X. *On the Vegetation of the Galapagos Archipelago, as compared with that of some other Tropical Islands and of the Continent of America.* By Joseph Dalton Hooker, *Esq., M.D., F.R.S., F.L.S. &c. &c.*

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THE Florula of the Galapagos Islands, which I recently had the honour of laying before this Society, was drawn up with the view of enabling me to discuss at length the geographical distribution of the plants contained in that singular Archipelago. As a field of observation, this group possesses the rare advantage of being one whose vegetation has never been interfered with by any aborigines of the human race; and it is only very lately that the operations of man, or of animals introduced by his means, have disturbed the indigenous Flora, and that to a very limited extent only. It possesses the further singularity of containing a Flora differing by upwards of one-half its species from that of the rest of the globe, a peculiarity shared by no other tract of land of equal size, excepting perhaps the Sandwich group; whilst only three out of the 123 new species, collected by various voyagers, have been previously described.

Before commencing the study of the plants, I was assured of their being of a very novel character, especially from the masterly sketch of the unique zoology and the unequal dispersion of the species over the several islets composing this group given by Mr. Darwin, to whose comprehensive view of the natural history of the Galapagos this essay can be considered as supplementary only. The results of my examination have been, that the relationship of the Flora to that of the adjacent continent is a double one, the peculiar or new species being for the most part allied to plants of the cooler parts of America, or the uplands of the tropical latitudes, whilst the non-peculiar are the same as abound chiefly in the hot and damper regions, as the West Indian islands and the shores of the Gulf of Mexico; also that, as

is the case with the Fauna, many of the species, and these the most remarkable, are confined to one islet of the group, and often represented in others by similar, but specifically very distinct congeners.

This examination has led me to take a survey of the vegetation of several other tropical islands, whose plants present much peculiarity, and to trace the effects of isolation in geographical position upon vegetation; as well as certain characters in some orders, their distribution and proportions, which seem to distinguish insular floras from the continental.

Before entering upon the details of the vegetation, I shall shortly allude to the position of the Galapagos, and some of their most important features of climate and soil which affect the plants, and which I shall extract from the Journals of Mr. Darwin and of other voyagers, including one by the late Mr. T. Edmonstone, hitherto unpublished.

The Archipelago consists of ten islands situated under the equator, between 500 and 600 miles west of the mainland of America at Guayaquil, and the same from the Isthmus of Panama, which lies to the north, and 3000 miles from the nearest of the tropical Pacific islands. The islets are wholly volcanic; several of the peaks attain a height of 3000 to 4700 feet, some having their flanks studded with innumerable small craters. These are considered to have been formed in the sea, and to be, as compared to the adjoining continent, of recent formation.

The climate is far from intensely hot, being moderated both by the insularity of their position and the low temperature of the waters of the great south-polar current which washes their shores. The extremes of temperatures observed at different times of day between 9 A.M. and 3 P.M. for thirty-five days in September and October include a range of eight degrees only (73° and 65°). These are however, according to Capt. Fitzroy's observations, taken on board ship. The plants on shore are exposed to a much higher and very prejudicial temperature. Thus Mr. Darwin experienced a heat of 93° in his tent, when the thermometer stood at 85° only in the wind and sun, but which, when plunged into the soil, rose at once to 137°, and would have risen higher had the tube been longer. On the other hand, nocturnal radiation does not in all probability reduce the temperature proportionally, the nights being generally misty. The prevailing weather is overcast and gloomy, the winds varying for the period alluded to

between south and east. A failure of this, the trade-wind, caused the extraordinary rise of the thermometer mentioned above.

The nature of the coasts and surface of the islands is in some measure indicated by the plants contained in the various collections, some of the more generally diffused of which may thus be classified with reference to locality.

The genera *Avicennia* and *Rhizophora*, species of both of which bear the name of Mangrove in different parts of the world, prove that in some of the islands at least (Charles and Chatham) there is a phænogamic vegetation below high-water mark. On the other hand, from the steepness of the coasts and dryness of the soil near the ocean, there appear to be few maritime plants. Those which I presume to be more strictly such are *Cissampelos Pareira*, *Tephrosia littoralis*, *Scævola Plumieri*, *Convolvulus maritimus*, *Calystegia Soldanella*, *Verbena littoralis* and *Heliotropium Curassavicum*, all natives of the South American coast, and to which may probably be added some of the peculiar *Amaranthaceæ*.

The lower parts of the island are very arid and rocky, presenting thickets of starved shrubs and leafless trees, and to these situations are assigned* the weeds of the Flora, such as herbaceous or suffrutescent *Malvaceæ* and *Euphorbiaceæ*, many species of *Borreria*, some *Compositæ*, various *Lycopersica*, *Verbenæ*, *Galapagoa*, *Boerhaavia* and some grasses; to which may be added some larger shrubs, as small trees of *Acacia*, *Castela*, *Cactus* and *Opuntia*. Where marshy land occurs, and this is not uncommon on the summits, several species of *Cyperus* and *Mariscus* appear; and to a salt lake, which is beautifully fringed with succulent plants, belong *Portulaca*, some *Amaranthaceæ*, *Pleuropetalum*, and probably *Sesuvium*.

On ascending the hills the climate and vegetation both suddenly change, the sea-vapours are condensed on the higher parts of the islands, and a comparatively luxuriant flora is the consequence. From these more favoured localities are brought the greater number of the very peculiar vegetable forms of the island; curious arborescent *Compositæ*, which have no near allies in other parts of the globe, and of which there are eight species in this group, all

* In thus assigning localities to the species, I have been guided in many cases by notes attached to the specimens, in some by the plant growing in islands of a uniform surface and character, and in not a few instances by a knowledge of the situations which the species affect in other parts of the world.

closely related to one another. Associated with these are trees of *Phytolacca*, *Leguminosæ*, *Psidium*, *Psychotria*, *Chiococca* and *Clerodendron*, all tropical in appearance, accompanied by others no less characteristic either of a warm and equable temperature, humid atmosphere or wooded region; such are the genera *Passiflora*, *Viscum*, *Ipomœa*, *Epidendrum* and *Peperomia*, with the great majority of the Ferns, and all the *Jungermanniæ* and *Musci* that have been collected on the group.

The naturalists who have explored this archipelago are very few in number, and as all have added more or less to a knowledge of its botany, I shall mention their names in the order of the date of their respective visits. Mr. Hugh Cuming in 1829 paid a very short visit to the islands. The late David Douglas and Dr. Scouler touched at James's Island on their way to the Columbia River. Mr. Macrae landed on three of the islets when employed in collecting by the Horticultural Society, and formed a rather considerable herbarium. In 1835, Mr. Darwin spent some weeks in the archipelago, visited four islets, and formed the excellent collection of upwards of 200 species which forms the groundwork of this essay. Admiral Du Petit Thouars collected a few plants in one island only, for specimens of which I am indebted to the kindness of M. Decaisne of Paris, and very recently one of the Galapagos group was the last place explored by the lamented Mr. Edmonstone in the winter of 1845. His herbarium is second to that of Mr. Darwin in numbers, and contains several plants which are not in any of the others. The total number of species brought together from these various sources amounts to 265, of which 225 are flowering plants, and 28 Ferns. The other orders of *Cryptogamia* have not been attended to by any collector: of these there are 2 *Musci*, 6 *Hepaticæ*, 3 *Lichens* and a *Fungus*. All the above, except perhaps 17, natives of Charles, the only inhabited island, are truly indigenous to the group: but that this is only an approximation to the real number of species inhabiting the archipelago is probable from the circumstance of only 40 of these having been collected by more than one of the six collectors whose herbaria I have examined.

Under any circumstances it appears that the Flora of the Galapagos is an exceedingly poor one when compared with that of other tropical islands of their own or even less extent. Thus the Cape Verds, scarcely so well

explored, (and whose mountains, which attain 8000 feet, have not been ascended above 1000 feet,) are known to yield upwards of 300 species on a soil quite as sterile as that of the Galapagos, whilst the Sandwich and Society groups are much richer, though further detached from any continent. What however is known suffices to institute a comparison between the vegetation of this group and that of the neighbouring continent and with that of other tropical islets; a subject which divides itself into the following branches:—

I. As the most important considerations regarding the vegetation of a country relate to its most characteristic natural orders, I shall first offer a few observations upon the number of species contained in the different families, and on the proportion which each of the principal ones bears to the whole Flora, and then compare the results with what have been obtained on the neighbouring continent, or on other islands somewhat similarly circumstanced with the Galapagos.

II. Here, as in other countries, the vegetation is formed of two classes of plants; the one peculiar to the group, the other identical with what are found elsewhere. In this there are even indications of the presence of two nearly equal Floras, an indigenous and introduced, and these are of a somewhat different stamp; for the introduced species are for the most part the plants of the West Indian islands and of the lower hot parts of the South American coast; whilst the peculiar Flora is chiefly made up of species not allied to the introduced, but to the vegetation which occurs in the Cordillera or the extra-tropical parts of America.

III. In the third place, I shall allude to the most singular feature in the botany of the group, the unequal dispersion of the species, the restriction of most of them to one islet, and the representation of others by allied species in two or more of the other islets.

The first peculiarity in the Flora of the Galapagos which demands attention is the paucity of Monocotyledonous plants, which hardly equal $\frac{1}{9}$ of the Dicotyledons. In all tropical countries the *Monocotyledones* bear a smaller proportion to the *Dicotyledones* than is found in the temperate or colder latitudes: Baron Humboldt has stated this proportion to be $\frac{1}{6}$ of the vegetation for the tropics of the new world, and Mr. Brown $\frac{1}{5}$ for that of the old. As however that of Baron Humboldt was obtained from materials collected partly from very

nigh levels, where the tropical proportion no longer obtains, it is probable that Mr. Brown's results are the more accurate. If the Galapagos number of *Monocotyledones* is small as compared with that of the continent, it is even more so with regard to that of other tropical islands: thus in St. Helena they equal nearly $\frac{1}{5}$ of the *Dicotyledones*, in the Society Islands $\frac{10}{42}$, and in the Sandwich Islands $\frac{1}{4}$. This paucity is not due to the sterility of the soil or dryness of the climate, for the Cape Verd proportion is $\frac{1}{5}$, these islets being, as I have mentioned above, equally barren with the Galapagos.

Although I can offer no explanation of this apparent anomaly, it may not be out of place to notice here, that the tropical islands in general possess proportionally more *Monocotyledones* than do the continents. This is no doubt due to the same causes which determine the increased proportion which the temperate zone shows over the tropical, and is the more striking from this circumstance, that the nearer the tropical islet is to a great continent, the greater does the proportional number of *Dicotyledones* become, as is shown by the Galapagos and Cape Verds, both adjacent to great continents, possessing more than the Sandwich Islands, Society group, St. Helena, or Ascension.

The individual species of the very largest Monocotyledonous families being more widely dispersed than any of equal extent amongst the Dicotyledonous, is also a reason why the insular proportion of the latter should be different from the continental*.

If the insular tropical proportion be assumed to be $\frac{1}{4}$, it is larger than that for the islands of the Atlantic immediately beyond the tropics. Thus for the Canaries (lat. 28°) it is probably $\frac{1}{6}$, and for Madeira $\frac{10}{54}$; whence they again increase

* And for the same reason great caution is required in deducing the continental proportions from small local collections, however complete in themselves. The results obtained from a small area are almost necessarily erroneous if applied to the greater one of which it forms a part, although the general features of vegetation may be well displayed by the latter. To this I attribute the remarkable discrepancy between the results obtained for West Tropical Africa by Mr. Brown, after an examination of the Congo Expedition plants, and those which my examination of the Niger Expedition collections led to, the *Monocotyledones* equalling $\frac{1}{4}$ in the former case, and $\frac{10}{64}$ in the latter, of the *Dicotyledones*. This appears to be owing to the same species of *Cyperaceæ* and *Gramineæ* (which form the majority of the *Monocotyledones* in both instances) prevailing throughout a great extent of coast, but accompanied by different species of *Dicotyledones* at different parts of the same tract. Hence it is probable that up to a certain point the Monocotyledonous proportion will decrease as the area under examination is extended, and the proportion for the tropics may even fall short of $\frac{1}{5}$.

on approaching the frigid zone, from Madeira (lat. 32°) $\frac{1}{54}$, Azores (lat. 38°) $\frac{1}{41}$, Great Britain (lat. 50°·57) $\frac{1}{4}$, Shetland (lat. 60°) $\frac{1}{33}$, which is the maximum for the northern hemisphere. In the arctic regions, on the other hand, all the proportions obtained, either from isolated localities (except Melville Island) or from extended tracts, tend to confirm Mr. Brown's first theory, that the proportion is again inverted. Thus that of Iceland (lat. 65°) is $\frac{1}{48}$, Spitzbergen (lat. 78°·80) $\frac{1}{49}$, east coast of Greenland $\frac{1}{5}$, the Arctic American islets (lat. 68°) $\frac{1}{53}$, Baffin's Bay (lat. 70°·76) $\frac{1}{57}$, Port Bowen and Prince Regent's Inlet (lat. 74°) $\frac{1}{7}$. To this regular progressive decrease, Melville Island offers the only exception, its proportion being that of the Shetlands*.

From the above facts it may be assumed that equable, temperate, and rather humid climates are most favourable to a Monocotyledonous vegetation, for it diminishes both under the extreme cold of the arctic zone and the great heat of the tropics; on the other hand increasing towards the southern temperate and antarctic zones, where such conditions are best fulfilled, proportionally with the latitude, to as far south as a Phænogamic vegetation extends.

With regard to the amount of peculiarity existing in the two great divisions of flowering plants in any country, it is a curious subject, but one towards the illustration of which little has been done. Generally speaking the *Monocotyledones* present much the lesser proportion of novelty; but this is not the case in the Galapagos, nearly one-half of whose Monocotyledonous plants (10 out of 22) are confined to that group: whence it may be inferred, that the paucity of this division there in reference to the whole Flora is owing in some measure to obstacles to the transport of seeds from the continent.

The prevailing natural orders in the Galapagos are the Ferns, containing 28 species; *Compositæ* 28; *Leguminosæ* 24; *Euphorbiaceæ* 18; *Rubiaceæ* 15; *Solaneæ* 13; *Gramineæ* 12; *Amaranthaceæ* 10; *Verbenaceæ* 9: *Cyperaceæ* and *Borragineæ* each 7: of the other 43 orders none are so extensive, or are otherwise worthy of particular mention, except *Cordiaceæ*, of which there are six species, only one or perhaps two of which inhabit the adjacent continent. All

* With regard to Melville Island, it should be borne in mind that it is beyond those limits up to which every degree of latitude is marked by some one or more peculiar species of plant which is not found beyond it. It is on the verge of the extinction of terrestrial vegetation in that longitude, and therefore presents us with such species only as can struggle successfully against the climate they there encounter.

of these orders will be recognised as forming a great part of the vegetation of every tropical country, except the *Amaranthaceæ*, which however find their maximum on the west coast of South America. Hence it is not to the prevalence of any particular natural order, or the undue number of species contained in any one, that the Galapagos owe their extraordinary amount of novelty. All the general features of a tropical vegetation are retained, and even the genera to a great extent, but the change is in the species, of which one half are confined to that archipelago; and this peculiarity in species not only relates to the difference existing between the Galapagos and the mainland of America, of which it is a botanical province, but to the separate islets of the archipelago, which, as Mr. Darwin aptly remarks, should be called "a group of satellites, physically similar, organically distinct, yet intimately related to each other, and all related in a marked though much less degree to the great American continent."

GLUMACEÆ.—This somewhat artificial group, including *Gramineæ*, *Cyperaceæ* and *Junci*, has been defined by Humboldt as including the majority of *Monocotyledones* in all latitudes. In the tropics of America these collectively form $\frac{1}{11}$ of the flowering plants, which is precisely the Galapageian proportion, and one that would not be expected if the fewness of the *Monocotyledones* previously alluded to be borne in mind. Two conclusions may be drawn from this, that this paucity is owing to the scarcity of petaloid families, and that the fewness of *Gramineæ*, to which I shall next refer, is compensated by the *Cyperaceæ*.

GRAMINEÆ.—This order forms little more than $\frac{1}{20}$ of the Phænogamic flora, the smallest proportion I have obtained from any country. This is the more remarkable, as nearly three-fourths are peculiar, proving that the order, though having many species which are well adapted for transport, has not sent its colonists to the Galapagos in the same proportion as it has to other countries; as to the Sandwich Islands for instance, three-fourths of whose grasses are those of other countries. This paucity is further conspicuous from the islands within the tropics being richer in *Gramineæ* than the continents, where they do not form more than $\frac{1}{12}$, whilst in the Sandwich Islands they amount to $\frac{1}{6}$, and in the Society's, lying in the same longitude and equidistant from the equator on the opposite side, also $\frac{1}{6}$, which is the Cape Verd proportion also; a singular concurrence, considering that in all three localities the species are very dif-

ferent. The relative abundance of *Cyperaceæ* to *Gramineæ* is extremely fluctuating, though in a measure amenable to very conflicting causes, which we can only partially follow. Of the Galapageian *Gramineæ* the *Poæ* and *Paniceæ* are nearly equal, which is very unusual within the tropics; one of the species belongs to *Eutriana*, a genus almost peculiar to America, and particularly to the mountainous regions or cooler parts. Two new species belong to *Aristida*, which is also represented by a species in the sterile island of Ascension.

The Compositæ are in every respect the most remarkable family in the Galapagos, both as regards number of new species and new genera, and from their forming much of the wood of the islands. They also are the most instructive, as the species are very clearly defined: the peculiar genera have representatives in the different islets; and whilst the new species are almost wholly allied to plants from the Andes or extra-tropical parts of America, the old are almost universally the weeds of the low coast of the same continent. It is not therefore with this family as with some others, that the new species are, though permanently, only partially distinct from the continental ones, and possibly varieties due to climatic causes; but they are the representatives of species which are only found beyond the reach of direct migration, or are to a great extent entirely new genera.

In respect of the peculiarity of their *Compositæ*, the Galapagos may be compared with some other tropical islands, as the Sandwich group and St. Helena; also with two extra-tropical islands, Juan Fernandez and New Zealand. All of these have a larger amount of peculiarity in their floras than any other tracts of land of the same size. It has been noticed that the four last-named islands or groups are remarkable for possessing a great proportion of arborescent *Compositæ*, and in this too the Galapagos share, though the comparison can be carried no further between any of them; for whilst the order is here represented by *Melampodineæ* and *Helianthеæ*, in Juan Fernandez it is by *Senecioneæ* and *Cichoraceæ*, in St. Helena chiefly by *Asteroideæ*, in the Sandwich group by *Verbesineæ* and *Bidentineæ*, and in New Zealand by *Helichryseæ* and *Astereæ*. In all these cases, the further the islands are from the mainland, the less evidence do the *Compositæ* they contain afford of the botanical province to which each may belong. Thus the Galapagos contain, in the peculiar plants of this order

alone, internal evidence of a strong botanical relation between that Archipelago and Mexico, which a further examination of other orders confirms. Juan Fernandez in like manner abounds in a tribe peculiarly copious in Chili, and the New Zealand arborescent *Compositæ* are allied to, though generically and specifically very different from, those of New Holland: but on the other hand, the peculiar genera of the Sandwich group are scattered through many tribes, belonging some to the old world and others to the new; whilst in St. Helena (the whole of whose *Compositæ* are shrubby or arborescent, and all belonging to peculiar genera), the order seems made up of the fragments of groups characteristic of very remote parts of the world: the majority belong to a genus of *Astereæ* related to what occurs in New Zealand; others to such *Labiatifloræ* as Juan Fernandez possesses; a third genus to the Melampodinous family of the Galapagos, and the fourth belongs to the same tribe of American *Compositæ*.

This order here equals $\frac{1}{8}$ of the whole Phænogamic plants, or is nearly the same as its proportion is for the flora of the whole world, and the same as that of the Sandwich group, but smaller than that of Juan Fernandez, and especially of St. Helena, where it equals one-third of the flowering plants remaining there. On the other hand, the Society group, in possessing only $\frac{1}{35}$ of *Compositæ*, the smallest number relatively to the whole flora of any tropical country, betray their relationship to the flora of the torrid zone in the old world, which in this respect is strikingly contrasted with that of the new; for it is not improbable that there are more species of this order contained in the comparatively narrow belt of land comprised between the tropics of America, than the same latitudes produce from the west coast of Africa eastwards to the remotest of the Pacific islands.

Except St. Helena, there is no part of the globe whose *Compositæ* are so nearly unexceptionably different from those of any other country as the Galapagos. Of the 17 genera in which they are included, 5 are widely different from any previously known; and of the species, 28 in number, 23 are peculiar and 5 are tropical weeds, readily introduced by man, and found in the colonized islets alone; whence their origin is suspicious. Of the 12 remaining genera, 9 are almost exclusively American, and the remainder of more general distribution. The last circumstance connected with this order

to which I shall allude, is the gummy exudation for which the shrubby *Scalesiæ* are conspicuous, and which is equally a characteristic of some of the St. Helena *Compositæ*. The species in both instances are inhabitants of arid spots, fully exposed to the sun of the torrid zone, which together seem favourable to the copious secretion of gums and gum-resins in various parts of the world.

Leguminosæ.—This order is second only to the last in number of species, of which there are 24 contained in the various collections, but differs conspicuously in its proportion of novelty, there being no peculiar genus, and only 7 species which are not found on the adjacent continent. Of all the large natural orders of flowering plants, the *Leguminosæ* contain by far the largest amount of universally diffused species, including very many of the littoral weeds of the tropics. Observation proves that this is in a great measure due to the transporting power of water, for neither do the seeds of the dispersed species bear winged appendages, nor are they of such a size as renders it probable that they are carried by aërial currents. The ubiquitous species possess, on the other hand, remarkable powers of resisting the effects of time and exposure, besides a vegetative power that enables them to overcome obstacles in the soil and climate of the locality they are transported to; qualities which the *Compositæ* probably possess in a very limited degree, for we see their feathery pappus to have had little effect in spreading the majority of the individual species beyond any but very narrow limits.

Of the Galapageian genera only *Dalea* and *Galactia* are exclusively American, and all but the 7 species mentioned above are common tropical species, particularly in the West Indian islands.

Euphorbiaceæ form a very large proportion of the Galapageian Flora, consisting of 18 species, included in the tropical genera *Acalypha*, *Croton*, *Euphorbia* and *Phyllanthus*. They form $\frac{1}{11}$ of the Phænogamia, very much exceeding the proportion for the tropics of the new world, which is stated by Baron Humboldt as $\frac{1}{35}$, or of Western Africa, which Mr. Brown gives as $\frac{1}{28}$. In amount of peculiar species this order here ranks next to *Compositæ*, $\frac{5}{6}$ of the whole belonging to species very distinct from those of other countries; the remainder are common West Indian or Southern United States plants.

In the prevalence of peculiar *Euphorbiaceæ* and *Rubiaceæ*, this group has

features in common with the similarly barren island of Ascension, where almost the only Dicotyledonous plants are one of *Rubiaceæ* and a prostrate *Euphorbia*, allied to, and of the same habit as, the Galapageian ones. The *Aristida* too of Ascension, which is there the only abundant grass, is represented here by two congeners which occupy similar situations. This feeble though decided analogy existing between the vegetation of arid volcanic islets in opposite oceans is very singular, and is a feature analogically repeated as it were by the two moister islands of Juan Fernandez and St. Helena, which possess very similar and closely-allied peculiar forms of *Wahlenbergia*.

The shrubby Crotons of this group are no doubt conspicuous features in the vegetation; the other species of the order are mere weeds.

RUBIACEÆ.—An order largely represented, including upwards of $\frac{1}{15}$ of the flowering plants, whilst of the tropical Flora of the neighbouring continent they form but $\frac{1}{29}$, and of that of the whole globe $\frac{1}{23}$. The amount of peculiarity is also very large, though (as in *Euphorbiaceæ*) the new species are found under a very few genera; in this case 11 of the 15 are such, belonging to three genera, of which one, *Borreria*, alone contains 8. This last and *Euphorbia* contain the majority of the weeds of the Galapagos, and are further the two largest Phænogamic genera in the group.

It is singular to remark to what different genera of plants various islands are indebted for their greatest peculiarity, and how often it is the case that such genera give a character of individuality to the scenery. This is effected in the Galapagos by covering the lower lands with *Euphorbia* and *Borreria*, whilst the large genera *Scalesia*, *Croton* and *Cordia* give the conspicuous features of the vegetation of the higher regions. In like manner in Juan Fernandez and St. Helena the most conspicuous, which are also the largest genera, are of *Compositæ* and *Campanulaceæ*; and in the Sandwich Islands *Goodeniaceæ* and *Lobeliaceæ*; while in the Society group, on the other hand, out of upwards of 200 genera, *Piper* is the only one containing as many as 3 peculiar species. This leads me to another remark, that the greater the amount of peculiarity an insular flora presents, the closer relationship do the species it contains bear to one another. This is best shown by observing the proportion that the species bear to the genera, which more frequently contain several species in the peculiar than in the borrowed floras. This may be stated in another

form, thus: the more an island is indebted to a neighbouring continent for its vegetation, the more fragmentary does its flora appear, migration being effected by the transport of isolated individuals, generally in nowise related, while an independent flora is generally made up of groups, the lowest order of which we call genera. Hence the Coral Islands, whose flora is wholly borrowed, seldom have two species belonging to the same genus; as Keeling Island, for instance, on the west, and Malden Island to the eastward of the Pacific, in both of which the genera are to the species as 1 : 1; or the Society group, which presents so little novelty, and whose proportion of genera is as 1 : 1·3. In the Sandwich Islands, on the other hand, our very imperfect materials give a proportion of 1 : 2; the Galapagos of 1 : 1·7; and St. Helena about the same.

In the abundance and peculiarity of *Rubiaceæ*, the Galapagos may be compared with the Sandwich group, which contain 18 species of this order unexceptionably peculiar, and all belonging to genera even confined to those islands. None of the Galapageian species belong to any but very common genera*.

Of SOLANEÆ there are 13 species, a considerable number in proportion to the extent of the Flora, but almost the whole of them derived from the neighbouring coast. Only one, a species of *Acnistus*, is previously undescribed, except the *Dictyocalyx*, which is however a native of the shores of Peru. *Solanum nigrum* is the only flowering plant common to Great Britain and the Galapagos, except *Verbena officinalis* and *Calystegia Soldanella*; all are found in most intervening shores.

The AMARANTHACEÆ are the only other family of flowering plants appearing to demand a particular notice, for their abundance and novelty are without a parallel in any tract of land of equal extent. This is partly to be accounted for by their being partial to the immediate neighbourhood of the sea, but is more due to the position of the Galapagos being near to America, where, according to Martius, they attain their maximum. Littoral and widely diffused as many plants of this order are, we do not find one of the ubiquitous species in this group; and indeed, except two belonging to the genus *Ama-*

* In respect of *Rubiaceæ*, the vegetation of the Sandwich group has no analogy with that of any other islands. The Society Islands contain many more species, but all belonging to Asiatic genera. Even the specifically peculiar *Rubiaceæ* of St. Helena and Ascension have Cape congeners, and there is no genus of this order confined to Juan Fernandez.

ranthus itself, and these hardly identical with previously described plants, there is no species common to the Galapagos and adjacent continent. The *Amaranthaceæ* form $\frac{1}{23}$ of the Phænogamous Flora of the Galapagos, which is a ten-times greater proportion than the order bears to the vegetation of the whole globe.

Filices.—The very variable characters of the species belonging to this order and their geographical limits being very far from defined, I hesitate in considering the data they afford as of equal value with those obtained from the Phænogamic Flora. The number found in the Galapagos, 28, is certainly small, considering how numerous they are on Cocos Island, a very few degrees to the north, and on Juan Fernandez to the south. Their scarcity, together with the absence of any Tree-fern, is no doubt due to the dryness of the land and atmosphere, though the upper regions, where an epiphytical orchideous plant flourishes, are to all appearance sufficiently humid for their wants. Judging from botanical grounds of the humidity of a climate, we must be guided by the prevalence of Ferns or their scarcity; and when the nature of the species belonging to this order is considered, it will be found that many of the Galapageian species are common to drier parts of and arid places in the tropics, such as *Marginaria incana*, *Litobrochia pedata*, *Polystichum coriaceum*, *Nephrodium molle* and some others; whilst the extensive genera *Hymenophyllum* and *Trichomanes* are entirely wanting, together with the whole order of *Lycopodiaceæ*, including that most frequent of all tropical plants, *L. cernuum*, L. A small proportion, equalling $\frac{1}{5}$ of the whole, are new; the remainder are the common plants of the West Indies and South America.

The Galapagos are further the only tropical group of islands of any extent which contain no *Dicksonieæ* and *Cyatheæ*, except the Cape Verds; a further evidence of the aridity of the climate.

The remaining orders are all small and demand little notice; they may however be enumerated under three heads, according to the distribution of the Galapageian species they contain:—

1. Orders, all the Galapageian species of which are common to both the old and new world, are:—*Menispermeæ* 1; *Cruciferæ* 1; *Caryophylleæ* 2; *Sapindaceæ* 1; *Zygophylleæ* 1; *Rhizophoreæ* 1; *Scævoleæ* 1; *Plumbagineæ* 1; *Commelineæ* 1.

2. Orders whose Galapageian species are American solely :—*Xanthoxyleæ*, a West Indian species; *Simarubeæ*, the West Indian *Castela Nicholsonii*; *Umbelliferæ*, 2 *Helosciadia*; *Lobeliaceæ*, the Mexican *L. Xalapensis*; *Apocyneæ*, the West Indian *Vallesia glabra*, Lk.; *Plantagineæ*, the Chilian *P. tomentosa*; *Phytolacceæ*, *P. decandra*; *Chenopodiæ*, *Cryptocarpus* and *Boussingaultia*; *Hypoxideæ*, *H. erecta*, Willd.

3. Orders containing only such Galapageian species as are confined to that group :—*Polygaleæ*, 2 species; *Byttneriaceæ*, a new *Waltheria*; *Celastrineæ*, a new plant of the American genus *Maytenus*; *Rhamneæ*, a *Discaria* allied to a Chilian species; *Myrtaceæ*, a *Psidium*; *Cucurbitaceæ* 2; *Cacteæ*, a *Cereus* and *Opuntia*, the latter one of the largest of the order; *Passifloreæ*, 3 new species allied to West Indian congeners; *Loaseæ* 1; *Portulaceæ*, a new genus and a new species of *Sesuvium*; *Lorantheæ* 2; *Piperaceæ*, 3 very distinct species of *Peperomia*; *Orchideæ*, an epiphytical *Epidendrum*.

4. The other orders are :—*Malvaceæ* 4, including 2 *Sidæ*, considered as new, but possibly altered states of continental species; *Convolvulaceæ*, 4 species, two belonging to the first of the foregoing divisions, one to the second, and three, a *Cuscuta* and two *Ipomææ*, to the third. *Verbenaceæ* 9; two belonging to the first division, and the rest (except possibly two which are indeterminable) to the second; *Labiatæ* 5, one to the first division, three to the second and one to the third; *Scrophularineæ*, the ubiquitous tropical *Scoparia dulcis*, and an indeterminable, probably new plant; *Borragineæ*, a new genus, *Galapagoa*, with two species, the wandering *Heliotropium Curassavicum*, two new *Tournefortiæ* and two South American plants; *Acanthaceæ*, *Dicliptera Peruviana*, and a new *Tetramerium*; *Nyctagineæ*, an undescribed *Pisonia*, and four very widely distributed *Boerhaaviæ*; *Urticeæ* 5, all common South American plants, one of which, *Pilea peploides*, is also found in the old world.

The general results of this summary of the orders, and of the comparison of these and of the species with those of the continent of South America and the other islands, which in peculiarity of flora for their size may be compared with the Galapagos, (as New Zealand, the Sandwich group, Juan Fernandez and St. Helena,) are, 1st, That there are points of agreement inexplicable in our state of knowledge; such are the peculiarities of *Rubiaceæ* and of frutescent and arborescent *Compositæ*; which is rendered the more remarkable from

the species and genera of those orders contained in one group of islands having little or no relation with those of the others. 2ndly, That the chief points of difference are explicable, and owing chiefly to the relations the islands bear to the nearest continents, and to the nature of the soil and climate, &c.; such are the absence of Ferns, and the peculiar forms of *Compositæ* and *Rubiaceæ*, and other orders having their nearest allies on the neighbouring continents. 3rdly, The smallest amount of novelty will be found amongst the more perfect plants, if such be so considered as possess a double floral envelope and polypetalous corolla, including the *Thalamifloræ* and *Leguminosæ*, whilst the greatest amount of new species exists in the lower orders, as *Amaranthaceæ* and *Piperaceæ*, or in the incomplete genera of *Euphorbiaceæ*, and in the *Compositæ*. On the other hand, there are somewhat fewer peculiar and new plants amongst the *Monocotyledones* than the *Dicotyledones*; and the amount of novelty amongst the Ferns is small in comparison to the higher orders.

II. In this second part of the essay I propose to treat of the Flora of the Galapagos as divisible into two types: these are the West Indian (including Panama), to which the plants common to other countries and the dubious species almost universally belong; and the Mexican and temperate American type, or that under which the great majority of the peculiar species will rank. Those which I have called dubious species consist of a few plants which more properly belong to neither of these divisions, including all such as are so nearly allied to continental forms as to appear scarcely distinguishable specifically, or if distinguishable, dependent on characters which, though sufficiently obvious, are extremely liable to variation; such are possibly altered forms of introduced species, dependent on the combination of circumstances which they are exposed to in the Galapagos for the appearances they assume: such plants are noticed in the descriptions given of the species, and it is sufficient to state here, that they nearly all belong to the West Indian type.

The species which I have referred to the Mexican type (from the affinities of the remarkable *Compositæ*) include those whose nearest allies belong to Mexico or the higher levels in Columbia, or to the lower latitudes of the Southern United States, California or Chili; unlike those of the West Indian type, they are all specifically entirely distinct from their continental congeners, and are about 45 in number, belonging to such genera as *Discaria*, *Dalea*, *Phaca*,

Galactia, *Opuntia*, *Cereus*, *Viscum*, all the new genera of *Compositæ*, besides *Aplopappus* and *Hemizonia*, species of *Ipomœa*, *Psidium*, *Cordia*, *Tournefortia*, *Croton*, *Peperomia*, *Epidendrum*, *Eutriana* and *Aristida*. Those belonging to the Savannah lands of the United States, or dry parts of the tropics rather than the damp, hot, low grounds, are 24 (out of the 45) of *Polygala*, *Galapagoa*, *Elaterium*, *Sicyos*, 7 species of *Borreria*, 6 of *Acalypha*, and 5 of *Euphorbia*, besides a *Brandesia* and *Alternanthera*. Thirteen from the following genera, though very distinct, are exceptional, as being allied to plants of the same range as those included in the West Indian type; they belong to *Desmodium*, *Phaseolus*, *Acrolasia*, *Pleuropetalum*, *Pisonia*, *Frœlichia*, 3 species of *Bucholtzia*, *Mariscus*, *Cyperus*, and *Paspalum*.

If, on the other hand, the species common to other parts of the world, including those which are possibly allied, be contrasted with the above, they will be seen to belong to a different type of vegetation, being inhabitants of hot, low and marshy countries, or purely littoral species; they amount to 120, 88 of which are natives of the West Indies or Southern United States. Again, of these, 35 are common to the old and new world, affording no evidence of botanical relationship to any country; whilst the following 26, some of them remarkable species, are particularly prevalent over the Caribbean Sea, Gulf of Mexico and Galapagos.

Paritium tiliaceum.
Sida rhombifolia.
Gossypium purpurascens.
Malachra capitata.
Turnera ulmifolia.
Xanthoxylum pterota.
Mimosa asperata.
Parkinsonia aculeata.
Poinciana pulcherrima.
Tephrosia littoralis.
Rhynchosia reticulata.
——— *minima.*
Chiococca racemosa.
Spermacoce tenuior.
Wedelia frutescens.
Spilanthes Acmella.
Convolvulus alsinoides.
Lantana recta.
Varronia dasycephala.
Hyptis capitata.
Heliotropium Indicum.
Phyllanthus obovatus.
Urtica Canadensis.
——— *divaricata.*
Poa pilosa.
Digitaria serotina.

Of the remainder of the 120, the following I have assumed to be confined

to the west of the American Cordillera and the Galapagos, or only to cross to the eastward on the lowest part of Mexico.

Drymaria glaberrima.	*Verbena littoralis.*
Acacia Cavenia.	———- *polystachya.*
Cassia picta.	*Plantago tomentosa.*
Baccharis pilularis.	*Cryptocarpus pyriformis.*
Dictyocalyx Miersii.	*Boussingaultia baselloides.*
Clerodendron molle.	*Mariscus Mutisii.*

Again, these 120 are of such common occurrence over a large extent of coast, that their introduction into the Galapagos by causes now in operation can hardly be doubted. Presuming that such is the case, it may not be out of place to trace here the course of migration, the means by which it may have been effected, and the facilities for transport presented by the individual species.

The position of the group between the Pacific Islands and America, points to these as the only mother-countries from which plants could have migrated. We have seen that many are common to the latter country; but as at least 15 species are also found in the South Sea Islands, it may be supposed that there has been migration from that quarter, especially as many plants are dispersed in a very remarkable manner over every group in the Pacific, establishing themselves very soon after the formation of any new land, and whose further extension to the Galapagos might have been deemed possible*.

There are 16 species found both in the Galapagos and South Sea Islands, which is nearly the half of what are common to the latter locality and America,—a very large proportion; but as they are unaccompanied by any

* The species to which I allude as being so very prevalent over the tropical South Sea Islands, are:—

Oxalis corniculata.	*Scævola Kœnigii.*
Dodonæa viscosa.	*Cordia orientalis.*
Lepidium piscidium.	*Pisonia mitis.*
Tephrosia piscatoria.	*Achyranthes velutina.*
Guilandina Bonduc.	*Aleurites triloba.*
Sesuvium portulacastrum.	*Pandanus odoratissimus.*
Metrosideros polymorpha.	*Cocos nucifera.*
Portulaca oleracea.	*Davallia solida.*
Adenostemma viscosum.	*Phymatodes vulgaris*;

together with several other Ferns, some *Cyperaceæ* and *Gramineæ*.

Polynesian species not found in America, it is perhaps the more probable that they migrated from the eastward into the Galapagos*.

The means of transport which may have introduced these plants are, oceanic and aërial currents, the passage of birds, and man.

To the first of these divisions the majority of the littoral species may be referred; they are about 20 in number, chiefly such as are common to most warm latitudes, as:—

Cissampelos Pareira.	*Avicennia tomentosa.*
Tribulus cistoides.	*Scævola Plumieri.*
Tephrosia littoralis.	*Ipomæa maritima.*
Rhizophora Mangle.	*Calystegia Soldanella.*
Verbena littoralis.	*Heliotropium Curassavicum.*

To the non-littoral species, also possibly introduced by marine currents, belong the greater part of the remaining *Leguminosæ*, the *Borragineæ*, *Verbenaceæ* and *Solaneæ*. These and the above have seeds too large for probable transport by winds; they possess no means of attaching themselves to birds, &c., whilst the indurated seed-coats of some, and the exalbuminous embryos of many, probably aid them in resisting for some time the effects of salt water.

It is only such species as have small seeds, or in which these are furnished with wings or other appendages, that offer aids to the transport by winds; they are few in number: such are *Gossypium*, *Baccharis* and *Ageratum*, the caryopsides of which last are, singularly enough, *in this group only* deprived of pappus. *Lobelia Xalapensis*, *Scoparia dulcis* and the *Urticeæ* have very small seeds.

That birds are active agents in transporting species may be presumed from

* The more clearly to show the discrepancy between the Floras of the Pacific and Galapagos, I may mention that I have examined that of Malden Island, the nearest of the Tropical Polynesian Islands to the Galapagos. Most of its species are very abundant over all the tropical South Sea Islands, and none are absolutely peculiar: they are, 1. *Phymatodes vulgaris*; 2. *Davallia solida*; 3. *Eragrostis*, sp.; 4. *Guettarda*, sp.; 5. *Euphorbia ramosissima*; 6. *Achyranthes velutina*; 7. *Boerhaavia*; 8. *Lepidium piscidium*; 9. *Sida*; 10. *Oxalis corniculata*; 11. *Tribulus cistoides*; 12. *Crotalaria*; 13. *Portulaca*; 14. *Talinum patens*; 15. *Coprosma*, sp.; of which only the *Tribulus*, and perhaps the *Portulaca*, are Galapageian, whilst even the Ferns and 8 of the 15 genera are not so. This, coupled with the fact stated above, that there is no species an inhabitant of the Galapagos and the old world, that is not equally found in the new, are conclusive against the probability of any direct migration from the westward.

the very considerable number of widely diffused plants which are admirably adapted for availing themselves of this means of transport; though, on the other hand, the exquisite care with which sea-fowl plume themselves must not be overlooked, nor the slender chance there is of a seed remaining attached to a body subjected to such violent motion and constant immersion as these birds undergo. The plants which may have been thus introduced are species of *Tribulus, Siegesbeckia, Nicotiana, Dicliptera, Plumbago, Pisonia, Boerhaavia, Poa ciliaris* and *Setaria Rottleri*: all belonging to this section are ubiquitous plants throughout the tropics.

As no land-bird is common to the Galapagos and mainland of America, this group is deprived of one very frequent means of transport,—the stomachs of birds, which often receive seeds as the food, especially of the migratory species; these pass undigested from them in a locality far removed from that where they were collected, not only with unimpaired vitality, but with the process of germination accelerated.

Man is the last agent to which I alluded: that he has been already active is very perceptible from the fact, that Charles Island, the only colonized island, contains the smallest proportion of peculiar plants, and numerically far the most of these common to and probably introduced from the coast with cultivation.

If the non-peculiar plants of the Galapagos then have been introduced from the continent of America, it is the currents and winds that we must regard as the agents; of these, the winds are steady south-east trades, blowing from the coast of Peru, by which the West Indian species cannot have been carried. The currents are more variable; and to these I would direct attention, and have brought together all the information on this subject I could command, from the voyages of the English and French in the seas between the Galapagos and American shores.

The principal oceanic current is a branch of the Antarctic or Southern Polar; it is a large body of cold water, which flows northwards from the icy regions to the equator, parallel to, or perhaps impinging on the west coast of South America, and becoming deflected at its northern limit near the Galapagos, where its course is between W. and N.W., flowing with so great rapidity between some of the islands as to render much interchange of seeds between such by its means highly improbable. To its influence the canes, bamboos and palm-nuts,

mentioned by Colnett as being drifted on the south-east coasts of the Galapagos, are perhaps, though remotely, due; and to its agency may be ascribed the introduction of the following littoral Peruvian and Chilian plants:—

Vigna Owyhensis.	*Lycopersicum Peruanum et pimpinellifolium esculentum.*
Acacia Cavenia.	*Verbena littoralis.*
Nicotiana glutinosa.	——— *polystachya.*
Dictyocalyx Miersii.	*Plantago tomentosa.*

Had this body of water flowed along more fertile coasts than the desert shores of Peru, or received any large rivers in its course, the Flora of the Galapagos might have presented a very different appearance. On the other hand, let it be borne in mind, that the sterility of the coasts of this archipelago is peculiarly unfitted to the propagation of any but the most vigorous weeds of the tropics; had it been otherwise, it cannot be doubted that the palms, canes and bamboos (which are probably originally from the Guayaquil river, and taken up by the north edge only of this current,) would have vegetated here as well as in Cocos Island, only 300 miles to the north, whose vegetation is of tropical luxuriance*.

Another current, that by which the West Indian plants are probably introduced, is one which, though not laid down in any chart, appears from the observations of Captain Fitzroy to flow from the Bay of Panama, on the north-east of the Galapagos, and mingle its waters with the polar current; its origin is in the heated waters of that gulf; and the evidence of its visiting the Galapagos rests not only on the presence of so many species of plants, but on the fact, that the currents which wash the shores of the northern islands of the group are sometimes 10 degrees warmer than the south polar current at the southern islands; whilst the intervening space is far too narrow to admit of the supposition that the difference is owing to local causes. This current is doubtless a very partial one, but its effect is powerful, rendering the climate of one part of the group very different from that of the other,—a difference which is accompanied by certain changes in the vegetation.

There is one other point demanding attention, which relates to the crossing

* The presence of this current is of the highest importance in effecting the distribution of antarctic Algæ, for its cold waters are the means of carrying far into the tropics of this meridian, species which in other longitudes are entirely confined to very high latitudes.

of the common West Indian forms of vegetation from the east to the west coast of South America. So powerful a check to migration are the Andes, that almost throughout their whole length there is no mingling of the Floras of the east and west sides of America. The narrow Isthmus of Panama offers the only exception to this chain being continuous in the tropics; there the land is described as low and flat; and Mr. Hinds, in particularly alluding to this circumstance, states, that consequently the mahogany crosses from the Atlantic to the Pacific side. By this means, many species which prevail over the Mexican and Caribbean Seas from the Bahamas to Honduras, are further extended, first, for a short distance west to the Pacific, and then along its shores to Guayaquil on the south, and probably to California on the north, their further extension being probably checked by the dry plains of Peru on the one hand, and the changes in the climate of California on the other. Seeds of these are always liable to be exposed to the influence of that current, which I have noticed as flowing to the Galapagos from the Gulf of Panama.

I shall conclude this part of my essay with pointing out the adaptation of the several plants for transportation, under the natural orders to which they severally belong.

Menispermeæ.—*Cissampelos* presents a hard inner coat of the pericarp. Albumen scanty, fleshy.

Cruciferæ.—*Senebiera didyma*, the only Galapageian species, forms an exception to the general rule, that the plants of this order are impatient of transport from the oily nature of their cotyledons; it is, as DeCandolle remarks, probably a native of Buenos Ayres, whence it has been diffused over nearly all the globe, and is continuing to spread.

Curvembryosæ.—An artificial group, sufficiently natural however for the present purpose. Seeds very minute in some, as *Drymaria* and *Mollugo*. The *Chenopodeæ*, *Phytolacceæ* and *Portulaceæ* have a constitutional predilection to salt water. Albumen farinaceous in the greater part of the Galapageian genera.

Malvaceæ.—Indurated pericarp of many. The floral envelopes of *Malachra* are well-adapted to stick to various means of transport.

Sapindaceæ.—Crustaceous testa and exalbuminous seed of *Cardiospermum*.

Zygophylleæ.—*Tribulus cistoides* offers singular advantages for transportation in its woody seed-vessels, their spines beset with reversed prickles, and exalbuminous seeds.

Xanthoxyleæ.—Osseous testa of *Xanthoxylum*.

Simarubeæ.—*Castela* has a crustaceous endocarp and scanty albumen.

Leguminosæ.—Generally firm testa, exalbuminous seeds, and great power of some to retain vitality.

Rubiaceæ.—The densely corneous albumen of many may afford a sufficient protection to the seed.

Umbelliferæ.—*Helosciadium laciniatum* is one of the few species enjoying a wide range, for which I can offer no explanation.

Compositæ.—Exalbuminous seed. Pappus of *Baccharis* and adhesive pubescence of *Siegesbeckia orientalis.*

Lobeliaceæ and *Scrophularinæ.*—Very minute seeds of *Scoparia dulcis* and *Lobelia Xalapensis.*

Rhizophora, Avicennia and *Scævola.*—These all have a predilection for salt water, and constitutional power in the embryo of resisting its destructive effects. *Scævola* has a hard putamen and scanty carnose albumen; the other species are exalbuminous.

Apocyneæ.—*Vallesia* I believe to be a salt-marsh or sea-side plant; it has a scanty albumen.

Convolvulaceæ.—These have a scanty mucilaginous albumen. Two of them, *Ipomœa maritima* and *Calystegia Soldanella,* are sea-side species, with particularly wide ranges.

Solaneæ.—Small seeds and adhesive glands of *Nicotiana glutinosa*; indurated osseous testa of *Dictyocalyx, Solanum* and *Lycopersicum.*

Verbenaceæ.—Exalbuminous embryo and osseous endocarp of *Clerodendron* and *Lantana.*

Labiatæ, Cordiaceæ and *Borragineæ.*—Nucumentaceous pericarps and very scanty albumen. *Cordia* and *Borragineæ* are exalbuminous.

Acanthaceæ.—Exalbuminous hooked seeds.

Plantagineæ.—Very dense corneous albumen.

Plumbagineæ and *Plantagineæ.*—Viscid glands on calyx, and hooked prickles of some *Pisoniæ.*

Euphorbiaceæ and *Urticeæ.*—Non-peculiar species of these may have been introduced through the agency of man into Charles Island.

Hypoxideæ and *Commelineæ* offer no apparent facilities for the extraordinary range of the two species that represent these orders.

Cyperaceæ.—These have some facilities for adhesion to foreign substances, and the firm nature of the pericarp, further covered by the coalescing scales of the perianth, are protections.

Gramineæ.—The ciliated glumes of *Poa ciliaris* and the awns of *Setaria Rottleri* are the only very evident aids to migration which I can adduce. The resistance of the seed to the action of salt water must be very slight indeed.

Cryptogamia.—The excessive minuteness of the sporules in this great class, together with the sporadic appearance of these where they are most minute, and the sudden development of others in suitable situations, leave little doubt that their diffusion by the winds is a never-ceasing though invisible operation.

From the above it appears, that of the species presumed to be introduced into the Galapagos through various agencies, about 40, or nearly so, have exalbuminous seeds; and of the 50 albuminous-seeded ones, the majority have that substance dense or carnose; some farinaceous, but only two or three oily. These results agree to a considerable extent with what the gardener practically deduces, from the success or failure which attends the planting of seeds from foreign climes. The *Leguminosæ* and *Solaneæ*, the very two orders the Galapagos' proportion of which shows so undue an amount of continental American species, are in miscellaneous collections of seeds, those which best retain their vitality during long voyages.

III. The last feature in the Galapageian Flora to which I alluded is, that the several islets are tenanted for the most part by different plants; this difference between the Florulæ is as decided as that which exists between the botany of the whole coast and that of America, or even more so in proportion, if it be remembered how very similar the islets are in climate and geological structure, and how close to one another in geographical position.

Were this peculiarity effected only by those species which may have come from the continent, it would have admitted of some explanation, so capricious are the elements which regulate the interchange of species, and so uncertain in their effects even when apparently most uniform in their action. But in this case, the difference is most marked in the distribution of the species that are Galapageian only, the individuals of which are not common to every part of the archipelago, but for the greater part confined each to one solitary islet; only 13 of the 128 peculiar flowering plants and ferns having been found hitherto on two of the four whose Flora we know, two upon three of the islets, and but one upon all four. On the other hand, the amount of difference, though great numerically, is as regards its nature restricted within very narrow limits, the plants of one island being represented in others by similar though not identical species, producing a similarity in all general features combined with a difference in details.

Such well-marked and at the same time very narrow limits to the dispersion of nearly 130 species, is probably nowhere to be met with but amongst the Galapagos, and, wonderful though it must appear, it is still very much the accident of their birth-place; it is in a great measure due to the want of means

of intercourse, especially atmospheric storms, between the several islets, and argues no physical peculiarity or want of vigour in the species themselves. Supposing all the species now inhabiting the Galapagos to be collected on a continuous surface, equalling in area the aggregate of the islets forming that archipelago, then would the Flora lose much of its characters; the strife with its neighbours for position, which marks all stages of the life of any two or more contiguous plants, would terminate in a few replacing the many, and the introduced species bearing a greater proportion to the indigenous, whilst the individuality of the Flora would thus be lessened in degree or wholly destroyed. It must be admitted, that the first steps towards ensuring the continuance of many species in a given area, are to isolate them, and to cut off the means of migration; exactly as in a garden the plants are protected from encroachment mechanically, and the seeds of the more volatile collected betimes, to prevent a like effect being naturally brought about.

Though, however, this in some degree explains why the florulæ of the islets should be distinct in character, it can give no clue to the representation of species amongst them; which representation, whether it be regarded in the light of the whole group bearing the imprint of America, with but few of the productions of that continent, or of the several islets each individually distinct combining to form an harmonious whole, is a mystery which it is my object to portray, but not to explain; and I shall proceed to show the amount of this difference, and its relation to the physical features of the islets.

The following table shows the amount of peculiarity in each island of flowering plants and ferns, and the proportion confined to itself; those common to itself and one or more other islets; and such as are found on the American continent.

Name of island.	Total number of species.	Confined to Galapagos, *i. e.* total excluding those common to America.	Absolutely peculiar to the islet.	Confined to the group, but found likewise on other islets.
Charles Island	96*	47	32	13
James Island	100	48	38	10
Albemarle Island ..	47	27	20	7
Chatham Island ..	40	21	17	4
Whole group	253	123		16

* I have excluded seventeen species from the flora of this islet, as being almost certainly introduced with cultivation.

Hence it appears that James Island is the most rich in species, as might be expected from its central position in the archipelago, and from its containing very elevated land. Albemarle, though the largest, is on the other hand singularly deficient in individuals and kinds, and, as well as Chatham Island, is described as peculiarly sterile and arid. Charles Island, the smallest of all, is almost the richest in species; and though it does not follow that it is hence peculiarly productive for man, we cannot but couple its varied flora with the fact, that it is the only one hitherto colonized.

With regard to the relative amount of peculiar species possessed by each islet, it would seem to be affected by its climate, and may be thus expressed:

Charles Island has 22 species common to other islets, which are as 1 : 4·4 of its whole flora.
James Island has 23 species common to other islets, which are as 1 : 4·3 of its whole flora.
Albemarle Island has 18 species common to other islets, which are as 1 : 2·6 of its whole flora.
Chatham Island has 17 species common to other islets, which are as 1 : 2·4 of its whole flora.

This accordance of the proportions obtained for the two fertile islets and of those for the two sterile is very striking, and especially as they are obtained from collections made by six different and wholly independent voyagers, and indicate that sterility of soil has proved an important agent in preventing the confusion of the floras, and also shows how few are the agents of migration; for Albemarle being the westernmost, and Chatham the easternmost of the whole archipelago, they would otherwise have shown very different proportions.

If we analyse the florulæ still further, and seek to know how far each has profited by immigrants from America, a similar difference will be found between the fertile and the sterile islets.

Charles Island contains 49 American plants, which are to whole flora as 1 : 1·9.
James Island contains 52 American plants, which are to whole flora as 1 : 1·9.
Albemarle Island contains 20 American plants, which are to whole flora as 1 : 2·3.
Chatham Island contains 19 American plants, which are to whole flora as 1 : 2·1.

Whence it appears that the fertile islets, though in position not more favourably placed for receiving the plants of the American coast, still show, not only numerically but proportionally, their aptitude for supporting a richer flora than that which is peculiar to the group.

The nature of the collections is hardly such as to warrant the drawing any

further conclusions, the numbers representing the relationship of the peculiar and non-peculiar plants of each islet to one another being small. There is however one point which demands a notice, and that is, the obvious relation between the distribution of the peculiar species over the four islets in question and the direction of the easterly current. Chatham Island being situated east of the group, it follows that the current can never transport insular species to it: on the other hand, Albemarle, on the west, lies directly in its course. Now, excluding the American plants altogether, we have the following evidence of the western islands being peopled by colonists from the eastern; shown by the proportion each islet contains of the Galapageian species found on others.

Chatham Island; its Galapageian species found on other islets are to whole florula as 1 : 5·0.
James Island; its Galapageian species found on other islets are to whole florula as 1 : 4·8.
Albemarle Island; its Galapageian species found on other islets are to whole florula as 1 : 3·9.
Charles Island; its Galapageian species found on other islets are to whole florula as 1 : 3·1.

The amount of difference between the islets is, as I have stated above, mainly specific, and is apparent in no less than fifty-eight of the peculiar species of the archipelago, which thus represent one another, and for whose names I would refer to the catalogue of the species already before the Society.

The above remarks I have confined to the most salient features of the Galapageian Flora, and such as I would hope may not be materially affected by future investigations in this most interesting archipelago. There are others which appeared prominent, it is true, but which required for their confirmation more ample collections than have hitherto been formed, and these I have suppressed until materials for their establishment shall be forthcoming*.

Royal Gardens, Kew, November 1846.

* The following described species, collected by the late T. Edmonstone, Esq. in Charles Island, together with one undescribed found by Mr. Darwin in Chatham Island, were omitted in my enumeration, but are included in the foregoing remarks.

1. *Digitaria serotina*, Michx.—2. *Alternanthera radicata*, n. sp. (See below).—3. *Heliotropium Indicum*, L.—4, 5. *Clerodendron*, species 2 (exemplaria manca).—6. *Hyptis capitata*, Jacq.—7. *Varronia dasycephala*, Desv.—8. *Nicotiana*, sp.—9. *Physalis*, sp.—10, 11. *Solani*, species 2.—12. *Calystegia Soldanella*, R. and S.—13. *Wedelia frutescens*, Jacq.—14. *Spilanthes Acmella*, L.—15. *Eupatorium*? sp. —16. *Baccharis pilularis*, DeC.—17. *Composita*.—18. *Galactia*, n. sp.—19. *Poinciana pulcherrima*, L.

—20. *Parkinsonia aculeata*, L.—21. *Acacia*, sp.?—22. *Piptadenia*? sp.—23. *Mimosa asperata*, L.—24. *Turnera ulmifolia*, L.—25. *Sida rhombifolia*, L.—26. *Paritium tiliaceum*, St. Hil.

ALTERNANTHERA RADICATA, *Hook. fil.*; radice validâ lignosâ apice 3–5-cipiti, foliis stellatis recurvis lanuginosis teretibus carnosis elongato-linearibus integerrimis obtusis medio supernè canaliculatis, ramis floriferis radicalibus abbreviatis lanuginosis apice oligocephalis, capitulis globosis, perianthii foliolis oblongis obtusis emarginatis, antheris 2, stigmate bipartito.

Hab. Chatham Island, *C. Darwin, Esq.*

Radix pro plantâ maxima, elongata, lignosa, crassitie pollicis, supernè divisa. Folia perplurima, patenti-recurva, $1\frac{1}{2}$–2 unc. longa, teretia, 1 lin. diametr., basi densè lanuginosa, ceterùm arachnoideo-tomentosa. Caules floriferi (seu scapi) foliis breviores, validi, supernè bracteati, simplices v. divisi, plerumque monocephali; bracteis 3–4, capitulo brevioribus, lanuginosis. Capitula alba, $\frac{1}{3}$ lin. lata, multiflora; floribus compressis lanâ subscariosâ immersis, $1\frac{1}{2}$ lin. longis. Bracteolæ floribus paulò longiores, laterales dorso acutæ, postica concava. Perianthii foliola enervia. Tubus stamineus cyathiformis, brevis; filamentis fertilibus 2, lateralibus, dilatatis, sterilibus nullis. Ovarium orbiculare, compressum. Stigmata brevia.

The root of this species is much larger than that of *A. subscaposa*, with which it agrees in habit. The foliage will distinguish it from that, and from every other described species.—*July* 1847.

ERRATA.

Page 194. *No.* 105 *should be* PLANTAGO TOMENTOSA, *Lam.*?

— 195. *Before No.* 114 *dele* RUBIACEÆ.

— 229. CASTELA GALAPAGEIA, *Hook. fil.*=varietas inermis *C. Nicholsonii*, Hook. *The genus should be referred to* Simarubeæ.