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## On Biologic Regions and Tabulation Areas

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IX. *On Biologic Regions and Tabulation Areas.**By* C. B. CLARKE, *F.R.S.*

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[PLATES 24, 25.]

*Section I.*

I HAVE been for some years engaged on a revision of the sedges, a natural order of 3000 species. I have determined a great number of specimens which have the locality where each was collected satisfactorily fixed, and have noted these localities. I thus can append to each species a list of all the localities where it is known to me to grow. Sedges extend over nearly the whole area of the world occupied by flowering plants. The question arose, which areas for reference will it be most convenient for me to use in recording after each species its geographic distribution. It is evident that it will be advisable to use for every species the same set of reference areas; then the results can be easily exhibited on a table, and can be combined by simple addition to give the distribution for the genera, sub-orders, &c.

I commenced experiments in systematizing my habitats (at the end of each species described) about 18 months ago; I have tried many plans and made many maps; I have experimented on a few genera and tabulated the results in different ways. I have also looked up the works of others, more especially the 'Geographical Distribution of Animals,' by Mr. WALLACE, and have been led much farther than I anticipated, and in particular to one conclusion that appears to me of importance. As this affects all naturalists, including palæontologists, I have drawn up the present paper for reading here, rather than at the Linnean Society.

I state shortly this one important conclusion. Mr. WALLACE, and many others since, assumed that the most natural biologic regions would form also the best areas of reference; my conclusion is that natural biologic regions and sub-regions, as defined by WALLACE, are inconvenient, I might say, impracticable, as reference areas for species; and that generally each improvement in the circumscription of biologic regions results in an increasing complication of their boundary lines, and renders them more impossible to use as the framework on which the distribution of large numbers of species shall be displayed.

There are on the wall (A) a copy of WALLACE's map, showing his zoogeographical

regions (see Plate 24\*); (B) the World divided into tabulation areas and sub-areas as employed by me for the reference of each species of sedge (see Plate 25); (C) and (D) a small genus of sedges tabulated (see pp. 384 and 385) with reference to the map (B).

It is found convenient to divide the globe primarily into about 6 regions and 20–30 sub-regions. The terms regions and sub-regions, used by WALLACE, have been lengthily criticised; I have no time to discuss the propriety of the terms. They will do very well for me. The sub-regions must, of course, fit into the regions, or the summation of results is not possible; and, for the same reason, the boundaries of the sub-regions should be selected so that, as far as possible, the political areas already used for biologic reference in local manuals, &c., may, as sub-sub-regions, fit into the sub-regions.

WALLACE commences (vol. 1, p. 54):—"The first éssential is a broadly marked and easily remembered set of regions." This is quite right; but it is clear that WALLACE had in his mind only one of the functions which he required of his regions, viz., their use as areas of reference, when he wrote these words. When it comes to referring the habitats of tens of thousands of specimens to some framework, such framework of tabulation areas must be the simplest possible; each area must be bounded by a precisely defined line; nor must it be necessary frequently to have recourse to a large scale map to determine whether a specimen was collected in Region I. or in Region III.

It will be noticed at once that my framework of tabulation areas differs very little from WALLACE's natural zoologic regions. I have, in fact, reduced the former from the latter, with the minimum of alteration that would enable me to use it for practical reference. The main difference noticeable at first sight is that I have extended the boundary lines over the sea so as to include the oceanic islands in the adjacent continental areas. I should observe that I do not mean or propose by this map to divide the sea into tabulation areas; the subject of marine biologic regions has its own additional difficulty, and I leave it to those competent to deal with it. But however alike in general aspect are WALLACE's map (A) and my map (B), they represent different aims; WALLACE's map (A) represents the World divided into the most natural regions for the Mammalia; my map (B) is intended to represent the World divided into convenient areas of universal reference; I do not admit that the areas and sub-areas in it are inferior in naturalness to any scheme of regions yet proposed; but that is not my point. I have had the advantage of showing this framework map of mine to several most distinguished naturalists; I believe each of them, without a single exception, in the course of a very short conversation, drifted into some criticism arising solely from his ideas as to natural biologic regions. Thus, one wanted to throw Greenland into Northern Europe; another wanted to divide New Guinea into two by a parallel of longitude. I venture to reiterate that my map (B) has been arrived at by continual trials of it as a framework of reference with continual

\* Plate 24 is a copy of the frontispiece to Mr. WALLACE's "Geographical Distribution of Animals," reproduced by kind permission of Messrs. MACMILLAN and Co.

emendations; and not in order to exhibit the natural distribution of plants or animals, or of any Order of them.

Before going into the various considerations which have influenced me in the preparation of my map (3), I will show some of the great difficulties which I met with in first trying to tabulate on WALLACE'S map.

I endeavoured to tabulate the Himalayan plants between his Regions I. and III.; but WALLACE'S line is a broad one on a small scale map, and, though I have a particular acquaintance with the geography here, and know the precise spot where the plant was collected, I often cannot tabulate it; I cannot say as to 1 Himalayan plant specimen in 20, whether it was collected in WALLACE Region I. or in WALLACE Region III. There exists, no doubt, an unusually strongly marked natural line between the high level Himalayan flora with Firs, Oaks, and Blackberries, and the Indo-Malay tropical flora. I could assume as to many a Himalayan plant that in character it was European, and tabulate it in Region I. accordingly. Each tabulation of a specimen made in this manner will be illusory; the thing to be proved is assumed, and we are in a complete circle; tabulators have, however, sometimes allocated specimens in this way, and such additions only serve to mask the conclusions that could have been drawn from the resulting numbers had they been omitted. But further, this way of tabulating causes some of the most striking facts of geographic distribution to disappear. I may have, for instance, a Himalayan pine to tabulate, and, as I do not know exactly which side of WALLACE'S line it comes from, I place it in Region I. But it perhaps was a specimen of *Pinus longifolia* from the tropical zone. Or I may find a Bengal specimen of the common stag's-horn moss, which we have to go to the mountains of Scotland or of Wales to find; and, regarding this as an alpine plant, I might refer it *à priori* to Region I., whereas this identical series is abundant in the subtropical zone in Bengal.

This work of tabulating must not be done from *à priori* assumptions of what the results will be. Mr. WALLACE has not made this error; his map at the beginning of his book is really the result attained by all his work in the book; in all this work, before he had made his map, he referred the Mammalia to ordinary geographic areas more or less well-defined, as to France, to India, to Africa south of the Tropic of Cancer, &c. And in his book, though he starts with this map, he perpetually finds it more convenient to describe the area of a species by reference to ordinary geography rather than to the regions and sub-regions of his own map.

I have taken WALLACE'S undefined line between Regions I. and III. along the Himalaya as a single example to illustrate the difficulties I met in endeavouring to use his map as a reference map for tabulating upon; it is a primary important line. But there are many ill-defined tortuous boundary lines on the map (A) which are most inconvenient for tabulation. One such is the boundary between Regions V. and VI., a primary important line; here WALLACE prolongs the Nearctic Region V. in a long



promontory down the Mexican plateau. This is quite right as to the distribution both of Mammalia and of plants. I think I may safely challenge any botanist to tabulate the plants from Mexico in our collections by this boundary; in proportion as it is natural, so is it difficult to tabulate on.

Mr. SCLATER, in 'Journ. Linn. Soc.,' vol. 2, "Zoology," 1858 (paper read 1857), p. 30, discussed before WALLACE the question, "What are the most natural primary ontologic divisions of the earth's surface?" Mr. SCLATER proposed that each enquirer should work out, from his own subject alone, what he conceived to be the most natural divisions of the earth's surface, and that these might ultimately be combined so as to arrive at a correct solution of the problem. Mr. SCLATER appears to have meant that each enquirer should use his own system of geography of reference. It is evident that the combination of results contemplated by SCLATER would be hardly possible if the enquirers used different systems, but could be done by a clerk if all the enquirers worked on one framework. The large tabulations done by ENGLER and others, the complex maps of geographic botany published, the innumerable systems of regions proposed as the most natural (down to the last I have seen, that of Professor MOEBIUS, in 'Nature,' for 3rd December, 1891, p. 104), utterly defy all attempts at general combination. To collect even general conclusions from these huge labours in the form in which they have been published, demands not only great toil, but the separating out the facts and retabulating them on one system before the results can be added together, in other words the doing of the work over again.

Mr. WALLACE foresaw and unavailingly deprecated the course which his successors would pursue in the matter of biologic regions. He foresaw that, as his regions were constructed to represent the existing distribution of Mammalia (so far as then known) only, the distribution of other vertebrates being only brought in to settle doubtful points, and geologic evidence being excluded, other enquirers would use regions representing more accurately the distribution of their own groups, with complex maps. In this way, his earnest wish to establish one set of regions as "typical," *i.e.*, one map of reference areas, has been completely defeated.

The object of the present paper is to show that what is wanted is to separate absolutely the two purposes of WALLACE. It has proved quite impossible to persuade all zoologists to use as reference areas regions devised to represent the distribution of existing Mammalia. The botanists, moreover, maintain that, owing to the fixity in the soil of nearly all vascular plants, their enormous numbers, both in species and individuals, and, still more, the large number of specimens in our herbaria of which the habitat is accurately noted, "natural regions" can be better limited from their plants than from the Mammalia. The tabulations of ENGLER, HEMSLEY, and many others, have reached proportions probably not contemplated by Mr. WALLACE in 1876. It appears to me that such tabulations are antecedent to the construction of biologic regions, and that the difficulties of studying and representing the distribution of life on the globe would be greatly lessened if all naturalists could agree to tabulate

on one geographic framework, at least as far down as the primary areas and sub-areas.

I now venture to put forward a framework which may answer this purpose, and I propose to print a large number of such maps in hopes that they may be largely used. This framework has the recommendation that it agrees closely with the regions of SCLATER and WALLACE which have already been largely employed. I am well aware that every line of it may be criticised. I wish a framework, either this or some better one prepared by competent naturalists, could be issued by authority.

### Section II.

This section explains how I have arrived at the map (B)—tabulation areas and sub-areas. I have made trial maps, and then trial tabulations of a genus on them; and, by making emendations in the map to avoid various difficulties encountered, have finally got to map (B).

I will mention at the outset that the problem of finding convenient tabulation areas alters in character with the size of the areas. Suppose that I am endeavouring to represent the distribution of a large genus in England. I may very conveniently tabulate the distribution of each species according to the English counties, sum the results, and draw up a shaded map to exhibit the distribution of the genus at a glance. The general result will not be seriously interfered with, because the boundary lines of the counties are not natural, but very irregular; it will be more injured by the great inequality of the areas; it would be better to take Yorkshire in Ridings. The good result is attained because (1) the boundary lines of my fifty-two tabulation areas are definite, shown on accurate maps, and in general use so that I can work without perpetual recourse to large scale maps, and (2) because collectors employ largely the same areas and ticket their collections accordingly. The supposed tabulation may for instance show that our genus extends through the six northern counties, Derby, much of Wales and Devonshire, and may give us nearly as distinct a view of its distribution as if we had tabulated on natural regions. If we actually possessed a map of England divided into the fifty-two most natural regions possible, *i.e.*, if we had attained the ideal of some writers on biologic regions, these complex regions would be most troublesome to tabulate upon, and the result would differ little from that got much more easily by tabulating on the fifty-two counties.

It would therefore appear that if we were to divide the whole land surface of the globe into small areas, say quadrangles of 2° side, no better framework for tabulation could be desired. And this is so; but it would require 2000 such small areas. The finiteness of human strength comes in; we want, to begin with, the land surface of the globe divided into twenty to thirty sub-areas; and we want, this is the real underlying motive, these sub-areas so devised as, *on our first sorting*, to separate out the material as far as possible. If we take our sub-areas so that one sub-area, say

$n$  13, contains nothing but what is found in  $n$  14, or contains all that is found in the sub-areas 14, 15, then we shall expend a great deal of our labour on our first tabulation to little purpose. In these tabulations of very numerous specimens and species we want our first sorting to divide them, as far as possible, into separate boxes. If we can attain to this, our first tabulation will exhibit the broader features of the distribution, and will immensely facilitate any subsequent inquiry into the detailed distribution.

Suppose, as an example taking only a moderate area into consideration that, in a tabulation of the plants of Europe, the scale of work would only permit three areas for England and Wales. If I framed these areas so that they were bounded roughly by lines running N.W. and S.E., I should get nearly all the plants in each of my three areas; but, if I bounded roughly my areas by lines running N.E. and S.W., I should at once discover that a number of the plants of the western and hilly region did not occur in my south-east area. And, for any subsequent examination in detail, my three boxes would each contain a much smaller number of species to be dealt with than are contained in the whole of England and Wales.

The division of the globe into primary areas and sub-areas involves other difficulties. If political areas are used they are liable to change. Thus, during the preparation of the flora of British India, designed by the Secretary of State to include the political area, this area has materially changed; the plants of Burma and of Quetta, included in the later volumes of the work, were excluded in the earlier; so that any distribution results deduced mechanically from the whole of that work, must be more or less invalidated; the labour of going over every volume and correcting or making allowance for these changes of area would be very great, and would require an extraordinary knowledge of the details to do it profitably.

It is on such considerations that naturalists have of late years preferred to work upon permanent boundary lines. A great river will not do; as nearly all the plants that grow on one bank may usually be found on the other. Some naturalists have, therefore, adopted the lines of water-parting; but I find these little better than the rivers; in a few cases plants are confined to a particular drainage area, but in most cases not. A line of water-parting is in many cases, as that of the Rocky Mountains, much more difficult to follow accurately on an ordinary map than a river. Even on the small scale, with good maps and the ground thoroughly known, I do not find the water-partings satisfactory as dividing lines. They have been largely used in the county floras of England. Thus, my own county, Hants, has been divided into the basins of the Test, the Itchen, the Avon, &c., taken as the reference areas for the species of plants. But the basin of the Test extends from the water-parting at Walbury, 1100 feet above sea, to the mud of Southampton Water, and very nearly all the plants that are to be found in the county at all are to be found in this basin; to tabulate on it as a sub-area of the county leads to nothing. Still more futile is it to divide North India into the basins of the Ganges, the Brahmapootra, &c., as reference

areas. Whilst the flora of the Ganges basin differs little from that of the Brahmapootra basin, each contains a series extending from the purely Mongolian to the Malayan flora.

I have, in devising the framework shown on map (B), given most weight to the following considerations :—

1. The areas and sub-areas are, as far as compatible with other requirements, “natural,” *i.e.*, so devised as to ensure, on the primary tabulation, a division, as far as possible, of the material.

2. These areas are made, as near as practicable, coincident with the regions of SCLATER and WALLACE; because those have been largely adopted, and because they broadly do represent the primary ontologic division of the Earth's surface. The sub-areas, also, are near the sub-regions of WALLACE, but are less closely coincident.

3. The number of areas (6), and sub-areas (23), is kept nearly as in WALLACE. It is, in many cases, easy to improve the separation by increasing the number of the sub-areas. I am satisfied, by trials, that 23 is quite a large enough number of columns for the primary tabulation. I think it might be better to include the Sandwich Isles in Polynesia, rather than to make any additional sub-area.

4. All the boundary lines in my map (B), are fixed definitely. A political line is now sometimes easier to work with than the tropic or parallel 100° west longitude. But when, after a few years, we may have to work with some abandoned political line (the political boundary on 1st January, 1890), it will be different; it may be difficult, even twenty-five years hence, to get a map that shows the political boundaries of some countries on 1st January, 1890. All my later emendations of map (B), have been in one direction, *viz.*, the replacing of political lines by parallels of latitude and longitude.

5. The boundary lines are made, as far as possible, “easily remembered,” to use WALLACE'S words. I find that I can, with the lines of map (B), carry on tabulation with only a very occasional reference to an atlas.

### Section III.

This section defines the boundary lines in map (B), and explains the reasons for some of the more anomalous; Section II. will thus be illustrated by some concrete examples.

Area I.—PALAEARCTICA.

Sub-area 1.—*Europa Frigida.*

„ 2.—*Mediterranea.*

„ 3.—*Mongolia.*

Area I. (PALAEARCTICA) is nearly coincident with WALLACE'S palaeartic region. The south boundary in Africa is the Tropic of Cancer, which I have made “absolute;”



*i.e.*, I have avoided WALLACE'S two loops, which include in his Mediterranean region the isles of Cape Verde, and a small area of high land in the Sahara. The straightening the line is a simplification very convenient for tabulation purposes; moreover, here, as in many other cases, I doubt whether the straight line is less natural than WALLACE'S crooked line. Is it true that the Isles of Cape Verde, lying on 15° north latitude, are biologically more closely allied with the Mediterranean region than with the part of Africa lying between the Equator and the Tropic of Cancer?

I keep Arabia in one sub-area, whereas WALLACE divides it between two regions, which is inconvenient. As to naturalness, my line is not natural, but it is less unnatural than WALLACE'S.

The boundary line between Areas I. and III., *i.e.*, between Mongolia and Indo-China, is one of the very troublesome points. I have laid it down so that the political areas of India, China proper, and Japan, on 1st January, 1890, fall entirely into Area III., Indo-China. This enables me to make the sub-areas 8, 9, 10 fit exactly into the main Area III., Indo-China, and also to coincide severally with India, China, Japan, as areas already used by naturalists. This is at least temporarily convenient, as it enables a naturalist readily to make use of existing books in comparisons. As to naturalness, no boundary can be more unnatural botanically than WALLACE'S line, which throws the whole basin of the Yangtsekiang into the palaeartic region, and leaves of China, in the Indo-Chinese region, only the provinces of Fokien, Quantung, and Quangsi. At the same time, I think all these political lines will give trouble in the future, and, if a committee of competent naturalists were to recommend as the boundary between the Areas I. and III., the line 40° north latitude, from the Pamir to Japan, I should offer no objection.

Sub-area 1. (*Europa Frigida*) takes in all Europe north of 45° north latitude, which cuts France and Italy in two. No line has troubled me more. The difficulty is this. If we make our first two sub-areas, as WALLACE has done, to be Northern Europe and Mediterranea, we must either divide France or spoil these areas for separation purposes. If we throw all France into Northern Europe, we shall get tabulated into our sub-area 1, all the strictly Mediterranean fauna and flora of the south of France, the tabulation would be hardly worth doing; it would be preferable to make our sub-areas 1 and 2 into one.

Granting, then, that France is to be divided between (1) *Europa Frigida*, and (2) *Mediterranea*, the most natural line would *perhaps* be to follow the waterparting, and keep the basins of the Garonne and Rhone in *Mediterranea*. I might, then, make a list of the Departments which should belong to *Mediterranea*, but this gives no better result, and is infinitely more trouble to remember than the line of 45° north latitude, which took me a year of trials to arrive at.

Area II. ETHIOPIA ; includes all Africa south of the tropic of Cancer, and divides readily into—

- Sub-area 4. *Africa Tropica Borealis*.  
 5. *Africa Tropica Australis*.  
 6. *Caput, i.e.*, Extratropical South Africa.  
 7. *Mascarenia, i.e.*, Madagascar with the allied islands.

I find these the most satisfactory areas that I have devised. They are no trouble, either to remember or to work with. The sub-areas 4 and 5 together make up the area of our existing book, OLIVER'S 'Flora of Tropical Africa ;' sub-area 6 agrees with the area of HARVEY and SONDER'S 'Flora Capensis ;' sub-area 7 is one accepted by all zoologists and botanists.

I divide tropical Africa into two, because it is advisable to make our primary sub-heads equivalent (roughly) in value, not to commence with a Yorkshire and a Rutland. The equator is a definite and easily-remembered line, and proves on trial a fairly "natural" one ; *i.e.*, the boxes 4 and 5 do not, on my tabulations, contain nearly the same things.

Area III. INDO-CHINA.

I have altered WALLACE'S name (Orient) for this, because his name is, botanically at least, preoccupied. By the Orient Region botanists understand, as in BOISSIER 'Flora Orientalis,' the main part of WALLACE'S Mediterranean Region, and no part of India or Malaya. To avoid extreme confusion I therefore re-name Area III.

There is no boundary line on map (B) which will be probably such a stumbling-block to botanists as the line which I have drawn between Areas III. and IV. ; it is the "WALLACE" line, passing through the Macassar Sea and immediately east of Java, and thus carrying off Celebes and the Moluccas themselves out of Malaya into Polynesia. There is, I need hardly say, no botanic separation between the Moluccas and Malaya. But the whole Polynesian tropical flora, even as far as Tahiti, is only an appendage to the Malay flora ; and I found, to my surprise, on some trial tabulations, that the WALLACE line is as convenient as any other. It is a botanic objection to it that it cuts in half the Malay flora comprised in MIQUEL'S large work, 'Flora Indiæ Batavæ.' A distinguished naturalist suggested to me that it might be better to bound the Indo-China area by the parallel of 140° E. longitude, which would be more natural, and would keep our sub-area *n* 11 coincident with MIQUEL'S Malaya. But, as the WALLACE line is zoologically a natural one, and no botanic line can be said to exist anywhere hereabout, I think the botanists ought in this case to give way.

I need add nothing here about the sub-areas of Area III., because the boundary line between Areas I. and III., already discussed, was devised to save these sub-areas.

## Area IV. OCEANIA.

- Sub-area 12. *Australia.*  
 13. *Neo-Zeelandia.*  
 14. *Polynesia.*  
 15. *Sandwich.*

Assuming that we have already fixed the boundary between our Areas III. and IV., the only point in the arrangement of the sub-areas that I have much hesitated over is whether the sub-area 15, Sandwich, might not be better sunk in 14, Polynesia. The sub-area 15, Sandwich, is too small; on the other hand, it has relations with America which make it inconvenient to include it in the sub-area Polynesia, which includes also the Moluccas.

Another point that may attract notice is the apparently huge extension of the New Zealand sub-area to include Kerguelen and the Crozets. It must be recollected that the map is on MERCATOR'S projection; there is really no very great extension; the sub-areas 13 and 23 run into one on their southern frontier, exactly as sub-areas 3 and 16 do on their northern frontier. It may be a question whether Kerguelen should not be tabulated under 23 rather than under 13, but this would make hardly any difference in the primary tabulations.

## Area V. NEARCTICA.

For the southern limit I have taken the tropic of Cancer. WALLACE'S line is impossible to tabulate upon; the alternative to the tropic is the political boundary between the United States and Mexico on January 1, 1890. I prefer the tropic.

Sub-area 16. *Canada.*

I take WALLACE'S line, *i.e.*, the political boundary on January 1, 1890. This is rather more natural than taking a parallel of latitude, as the political line runs more south on the east side of the continent than on the west. Also, if the political boundary should be altered, this boundary being made up of the St. Lawrence on the east, a parallel of latitude on the west, will always be easy to work. If, however, any competent committee would prefer the parallel of 45° or 50° north latitude, I could offer no objection.

- Sub-area 17. *United States Orientalis.*  
 18. *United States Occidentalis.*

Though parallels of latitude answer well in the Old World, in the New the direction of the great mountain range alters matters. The United States, like tropical Africa, is so large that it requires dividing into two sub-areas. WALLACE effects this by the Rocky Mountain line of water-parting. I found this a troublesome line to

work, even with a large and good map ; and, moreover, as far as my plants go, it does not effect a good separation on the primary tabulation. For a very large number of western plants on the western slopes of the Rocky Mountains are also found on their eastern slopes. On the other hand, the line of  $100^{\circ}$  west longitude sorts off the Eastern United States' flora well ; in short, I find it both an easier and a more natural boundary than the water-parting.

The fact is that, in the final result, I come very near to Mr. WALLACE. In order that the dividing-lines of my tabulation areas may effect a good sorting of the plants on the primary tabulation, these lines must be made to coincide approximately with the boundaries of natural biologic regions. If we bound these regions by broadly-marked and easily-remembered limits (to quote Mr. WALLACE'S words), his biologic regions become practically my tabulation areas. But, if the details are filled in to his regions and sub-regions, the boundary lines become too complex to tabulate upon.

#### Area VI. NEOTROPICA.

Sub-area 19. *America Centralis.*

20. *Andesia Tropica.*

21. *Brasil Borealis.*

22. *Brasil Australis.*

23. *Argentina.*

I have not been able to subdivide this Area VI. at all to my satisfaction. The boundaries I have adopted are (except that between sub-areas 21 and 22) political, and are—

Sub-area 19. Mexico to the Columbia frontier, with the West Indies (except Trinidad).

20. Columbia, Ecuador, Peru, Bolivia.

23. Argentina, Uruguay, and extratropical Chili, to Cape Horn.

21. } The rest of the continent, the division between these two  
22. } being the line  $10^{\circ}$  south latitude.

There is an inherent difficulty in every plan of subdividing Neotropica ; it is intrinsically of one biologic character from the lowlands of Mexico and the West Indies to Rio Janeiro. The tropical Andes region differs a good deal, as see JOHN BALL and Dr. GUENTHER.

The main objection I feel to my present arrangement is that the boundaries, being the political boundaries of January 1, 1890, are unstable. I have failed to find any lines of latitude and longitude that are feasible. If the north boundary of Argentina is drawn about  $30^{\circ}$  south latitude, it would throw half the Argentine flora with the Brazilian ; and if the line be drawn at the tropic, it would throw all Paraguay and South Brazil with Patagonia. It might be possible to bound Argentina by the tropic on the north, by the meridian  $57^{\circ} 30'$  west longitude on the east ; but this would be a



complication. Even greater difficulties will be found in bounding the sub-area 20, Andesia Tropica, by a line of longitude, or by any slanting line drawn from some one defined point to another. I have tried the line  $70^{\circ}$  west longitude, but this cuts off all Bolivia from the adjacent Peru highlands, and works badly.

*Andesia Tropica* and *Argentina*, however difficult to define by broadly-marked and easily remembered limits, are at all events natural divisions; unfortunately the line between the West Indies and Venezuela is entirely artificial; it is, however, easily remembered. The line  $10^{\circ}$  south latitude, which I employ to divide Brazil, appears on the other hand fairly natural, but with an increase in our knowledge of Matto Grosso, the great interior of Brazil, it can hardly be hoped to remain so. At present some difference can be seen between Rio Janeiro with Paraguay, on the one hand, and Venezuela with Guiana on the other.

#### Section IV.

I add but a few words here on the method of using these areas and sub-areas; inasmuch as tabulation, on a large or on a small scale, is a process now familiar to every naturalist.

For each species, in the citation of specimens, I arrange the authenticated localities in regular order under the areas and sub-areas from 1 to 23.

At the end of a genus, the results can be collected on the table by a clerk. The table (C) shown I have thus formed for the genus *Kyllinga* of thirty-four species. The asterisks denote that the species is recorded from the sub-area, and the blanks that it is not, according to the usual notation. The distribution for the areas is got by mere inspection from those of the sub-area; I have added columns to show at a glance the distribution as between the Old World and the New.

I am, however, employing a slightly different way of tabulating, which gives much improved results at very small extra labour. In this table (C) the asterisk here represents that a single collection of this sub-tropical species has been once made in a hot spring in Kamschatka. A similar asterisk in the same table is all that records that a species is present in great abundance throughout India. In table (D) the numbers put in place of the asterisks denote the number of specimens actually recorded under each sub-area. This represents very imperfectly the quantitative distribution of the species; it might give better final results if these numbers in table (D) were cubed before the agglomerative process was commenced; but the totals shown in (D) are at least all well within the mark, and certainly represent the quantitative distribution much better than does table (C).

My clerk can make a table similar to D for each genus in the Order; he can thence by addition make out similar tables for the sub-Order and the Order.

The true natural regions for each species and genus of sedges can be constructed, and might be represented on a map. Thus, for this genus, *Kyllinga*, in a framework

map (B), each sub-area might be shaded a depth proportional to the totals at the foot of each sub-area.

The finding the most natural regions of the globe, so far as sedges are concerned, will be an arithmetical process; but by inspection and a few trials it can be done approximately, and, indeed, near enough. For the deficiencies in collections, inequalities in the size of species, and doubts or errors in the determination of the critical plants will introduce wider percentages in the limits of possible error.

*Summary.*

(1) The preparation of biologic regions presupposes a tabulation of material on some geographic framework.

(2) The use of natural biologic regions to tabulate upon has been found inexpedient, and is absolutely impracticable as, with increasing knowledge, their boundaries become ever more complex.

(3) If naturalists would agree to tabulate on one geographic framework, each might have every liberty in making out his own regions and sub-regions for exhibition of his results; and yet all the advantages aimed at by WALLACE in enforcing the employ of one set of regions might be secured.

(4) I accordingly put forward a framework of areas and sub-areas, adapted for tabulation upon by all non-marine naturalists.

(5) I show the considerations which have guided me in drawing up this framework, which coincides in the main with the zoogeographic map of WALLACE.







*Postscript.*

Received June 20, 1892.

I have received, from the Secretary of the Society, the following remarks made by a referee of the foregoing paper :—

“The author is invited to reconsider—

- “(1.) The exclusion of the Malay Peninsula from sub-area 11. Malaya.
- “(2.) The inclusion of the Argentine and Chilian floras under one area.  
23. Argentina.
- “(3.) The exclusion of Greenland from I. Europa Frigidior.
- “(4.) The division of the Australian sub-area under two areas.”

I gladly reconsider these suggestions as they throw light on some points not explained in sufficient detail in the paper. I am not sure but that all of them may be improvements on my map. I have not pretended to provide the best possible system of tabulation areas; the primary object of my paper is to show that for any large tabulation (and a very large tabulation is requisite to get valuable results), a system of areas and sub-areas “absolutely defined, easily remembered,” is required. I find also by experience that 23 (WALLACE'S number) of sub-areas is quite the maximum number that can be worked by human infirmity on the first tabulation of 3000 species. Instead of increasing this number 23, we must look to the subsequent tabulation into sub-sub-areas.

I observe that the smaller the sub-area the more easy it is to make it a “natural” one; my smallest sub-area is 15, Sandwich, and it is very natural; but it is the very one that I would select to sacrifice to enable me to subdivide some other. Mr. W. T. BLANFORD observed at the reading of the paper that to make the sub-areas natural I must make a great many more. This is perfectly true; but my opinion is that the number 23 should not be exceeded for the first tabulation. No doubt if an author is dealing with a limited group of species, or with a limited portion of the globe, he may use a greater number than 23 sub-areas; but that is a much simpler problem than the one I am attacking.

I am disposed now to think that the referee's proposal to subdivide 12, Australia, into two, by including the Sandwich Islands in Polynesia, would be, perhaps, an improvement on my scheme as it stands.

The sub-division of the Argentine sub-area (23) into two, would make each of the two far more natural than the present sub-area 23. This might be done without increasing the total number of the sub-areas, by throwing the two sub-areas of Brazil, 21 and 22, into one. The objection to this is that it would make the sub-areas so very unequal in size and importance.

The Malay Peninsula undoubtedly goes with Sumatra biologically. I have put

it in my map in British India, merely to make my sub-areas run with Sir J. D. HOOKER'S 'Flora of British India.' To separate, as suggested, the Malay Peninsula, would give sub-area 8, India Orient., a boundary partly political, partly geographic; nor would doing this materially improve the naturalness of sub-area 8. The Malay Peninsula goes well enough with Tenasserim and Lower Burma; but, if it were excluded, we should still have included in sub-area 8, first, the Tibetan flora (from North Sikkim to Baltistan) which is Mongolian, or at all events widely different from that of India at 0-1000 feet elevation; secondly, the Sind Flora which is that of BOSSIER'S 'Flora Orientalis,' *i.e.*, my sub-area 2, Mediterraneana. The fact is that it is hopeless to get sub-areas the size of my 23 sub-areas "natural;" smaller sub-sub-areas may be devised that are far more natural.

Greenland goes more naturally with Iceland than with North Canada, but the difference is not very large (as it is in the case of the Tibetan flora included in the sub-area of India Orient.). I put Greenland with America (in Nearctica) because WALLACE did so. If we stick to the grand division into Old World and New World, I do not think it matters much into which Greenland is thrown. But this suggestion about Greenland raises a wider question. The whole area round the Pole down to about 50° N.L. would form a very natural sub-area. But it would be too small (in number of species) for my purpose; and, if it were enlarged by carrying it much lower down, its naturalness would rapidly disappear.

I would not resist any of the improvements suggested by the referee for my consideration; but I would hold that they must be carried out in detail subject to the following restrictions (and many other complex considerations):—

1. The total number of sub-areas must not exceed 23.
2. The 23 (or fewer) sub-areas must be sub-equal, *i.e.*, in biologic richness, not necessarily in square miles.
3. The boundary of the new sub-area must be accurately defined. It is not sufficient to say that the Andes flora and fauna require a sub-area to themselves; the boundary of this sub-area must be stated "to an inch."

Arke.



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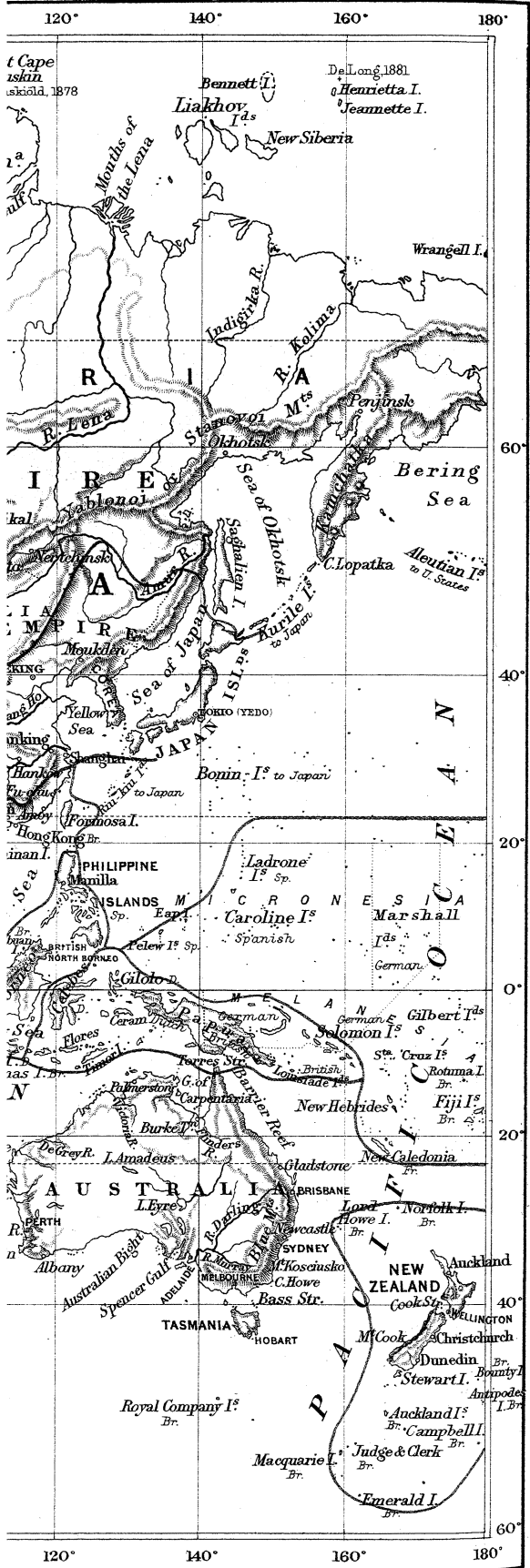


# MAP (A)

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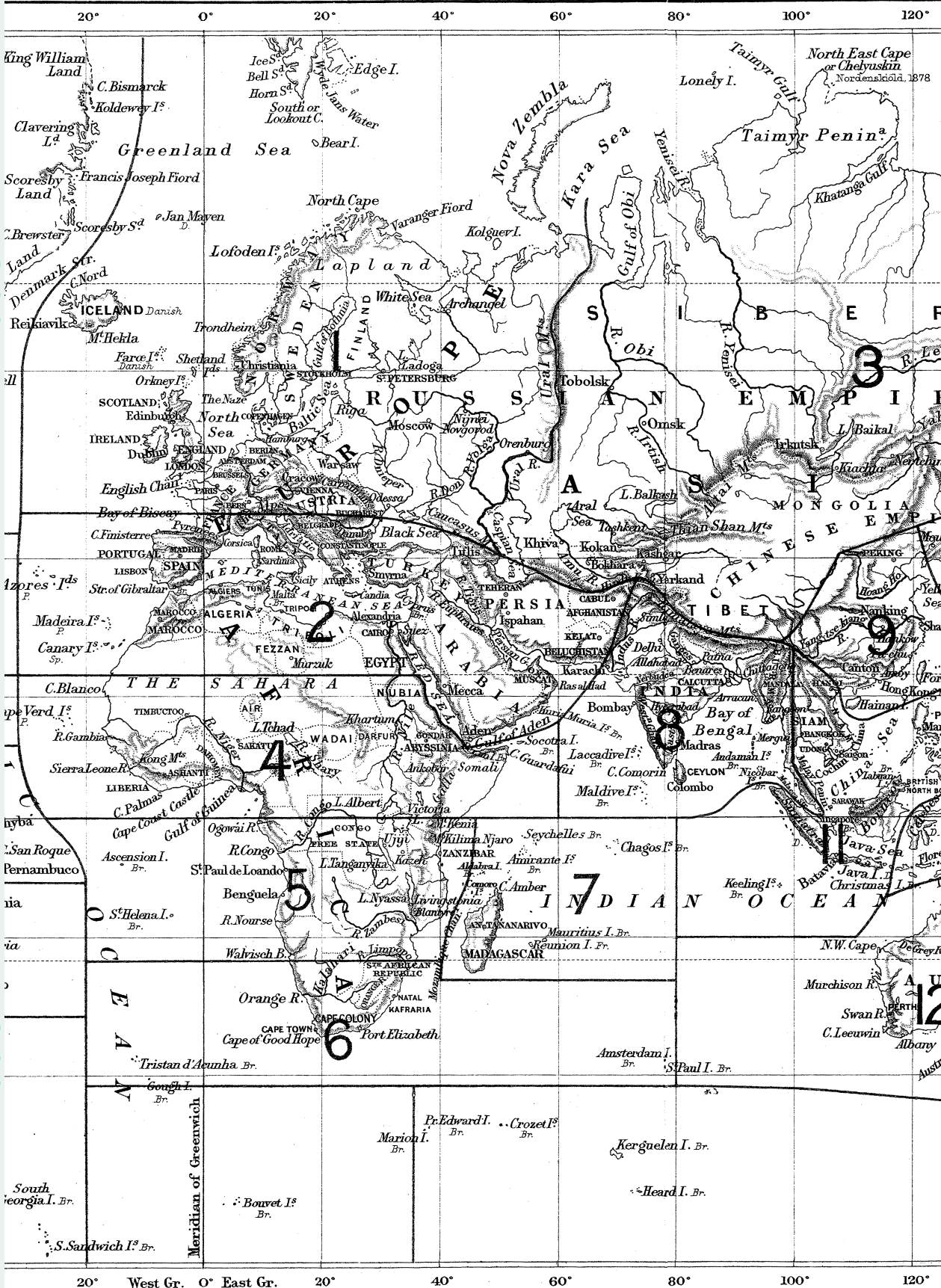




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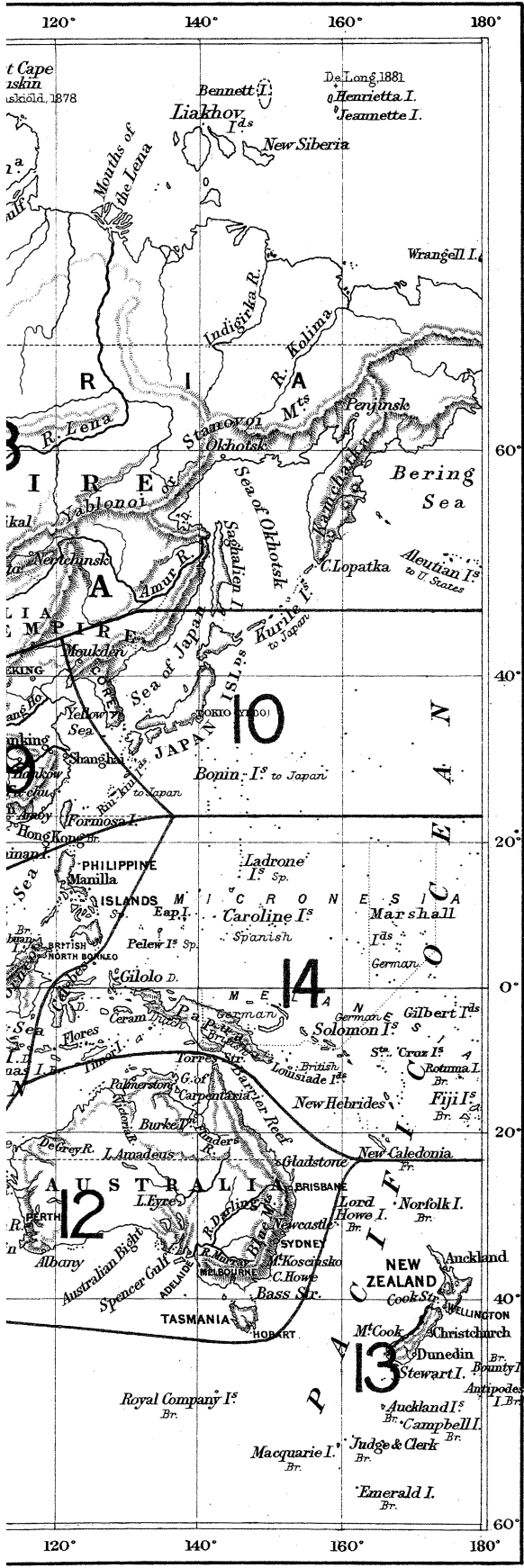


# MAP (B)



20° West Gr. 0° East Gr. 20° 40° 60° 80° 100° 120°





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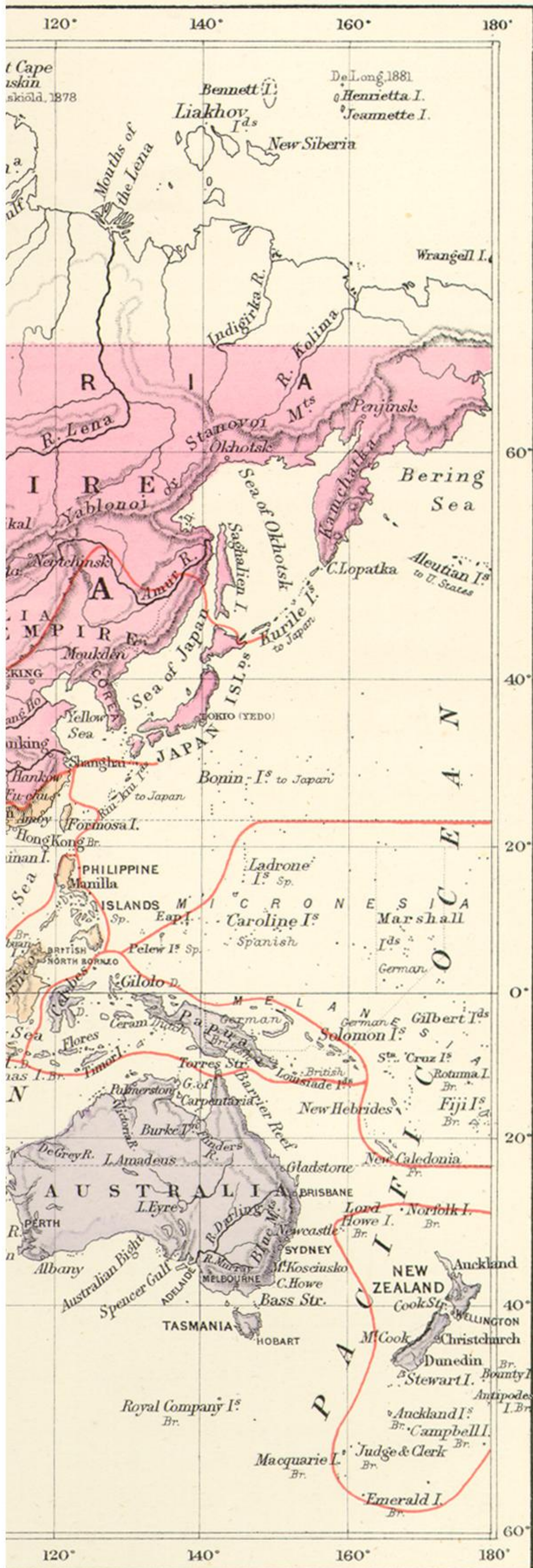




# MAP (A)







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MAP (B)

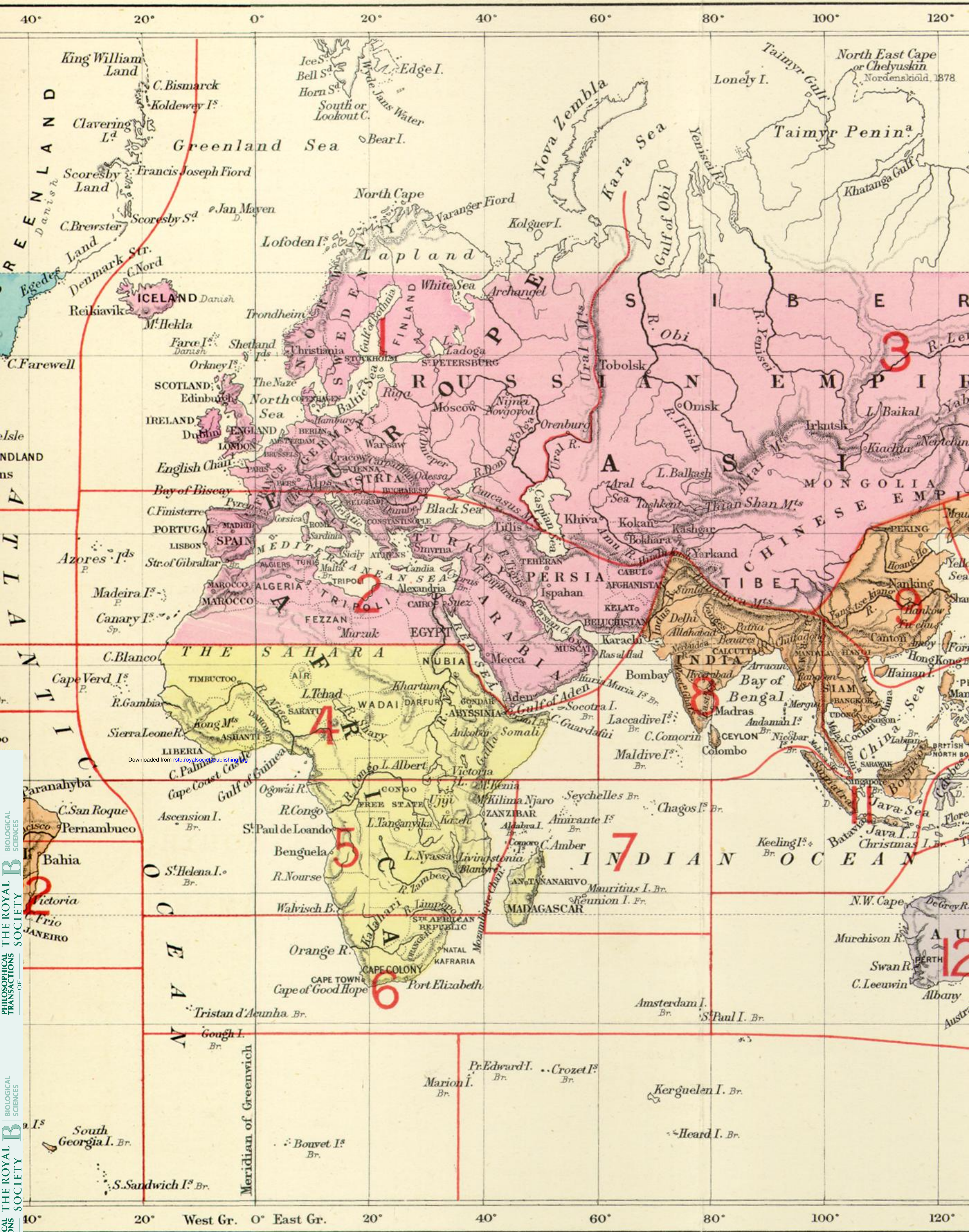








# MAP (B)



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