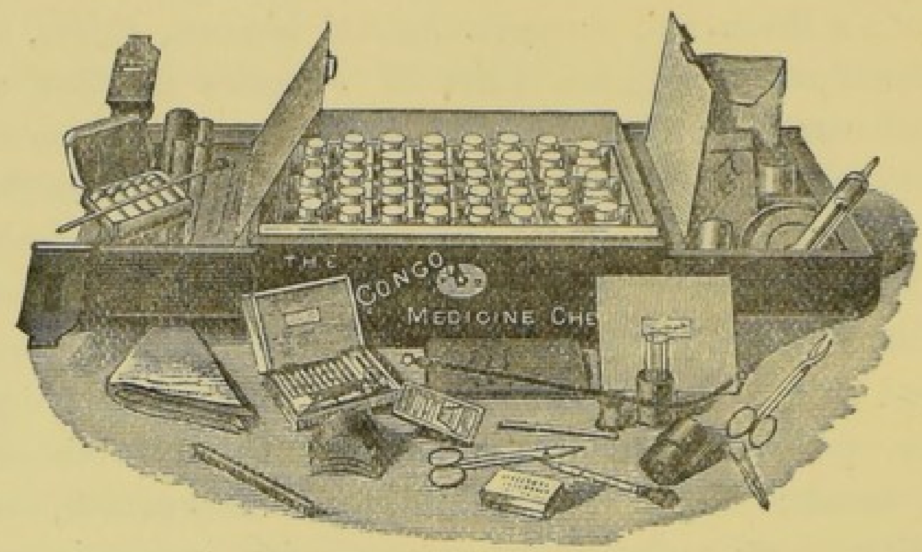
Tent of rot-proof canvas, with fly and ground sheet; valise of same for Parke's African bedstead, folding arm-chair, hair mattress, 2 uninflammable mosquito curtains, 4 best Austrian blankets, indiarubber basin and bath, small air-pillow, ditto feather, 6 washing linen pillow-covers, rubber hot-water 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 inches outer measure, aluminium fittings; weight, 50 to 60 lbs. when full; lined with thinnest zinc sheeting is best. Stationery; pens, ink pellets, paper, note-books, drawing-books, rubber, pencils, Bible, Shakespeare, a few other unbound books, matches, luminous match-box, camphor tablets, toilet necessaries in leathern case, 6 tooth-brushes at least, 2 nail-brushes, 4 sponges, sponge-bag, some finest scented soap, musk and ottar of roses, waterproof canvas bag (green) for odds and ends, with lock. 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 nickeled 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,

* See Parke's *Guide to Health in Africa* for list of drugs, &c.

tutties, leggings of canvas. Silk and flannel loin-cloths; French cambric, cotton cellular cloth, long-cloth shirts. Harris's linen and Jaeger's flannel blouses, shirts, and under-blouses; pyjama suits of Jaeger's lightest and cellular cotton; Cameron's of ditto, ditto. Cotton and woollen socks of various thicknesses; smock-frock Norfolk jackets of stout porous tweed, Indian gossamer tweed, Harris's linen, cotton drill, cotton long-cloth, Chinese silk, and grass-cloth. One thick but porous tweed suit, and one reefer jacket of pilot cloth; light, large, porous tweed "Inverness," with movable cape and hood; North British stitched mackintosh, best quality, same make as Inverness, with movable cape, large. Solar helmet, Congo hat, Terai, cowboy, or Panama hat, with puggaree, net, &c.; neck and spine screens; travelling cap or pilot. Flannel and cotton loose, long, porous dressing gowns; braces; umbrellas, lined and strong; pocket-handkerchiefs of all kinds; quantity of under-blouses of cotton, cotton cellular, linen, and Jaeger; woollen and Cashmere comforters; spare flannel; towels, large and small; buff gloves, life-belt, housewife, light field-glass, fishing tackle, handbag, cabin pockets and hooks; light jersey, moleskin riding-breeches, canvas coat and trousers; pocket compass, arms, handbag; cabin trunk, 30 × 16 × 14 in.; medicines in Stanley or Congo chest.



THE CONGO MEDICINE CHEST.

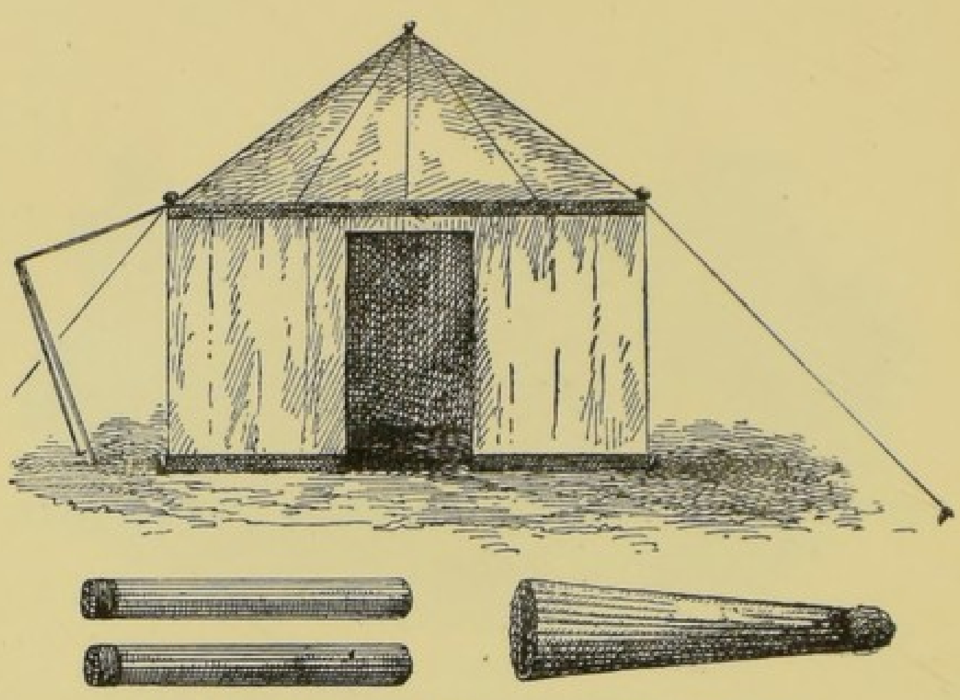
CHAPTER XIX.

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 3 pieces of coarse calico *(dungaree)* in both roof and walls, and it may be easily carried on a pony.



THE BECHOBA, OR INDIAN SPORTSMAN'S TENT.

"It holds two comfortably, being 10 feet 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 Crimean war:—"Such tents are toys, and most uncomfortable."

On my Zambesi trip I took with me two tents, made by Benjamin Edgington, London, of green rot and damp-proof canvas,* on a pattern approved by Stanley, Cameron, Wissmann, and other authorities.

* 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 Wissmann tent of this pattern measures 9 × 7 × 7 feet, and weighs 90 lbs.

EDGINGTON'S APPROVED TENT FOR TROPICAL AFRICA (9 × 8 × 6 FT.)

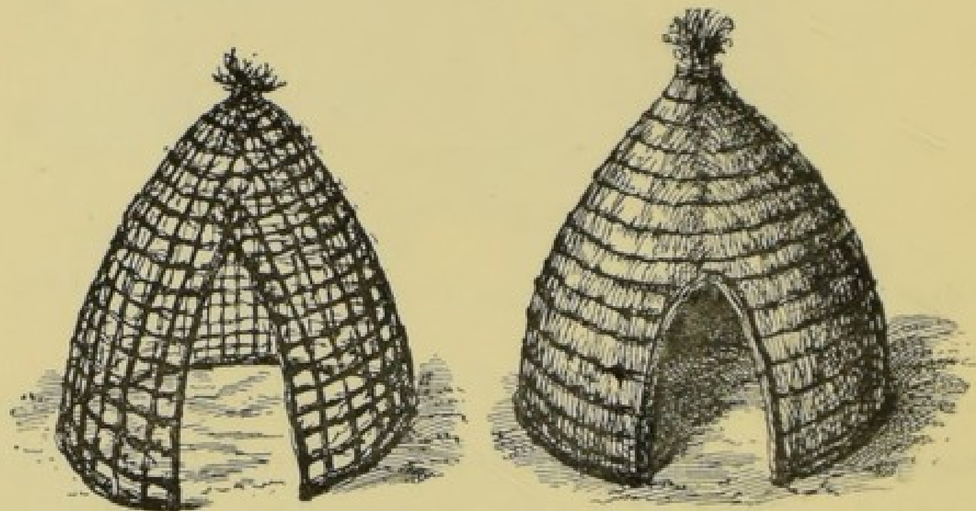
These tents were provided with large flies and ground sheets of same canvas, and, following Dr. Pruen's advice, I added ceilings of coarse green baize. I regret not having had the walls similarly lined, and a baize screen to draw across the door, as more perfect defence against oscillations of temperature.

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.

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. This hut is dark and cool inside even at mid-day, and *the thermometer hung from centre of 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.



DR. PRUEN'S HOSPITAL HUT FOR NATIVES.
From "*Arab and African*"—6 to 7 feet in diameter, and about the same in height.

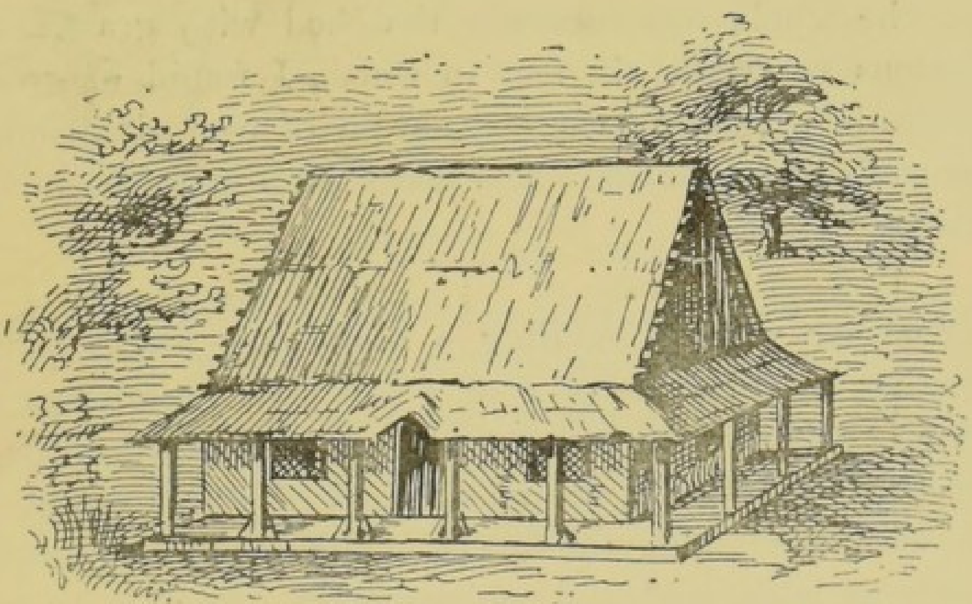
HOUSE-BUILDING.

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 or 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° F. 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.



THE ARNOT TEMPORARY HOUSE FOR TROPICAL AFRICA.

He thus tells us how he built it :—

"After measuring out a piece of ground 30 feet by 15, 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, six feet 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 feet apart, a number of 6-inch uprights with forked tops, and then binding them together with wattle, the insterstices 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 house forming gables, will vary, of course, in length, according to the required pitch of roof. Thatch, or bark roofing, or both combined, will suit such houses best.

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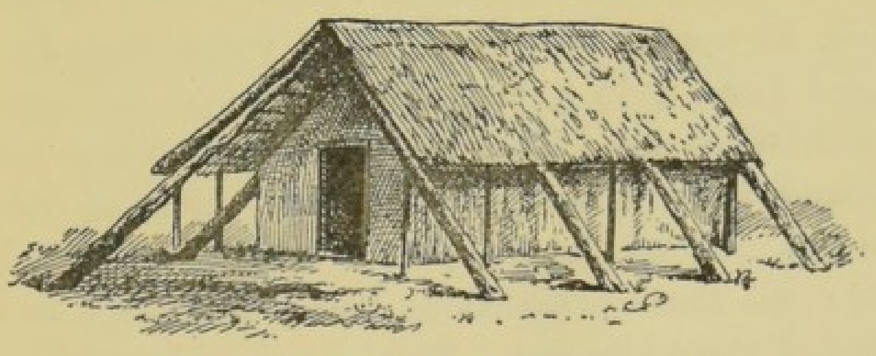
* The illustration and description are taken from *Garenganze, or Seven Years' Pioneer Missionary Work in Central Africa.* By S. F. Arnot. (James E. Hawkins, London).

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 space intervening; the inside bamboos are then covered with native mats, the outside plastered and whitewashed.

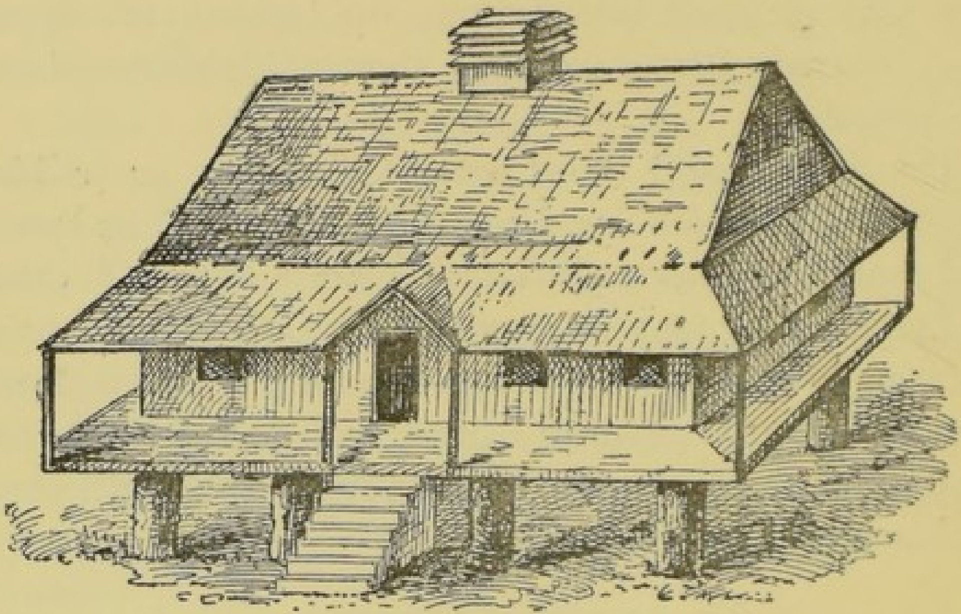
The floor should be of cement, concrete, or trodden ant-hill clay, which Dr. Pruen recommends to be tarred and sanded over as a protection against ants. A calico or baize ceiling may be stretched beneath thatch; baize curtains behind outer doors and instead of inner doors, the door may be made of canvas nailed on light frame, while one or two layers of mosquito-netting will serve provisionally for windows.

Another form of temporary house is shown in 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.



DR. PRUEN'S TYPE OF TEMPORARY HOUSE FOR AFRICA.
(From "*Arab and African.*")

Dr. Murray's house may be taken as one type of a permanent habitation, planned with view to combine *minimum lightness and strength of materials with maximum resistance to passage of heat through roof, walls, and floors, and thorough ventilation with exclusion of malaria.*

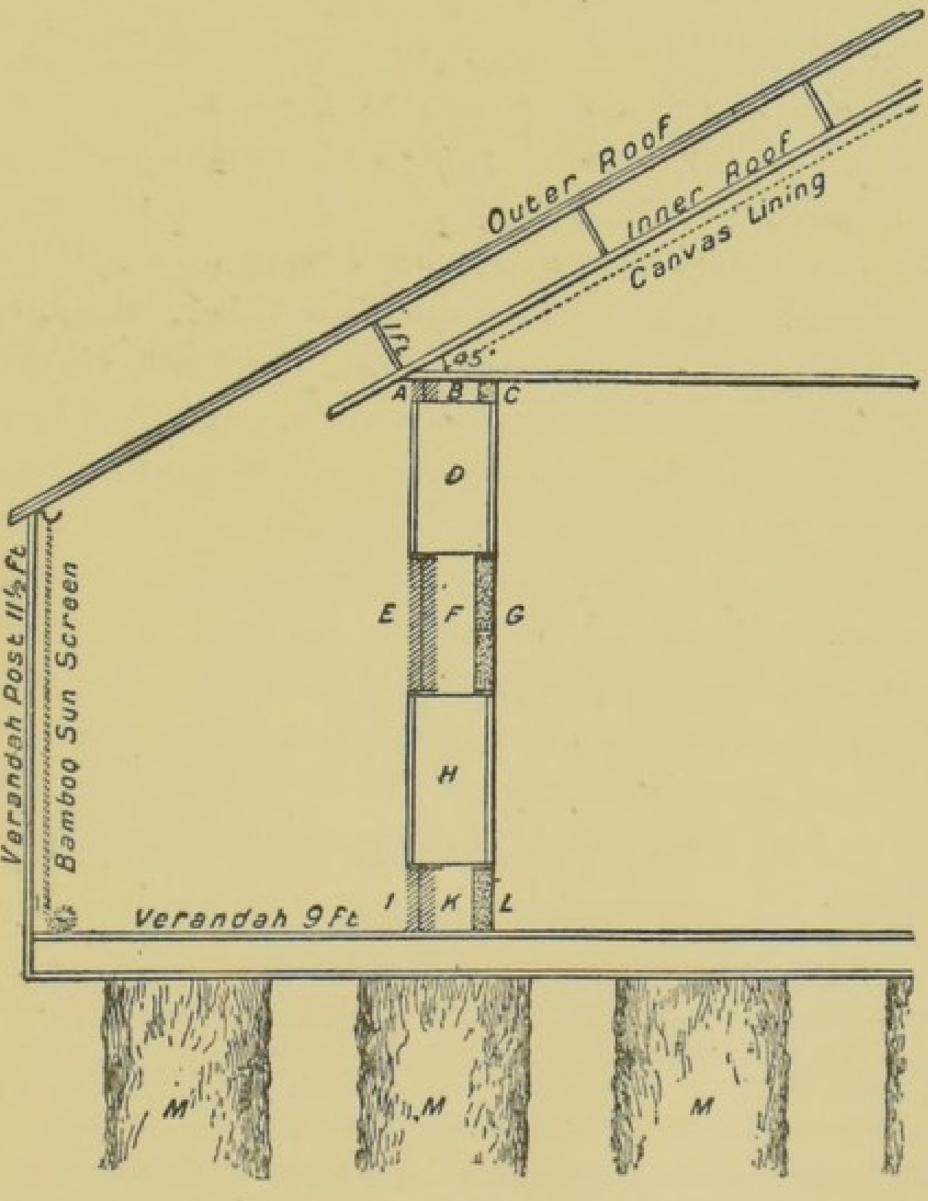


DR. MURRAY'S TYPICAL SANITARY HOUSE FOR TROPICAL AFRICA.
(PLATE I.—Perspective).

The best way to build Dr. Murray's style of house is as follows:—The ground having been carefully cleared and levelled, the logs which are to support the house are put in at convenient distances apart. They should, if possible, be round hardwood boles, measuring 20 feet long and from 2 to 3 feet thick, charred, tarred, and seasoned before use. They should be sunken 4 or 5 feet, and stand upon a foundation 2 feet thick, of broken stones or trodden in clay, over which tar has been poured; all these precautions being necessary to stop ravages of the white ant. The logs should project some 15 or 16 feet above the level of the ground, and on them a solid platform of tarred ant-proof wood is constructed, which will form the basement of house and verandah.

If lime can be obtained, masonry pillars may be advantageously substituted for these wooden supporters.

The house should be built of stout plank—the thicker the better. Walls, roof, and floors are to be double, as shown in accompanying plan.



DR. MURRAY'S TYPICAL SANITARY HOUSE FOR TROPICAL AFRICA.
(PLATE II.—Vertical Section Plan).

Description.

The outer roof consists of wood, covered with shingle or thatch; it projects over walls, and covers verandah. The inner roof is also of wood, lined with canvas. There is 1 foot interspace between roofs. A canvas, baize, or green calico ceiling may be arranged at the level *A B C*, to draw across in lengths upon wires when wholly or partially wanted (as we see in photographic studios).

A is one of the ceiling louvres, *B* an air space, *C* a tattie* frame. The walls, which are of stout timber—say 1 in. planking—are 18 in. thick, with 16 in. interspace. These interspaces of roof, floor, and walls (*D* and *H*) are represented empty, but they should be filled tightly with very dry grass, straw, reeds, moss, cocoanut, or other fibre, to increase their resistance to the passage of heat.† *E F G* is one of the windows; it has a removable louvre or venetian (*E*) outside, and a removable tattie screen (*G*) inside, and may have a double-hinged window between. *I* is one of the surbase louvres; *L* a surbase tattie, both removable in very hot weather. The verandah is 9 ft. wide and 11½ ft. high at outside, where it is shaded by a bamboo screen or "*chic.*" The floor interspace is 6 in. deep. *M M M* represents the logs or pillars of house.

* The *tattie* or *tatta* in India is a frame or trellis lined with grass, over which water is suffered to trickle with a view to cooling the air as it enters an apartment. Removable tattie frames are used for doors as well as for windows. When dry, they still act as effective air filters, stopping microbes, dust, fog, and other floating matter.

† This principle was illustrated in Count Rumford's experiments with his passage thermometer (see chap. xvii.). He found diathermancy to diminish in proportion to the quantity of vegetable or animal fibre packed into interspace between bulb and thermometer.

The louvres and tattie frames of the ceiling ventilators (*A B C*) should be fixtures. Each ventilator should be 2 ft. long by 1 ft. wide, and disposed around top of room at 2 ft. intervals. The same remarks apply to the surbase ventilators, *I K L*, save that in very hot weather they may be removed by day. The window venetian (*E*) can be used alone, *G* being left out save in very hot, foggy, or damp weather; it may be wetted at times for coolness. At night all louvres and tatties should be closed and locked against ærial and other enemies, *as it is of vital importance in malarial regions not to sleep with outer doors or windows open.* The outer doors should have movable pannels, for insertion of tattie frames, as in India, or they may be double; the outer door a louvre, or half glass and louvre; the inner a tattie holder, with the usual 16 in. air interspace between the two.

All the inner doors of house should be of light framework, covered with green mosquito-net on either side, or simply uninflammable gauze or mosquito-net curtains, shotted below and running on wires. At night the verandah "chics" should all be lowered.

In some central fire-place a small fire should be kept smouldering all night, to ensure free circulation of filtered air, which will find constant entrance through the numerous porous apertures without causing draughts. The heated air should find free issue through one or more chimneys, which may be provided with openings in the flues, especially near the roof, through which the foul and heated air may escape, while some simple automatic contrivance will prevent down draughts. The outside chimneys should be louvred, as seen in perspective view of house (Plate I.).

The advantages of a wide, lofty, and shady verandah, which may be called the lungs of a house in the tropics, need not be insisted upon.

Of course, there are other and easier ways of building this house and attaining the desired results. Thus, the walls and roof might be constructed of wattle and thatch, like the Zulu hut, and if 18 to 24 inches thick, they will prove effective in maintaining a low range of internal temperature. The floors in this case should be made of thick sawn or adzed planks, carefully joined and caulked, tarred on either side; and, if possible, covered above with a layer of cement, or concrete of tar and sand. The doors, windows, ventilators, and chimneys need not differ materially, at least in principle, from those already described.

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.*

Floor Washing.

The floors and woodwork of houses should be carefully washed once 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.

Latrines.

The earth closet is the best for tropical countries. The latrines should be placed to lee of dwellings, far as possible removed from them, and surrounded by a natural thicket or shrubbery. A good supply of dry earth should be stored in a close vessel in each latrine. Care should be taken that no underground communication exists between necessaries and wells. Natives should be taught how to use similar closets, placed on the outside and to lee of compound.

The Indian Bungalow.

(See Frontispiece.)

This is a perfect type of house for the tropics.

The sketch is taken from a photograph of one in India. It is built upon a masonry platform raised 2½ feet 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 feet 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 verandah, which is shaded in parts by shrubs, and generally by bamboo sun-screens, or "chics," three of which, wholly or partially drawn down, are represented in sketch.

The walls of house are of mud, 2½ feet thick below, somewhat less above, and 24 feet high, to junction of roof. They are whitewashed without and tinted within.

The windows seen above verandah are for ventilation merely, as there is no upper storey in bungalows. The house is thatched with reeds or grass, the roof being about $2\frac{1}{2}$ feet thick, and rising to a ridge 15 feet above top of the walls, which it overhangs some $3\frac{1}{2}$ feet 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 windows and doors somewhat in the way already described; two windows, with venetians closed, may be seen in sketch.

For Africa, the platform should be raised, say 15 feet above ground in malarial districts; and a space of 3 or more yards wide outside of this should be cemented. Then would come flower plots and a low hedge, on the outside of which should be a snake fence, made of broken stones and glass in infested districts.

The Indian bungalow is the one perfect type of house for all tropical countries.

FINIS.

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