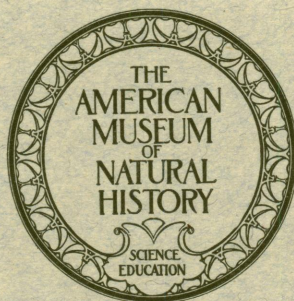


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Students of the distribution of animals and plants have divided North America, especially United States, into sections, within each of which the fauna or flora, or both, is believed to be more or less homogeneous and more or less distinct from other, corresponding sections. I must confess that these sections seem to me less distinct than they once did. It is a characteristic of human psychology that we classify and make categories where there are no definite classes or categories. We speak of north, east, south, and west. When we go more deeply into the subject we speak of northeast, southeast, and so on. At sea, however, we box the compass by such gradual steps that we have a continuous circle with no separate divisions. This does not mean that "north," "east," and so on are not convenient and useful conventions but, as a matter of fact, they are only very general terms. In the same way, there is no definite "arctic-alpine," "austral," and so on, and a definiteness can only be maintained for these zones by a special selection of "indicator species" or something of that sort. If this procedure be accepted, almost any sort of system of zones may be devised by selecting appropriate "indicators."

On the other hand, some system is convenient and useful. The carefully investigated system of Merriam, based on the fundamental studies of Allen, has been widely accepted. Can we take the proposed biotic areas and get some concrete expression for them that will be based on the biota as a whole? This expression should, if possible, be something that will help us to say with a fair degree of assurance that a given limited area or a given species belongs in this section or that. After trying a number of different methods of getting such an expression, it seems to me that what I am calling the "geographic average" gives the best promise.

Partly because plants are a large determining factor in the distribution of animals and partly because it was convenient to use the data given in Britton and Brown's 'Illustrated Flora of the Northern States and Canada,' the illustrations given here are based on data secured from the second volume of that work, Portulacaceæ to Papilionaceæ, inclusive. There was no reason for taking this portion of the flora rather than some

other; I merely wanted a random sample. The only species intentionally omitted from this lot were those that were said to have been introduced by man and a few in which the distributional range was not clear to me.

The limits of the range of a species outline a polygon. If we are given the latitude and longitude of these limits we can average them and get the latitude and longitude of a point which is approximately in the center of the range of a species.¹ This would be the geographic average of that species, and it would indicate rather clearly whether the species tends to be northern or southern, eastern or western. Having calculated the geographic averages of each of an aggregate of species (those in a particular sphagnum bog, or at a given altitude on a certain mountain, or in a given political division, or what not) one could average these species averages and get a geographic average for the aggregate under consideration.

In Britton and Brown's 'Flora' the range of each species is stated by giving the names of the states or other political divisions to which the species extends. I took the approximate center of each of these political divisions as the limit of the range in that direction and calculated geographic averages for each species. On the basis of the 77 of these that occur in Labrador, I found that the geographic average in North America, including Greenland,² of the Labrador flora is at about 51° N., 89° W., with an average range in latitude of about 20° and in longitude of about 79°. If the complete flora were considered, this average might be somewhat different but, as a first approximation, it indicates that, in North America, the flora of Labrador is one that centers a little south of Hudson Bay and, on the average, extends southward to about the latitude (41° N.) of southern New York or northern Colorado and westward to about 130° W., say British Columbia.

Britton and Brown's 'Flora' concerns itself only with northeastern North America. Taking up several areas along the northern Atlantic slope and basing the averages on species of plants from *Portulacaceæ* to *Papilionaceæ*, inclusive, we get the following.

¹If the range were crescentic in shape, the geographic average might be a point between the horns of the crescent, where the species does not, in fact, exist.

²I did not use limits in Asia or Europe in calculating these averages; they were not given definitely and did not seem important for what I had in mind. Of the 91 North American species which occur in Palearctica and for which I have calculated the geographic averages, 12 that occur in Asia but not in Europe have a geographic average of 48° N. (Range, 22°), 95° W. (Range, 79°), and 14 that occur in Europe but not Asia have a geographic average of 49° N. (Range, 13°), 78° W. (Range, 42°). The numbers on which these averages are based are too small to be entirely significant and they are based only on species of northeastern North America. A study based on fuller data is being prepared.

	Geographic Average		Average Range	
	Latitude	Longitude	Latitude	Longitude
Labrador	51°	89°	20°	79°
Newfoundland	48	87	20	70
Nova Scotia and New Brunswick	45	87	19	56
New England	42	85	17	44
Md., Va., and Del.	39	85	14	26

It is clear, as would be expected, that the average latitude decreases as we take more southern areas but it might not have been so certainly anticipated that the longitude would also decrease, that is, that the geographic average of the areas would steadily move eastward although the areas in question are more and more western. This seems to be bound up with the further fact that the average longitudinal range¹ decreases steadily and markedly as we pass from north to south. The similar decrease in the average latitudinal range, while not so great, is more surprising, as one might have expected that Labrador species, being restricted by extreme arctic conditions from spreading in a northward direction would have a less average north-and-south range than those in Virginia, for example, which have a great distance, both north and south, to which they can spread.

It is true that a study of the average ranges of 386 species of plants native to northeastern North America shows that there is a close positive correlation between the extents of latitudinal and longitudinal ranges but I do not think that this, coupled with the relatively wide longitudinal range of northern species,² is a full explanation of the wide latitudinal range of such species. Perhaps the explanation is that a species which is able to survive difficult northern conditions finds it easy to live in a relatively wide range of other conditions, while the same is not true of the more southern species.

Labrador is in what was called the Barr en-Ground Fauna of the Arctic Realm by Allen and the Arctic Zone of the Boreal Region by Merriam. There is little or nothing from farther north which might

¹Longitudinal range as measured by degrees of longitude. It should be remembered that a degree of longitude is not as many miles in higher latitudes as in more equatorial ones. However, this difference is not great enough between Virginia and Labrador to negative the indication that, among these plants of northeastern North America, the more northern ones tend to have a wider east-and-west distribution than the more southern ones.

²Not only is the average longitudinal range in North America of the Labrador species considered here 79°, as compared with 26° for those in Virginia, but other data on the Labrador flora as a whole show that 72% of the Labrador flora occur also in Palearctica.

have extended out of its "regular" range into Labrador, but it is conceivable that really southern things got into unusually favorable, ecologically speaking, situations in Labrador and were able to survive there, at least long enough to be collected and recorded by the botanists. These latter plants, classed as Hudsonian, would, for the most part, have a range along eastern North America southward from Labrador. The material from Labrador can be analyzed as follows.

	Average Latitude	Average Longitude
(A) 40 species that do not occur far directly southward	54°	90°
(B) 37 species that occur directly southward	49	85

The number of species is small for the purpose of computing averages and the grouping is admittedly rough but, as an illustration of method and until we have something better, we can take the geographic average for A as that of the Arctic¹ and the one for B as that of the Hudsonian.

Newfoundland is considered by Allen to be partly in the Cold Temperate Subregion and partly in the Arctic Realm. Merriam divides it between the Arctic, Hudsonian, and Canadian Zones of the Boreal Region.² The present material may be analyzed as follows.

	Average Latitude	Average Longitude
(C) 57 species which range north of Newfoundland	50°	89°
(D) 27 species which occur in Newfoundland but not in Labrador	44	83

Of these, C is doubtless a mixture of Arctic and Hudsonian; and D may be largely Canadian.

Nova Scotia and New Brunswick are entirely in the Cold Temperate Subregion (Canadian Fauna) of Allen but Merriam recognizes Alleghanian Zone of the Austral as well as Canadian Zone of his Boreal Region. The geographic averages of 152 plants from there may be analyzed as follows.

¹The geographic average in North America (including Greenland) of 20 Labrador plants that occur in Greenland is 54° N., 81° W.

²His map, 1912, *Canadian Entomologist*, XLIV, opposite p. 128, shows some yellow and blue, indicating Upper Austral and Transition. I do not know whether he meant this or whether it is due to faulty registration of the color-plates in printing.

	Average Latitude	Average Longitude
(E) 56 species that occur also in Labrador	50°	90°
(F) 26 species that occur also in Newfoundland but not in Labrador	44	85
(G) 70 species that occur in neither Labrador nor Newfound- land	42	86

Of these, E probably represents a mixture of Arctic and Hudsonian species that extend south; F may be largely Cold Temperate (Canadian) species; and G may be Alleghanian.

The geographic average for 207 New England plants is stated above to be 42° N., 85° W. Analyzing it in the same way as was done above for the material from Nova Scotia and New Brunswick, we get the following results.

	Average Latitude	Average Longitude
(H) 40 species that occur also in Labrador	48°	89°
(I) 24 species that occur also in Newfoundland but not in Labrador	44	84
(J) 69 species that occur also in Nova Scotia or New Brunswick but not northeast of there	42	86
(K) 74 species that do not occur northeast of New England	39	84

Four classes of plants may be considered to be present here: probably largely Hudsonian with a geographic average of 48° N., 89° W.; the Canadian with a geographic average of 44° N., 84° W.; the Alleghanian with a geographic average of 42° N., 86° W.; and an element of warmer-region plants with a geographic average of 39° N., 84° W. This last element is probably to be identified with Allen's Carolinian Fauna of the Humid Province of the Appalachian Subprovince of the Warm Temperate Subregion, or with the Carolinian of Merriam's Upper Austral.

The following is an analysis of the geographic averages of 282 plants that occur in Maryland, Virginia, or Delaware.

	Average Latitude	Average Longitude
(L) 12 species that occur also in Labrador	46°	89°
(M) 11 species that occur also in Newfoundland but not in Labrador	42	84
(N) 57 species that occur also in Nova Scotia or New Bruns- wick but not northeast of there	41	86
(O) 150 species that do not occur northeast of New England	38	84
(P) 52 species that do not occur northeast of Md.	34	84

What is apparently a new element (P) here might be considered to be the coming in of plants that would be classed in Allen's Austroriparian Subprovince (Louisianian Fauna) of the Humid Province of the Warm Temperate Subregion or of Merriam's Austroriparian Fauna of the Lower Austral Zone. As they are only the more northern species, the latitudinal average for this distributional section as a whole is doubtless less. O may be largely Carolinian; N, Alleghanian; L and M each have too few species to make the averages even approximately trustworthy.

Collecting the data, we get the following provisional suggestions as to the latitudinal averages for various regions.

Arctic	More than 52° N.
Hudsonian	48 or 49° N. ¹
Canadian	44 or 45° N. ¹
Alleghanian	41 or 42° N. ¹
Carolinian	38 or 39° N.
Louisianian or Austroriparian	Less than 34° N.

The tabulation just given indicates, at first sight, that these regions are definite, concrete entities, but, when we bear in mind that they were derived by first grouping the data into disconnected lots, we realize that another grouping might fill in the gaps. Furthermore, they are averages in which we lose sight of the extremes of each group. On the other hand, as stated above, categories, even if only conventional, are often useful aids to thinking and it might be well if we had concrete expressions for our categories—something more definite and tangible than mere names. I believe that the "geographic average" is such a concrete expression. I do not mean to intimate that the figures just obtained should be considered final, even for the regions that have been studied here. Although they are based on considerable material, this material includes only a small part of the plants of these regions and it does not include any of the animals. Also, it includes only relatively small areas of each section ("zone" or whatever we wish to call it). Furthermore, altitude and other ecological conditions have been disregarded.

I have been unable to devise, as yet, satisfactory corrections for altitude. Doubtless it could be done in the following way. We could study a limited area containing a wide altitudinal range, for example,

¹It will be noted that these are south of the principal boundaries of the "zones" in question, as given in Merriam. The finger-like southern extensions of the zones along mountain ranges is one of the causes and the discrepancy will be less when the corrections for altitude have been worked out. However, it is a matter of little moment, since the geographic average need not necessarily fall within the area actually covered by the species or the aggregate of species under consideration.

North Carolina, Virginia, or the central part of Colorado or of California. We could then calculate the geographic averages for various altitudes, keeping other ecological conditions, such as soil, exposure, etc., as nearly uniform as possible. We might get, in this way, a fairly accurate, concrete expression for the known fact that going to higher altitudes is, faunistically and floristically, analogous to going to higher latitudes and we might also get a factor for modifying our data so that, instead of working with the exact latitude of a place on a mountain, we could work with a modified figure, the modification being greater as the altitude is greater. In much the same way, the geographic average lends itself to a study of other ecological conditions.

Having obtained fairly approximate expressions in average latitude and longitude for each of the zonal names that we care to accept as a matter of convenience, we can then say rather definitely whether a certain animal or plant belongs in a given zone or not. This can be done by a comparison of its geographic average with the geographic averages of the zones. In the same way we can say whether a given small area is in one zone or another—or between two of them. One of our common bumble bees, *Bombus americanorum*, has a geographic average of approximately 38° N., 92° W. Its latitudinal average would put it in Carolinian, on the basis of the tabulation given above. Its longitudinal average is greater (farther west) than the longitudinal average of the areas studied here having the same latitudinal average.

The matter of longitudinal average is important in connection with the change in humidity that occurs at about 100° W. in the United States. Allen made this the basis upon which he divided the Warm Temperate Subregion into Provinces (Humid and Arid). Merriam laid more stress on temperature than on humidity and considered the latter as causing merely a subdivision of certain of the zones that were based on temperature. I, personally, incline more to the former idea than to the latter, especially where the latitudinal average is less than about 40° N., but I do not yet have enough data to discuss the question further.

The present paper is intended to outline a method, rather than to state results obtained by the use of the method. This method of geographic averages is suggested as a better tool for the study of distribution than, for example, indicator species or percentages of species from one area occurring in another. Incidentally, it has been indicated that the named "regions," "zones," etc. are far from the definite entities that they often seem to be. At the same time, what are believed to be first approximations to concrete expressions have been obtained for some of them.

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