refreshment and chemists' shops in the Metropolitan District of Sydney and the Municipal Areas of Adamstown, Carrington, Hamilton, Lambton, Merewether, Newcastle, New Lambton, Stockton, Wallsend, Waratah and Wickham should be closed during Easter Saturday, April 19, 1919.

In a further proclamation it was determined that all the provisions aiming at the prevention of spread of influenza should be applied to persons within the Municipal Areas of Wilcannia, Jerilderie, Blayney, Braidwood, Bathurst, Cootamundra and the Shires of Cessnock and Crookwell.

It is with regret that we have to announce the death from influenza of Dr. William Henry Elworthy, of Randwick, New South Wales, on April 16, 1919.

Medical Appointments.

Dr. W. T. Hodge (B.M.A.) has been appointed Acting District Medical Officer and Public Vaccinator at Moora, Western Australia.

The resignation of Dr. Bruce Boyle Barrack as Resident Medical Officer at the Brisbane Hospital has been accepted.

Dr. Ralph Worrall (B.M.A.) has been appointed by the Department of Public Health an Honorary Surgeon at the Coast Hospital, Sydney.

In pursuance of the provisions of *The State Children Acts, 1911 to 1917*, of Queensland, Dr. Patrick J. Kelly (B.M.A.) has been appointed Medical Officer to the State Children at St. Vincent's Orphanage, Nudgee, Queensland.

Medical Appointments Vacant, etc.

For announcements of medical appointments vacant, assistants, locum tenentes sought, etc., see "Advertiser," page xv.

Department of the Navy: Surgeons.
Department of Public Health, Queensland: Medical Officer for Venereal Clinics.
Newcastle Hospital: Resident Medical Superintendent.

Medical Appointments.

IMPORTANT NOTICE.

Medical practitioners are requested not to apply for any appointment referred to in the following table, without having first communicated with the Honorary Secretary of the Branch named in the first column, or with the Medical Secretary of the British Medical Association, 429 Strand, London, W.C.

Branch.	APPOINTMENTS.
VICTORIA. (Hon. Sec., Medical Society Hall, East Melbourne.)	All Friendly Society Lodges, Institutes, Medical Dispensaries and other Contract Practice. Australian Prudential Association Proprietary, Limited. Mutual National Provident Club. National Provident Association.
QUEENSLAND. (Hon. Sec., B.M.A. Building, Adelaide Street, Brisbane.)	Australian Natives' Association. Brisbane United Friendly Society Institute. Cloncurry Hospital.
TASMANIA. (Hon. Sec., Macquarie Street, Hobart.)	Medical Officers in all State-aided Hospitals in Tasmania.
SOUTH AUSTRALIA. (Hon. Sec., 3 North Terrace, Adelaide)	Contract Practice Appointments at Renmark. Contract Practice Appointments in South Australia.
WESTERN AUSTRALIA. (Hon. Sec. 6 Bank of New South Wales Chambers, St. George's Terrace, Perth.)	All Contract Practice Appointments in Western Australia.
NEW SOUTH WALES. (Hon. Sec., 30-34 Elizabeth Street, Sydney.)	Australian Natives' Association. Balmain United Friendly Societies' Dispensary. Canterbury United Friendly Societies Dispensary. Friendly Society Lodges at Casino. Friendly Society Lodges at Lithgow. Friendly Society Lodges at Parramatta, Auburn and Lidcombe. Leichhardt and Petersham Dispensary. Manchester Unity Oddfellows' Medical Institute, Elizabeth Street, Sydney. Marrickville United Friendly Societies Dispensary. New South Wales Ambulance and Transport Brigade. Newcastle Collieries—Killingworth, Seaham Nos. 1 and 2, West Wallsend. North Sydney United Friendly Societies. People's Prudential Benefit Society. Phœnix Mutual Provident Society.
NEW ZEALAND: WELLINGTON DIVISION. (Hon. Sec., Wellington.)	Friendly Society Lodges, Wellington, New Zealand.

Diary for the Month.

Apr. 29.—N.S.W. Branch, B.M.A., Medical Politics Committee; Organization and Science Committee.
Apr. 30.—Vic. Branch, B.M.A., Council.
Apr. 30.—Western Suburbs Med. Assoc. (N.S.W.).
May 2.—Q. Branch, B.M.A.
May 6.—Tas. Branch, B.M.A., Council.
May 7.—Vic. Branch, B.M.A.
May 9.—S. Aust. Branch, B.M.A., Council.
May 9.—N.S.W. Branch, B.M.A., Clinical.
May 9.—Q. Branch, B.M.A., Council.
May 13.—N.S.W. Branch, B.M.A., Ethics Committee.
May 15.—Vic. Branch, B.M.A., Council; Election of Representative on Representative Body.
May 20.—Tas. Branch, B.M.A., Council.
May 20.—N.S.W. Branch, B.M.A., Executive and Finance Committee.

EDITORIAL NOTICES.

Manuscripts forwarded to the office of this journal cannot under any circumstances be returned.

Original articles forwarded for publication are understood to be offered to *The Medical Journal of Australia* alone, unless the contrary be stated.

All communications should be addressed to "The Editor," *The Medical Journal of Australia*, B.M.A. Building, 30-34 Elizabeth Street, Sydney.

The Secretary of the Victorian Branch is endeavouring to secure copies of the issues of the *British Medical Journal* of the following dates, to complete a file for one of the members. We shall be grateful to any of our readers who has a spare copy of any of the numbers sought, if he will offer them to the Secretary of the Branch:—

1915: April 3 and 10; July 10, 17, 24, 31; August 7 and 21.
1916: July 8, August 5 and 12, November 18.
1918: Title Page and Index, Volume I. and Volume II..

THE MEDICAL JOURNAL OF AUSTRALIA.

VOL. I.—6TH YEAR. SYDNEY: SATURDAY, MAY 3, 1919. No. 18.

TROPICAL AUSTRALIA AND ITS SETTLEMENT.

By A. Breinl and W. J. Young.

(From the Australian Institute of Tropical Medicine, Townsville.)

Contents.

Introduction.

Tropical Australia and its settlement by a British race has formed the theme of numerous public utterances and of a good deal of writing in both the scientific and lay press. Sometimes these utterances have been dictated by ultilitarian reasons alone, sometimes they have only formed part of a general political propaganda; many have been influenced by personal prejudice and were put forth by writers whose experience of life in Northern Australia did not qualify them to express an opinion on this subject.

On many occasions, when the ultimate fate of Northern Australia has formed the subject of discussion at various scientific meetings, the speakers have applied indiscriminately to Northern Australia the outcome of experiences gained by themselves or by others in various parts of the tropics, without realizing that Northern Australia occupies a different position, on account of the absence of a settled native population and its peculiar climatic conditions.

The following pages are the outcome of several years' investigation in and consideration of conditions obtaining in Northern Australia and their influence upon a settled white race. A résumé is included of previous investigations by other workers into the practicability of a white settlement of other parts of the tropics and the influence of tropical life upon a population of European descent. An attempt is made to sift facts and to review the results of previous investigations, published in numerous scattered journals, most of which, with the exception of the experiments carried out in the Philippine Islands, have not only been done in a haphazard way, but sweeping conclusions have been based upon a few unsystematic observations.

The problem of the settlement of tropical Australia by a white race is a very difficult and complicated one, since two factors enter into the question. In the first place, climatic conditions and their effect upon the white man are of paramount importance, since racial degeneration, brought about by climatic conditions alone, would decide the problem. At the same time the economic side of the question plays an important part and cannot be neglected, and a discussion on this aspect has been included.

Opportunity is taken here to thank Mr. H. A. Hunt, the Commonwealth Meteorologist, for putting at our disposal the climatic data, and also Mr. G. H. Knibbs, C.M.G., the Commonwealth Statistician, for help and suggestion in connexion with the statistical data.

The Climate of Northern Australia.

The Australian living in the southern parts of his continent generally possesses only a very uncertain knowledge of the climate of the northern parts. He assumes that the whole of the north above the tropic has a uniformly hot climate, that heat and mugginess persist and that a feeling of personal comfort is only a rare sensation. This popular conception arises from the general idea of "tropics"; most people in their early youth associate with "tropics" a land of impenetrable jungle, heat, swamp and fever, an impression gained by reading books of adventure and travel.

The scientific study of climates within the tropics shows, however, that there exists a great diversity of climatic conditions, regulated by a number of factors, such as the nearness to the ocean, elevation above sea level, proximity to high mountain ranges which control rainfall, prevailing wind and, above all, the amount and monthly distribution of the rainfall.

To describe climate from the point of view of its effects upon a human race is impossible with our present means. It is only to a certain extent that climate, as we feel it, finds a graphic expression in those meteorological observations usually recorded, which measure heat and humidity only, namely, the readings of the dry and wet bulb thermometers. From these readings is further calculated the relative humidity, that is, the extent to which the atmosphere is laden with moisture. The degree of personal comfort or discomfort experienced is indicated to some extent by these readings, but it is certain that many other factors play a large part in determining individual sensations.

Numerous attempts, summarized as far as 1908 by Hann, have been made to construct a "discomfort scale," but no satisfactory solution has yet been attained. Conspicuous amongst these is that of Cleveland Abbé, who suggested a "curve of comfort," based upon three factors, namely, air temperature, relative humidity and wind velocity. By plotting temperatures against humidities for a certain velocity of wind and estimating personal comfort or discomfort under these conditions, he obtained charts which correlated his personal sensation with the above factors.

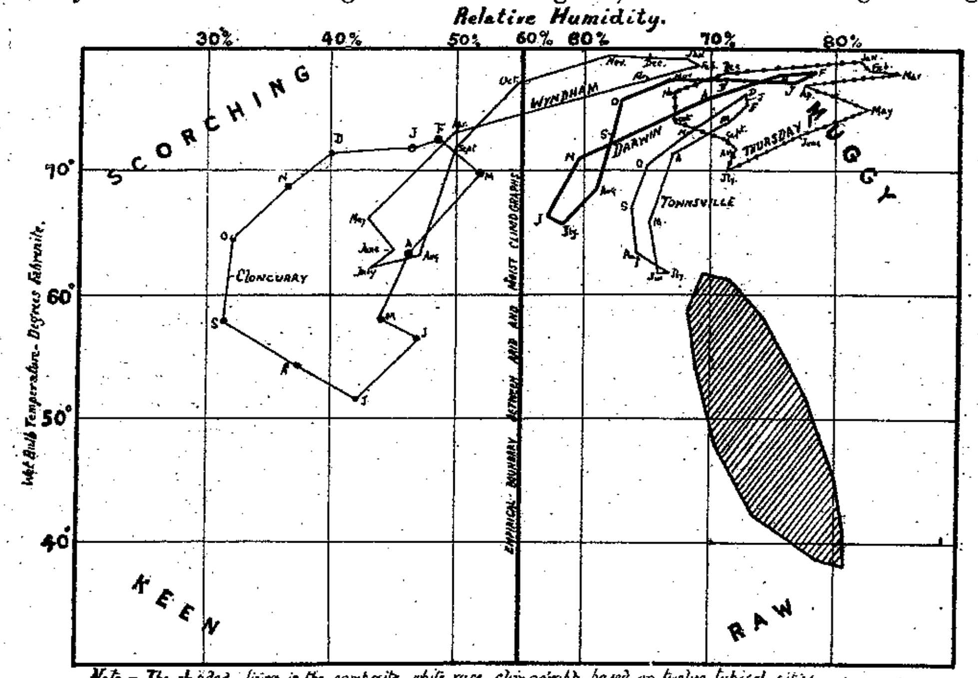
Wet bulb temperatures alone were first used as a guide to comfort by Harrington, who termed them "sensible temperatures" and mapped out wet bulb isotherms for the United States of America for the month of July. The importance of wet bulb readings has been further emphasized by Haldane (1905), who demonstrated experimentally that the regulation of body temperature above a certain wet bulb reading became disorganized and human energy was paralysed. He therefore suggested wet bulb temperatures as a standard by which to regulate conditions in factories, mines and workshops.

Griffith Taylor (1916) has suggested a tentative scale of discomfort, applying only to warmer regions, where humidity and temperature are the chief factors, a scale depending on wet bulb readings. He divided "climate" into the following grades:—

8.3°-12.7° C. (45°-55° F.) wet bulb—Most comfortable.
12.7°-15.5° C. (55°-60° F.) wet bulb—Very rarely uncomfortable.
15.5°-18.3° C. (60°-65° F.) wet bulb—Sometimes uncomfortable.
18.3°-21.1° C. (65°-70° F.) wet bulb—Often uncomfortable.
21.1°-23.7° C. (70°-75° F.) wet bulb—Usually uncomfortable.
Over 23.7° C. (over 75° F.) wet bulb—Continuously uncomfortable.

A rough-and-ready indication of the degree of discomfort, used by Osborne (1916), is the amount of clothing required to enable him to lie in an open-mesh-work hammock. His experiences have led him to set a wet bulb of about 22.75° C. (73° F.) as an empirical standard above which truly tropical conditions arise.

Many authors, however, contend that wet bulb readings alone are not an unerring indication of the subjective sensation caused by climate. L. Hill (1914, 1916), for example, pointed out: "It is no use to trust to the ordinary thermometer, either wet or dry, because it does not show heat loss. It only shows its own temperature, the average temperature of the furniture, surroundings and walls; it does not show the heat loss of the body. Whilst the thermometer is a static instrument indicating average temperature, the human body is a dynamic structure, continually producing and losing heat, while its temperature remains sensibly constant." He deprecated the use of relative humidity as a criterion of comfort, and suggested the katathermometer, a new apparatus, which would register the rate of heat loss and thus indicate more closely the effect of temperature and atmospheric conditions upon the human body. The instrument consists of two thermometers, each having a large bulb filled with alcohol; one of these is kept dry—the dry bulb katathermometer; the other is kept moist by means of a wet cotton glove—the wet bulb katathermometer. Both are heated to 43.3° C. (110° F.) and the time which each takes to cool from 43.3° to 32.2° C. (110° to 90° F.) is noted. The dry bulb katathermometer thus measures the rate of cooling by convection and radiation, the wet bulb katathermometer that by convection, radiation and evaporation and thus measures not the actual air temperature but the rate of cooling of a moist body, due to the effects of the atmospheric condition at an actual temperature approximating to that of the human body. Practical experience has shown, however, that the wet bulb katathermometer is too sensitive to air currents. Osborne (1916) has pointed out that a series of readings taken in rapid succession yields fairly uniform results only in still air indoors, or outdoors if a steady breeze be blowing. On the other hand, when the wind comes in gusts, consecutive readings show great variations.



Note.—The shaded figure is the composite white race climograph based on twelve typical cities.

FIGURE I.

Observations in Townsville with the katathermometers have confirmed Osborne's experience and have proved that calm weather, as far as the katathermometer readings are concerned, is a rare exception and days classed as still to personal sensation may not be so to the katathermometer.

Griffith Taylor (1916) attempted to overcome the difficulty of judging a climate in a novel manner, by introducing a graphic representation, termed a climograph, and plotting the monthly means of relative humidity against monthly means of wet bulb readings. He compiled as a standard a composite climograph, by using average figures for towns situated in regions where human energy is at its best, selecting for this purpose five towns in the southern and seven towns in the northern hemisphere, where the average monthly wet bulb readings ranged between 2.7° and 16.6° C. (37° and 62° F.). This climograph, according to Taylor, represents ideal conditions for the white race, and he terms it the "white race climograph." On the same principle he constructed a number of climographs for different parts

of the world and differentiated in this way four extreme climatic types—hot and damp, hot and dry, cold and damp and cold and dry—and compared the climographs of Australian towns with these types (see Fig. I.). The shape of the climograph also indicates the seasonal distribution of rainfall.

It is an ingenuous and striking method of comparing in a general way the climate of any given locality with a type, but does not convey any further information than the mean readings of dry and wet bulb thermometers, and it is significant that Taylor himself, when discussing the question of discomfort in relation to climate, uses the wet bulb readings as guide.

Bruce (1916) has proposed the use of dew point as an indicator of the effects of atmospheric conditions upon the human body, and comes to the conclusion that the dew point most desirable for human activity is 16.6° (62° F.), that is to say, that air saturated with moisture at 16.6° (62° F.) is neither muggy nor chilly. If the dew point, however, rises over 21.1° C. (70° F.) the conditions become exceedingly trying.

This principle has been applied to the average temperatures recorded in Townsville and the results have indicated that the dew point at 9 p.m., is, as a rule, higher than at 9 a.m. or 3 p.m., although the conditions in the evenings are, on the whole, undoubtedly less trying than those prevalent during the day. Furthermore, this principles does not take into account the effects of other conditions, such as wind and sunshine.

It would appear, therefore, that neither humidity nor dew point give any more information in regard to personal comfort than the readings of dry and wet bulb thermometers.

Hunt, at Osborne's suggestion, constructed wet bulb isotherms for Australia—the only part of the world for which such complete isotherms have been published — attempting thus to represent graphically climatic conditions as far as personal comfort is concerned. As pointed out previously, wet bulb temperatures alone in this respect are only of limited value, since experience has shown that, although high wet bulb temperature, approaching the limit of safety, may be a guide to discomfort, yet lower ones, without the accompanying dry bulb readings, are indefinite. From our personal experience, wet bulb readings above a certain limit invariably denote discomfort, yet the dry bulb temperature even then modifies the degree of discomfort felt. For example, a wet bulb reading of 26.6° C. (80° F.) is never pleasant, but the degree of discomfort becomes exaggerated in direct proportion to the dry bulb reading. For these reasons it has been thought advantageous to make use simultaneously of the mean dry and wet bulb readings for the comparison of the various parts of Northern Australia. In the accompanying graphs (Fig. II.) are plated the average monthly dry and wet bulb temperatures, taken at 9 a.m. over a period of five years, and the points are connected by lines for distinctness only, the 10° C. (50° F.) line being indicated in order to make a comparison easy. Since the temperatures are so dependent on the rainfall,

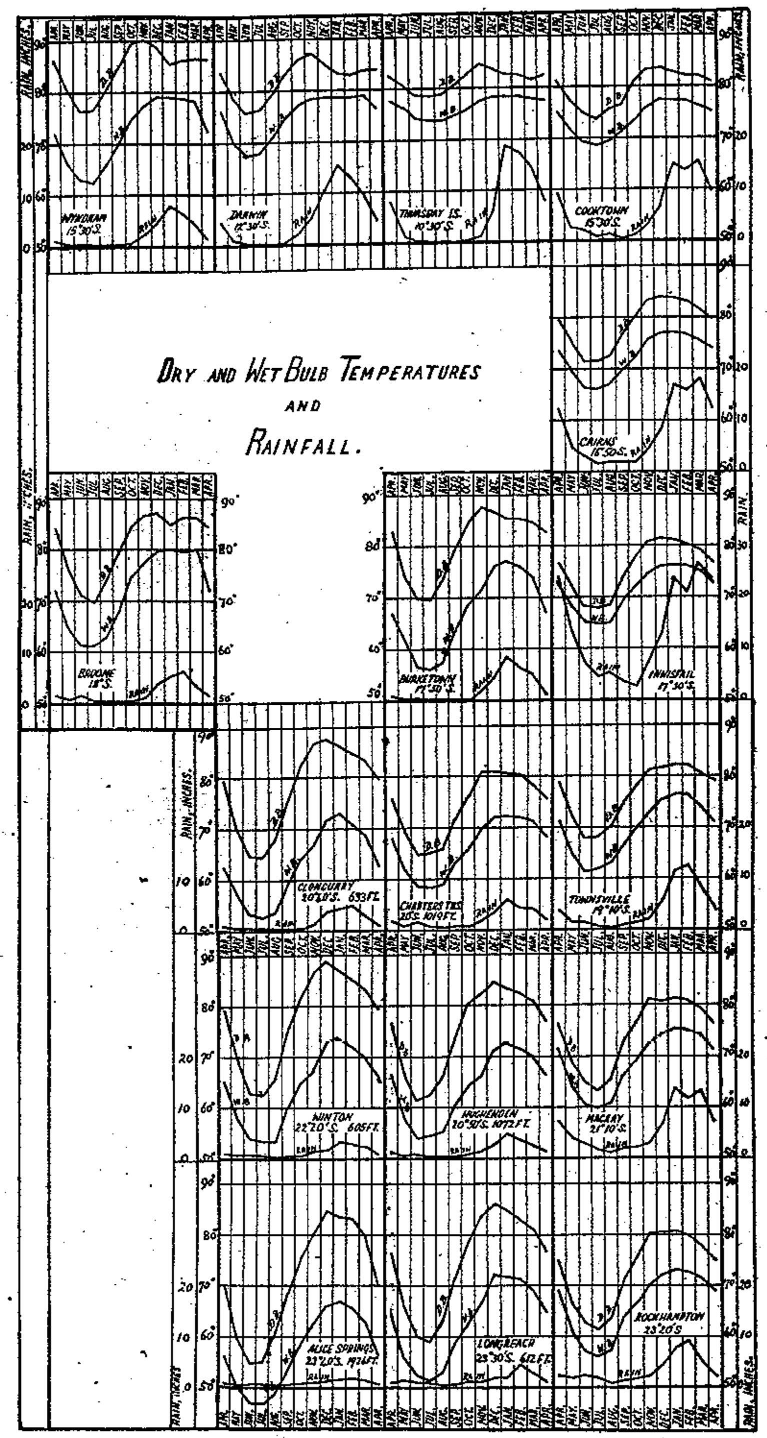


FIGURE II.

average rainfalls obtained from Hunt's publications have been plotted in these charts. The relative positions of the graphs of the various towns are arranged diagrammatically as near as possible in accordance with their geographical position (compare map, Fig. III.). Thus the coastal towns are represented on the outside of the diagrams and the inland towns in the interior. The graphs commence with the month of April, as in this month a distinct change of season sets in; beginning from then, the average temperature falls (rapidly at first and more gradually afterwards) and begins to rise again on or about July. In this way both fall and rise are more conveniently displayed for comparison than if the graphs were commenced with January in the usual way. In order to make the comparison more complete, the monthly averages for the maximum and minimum temperatures are displayed in a similar manner on a second series of charts (Fig. IV.).

The graphs make it clear that the climate of the coastal towns differs essentially from that of the inland towns. The former towns have, on the whole, higher wet and lower dry bulb readings than the latter. With the coastal towns the average readings increase gradually with decreasing latitude and the contrast between the cool and hot season becomes less and less pronounced. The charts of Rockhampton and Thursday Island, the two extreme towns of Queensland, situated within the tropics, illustrate this contention. In Rockhampton (latitude 23° 24′) the coolest month (July) has average dry and wet bulb readings of 16.3° C. (61.4° F.) and 13.3° C. (56° F.) respectively and the hottest month (January) has readings of 27° C. (80.6° F.) and 22.7° C. (73° F.) respectively. The average dry bulb temperature is therefore 10.7° C. (19.2° F.) higher and the average wet bulb reading is 9.4° C. (17° F.) higher in January than in July. In Thursday Island, however (latitude 10° 34′), the corresponding averages are 25.8° C. (78.3° F.) and 23.2° C. (73.8° F.) for July respectively and 28.1° C. (82.7° F.) and 25.9° C. (78.7° F.) for January, showing much smaller differences, namely, 2.3° and 2.7° C. (4.4° and 4.9° F.) respectively. In other coastal towns, such as Darwin, Wyndham and Broome, situated on the northern coast of Australia, the seasonal variations are more pronounced when compared with Thursday Island. During the hot season the average readings there are higher than in towns on the eastern coast in the same latitude. Broome and Innisfail, for example, both situated between 17° and 18° South, show this difference in a marked degree (see charts), but the geographical position alone explains this difference, since Innisfail lies within the region of the trade winds, and, in addition, possesses a larger average rainfall.

For comparison only, graphs representing the climates of Daru, Port Moresby and Samarai, all in Papua, have been added (Fig. V.). These graphs do not differ essentially from those of Thursday Island.

In most of the inland towns of Northern Australia weather conditions are greatly influenced by altitude and changes with latitude are consequently less pronounced.

The graphs representing the average maximum and minimum temperatures exhibit the same seasonal variations, which in the coastal towns become less marked with decreasing latitude and show smaller ranges of temperature. In the inland towns the average maximum readings in general are much higher and the average minimum readings much lower than in towns on the sea coast.

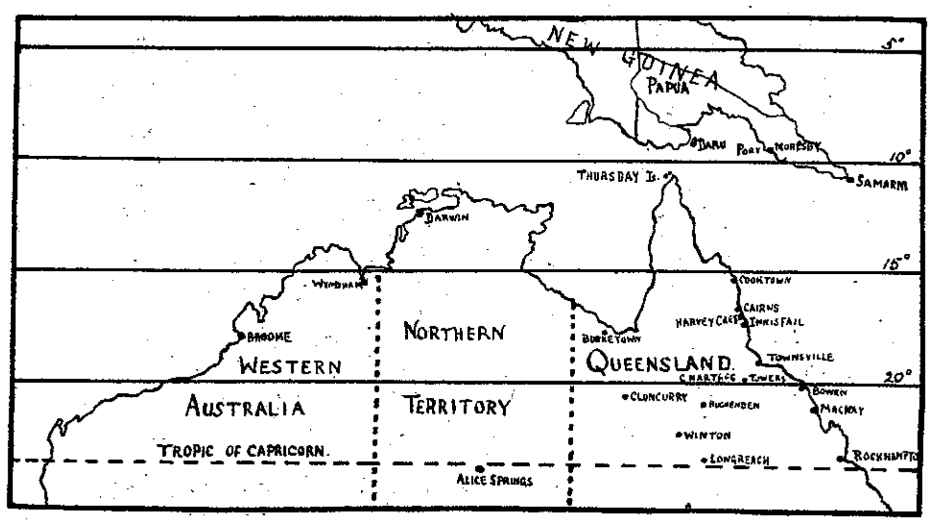


Figure III.

A comprehensive account of the distribution of rainfall throughout Northern Australia has been published by Hunt in a series of monographs issued by the Meterological Bureau. The rainfall in North Queensland shows a seasonal distribution corresponding to the monsoonal type of climate, the heaviest falls taking place during the hot months (December to March) and only occasional showers occur during the cooler months.

There is a "wet belt" on the north-eastern coast, the centre of which lies about Harvey Creek and which extends northward to a point beyond Port Douglas and southward as far as Halifax, where a very high general rainfall is registered (see Table I.).

Table I.—Rainfall.

Cooktown..	181.9 cm.	(71.6 inches)
Port Douglas	210.6 cm.	(82.9 inches)
Cairns	229.9 cm.	(90.5 inches)
Harvey Creek	426.0 cm.	(167.7 inches)
Innisfail	384.0 cm.	(151.2 inches)
Cardwell	218.6 cm.	(86.1 inches)
Halifax	226.6 cm.	(89.2 inches)
Ingham	204.5 cm.	(80.5 inches)
Townsville	125.2 cm.	(49.3 inches)

The inland towns, on the whole, are much drier than the coastal towns and show a similar seasonal distribution of rainfall.

In the coastal towns of other parts of Northern Australia conditions similar to those of North Queensland prevail, with the one difference that Broome and Wyndham show a comparatively small average rainfall; namely, 58.2 cm. and 71.4 cm. (22.9 inches and 28.1 inches) respectively. In New Guinea, Port Moresby and Daru, both situated within the monsoonal belt, possess in the same way a dry and wet season, whereas Samarai has its rainfall of 296.4 cm. (116.7 inches) more evenly distributed over the whole of the year.

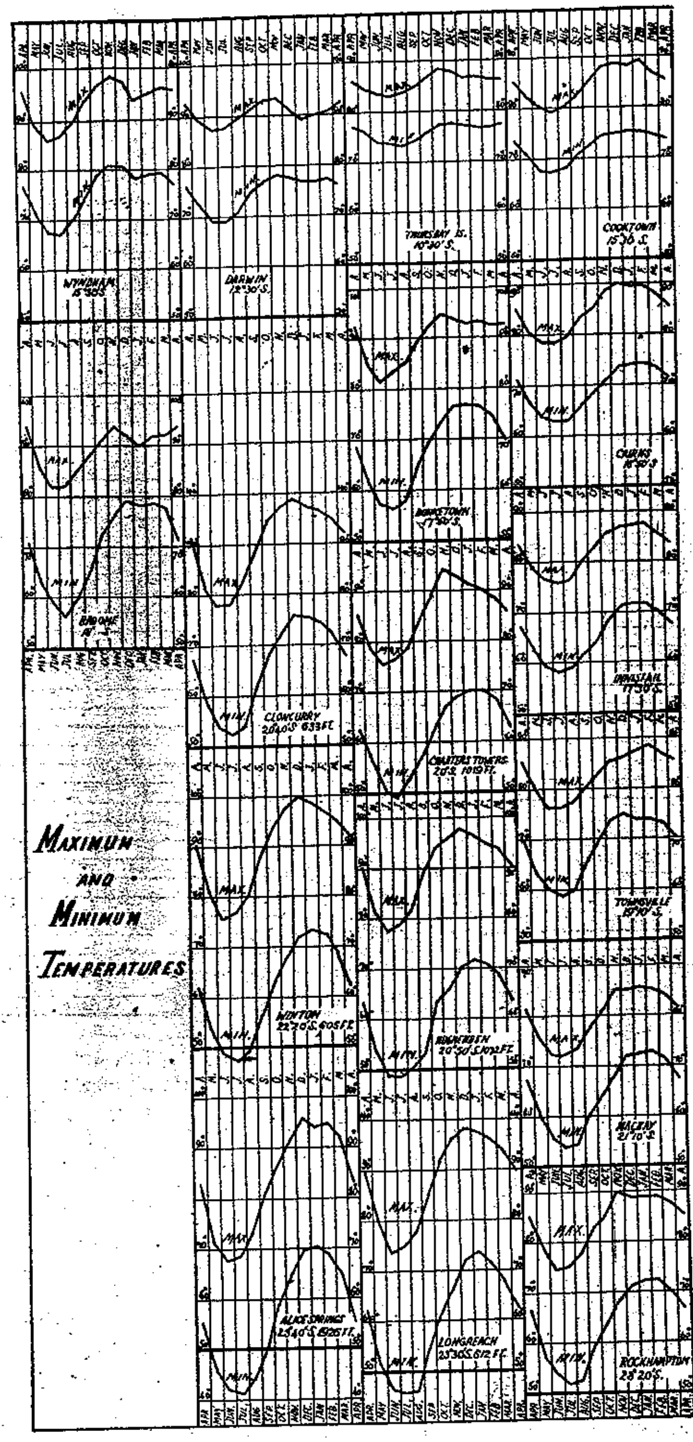


Figure 4

Sunlight in the Tropics.

The main difference between a temperate and a tropical climate lies in the greater intensity of the sun's rays in the tropics. This greater intensity is solely due to the less oblique path of the rays striking the earth, whereby they have thus passed through a smaller layer of atmosphere. As a result, a less degree of absorption and scattering has taken place, and the chemical and physical activities of these rays are therefore greater the nearer to the equator. This greater activity of the sun's rays manifests itself in everyday life. The newcomer to the tropics soon becomes aware that coloured materials, such as curtains, carpets and clothing fade quickly and written matter in ink, when exposed to the sun, gradually gets fainter, and, after a time, almost disappears. Similarly, a number of chemical preparations decompose, rubber rapidly perishes and certain qualities of glass are altered. The frosting of glass flasks, microscopic slides and high power lenses are examples only too well known to laboratory workers in the tropics.

The bactericidal action of sunlight has been known for a long time and has been investigated again recently by Clemesha (1912) in India, who exposed cultures of fæcal bacteria to the sun. In other experiments he added large quantities of fæces to water contained in a tank with a large surface area (0.6 hectares, or 1 acres) exposed to the sunlight and examined the liquid from day to day for bacterial content. Furthermore, he studied the bacteriological flora of waters of natural lakes during the monsoonal and dry seasons. All these inquiries led him to conclude that the sun has a very powerful action in destroying fæcal organisms in water.

Such changes as the above, together with numerous others of a similar nature, led to the question of the nature of the rays producing these results. Are they brought about by those rays of shorter wave length in the violet and ultra-violet portions of the solar spectrum (chemical rays), or are they to be attributed to rays of longer wave length, situated at the other end of the spectrum, the red and infra-red rays (heat rays)? The ultra-violet rays are known to increase chemical activity and many chemical reactions and decompositions may be brought about by exposure to these rays. An example is the decomposition of oxalic acid into carbon monoxide, carbon dioxide and water when exposed to the sun in the presence of a uranium salt. This decomposition is almost entirely due to those rays of the solar spectrum in the ultra-violet extending from 550 μμ to 291 μμ (Freer, 1912). Observers in the Philippines attempted to make use of this decomposition of oxalic acid under standardized conditions, in order to compare the intensity of the ultra-violet rays of the sun in different parts of the world. The results, however, showed that the amount of decomposition in the Philippines and other parts of the tropics was inconstant and did not bear any definite relationship to latitude. The figures obtained by the same method in a temperate zone were sometimes as high and even higher than those found in the tropics.

The extensive observations of the Philippine workers have led them to the conclusion expressed by Aron (1911): "That the spectrum of the sun's rays does not extend much, if any, further into the ultra-violet in Manila than in northern climates." These observers do not agree with Woodruff (1905) and others, who attribute the effects of tropical sunlight on the human organism to the influence of ultra-violet rays only. Aron (1911) believes that "the rays of the tropical sun, having greater wave length than those in the red and ultra-red end of the spectrum, play the most important rôle in producing the untoward effects generally attributed to tropical sunlight"; in other words, he attributes such effects to the heat rays alone.

Gibbs (1912), working in conjunction with Freer and Aron, expresses a somewhat similar opinion, and, if altitude and local meteorological conditions are taken into consideration, he does not believe that "when the normal intensities are compared, the light of the tropics is different from the sunlight of any other regions." Effects upon life in the tropics, usually attributed to sunlight, are, in his opinion, due to "other meteorological modifications, which go to make up climate, namely, duration of sunshine, clouds, rainfall, winds and humidity, all of which affect the air temperature; the last is probably the most important fact and depends to a large extent upon the duration of sunshine."

In Manila and Baguio, both in the Philippines, Aron (1911) and Gibbs (1912) carried out experiments on animals in order to study the effects of exposure to the sun's rays under varying conditions. Different experimental animals, such as rabbits and monkeys, were exposed to the midday sun for varying periods. These animals, when shielded from draughts, died after an exposure of from thirty-four minutes to about one and a half hours, and showed the post-mortem appearances characteristic of heat stroke. Black rabbits, as a rule, succumbed more quickly than light-coloured animals and it was noticed that the subcutaneous temperatures, taken by means of a thermocouple, in the case of black rabbits, rose quicker and higher than in that of the lighter-coloured ones.

Aron, furthermore, carried out exposure experiments on dogs which had been tracheotomized and thus had part of their effective heat-regulating mechanism put out of action.[1] It is well known that dogs do not possess sweat glands on the body, but keep their body temperature from rising by means of an increased rate of respiration and an increased evaporation from their respiratory tract. These animals died after about an hour with typical symptoms of heat stroke and corresponding post-mortem appearances. In a similar manner the body temperature of tracheotomized rabbits rose on exposure to the sun more rapidly than that of normal rabbits.

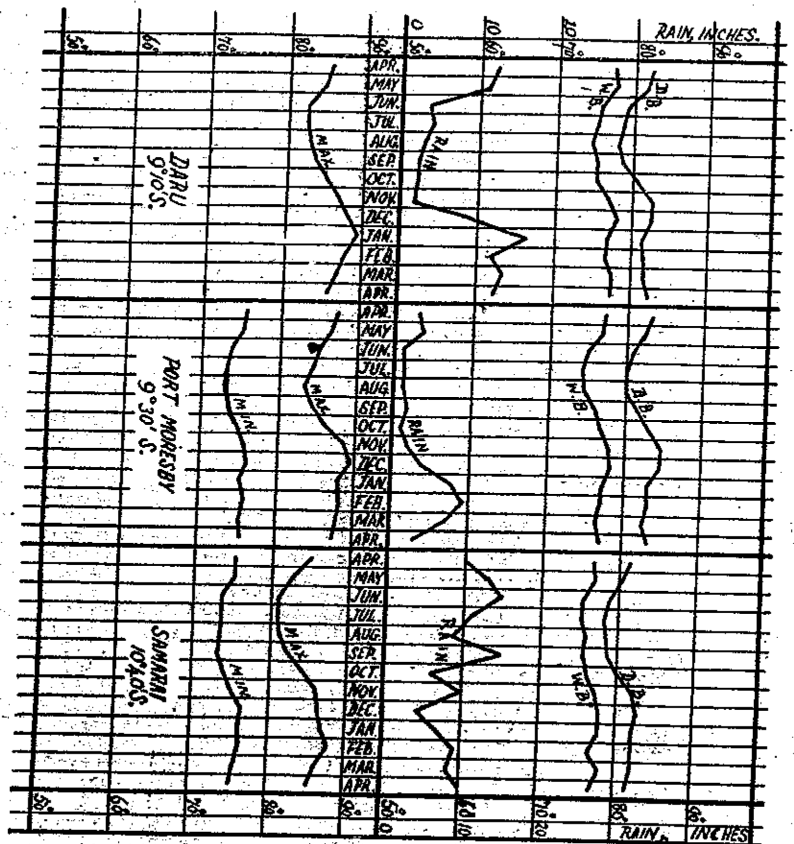


FIGURE V.

When monkeys were exposed to an artificial draught during the experiment, or were protected by shade from the direct sun rays, no injurious effects were noticed. These experiments, according to Aron (1911), show that "when placed under the fan animals lost the excessive heat which reached them by radiation from the sun. Rays including the ultra-violet were nevertheless present and were absorbed by the body in the same manner and degree as by that of the control monkeys."

These experiments have recently been repeated by Shaklee (1917) and further amplified, to ascertain whether it is possible for monkeys to become accustomed to the sun (acclimatized) by a gradually increasing daily exposure. His results differed from those of Aron, as several of his monkeys, even in the beginning of the experiment, lived for hours in the

[1] Considering the relatively small surface of mouth, nose and throat above the tracheotomy wound, compared with the breathing surface of the lungs, it is evident that the operation had put out of action only an extremely small portion of the respiratory surface, and cannot altogether account for the quicker death of these animals.

direct sunlight without being protected in any way. Summarizing his results, he states that experimental monkeys, exposed to the sun in Manila, may die from heat stroke after varying periods, depending to a less extent upon the sun's rays than on other local conditions, such as proximity of a large, hot surface (ground or roof), high relative humidity of the atmosphere and low wind velocity. Monkeys, however, may become temporarily acclimatized by gradually increasing the time of exposure to the sun. This, in his opinion, increases the sensitiveness of the nervous mechanism which regulates body temperature by an increased rate of perspiration. The fact that administration of atropine, which impairs the function of the sweat glands, causes the death even of an acclimatized monkey on exposure, is evidence in support of this conception.

Animal experiments were also carried out by Schmidt, who, working in a temperate climate, exposed rabbits to the sun and found a rise in the anal temperature which was more pronounced in a black than in a white rabbit. In the same way Schilling (1909) observed a rise in the skin temperature of rabbits exposed to the sun and several other authors have made similar observations. It must be kept in mind, however, that the temperature of rabbits varies considerably even under normal conditions, and the struggling alone, when the animal is handled, may cause a considerable rise.

It is not a new observation that animals, even in a temperate zone, may succumb to exposure to the sun, as the following example illustrates: In a laboratory in the north of England, in which monkeys were kept in a glass house, on more than one occasion during the summer months several animals died under the symptoms of heat stroke, showing an ante-mortem rectal temperature of 43.3° C. (110° F.), which still rose after death. The painting of the glass roof with a white wash reduced the inside temperature of the animal house and prevented death.

A consideration of the foregoing observations makes it evident that exposure to the direct sun's rays caused such an increase in body temperature that the animals finally succumbed to hyperpyrexia. In every case animals of dark colour died more quickly than those with light fur, on account of the greater absorption of heat.

The dark skin of most of the aboriginal races in the tropics, from the above point of view, would appear to be a disadvantage and the explanation that dark skin affords protection against the effects of the sun merely by insulating the body against the deep penetration of harmful rays must be modified.

Attempts to elucidate the rôle played by the pigment in a protective sense are not lacking in the literature. Eijkman (1895), in Batavia, covered the bulbs of two thermometers with pieces of white and coloured human skin and placed the thermometers in the sun. He noticed that the brown skin caused a higher rise of the mercury (50.1° C.) than the white skin (47.5° C.).

Aron (1911) and Gibbs (1912), in the Philippines, experimenting with live skin, exposed white and coloured persons to the sun and recorded the skin temperatures of various parts of the body by means of a thermocouple. Their results were somewhat inconstant; the skin temperature invariably rose after a time to from three to four degrees above normal. Whilst Gibbs found temperatures distinctly higher for the dark skin, Aron noted that the white skin was always hotter than the brown, and that after prolonged exposure the temperature of the brown skin showed a more distinct fall. "It may be said," as Freer (1912) remarks in summarizing the results of both investigators, "that as regards rise in temperature on exposure to the sun, the white and brown skin (Filippino) are about equal, with a slight factor in favour of the white, but that in regard to the very dark skinned negro the temperature on exposure reaches a decidedly higher point than it does with either of the others." In its physiological action, on the other hand, the dark skin is superior to the white skin. It absorbs a greater quantity of heat rays, warms up more quickly and reaches the point where perspiration commences earlier and the evaporation of the sweat causes heat loss and consequently affects the cooling of the body.

A consideration of the foregoing experiments and observations upon the effects of exposure to the sun suggests that any ill-effects are due not to light but to heat. These experiments, however, only take into consideration those effects known as sun stroke or heat stroke, and it is, moreover, an almost impossible task in such experiments to study the physiological action of the other rays with the entire exclusion of heat rays.

The effect of sunlight on living organisms has formed the subject of many publications and many opinions have been put forward which are not founded upon facts but are only wild speculations. Woodruff (1905), for example, wrote an extensive monograph on the effects of tropical light on the white man, and his conclusions have been widely quoted in the literature. He contended that the ultra-violet rays of the tropical sun are inimical to white settlement, but, unfortunately, he based many of his arguments on false premises, and many of his statements were merely expressions of personal opinion. As a glaring example, the following sentence may be quoted: "The southern hemisphere, except the tip of Patagonia, is north of 45° and therefore unfit for blondes" (he assumes that a blonde race cannot live nearer to the equator than 50°) and "even in New Zealand and Australia the native white families are already dying out or kept alive by constant new importation from home." He assumes, further, that in New Zealand there is ample evidence of the physical decay of the white population. In view of such statements, entirely without foundation, it is difficult to consider any of his conclusions seriously.

(To be continued.)

NOTES ON EPIDEMIC BRONCHO-PNEUMONIA (SPANISH INFLUENZA) IN SAMOA.

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This epidemic arrived from New Zealand, Novembe 7, 1918. Natives from different parts of the grou had assembled in Apia to meet friends coming fron New Zealand, went on board and carried infectio back to the most distant parts of the group.

After an incubation period of two days, the scourge was raging through the group, rising to its height on the tenth day, by which date it is calculated that in Upolu alone two thousand had died. The ages most prone are 18 to 35 and the old. It is more fatal for men than women as 15 : 13.[1] The ages least prone are six to eighteen and thirty-five to forty-five. The incidence amongst the natives (for it is with their epidemic I was chiefly concerned) was 80% and as the total deaths number almost exactly one fifth of the entire population (to be exact, 7,264 out of 36,405), this means a mortality of 25% for the disease.

To this high mortality the following factors contribute:—

(1) The natives, although apparently of fine physique, have generally a poor chest expansion.

(2) From smears examined it appears that the potential pathogenic respiratory flora of the whites are not found amongst the natives in the natural state nor have they any immunity to the toxins of these organisms. Coryza is in any case uncommon amongst the whites in the tropics.

(3) The natives are generally remarkably free from sickness and when an illness with marked malaise visits them, they make up their minds to die; not that they are fatalists, but they have not the will to live that the white man has. They are not in the least upset by the loss of relatives.

(4) The native house or "fale" is normally a healthy place; it has a raised floor of coral and lava pebbles, no walls and a thatch roof supported on poles. These houses are healthy and airy and do very well for the nursing of patients suffering from pneumonia. A whole family (children, parents and grandparents) live in a fale and sleep on mats. Generally the natives are cleanly in their habits and spit outside the fale, although apart from some affection of the respiratory tract (which they bear ill) a healthy native rarely spits at all. The procedure early in the epidemic was that when a native fell ill, he lay down in his hut and all his family, having pulled down the blinds which normally come down only in wet weather, lay down too in sympathy; all then became infected. When the fever was at its height, on the third day, the natives would cast off their clothes and pull the blinds up, the men often going into the sea to cool themselves; this of course determined a pneumonia, although in any case few even with precautions escaped a broncho-pneumonia, except children.

(5) The natives are very lazy and spend the livelong day squatting *faa Samoa* (Samoa fashion). The women do a certain amount of work and it is to be noted that they were less affected. The islands contain abundant food and the only serious work done is food collecting by the young men; the collecting of yams requires a certain skill.

(6) At the height of the epidemic many lives were lost by famine consequent on the cessation of food collecting. The Administration did what they could by supplying all the rice and condensed milk they had.

(7) Before we introduced supervision, patients would go into the bush for necessary purposes and often die there.

(8) The natives are helpless without their chiefs and most of these succumbed.

(9) Foster mothers were difficult to obtain for motherless infants who, before our arrival, would succumb either to starvation on the one hand or to gastro-enteritis on the other. Gastro-enteritis in the normal state appears to be curiously uncommon amongst native infants, although fed most injudiciously from our point of view: bananas, bread-fruit, taro, pine apple; in short, the identical food of adults in small quantities.

(10) The medicine men before our arrival had already done a good deal of damage. These wretches treat *inter alia* conjunctivitis by scarification and instillation of an irritant, never failing to cause blindness by the consequent corneal opacities. Abscesses are incised regardless of the anatomy of the part, with results that may be imagined.

(11) No facilities for the isolation of infected persons existed at the outbreak of the epidemic.

On the same day in both islands, *viz.*, Saturday, December 8, 1918, food collecting was resumed and the breaking of the back of the epidemic is popularly dated thence.

Broncho-pneumonia (75% of chest cases) and pneumonia (25%) are to be considered rather as an integral part of the disease itself than as complications, seeing that 5% only of adults escape. It is not a question of "picking up a patch of tubular breathing," but the whole base, in the case of the pneumonias, becomes so rapidly involved in the process that the merest tyro with the stethoscope could not miss the awful sounds (for it amounts to that) one hears in the lungs of these unfortunate people.

Cholangitis was seen in about 1% of adults and in 1‰ of children; parotitis sometimes going on to suppuration in about 5‰ cases. Two cases of suppurative periphlebitis and three cases of post-influenzal insanity were noted. No endocarditis was seen. Rare complications were orchitis, arthritis, meningitis, lymphadenitis and pleurisy. Empyema was very rare, only one case being seen outside Apia.

As to type, the vast majority were of the pneumonic, the nervous and enteric types being very rare.

The disease is ushered in suddenly with headache and fever and pains in the legs. Uncomplicated it has a course of three days as seen in young children who perspire profusely for three days and are up and about on the fourth. Adults too often got up on the fourth day, but then almost invariably came down with pneumonia. In any case broncho-pneumonia usually set in on the fourth day. Fatal cases showed marked dyspnœa, cyanosis and delirium.

There was neither time nor opportunity to do any post-mortem work; the native prejudices in this respect are almost insuperable.

Neither culture media nor the necessary raw materials were to be found, nor is there any seaweed in these islands; and not till after Christmas did the media arrive which I had cabled for from New Zealand. By this time, of course, my material had

[1] In the island of Savaii, where 2,816 died, 1,232 were men, 1,019 women, 292, boys, 273 girls.

practically disappeared, but in six consecutive cases I grew Pfeiffer's bacillus and a hæmolytic streptococcus and was successful in subculturing Pfeiffer's bacillus no less than four times. I had already noticed in my smears that a Gram-negative bacillus (presumably Pfeiffer's) was easily seen early in the disease (the first four days) and was thereafter displaced, apparently in geometrical progression, by a streptococcus.

In twenty fresh films I saw organisms morphologically indistinguishable from Pfeiffer's bacillus no less than fifteen times; streptococci were seen in every case; the pneumococcus ten times; the *Micrococcus tetragenus* in every case; a Gram-negative diplococcus morphologically indistinguishable from the *Micrococcus catarrhalis* only four times; the *Diplococcus crassus* three times; the tubercle bacillus and the pneumo-bacillus of Friedländer twice and a Gram-positive bacillus (not acid fast) once.

Smears from five empyemata all contained pneumococci and from eight cases of suppurative parotitis showed a streptococcus in every case, the pneumococcus five times and a Gram-positive bacillus (not acid fast) once.

Of fifteen blood samples examined, four from cases of parotitis and five from cases of empyema showed a leucocytosis, and six from cases of broncho-pneumonias a leucopenia. No organisms were grown from the blood.

We were too late to know whether any drug is specific, although good results were reported from the use of quinine as a prophylactic before we came. My experience inclines me to this view: all my officers and men were kept under the influence of quinine. Hydrotherapy, strophanthus and brandy were of therapeutic value, as also acetyl-salicylic acid and potassium nitrate.

The high incidence (60%) and the low case mortality (2%) for whites of a disease brought from New Zealand where the mortality touched 10% suggest, when one considers the high bactericidal action of direct sunlight, that the disease is mitigated for whites in the tropics.

The extraordinary value of the vaccine supplied me from the Commonwealth Serum Laboratories has formed the subject of a previous communication.[2] A full dose contained 125 millions of *Micrococcus catarrhalis*, 50 millions each pneumococci, streptococci and of a Gram-positive diplococcus. That experience shows Pfeiffer's bacillus to be unnecessary as a constituent of a vaccine directed against this epidemic and in view also of the risk of a negative phase, it is in any case clearly unwise to use it in any community where the epidemic is already well under way.

If Spanish influenza be caused by a streptococcus[3] for which the way has been prepared by, say, the bacillus of Pfeiffer or a filter passer, and especially if this last represent a stage in the development of the streptococcus, an anti-streptococcal vaccine should be, and in my experience has been, competent to protect.

In the middle of March (a fortnight after my first communication[4] was submitted), an epidemic broke out in the ship referred to in paragraph one and by the end of the month there were about one hundred cases with no deaths. Inoculations (end November and end December) appear therefore to have given immunity up to the middle of March and when the disease broke through to have rendered it non-fatal. To deny mitigation by inoculation in this case is to say that the disease was not Spanish influenza (which has a high mortality) and therefore that the immunity was absolute.

Soon after my first communication was submitted, an influenzoid epidemic broke out in the Naval Depôt at Williamstown and within a fortnight we had a hundred cases (characterizezd by high infectivity, extraordinary mildness and an average age incidence of 18½). I regarded this as a separate clinical entity, but if it were Spanish influenza then the case for inoculation is stronger than ever.

[2] Grey, *The Med. Journ. of Aust.*, April 12, 1919.
[3] I include in this term the pneumococcus.
[4] Grey, *l.c.*

Reviews.

WAR SURGERY.

A concrete example of the industry and foresight of our American confrères is to be seen in "Abstracts of War Surgery,"[1] published by the Division of Surgery, Surgeon-General's Office, Washington.

It is a volume unrelieved by illustrations, in which are aggregated together many articles from various journals of different nations recently at war. The American Army Medical Staff faced service at a stage made easier by the experience of earlier combatants. A machine had been pieced together as nearly perfect, in France at least, as one could wish. The lessons of South Africa had been dearly bought, but they were not forgotten. Even yet, there is no adequate realization of the triumphs gained by preventive medicine in this war. It was not the lot of American medical officers to stumble suddenly on numerous cases of tetanus before the use of prophylactic serum had become a routine. It was their privilege also to watch the treatment of war wounds graduate through the tragedy of expectancy and the failures of hypertonic saline solution to the security of Carrel-Dakin's technique. Gas gangrene was already by comparison but a casual visitor in the wards when the American armies reached France. Yet it must be said for the American side that they followed developments from the first with observant eyes and keenly critical minds, quick to seize on the new and the valuable.

In this book then we see a sort of ready reckoner of surgical treatment prepared for the use of surgeons new to war. Its defects are obvious. There is too much a suggestion of the scrap-book, of editing by scissors and paste. But its value to the newly enrolled, about to start on a pilgrimage of strange experiences, cannot be gainsaid. If that value has become depressed by the cessation of the conflict, it is merely sharing the fate of many other manuals of war work. It will still remain as an epitome of international opinion on many problems, in the treatment of which not a few principles may have a valuable application in civil surgery.

WAR WOUNDS.

Henri Hartmann is so well-known as the Professor of Clinical Surgery at the Hôtel Dieu, Paris, that his recent work, *"Plaies de Guerre,"*[2] may be taken as representative of French surgical opinion. The subject is compressed within the narrow compass of eighteen lectures, and it would be

[1] Abstracts of War Surgery: An Abstract of the War Literature of General Surgery that has been Published since the Declaration of War in 1914. Prepared by the Division of Surgery, Surgeon-General's Office (United States of America), 1918. St. Louis: C. V. Mosby Company; Melbourne: Stirling & Company; Demy 8vo., pp. 434. Price, $4.00.
[2] Les Plaies de Guerre et Leurs Complications Immédiates, Leçons faites à l'Hôtel Dieu; par Henri Hartmann; 1918. Paris: Masson et Cie; Royal 8vo., pp. 200. Price, 8 francs.