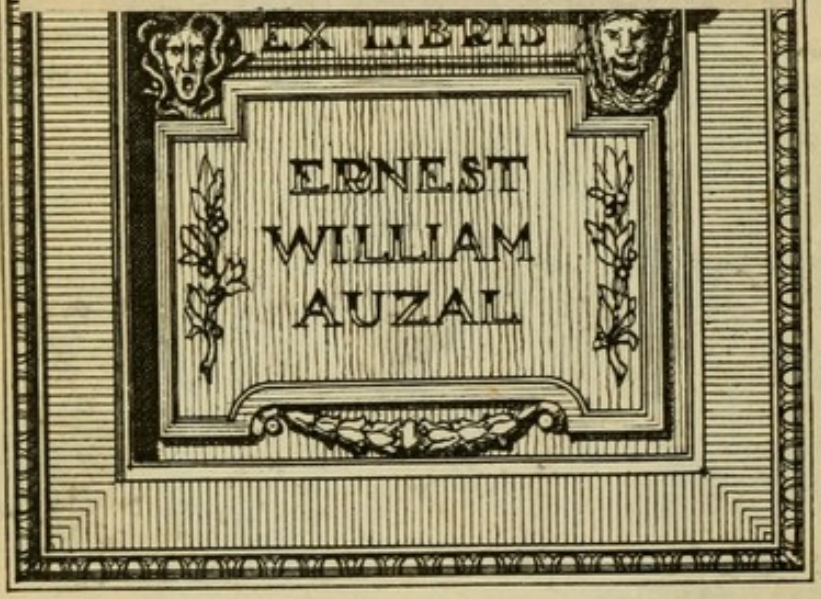
On the geographical distribution of some tropical diseases and their relation to physical phenomena / by R.W. Felkin.



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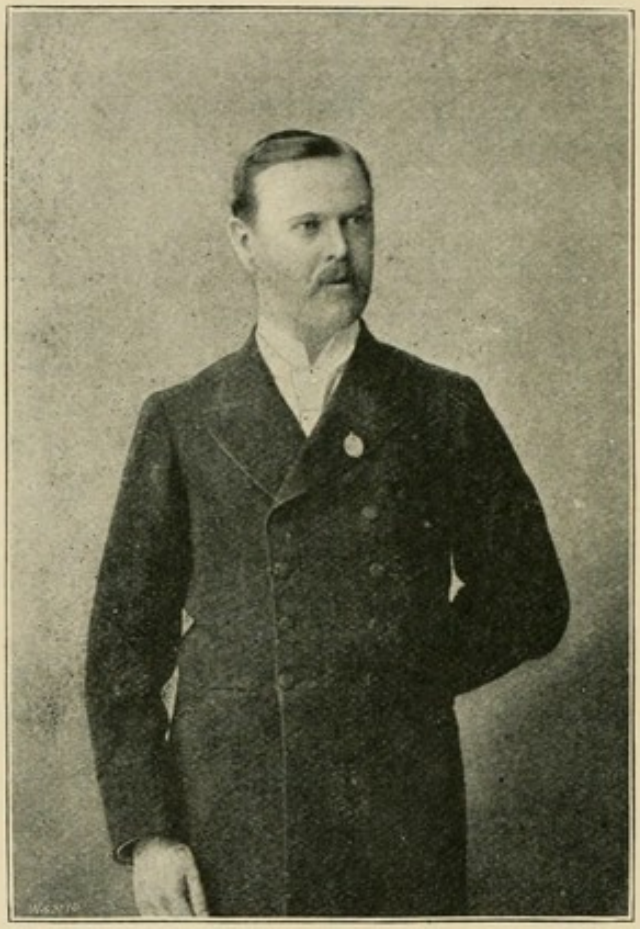
THE GEOGRAPHICAL DISTRIBUTION OF SOME TROPICAL DISEASES.



DR. ROBERT W. FELKIN.
Photo. by Barraud, Oxford Street.

ON THE

GEOGRAPHICAL DISTRIBUTION OF SOME TROPICAL DISEASES,

AND THEIR

RELATION TO PHYSICAL PHENOMENA.

BY

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WITH SIXTEEN MAPS.

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The Author will esteem it a favour if any one possessing additional information with respect to the geographical distribution of tropical diseases would kindly communicate with him.

20 Alva Street,
Edinburgh, *October 1889.*

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INTRODUCTION.

The subject of the present paper has occupied my attention for some years, but I may state that what follows is the outcome of notes prepared for lectures to my students and is only a preliminary attempt to focus our present knowledge of the geographical distribution of some tropical diseases, and to indicate as far as possible the knowledge which we at present possess of those physical phenomena which influence the production of these diseases and the area of their distribution. Why, for instance, some diseases are confined to limited areas of distribution, whereas others are endemic in extensive districts, and others again periodically extend their ravages throughout clearly defined, though wide-spreading, regions.

A map was published by A. Keith Johnston in 1856 representing the geographical distribution of health and disease, chiefly in connection with natural phenomena; but although it gives a great deal of information, it does not indicate with sufficient clearness the definite areas of the various diseases referred to. Since its publication, too, our knowledge both as to the distribution of tropical diseases and the cause of disease has made considerable progress. More recently Mr Alfred Haviland, M.R.C.S., published three very valuable and instructive maps dealing with the geographical distribution in England and Wales of cancer in females, of phthisis in females, and of heart disease. These maps show very strikingly the influence exerted on these diseases by locality.

Two maps, illustrating the distribution of diphtheria and scarlet fever in England and Wales, were published by Dr E. G. Barnes in

the *British Medical Journal*, July 28, 1888. In the same *Journal* for January 19, 1889, there is a report of the collective Investigation Committee of the British Medical Association, prepared by Dr Isambard Owen, on the geographical distribution of ricketts, acute and sub-acute rheumatism, chorea, cancer, and urinary calculus in the British Islands; and various maps, illustrating the geographical distribution of ricketts, chorea, and cancer, have been prepared but not published.

In 1886 the report on the mortality and vital statistics of the United States, as returned at the tenth census (June 1, 1880), was published; and it contains some most instructive maps and charts showing the distribution of deaths from various diseases in the United States, which indicate to a certain extent the geographical distribution of those diseases, as also the localities in which they are most prevalent. None, however, of the publications to which I have referred, nor any with which I am acquainted, attempt to depict graphically the geographical distribution of tropical diseases in a manner which would give at a glance the areas throughout the world which are affected by them, and their possible or probable connection with physical phenomena. It must be remembered, too, that in the works above mentioned the various authors were dealing with civilised districts, where authentic statistics were obtainable, and where it was possible to localise the distribution of disease in a minute form, which, however desirable, it is at present completely out of my power to attempt to imitate.

I propose to treat my subject on a definite plan. I intend first to give the name of the disease and its various synonyms; secondly, a short definition of the disease, and a very brief description of it. I will then sketch out with some attempt at detail the geographical distribution of the disease, and finally point out as far as possible its relation to various physical phenomena as affecting both its causation, its area, and its epidemic spread. I may state at the outset, that I have taken the definition and description of each disease from the Dictionary of Medicine edited by Richard Quain, M.D., F.R.S., because the definitions and descriptions there given are the generally accepted ones, and in a paper of this character, which deals more or less with broad outlines and general facts, it would be out of place to enter into any personal views I may

have as to either the cause, the definition, or the description of the diseases referred to.

With regard to the data concerning the geographical distribution of the diseases, I am indebted for my principal facts to the *Handbook of Geographical and Historical Pathology*, by Dr August Hirsch, and to the copious bibliography which accompanies his various chapters. I have not, however, hesitated in any case where my own information, or information gathered from other sources, modifies or supplements his data, to make use of the same, and I have as far as possible verified the facts I have given.

The maps which illustrate this paper have been specially prepared for it, and in order to ensure as great accuracy as is possible on such small maps, the areas of the distribution of the various diseases have been drawn upon large maps used for lecturing purposes, and subsequently reduced by photography to the scale suited for publication in the *Proceedings* of this Society.

The maps illustrating some of the physical phenomena with which my paper deals are adapted from various sources. The chart of the world depicting the mean annual temperature of the tropical and sub-tropical zones is taken from the *Challenger Reports*, and is based upon the most recent investigations on the subject. The chart representing the mean annual rainfall throughout the world is after the most recent map published, namely, that in the *Contributions to Meteorology*, by Professor Elias Loomis (1889).

Map No. 16 gives the isoclinal lines with reference to pandemic waves of disease, and the prevailing winds upon the ocean. It has been compiled from two maps; one published by Dr Robert Lawson in 1888, and the other by Dr W. S. Wilson in 1881.

I trust that this paper may be of special interest to members of my own profession, who will be able to see at a glance the diseases infesting the various districts in the tropics, and who will therefore be the more readily able to give the necessary advice to patients. It should be useful to intending emigrants, and of special service to insurance companies, as indicating the areas of comparative safety or risk for the residence of their clients.

The diseases treated of are—1. Malaria; 2. Dengue; 3. Asiatic Cholera; 4. Yellow Fever; 5. Oriental Boil; 6. Endemic Hæmaturia; 7. Beri-beri; 8. Oriental Plague; 9. Dysentery; 10. Leprosy

(Elephantiasis Grecorum); 11. Yaws; 12. Fungus Disease of India; 13. Elephantiasis Arabum (Barbadoes Leg); 14. Guinea-Worm; 15. Filaria Sanguinis Hominis; 16. Scurvy; 17. Tropical Abscess of the Liver.

In a future paper I hope to continue the subject with a more extended range of diseases, which, although to a certain extent met with in the tropics, are also to be found in the temperate zones.

I. Malarial Diseases.

(See Map I.)

It has been hitherto the custom to subdivide the diseases due to malaria, or, in other words, to the malarial process, but I am so convinced that the same cause produces the various types or manifestations of malaria that I include them all under one heading.

Malaria (*Ital.*)—*Synon.*—Marsh Miasm.; *Fr.* Mauvais air; Intoxication des Marais; Intoxication telurique; *Ger.* Malaria.

Definition.—An earth-born poison, generated in soil, the energies of which are not expended in the growth and sustenance of healthy vegetation. By almost universal consent, this poison is regarded as the cause of all the types of intermittent and remittent fevers commonly called malarial, and of the degeneration of the blood and tissues from long residence in places where this poison is generated.

Malaria therefore includes—

A. *Intermittent Fever—Synon.*—Ague; *Fr.* Fièvre Intermittente; *Ger.* Kaltes Fieber.

Definition.—A fever of malarial origin, characterised by a sudden rise of temperature during the paroxysm, by an equally sudden fall at its termination, and by the regularity of the times of accession and apyrexia.

B. *Remittent Fever—Synon.*—Bilious Remittent; Marsh Remittent, The Jungle Fever of the East Indies; The African, Bengal, Mediterranean, Persian, or Walchern Fever; *Fr.* Fièvre Remittente; *Ger.* Bösartiges endemisches Fieber.

Definition.—A paroxysmal fever of malarial origin, in which the paroxysms do not intermit, but only, as the name implies, remit.

C. *Pernicious Malarial Fever* including—(*a*) Febris Algida; (*b*) Febris Comatosa.

Geographical Distribution.—The distribution of malaria is very extensive, although the intensity of the malarial process varies in different regions. Commencing with Africa, we find that on the west coast malaria is very prevalent in the basins of the Senegal and Gambia, and on the Guinea coast from Sierra Leone to Cape Lopez, especially in the basins of the Niger and Gaboon, on the Ivory and Gold coasts, at Fernando Po, and St Thomas. It diminishes rapidly in intensity until lat. 18° S., where it disappears. On the East coast, the malarial region commences in the south at Delagoa Bay, and extends northwards as far as 5° N. lat., including the islands of Zanzibar, Madagascar, Mauritius, Bourbon, and Seychelles. Areas of endemic malaria are also found in the lowlands of Abyssinia and in the Somali district, in the valley of the Nile, from Khartum to the Great Lakes, west of the Nile between Dongola and Khartum, and all over Tropical Central Africa, up to an altitude of 3000 feet. Egypt, Tripoli, Tunis, and Algiers are likewise affected. The malarial process is most intense upon the equatorial African coast-line until an altitude of 500 feet is reached, and it also extends in its gravest form for about 300 miles up the banks of the Zambesi, the Congo, and the Niger.

Malaria is met with in Arabia, on the east coast of the Red Sea, especially on the coast of Hedjaz, and in Yemen from Jisan south to Moccha. It is also found at Muscat, on the shores of the Persian Gulf and its islands, and in the valleys of the Euphrates and Tigris. It also exists in Syria, especially in the damp valleys of the Lebanon, in the valley of the Jordan and along the shores of the Levant; and this malarious area extends to Asia Minor, from Adana and Tarsus to the Dardanelles, including Smyrna. The disease extends all round the Caspian Sea, overspreads Persia, Beloochistan, and Afghanistan; and is met with all over India, with the exception of places having a high altitude. Ceylon too and Burmah, Siam, Sumatra, Borneo, New Guinea, the Philippine Islands, Japan, the Andaman Islands and Australia as far south as lat. 17°, are all affected. The disease also prevails in a severe form in the tropical and sub-tropical parts of China.

In Europe we may commence by tracing malaria in the steppe lands of the Caspian. It follows the course of the Volga through Astrakan, includes the central Caucasian plain, and the countries

bordering the Black Sea to the north, the basins of the Dnieper and Dniester as far as Ekaterinoslav, the Crimea, Wallachia, and Bulgaria. There are also endemic areas of malaria in the marshy plains of western Russia, in many places in the Baltic provinces, and in the district of Novgorod. In Galicia malaria is only endemic in Cracow, Wadowice, Zolkiewo, and Zloczow; and in Poland only in the province of Agustusowo. One of the largest malarial areas of Europe follows the course of the Danube and its tributaries, from the plain of lower Austria, over a great part of Hungary. It is also endemic in the marshy districts of Croatia, in the damp valleys of Servia and Montenegro, and in the valley of the Save. In the Balkan peninsula there are various endemic areas in Roumania, on the shores of the Black Sea and of the Sea of Marmora, in Albania, and northwards along the coasts of Dalmatia and Istria. In Greece malaria occurs at many points in Boetia, Zeituni, Naupantos, and Vonitza; at Chalcis, Corinth, Mistra, Navarino, Modon, and many other places on the coast. In Crete, Cephalonia, St Maura, and Corfu malaria is also endemic. In Italy there are two areas of endemic malaria, occupying the plain of the Po and its tributaries, and the west coast from Pisa, as far as and including most of Calabria. In the Iberian peninsula, malaria is most severe in the southern and western coast regions, in the low-lying country of Andalusia, on the marshy banks of rivers, especially the Guadiana and Guadalquiver, on the flooded plains of the Tagus, Sado, Mondego, and other coast rivers of Portugal, on the level coasts of Granada and Murcia, and on the plains of Algara and Alemtejo. In France malaria is most prevalent in the western and southern parts of the country, especially from the basin of the Loire as far as the Pyrenees. Another area stretches along the coast of Languedoc and Provence. There are several other small malarial areas, of which the plain of Auvergne and the marshy country around Lake Indre may be noted. In Switzerland endemic malaria is only found in the southern part of the canton Ticino, and in the canton of Valais along the Rhone. In Austria the chief seats of the disease are along the Danube, and there are smaller areas in the river valleys of upper Austria, Salzburg, Styria, and Carinthia. Where the river widens at Krems we meet with a great region of malaria, which extends as far as the Black Sea. In south-west Germany

there are small and isolated areas where malaria is endemic on the marshy banks of the rivers or lakes, *e.g.*, the valleys near the Neckar in the Black Forest. The more extensive malarial regions are on the banks of the Rhine, in lower Alsace, in the Palatinate, in the Rheingau, and in the low grounds of the Danube, and its side valleys in Wurtemburg and Bavaria. In central Germany it is only endemic in a few small districts. In North Germany it is found in the basins of the Vistula, Oder, Elbe, Weser, and Rhine. Holstein and Schleswig (west coast districts), the coast belt west of the Elbe, the moorlands of Hanover and Oldenburg, the low grounds of Westphalia, and the plains of Rhenish Prussia are also infected. In the Netherlands malaria is mostly found in the provinces of Grönland, Friesland, and Zealand, on the coast belt of the provinces of north and south Holland, and in the provinces of Drenthe Overyssel. Belgium, West Flanders, East Flanders, and Antwerp are affected. The disease also occurs in Laaland and Falster, on the Hvalöen islands, and in the neighbourhood of Fredericstadt. In Sweden it is endemic at three principal points—around Lakes Maler and Werner, on the east coast of Torhamn, and at the mouth of several coast streams, such as the Angermanna-elf, the Dal-elf, and Gotta-elf. In Britain, the East Riding of Yorkshire, the Fen district, Essex and Kent, the banks of the Thames in Surrey, and the south marsh of Somersetshire, are slightly infected by malaria.

In the western hemisphere, endemic malarial fever of the severest type has its principal seats in the West Indies, on the Mexican Gulf coast, and in Brazil, but considerable regions of fever, though of a less intense kind, are met with in the northern parts of the Pacific coast of South America, and in the southern, central, and prairie States of the Union. All the West Indian Islands are affected, save Antigua, St Vincent, and Barbadoes, the Bahamas and the Bermuda group, in which islands it is rarely seen.

In South America the worst centre of malaria is the east coast, including the ports of Carthagena, Maracaybo, and Puerto Cabello, and the country of Guiana. Another extensive area covers the whole of the north of Brazil as far as Rio de Janeiro, the banks of the Amazon, Rio Madeira, Maranhao, Paranahyba, San Francisco, Parana, Rio Doce, and their tributaries; also the island of Santa

Caterina and the marshy districts of the provinces of Piauhy, Para, Mato-Grosso, Goyas, and Minos Geraes. Endemic malaria is also found in the prairie lands of Paraguay and Bolivia, particularly in the provinces of Tucumana, Salta, and Santa Cruz. Chili and Peru are also affected, and the disease extends thence along the coast to Ecuador, probably also to New Granada.

The disease is found all over Central America, but it is less severe on the Pacific coast, except at Corinto. In Mexico malaria is most prevalent on the Atlantic coast, and is less frequently seen everywhere up to 3000 feet in height, except on the tableland proper (Anahuac). On the Pacific coast of Mexico malaria is confined to Acapulco, Tepic, and the strip of coast from San Blas to Mazatlan.

In the United States from the Rio del Norte a great malarial field extends all over the Gulf coast to Cape Florida, spreading far into the interior along the Colorado, Brazos, and Mississippi and their tributaries. In Texas the malarial region stretches from the coast into the highlands as far as Fort Duncan in Eagle Pass, and Fort Makavit. In New Mexico malaria is very widely diffused, the limit of its prevalence being Santa Fé. From the western part of the Louisiana coast, between the Sabine and the Mississippi, the malarial region extends across the zone of bluffs in that State, over a great part of Arkansas, especially along the banks of the Mississippi and Arkansas rivers, over the marshy plains of the north-east of the country towards Missouri, and over the eastern part of the Indian territory, including Fort Gibson and Fort Still. In the peninsula of Florida malaria is only met with on the Gulf coast, especially in Escambia and Tambabay, and at Fort Meade. In Georgia we find it in the creeks along the coast. In the Central States of the Union malaria is met with in South Carolina, North Carolina, Virginia, and Maryland, and to a moderate extent in Tennessee and Kentucky. It is also found within the prairie States proper, *e.g.*, in Ohio, Indiana, Illinois, Missouri, Iowa, Minnesota, Wisconsin, and Michigan. In no case, however, does malaria extend farther north than 46° 10′ N. (Fort Ripley). In the southern parts of the State of Michigan malaria skirts both shores of Lake St Clair to its junction with Lake Huron, and the southern shores of Lakes Erie and Ontario as far as the St Lawrence. Severe malarial fever is found at Fort Gratiot, Detroit

and Plymouth, on the United States side of the Lake; and at Amhurstbury, Fort Maldon, and Sandwich, on the Canadian side. On the northern side of Lake Ontario malaria extends from Hamilton to Kingston, and up the ridge of hills which runs along the shore from Burlington to the mouth of the Trent, attaining in some places an altitude of 600 feet. Endemic malaria extends also to the north-western parts of the State of New York, although there are many localities now free from fever. It is most frequently met with along the banks of the Hudson and on a narrow strip of coast. During recent years the disease has increased in the mountain districts of New York and also in Pennsylvania. In the New England States the disease is endemic at only a few points, and it is not endemic in the greater part of British North America. Malaria, as an epidemic, is met with on the banks of the St Lawrence and its tributaries, and on Lake St Peter, as well as at Montreal and Quebec, and at various coast places, such as Halifax (N.S.) and Miquelon (N.F.). In Nova Scotia (except at Halifax), in New Brunswick, and in Greenland, the disease is quite unknown. In western North America the limit of malaria reaches somewhat higher latitudes. It is met with chiefly on the slopes and valleys of the Rocky Mountains and in the territories of Wyoming, Utah, and Colorado. In California there are considerable malarial regions, especially up the valleys of the Sacramento and San Joaquin, and in the inland southern part of the State of Arizona.

The incidence of malaria throughout the world has been summarised by Dr Leon Poincasé whose classification, slightly added to by Mr W. North, I will quote.*

First Category. Highest Degree of Intensity.

Class I. Senegal; Coasts of Gulf of Guinea; West Coast of Africa, as far as the 20th parallel of S. latitude; Madagascar; the Guianas.

Class II. India; Cochin-China; Ceylon; Afghanistan; Burmah; Siam; the whole of the Malay and Philippine Archipelago; New Guinea; Nubia; parts of Abyssinia and the Soudan, and Central America.

* See *Nineteenth Century*, June 1889, p. 867; *Prophylaxie et Géographie Medicale*, 1884.

Class III. The East Coast of Africa; Egypt; the coast-line of Arabia; Mexico; China Proper; the Brazils and Peru.

Second Category.

Class I. Tripoli; Algeria; Morocco; the Cape de Verde Islands; and the Oases of the Sahara.

Class II. Turkey, in Europe; Greece; the Islands of the Archipelago; Sardinia; Malta; Sicily, and parts of Italy.

Class III. Roumania; Hungary; Italy; Corsica; Spain; Portugal; Southern Russia, and a large part of the United States.

Third Category.

Southern Sweden; Denmark; Belgium and Holland; Germany; France; La Plata; Chili, and the Islands of Madeira; Bourbon and at Helena.

Fourth Category. No Malaria or Insignificant.

The British Islands; Norway; the southern parts of Sweden; Finland and Russia; all North America above the 50th parallel of N. latitude; Uruguay; the Argentine Republic and Patagonia; Northern China; almost all Siberia and the greater part of Japan; New Zealand and the southern part of Australia.

Remarks.—Of the malarial fevers, the intermittent is the most widely distributed type, and it will be noticed that the remittent and pernicious fevers are only met with in comparatively small areas, and that they are, as a rule, confined to tropical or sub-tropical countries. A glance at the map will show, without further specification, their distribution. It may be noted, however, that the quotidian and quartan types of intermittent fever are those which are most frequently met with in the tropics, and that the tertian type is that form which is most widely distributed in the more temperate zones. In fact, the type of fever stands in a definite relation to the intensity of the malarial process; thus we find that the tertian type prevails in those regions within the tropics where the milder malarial fevers are indigenous. Again, the frequency of the occurrence of the quotidian type of fever in endemics or in epidemics is in direct proportion to the severity of the disease. When an epidemic

wave of malarial fever passes over a district, the tertian type is seen at its outbreak, whereas at the height of an epidemic, or whenever it assumes a severe character, the quotidian type obtains, and as the outbreak of sickness abates one meets with a return to the types of fever having a longer interval between the paroxsyms, so that in tropical and sub-tropical countries the fever takes on the tertian type, and in the higher latitudes the quartan type makes its appearance. These remarks apply also to outbursts of the disease where it is endemic. In temperate zones remittent malarial fevers are exceedingly uncommon, in fact, so uncommon as to be regarded as a departure from the ordinary type and as due to exceptional causes.

All races may suffer from malaria, although the Negroes are less prone to it, always provided that they do not migrate. Indeed, it is very generally acknowledged that in all parts of the world strangers suffer more severely from malaria than does the indigenous population. The incidence of malaria is to a certain extent governed by the seasons. In those places where it is endemic it occurs all the year round; but where it is only slightly developed there are two maxima—one in spring and one in autumn, and a considerable decrease of the disease in the months between them. In regions with strongly developed malaria, there is a maximum beginning in summer, which reaches its height at the end of summer or the beginning of autumn, lasting not rarely into winter, and which so far exceeds the spring maximum, that the latter not unfrequently disappears altogether, so that there is only one minimum, winter and spring, and one maximum, summer and autumn. In tropical countries, in the worst malarious districts, the disease is most rife during the rains. The relation which malaria bears to heat is as follows—the greater the mean summer temperature, other things being of course taken into account, the more malaria, and the amount of malaria decreases with the mean annual temperature of the place, ceasing altogether with the summer isobar of 60° F. But, as Hirsch says, "in higher latitudes, the malarial fevers which have prevailed endemically or epidemically in spring undergo for the most part a considerable remission on the setting in of summer heat, and they do not revive until the cooler weather of autumn," and again, "in the regions of severe malaria the disease shows itself, and attains wide diffusion,

not at the height of summer, but only when the high temperature is declining in late summer and in autumn, and, for the tropics in particular, at the end of the hot season. As many observers state, this is directly due to the great diurnal range of temperature that occurs at that season."

The influence of rain or moisture has undoubtedly much to do with both the production and spread of malaria. With regard to the rains, we may say that the malarial poison is most virulent either when they set in after a long period of heat, or when the rains cease and give place to warm, dry weather. An endemic outbreak of malaria, and its epidemic spread are both notably diminished at the height of the rains, if they are very abundant, and it has been proved over and over again that the malarial process is developed more abundantly in wet than in dry years. These remarks hold good both as to tropical and temperate climates. But it is not with rainfall alone that we have to do, for moisture must be present in the soil in order for the production of malaria, and this saturation of the ground may be produced in various ways apart from atmospheric precipitations. Drainage from rivers, lakes, and pools may constantly saturate the soil, and so may inundations either periodic or irregular. The irrigation of the soil exerts an undoubted influence on the production of the poison; its effect is very marked in Egypt, and in the irrigation districts of India. Lastly, the soil may be saturated by sub-soil water. This point is of importance, because it explains the occurrence of malaria in localities remote from river basins, and where the soil cannot become saturated in other ways. The occurrence of malaria in the Sahara, in Spain, Greece, Algiers, Tripolis, and Darfour, is in all probability due to this sub-soil water, arising either from springs or in other ways and resting upon impermeable strata of rock or marl.

Apart from the moisture in the soil, it must possess other physical characteristics, although the geological characters of the country would appear to exert little or no influence on the production or non-production of the disease, except in so far as they affect the physical nature of the soil. Clay, loam, clayey marl, and marshy soil are most favourable to the production of malaria; a porous chalky soil is less favourable and sandy soil least so, provided always that the chalk or sand does not rest either upon clay or firm

rock. The exemption from malaria of some of the islands in the West Indies with a chalky soil is remarkable when contrasted with its special prevalence in islands of volcanic formation. The amount of organic material too, contained by the soil is bound up with the production of malaria. All other circumstances being equal, the greatest amount of malaria will be found where the amount of organic matter in the soil is greatest, the prevalence of the disease diminishing as the organic matter is found in less abundance. Changes in the soil produced by cultivation, the neglect of cultivation, and by excavations, also affect the presence or absence of malaria, but space forbids us entering into these details. In reference to marshes, however, it may be noted in passing that malaria will disappear from a marshy district if it is completely drained and dried, or if a marsh is converted into a pool or lake.

The amount of malaria, as also its severity, is affected by altitude and the configuration of the ground. The altitude at which malaria can be produced varies in different regions, being higher in the tropics than in the temperate zones. Thus in Central Africa we find that a height of some 3000 feet must be attained before one reaches a district free from malaria, whereas in the Apennines a height of 1500 feet only is required, and farther north only 500 feet. This, however, must be explained more by variation in temperature than by mere altitude. On the other hand, however, examining the configuration of the ground in plains, it is found that the disease is distinctly more virulent the lower the level of the country. This fact is so marked that often even 50 or 100 feet less makes a considerable difference to the salubrity or otherwise of a given spot.

Although winds do not exert any direct influence upon the production of the malarial poison, they act indirectly, as, for instance, by moderating temperature, &c. They act, however, directly in the diffusion of the poison or in preventing it exercising its potent effects. Wind may carry the malarious poison from a marsh to a healthy district, but it is probable that it can only thus convey it for a distance of some two or three miles. Malaria may rise to a height of some 700 or 800 feet in a calm atmosphere; wind will prevent this vertical diffusion. Probably on some islands, where from analogy we should expect to find malaria present, the constant

winds rapidly changing the atmosphere carry away the morbific elements before they have time to do harm.

Water can convey the malarial poison, but it is unknown at present how far it can carry it or how long the poison can remain unimpaired when carried either by a stream or a current.

From what has been said, some idea may be obtained of those factors requisite for the production of the malarial poison. It is in all probability due to a micro-organism which may find entrance into the body by means of the air, by drinking water and possibly also by the consumption of food contaminated by it. It is certainly ponderable, as is proved by the effect of altitude, of barometrical pressure, and by the action which winds have in its dissemination. It is also miscible with water. We may sum up our definite knowledge of the disease by saying that it requires for its production a specific germ, suitable soil, a certain amount of moisture, a sufficiently high temperature, and a certain time for development.

An examination of the map, bearing what has been said in view, will I think show how the presence of malaria in the various quarters in which it exists is to be accounted for by physical phenomena.

II. Dengue.

(See Map II.)

Synon.—Dandy Fever (West Indies); Third Day Fever; Red Fever; Leg Fever; Breakbone Fever; Scarlatina Rheumatica (Aitken); Aburukah, or Aburuka-bar, or Father of the Knee (Arabia); Nadak-Mariata, or the Deity (Southern India); Tootiah (Bengal); Kidniga pepo, *i.e.*, Spasmodic pains (Zanzibar); *Fr.* and *Ger.* Dengue.

Definition.—An infectious, eruptive fever, commencing suddenly, and characterised by severe pain in the head and eye-balls, swelling and pain in the muscles and joints, prone to shift suddenly from joint to joint, catarrhal symptoms, sore throat, congested conjunctivæ, and affection of the sub-maxillary glands. The disease may remit, and is liable to relapse.

Geographical Distribution.—Dengue has been known since 1780, in which year it attained a considerable diffusion in the tropical and sub-tropical parts of both eastern and western hemispheres. It

is now known to have visited Egypt, Senegambia, and Tripoli, and the valley of the Nile as far as Khartum; also Arabia along the coasts, and Mecca. It is epidemic all over India and Further India, and in Batavia; and has appeared in Shanghai, Amoy, and the island of Formosa. It has also visited Réunion, Tahiti, Zanzibar, and the Canary Islands; and epidemics have overspread the West Indies and a great part of the Southern States of the Union, as well as the northern shores of South America. Space will not permit of indicating the various areas of diffusion during the several great epidemics of Dengue, but it must suffice to state that its greatest area of diffusion lies between 33° N. lat. and 23° 30′ S. lat.

Remarks.—The period of incubation of Dengue is probably about six days. It is a highly infectious disorder, spreading with extreme rapidity. Summer and early autumn are undoubtedly the Dengue season, and the disease appears to depend on a high temperature for its production. In the tropics as well as in the subtropical zones, nearly all the epidemics of Dengue have been in the hot weather, and as soon as a great fall of temperature takes place the disease declines rapidly. It is probable that the moisture of the atmosphere has little or nothing to do with the production of Dengue; as a rule it is chiefly confined to coast districts, to the courses of great rivers, and to places having a low altitude. It has been noticed in various epidemics of Dengue that it spreads in a curious way amongst various classes of the community. Every race, nationality, age, and sex may be attacked by the disease, although in separate epidemics a remarkable immunity has been noticed on the part of certain classes. Sometimes Europeans will be attacked, and natives enjoy comparative freedom from the disease; again, in other cases, natives will be almost solely attacked; sometimes children suffer more than adults, or the reverse may obtain. For instance, Pasque says, speaking of the epidemic at Benghazi, that it was noticeable for the decided immunity experienced by the blacks, but they are attacked as much as anyone else in Egypt and Senegal. Christie remarks that in one or two of the epidemics which he witnessed in Zanzibar, the natives suffered less than the Europeans. In the epidemic in Mauritius in 1873, hardly any children were attacked by the disease. In the Deccan epidemic of 1872 there was noticed a peculiar predisposition to

Dengue in persons suffering from any surgical complaint. In Goojerat in 1824, and in Amoy in 1872, it was found that all the severe cases were limited to the native population, that the Europeans suffered to a far less extent, and that those who were attacked by the disease had it in a remarkably mild form.

As to the specific nature of Dengue, there can be no doubt, but whether due to a parasite or not is at present unknown, nor is it yet ascertained whether the poison springs up *de novo* at all points where its potency is manifested, or whether it is only epidemic at a few places, and spreads from these under favouring circumstances. At first Dengue was not thought to be contagious, but it is both infectious and highly contagious, and the diffusion of the disease could be traced in the epidemic of 1871–73, in the East from port to port, and from country to country along the highways of land and water traffic. One attack of Dengue does not confer absolute immunity from subsequent attacks, although it does so to a certain extent.

III. Asiatic Cholera.

(See Map III.)

Synon.—Serous Cholera; Spasmodic Cholera; Malignant Cholera; *Fr.* Cholèra asiatique; *Ger.* Asiatische Cholera.

Definition.—Asiatic cholera is a specific disease, characterised by violent vomiting, rice-water evacuations, cramps, prostration, collapse, and other striking symptoms; tending to run a rapidly fatal course; and capable of being communicated to persons otherwise in sound health, through the dejecta of patients suffering from the disease.

Geographical Distribution.—With regard to the distribution of cholera, it is not advisable to proceed on exactly the same lines as with other diseases, for, although the epidemic area of cholera is very vast, its endemic area is very limited. It will be well therefore, in the first place, to specify those regions which have hitherto escaped the ravages of the disease, next to define its endemic area, and finally to make some general remarks as to its pandemic diffusion. A glance at the map will render this division clear.

Up to the present time, Australia and the islands of the Pacific

Ocean have remained unaffected by the disease. So too has the whole of Africa, with the exception of a strip of coast-land commencing at Delagoa Bay and running all round the eastern and northern coasts of the Continent as far as lat. 14° N. The islands of St Helena and Ascension have also escaped. In South America, Terra del Fuego, Patagonia, Chili, the higher slopes of the Andes and the Falkland Islands have been hitherto exempt. In North America, the whole of the country north of 50° N. lat. has remained free from cholera, as well as the highest slopes of the Rocky Mountains and the Bermudas. Greenland and Iceland have not been visited by the disease.

In Europe, we find that the Faroe Islands, the Hebrides, the Shetlands and Orkneys, Lapland, the Russian territory north of the 64th parallel, Switzerland, and the northern part of Scotland have escaped.

In Asia, the northern districts of Siberia and Kamtschatka have remained free, as also probably Mongolia and Manchuria. We see from these exceptions, what an immense area of the earth's surface has been visited from time to time by the terrible scourge of cholera. It must be remembered, however, that, although the area of distribution of cholera has been so vast, yet certain isolated districts in the various countries visited by it have remained unaffected. For instance, some mountainous districts in the south-west of France, the south-west of Germany, notably Baden and Würtemburg, and the greater part of Greece.

Even in India itself there are places where its ravages are unknown; for instance, it has not attacked the hilly regions of Bengal, but the reason for this is apparently to be found in the fact that the hill men have little or no communication with individuals from the affected area. Should they descend from their mountains, or have any communication with the inhabitants of the plain, they suffer from the disease very severely.

With regard to the home of cholera, we must define it as situated in the delta and valley of the Ganges, from which point it receives an impulse which enables it at times to become pandemic in character. There can be no doubt that cholera existed long before 1817; of its previous epidemic spread no very certain information can be given, but that it overspread India and the adjacent

countries is certain. It appears to be equally certain that, apart from the original impetus given to cholera in 1817, the commerce of the world has been the means of spreading it over such a world-wide area as indicated on the map.

The first pandemic, of which we have authentic data, occurred during the years 1817–1823, in which period the disease devastated an area from Nagasaki, 147° E., to the coast of Syria, 52° E., and from Bourbon, 21° S., to Astrakan, 46° 21′ N.

The second pandemic, which took place during the years 1826–1837, overspread nearly the whole of the countries marked on the map as being affected by cholera. From 1837–1846 Europe, Africa, and America were free from further outbreaks of the disease.

The third great pandemic occurred from 1848–1863, with a remission, as far as the eastern hemisphere is concerned, between 1850 and 1852; and during this pandemic it visited the whole of the northern hemisphere, and reached lat. 25° S. in the Old world and 30° S. in the New.

The fourth pandemic occurred during the years 1865–75, and is noticeable for the rapidity with which cholera was introduced into Europe by sea from the coast of Arabia. In the former pandemics it had always come from the east by way of Afghanistan, Persia, and Asiatic Russia. From 1875 until the limited outbreak in 1883, when cholera appeared in Italy, Spain, and the south of France from Egypt, the disease has been confined to Asiatic soil, and in the year mentioned the spread of cholera was very strictly limited.

Remarks.—Before referring briefly to some points in the origin and spread of cholera, it may be well to remark that, however the disease is produced, the researches of Koch, which have been very recently confirmed by Drs Milles and Macleod, who investigated the subject in 1875 at Shanghai, and an abstract of whose researches was read before the Royal Society of Edinburgh on Dec. 17, 1888, have almost definitely proved that the comma bacillus has a causal relation to cholera. This bacillus is constantly present in Asiatic cholera, and it has never been found anywhere but in Asiatic cholera. Granting, as we think we are right in doing, that cholera is produced by a morbific microbe, we must next refer to various facts with regard to the conditions necessary for an epidemic of

cholera to arise. Cholera may be introduced into a given area, and yet it does not necessarily follow that it will thrive in that area, and some definite local condition must exist for its propagation. With regard to the influence of altitude, it may be said that, although cholera can penetrate to a considerable height, yet, unless in very severe epidemics, the number of cases are fewer the higher it ascends; and Farr adduced the law, that "the proportion of deaths among the inhabitants from cholera is inversely as the elevation of the ground." This law holds good, not only in high altitudes, but in slight elevations in very limited areas. Acland, writing on the mortality from cholera, mentioned the fact that in three epidemics of cholera in Oxford, in 1832, 1849, and 1854, the mortality per thousand people, living at a mean height of 30 feet above water-level, was respectively 3·3 and 1·8, as compared with 9·8 and 5·3 deaths per thousand which occurred amongst the people living in the low-lying part of the town. There are, however, exceptions to this rule, as in some epidemics hilly districts have suffered more than the lower-lying surrounding country.

Again, cholera follows the course of rivers, this probably being due to the fact that the riparian areas possess soil saturated with water and decaying organic matter. There can be no doubt, too, that cholera spreads most rapidly in countries having an alluvial or tertiary soil.

With reference to the influence of weather on cholera, we know that the disease is met with under every known variety of climate; yet doubtless a high temperature aids its spread, and most epidemics are brought to an end, or at least are most markedly reduced in extent, when the temperature falls greatly. The Vienna Conference of 1884, in which were assembled representatives of all countries, stated that there were no facts to show that atmospheric causes alone could bring on cholera, and also, that all facts go to show that in free air the generative principle of cholera rapidly loses its morbific character.

With regard to the influence of the moisture of the atmosphere upon the production or spread of cholera, it would appear that a certain amount of moisture in the atmosphere, or perhaps more correctly speaking, in the soil, is needed for its development and spread; it is probable that spring showers or sudden summer

rains will give to cholera an impetus, whereas continuous rains, by completely saturating the soil, prevent its occurrence. No one knows the cause which gives it epidemic impulse, but we know that, generally speaking, cholera becomes epidemic during the intensely hot weather following heavy rains.

The wind may have a certain action on the spread of cholera, always provided that it be a moist wind, but the old idea that winds could convey cholera poison for long distances seems now to be obsolete. But indirectly the south-west monsoon certainly aids in spreading cholera, because it brings with it moisture which is necessary for its propagation, and because numbers of vessels take advantage of this monsoon to sail from the endemic area of cholera to other places. As Macnamara justly remarks, "cholera thus progresses with man along the great high-roads upon which he travels, spreading no faster than he moves, and being generated by wet, hot weather." Although the disease is thus indirectly spread by the south-west monsoon, it must not be concluded that it cannot travel against wind, for it travels just as fast against the wind as with it. Water is capable of disseminating cholera germs after they have been produced in the soil, or after it has been contaminated by the discharges of cholera patients.

The great factor in the distribution of cholera is certainly that of human intercourse. Persons suffering from the disease, though it may be only in a latent form, undoubtedly convey the poison for long distances, and it is a well known fact that troops, pilgrims, and emigrants have spread it far and wide. It is necessary, however, for an epidemic of cholera to arise, that the poison conveyed into a district should find there a fitting soil for its growth. What that fitting soil is, it is impossible yet to say.

IV. Yellow Fever.

(See Map IV. A.)

Synon.—Yellow Jack; Bronze John; Vomito Prieto; *Fr.* Fièvre jaune; *Ger.* Gelbes Fieber.

Definition.—A pestilential contagious fever of a continuous and special type. It presents two well-defined stages. The first extends from 36 to 150 hours, and is marked by rapid circulation and

elevated temperature. The second is characterised by depression of the nervous and muscular powers, and of the circulation, with slow and often intermittent pulse; jaundice; suppression of urine, albuminuria, and desquamation of the renal epithelium; diminution of the fibrin of the blood, capillary congestion, passive hæmorrhages from the mucous surfaces and black vomit; fatty degeneration of the heart and liver; and convulsions, delirium and coma. As a general rule, it occurs but once during life.

Geographical Distribution.—Although yellow fever extends over the areas mentioned below, it must be noticed that there are only three districts where it is really endemic, *i.e.*, (*a*) in the West Indies, especially in the Greater Antilles; (*b*) on the Mexican part of the Gulf Coast; and (*c*) on the Guinea coast at Sierra Leone.

The area of distribution of yellow fever is at present limited in Africa to the west coast from 19° N. to a point on the mainland opposite Fernando Po. In the Western Hemisphere it occurs along the eastern shores of the United States from lat. 38° N., and, skirting the coast round the Gulf of Mexico and Central America, it passes along the northern coast of South America and the eastern coast as far as 32° S. On the western shores of South America yellow fever has appeared in epidemics from 5° S. to 42° S. It is also prevalent throughout the whole of the West Indies. Although in the United States and South America yellow fever chiefly infests the coast regions, exception must be made to the great rivers, such as the Mississippi, the Amazon, and the Rio de la Plata, for it extends up these rivers to varying distances. In the western hemisphere the yellow fever area is bounded on the north by 44° 39′ N. (Halifax), and on the south by 34° 54′ (Monte Video); in the eastern hemisphere by 43° 34′ N. (Leghorn), and 8° 48′ S. (Ascension); these are its extreme limits.

Remarks.—There are some curious facts with regard to yellow fever and its relation to climate which it is necessary to remember. Firstly, Negroes are less liable to it than whites, unless they leave the tropics for any length of time and then return; if they do this their comparative immunity seems to be lost. It appears, too, that Mongolians escape yellow fever. All other races, however, suffer from it, and it is noteworthy that the further north from its area a person was born the more likely is he to suffer from it,

should he come within reach of an epidemic. New arrivals are most exposed to this disease; should they escape it at first they are the less liable to suffer from it, the longer they reside in one place; but if they travel about, this acclimatisation appears to be lost. Whatever may be the real cause of yellow fever, its origin seems to be connected with heat, for although it occurs in sporadic and epidemic forms at all seasons in the tropical part of the yellow fever zone, the disease is greatest, and takes an epidemic spread at the hottest period of the year, a temperature of at least 70° F. being required for its production. Frost puts an end to an epidemic at once, and storms, heavy rains, or cold weather check its progress. Although heavy rainfall will stay an epidemic, yet moisture in the atmosphere would seem to be necessary for the production of the poison, for in dry years or during seasons of long-continued drought the number of yellow fever cases are always remarkably few. Winds influence yellow fever by their effect upon the atmosphere, but it does not appear that they are capable of conveying the poison, at least to any distance. On looking at the chart, it will at once be seen that yellow fever is most prevalent on the sea coast and along the courses of the great rivers; it always spreads from centres of dense population, and the greatest number of cases occur in the dirtiest and most overcrowded parts of large towns. Altitude, certainly, has an important influence on the spread of yellow fever, and it is only in very severe epidemics that it leaves the plains. The protection which altitude confers against the disease is almost certainly due to the lower temperature of elevated spots, because where yellow fever has made its appearance in highly situated regions, it has always been in localities noted for the exceptional heat of the days.

A certain saturation of the atmosphere is an essential condition for an epidemic of yellow fever. It is probable that it does not occur until a high dew-point, the minimum being upwards of 74, exists, and it is certain that epidemics cease before the dew-point descends to 58. The geological characters of the soil have apparently nothing to do with the production of yellow fever, and all those conditions of soil which we found to be necessary for the production of the malarial poison, exert no influence in producing yellow fever. Electricity has a curious influence upon

persons suffering from the disease, even should they be almost convalescent. It is said that should a thunderstorm occur, severe symptoms are immediately manifested in persons suffering from the disease, or a relapse occurs in the apparently convalescent.

Yellow fever poison clings to the ground, and its diffusion may be barred by streams, walls, and, some say, by much travelled thoroughfares, and it does not appear that the water-supply of cities aids its spread. Its period of incubation is variable, and may be said to be between twenty hours and several weeks; this varies in different epidemics, and the most common period of incubation is from twenty to one hundred hours.

Preventive inoculations are now being largely practised against yellow fever with very great success, and there seems to be every reason to hope that at last a method of preventing the disease will be firmly established, although up to the present its true origin has escaped scientific inquiry.

The disease may be spread by fomites, and its toxic power retained for very long periods.

V. Oriental Sore or Boil.

(See Map IV. B.)

Synon.—Aleppo Evil; Mycosis Cutis Chronica (Carter); Lupus Endemicus (Lewis and Cunningham); Oriental Sore (Fox); Mooltan and Biscara Boil; Date Disease; Caneotica; Liblib; Yemen and Cochin-China Sores; Scinde Boil; Parangi; Mal d'Alep; *Fr.* Bouton d'Alep; *Ger.* Veule von Alep.

Definition.—An indurated, indolent, and very intractable sore; papular in the early, encrusted or fungating in the advanced stages; spreading by ulceration of the skin, single or multiple; and often occupying extensive surfaces of the exposed parts of the body, such as the face, neck, and extremities. It is capable, if inoculated, of reproducing the disease, and it also affects dogs and horses.

Geographical Distribution.—In Europe the boil is met with in Crete, in Cyprus, and in the Crimea. In Africa there is a considerable area in Morocco, on the banks of the Muluia, where the disease abounds, as it does also in numerous oases of the Algerian desert and in the Tunisian Sahara. It is occasionally met with in

Egypt between Suez and Cairo. In Asia it is more widely distributed; it is seen at Broussa, and in Syria it is endemic, chiefly between Killis and Aleppo. In Mesopotamia it is endemic over the whole plain between the Euphrates and the Tigris, extending from Diarbekir to Bagdad and Bassara. In Persia it is endemic at Teheran, Kashan, and Ispahan; whereas in Hamadan it is not so frequently seen. There is also a small endemic focus in the district of Elizabethpol.

The sore is met with in Tashkend and skirts the river Tchirtchik, and in all probability it exists in Turkestan, Afghanistan, and Beloochistan. Another very important endemic area extends along the Indus from the Punjaub southwards through Scinde as far as Goojerat and the Gulf of Cambay, and to the east through Rajpootana and the North-West Provinces as far as Delhi, Meerut, Lucknow, and Gwalior.

Remarks.—Objection may be taken by some to classing under one heading a sore having so many names, but it seems to me that, taking all things into consideration, the various designations all refer to one and the same disease, and that their different features are simply modifications produced by varieties of climate; their various manifestations are also most probably, to some extent at least, influenced by racial characteristics and by the habits of the patients attacked. In each locality where these sores obtain, they vary considerably in their appearance with the character of the season. Two theories have been, and still are, advanced as to their cause, some authorities considering that they are a local manifestation of a cachectic condition due to a residence in unhealthy localities or badly drained towns in certain parts of the tropics. Others again, and notably Carter, consider that the disease is distinctly due to a parasite, and this view is supported by cogent facts. Carter has found in the sores spheroids and mycelium; the disease is localised, and this fact is against it being the outward manifestation of a constitutional state. The disease can be inoculated, and it is contagious. Again, many facts lead one to suppose that the parasite is introduced into the body, either during ablution or by the bite of some insect.

The area of the distribution of this disease prevents us entertaining the idea that its production is influenced by the physical

characters of the soil, nor has altitude anything to do with its production. With regard to water, however, it may be that we should consider it as a cause, for there are instances on record where a change of the source of the water supply has exerted a marked influence upon the number of cases seen. When, however, we come to inquire as to what substance in the water produces or might produce the disease, we are met by various statements which are contradictory, or at any rate give no certain clue on which to base a definite opinion. For instance, the gypsum found in the water at Aleppo is given as a cause: the abundance of nitrates in the water of the Punjaub, or the presence of sulphurated hydrogen due to putrefying matters, is blamed. Hard water is suspected by others, and in Algiers the excessive amount of choride of sodium is considered suspicious; lastly, the amount of earthy salts contained in some waters is said to cause the sore. But there are many other observations which cause grave doubts as to the correctness of any of these views.

Meteorological conditions must, we believe, exert a not inconsiderable power in the production of Oriental sores. It will be noticed that the distribution of the disease is over arid regions, but in these regions it is strictly localised to various foci. In the subtropical regions the disease makes its appearance in the late autumn, and it is met with in the winter in the tropical zone. Where it is found at all seasons of the year, the climate is characterised by hot, dry air during the day, sometimes heavy dew at night, and rapid fluctuations of the thermometer. It must, however, be remembered, that in some places the Oriental sore attacks its victims in the season of the year when vital powers are lowest. It is important not to mistake phagedænic tropical ulcers for the Oriental sore, as the former are due to constitutional debility, induced either by anæmia, malaria, scurvy, fatigue or want, in persons residing or travelling in swampy regions, where the atmosphere is hot and moist.

VI. Endemic Hæmaturia.

(See Map IV. C.)

Synon.—Distoma Hæmatobium; Bilharzia Hæmatobia.

Definition.—Endemic hæmaturia is caused by the entrance into

the body of a trœmatoid hœmatozoon, which is found in the portal system, the mesentery, bladder, &c. It produces hœmaturia and anœmia more or less profound.

Geographical Distribution.—The distoma has, so far as we know, a peculiar and very limited area of distribution. It is found in Mauritius, where the disease it causes was first described in 1812 by Chanotin. It is strictly limited to the delta of the Nile and to various points of the White Nile between 6° N. and the Albert Nyanza. It is also indigenous at the Cape, where it is strictly confined to the coast territory and to the banks of streams for a distance of some 10 or 20 miles from the sea. Its chief seat is in the south-eastern districts of Cape Colony near Algoa Bay, especially at Uitenhage and Port Elizabeth, the neighbourhood of King William's town and East London in Kaffraria, as well as at several places in Natal; for example, on the banks of the Umlasi, the Ungeni between port Natal and Pietermaritzburg, and the Umhloti. It is probably also found in various other places in Central Africa.

Remarks.—A knowledge of the geographical distribution of this parasite is of great importance, because, by taking proper precautions when residing in its limited area of production, it is possible to escape its ravages. There can be no doubt that it exists in stagnant pools, in the shallow water of declining rivers, near estuaries, and at the sea coast. It is affected by season, being found in the water in the summer, and it is during the summer too that most people are affected by the disease. It is curious to notice its preference for the male sex, and it is most commonly seen in them between the ages of five and thirty-five years. At Pietermaritzburg the majority of youths are affected by the parasite. As it can only obtain entrance into the body by means of drinking water or in bathing, the necessary precautions should be taken, and Europeans who may contract the disease should immediately remove from the infected area.

VII. Beri-Beri.

(See Map V. A.)

Synon.—Barbiers; Loempoe (Java); Kak-ké (Japan); Maladie des Sucreries (French Antilles); Sleeping Sickness (west coast of Africa); the Bad Sickness of Ceylon.

Definition.—A disease characterised by anæmia, anasarca, degeneration of muscular tissue, effusion into the serous cavities, debility, numbness, pain and paralysis of the extremities, especially the lower; precordial anxiety, pain, and dyspnœa, and in some cases drowsiness or sleepiness. Beri-beri occurs in a chronic and an acute form.

Geographical Distribution.—Beri-beri, like other similar diseases, has a wide distribution in many countries situated in the tropical and sub-tropical zones, but, although its area of distribution is so extensive, it is strictly limited in its endemicity. It is to be found both in the eastern and western hemispheres. Looking at the eastern hemisphere first, we find that one of its chief habitats is in Japan. There it was limited, until fifty years ago, to the coast towns, but since that time it has been met with practically all over the islands. In China it is not so frequently seen now as it used to be, but it is endemic in Burmah, in Singapore, and in the Calabash islands. In the Malay Archipelago, we find that most of the islands are endemically affected, especially Sumatra, Banka, Borneo, Labuan, Celebes, and some of the Molucca group of islands. We meet with it, too, on the west coast of New Guinea, and on the extreme east of Java, as well as in the prisons of Batavia in Passuruan and Samarang. With regard to India, Beri-beri infests a strip of country, 100 miles broad, on the coast from Grandjam to Masulipatam, while it is more rare on the Coromandel and Malabar coasts, and in the plain of the Carnatic. It is also met with at various isolated spots in the provinces of Decca and Assam, and it is seen occasionally in Calcutta. It exists in Ceylon, especially at Trincomalee and Candy. As an epidemic, it is met with in Mauritius, Réunion, Nossi Bé, Zanzibar, and probably on the Congo. Passing to the western hemisphere, we find that Beri-beri has been undoubtedly imported from the east. Thus, at various times it has been epidemic in Guadaloupe, Cuba, Cayenne, Paraguay, and San Francisco. Beri-beri may be said to be endemic over the greater part of Brazil, where it commenced in the Bahia Province, and it is also met with in Guiana. It must be mentioned, too, that Beri-beri often breaks out on board ship, especially in transports, coolie ships, and vessels trading in the Malay Archipelago, Bay of Bengal, and with Japan.

Remarks.—Many have been the theories started to explain the cause of Beri-beri, but, owing to the limited well-defined areas in which the disease is endemic, most of them are unsatisfactory. Its epidemic spread, however, is probably influenced by climate, and seems to coincide with conditions of high atmospheric moisture and extreme thermometric variations. Some parasite will, doubtless, ere long, be proved to be the real cause of the disease, and it is probable that its production will be traced to the soil, for in those places where Beri-beri is endemic the soil abounds in saline materials, such as magnesia, lime, chlorides, alumina, and iron. Although all races and persons of all ages are attacked by Beri-beri, the dark races suffer most, and adult men far more than women and children. Indeed, so great is the disproportion between male and female sufferers, that the cases seen in women are about one to thirty-one in men. Although it is, as a rule, rare for children under fifteen to be attacked by Beri-beri, yet there are epidemics on record in which children seem to have suffered most. Whatever be the cause of Beri-beri, a residence of eight or ten months in an endemic area appears to be necessary before a person can be attacked by it, and it is also a remarkable fact that it attacks by preference persons in an apparently robust condition according to some authorities while others think debility a predisposing cause.

VIII. Oriental Plague.

(See Map V. B.)

Synon.—The Pest; Inguinal, Bubolic, Glandular, Oriental, Indian, Pali, and Levantine Plague; Oriental Typhus; Septic Pestilence; *Fr.* La Peste; *Ger.* Die Pest.

Definition.—A specific fever, attended by bubo of the inguinal or other glands, and occasionally by carbuncles.

Geographical Distribution.—In olden times Oriental Plague had a very wide distribution; now it is met with in much narrower limits, and it is to its present distribution that we refer.

In Africa its area is distinctly limited to the northern coast belt, including Morocco, Algiers, Tunis, Tripoli, and Lower Egypt. In Egypt it has never gone beyond the first cataract of the Nile. In Russia it is met with in Astrakan along the Volga, and outbreaks

The four principal foci of the bubonic plague are (R. Koch, 1898):

1. Mesopotamia
2. Tibet
3. Westcoast of Arabia south of Mecca (Assir mountain district)
4. British East-Africa (Uganda) and the northwestern region of German East-Africa near the Victoria-Nyanza.

sometimes occur in Turkey. In Asia, epidemics of plague arise in Syria, Caucasia, Mesopotamia, and Persia; also in Arabia, on the coasts, and inland as far as Mecca. Epidemics have visited Hindostan, and there are endemic centres of plague on the southern slopes of the Himalaya, in the provinces of Kumaon and Gharwal and in Peshawur. It is probably endemic in the mountain valleys of Yunnan in China, and in Burmah.

Description.—In recent outbreaks of plague, three varieties have been described—(*a*) Abortive or larval plague; (*b*) Plague proper; (*c*) Fulminant plague. The usual characters of plague may be rapidly summed up as follows:—After a day or two's lassitude, shivering, and vomiting of a black material, high fever is experienced, with great pain in the axillary and inguinal regions, where buboes soon form. Often, too, the body assumes a livid hue, which gave plague the name of "black death." The aspect of the plague patient is peculiar; the face is haggard, the eyes retracted, and the conjunctivæ red.

Remarks.—In considering the causes of plague, there can be no doubt that the influence of the seasons is very marked. The disease commences to make its appearance in the winter, and cases become more numerous as spring sets in; but extreme heat or extreme cold usually puts an end to an epidemic. It is probable that plague has no relation to soil, and with regard to altitude, moderately high situations are more prone to be affected by the disease than are low-lying places, although from this it must not be understood that plains escape. There can be no doubt, however, that want, filth, and overcrowding are necessary to the production of plague, and it is well known that hygienic measures both prevent its appearance and stop its epidemic progress. In conclusion, it may be noted that the closer the association of healthy people with the sick the more liable are they to contract the disease; hence, persons residing in the same house with plague-stricken patients are much more likely to be attacked than others, and clothing and bedding may carry the infection.

IX. Dysentery.

(See Map VI.)

Synon.—*Fr.* Dysenterie; *Ger.* Dysenterie.

Definition.—A specific febrile disease, characterised by considerable nervous prostration and inflammation of the solitary and tubular glands of the large intestine, sometimes ending in resolution, but frequently terminating in ulceration, occasionally in more or less sloughing or gangrene; always accompanied by tormina and tenesmus.

Geographical Distribution.—The distribution of tropical dysentery is very wide, and to a great extent coincides with the area in which malaria is endemic. Commencing with its existence on the west coast of Africa, we find that it is extremely prevalent in Senegambia, on the Sierra Leone coast, in Upper Guinea, and on the Gold and Slave coasts, as well as throughout the area watered by the Niger. In all these regions it affects natives as well as Europeans. It is not so frequently met with in the Cameroons, and from thence southward to Cape Lopez it is also less frequent. From Cape Lopez along the Congo coast endemic areas of dysentery are only to be found in isolated spots. Fernando Po is severely affected by this disease, as are also the islands of St Iago and Nicolao. In Madeira it is only epidemic. Passing on to the Cape of Good Hope, we again meet with a wide area of its distribution, the natives being especially affected by it; but it is to be noted that the disease is more severe in the interior of the country than at the coast. On the east coast of Africa dysentery is endemic at Mozambique, Madagascar, Réunion, and Mauritius; also at Zanzibar and along the adjacent coast, but it is much less severe in Mayotte, Nossi Bé, and St Marie. It is very prevalent all over Abyssinia, except in the dry open tablelands, and it is met with throughout the whole of the southern Soudan and Nubia; it also passes down the valley of the Nile to the Delta. It is endemic in Algiers and along the coast regions of Morocco, Tunis, and Tripoli.

In Asia dysentery is met with in the valleys of Syria, in the plain of Mesopotamia, and in many parts of Persia, but it is most severe on the western and southern coasts of Arabia. It is found in the deep mountain valleys of Beloochistan and Afghanistan, and throughout

all India, being least severe in the Presidency of Bombay. It occurs in Ceylon, in Further India, in most of the islands of the Malay Archipelago, and on the southern and eastern coast zones of China. In the islands of the Japanese Empire the disease is only epidemic.

In Australia dysentery is endemic only on the west coast, although it occurs in slight epidemics in Melbourne, Sydney, Tasmania, and New Zealand. Endemic dysentery is also met with in New Caledonia, the Fiji Islands, Tahiti, the Mangareva group, and in the Hawaiian Islands.

Passing to the western hemisphere, we find that in South America dysentery is endemic in French and Dutch Guiana, in Brazil, especially on the coast of the provinces of Maranhâo, Piauhy, and Parahiba, and in the northern and central parts of the country. It is seen in Paraguay and on the coast of the Argentine Republic, as well as in the Provinces of Tucuman and Salta. The coast of Chili is also infested by dysentery, and the disease extends northwards along the coast of Peru; it is, however, most severe in the forest region on the eastern slopes of the Cordillera, on the Peruvian Pampas, and in the marshy country bordering the Amazon. This area ends at the coast-line of Ecuador, Granada, and Venezuela.

Dysentery is also endemic in Central America; that is to say, in Panama, Costa Rica, Nicaragua, the Mosquito shore, San Salvador, Guatemala, and Mexico. It is found all over Mexico until the Anahuac Plateau is reached. In the West Indian islands, Cuba and Hayti are its principal seats, Jamaica being less subject to it, and it is probably met with in the other islands.

With regard to the United States of America, it is difficult to say where the disease is endemic, but it occurs more or less all over the States, including California, and is most frequent along the Atlantic and the Gulf coasts. In British North America, Prince Edward Island and Vancouver Island are affected.

In Europe, endemic dysentery is confined to a few spots chiefly in the southern peninsulas and islands. It is common in Andalusia, on the tableland of Estremadura and New Castile, in Aragon, and in the southern parts of Galicia and Catalonia. It is prevalent throughout Italy, especially in the southern provinces and in Sicily; also in Malta. It is found in Greece in the Peloponnese, and in Constantinople, Roumelia, and Asia Minor. In France it is

endemic in some parts of Guyenne and Provence, in Lyonaise and Auvergne, in a few valleys of the Vosges, in the marshy districts of the Brenne, and in Sologne and Guer. In Sweden it is probably endemic at Jönköping, Skaraborg, Elfsborg, Wermland, Göteborg, and Bohus, and in the island of Gottland. In Russia it casually occurs in the Baltic Provinces, but more especially in Trans-Caucasia.

Remarks.—That endemic dysentery is due to some microbe, there can be little or no doubt; at least the researches of Prior and Cartullis almost definitely prove it. It is, however, difficult to say with exactitude what gives rise to the morbific microbe. Although, as above stated, endemic dysentery occupies very nearly the same geographical distribution as malaria, yet it has some points of difference. For instance, its endemic spread can proceed to far higher latitudes than does malaria.

Various facts prove that the disease is influenced by climate, for it is endemic at all seasons in hot tropical regions, and it is also found that in more temperate latitudes outbursts of the disease occur chiefly, one might almost say solely, during the late summer and early autumn season. Extreme cold puts an end to epidemic dysentery just as it does to yellow fever. All this shows that heat is necessary for its production. But, again, we find that fluctuations in temperature exert a marked influence in its production and spread. Where hot days and cold nights obtain in tropical regions dysentery is most prevalent. This fact has been observed again and again in various wars, as, for instance, in Ashantee, Abyssinia, China, and more recently still in the Soudan. In Sweden the disease rarely attains any considerable epidemic diffusion, unless the summer has been remarkable for great heat; and even the severe epidemics confined to limited portions of the country mostly coincide with extremely hot summer weather. It is difficult to decide what influence the moisture in the atmosphere has upon the production of dysentery, as authorities differ very much on this point, but we cannot help believing that moisture does play a part in either the production of the disease or in predisposing persons to suffer from it, and that marshy districts and the neighbourhood of large rivers where morning fogs are of frequent occurrence, are certainly injurious, even if the moisture itself does

not aid in producing the dysenteric poison. It may, of course, be that swampy districts exert their influence more indirectly than directly, for, doubtless, malaria does predispose individuals to attacks of dysentery, and the marshes may give rise to malaria which is only too often followed by intestinal disease. It has been stated by Annesley that dysentery rages in Bengal in the rainy season, and it is well known that the disease is most prevalent in lower Egypt at the time of the overflow of the Nile. It does not seem that elevation or configuration of the ground, nor the geological formation or the physical characters of the soil, have any connection with the production of dysentery.

Although, as we have just remarked, malaria may predispose to dysentery, we do not find, in considering the geographical distribution of the two diseases, that the points in which they are severally most virulent coincide, which one would naturally expect to be the case were the diseases produced by the same factors, or if they had a very intimate relation the one to the other.

It can only be said, in conclusion, that contaminated drinking water may frequently serve to introduce the virus of dysentery into the system, and that it appears to be proved that a person suffering from the disease may introduce it into a previously healthy community.

X. Leprosy.

(See Map VII.)

Synon.—Elephantiasis Grecorum; Lepra; Lepra elephantia; Black Leprosy; Red Leprosy; Elephantiasis tuberosa, anæsthetica, nodosa, mutilans, leontina, satyria; Joint Evil; the Myckle Ail or Great Disease; *Fr.* La Lèpre; *Ger.* der Aussatz; *Scand.* Spedaklalskshde; *Norway*, Likpra.

Definition.—A specific disease, endemic in many parts of the world, characterised by the slow development of nodular growths in connection with the skin, mucous membranes and nerves, and (in the last case) by the supervention of anæsthesia, paralysis, and a tendency to ulcerative destruction and gangrene (Bristowe). Two types of leprosy are described—the tubercular and anæsthetic varieties; the first variety is more frequently seen in temperate climates, the latter in the tropics.

Geographical Distribution.—Leprosy is endemic at the present time in Egypt, and throughout the whole of the basin of the Nile, as well as on the shores of the Mediterranean and Red Seas. It is very prevalent in Abyssinia, on the coast, on the plains, and in the hill districts. It is also endemic at Zanzibar, Mozambique, Madagascar, St Marie, Mauritius, Réunion, St Helena, in the Canary Islands, and on the west side of the island of Madeira. It is met with in Algiers and Morocco, but is rarely seen in the Azores, and Tripoli and Tunis are said to be free from it. On the west coast of Africa leprosy is endemic in a very extensive area, extending from Senegambia to Cape Lopez. In this region it exists all over Senegambia and Sierra Leone; it overspreads the districts watered by the Niger and the Binué, as well as the whole of the Cameroons district. Leprosy is not met with on the Loango coast, and Angola as well as the Congo are free from it, as also is the province of Natal, but it is endemic to a considerable extent at the Cape and in Zululand. Passing on to the endemic area of leprosy in Asia and the Archipelagos adjoining it, it is to be noticed that India and the eastern parts of Asia are the most affected. In Nearer Asia the disease is endemic in a few limited areas; *e.g.*, on the southern coast of Arabia, especially at Muscat, as well as in the centre of the country. The mountainous districts of Persia, Syria, and Cyprus are affected, as are also some parts of Turkestan, especially Samaracand, Miankal, and Hissar. In Asia Minor it is now only endemic in isolated spots —at Smyrna, in the neighbourhood of Sinope, and on the shores of the Black Sea. It is met with all over India, but is least prevalent in the Madras Presidency. The disease is fairly common in Ceylon, but chiefly on the south and south-western coasts, and endemic areas are found in British Burmah, in the peninsula of Malacca, in Siam, and Cochin-China. In the East Indian Archipelago the most important areas of endemic leprosy are on the west coast of Java and in its mountainous regions, the disease being more rarely met with on the southern and eastern coasts. Leprosy is also endemic in the Andamans and Nicobars, in the elevated and inland regions of Sumatra, on the west coast of Borneo, in Celebes (province of Menehasse), in Flores, in the interior of Timor, in Banda, and in the Philippines. In the Chinese Empire the areas of endemic leprosy are chiefly confined to the southern and eastern coasts; it is rarely met with in the

interior, except towards the northern part of the empire. In Japan leprosy is very prevalent, only the Loo-Choo Islands being free from it. It exists in New Zealand, in the Hawaiian group, and sometimes in Tahiti.

In Europe leprosy only occurs endemically, in small and, for the most part, clearly defined areas; in Spain it is confined to the provinces of Catalonia, Andalusia, Galicia, Asturia, and Granada. In Portugal it is met with in the provinces of Beira, Estremadura, and Algarve. In Italy it is endemic in two places—viz., at the Riviera-di-Ponete and at Comacchio. It is also found in Sicily. In the Balkan Peninsula leprosy still exists in small centres on the coast of the Ejalet of Salonica (Thessaly and Macedonia), and a few cases occur in Constantinople, which are probably imported. In Greece it is sometimes seen in the neighbourhood of Parnassus, and on the islands of Samos, Rhodes, Chios, and Mitylene, but the chief seat of leprosy in this region is Crete. In Roumania and Hungary occasional cases of leprosy occur, but it has ceased to be endemic there. In Sweden leprosy is met with in the districts of Angermanland, Mendelpad, Helsingland, Upland, and Bohus, but it has diminished very greatly in recent years. The most considerable area of endemic leprosy in Europe is the west coast of Norway, from Stavanger up to Tromsöe, most of the cases belonging to the departments of Söndre and Nordre Berghus. The disease is also met with in Iceland. Turning to the western hemisphere, there are three endemic areas of leprosy in North America—Mexico, Louisiana, and New Brunswick and Nova Scotia, and it is found amongst the Chinese immigrants in California. It also occurs in Costa Rica and in the West Indies, particularly in Cuba, Jamaica, St Bartholomew, St Kitts, Nevis, Antigua, Guadaloupe, St Vincent, Barbadoes, Trinidad, and the Bahamas. Leprosy is endemic in the elevated regions of Ecuador, and in various parts of Guiana, but its headquarters in South America are undoubtedly in Brazil, the provinces of Maranhao and Rio Grande being almost exempt. From the southern provinces of Brazil the area extends over Paraguay and the northern parts of the Argentine Republic, especially throughout the provinces of Entre Rios and Salta, and it stretches across the continent as far as the eastern frontier of Bolivia.

Remarks.—There seems to be no doubt now that leprosy is

both contagious and hereditary, and that it is caused by the bacillus leprae, but for the present we must confess ignorance as to its origin. It should be stated, however, that the production of leprosy has been ascribed to extremes and frequent and rapid transitions of temperature, associated with high degrees of atmospheric moisture, but a glance at the chart will disprove this idea. Again, it has been said that leprosy must bear a special relation to the sea coast; but although in isolated cases it does occur chiefly near the sea, its area of distribution completely disproves this theory. Various articles of diet have been blamed as its cause—fish diet, salt or rotten fish, immoderate use of pork, and the use of decomposed rice or maize. It is, however, impossible, after studying the subject, to arrive at the conclusion that any of these causes is the true one. The mere fact of the very definite isolation of the areas of endemic leprosy goes against these theories.

XI. Yaws.

(See Map VIII. A.)

Synon.—Framboesia; Button Scurvy; Verruga-Peruviana; Peruviana Wart; Buba or Boba, and Patta (West Indies); Framosi (Calabar); Tetia (Congo); Tonga or Coco (Fiji); Lupani and Tono (Samoa); *Fr.* and *Ger.* Pian.

Definition.—Yaws consists of an eruption of yellowish or reddish-yellow tubercles, which gradually develop into a moist exuding fungus without constitutional symptoms, or with such only as result from ulceration and prolonged discharge, namely, debility and prostration. It is epidemic, and contagious by actual contact. The period of incubation of the poison varies from three to ten weeks, and as a rule it only occurs once in a life-time.

Geographical Distribution.—In Africa, yaws is to be met with on the west coast, from Senegambia in the north, as far south as Angola, together with the westerly Soudan, where it is especially frequent in Timbuctoo and Bornu. It is occasionally seen in the Nile Valley, as well as on the northern and north-eastern African coast-line. It is very frequently met with in Madagascar, Mozambique, and the Comoros. In the East Indies it is chiefly seen in the Moluccas, Java, Sumatra, and Macassar; it is also

endemic in Ceylon, New Caledonia, Fiji, and Samoa; and it is met with amongst the Hindoo population of Pondicherry. In the West Indies it is endemic in San Domingo, Jamaica, Barbadoes, Martinique, Guadaloupe, Sta Lucia, and Dominica. It is found all over Brazil and in Guiana, and is said to be rather frequent at Punta Arenas in Central America.

Remarks.—Yaws is distinctly a tropical disease, and the poison, whatever it may be, depends for its production on extreme heat and moisture; but although these factors would appear necessary for its production, there must be other causes, for in some countries, as in India for example, where the same temperature and moisture exist, yaws is unknown. Negroes chiefly suffer from its ravages, but no race is exempt, although it must be admitted that it attacks Europeans with comparative rarity.

XII. Fungus Disease of India.

(See Map VIII. B.)

Synon.—Madura Foot; Mycetoma; Morbus tuberculosos pedis; Ulcusgrave; Podelkoma; *Fr.* Dégénérescence endémique des os du pied; Pérical; Keerenugra.

Definition.—A diseased condition of the hands and feet, occurring in India, characterised by enlargement and distortion of the affected extremity, due to thickening of the cutaneous tissues, with degeneration and subsequent fracture of the osseous structures. There are two varieties of this malady—one, the pale or ochroid form; the other, the melanoid or dark form.

This disease has been recognised since 1712, when Kampfer first called attention to it, but little definite was known about it until Goodfrey in 1846, and Vandyke Carter in 1860, investigated it thoroughly. In all probability, as Carter assumes, the disease is due to a parasite, but authorities still differ as to the nature of the parasite, and also as to the nature of the method by which it finds entrance into the hand or foot affected. It seems to be clear that it is not a constitutional disease, but the various theories which have been put forward as to its precise cause cannot be reconciled. Hindoos of all classes are affected by the disease. Mahommedans

are rarely attacked by it, and as yet there is no case on record of a European or half-breed suffering from it.

Geographical Distribution.—Broadly speaking, this disease is met with in its dark variety in Madras, Bombay, the west and north-west of India, whilst cases of the pale variety occur all over India. The Malabar coast and inland places near it are chiefly affected, and the disease is reported as being present at Pondicherry, Bellary, Tanjore, Guntoor, Madura (whence one of its names), Cuddapah, Trichinopoly, and Combacumum. It is also met with on the slopes of the western Ghauts, in Rutnagherry, Poonah, and other parts of the Bombay Presidency, as well as in Kattivar, Goojerât, and Cutch ; in Kurrachee and other places in Scinde ; in Bawalpur, Bicanir, and other parts of Rajpootana ; and in the Punjaub at Jhelum, and the North-West Provinces at Sarsa and Hissar. It is very rare in Bengal, and the cases met with in Calcutta are all imported.

Remarks.—It is most difficult to refer the cause of this disease to definite physical phenomena. It appears, however, that it is associated with certain definite local conditions, although what these conditions are it is hard to say. At the places where it occurs there is a heavy rainfall, the altitude of the district is not high, and as a rule the soil is moist, dolometic, and rich in vegetable matters. At the same time, it must be noticed that at Cuddapah the soil is clayey limestone, that at Pondicherry it is clay, and at Tanjore and in the places where the disease is known on the Malabar coast, the soil is alluvial. It is highly probable that the disease has an intimate relation to the soil; those most affected by it are persons employed in agriculture, and who go barefooted, exposing themselves thereby to wounds on the feet, which would readily permit the tissues to be invaded by a parasite, if a parasite, as we believe, causes the disease.

XIII. Elephantiasis Arabum.

(See Map IX.)

Synon.—Barbadoes Leg ; Cochin Leg ; Bucnemia indica ; Pachydermia ; *Fr.* Éléphantiasis ; *Ger.* Elephantiasis.

Definition.—A non-contagious disease, characterised by recurrence of febrile paroxysms, attended by inflammation and progressive

hypertrophy of the integument and areolar tissue, chiefly of the extremities and genital organs; occasionally by swelling of the lymphatic glands, enlargement and dilatation of the lymphatics, and in some cases by the co-existence of chyluria, and the presence in the blood of certain nematoid hæmatozoa; together with various symptoms indicative of a morbid or depraved state of nutrition.

Geographical Distribution.—Although elephantiasis may be occasionally seen in all parts of the world, it is endemic in circumscribed areas, in tropical and sub-tropical countries; in these areas of distribution it is not uniformly present, but is almost always limited to well-defined foci. In India, the disease is frequently met with along the littoral of Lower Bengal, in Pondicherry, and at a few other points on the Coromandel coast. It is especially frequent in the district of Tanjore, but most of all on the Malabar coast (principally in Travancore and Cochin). It occurs at Ramghar, Chota-Nagpore, Sirgooja, and in the district of Tirhoot. In Ceylon the headquarters of the disease are on the coast, especially between Colombo and Matura. In the East Indies the places most severely affected are Sumatra, Banka, the Nicobars, and Philippines. In Further India it is met with in Penang and Cochin-China. In China elephantiasis is principally seen on the southern and south-eastern coast districts, especially at Canton, Amoy, Shushan, and Shanghai. Some of the worst regions of endemic elephantiasis are to be found in the Polynesian Archipelago, *e.g.*, the northern part of New Caledonia, the Tonga and Fiji groups, the Samoa group, Wallace Island, the Society Islands, especially Tahiti, and Raiatea, and the Gambier group. Elephantiasis is less frequently seen in the Marquesas and Hawaiian islands. In equatorial and sub-tropical Africa and the adjoining islands, elephantiasis is very common, especially in Réunion, Mauritius, Seychelles, Madagascar, Nossi-Bé, the Mozambique and Zanzibar coasts, the coasts of Senegambia and Liberia, and the Guinea coast as far as the equator. Further inland elephantiasis is met with in the Cameroons, in Bornu, and Sego; and a few cases occur in Tunis, Algiers, and Egypt, not far from the sea coast, and in the swampy valleys of the interior of Abyssinia. Throughout the whole of the upper Nile valley and the adjacent districts isolated cases only are met with, save in the Bari and Madi districts, where

it is more frequently seen. It is said to be often found to the west of Lake Nyassa. In the western hemisphere elephantiasis is met with in New Granada, Venezuela, and Peru, in those parts of Brazil which are mostly tropical in character, on the coasts and marshy levels of Guiana, on the Gulf coast of Central America and of Mexico. Elephantiasis is also seen in the following islands of the West Indies:—Barbadoes, Martinique, Guadaloupe, Trinidad, St Vincent, and St Bartholomew.

Remarks.—Although sporadic cases of elephantiasis are met with occasionally in Turkey, the south of France, Lisbon, and the south of Spain, as well as on the east coast of Scotland and in some parts of the south of Ireland, the endemic area of elephantiasis is from 35° N. to 25° S. in the eastern hemisphere, and 25° N. to 30° S. in the western. We must, therefore, consider that the disease for the most part depends upon high temperature and much atmospheric moisture for its production. Where cases occur outside the limits indicated above, it is in connection with moist soil and humid atmosphere, such as is met with on sea coasts and the banks of rivers. Climate not only appears to influence its production, but variations in temperature undoubtedly bear some relation to its growth, and some observers have maintained that it has a lunar periodicity. At any rate, as Hirsch says, "the more flat and damp the ground is in a tropical or sub-tropical piece of country, the more suited does it seem to be for the endemic existence of elephantiasis." Various theories have been advanced to explain the production of this disease. It has been said to be due to fish forming the staple of diet, to the drinking of water rich in saline constituents or tainted by organic matters; and others have thought that it is a form of malarial poisoning, but there are numerous facts which prevent these views from obtaining general assent. It is, however, agreed by nearly all observers that the disease attacks principally the male sex, of dark races, over twenty years of age. Before concluding this note, it may be remarked that there is an increasing number of observers who believe that the cause of elephantiasis is the *filaria sanguinis hominis*; the maps show how far the distribution of this parasite is identical with that of elephantiasis.

XIV. Guinea-Worm.

(See Map X.)

Synon.—Dracunculus; Filaria medinensis.

Definition.—The Guinea-worm is a nematoid parasite, usually measuring from 1 to 3 feet in length, and having a breadth of $\frac{1}{10}$ of an inch. It infests the feet and legs, as well as other parts of the body that are much exposed.

Geographical Distribution.—As a general rule, the Guinea-worm is only found in the tropical parts of the eastern hemisphere, and even there the area of its endemic distribution is limited. It may, however, be conveyed from place to place, and, although rarely, become propagated in a fresh locality. In Africa, the principal area in which the Guinea-worm is found extends from Senegal as far as Cape Lopez. In Senegambia it is met with, not only on the coast, but in that more elevated region which extends from Bakel to Galam, but the parasite does not infest the banks of the Casamance. The Sierra Leone coast is less extensively infested by Guinea-worm than the Grain coast, Ivory coast, Gold and Slave coasts; it is met with on the shores of the Niger and Gaboon. It is to be noticed that on these coasts various places, such as Cape Coast Castle, Elmina, Cormantia, and Accra, are especially affected, whereas the surrounding country is very often free from the parasite. The Guinea-worm is found throughout Sennaar, the southern district of Kordofan, and the whole of the Bahr-el-Ghazel, the district between Dem Suliman and the Sobat being very extensively affected. It is doubtful if it exists south of latitude 6° N., and in Abyssinia the parasite is limited to the sea coast.

In Asia the endemic seats of the Guinea-worm are Arabia-Petræa, a few points on the coast of Hedjaz and Yemen, and the south coast of Persia. It is said to have been met with in the Bay of Skanderoom, and it is known in some parts of Turkestan, in Khiva, Bokhara, and Kokaun, on the shores of the Sir-Daria and on the northern shore of the Caspian (lat. 47° N.). In India the Guinea-worm is most widely diffused in the northern division of the west coast, the Rajpootana States, and the western parts of the Deccan. It rarely occurs in the North-West Provinces, where it is only known at Dehra Dhun, Sirsa, and Hansi. The parasite is also rarely met

with on the coast of the Madras Presidency, being chiefly seen near Madras and Pondicherry. It is known too in the plain of the Carnatic, from Mysore between the eastern and western Ghauts towards Cape Comorin. On the western sea-board the worm is found in the Bombay Presidency from lat. 18° N. up to Goojerat, at Rutnagherry, Matunga, Bombay, and Daman; also at Baroda, Caira, and Jambosir, and at Bhooj in Cutch. Great centres of the disease are met with in the Mewar and Marwar (Rajpootana States), in the district of Chanda, at Dhoolia in Khandeish, at Nagpore, in Behar, at Aurungabad, Jalnah, Hyderabad, and Secunderabad, on the east side of the western Ghauts and in the adjoining districts of the Deccan, where it is especially prevalent at Ahmednuggar, Jedjhuri, Baramati, Poona, Satara, Aculcota, Tasgoon, Miraj, and Beejapore, the district of Savant-Warri, Balgâm, Darwar, and Bellary.

In the New World the disease was imported from the west coast of Africa into Guiana, Brazil, and the West Indies, but it has almost disappeared except at the island of Curaçoa, and in the small town of Feira da Santa Anna in the province of Bahia.

Remarks.—It is useful to remember certain facts with regard to Guinea-worm. In the first place, all races of both sexes and at all ages may suffer from it, but it certainly attacks by preference natives who go about barefooted, and it is most usual in middle life. In all probability it gains entrance into the body by direct contact of an exposed part of the body with water or mud, the parasite penetrating the pores of the skin. There have been many attempts made to connect the occurrence of the Guinea-worm with the geological features of the soil where it is found, but, although on the whole it is most prevalent in localities composed of secondary trap rock, it is also met with where the geological structure is sand on sandstone. There is a certain relation between heat and moisture and the production of the parasite. It is found in places where there is a mean temperature in summer of about 88° F. On the whole, the Guinea-worm is most frequently met with at the beginning of the rains, and in the hot weather succeeding them, although it appears to be the case that in India it is most usually found during the rains. It is impossible to say how long is the period of the incubation of the Guinea-worm, but it probably varies from one month to a year, and with regard to the part of the

body in which it makes its appearance, in at least 95 per cent. of the cases, it is met with in the lower extremities. In a person suffering from Guinea-worm the first symptom usually noticed is a cord-like substance felt beneath the skin. There is usually some pain, and more or less fever, the temperature of the patient being sometimes exceedingly high. As the worm commences to make its exit from the body, a small blister forms at the point it selects for its escape; this blister is often surrounded by a distinct rash.

XV. Filaria Sanguinis Hominis.

(See Map XI.)

Definition.—The *Filaria sanguinis hominis* is a nematoid hæmatozoon, about the thickness of a hair, and from 3 to 4 inches in length, which is found in the blood of some animals and men.

Its geographical distribution is of importance, because when the parasites gain entrance into a human being, in the tropics at any rate, they frequently induce chyluria, lymphorrhagia, elephantiasis, lymphangiechodes, chylous hydrocele and varicocele, and possibly also true elephantiasis arabum. It may be incidentally remarked, that the filaria are almost invariably totally absent from the blood during the day—*i.e.*, from 9 A.M. to 6 P.M. They commence to appear between 6 or 7 in the evening, rapidly increase in number until their maximum is reached about 2 or 3 A.M., and then gradually disappear.

Geographical Distribution.—As far as we are yet aware, the *Filaria sanguinis hominis* occurs principally, if not entirely, in tropical regions. It is known to be indigenous in the following regions, but it is not improbable that future observations will show its distribution to be rather greater than that which we can now give to it. Commencing with Brazil, it is most extensively distributed throughout the tropical parts of that country, excepting however the southern districts and the province of Sta-Caterina. In all probability, too, it occurs in Chili, Peru, Venezuela, and Mexico, as also in Guiana. It certainly occurs in Barbadoes, Cuba, Mauritius, St Domingo, and St Thomas. In Africa it is found in Egypt, on the shores of the Zambezi and Lake Nyassa, the Zanzibar coast, Mauritius, and Réunion; it is probably indigenous on the west coast, and it has been met with in various districts of the Negro part

of the Egyptian Soudan (Bari and Madi districts, Bahr-el-Ghazal, and Uganda). In Mayotte and Madagascar it almost certainly occurs, and it probably exists in Queensland. The *Filaria sanguinis hominis* is extensively found throughout China and India, but curiously enough, the Dutch East Indies and Formosa are free from it.

Remarks.—From what has been said, it will be seen that the habitat of the *Filaria sanguinis hominis* is confined to the tropical or sub-tropical regions, and it is also of great interest to notice that the mosquito forms its intermediate host. As was mentioned above, the *Filaria* are found during the night in the blood, and consequently in the subcutaneous capillaries, where the mosquitos are able to reach them. In the insect's stomach they undergo developmental changes, and they are probably discharged with the larvæ of the mosquito into drinking water, and by this means again conveyed into the human subject.

XVI. Scurvy.

(See Map XII.)

Synon.—Scorbutus; *Fr.* Scorbut; *Ger.* Scharbock.

Definition.—Scurvy is characterised clinically by intense general debility; sponginess and swelling of the gums; ecchymoses closely resembling bruises, about the thighs and legs; a brawny hardness about, and sometimes a contraction of, the muscles of the calf; pearly conjunctivæ; and a sallow aspect, somewhat akin to mild jaundice.

Geographical Distribution.—Apart from the occurrence of scurvy at sea and amongst troops on campaign, and outbreaks of it, which occasionally occur all over the world in prisons, and among emigrants who have rapidly settled in given districts, scurvy is still endemic in some parts of the world. In Russia we find one of the chief seats of the disease at the present time. It is endemic in the Baltic provinces and at St Petersburg, in the governments of Olonetz and Novgorod, along the shores of the Arctic Ocean and other parts of the Siberian littoral, such as the Amoor region and at Kamtschatka. It is endemic in Asiatic Russia, along the Chinese frontier, and also at Tomsk. It is met with in the government of Kasan, but more especially in the southern provinces of the empire—

e.g., Jekaterinoslav, the Steppes of Saratov, the Ukraine, the adjoining districts of western and little Russia, and in the Crimea; also in Kutais (Trans-Caucasia). The area of endemic scurvy in southern Russia joins an endemic district in Roumania. In Sweden scurvy may be said to be endemic only in the neighbourhood of Umea, in the districts of Udewalla and Jemtlandslän; and in Norway it is endemic in Finnmarken.

Scurvy is endemic in various countries in Asia. We meet with it on the Yemen coast of Arabia, especially at Aden; in some parts of India, *e.g.*, North-West Provinces, Rajpootana, and Malwa; in Cochin-China, the northern part of China, particularly at Pekin, and in Japan. In Australia it is endemic in the north-west of New South Wales; and it occurs endemically on the Darling Downs.

In Africa scurvy is met with in the eastern Soudan, and throughout nearly the whole of the rainy zone of Africa, especially during the overflow of the Nile. On the west coast of Africa it is also endemic in Benguela, and on the Gold and Ivory coasts.

In the western hemisphere, endemic centres of scurvy are found in the most northern latitudes, in Greenland, Alaska, and the Ottawa district of Canada.

Remarks.—There are several points in regard to the geographical distribution of scurvy which are well worthy of notice. Apart from its production in jails and camps, during sieges, and in armies on the march, it is also met with amongst explorers and at sea. It is seen too very frequently in damp low-lying localities, where the soil is highly impregnated with saline matter, chiefly nitrate of potash, and where consequently the production of vegetables is scanty; or else in arid regions where cultivation is not practised. A number of general causes, apart from mere locality, predispose to this disease. Malaria, fatigue, a humid atmosphere, great variations in temperature, bad water, insufficient clothing, and residence in crowded or ill-ventilated rooms or cabins, all seem to invite the onset of the malady, although, as a matter of fact, its absolute occurrence is due to the want of fresh anti-scorbutic vegetables or of lime-juice, which, when not too old, takes their place.

XVII. Tropical Abscess of the Liver.

(See Map XIII.)

Synon.—Hepatic Abscess; *Fr.* Abscés du Foie; *Ger.* Leberabscess.

Definition.—An abscess of the liver, due to hepatitis, sometimes, but not always, associated with malaria or dysentery.

Geographical Distribution.—Tropical abscess of the liver is met with all over the Indian Peninsula, except in the very highest altitudes, but it is most frequent in the Madras Presidency. It also occurs in Ceylon, in Burmah and in the Peninsula of Malacca. In Cochin-China, the Chinese ports, and in the southern and subtropical parts of Japan it is not so frequently met with, and it is exceedingly rare in the northern parts of Japan. The chief seats of the disease in the East Indies are the coast of Java, Sumatra, and Borneo, and the island of Luchon (Philippines). It is much less frequently found in Banka, Celebes, Moluccas, the Riouw-Lingga Archipelago, and the Andamans. It occurs in Polynesia, especially in New Caledonia, and more rarely in the Hawaiian Islands and Tahiti. Tropical abscess of the liver is very prevalent in the tropical parts of Persia and Arabia, especially in the neighbourhood of the Persian Gulf and Red Sea.

In African regions the disease is most often found in Réunion, Mauritius, Madagascar, Mozambique, Nubia, and Egypt; less frequently on the Zanzibar coast; it is very prevalent in Senegambia, on the coast of the Bight of Benin and the Bight of Biafra, on the Slave and Gold Coasts, and on the island of Fernando Po. But along the coast farther south it becomes less prevalent, and is extremely rare south of the Congo.

In South America it is found in Chili, especially in the north, in the coast and forest regions of Peru, in Venezuela, and rarely in Brazil and Guiana. It occurs in Panama, and is said to be known in Costa Rica, Guatemala, and Salvador. The disease is sometimes to be seen in Mexico, more especially on the west coast.

In Europe abscess of the liver occurs in Turkey and Greece, southern Italy, and southern Spain.

Remarks.—Although abscess of the liver is occasionally met with in temperate zones, it is of endemic occurrence only in the tropics.

The statistics showing the frequency of the disease are chiefly based upon the records which refer to Europeans in the tropics, but it also affects the natives of tropical places.

There is no doubt that congestion of the liver in the tropics is brought about by heat and malaria, and that it most frequently occurs in the cold or rainy season. It is to a great extent caused by the great diurnal fluctuations of temperature, the days being very hot and the nights cold, but this is not the only cause. Malaria may, and probably does, predispose to tropical abscess of the liver, on account of the congestion of the liver caused by it, and yet the areas of distribution of the two diseases do not coincide. Alcohol is another cause of the disease in question; this is shown by the fact that it occurs chiefly in Europeans, and in Europeans of the male sex; also that natives who ape European customs of drinking suffer severely, and that Mohammedans are very rarely affected.

It was at one time very generally thought that dysentery was the great cause of tropical abscess, but this is not the case. The two diseases do occur together sometimes, and abscess of the liver may cause dysentery, but many things go to prove that dysentery is not the cause of abscess of the liver. In very many instances *post-mortem* examinations have revealed no intestinal lesion at all in the case of deaths from abscess of the liver. Dysentery occurs in temperate climates, but is not there followed by abscess of the liver, as would be the case were it the cause of that disease. Again, in the tropics women suffer very rarely from abscess of the liver, but are as liable to dysentery as men are. Dysentery is very common in Egypt, whereas abscess of the liver is of very rare occurrence there. Lastly, children are very frequently the victims of dysentery, but not of abscess of the liver.

To what, then, is abscess of the liver due? To the action of excessive heat (and possibly too to the amount of moisture in the air), to chills caused by great diurnal fluctuations of temperature, and to the consumption of a too stimulating diet with regard to both food and drink.

A few general remarks must bring this paper to a close. I have endeavoured as briefly as possible to call attention to the various physical phenomena which may influence the production or spread

of the various diseases dealt with. Although it must be allowed that such factors as heat, moisture, the character of the soil, and so forth, do exert a great effect on the production of disease, it is most difficult to estimate justly or with accuracy the parts they severally play in the etiology of disease. A wide field for further research presents itself in this direction, and one of my objects in compiling this paper has been to draw attention to a subject which deserves close and extended investigation.

In looking at the maps which I have drawn, it will be seen, on comparing them with Map XIV., that all the diseases depicted, with the exception of scurvy, are endemic in various areas where the highest mean annual temperature of the globe is to be found, and it will also be noticed that they are most prevalent in regions having a rainfall of over 50 inches in the year.

In investigating the etiology of tropical diseases, certain other factors have to be taken into account, factors which I have been obliged almost entirely to exclude from this paper, as, had I dealt with them, it would have involved considerable space and a much larger number of maps. The factors I refer to are the races inhabiting tropical regions, and their habits and customs, the geology and physical geography of the countries, and the character of the vegetation met with. The regions where the diseases I have included in my list are endemic are characterised by distinctive features with regard to food supply. They are chiefly, although not entirely, within the zone where a vegetable diet obtains, and where tropical grains and fruits are indigenous.

In conclusion, I should like to mention Dr Lawson's theory of pandemic waves of disease coinciding with the isoclinal lines which are found depicted upon Map XIV. For instance, in regard to fever, he believes there is a factor which determines its appearance at points more and more northward in successive years, and he apparently proves that this factor, whatever it may be, revives periodically every second year, or at some multiple of two years, and then passes over a more or less extensive portion of the earth's surface, giving epidemic impulse on its way to various diseases, and finally disappearing in the north. He found that the position of these pandemic waves, as he calls them, could be defined from year to year, approximately at least, by referring them to lines of equal

magnetic dip (isoclinal lines).* I think that this theory is well worthy of study.

I must reserve for the present any further elaboration of the subject of this paper, hoping to be able to resume it at a future time.

My thanks are due to Dr John Murray for permission to use Map No. XIV., and to Dr Buchan, Dr Woodhead, and Mr J. G. Bartholomew for some assistance and advice. My indebtedness to authors is acknowledged in the text.

EXPLANATION OF MAPS.

Map I.

Chart of the world showing the area of endemic and epidemic malaria. The colouring depicts, as nearly as possible on such a small scale, the severity of the disease in various regions.

Map II.

Chart showing the endemic habitat of Dengue and also the area of its epidemic spread. The darker colour shows where the disease is endemic.

Map III.

Chart showing—I. The native habitat of Asiatic cholera ; II. The area over which pandemic waves of cholera have spread ; III. Regions to which cholera has never penetrated ; IV. Districts from which no information is obtainable.

Map IV.

Chart showing—A, the area over which yellow fever is endemic and epidemic ; B, the districts in which Oriental boils or sores are endemic ; C, the limited areas in Africa and in the Mauritius in which, so far as yet known, endemic hæmaturia occurs.

Map V.

Chart showing—A, the areas in which Beri-Beri is met with; B, the districts which have been visited by Oriental plague during recent years.

Map VI.

Chart showing the geographical distribution of tropical dysentery, its prevalence being indicated, as far as possible, in the colouring. Its epidemic occurrence in non-tropical countries is also shown.

Map VII.

Chart showing the distribution of leprosy at the present time, its greatest prevalence being distinguished by the colour.

Map VIII.

Chart showing—A, the geographical distribution of Yaws ; B, the regions where the Fungus disease of India is met with.

* The *Milroy Lectures*. Lawson, 1888.

MAP IX.

Chart showing the geographical distribution of *Elephantiasis arabum* (Barbadoes leg).

MAP X.

Chart showing the distribution of Guinea-worm.

MAP XI.

Chart showing the geographical distribution of the *Filaria sanguinis hominis*, so far as at present known.

MAP XII.

Chart showing the occurrence of scurvy on land, as also the seas in which it is still sometimes met with in badly-found sailing ships.

MAP XIII.

Chart showing the distribution of tropical abscess of the liver. The regions in which it is most prevalent are indicated by a darker shade.

MAP XIV.

Chart of the world illustrating the mean annual temperature of the tropical and sub-tropical zones.

MAP XV.

Chart showing the mean annual rainfall throughout the world.

MAP XVI.

Chart showing—A, the isoclinal lines with reference to pandemic waves of disease ; B, the prevailing winds on the ocean.

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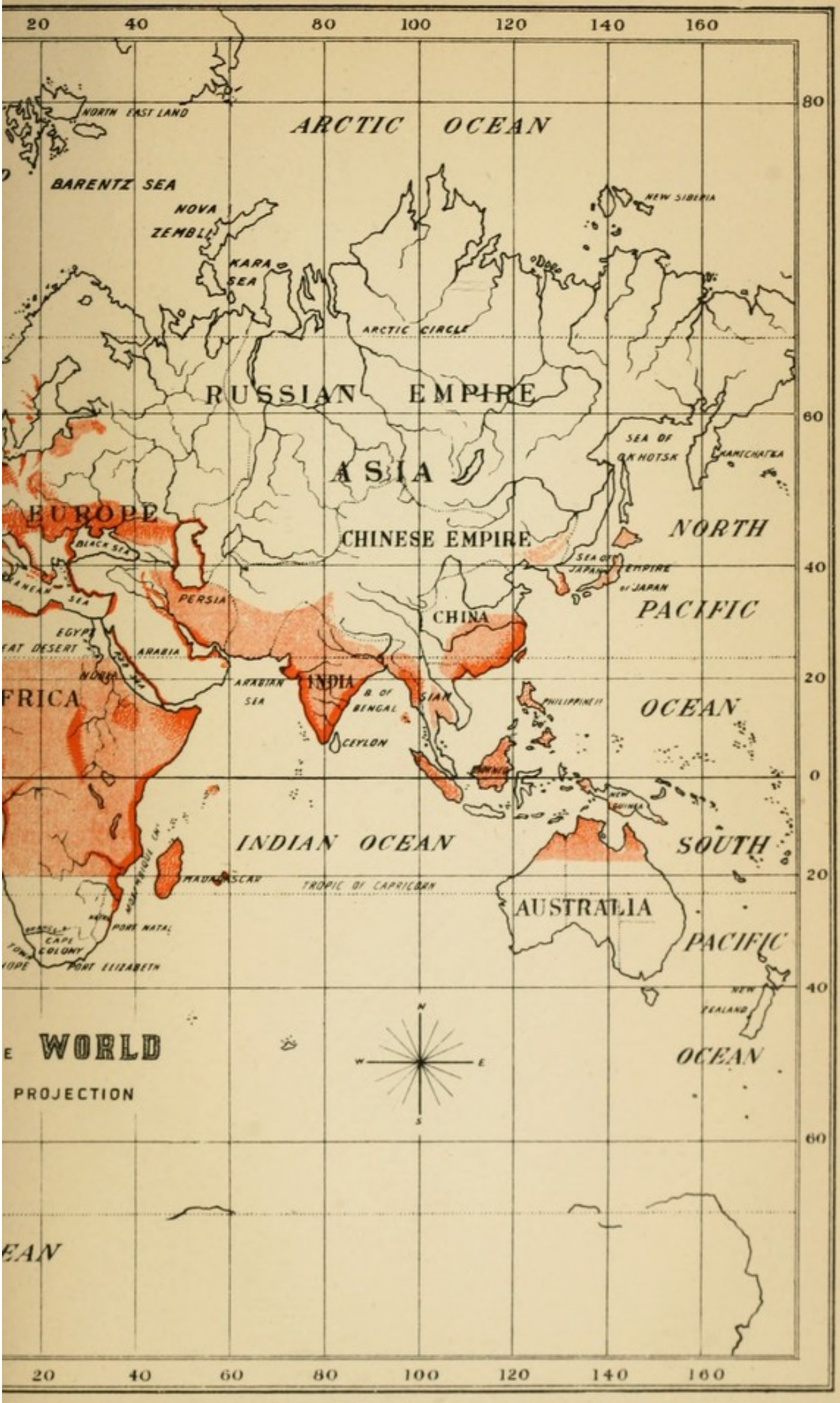
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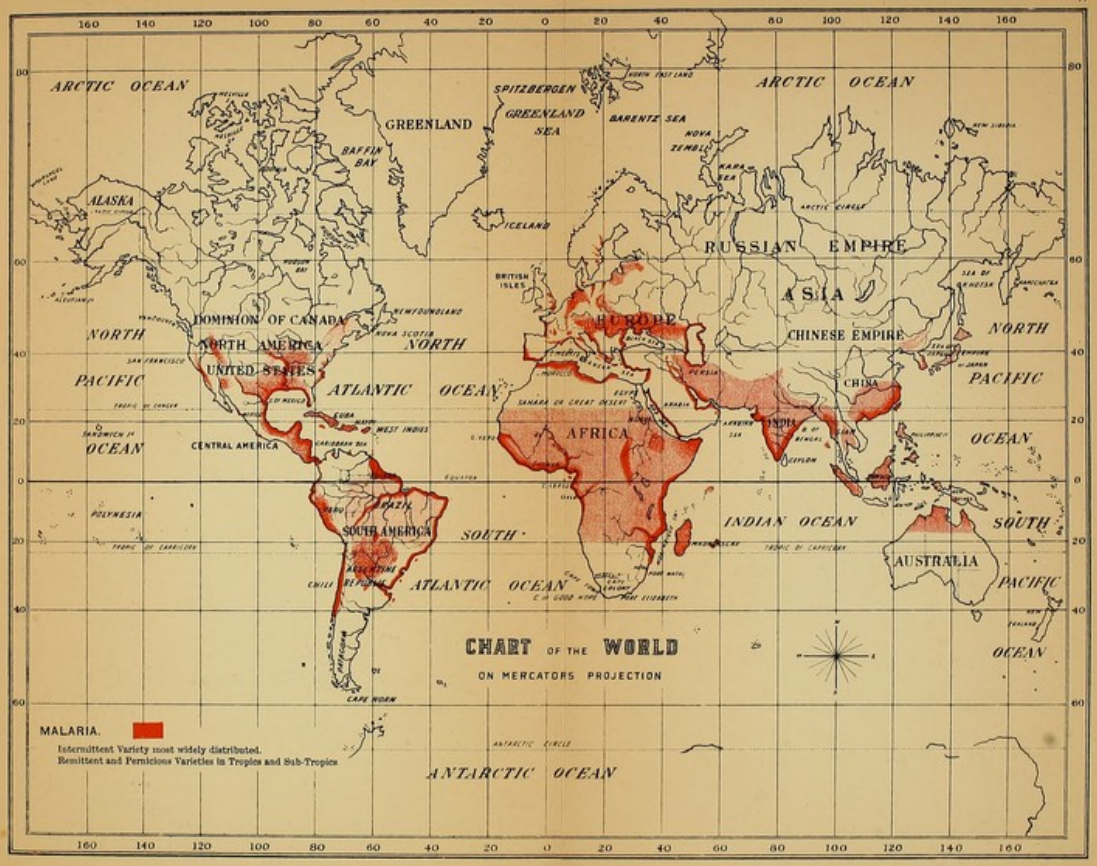
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CHART OF THE WORLD
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MALARIA.
Intermittent Variety most widely distributed.
Remittent and Pernicious Varieties in Tropics and Sub-Tropics
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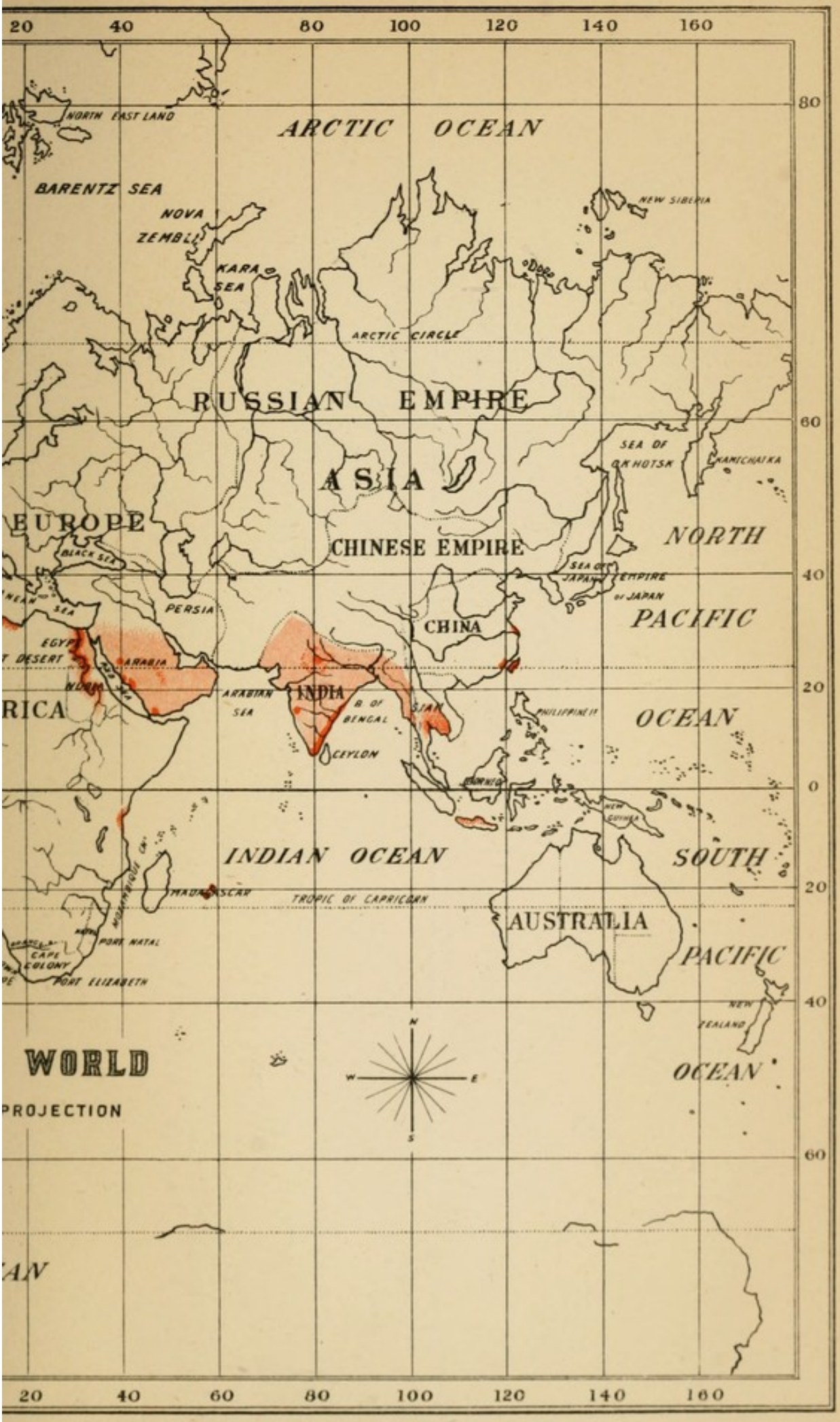
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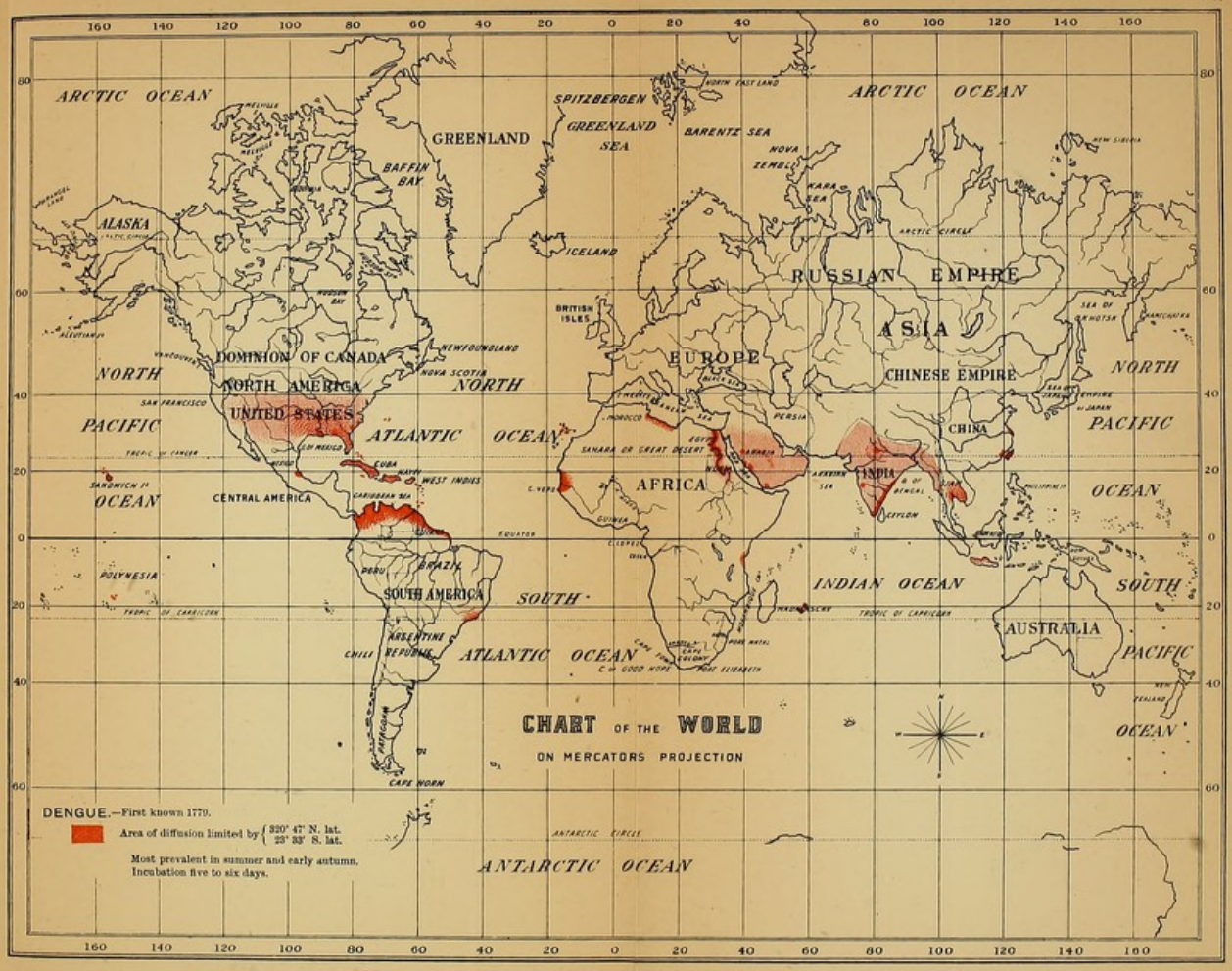
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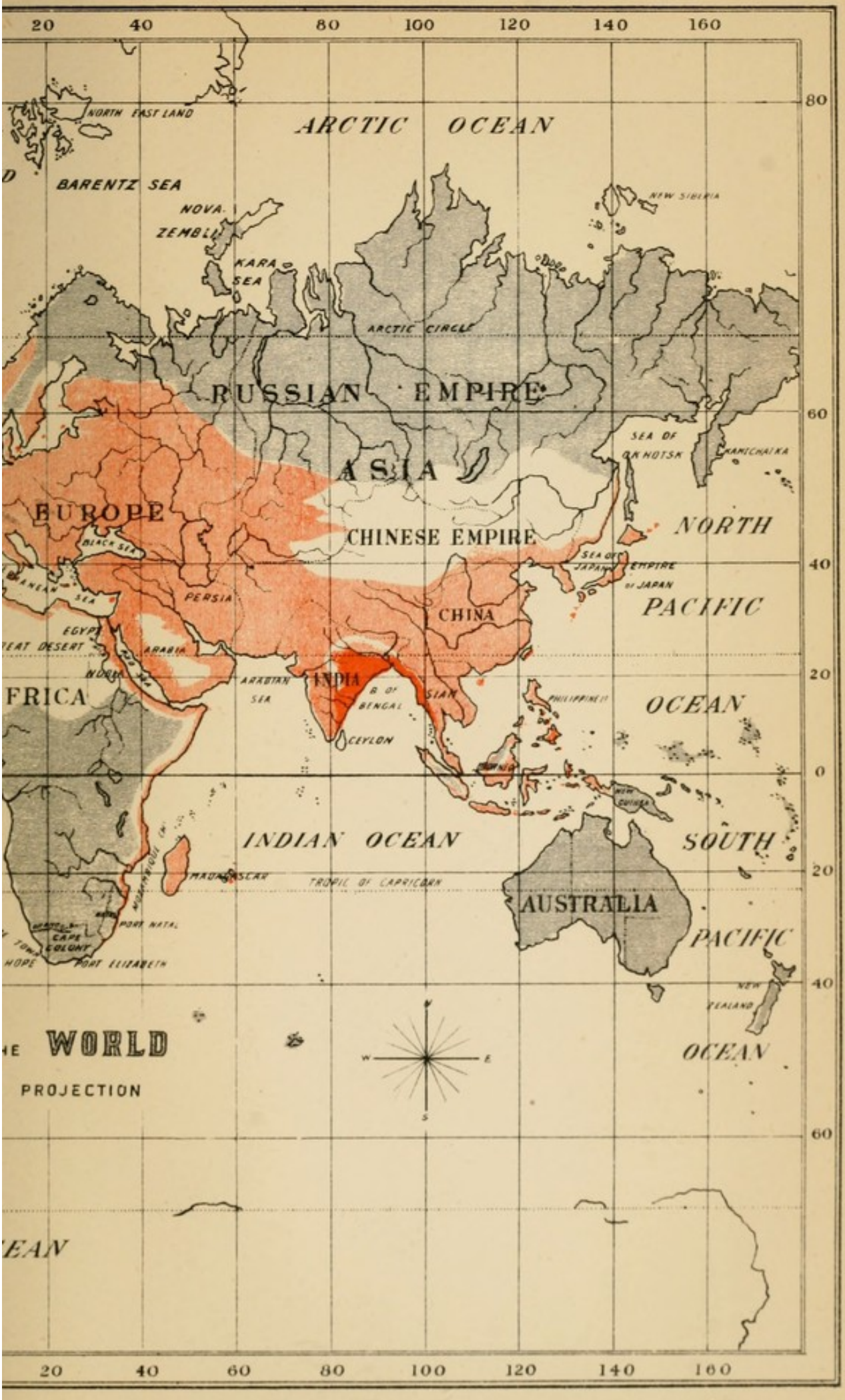
ANTARCTIC CIRCLE
ANTARCTIC OCEAN
DENGUE.—First known 1770.
Area of diffusion limited by { 320° 47' N. lat. / 23° 33' S. lat.
Most prevalent in summer and early autumn.
Incubation five to six days.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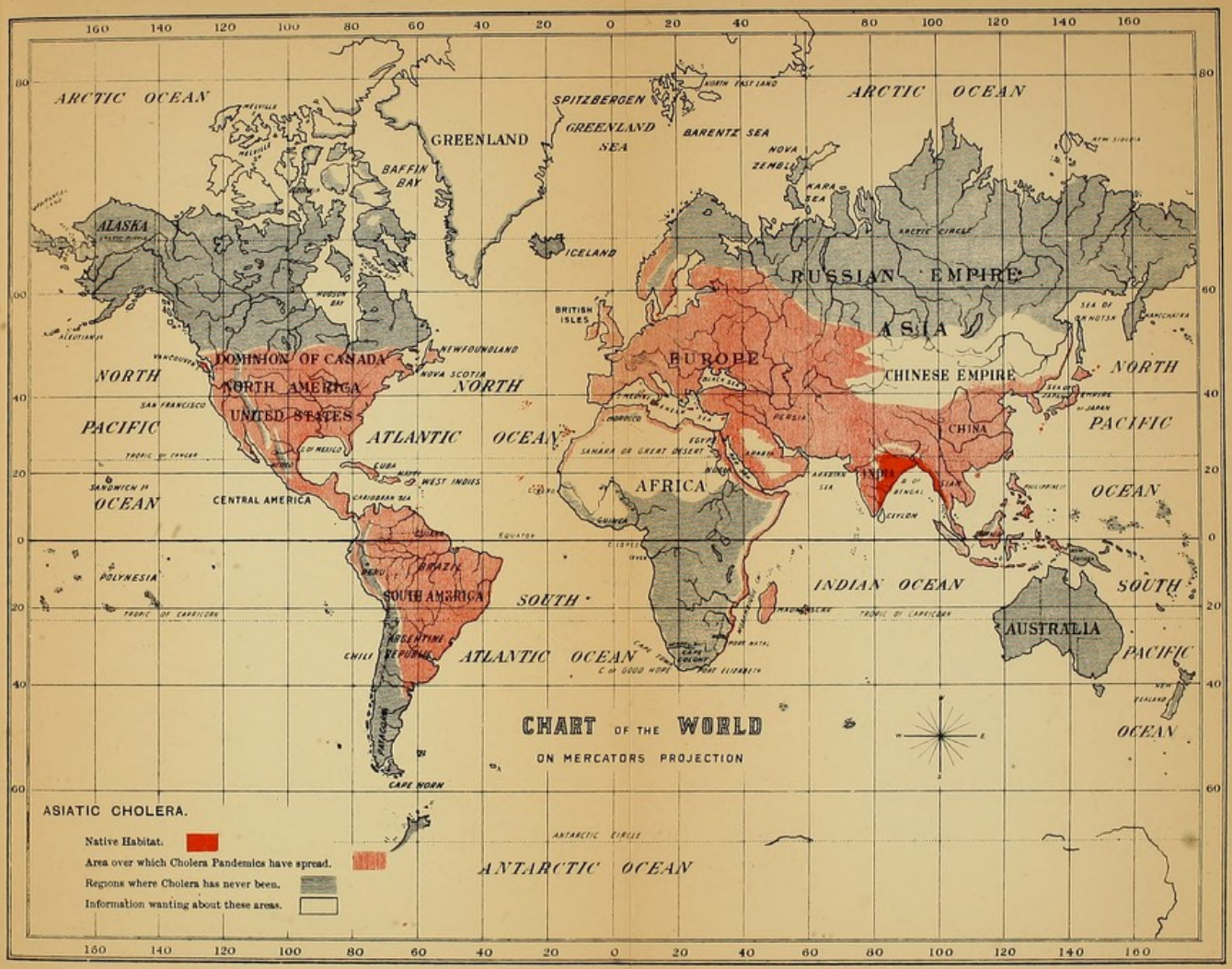
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CHART OF THE WORLD
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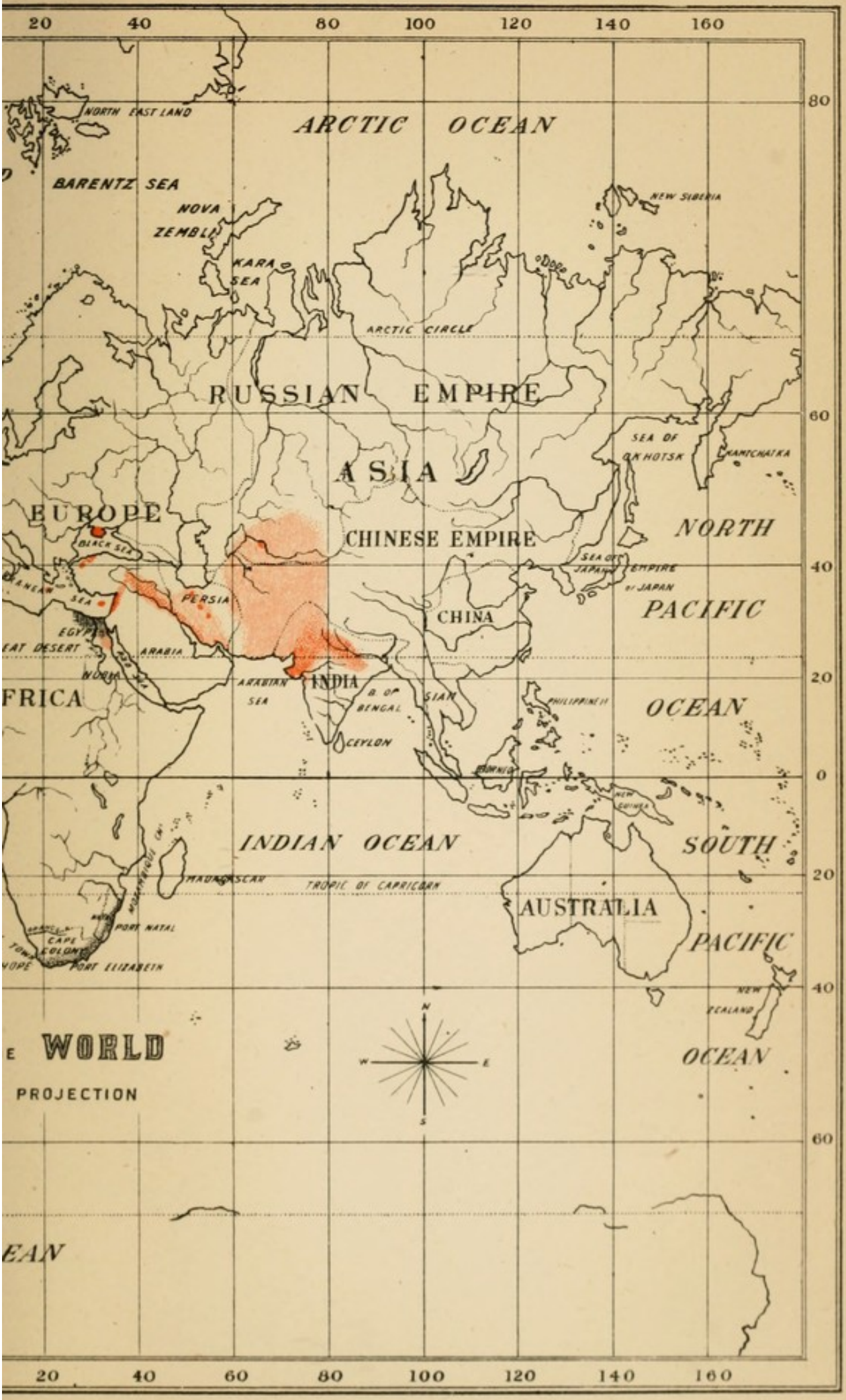
ASIATIC CHOLERA.
Native Habitat.
Area over which Cholera Pandemics have spread.
Regions where Cholera has never been.
Information wanting about these areas.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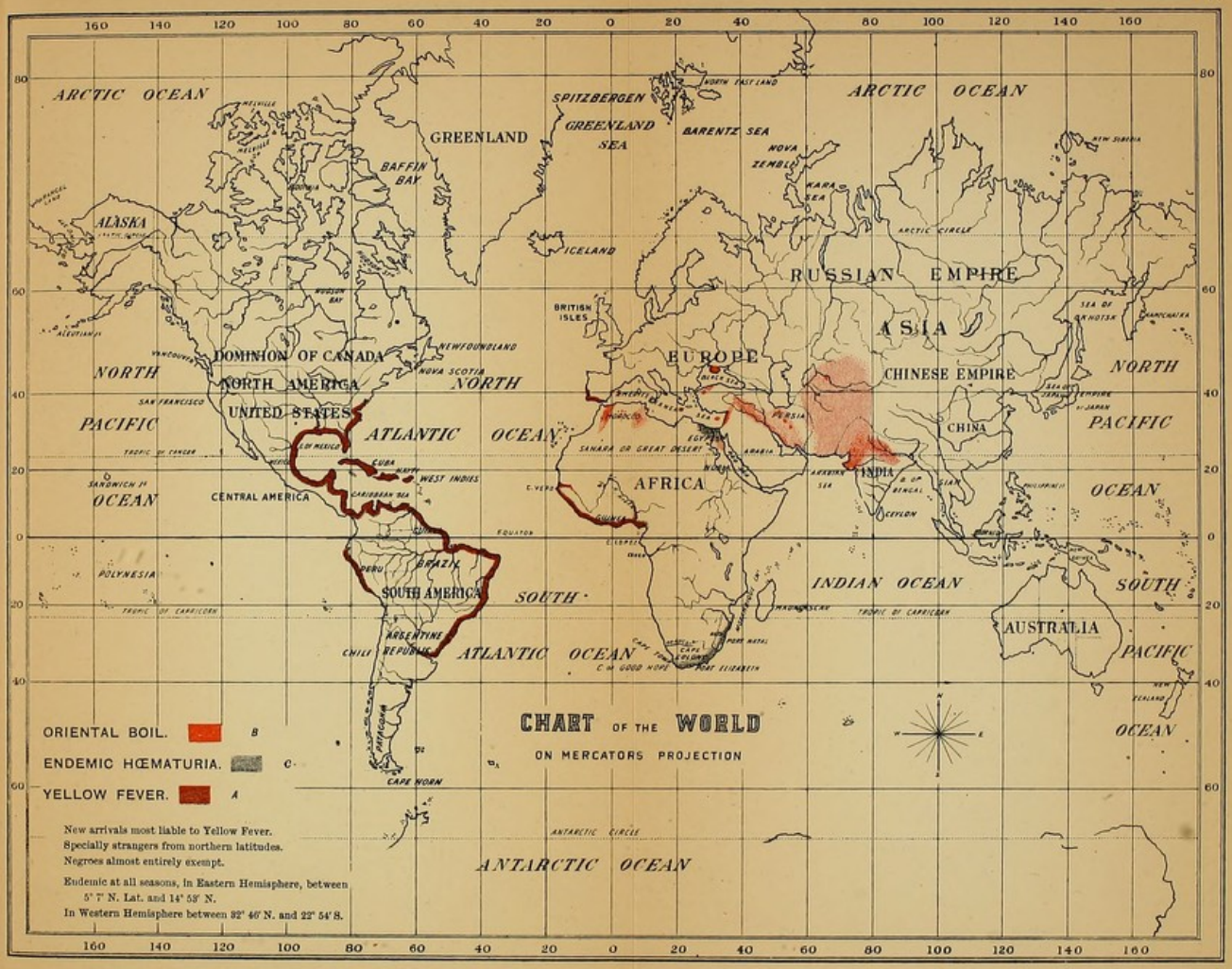
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ORIENTAL BOIL. B
ENDEMIC HŒMATURIA. C
YELLOW FEVER. A
New arrivals most liable to Yellow Fever.
Specially strangers from northern latitudes.
Negroes almost entirely exempt.
Endemic at all seasons, in Eastern Hemisphere, between 5° 7' N. Lat. and 14° 53' N.
In Western Hemisphere between 32° 46' N. and 22° 54' S.
CHART OF THE WORLD
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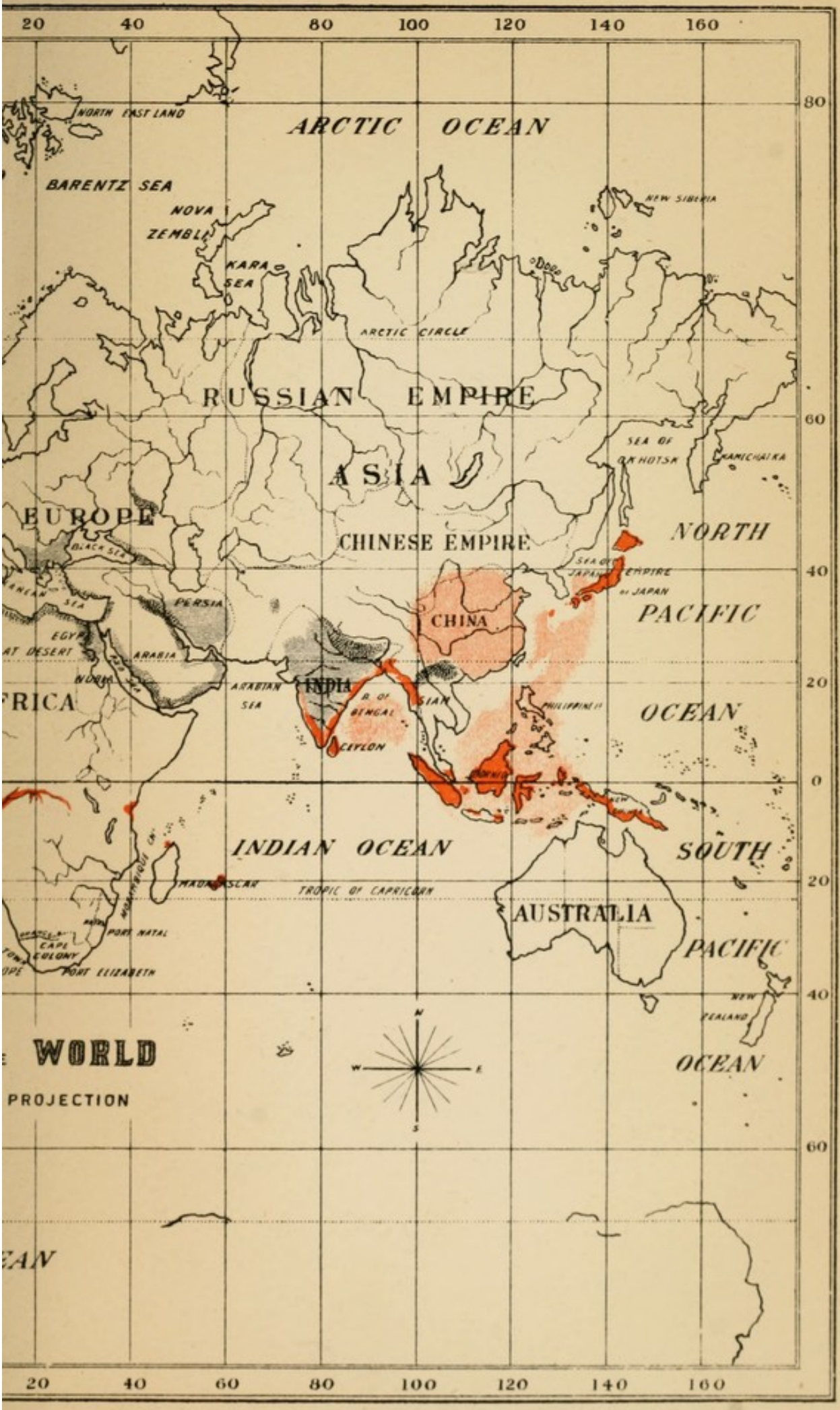
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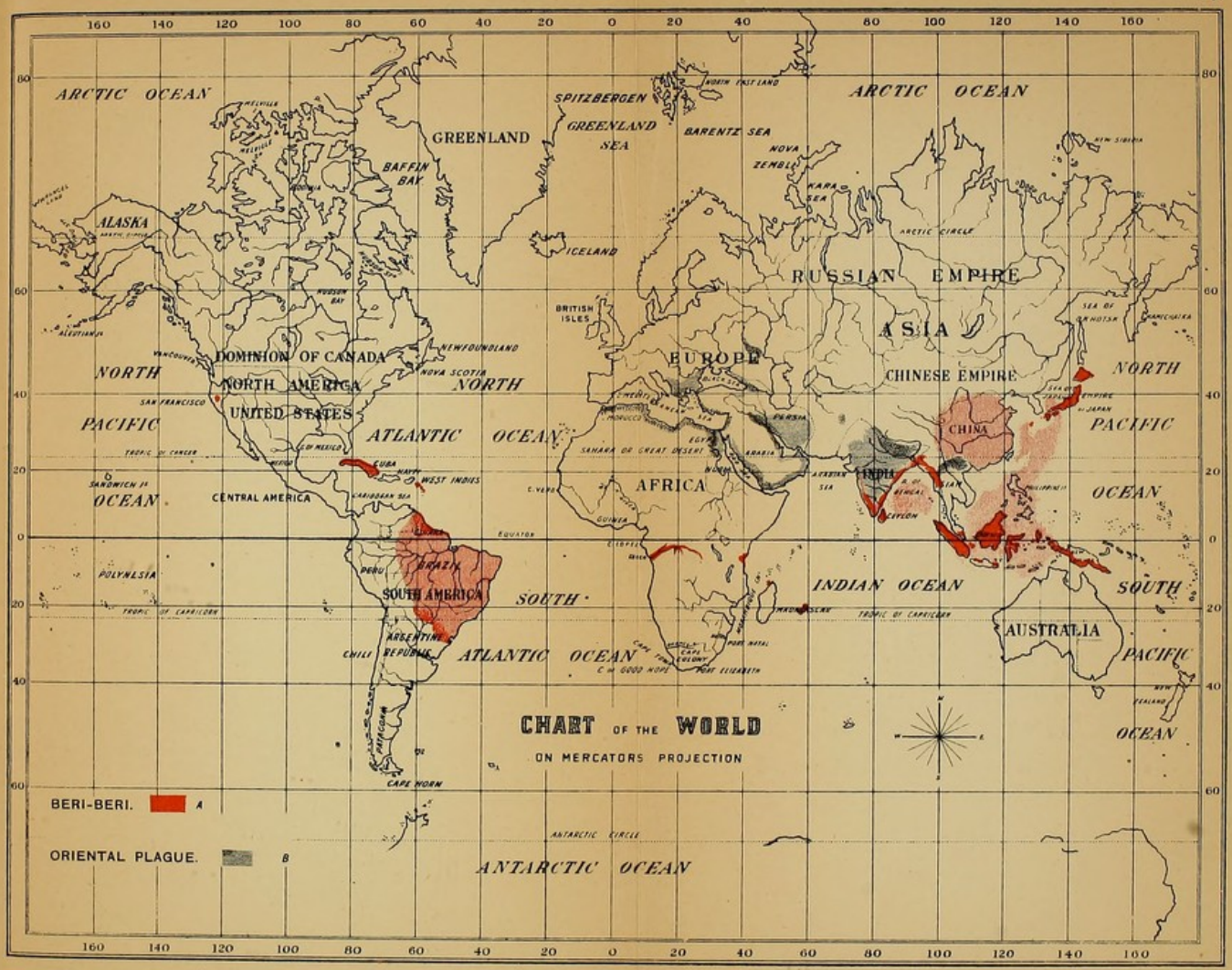
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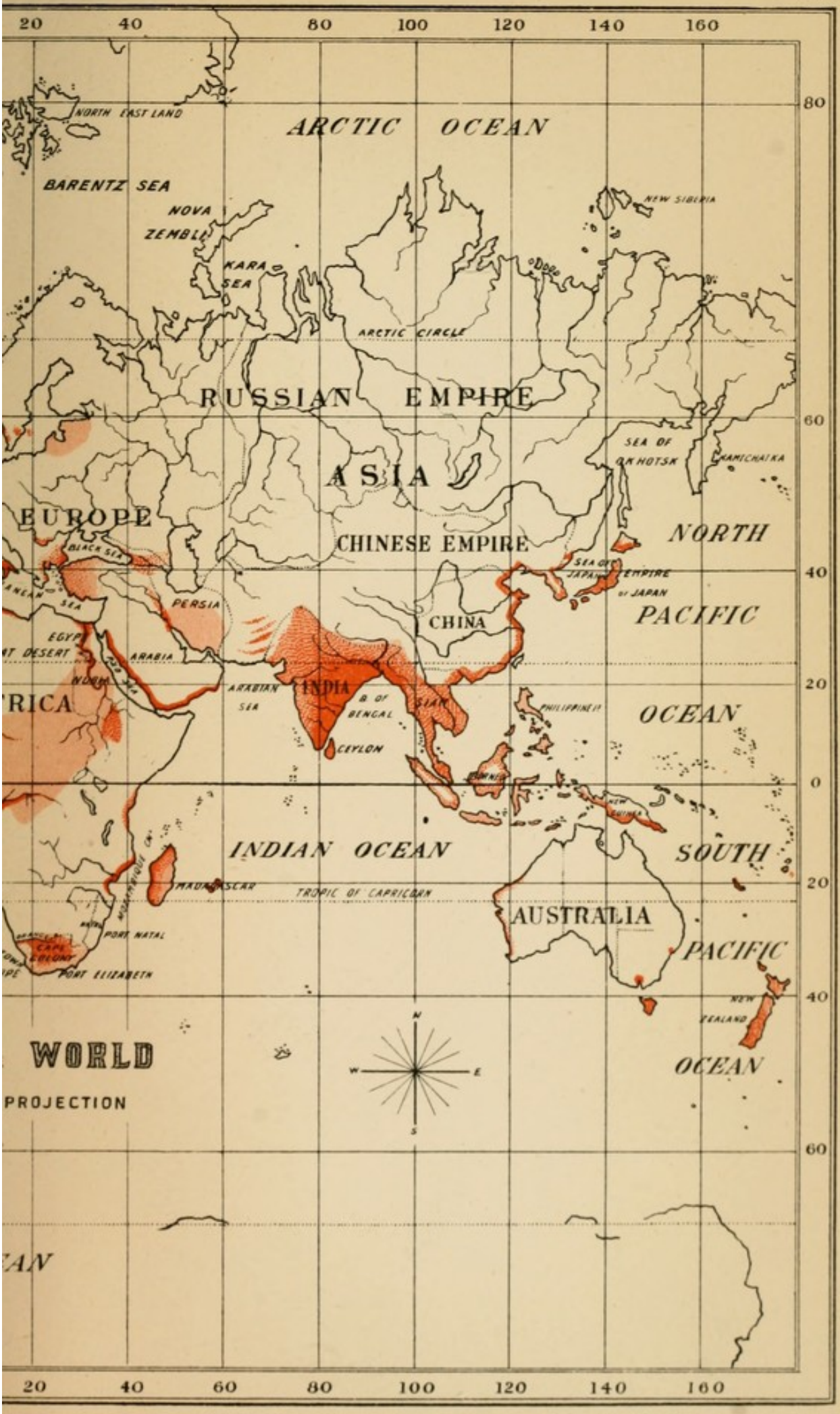
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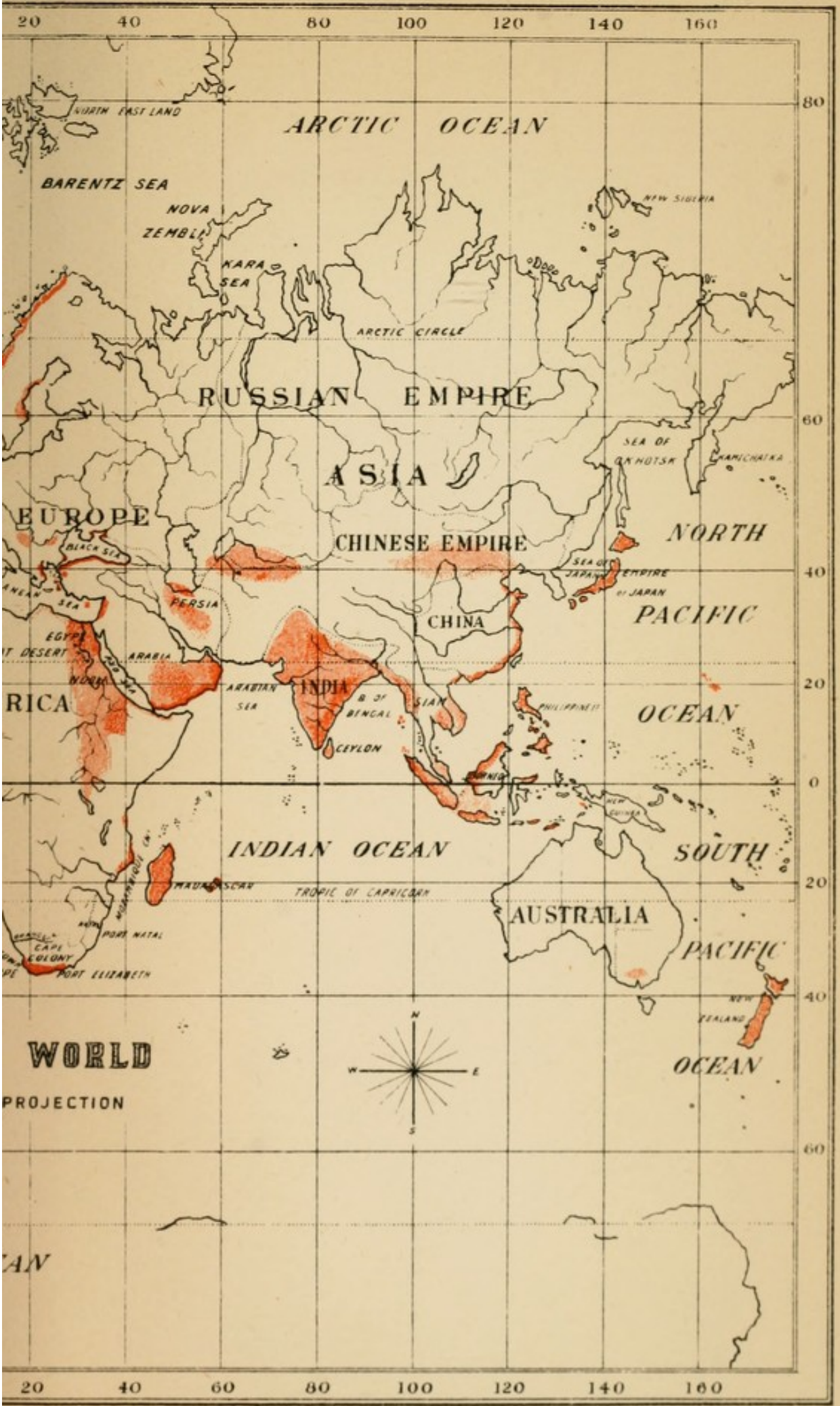
CAPE HORN
CHART OF THE WORLD
ON MERCATORS PROJECTION
TROPICAL DYSENTERY.
Endemic in the Tropics.
Epidemic in Temperate Zones.
ANTARCTIC CIRCLE
ANTARCTIC OCEAN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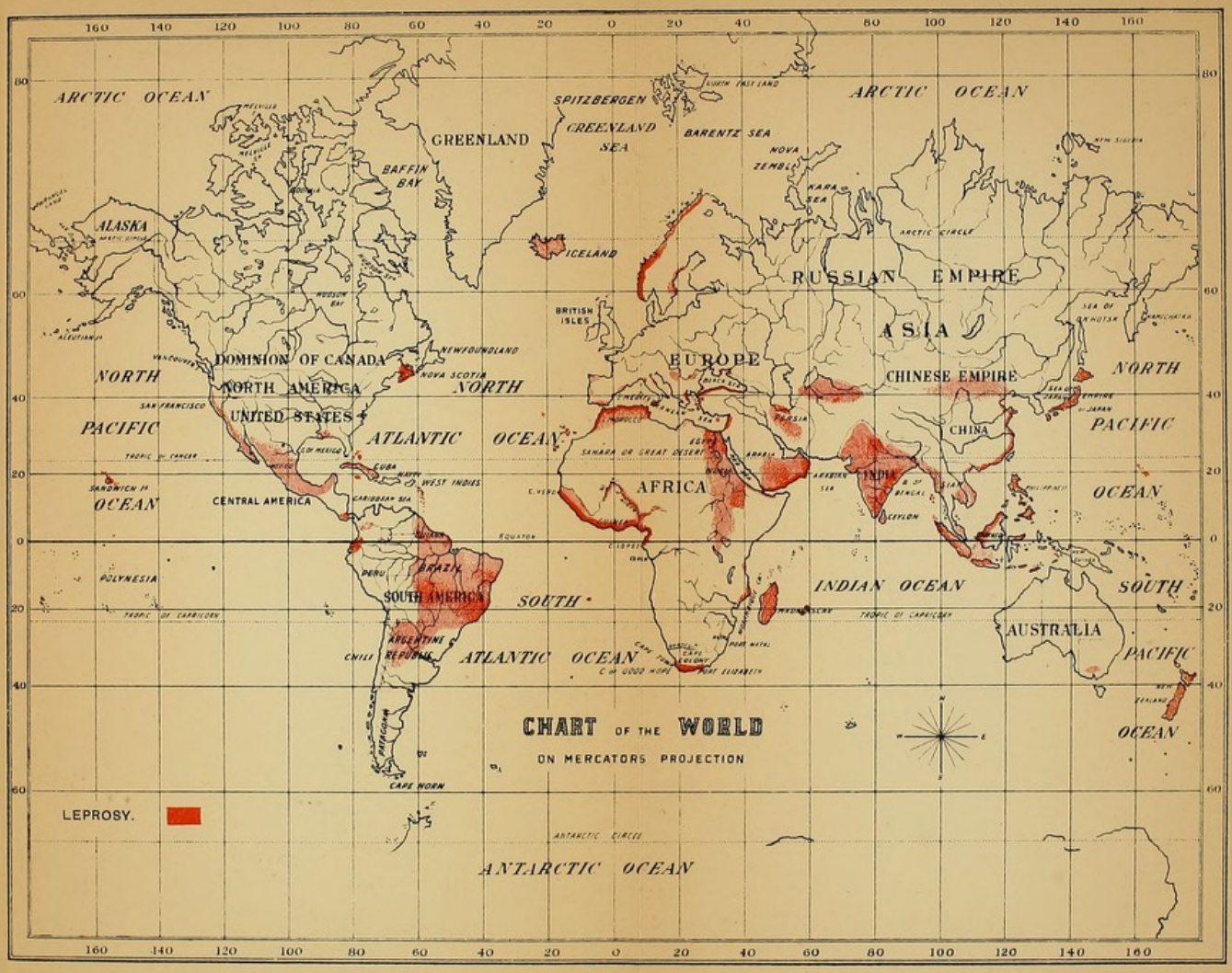
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LEPROSY.
ANTARCTIC CIRCLE
ANTARCTIC OCEAN


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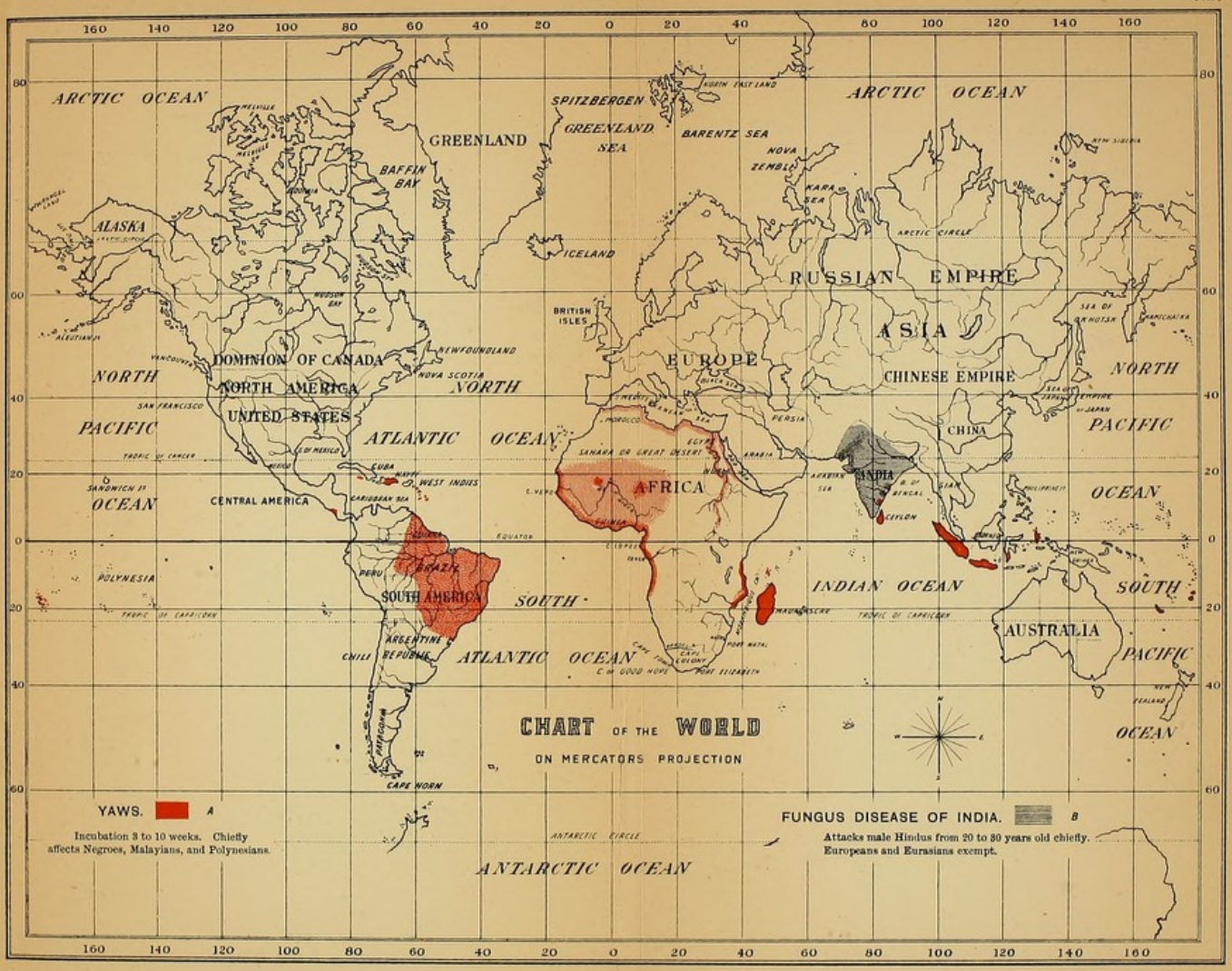
B
Attacks male Hindus from 20 to 30 years old chiefly.
Europeans and Eurasians exempt.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ANTARCTIC CIRCLE
ANTARCTIC OCEAN
CHART OF THE WORLD
ON MERCATORS PROJECTION
YAWS. A
Incubation 3 to 10 weeks. Chiefly affects Negroes, Malayians, and Polynesians.
FUNGUS DISEASE OF INDIA. B
Attacks male Hindus from 20 to 30 years old chiefly. Europeans and Eurasians exempt.


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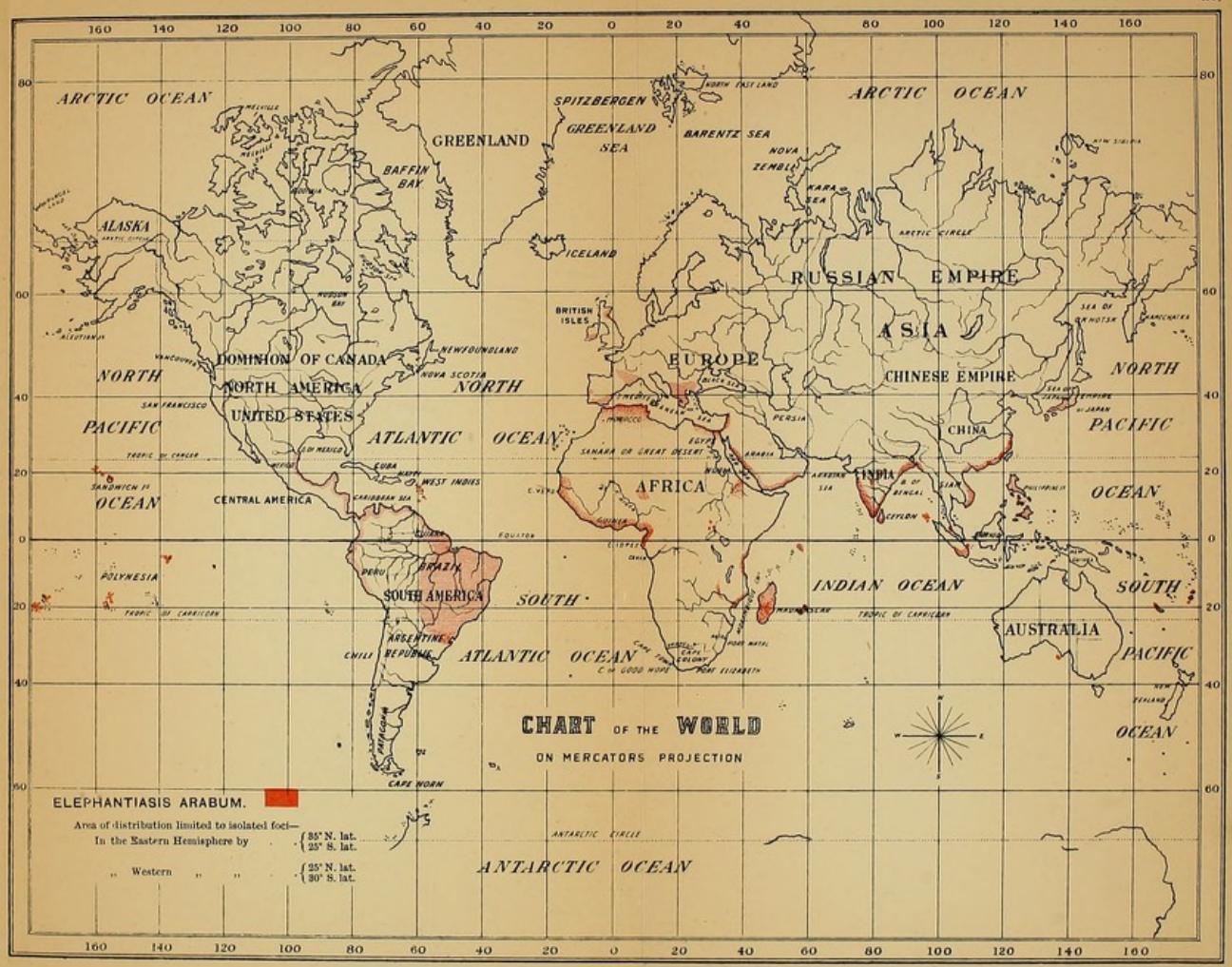
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CAPE HORN
CAPE OF GOOD HOPE
ANTARCTIC CIRCLE
ANTARCTIC OCEAN
CHART OF THE WORLD
ON MERCATORS PROJECTION
ELEPHANTIASIS ARABUM.
Area of distribution limited to isolated foci—
In the Eastern Hemisphere by 35° N. lat. / 25° S. lat.
" Western " " 25° N. lat. / 30° S. lat.


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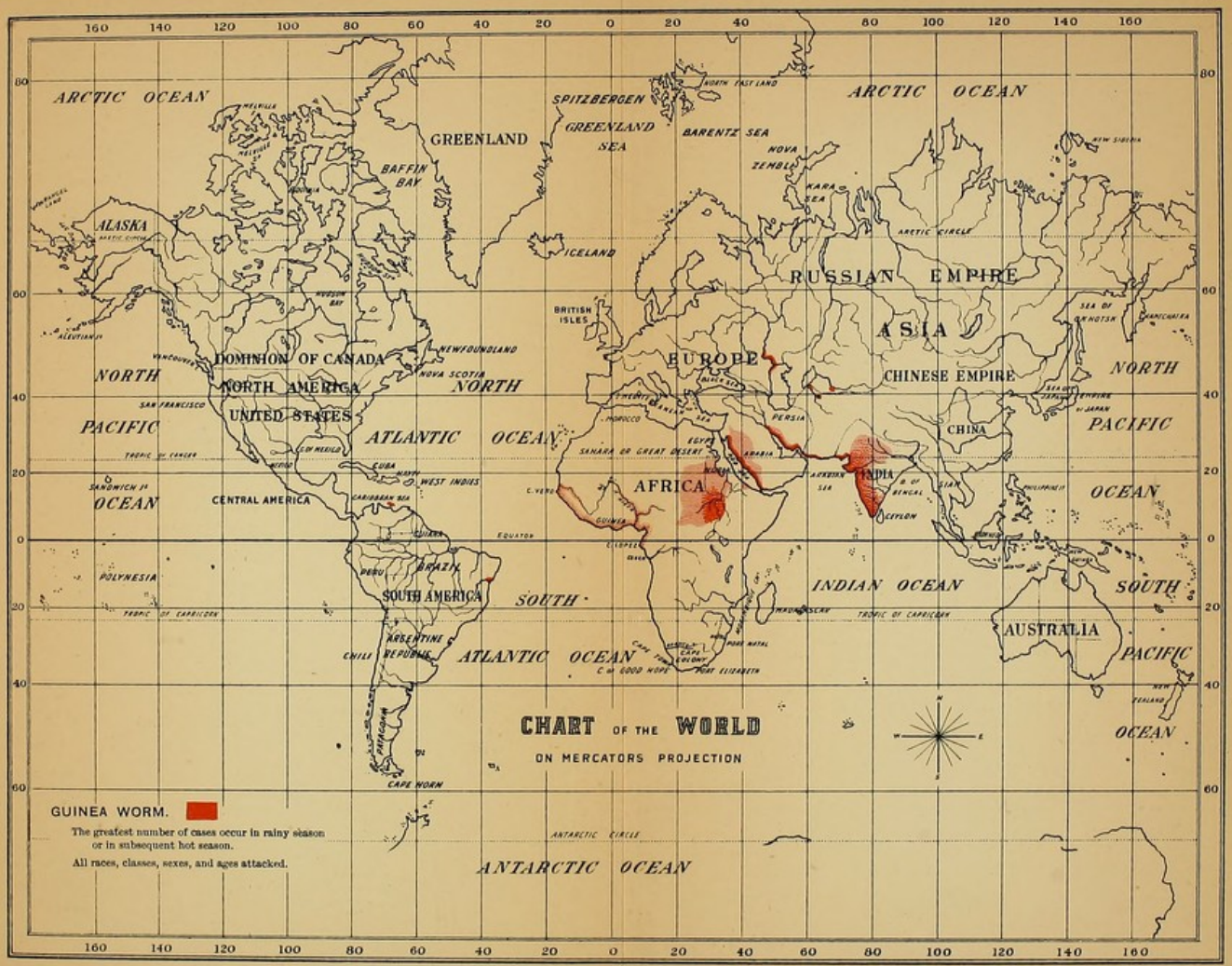
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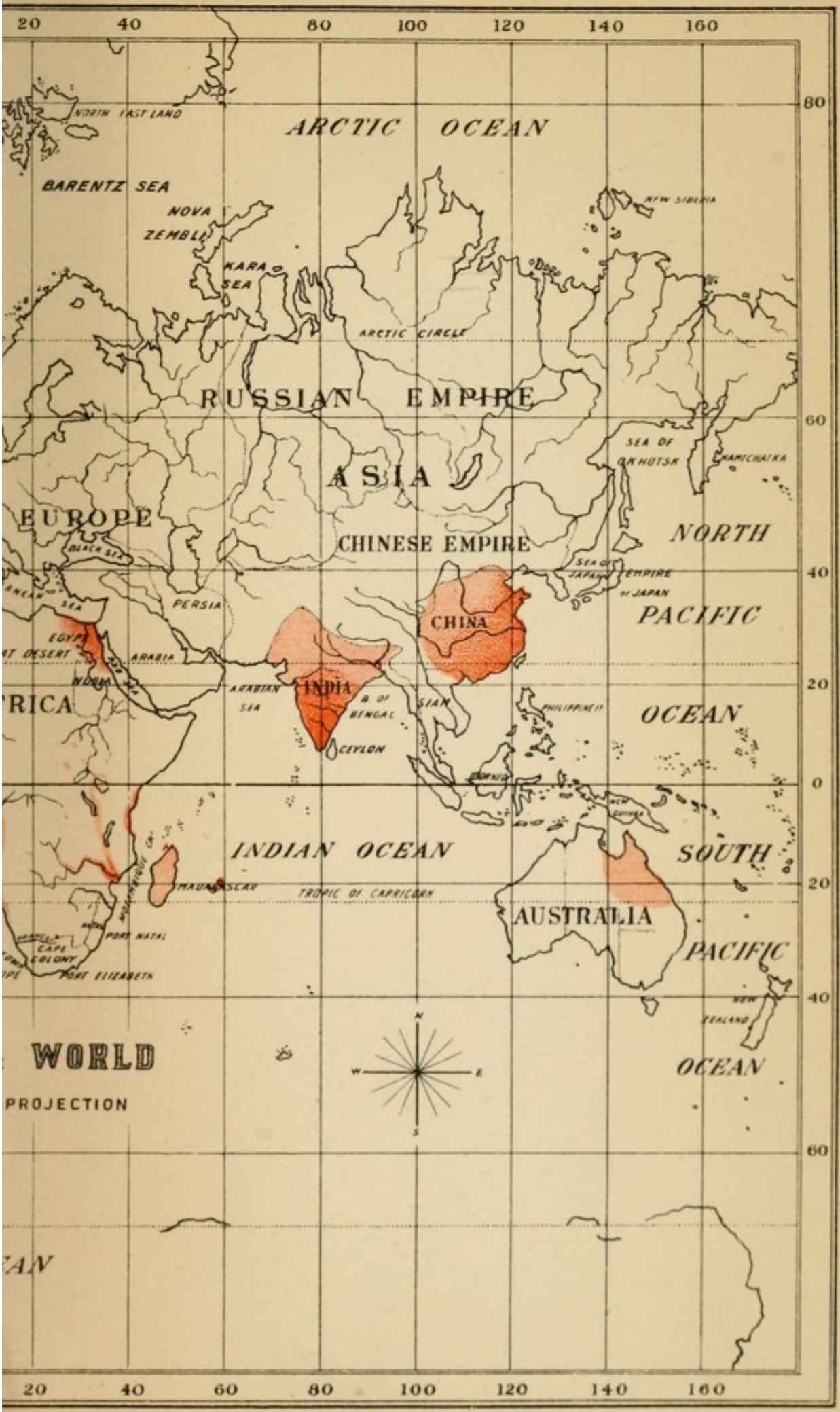
CHART OF THE WORLD
ON MERCATORS PROJECTION
CAPE HORN
ANTARCTIC CIRCLE
ANTARCTIC OCEAN
GUINEA WORM.
The greatest number of cases occur in rainy season or in subsequent hot season.
All races, classes, sexes, and ages attacked.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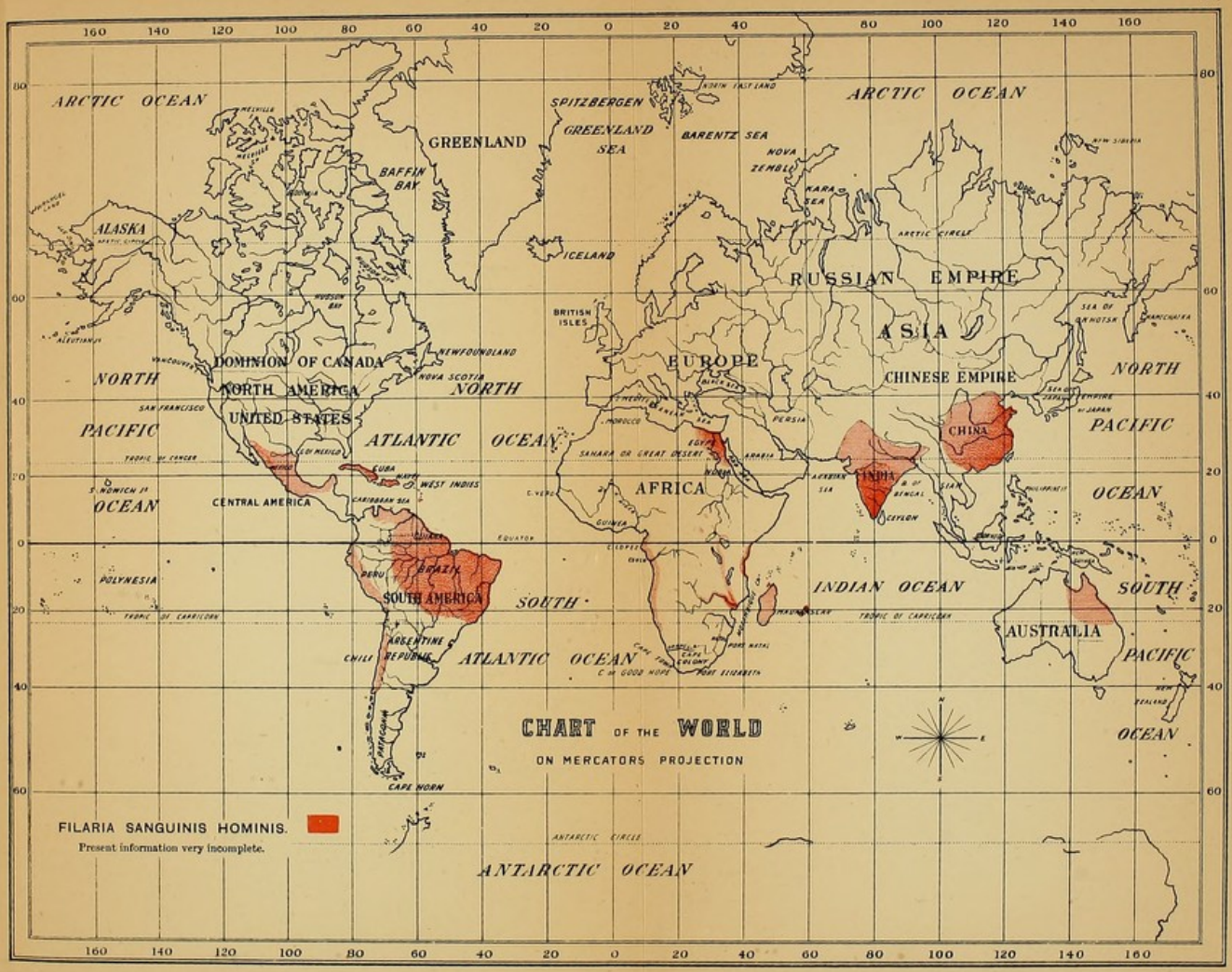
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ON MERCATORS PROJECTION
FILARIA SANGUINIS HOMINIS.
Present information very incomplete.


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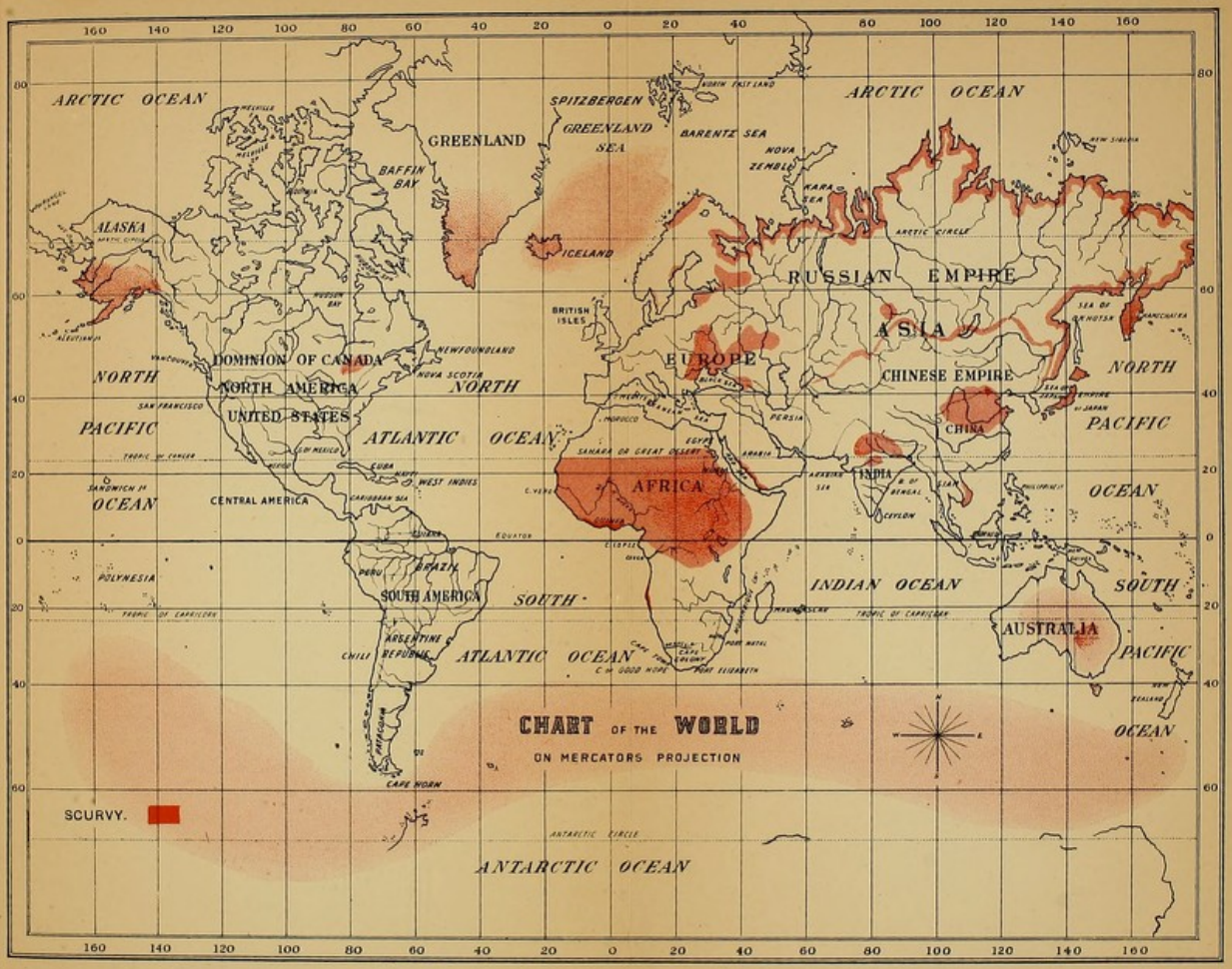
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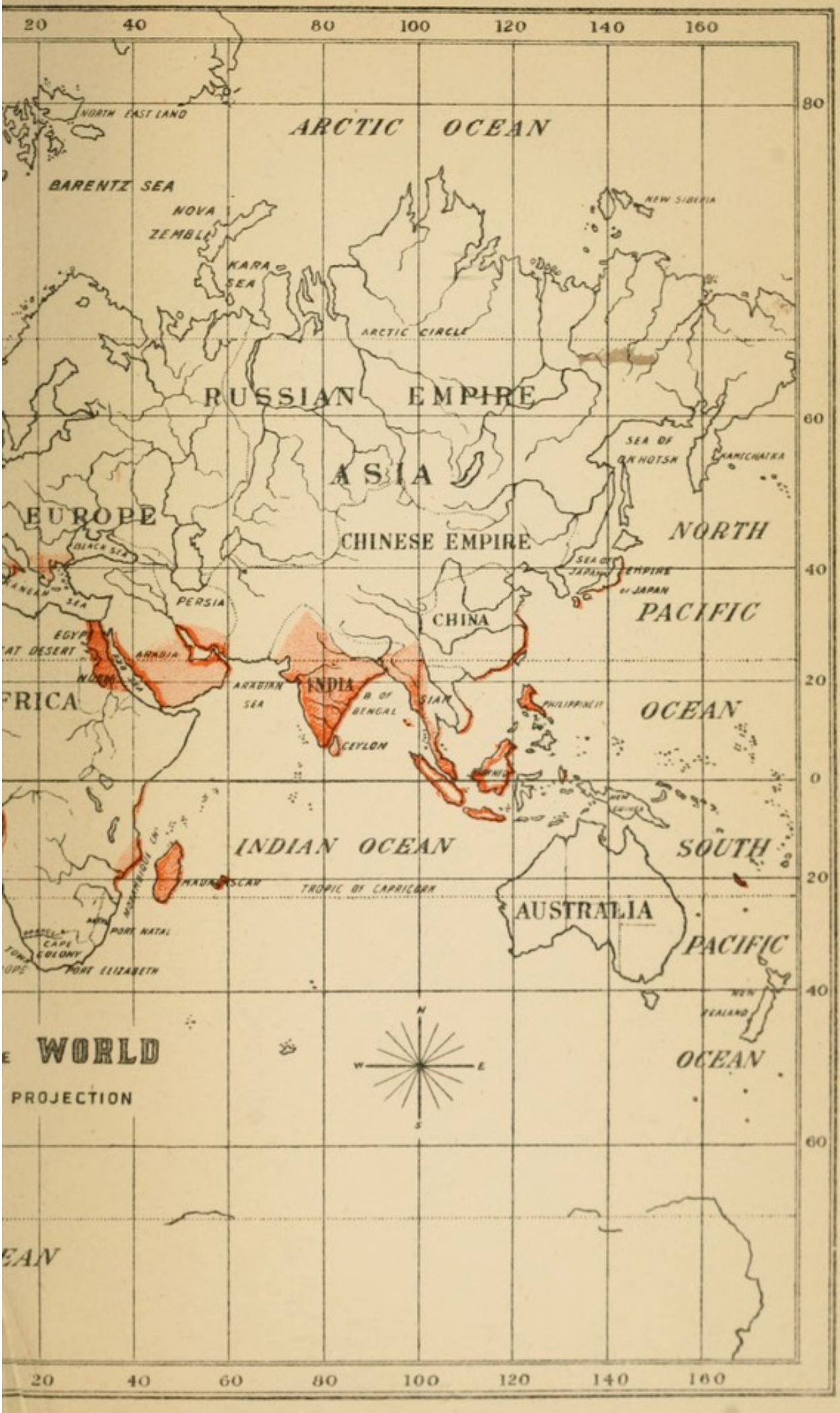
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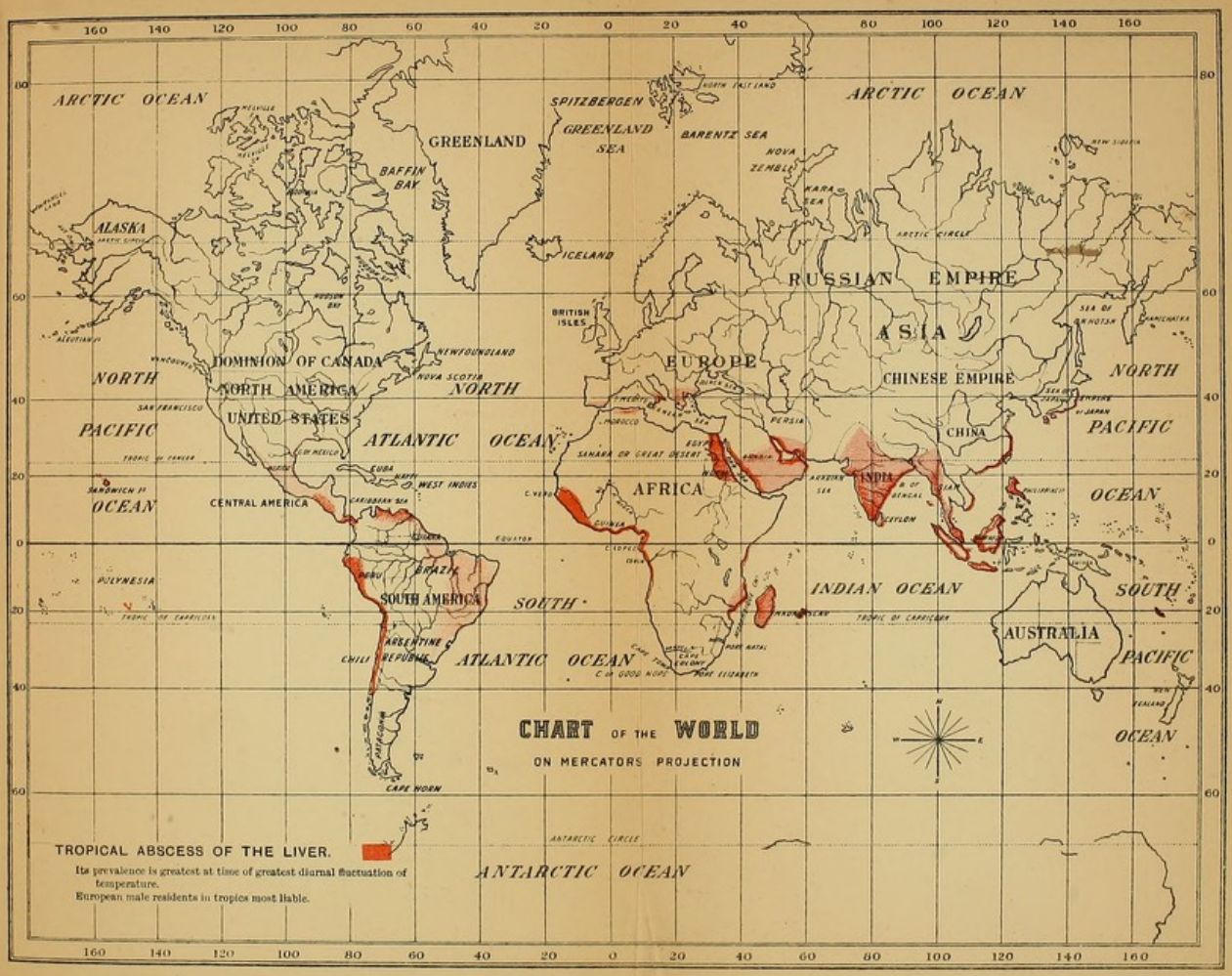
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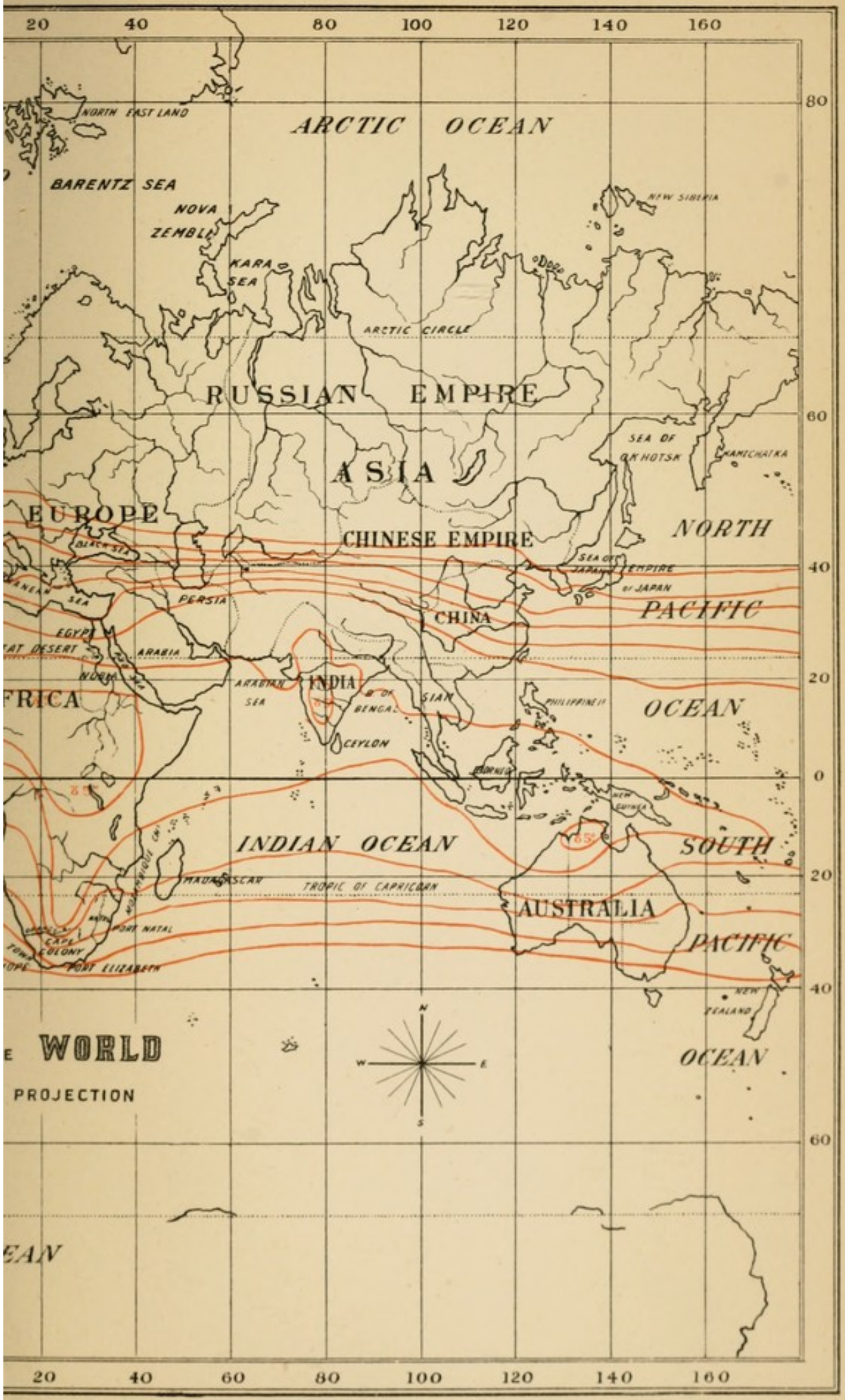
CAPE HORN
CHART OF THE WORLD
ON MERCATORS PROJECTION
ANTARCTIC OCEAN
TROPICAL ABSCESS OF THE LIVER.
Its prevalence is greatest at time of greatest diurnal fluctuation of temperature.
European male residents in tropics most liable.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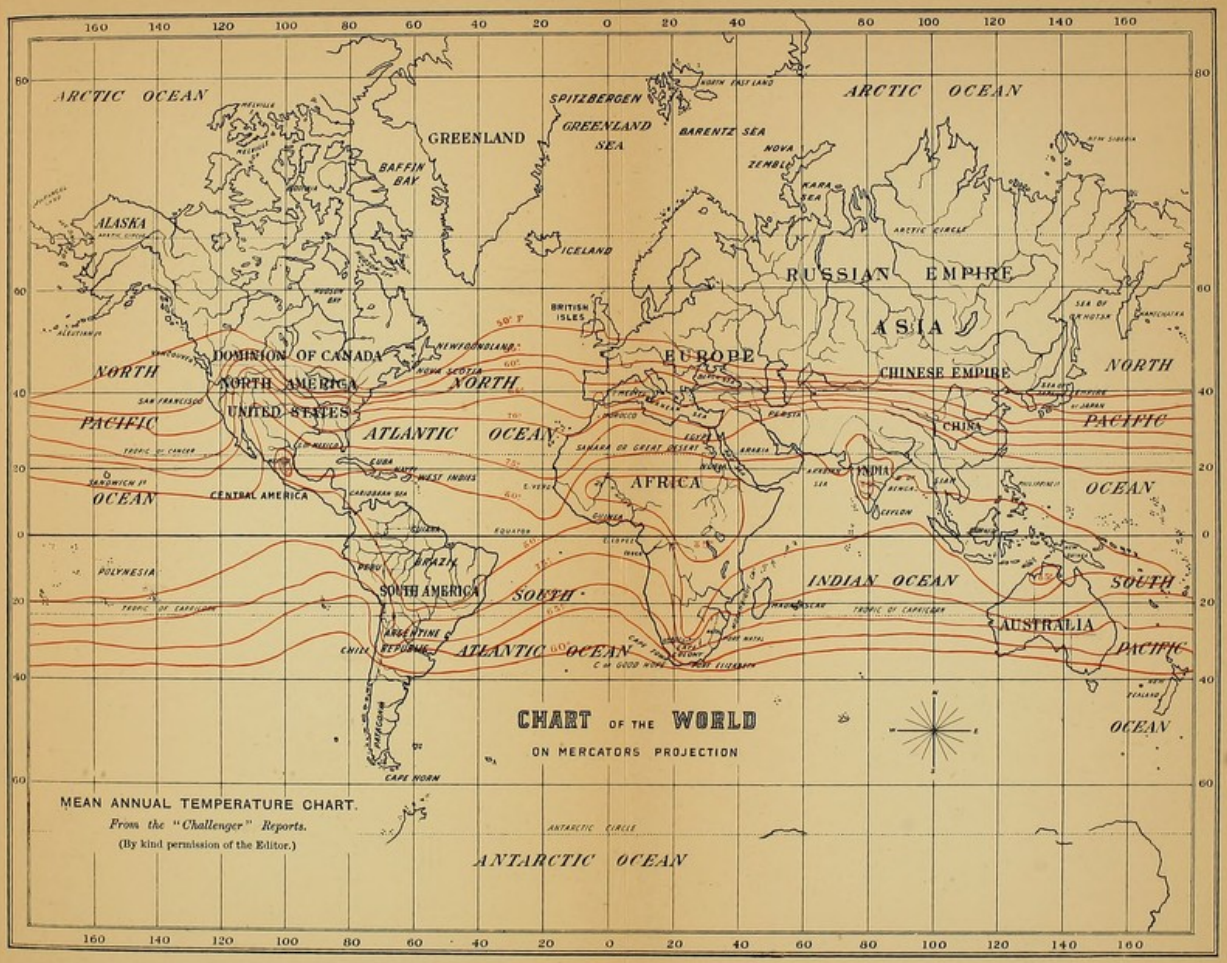

MEAN ANNUAL TEMPERATURE CHART.

From the "Challenger" Reports.

(By kind permission of the Editor.)


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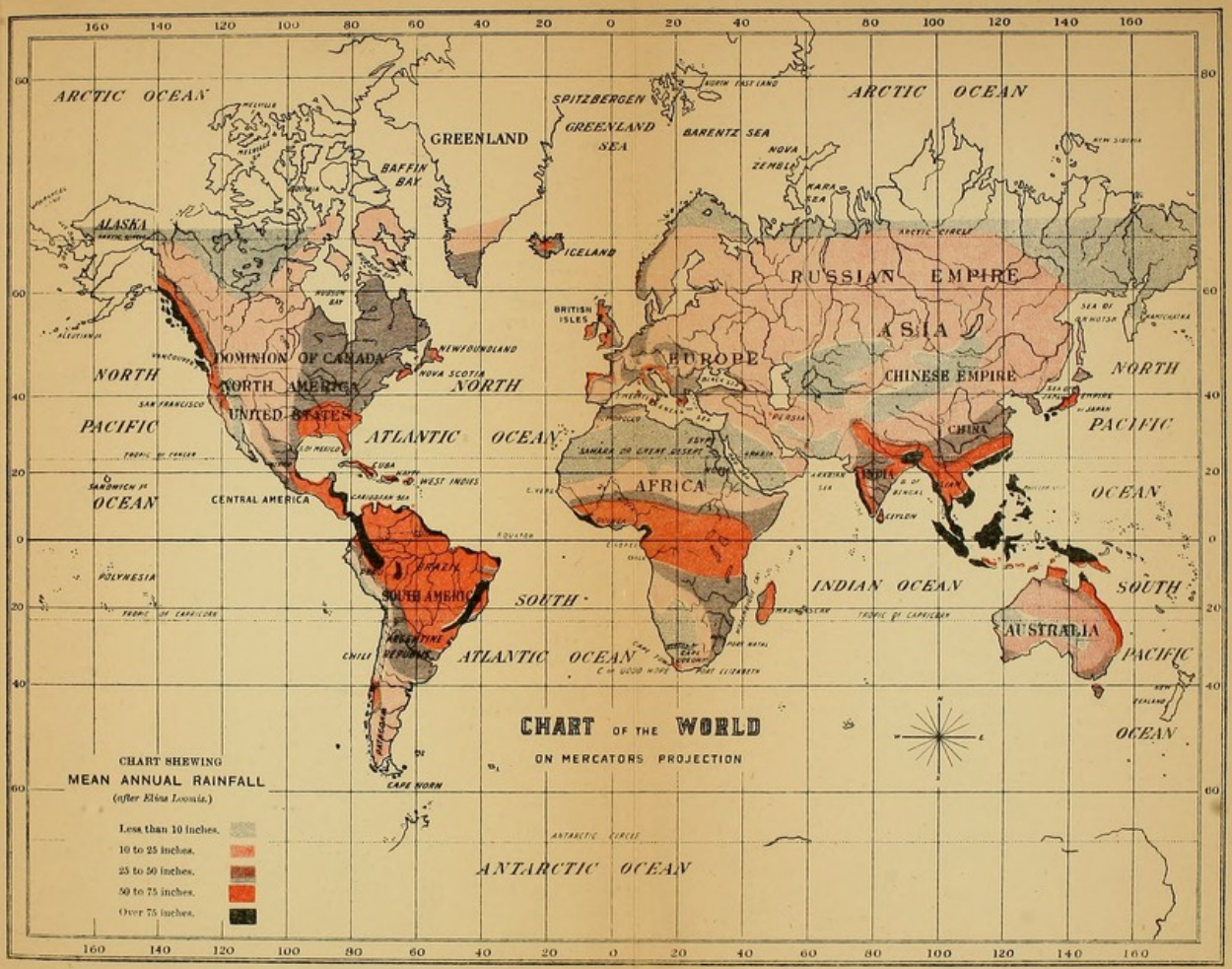
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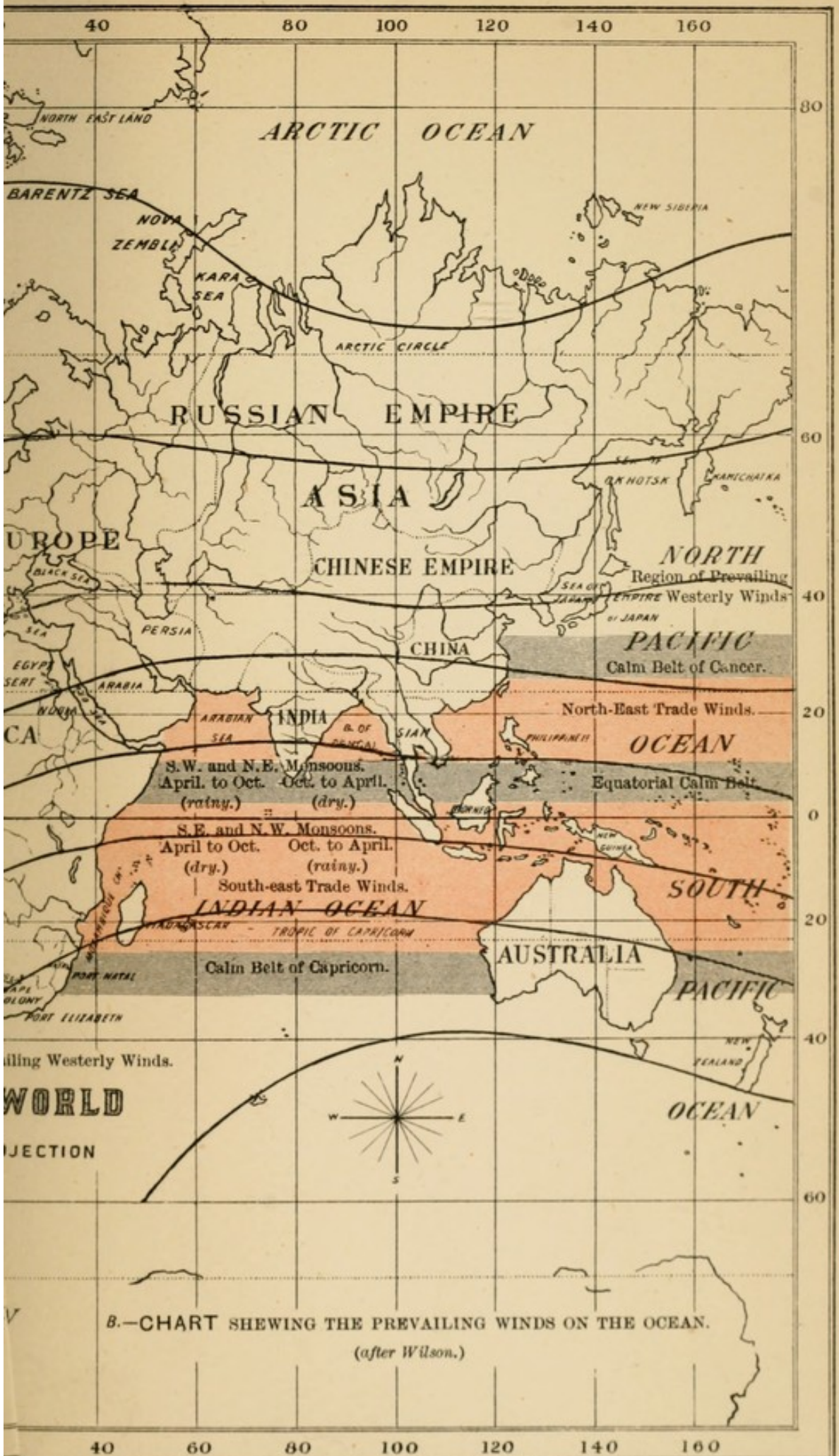
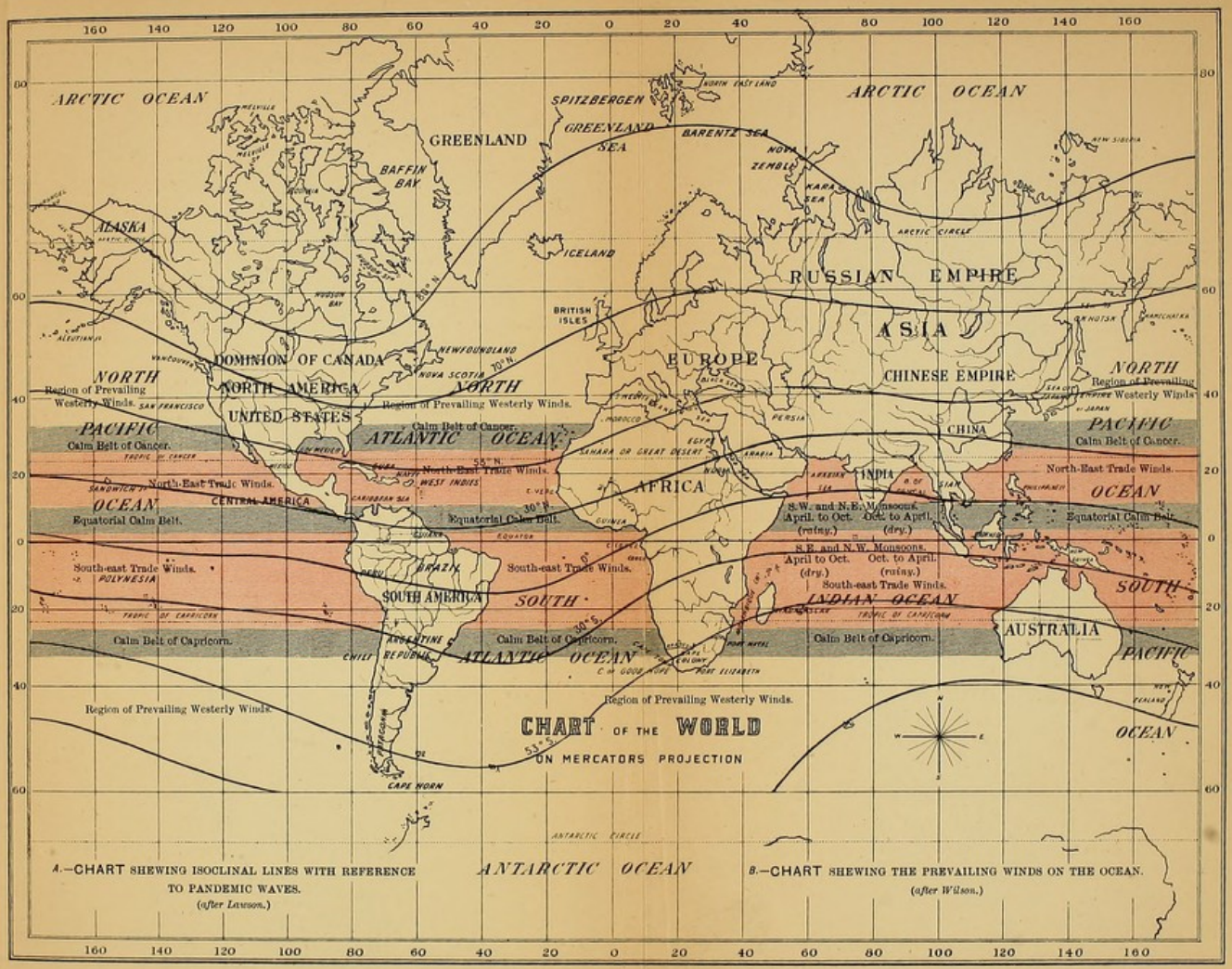
SOUTH PACIFIC OCEAN
CAPE HORN
CHART OF THE WORLD
ON MERCATORS PROJECTION
CHART SHEWING
MEAN ANNUAL RAINFALL
(after Elias Loomis.)
Less than 10 inches.
10 to 25 inches.
25 to 50 inches.
50 to 75 inches.
Over 75 inches.
ANTARCTIC OCEAN



B.—CHART SHEWING THE PREVAILING WINDS ON THE OCEAN.

(after Wilson.)



A.—CHART SHEWING ISOCLINAL LINES WITH REFERENCE TO PANDEMIC WAVES.
(after Lawson.)

B.—CHART SHEWING THE PREVAILING WINDS ON THE OCEAN.
(after Wilson.)

YOUNG J. PENTLAND'S PUBLICATIONS.

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