GEOGRAPHICAL STATISTICS OF THE EXTRA-BRITISH EUROPEAN FLORA.

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I.—Introduction.

In a paper read before your Society in January, 1874, wherein certain questions respecting the dispersion of plants were discussed, by means of the average specific areas of species indigenous to Britain, I pointed out that, as the investigation had been limited to the flora of a single country, the results arrived at could not be regarded as at all conclusive. However suggestive they might be, they required, in so far as they differed from the conclusions of Professor Alph De Candolle and others, or opened out fresh questions, to be confirmed by comparison with the results of similar investigations on the floras of other countries. With a view of ascertaining whether they would be thus confirmed, I have been led to treat the *extra*-British European, or, as I shall term it hereafter for brevity, the Continental flora, in the same manner as the British species were treated in my previous paper.

The first step in the investigation was to settle a list of species; and I have adopted as a ground work Nyman's Sylloge, with its supplement; rejecting therefrom (*a*) doubtful or disputed species, such as the numerous forms that have been ranked as species by M. Jordan, but are not generally recognised by other botanists: and (*b*) new or recently described species, regarding as such all published since 1850; for, the geographical distribution of these can be only very imperfectly known. Thus reduced, Nyman's lists, which contain altogether over 10,000 names, are brought down to 7768 species; and further, deducting those that are native in

Britain, or are sub-species of British super-species, we have remaining 6617 Continental species.

The geographical distribution of these had next to be analysed, on much the same principle as that of British species was, in a paper read before your Society in 1873 ; but the extension of the flora brought into consideration, rendered some modification necessary. For British plants, according to latitude and elevation, four *zones* were proposed, viz :— the Arctic, Northern, Temperate, and Southern ; but, as a far larger proportion of Continental species comes under the Southern zone, it is necessary to sub-divide this into three sections, viz. :—1, *Upper* (the only one represented in Britain) comprising those Southern plants which range Northward beyond the limit of vineyard cultivation ; 2, *Middle*, composed of plants stretching Northward beyond the limit of olive cultivation, but not beyond the vineyard boundary ; and 3, *Lower* or *Mediterranean*, containing species confined within the region of olive cultivation. We have thus three lines of demarcation, the polar limits of cereal cultivation, of vineyard cultivation, and of olive cultivation. Zone 1, *Arctic*, finds its lower limit in the cereal line ; zone 2, *Northern*, its lower limit in the vineyard line ; zone 3, *Temperate*, ranges both above the cereal line and below the vineyard line : while of zone 4, *Southern*, the upper section has its upper limit in the cereal line : the middle section its upper limit in the vineyard line ; and the lower section its upper limit in the olive line.

In determining under which zone a plant should properly be placed, *altitude* is of equal importance with latitude ; as is evident from the re-appearance of most high Arctic species on lofty mountains much further south. They are there accompanied by other plants, whose range on the mountains agrees exactly with their own, both growing only at high elevations, and not descending into the agrarian region ; but these Alpine plants have not yet been met with in the extreme

Northern latitudes to which Arctic plants extend. In the British flora there are only two or three such Alpine plants; for, a species that reaches as far as Britain usually stretches further North to the Arctic regions. These British Alpine forms, notwithstanding their range only Southward from Britain, were classed as Arctic plants, for it was not worth while to separate so small a number as a distinct group; but in the Alps and other mountain regions of Southern Europe the number of Alpine plants increases so greatly as to exceed that of Arctic species; and it therefore becomes necessary to split up the Arctic zone into three divisions—1, *Arctic* (restricted) for plants found only in the extreme North; 2, *Arctic-Alpine*, for those found on the mountains further South, as well as in high latitudes; and 3, *Alpine*, for those found only upon the mountains. Before leaving this subject I may mention that some species, such as Veronica macrostemon and Castilleja pallida, are, in Europe, strictly Arctic, but occur on the Himalayas or the Rocky mountains: and, *vice-versa*, other species, such as Gentiana frigida and G. prostrata, are strictly Alpine in Europe, but have been found in Arctic Asia or America.

Northern plants also generally recur on mountains further South, where they range downward lower than Arctic plants, and descend more or less into the agrarian region, but do not reach the vineyards. With a like lower limit of level there are found on the hills numerous Sub-alpine or Montane plants, which do not grow in the North. We must therefore divide the Northern zone also into three parts—1, *Northern* (restricted); 2, *Northern-montane*; and 3, *Montane* only.

Again, we find plants Southern as regards latitude, but with a great range of elevation, which thus bear the same relation to Temperate plants that Alpine do to Arctic, or Montane to Northern. Their occurrence within the vineyard region, or at times even within the olive region, forbids their being con-

sidered Montane ; while their ascent above the line of cereal cultivation on the mountains prevents our placing them in the Southern zone. These I have classed with Temperate plants, distinguishing them however as " Southern in latitude." As an example I may refer to Astrocarpus sesamoides, which occurs only in Southern Europe, but there ranges from the hot plains almost to the snow line.

Continental plants require, with reference to longitude also, a somewhat more elaborate classification than British plants. Those British plants, which have the most limited area, are necessarily confined to Western Europe ; and the occurrence of a British species in Eastern Europe implies a more extended range : but in the Continental flora this is not the case, for species of very limited area may grow only in the East. I have therefore found myself obliged to adopt, with regard to range East and West within Europe itself, the following six sub-divisions :—1, Confined to Western Europe; 2, to Central; 3, to Eastern ; 4, extending to West and Central ; 5, to East and Central ; and 6, to all three sections of the Continent.

With respect to range Eastward into Asia the same sub-divisions are adopted for Continental as were for British plants, according to their extension, 1, to Western Asia, or as far as the Altai mountains in Siberia ; 2, to India, or as far as the Baikal range in Siberia ; 3, to Eastern Asia.

We have next plants found in Europe and America, but not recorded from Asia : and finally species which extend to all three Continents. These last, which in the paper on British plants were termed " Universal," may be sub-divided into two sections, according as they (1) are confined to the Northern hemisphere ; or (2) cross the tropics, and are found in the Southern hemisphere as well.

The accompanying table shows at one view the result of an analysis of the Continental flora, dividing it in one direction longitudinally, in the other latitudinally and altitudinally, as above detailed :—

ZONE.	EUROPE (ONLY).						EUROPE AND ASIA.									EUROPE AND AMERICA.	UNIVERSAL.		TOTAL.
	CONFINED TO			EXTENDING TO			WESTERN ASIA TO			CENTRAL ASIA TO			EASTERN ASIA TO						
	Western.	Central.	Eastern.	West. and Cent.	East. and Cent.	All 3 Sections.	East. Europe.	Centr. Europe.	West. Europe.	East. Europe.	Centr. Europe.	West. Europe.	East. Europe.	Centr. Europe.	West. Europe.		N. Hemisphere.	S. Hemisphere.	
Arctic (restricted)	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	2	20	..	23
Arctic-Alpine	..	1	..	..	3	1	3	2	1	2	..	..	3	6	3	4	69	3	101
Alpine	68	77	71	23	67	49	17	8	13	..	1	1	1	3	3	2	..	..	404
Northern (restricted)	2	19	2	2	6	..	1	1	..	1	3	..	5	5	..	5	11	..	63
Northern-Montane	..	4	1	..	6	7	2	2	7	..	..	..	5	7	13	3	41	1	99
Montane	166	89	103	54	80	138	43	17	44	2	1	6	5	2	7	..	3	..	760
Temperate	..	..	..	..	2	19	..	3	67	..	..	40	7	4	47	4	42	12	247
Do. (S. Latitude)	27	..	2	17	2	35	18	6	44	1	1	9	2	2	2	..	..	..	168
Southern (Upper Section)	14	4	15	17	14	96	41	22	205	11	3	66	17	3	38	2	10	15	593
Do. (Middle do.)	44	35	225	29	80	116	260	47	231	35	2	38	29	7	8	3	4	5	1198
Do. (Lower do.)	723	494	522	198	125	268	165	75	328	7	4	27	3	2	4	..	6	10	2961
TOTAL	1044	723	941	340	385	729	550	183	940	59	15	187	78	41	125	25	206	46	6617

It will be seen that by far the largest number of species falls into the lower or Mediterranean section of the Southern zone: and that a very much smaller proportion extends across the Atlantic than was the case with British plants.

Degrees of dispersion.—To each species is assigned a figure representing its degree of dispersion, according to the group in which it is placed by the analysis. The figures,* ranging from 1 to 12, correspond with those employed in the investigation respecting British plants; and the averages of them, by means of which the present inquiry is conducted, are, as in the former paper, carried to two places of decimals.

II.—Dispersion with regard to latitude.

The wider range, East and West, of plants which reach high Northern latitudes is shown in quite as marked a degree by Continental as by British plants; as is evident from the following averages:—

Species.		Average.
23	Arctic	
101	Arctic-alpine	
63	Northern	
99	Northern-montane	
247	Temperate	
533	reaching high N. latitude	7·24
404	Alpine	
760	Montane	
168	Temperate (S. L.)	
4752	Southern	
6084	not extending N. of cereal line ...	2·28
6617	Total of Continental flora	2·63

* The degrees of dispersion have been fixed as follows:—
As regards range within Europe itself and Africa. Arctic and Northern zones (restricted), in which the range both of longitude and latitude is small, 1. Southern, Alpine and Montane zones, and Temperate plants confined to S. latitudes, if found in only one longitudinal division of the Continent, 1; if in

It will be seen that the general average of the whole Continental flora is considerably under that of British plants, indeed less than half, the figures being 2·63 against 7·00. This arises mainly from two causes. 1. That most of the widely diffused European species occur in this country, and, having thus appeared in the British lists, are excluded from the present ones. 2. That a larger proportion of Continental plants is confined to S. latitudes. The latter influence can be avoided by comparing with the British average that of only those zones which are represented in Britain. These contain 1126 species, and average 5·50; while the remainder, comprising the two lower sections of the Southern zone, Alpine, Montane and Temperate plants confined to S. latitudes, number 5491 species, and average 2·04.

III.—Dispersion as affected by Station.

Aquatic and palustral plants.—So generally dispersed are aquatic plants, that most European species are found in Britain; and only a few fail to reach us from the Continent, the most marked being Elatine Alsinastrum and Trapa natans. The proportion of palustral plants is also much smaller in the Continental flora. The average degree of dispersion of each is considerably greater than that of terrestrial plants, thus fully confirming the British figures.

Species.		Average.
19	Aquatic	5·00
198	Palustral or semi-aquatic	4·21
6400	Terrestrial	2·58

two, 2; if in all the three divisions, 3. Arctic-alpine, Northern-montane and Temperate plants, which have a greater range of latitude, if confined to one longitudinal division, 2; if to two divisions, 3; if found in all three divisions, 4.

For range into Asia 1, 2 or 3 is added to the European figure, according as the plant reaches W., Central or E. Asia. Asiatic plants therefore range from 2 to 7.

Species common to Europe and America, belonging to zones with but little range of latitude, 8; to Arctic-alpine, Northern-montane and Temperate zones, 9.

Universal division, if confined to N. hemisphere, zones with small range of latitude, 10; the three zones with greater range of latitude, 11; if extending to the S. hemisphere, 12.

Maritime plants.—Prof. Alph. De Candolle's calculations (Geog. Bot. vol. I, p. 522), attributed to maritime and salt-loving plants a wider range than that of other plants. Our British lists gave a different result, the maritime average being somewhat less than that of other plants: and from the following averages, in which the salt-loving species so common on the Eastern steppes are ranked as maritime, it will be seen that this is also the case in the Continental flora:—

Species.		Average.
315	Maritime or salt-loving	2·53
6302	other plants.....	2·64

Calcareous plants.—In some of the works on Continental botany, Stations are given very vaguely, or omitted altogether; and I have consequently not been able to separate as a distinct group, plants confined to sandy soils, or found only in woods and copses; but a predilection for a calcareous soil is more generally recorded, and Continental plants evincing it are found to have a lower degree of dispersion than other plants.

Species.		Average.
160	Calcareous	2.08
6457	Non-calcareous	2·65

Parasites.—The parasitic plants contained in the British lists were so few in number, that but little dependance could be placed on the averages obtained from them. In the Continental flora we have a considerably larger proportion, and they are found to have, like the British species, a low degree of dispersion. Species which are supposed to be semi-parasitic, but are probably never restricted in their choice of victim-plants (Rhinantheæ and Thesium) give on the contrary a high average; and this agrees with the former result. The figures are:—

Species.		Average.
68	Complete parasites	2·23
62	Semi-parasites	3·50
6487	Non-parasitic	2·59

IV.—Dispersion in relation to habit.

Trees and Shrubs.—British trees were found to "range "rather more widely than herbaceous plants over land, rather "less so over sea." This remark applies with equal force to Continental trees; of which only 3 (or 3⅓ per cent.) cross the Atlantic, against 4¼ per cent. of other plants; while 20 (or 22½ per cent.) are confined to Europe alone, against 63½ per cent. of other plants. But whilst in the case of British plants, almost half of which (41 per cent.) cross the Atlantic, the smaller range of trees over sea reduced their degree of dispersion *below* that of herbs; in the case of the Continental flora, of which only a small fraction of the members (4¼ per cent.) reach America, their wider range over land exerts the stronger influence, and raises the average of trees *above* that of herbs. The following averages show that Continental shrubs have a lower degree of dispersion than herbs, as was the case with British:—

Species.		Average.
89	Trees	3·73
803	Shrubs	2·36
5725	Herbs	2·65

Creeping Rhizomes or Stolons.—The mean dispersion of "repent" plants, as compared with others, corresponds with that calculated from the British lists:—

Species.		Average.
231	Repent	4·41
6386	Non-repent	2·57

Annuals, Biennials and Perennials.—In the foregoing instances the results of the examination of the British flora have been confirmed: such is not the case in the comparison we now come to; for amongst Continental herbs Monocarps are found to give a higher average than Perennials. In this respect therefore the plants of the more Southern latitudes of Europe appear to differ from those more Northern in situation.

Species.		Average.
1472	Annuals	3·03
74	Annuals or Biennials	2·47
311	Biennials	2·39
1857	Total Monocarps	2.90
3608	Perennials	2·62
260	Doubtful duration	1·38

V.—Dispersion according to character of the flower.

Structure.—The divisions of Phanerogams founded on well known structural differences of the flower, compare with each other, and with Cryptogams, as follows:—

Species.		Average.
1335	Thalamifloræ	2·66
1365	Calycifloræ	2·60
2608	Monopetalæ	2·33
333	Apetalæ	3·81
5641	Total Exogens	2·56
470	Petalloideæ	2·35
472	Glumaceæ	3·47
942	Total Endogens	2·91
34	Cryptogams	6·98

Endogens thus exceed Exogens, while in each class the most simply organised divisions, Apetalæ and Glumaceæ, attain the highest average. The low dispersion of Continental Petalloideæ, amongst which there is a very inconsiderable proportion of aquatic plants, agrees completely with the low dispersion of the same division of British plants, excluding aquatics.

Inferior Ovary.—Prof. De Candolle's observations as to the limited range of plants whose flowers have an inferior ovary, was corroborated by the investigations of the British

flora, and is further confirmed by the present lists, which divide as follows :—

Species.		Average.
2186	with ovary inferior	2·30
4369	other Phanerogams	2·76

Conspicuous flowers.—The relative range of plants bearing inconspicuously coloured flowers, those with white, and those with brightly-coloured flowers, calculated from the British lists, is quite confirmed by a similar comparison of Continental plants.

Species.		Average.
805	of whole orders having inconspicuous flowers	3·60
225	other plants with inconspicuous flowers	3·20
1030	Total with inconspicuously-coloured flowers..	3·51
1035	with white flowers	2·88
3657	with brightly-coloured flowers	2·28
861	with colour of flowers variable, unrecorded or unknown	2·62

The difference per cent. between the three averages is indeed greater in the Continental than in the British result, as is seen if the figures are reduced to an equal standard, making them average 100 in each case. They then contrast as follows :—

	British.		Continental.
Inconspicuous	110	...	121
White	102	...	100
Coloured	88	...	79

VI.—Dispersion according to nature of the fruit.

Fleshy fruit.—The hypothesis that a succulent fruit secures for a plant a wider dispersion of its seeds, from their being swallowed by birds and other animals, and deposited with their power of germination unimpared, was hardly supported by the British averages, that of fleshy-fruited species only slightly exceeding that of dry-fruited. The Continental averages give a more decided result, as follows :—

Species.		Average.
168	with succulent fruit.....	3·27
6387	with dry fruit	2·59

As the proportion of fleshy-fruited species is considerably greater in the British flora than on the Continent, a much more marked, and perhaps a more correct contrast is obtained if we combine the British and Continental lists together. The averages of the whole European flora are then :—

Species.		Average.
239	with succulent fruit.....	5·20
7406	with dry fruit	3·17

Dehiscence.—Dividing dry fruits into dehiscent and indehiscent, we have the following comparison, agreeing with that of British plants, in which also the indehiscent fruit was found to be accompanied by a somewhat higher average :—

Species.		Average.
3498	with indehiscent fruit	2·65
2889	„ dehiscent „	2·52

Special adaptation.—It is strange that plants bearing fruit to all appearances specially adapted for dispersion, being either provided with a pappus or other feathery appendage to facilitate its carriage by wind, or furnished with hooked spines, or some other contrivance, enabling it to cling to the coats of animals, should have an average specific area less than that of other plants : but such was the conclusion arrived at by Prof. De Candolle ; such the result of the investigation respecting British plants ; and such is again that of the present enquiry.

Species.		Average.
910	with pappus or other feathery appendage	2·18
146	with grappling organs	2·50
5527	with fruit not specially adapted	2·69

Taking Compositæ by themselves, the figures are :—

852	with pappus	2·10
265	without pappus	2·54

VI.—Dispersion according to character of the seed.

Coma.—While feathery organs on the *fruit* are thus found not to confer an extensive range, the case is otherwise with the coma, that answers the same purpose as a pappus, and is attached to the *seeds* of Salicineæ, many Asclepiadaceæ, and some genera of other orders. This coma was shown by Prof. De Candolle, and in my former paper, to be accompanied by a high degree of dispersion; and the following averages are quite corroborative:—

Species.		Average.
49	with comose seeds	4·67
6534	Seeds not comose	2·59

Size.—It was found impossible to draw the line between British plants with large, and those with small seeds, the change in size being so gradual. The same difficulty is experienced with Continental plants; and I therefore again confine myself to comparing those orders selected by Prof. De Candolle as being small-seeded, with the remaining orders of Phanerogams. The difference between the two is very slight:—

Species.		Average.
1847	belonging to small-seeded orders..	2·66
4736	,, ,, other ,, ...	2·59

Number.—The production of numerous seeds has been considered an advantage likely to lead to wide dispersion. Amongst British plants, however, it was found that species bearing seeds solitary in each cell, had a rather more extensive average range than those with seeds two or more in the cell: and this proves to be likewise the case on the Continent.

Species.		Average.
3595	with seeds solitary in each cell ...	2·66
2988	,, two or more seeds in each ...	2·55

Testa.—The contrast presented by Continental plants,

divided according to the nature of their testa, is similar to that by British. The highest average is attained by those species in which this outer coat is mucilaginous: next follow those which have it thin or membranous: and the lowest are those in which it is thick, hard or crustaceous:—

Species.		Average.
3246	with testa thin or membranous ...	2·66
506	„ „ soft, cellulose, &c.	2·74
1357	„ „ thick, hard or crustaceous	2·49

Albumen.—The more extensive range of British plants with albuminous seeds, and especially of those in which the albumen is floury or mealy, is also repeated in the Continental flora; the averages being:—

Species.		Average.
1072	with albumen floury or mealy.....	2·99
2307	„ „ fleshy or horny.....	2·61
3204	„ „ absent or very scanty	2·49

As bearing on the question whether albuminous seeds the better survive carriage by ocean currents, I referred in my former paper to Mr. Darwin's well-known experiments on the resistance of seeds to the action of sea-water. By the courtesy of Prof. De Candolle I have since received an account of a series of experiments on the same point by M. G. Thuret of Antibes, who kept the seeds of a number of plants in sea-water for so long a period as thirteen months. In some instances the material he used seems to have been bad, as the seeds did not germinate even when kept dry. Leaving such cases out of consideration I find that of the albuminous-seeded species experimented on 43¾ per cent. germinated, most of them vigorously, and as well as if they had not been in sea-water at all: while of the exalbuminous-seeded species only 27¼ per cent. germinated, and all of these very sparingly, merely a few seeds growing, out of a large number.

What relation the presence or absence of albumen in a seed

may bear to its retention of vitality, has scarcely been made a subject of inquiry. That distinguished botanist, the late Robert Brown, expressed the following view in his "Botany of Congo." Commenting upon the lists therein published of species common to Equinoctial Africa and other continents; and referring to dispersion by natural causes, he observes:—

"It may be stated as not unfavourable to it that of the "dicotyledonous plants of the lists, a considerable number "have the embryo of the seed highly developed, and at the "same time well protected by the texture of its integuments. "This is the case in the Malvaceæ, Convolvulaceæ, and par- "ticularly in the Leguminosæ, which is also the most numerous "family in the lists, and in several of whose species, as "Guilandina Bonduc, and Abrus precatorius, the two con- "ditions of development and protection of the embryo co-exist "in so remarkable a degree that I have no doubt the seeds of "these plants would retain their vitality for a great length of "time either in the currents of the ocean, or in the digestive "organs of birds or other animals. * * The dicotyledonous "plants in the lists which belong to other families have the "embryo of the seed apparently less advanced, but yet in a "state of considerable development, indicated either by the "entire want or scanty remains of albumen: the only excep- "tion being Leea, in which the embryo is many times exceeded "by the size of the albumen. In the monocotyledonous "plants on the other hand * * the embryo bears a very "small proportion to the mass of the seed, which is formed "of albumen, generally farinaceous. But it may be observed "that the existence of a copious albumen does not equally "imply an inferior degree of vitality in the embryo, but may "be considered as the natural structure of that primary "division; seeds without albumen occurring only in certain "genera of the paradoxical Aroideæ, and in some other mono- "cotyledonous orders, which are chiefly aquatic."

To test whether the absence of albumen from the seeds of Dicotyledons especially is favourable to dispersion, the following comparison is confined to that class alone:—

Species.		Average.
2501	with albuminous seeds	2·67
3140	with albumen absent or very scanty	2·47

Our British Dicotyledons divide as follows:—

Species.		Average.
402	with albuminous seeds	6·77
373	with albumen absent or very scanty	6·46

while from Prof. De Candolle's calculations (Geog. Bot. vol. I, pp. 515 to 517) the result obtained respecting the dispersion of Dicotyledonous orders is :—

Orders.		Species.	Per centage found in more than two districts.
101	...	22483 with albuminous seeds.....	4·6
59	...	26877 with exalbuminous ,, ...	3·7

In none of the three comparisons, therefore, is Mr. Brown's view supported.

VIII.—Dispersion according to classification.

Large orders.—The orders which contain more than 100 Continental species are:—

	Species.	Avge.		Species.	Avge.
Ranunculaceæ ...	180	3·52	Campanulaceæ ...	133	1·82
Cruciferæ	438	2·66	Scrophulariaceæ..	265	2·32
Caryophyllaceæ...	350	2·32	Labiatæ	313	2·30
Leguminosæ	644	2·39	Boraginaceæ	150	2.32
Rosaceæ	126	3·36	Liliaceæ.....	185	2·12
Umbelliferæ	368	2·44	Cyperaceæ.....	114	4·65
Rubiaceæ	109	2·09	Graminaceæ	358	3·10
Compositæ 1117		2·20			

Taken together they average 2·50, against 2·99 the average of the remainder of the flora. Classing the orders, according to the number of species they comprise all over the world, into "large" with over 1000 species, "moderate" with 500 to 1000, and "small" with fewer than 500, we get the following averages :—

Species.			Average.
4222	belonging to	16 "large" orders.....	2.52
1112	,,	13 "moderate" orders..	2·65
1249	,,	"small" orders	2·87

Like the British averages previously ascertained, they are in inverse proportion to the size of the orders.

Large genera, on the contrary, have a higher degree of dispersion than small, although the difference between them is not so great as in British plants. Ranking those genera as "large" whose total number of known species exceeds 100, we have this comparison :—

Species.			Average.
1933	belonging to 65 large genera		2.68
4684	„ smaller „		2·61

Variability, or a tendency to produce varieties differing from the typical form, was found amongst British plants to be accompanied by an increased specific range. In the following comparison, which shows that such is also the case amongst Continental plants, those species have been ranked as variable that comprise forms sufficiently divergent from the type to be considered by some authors distinct species :—

Species.		Average.
1528	variable	3·69
5089	not variable	2·31

IX.—Alpine Plants.

Having now checked, so far as the materials to which I have had access have enabled me to do so, as many as possible of the former observations respecting the dispersion of British plants, by similar enquiries concerning the Continental flora, I have in conclusion to draw your attention to a subject which did not present itself to our notice when we were considering the British lists, namely Alpine plants. Accepting Mr. Darwin's theory of a glacial migration, as accounting satisfactorily for the presence of what I have termed Arctic-alpine plants in the extreme North, and on the high mountains of Southern Europe, and their absence from the intermediate low grounds; the question arises, Why are not Alpine plants also

found in the Arctic regions? Does it arise from their more recent origin as species; from their not having come into existence until after the departure Northward of the Arctic-alpine species? The relative specific areas of the two may afford some evidence on the point. They average as follows:

Species.		Average.
101	Arctic-alpine	9·39
404	Alpine	1·77

The comparison indicates that very few of our present Alpine species can have been in existence *before* the glacial age: for if they had then flourished, along with the Arctic-alpine species in the circumpolar area, we should find them now equally widely spread over the mountains of the temperate zone. Of 101 Arctic-alpine species, 72 (or 71 per cent.) are found in all the Northern continents; and 44 (or 43 per cent.) are common to the mountains of the old and new worlds: but of Alpine plants, none are "Universal," and only 2 (or ½ per cent.) are found on both sides the Atlantic. With the exception of these two species, and possibly some few others which extend from the Alps to the Himalayas, or even to the Baikal mountains, Alpine species are of so limited a range that we cannot conceive their existence before the glacial age. Again, if they came into existence *during* that period, whilst the Arctic-alpine species occupied the plains of S. Europe, they would have had their opportunities for spreading equal to those of the Southern plants which now occupy the same position: but if they are of later origin, and only became the companions of the Arctic-alpine species after their retreat up the mountains, we should expect to find them less widely dispersed; for they are as much isolated on the mountains, as they would be on islands, the hot plains being as great a hindrance to their spread in the one case, as the sea is in the other. The comparison between plants now found only in

Southern latitudes, but confined to different elevations, is as follows :—

Species.		Average.
404	Alpine, above cereal line.....	1·77
4752	Southern, below cereal line.	2·29

This betokens that at any rate a great many of the Alpine species have originated since the isolation of the mountain ranges. Some however are common to the Alps and Pyrenees ; or to the Alps and the mountains of E. Europe and Asia Minor ; or even occur on all. Respecting these wider rangers three hypotheses suggest themselves :—1. They may have originated while the climate of S. Europe was still sufficiently severe to admit of their ranging over the low country ; mixing there with the older Arctic-alpine species which had come from the North. Returning warmth would drive them upwards on to the mountains, where they may have succeeded in establishing themselves ; but have failed to accomplish the longer journey Northwards. That some such extinctions would take place amongst the species migrating to the North is but natural, for they would be crowded together into a much smaller area, so that the struggle for existence would be more fierce. 2. They may have originally possessed a greater range of elevation than at present, resembling formerly what I have termed "temperate plants confined to S. latitudes." In connection with this we must bear in mind what Dr. A. Gray has pointed out, that a few plants of Alpine elevation in Europe, are only sub-alpine, or even inhabit the low country in America. 3. They may have originated since the isolation of the Alpine regions, but have been carried from one to the other by winds or birds.

Which of these three explanations is the correct one I will not attempt to decide, for statistics appear to afford no evidence on the point ; unless indeed the following comparison between Alpine plants with, and those without a

pappus or similar organ, has some bearing upon the third hypothesis, on the supposition that pappose fruit is the more readily dispersed by wind. It shows that amongst Alpine plants the average of species bearing such fruit is 8 per cent., whilst amongst other plants it is 19 per cent., below the average of species with fruit not pappose.

Alpine Species.		Average.
60	with pappus, &c.	1·65
344	without „	1·79