CHAPTER V.

Laws which regulate the geographical distribution of species—Analogy of climate not attended with identity of species—Botanical geography—Stations—Habitations—Distinct provinces of indigenous plants—Vegetation of islands—Marine vegetation—In what manner plants become diffused—Effects of wind, rivers, marine currents—Agency of animals—Many seeds pass through the stomachs of animals and birds undigested—Agency of man in the dispersion of plants, both voluntary and involuntary—Its analogy to that of the inferior animals.

NEXT to determining the question whether species have a real existence, the consideration of the laws which regulate their geographical distribution is a subject of primary importance to the geologist. It is only by studying these laws with attention, by observing the position which groups of species occupy at present, and inquiring how these may be varied in the course of time by migrations, by changes in physical geography, and other causes, that we can hope to learn whether the duration of species be limited, or in what manner the state of the animate world is affected by the endless vicissitudes of the inanimate.

That different regions of the globe are inhabited by entirely distinct animals and plants is a fact which has been familiar to all naturalists since Buffon first pointed out the want of *specific* identity between the land quadrupeds of America and those of the Old World. The same phenomenon has, in later times, been forced, in a striking manner, upon our attention, by the examination of New Holland, where the indigenous species of animals and plants were found to be, almost without exception, distinct from those known in other parts of the world.

But the extent of this parcelling out of the globe amongst different *nations*, as they have been termed, of plants and animals,—the universality of a phenomenon so extraordinary and unexpected, may be considered as one of the most interesting facts clearly established by the advance of modern science.

Scarcely fourteen hundred species of plants appear to have been known and described by the Greeks, Romans, and Arabians. At present, more than three thousand species are enumerated, as natives of our own island *. In other parts of the world there have been collected, perhaps, upwards of seventy thousand species. It was not to be supposed, therefore, that the ancients should have acquired any correct notions respecting what may be called the geography of plants, although the influence of climate on the character of the vegetation could hardly have escaped their observation.

Antecedently to investigation, there was no reason for presuming that the vegetable productions, growing wild in the eastern hemisphere, should be unlike those of the western, in the same latitude; nor that the plants of the Cape of Good Hope should be unlike those of the South of Europe; situations where the climate is little dissimilar. The contrary supposition would have seemed more probable, and we might have anticipated an almost perfect identity in the animals and plants which inhabit corresponding parallels of latitude. The discovery, therefore, that each separate region of the globe, both of the land and water, is occupied by distinct groups of species, and that most of the exceptions to this general rule may be referred to disseminating causes now in operation, is eminently calculated to excite curiosity, and to stimulate us to seek some hypothesis respecting the first introduction of species which may be reconcileable with such phenomena.

A comparison of the *plants* of different regions of the globe affords results more to be depended upon in the present state of our knowledge, than those relating to the animal kingdom, because the science of botany is more advanced, and probably comprehends a great proportion of the total number of the vegetable productions of the whole earth.

Humboldt, in several eloquent passages of his Personal Narrative, was among the first to promulgate philosophical views on this subject. Every hemisphere, says this traveller,

* Barton's Lectures on the Geography of Plants, p. 2.

produces plants of different species; and it is not by the diversity of climates that we can attempt to explain why equinoctial Africa has no lauriniæ, and the New World no heaths; why the calceolariæ are found only in the southern hemisphere; why the birds of the continent of India glow with colours less splendid than the birds of the hot parts of America; finally, why the tiger is peculiar to Asia, and the ornithorhynchus to New Holland *.

"We can conceive, he adds, that a small number of the families of plants, for instance the musaceæ and the palms, cannot belong to very cold regions, on account of their internal structure and the importance of certain organs; but we cannot explain why no one of the family of melastomas vegetates north of the parallel of thirty degrees; or why no rose-tree belongs to the southern hemisphere. Analogy of climates is often found in the two continents without identity of productions †."

The luminous essay of Decandolle on "Botanical Geography" presents us with the fruits of his own researches and those of Humboldt, Brown, and other eminent botanists, so arranged, that the principal phenomena of the distribution of plants are exhibited in connexion with the causes to which they are chiefly referrible ‡. "It might not, perhaps, be difficult," observes this writer, "to find two points, in the United States and in Europe, or in equinoctial America and Africa, which present all the same circumstances: as for example, the same temperature, the same height above the sea, a similar soil, an equal dose of humidity, yet nearly all, *perhaps all*, the plants in these two similar localities shall be distinct. A certain degree of analogy, indeed, of aspect, and even of structure, might very possibly be discoverable between the plants of the two localities in question, but the *species* would in general be different. Circumstances, therefore, different from those which now determine the *stations*, have had an influence on the *habitations* of plants."

* Pers. Narr., vol. v. p. 180. † Ibid.

‡ Essai Elémentaire de Géographie Botanique. Extrait du 18e vol. du Dict. des Sci. Nat.

As we shall frequently have occasion to speak of the *stations* and *habitations* of plants in the technical sense in which the terms are used in the above passage, we may remind the geological reader that station indicates the peculiar nature of the locality where each species is accustomed to grow, and has reference to climate, soil, humidity, light, elevation above the sea, and other analogous circumstances; whereas by habitation is meant a general indication of the country where a plant grows wild. Thus the *station* of a plant may be a salt-marsh, in a temperate climate, a hill-side, the bed of the sea, or a stagnant pool. Its *habitation* may be Europe, North America, or New Holland between the tropics. The study of stations has been styled the topography, that of habitations the geography of botany. The terms thus defined, express each a distinct class of ideas, which have been often confounded together, and which are equally applicable in zoology.

In further illustration of the principle above alluded to, that difference of longitude, independently of any influence of temperature, is accompanied by a great, and sometimes a complete diversity in the species of plants, Decandolle observes, that out of two thousand eight hundred and ninety-one species of phanerogamic plants described by Pursh, in the United States, there are only three hundred and eighty-five which are found in northern or temperate Europe. MM. Humboldt and Bonpland, in all their travels through equinoctial America, found only twenty-four species (these being all cyperacea and graminea) common to America and any part of the Old World. On comparing New Holland with Europe, Mr. Brown ascertained that out of four thousand one hundred species, discovered in Australia, there were only one hundred and sixty-six common to Europe, and of this small number there were some which may have been transported thither by man. Most of the others belong to those classes which are provided with the most ample means of dispersion to vast distances.

But it is still more remarkable, that in the more widely separated parts of the ancient continent, notwithstanding the

existence of an uninterrupted land communication, the diversity in the specific character of the respective vegetations is almost as striking. Thus there is found one assemblage of species in China, another in the countries bordering the Black Sea and the Caspian, a third in those surrounding the Mediterranean, a fourth in the great platforms of Siberia and Tartary, and so forth.

The distinctness of the groups of indigenous plants, in the same parallel of latitude, is greatest where continents are disjoined by a wide expanse of ocean. In the northern hemisphere, near the Pole, where the extremities of Europe, Asia and America unite or approach near to one another, a considerable number of the same species of plants are found, common to the three continents. But it has been remarked, that these plants, which are thus so widely diffused in the Arctic regions, are also found in the chain of the Aleutian islands, which stretch almost across from America to Asia, and which may probably have served as the channel of communication for the partial blending of the Floras of the adjoining regions. It has, indeed, been found to be a general rule, that plants found at two points very remote from each other, occur also in places intermediate.

In islands very distant from continents, the total number of plants is comparatively small; but a large proportion of the species are such as occur nowhere else. In so far as the Flora of such islands is not peculiar to them, it contains, in general, species common to the nearest main lands *.

The islands of the great southern ocean exemplify these rules; the easternmost containing more American, and the western more Indian plants †. Madeira and Teneriffe contain many species, and even entire genera, peculiar to them; but they have also plants in common with Portugal, Spain, the Azores, and the north-west coast of Africa ‡.

* Prichard, vol. i. p. 36. Brown, Appendix to Flinders.

† Forster, Observations, &c.

‡ Humboldt, Pers. Narr., vol. i. p. 270 of the translation. Prichard, Phys. Hist. of Mankind, vol. i. p. 37.

In the Canaries, out of five hundred and thirty-three species of phanerogamous plants, it is said that three hundred and ten are peculiar to these isles, and the rest identical with those of the African continent; but in the Flora of St. Helena, which is so far distant, even from the western shores of Africa, there have been found, out of sixty-one native species, only *two or three* which are to be found in any other part of the globe.

Decandolle has enumerated twenty great botanical provinces inhabited by indigenous or aboriginal plants; and although many of these contain a variety of species which are common to several others, and sometimes to places very remote, yet the lines of demarcation are, upon the whole, astonishingly well defined*. Nor is it likely that the bearing of the evidence on which these general views are founded will ever be materially affected, since they are already confirmed by the examination of seventy or eighty thousand species of plants.

The entire change of opinion which the contemplation of these phenomena has brought about is worthy of remark. The first travellers were persuaded that they should find, in distant regions, the plants of their own country, and they took a pleasure in giving them the same names. It was some time before this illusion was dissipated; but so fully sensible did botanists at last become of the extreme smallness of the number of phænogamous plants common to different continents, that the ancient Floras fell into disrepute. All grew diffident of the pretended identifications, and we now find that every naturalist is inclined to examine each supposed exception with scrupulous severity†. If they admit the fact, they begin to speculate on the mode whereby the seeds may have been transported from one country into the other, or inquire on which of two continents the plant was indigenous, assuming that a species, like an individual, cannot have two birth-places.

The marine vegetation is less known, but we learn from

* See a farther subdivision by which twenty-seven provinces are made, by M. Alph. Decandolle, son of Decandolle. Monogr. des Campanulées. Paris, 1830.

† Decandolle, Essai Elémen. de Géog. Botan. p. 45.

Lamouroux, that it is divisible into different systems, apparently as distinct as those on the land, notwithstanding that the uniformity of temperature is so much greater in the ocean. For on that ground we might have expected the phenomenon of partial distribution to have been far less striking, since climate is, in general, so influential a cause in checking the dispersion of species from one zone to another.

The number of hydrophytes, as they are termed, is very considerable, and their stations are found to be infinitely more varied than could have been anticipated; for while some plants are covered and uncovered daily by the tide, others live in abysses of the ocean, at the extraordinary depth of one thousand feet; and although in such situations there must reign darkness more profound than night, at least to our organs, many of these vegetables are highly coloured. From the analogy of terrestrial plants we should have inferred that the colouring of the algæ was derived from the influence of the solar rays; yet we are compelled to doubt when we reflect how feeble must be the rays which penetrate to these great depths.

The subaqueous vegetation of the Mediterranean is, upon the whole, distinct from that of the Atlantic on the west, and that part of the Arabian gulf which is immediately contiguous on the south. Other botanical provinces are found in the West-Indian seas, including the gulf of Mexico; in the ocean which washes the shores of South America, in the Indian ocean and its gulfs, in the seas of Australia, and in the Atlantic basin, from the 40° of north lat. to the pole. There are very few species common to the coast of Europe and the United States of North America, and none common to the Straits of Magellan and the shores of Van Diemen's Land.

It must not be overlooked, that the distinctness alluded to between the vegetation of these several countries relates strictly to *species* and not to forms. In regard to the numerical preponderance of certain forms, and many peculiarities of internal structure, there is a marked agreement in the vegetable pro-

ductions of districts placed in corresponding latitudes, and under similar physical circumstances, however remote their position. Thus there are innumerable points of analogy between the vegetation of the Brazils, equinoctial Africa, and India; and there are also points of difference wherein the plants of these regions are distinguishable from all extra-tropical groups. But there are very few species common to the three continents. The same may be said, if we compare the plants of the Straits of Magellan with those of Van Diemen's Land, or the vegetation of the United States with that of the middle of Europe: the species are distinct, but the forms are in a great degree analogous.

Let us now consider what means of diffusion, independently of the agency of man, are possessed by plants, whereby, in the course of ages, they may be enabled to stray from one of the botanical provinces above mentioned to another, and to establish new colonies at a great distance from their birth-place.

The principal of the inanimate agents, provided by nature for scattering the seeds of plants over the globe, are the movements of the atmosphere and of the ocean, and the constant flow of water from the mountains to the sea. To begin with the winds: a great number of seeds are furnished with downy and feathery appendages, enabling them, when ripe, to float in the air, and to be wafted easily to great distances by the most gentle breeze. Other plants are fitted for dispersion by means of an attached wing, as in the case of the fir-tree, so that they are caught up by the wind as they fall from the cone, and are carried to a distance. Amongst the comparatively small number of plants known to Linnæus, no less than one hundred and thirty-eight genera are enumerated as having winged seeds.

As winds often prevail for days, weeks, or even months together, in the same direction, these means of transportation may sometimes be without limits; and even the heavier grains may be borne through considerable spaces, in a very short time, during ordinary tempests; for strong gales, which can

sweep along grains of sand, often move at the rate of about forty miles an hour, and if the storm be very violent, at the rate of fifty-six miles *. The hurricanes of tropical regions, which root up trees and throw down buildings, sweep along at the rate of ninety miles an hour, so that, for however short a time they prevail, they may carry even the heavier fruits and seeds over friths and seas of considerable width, and, doubtless, are often the means of introducing into islands the vegetation of adjoining continents. Whirlwinds are also instrumental in bearing along heavy vegetable substances to considerable distances. Slight ones may frequently be observed in our fields, in summer, carrying up haycocks into the air, and then letting fall small tufts of hay far and wide over the country; but they are sometimes so powerful as to dry up lakes and ponds, and to break off the boughs of trees, and carry them up in a whirling column of air.

Franklin tells us, in one of his letters, that he saw, in Maryland, a whirlwind which began by taking up the dust which lay in the road, in the form of a sugar-loaf with the pointed end downwards, and soon after grew to the height of forty or fifty feet, being twenty or thirty in diameter. It advanced in a direction contrary to the wind, and although the rotatory motion of the column was surprisingly rapid, its onward progress was sufficiently slow to allow a man to keep pace with it on foot. Franklin followed it on horseback, accompanied by his son, for three-quarters of a mile, and saw it enter a wood, where it twisted and turned round large trees with surprising force. These were carried up in a spiral line, and were seen flying in the air, together with boughs and innumerable leaves, which, from their height, appeared reduced to the apparent size of flies. As this cause operates at different intervals of time throughout a great portion of the earth's surface, it may be the means of bearing not only plants but insects, land-testacea and their eggs, with many other species of animals, to points which they could never otherwise

* Annuaire du Bureau des Longitudes.

have reached, and from which they may then begin to propagate themselves again as from a new centre.

The seeds of some aquatic fresh-water plants are of the form of shells, or small canoes, and on this account they swim on the surface, and are carried along by the wind and stream. Others are furnished with fibres, which serve the purpose of masts and sails, so that they are impelled along by the winds, even where there is no current. They cannot take root until the water stagnates, or till they reach some sheltered corner, where they may live without being exposed to too much agitation from winds and currents *. The above-mentioned contrivances may enable aquatic plants to diffuse themselves gradually to considerable distances wherever there is a great chain of lakes, or a river which traverses a large continent.

It has been found that a great numerical proportion of the exceptions to the limitation of species to certain quarters of the globe, occur in the various tribes of cryptogamic plants. Linnæus observed, that as the germs of plants of this class, such as mosses, fungi, and lichens, consist of an impalpable powder, the particles of which are scarcely visible to the naked eye, there is no difficulty to account for their being dispersed throughout the atmosphere, and carried to every point of the globe, where there is a station fitted for them. Lichens in particular ascend to great elevations, sometimes growing two thousand feet above the line of perpetual snow, at the utmost limits of vegetation, and where the mean temperature is nearly at the freezing point. This elevated position must contribute greatly to facilitate the dispersion of those buoyant particles of which their fructification consists †.

Some have inferred, from the springing up of mushrooms whenever particular soils and decomposed organic matter are mixed together, that the production of fungi is accidental, and not analogous to that of perfect plants ‡. But Fries, whose authority on these questions is entitled to the highest respect,

* Rev. Dr. Rennie, Essays on the Nat. Hist. of Peat Moss, p. 248.

† Linn., Tour in Lapland, vol. ii. p. 282.

‡ Lindley, Introd. to Nat. Syst. of Botany, who cites Fries.

has shown the fallacy of this argument in favour of the old doctrine of equivocal generation. "The sporules of fungi," says this naturalist, "are so infinite, that in a single individual of Reticularia maxima, I have counted above ten millions, and so subtile as to be scarcely visible, often resembling thin smoke; so light that they may be raised perhaps by evaporation into the atmosphere, and dispersed in so many ways by the attraction of the sun, by insects, wind, elasticity, adhesion, &c., that it is difficult to conceive a place from which they may be excluded."

In turning our attention, in the next place, to the instrumentality of the aqueous agents of dispersion, we cannot do better than cite the words of one of our ablest botanical writers. "The mountain-stream or torrent," observes Keith, "washes down to the valley the seeds which may accidentally fall into it, or which it may happen to sweep from its banks when it suddenly overflows them. The broad and majestic river, winding along the extensive plain, and traversing the continents of the world, conveys to the distance of many hundreds of miles the seeds that may have vegetated at its source. Thus the southern shores of the Baltic are visited by seeds which grew in the interior of Germany; and the western shores of the Atlantic by seeds that have been generated in the interior of America *." Fruits, moreover, indigenous to America and the West Indies, such as that of the Mimosa scandens, the cashew-nut, and others, have been known to be drifted across the Atlantic by the Gulf-stream, on the western coasts of Europe, in such a state that they might have vegetated had the climate and soil been favourable. Among these the Guilandina Bonduc, a leguminous plant, is particularly mentioned, as having been raised from a seed found on the west coast of Ireland †. Sir Hans Sloane informs us that the lenticula marina, or sargasso, a bean which is frequently cast ashore on the Orkney isles, and coast of Ireland, grows on the rocks about Jamaica, where the surface of the sea is sometimes

* System of Physiological Botany, vol. ii. p. 405.

† Brown, Append. to Tuckey, No. V. p. 481.

strewed with it, and from whence it is known to be carried by the winds and currents towards the coast of Florida *.

The absence of liquid matter in the composition of seeds renders them comparatively insensible to heat and cold, so that they may be carried, without detriment, through climates where the plants themselves would instantly perish. Such is their power of resisting the effects of heat, that Spallanzani mentions some seeds that germinated after having been boiled in water †. When, therefore, a strong gale, after blowing violently off the land for a time, dies away, and the seeds alight upon the surface of the waters, or wherever the ocean, by eating away the sea-cliffs, throws down into its waves plants which would never otherwise approach the shores, the tides and currents become active instruments in assisting the dissemination of almost all classes of the vegetable kingdom.

In a collection of six hundred plants from the neighbourhood of the river Zaire, in Africa, Mr. Brown found that thirteen species were also met with on the opposite shores of Guiana and Brazil. He remarked, that most of these plants were only found on the lower parts of the river Zaire, and were chiefly such as produced seeds capable of retaining their vitality a long time in the currents of the ocean.

Islands, moreover, and even the smallest rocks, play an important part in aiding such migrations, for when seeds alight upon them from the atmosphere, or are thrown up by the surf, they often vegetate and supply the winds and waves with a repetition of new and uninjured crops of fruits and seeds, which may afterwards pursue their course through the atmosphere, or along the surface of the sea, in the same direction. The number of plants found at any given time on an islet affords no test whatever of the extent to which it may have co-operated towards this end, since a variety of species may first thrive there and then perish, and be followed by other chance-comers like themselves.

Currents and winds, in the arctic regions, drift along ice-

* Phil. Trans. 1696. † System of Philosophical Botany, vol. ii. p. 403.

bergs covered with an alluvial soil on which herbs and pine saplings are seen growing, which often continue to vegetate on some distant shore where the ice-island is stranded.

With respect to marine vegetation, the seeds being in their native element, may remain immersed in water without injury for indefinite periods, so that there is no difficulty in conceiving the diffusion of species wherever uncongenial climates, contrary currents, and other causes, do not interfere. All are familiar with the sight of the floating sea-weed

> "Flung from the rock on ocean's foam to sail,
> Where'er the surge may sweep, the tempest's breath prevail."

Remarkable accumulations of drift weed occur on each side of the equator in the Atlantic, Pacific, and Indian Oceans. Columbus and other navigators who first encountered these banks of algæ in the Northern Atlantic, compared them to vast inundated meadows, and state that they retarded the progress of their vessels. The most extensive bank is a little west of the meridian of Fayal, one of the Azores, between latitude 25° and 36°; violent north winds sometimes prevail in this space, and drive the sea-weed to low latitudes, as far as the 24th or even the 20th degree*.

The hollow pod-like receptacles in which the seeds of many algæ are lodged, and the filaments attached to the seed-vessels of others, seem intended to give buoyancy, and we may observe that these hydrophytes are in general *proliferous*, so that the smallest fragment of a branch can be developed into a perfect plant. The seeds, moreover, of the greater number of species are enveloped with a mucous matter like that which surrounds the eggs of some fish, and which not only protects them from injury, but serves to attach them to floating bodies or to rocks.

But we have as yet considered part only of the fertile resources of nature for conveying seeds to a distance from their place of growth. The various tribes of animals are busily engaged in furthering an object whence they derive such important advantages. Sometimes an express provision is found

* Greville, Introduction to Algæ Britannicæ, p. 12.

in the structure of seeds to enable them to adhere firmly by prickles, hooks, and hairs, to the coats of animals, or feathers of the winged tribe, to which they remain attached for weeks, or even months, and are borne along into every region whither birds or quadrupeds may migrate. Linnæus enumerates fifty genera of plants, and the number now known to botanists is much greater, which are armed with hooks by which, when ripe, they adhere to the coats of animals. Most of these vegetables, he remarks, require a soil enriched with dung. Few have failed to mark the locks of wool hanging on the thorn-bushes, wherever the sheep pass, and it is probable that the wolf or lion never give chace to herbivorous animals without being unconsciously subservient to this part of the vegetable economy.

A deer has strayed from the herd, when browsing on some rich pasture, when he is suddenly alarmed by the approach of his foe. He instantly plunges through many a thicket, and swims through many a river and lake. The seeds of the herbs and shrubs adhere to his smoking flanks, and are washed off again by the streams. The thorny spray is torn off and fixes itself in his hairy coat, until brushed off again in other thickets and copses. Even on the spot where the victim is devoured, many of the seeds which he had swallowed immediately before the pursuit may be left on the ground uninjured.

The passage, indeed, of undigested seeds through the stomachs of animals is one of the most efficient causes of the dissemination of plants, and is of all others, perhaps, the most likely to be overlooked. Few are ignorant that a portion of the oats eaten by a horse preserve their germinating faculty in the dung. The fact of their being still nutritious is not lost on the sagacious rook. To many, says Linnæus, it seems extraordinary, and something of a prodigy, that when a field is well tilled and sown with the best wheat, it frequently produces darnel or the wild oat, especially if it be manured with new dung: they do not consider that the fertility of the smaller seeds is not destroyed in the ventricles of animals *.

* Linnæus, Amœn. Acad., vol. ii. p. 409.

Some of the order of the Passeres, says Ekmarck *, devour the seeds of plants in great quantities, which they eject again in very distant places, without destroying its faculty of vegetation; thus a flight of larks will fill the cleanest field with a great quantity of various kinds of plants, as the melilot trefoil (*Medicago lupulina*), and others whose seeds are so heavy that the wind is not able to scatter them to any distance. In like manner, the blackbird and missel-thrush, when they devour berries in too great quantities, are known to consign them to the earth undigested in their excrement †.

Pulpy fruits serve quadrupeds and birds as food, while their seeds, often hard and indigestible, pass uninjured through the intestines, and are deposited far from their original place of growth in a condition peculiarly fit for vegetation ‡. So well are our farmers, in some parts of England, aware of this fact, that when they desire to raise a quick-set hedge in the shortest possible time, they feed turkeys with the haws of the common white-thorn (*Cratægus oxyacantha*), and then sow the stones which are ejected in their excrement, whereby they gain an entire year in the growth of the plant §. Birds when they pluck cherries, sloes, and haws, fly away with them to some convenient place, and when they have devoured the fruit drop the stone into the ground. Captain Cook, in his account of the volcanic island of Tanna, one of the New Hebrides, which he visited in his second voyage, makes the following interesting observation. "Mr. Forster, in his botanical excursion this day, shot a pigeon, in the craw of which was a wild nutmeg. He took some pains to find the tree on this island, but his endeavours were without success ||." It is easy, therefore, to perceive, that birds in their migrations to great distances, and even across seas, may transport seeds to new isles and continents.

* Amœn. Acad., vol. iv., Essay 75, § 8.

† Wilcke, Amœn. Acad., vol. vi. § 22.

‡ Smith's Introd. to Phys. and Syst. Botany, p. 304, 1807.

§ This information was communicated to me by Professor Henslow, of Cambridge.

|| Book iii., ch. 4.

The sudden deaths to which great numbers of frugivorous birds are annually exposed, must not be omitted as auxiliary to the transportation of seeds to new habitations. When the sea retires from the shore, and leaves fruits and seeds on the beach, or in the mud of estuaries, it might, by the returning tide, wash them away again, or destroy them by long immersion; but when they are gathered by land birds which frequent the sea-side, or by waders and water-fowl, they are often borne inland, and if the bird to whose crop they have been consigned is killed, they may be left to grow up far from the sea. Let such an accident happen but once in a century, or a thousand years, it will be sufficient to spread many of the plants from one continent to another; for, in estimating the activity of these causes, we must not consider whether they act slowly in relation to the period of our observation, but in reference to the duration of species in general.

Let us trace the operation of this cause in connexion with others. A tempestuous wind bears the seeds of a plant many miles through the air, and then delivers them to the ocean; the oceanic current drifts them to a distant continent; by the fall of the tide they become the food of numerous birds, and one of these is seized by a hawk or eagle, which, soaring across hill and dale to a place of retreat, leaves, after devouring its prey, the unpalatable seeds to spring up and flourish in a new soil.

The machinery before adverted to is so capable of disseminating seeds over almost unbounded spaces, that were we more intimately acquainted with the economy of nature, we might probably explain all the instances which occur of the aberration of plants to great distances from their native countries. The real difficulty which must present itself to every one who contemplates the present geographical distribution of species, is the small number of exceptions to the rule of the non-intermixture of different groups of plants. Why have they not, supposing them to have been ever so distinct originally, become more blended and confounded together in the lapse of ages?

But in addition to all the agents already enumerated as instrumental in diffusing plants over the globe, we have still to consider man—one of the most important of all. He transports with him, into every region, the vegetables which he cultivates for his wants, and is the involuntary means of spreading a still greater number which are useless to him, or even noxious. "When the introduction of cultivated plants is of recent date, there is no difficulty in tracing their origin; but when it is of high antiquity, we are often ignorant of the true country of the plants on which we feed. No one contests the American origin of the maize or the potato, nor the origin, in the old world, of the coffee-tree and of wheat. But there are certain objects of culture, of very ancient date, between the tropics, such, for example, as the banana, of which the origin cannot be verified. Armies, in modern times, have been known to carry, in all directions, grain and cultivated vegetables from one extremity of Europe to the other, and thus have shown us how, in more ancient times, the conquests of Alexander, the distant expeditions of the Romans, and afterwards the Crusades, may have transported many plants from one part of the world to the other *."

But besides the plants used in agriculture, the number which have been naturalized by accident, or which man has spread unintentionally, is considerable. One of our old authors, Josselyn, gives a catalogue of such plants as had, in his time, sprung up in the colony since the English planted and kept cattle in New England. They were two and twenty in number. The common nettle was the first which the settlers noticed, and the plantain was called by the Indians, "English man's foot," as if it sprung from their footsteps †.

"We have introduced everywhere," observes Decandolle, "some weeds which grow among our various kinds of wheat, and which have been received, perhaps, originally from Asia with them. Thus, together with the Barbary wheat, the inhabi-

* Decandolle, Essai Elémen. &c. p. 50.

† Quarterly Review, vol. xxx., p. 8.

tants of the south of Europe have sown, for many ages, the plants of Algiers and Tunis. With the wools and cottons of the East, or of Barbary, there are often brought into France, the grains of exotic plants, some of which naturalize themselves. Of this I will cite a striking example. There is at the gate of Montpelier, a meadow set apart for drying foreign wool *after it has been washed.* There hardly passes a year without some foreign plants being found naturalized in this drying ground. I have gathered there Centaurea parviflora, Psoralea palæstina, and Hypericum crispum." This fact is not only illustrative of the aid which man lends inadvertently to the propagation of plants, but it also demonstrates the multiplicity of seeds which are borne about in the woolly and hairy coats of wild animals.

The same botanist mentions instances of plants naturalized in sea-ports by the ballast of ships, and several examples of others which have spread through Europe from botanical gardens, so as to have become more common than many indigenous species.

It is scarcely a century, says Linnæus*, since the Canadian erigiron, or flea-bane, was brought from America to the botanical garden at Paris, and already the seeds have been carried by the winds, so that it is diffused over France, the British islands, Italy, Sicily, Holland, and Germany. Several others are mentioned by the Swedish naturalist, as having been dispersed by similar means. The common thorn-apple, *Datura stramonium*, observes Willdenow, now grows as a noxious weed throughout all Europe, with the exception of Sweden, Lapland, and Russia. It came from the East Indies and Abyssinia to us, and was so universally spread by certain quacks who used its seed as an emetic †.

In hot and ill-cultivated countries, such naturalizations take place more easily. Thus the Chenopodium ambrosioides, sown by Mr. Burchell on a point of St. Helena, multiplied so

* Essay on the Habitable Earth, Amœn. Acad. vol. ii. p. 409.

† Principles of Botany, p. 389.

in four years as to become one of the commonest weeds in the island *.

The most remarkable proof, says Decandolle, of the extent to which man is unconsciously the instrument of dispersing and naturalizing species, is found in the fact, that in New Holland, America, and the Cape of Good Hope, the aboriginal European species exceed in number all the others which have come from any distant regions, so that, in this instance, the influence of man has surpassed that of all the other causes which tend to disseminate plants to remote districts.

Although we are but slightly acquainted, as yet, with the extent of our instrumentality in naturalizing species, yet the facts ascertained afford no small reason to suspect that the number which we introduce unintentionally, exceeds all those transported by design. Nor is it unnatural to suppose that the functions, which the inferior beings extirpated by man once discharged in the economy of nature, should devolve upon the human race. If we drive many birds of passage from different countries, we are probably required to fulfil their office of carrying seeds, eggs of fish, insects, molluscs, and other creatures, to distant regions; if we destroy quadrupeds, we must replace them, not merely as consumers of the animal and vegetable substances which they devoured, but as disseminators of plants, and of the inferior classes of the animal kingdom. We do not mean to insinuate that the same changes which man brings about, would have taken place by means of the agency of other species, but merely that he supersedes a certain number of agents, and so far as he disperses plants unintentionally, or against his will, his intervention is strictly analogous to that of the species so extirpated.

We may observe, moreover, that if, at former periods, the animals inhabiting any given district have been partially altered by the extinction of some species, and the introduction of others, whether by new creations or by immigration, a change must have taken place in regard to the particular plants con-

* Principles of Botany, p. 389.

veyed about with them to foreign countries. As for example, when one set of migratory birds is substituted for another, the countries from and to which seeds are transported are immediately changed. Vicissitudes, therefore, analogous to those which man has occasioned, may have previously attended the springing up of new relations between species in the vegetable and animal worlds.

It may also be remarked, that if man is the most active agent in enlarging, so also is he in circumscribing the geographical boundaries of particular plants. He promotes the migration of some, he retards that of other species, so that while in many respects he appears to be exerting his power to blend and confound the various provinces of indigenous species, he is, in other ways, instrumental in obstructing the fusion into one group of the inhabitants of contiguous provinces.

Thus, for example, when two botanical regions exist in the same great continent, such as *the European region,* comprehending the central parts of Europe and those surrounding the Mediterranean, and *the Oriental region,* as it has been termed, embracing the countries adjoining the Black Sea and the Caspian, the interposition between these of thousands of squares miles of cultivated lands, opposes a new and powerful barrier against the mutual interchange of indigenous plants. Botanists are well aware that garden plants naturalize and diffuse themselves with great facility in comparatively unreclaimed countries, but spread themselves slowly and with difficulty in districts highly cultivated. There are many obvious causes for this difference; by drainage and culture the natural variety of stations is diminished, and those stray individuals by which the passage of a species from one fit station to another is effected, are no sooner detected by the agriculturist, than they are uprooted as weeds. The larger shrubs and trees, in particular, can scarcely ever escape observation, when they have attained a certain size, and will rarely fail to be cut down if unprofitable.

The same observations are applicable to the interchange of

the insects, birds, and quadrupeds of two regions situated like those above alluded to. No beasts of prey are permitted to make their way across the intervening arable tracts. Many birds, and hundreds of insects, which would have found some palatable food amongst the various herbs and trees of the primeval wilderness, are unable to subsist on the olive, the vine, the wheat, and a few trees and grasses favoured by man. In addition, therefore, to his direct intervention, man, in this case, operates indirectly to impede the dissemination of plants, by intercepting the migrations of animals, many of which would otherwise have been active in transporting seeds from one province to another.

Whether in the vegetable kingdom the influence of man will tend, after a considerable lapse of ages, to render the geographical range of *species in general* more extended, as Decandolle seems to anticipate, or whether the compensating agency above alluded to will not counterbalance the exceptions caused by our naturalizations, admits at least of some doubt. In the attempt to form an estimate on this subject, we must be careful not to underrate, or almost overlook, as some appear to have done, the influence of man in checking the diffusion of plants, and restricting their distribution to narrower limits.