

ON THE STRUGGLE FOR EXISTENCE AMONGST PLANTS.

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THE quaint dictum, "Plants do not grow where they like best, but where other plants will let them," which is credited to the late eminent horticulturalist, Dean Herbert, of Manchester, expresses a truth not yet half appreciated by botanists. It is a protest against the prevalent belief, that circumstances of climate and soil are the omnipotent regulators of the distribution of vegetables, and that all other considerations are comparatively powerless. The dean's crude axiom has lately found a philosophical exposition and expression, in Mr. Darwin's more celebrated doctrine of the "Struggle for life, and preservation thereby of the favoured races," and if to it we add that great naturalist's more fruitful discovery, of the necessity for insect and other foreign agencies in ensuring fertility, and hence perpetuating the species, we shall find that the powers of climate and soil are reduced to comparatively very narrow limits. Before proceeding to show what are the causes that do materially limit the distribution of species, it may be well to inquire how far the hard-pressed soil and climate theory really helps us to a practical understanding of one or two great questions that fall under our daily observation; of these, the following are the most prominent.

That very similar soils and climates, in different geographical areas, are not inhabited, naturally, either by like species, or like genera;—that very different soils and climates will produce almost equally abundant crops of the same cultivated plants;—and that in the same soil and climate, many hundreds, nay, thousands of species, from other very different soils and climates, may be grown, and propagated, for an indefinite number of successive generations.

Of the first of these statements, the examples embrace some of the best known facts in geographical botany; as, for example, that the Flora of Europe differs wholly from that of temperate North America, South Africa, Australia, and temperate South America, and all these from one another. And that neither soil nor climate is the cause of this difference, is illustrated by the

fact, that thousands of acres in each of these countries are covered, year after year, by crops of the same plant, introduced from one to the other; and by annually increasing numbers of trees, shrubs, and herbs, that have either run wild, or are successfully cultivated in each and all of them. The third proposition follows from the two others, and of this the best example is afforded by a good garden, wherein, on the same soil and under identical conditions, we grow, side by side, plants from very various soils and climates, and ripen their seeds too, provided only that their fertilization is insured. The Cape geraniums, London pride and *Lysimachia nummularia* in our London areas, the pendent American cacti in the cottage windows of Southwark and Lambeth, are even more striking examples of the comparative indifference of many plants to good or bad climate and soil; and what can be more unlike their natural conditions than those to which ferns are exposed in those invaluable contrivances, Ward's cases, in the heart of the city? True, the conditions suit them well, and with respect to humidity, and equability of temperature, are natural to them; but, neither is the absolute temperature, nor the constitution, nor freshness of the air, the same as of the places the ferns are brought from; nor is any systematic attempt made to suit the soil to the species cultivated, for, as Mr. Ward himself well shows, the arctic saxifrage, the English rose, the tropical palm, and desert cactus, live side by side in the same box, and under precisely similar circumstances, and, as it were, in defiance of their natal conditions.

Let it not be supposed that we at all underrate such power as soil and climate really possess. In some cases, as those of chalk, sand, bog, and saline and water plants, soil is very potent; but the number of plants actually dependent on these, or other peculiarities of the soil, is much more limited than is supposed. Of *bonâ fide* water-plants, there are few amongst phænogams. Sand plants, as a rule, grow equally well on stiffer soils, but are there turned out by more sturdy competitors; and with regard to the calcareous soils, it is their warmth and dryness that fits them, to so great an extent, for many plants that are almost confined to them, or are absolutely peculiar to them. So, too, with regard to temperature, there are limits, as regards heat, cold, and humidity, that species will not overstep and live; but, on the other hand, so much has been done by selection in procuring hardy races of tender plants, and so much may be done by regulating the distribution of earth-temperature, &c., that we already grow tropical plants in the open air during a portion of the year, and eventually may do so for longer periods.

Amongst the most striking examples of apparent indifference to natural conditions of soil and climate, I would especially

adduce two. One is the *Salicornia Arabica*, a plant never found in its natural state, except in most saline situations, but which has flourished for years in the Succulent House at Kew, in a pot full of common soil, to which no salt has ever been added; the other is the tea plant, which luxuriates in the hot humid valleys of Assam, where the thermometer ranges between 70° and 85°, and the atmosphere is so perennially humid, that watches are said to be destroyed after a few months of wear; and it is no less at home in North-Western India, where the summers are as hot and cloudless as any in the world, and the winters very cold. I may add, that the tea plant has survived the intense cold of this last January, at Kew, on the same wall where many hardy and half-hardy plants have been killed.

It is, further, a great mistake to suppose that the native vegetation of a country suffers little and very exceptionally by abnormal seasons. The most conspicuous instance of the contrary that ever fell under my observation, was the destruction of the gigantic gum-tree (*Eucalyptus*) forests, in the central districts of Tasmania, which occurred, if I remember right, about the year 1837. In 1840 I rode over many square miles of country, through stupendous forests, in which every tree was, to all appearance, absolutely lifeless. The district was totally uninhabited, consisting of low mountain ranges, 2,000 feet above the sea, separating marshy tracts interspersed with broad fresh-water lakes. The trees, much like the great gaunt elms in Kensington Gardens during winter, but much larger, were in countless multitudes, 80 to 180 feet high, close-set, and 10 to 20 feet in girth; their weird and ghostly aspect being heightened by the fact of most being charred for a considerable distance up the trunk, the effects of the native practice of firing the grass in summer during the kangaroo hunting season; and by the bark above, hanging from their trunks in streaming shreds, that waved dismally in the wind; for the species was the stringy-bark gum, that sheds its bark after this fashion. And not only had the gum-trees suffered, the hardier *Leptospermum* (tea-tree bush), and many others, were killed, some to the ground, and some altogether; so that though my journey was in spring, and the weather was delightful, the aspect of the vegetation was desolate in the extreme.

In such climates as our own, similar devastations are unknown, and though we know that our island was once covered with other timber than now clothes it, we have every reason to suppose that the change was slow, and the effect either of a gradually altered climate, or of the immigration of trees equally well or better suited to the conditions of the soil and climate, but which had not previously had the opportunity of contesting the ground with the ruling monarchs of the forest.

Making every allowance, then, for the influence of soil and climate in checking the multiplication of individuals, we have still two classes of facts to account for; the one, that plants which succeed so well, when cultivated, that we are assured both soil and climate are favourable to their propagation, nevertheless become immediately or soon extinct when the cultivator's care is withdrawn; the other, that plants of one country, when introduced into another, even with a very different soil and climate, will overrun it, destroy the native vegetation, and prove themselves better suited to local circumstances than the aboriginal plants of the country. In the first case, the reasons are very various, all of them relating to the conditions of the plant's existence. Of these the two most potent are, the absence of fertilising agents, and the destruction of seeds and seedling plants. In the present state of our knowledge it is impossible to say which of these is most fatal in its effect. In the case of our annual plants, or our cereals, which never run wild, it is the latter certainly, for they seed freely enough; in the case of many perennials, shrubs, and trees, it may be the former, as with the common elm and lime, which rarely or never seed in England, though the latter is so notably frequented by insects during its flowering season; whilst a third cause is to be found in their seedling plants being smothered by others, of which we have numerous examples in our common pasture grasses, which are, perhaps, the most prejudicial in this respect. A most conspicuous example of this is afforded by the common maple, of which the seedlings come up early in spring by thousands in the neighbourhood of the parent tree, in lawns and plantations, but scarcely ever survive the smothering effects of the common summer grasses, as soon as these begin to shoot.

When I visited the cedar grove on Mount Lebanon, in the autumn of 1860, I found thousands of seedling plants, but every one of them dead; and so effectual is the annual slaughter of the yearlings in that grove, that, though the seeds are shed in millions, and innumerable seedlings annually spring up, there is not a plant in the grove less than about sixty years old. It may hence have been sixty years since a cedar there survived the first year of its existence; that is to say, has struggled through its infancy, and reached the age even of childhood!

On the other hand, when once the natural conditions of a country have been disturbed, the spread and multiplication of immigrants is so rapid, that it shortly becomes impossible to discover the limits of the old, indigenous Flora. Take the English Flora, for example. If we contrast the cultivated counties with the uncultivated, the difference of their vegetation is so great, that I have often been compelled to doubt whether many of the most familiar so-called wild flowers of the cultivated

counties are indigenous at all; nay, more, I have been tempted to suspect that some of the more variable of them, as some species of *chenopodium* and fumitory, may have originated since cultivation began. In the uncultivated counties, the proportion of annual plants is exceedingly small, whereas, in the cultivated counties, annuals are very numerous; and the further we go from cultivation, roads, and made-ground, the rarer they become, till at last, in the uninhabited islets of the west coast of Scotland, and in its mountainous glens, annuals are extremely rare, and confined to the immediate vicinity of cottages. Let any one who doubts this contrast between the Floras of cultivated and uncultivated regions compare the annuals in such Floræ as those of Suffolk or Essex, the North Riding or Cumberland, with those of the Isle of Wight and the Isle of Arran. And it is not only that annuals abound in the cultivated districts, but that so many are nearly confined to ground that is annually or frequently disturbed. The three commonest of all British plants, for example, are, perhaps, groundsel, shepherd's purse, and *Poa annua*. I do not remember ever having seen any of these plants established where the soil was undisturbed, or where, if undisturbed, they had not been obviously brought by man, or the lower animals; and yet I have gathered one of these, the shepherd's purse, in various parts of Europe, in Syria, in the Himalayas, in Australia, New Zealand, and the Falkland Islands. Were England to be depopulated, I believe that in a very few years these plants, and a large proportion of our common annual "wild flowers," would become exceedingly rare, or extinct, such as the Poppies, Fumatories, Trefoils, Fedias, various species of Speedwell, Anagallis, Cerastiums, Lithospermum, Polygoum, Mallow, Euphorbia, Thlaspi, Senebiera, Medicago, Anthemis, Centaurea, Linaria, Lamium, &c., &c.

It is usually said of some of the above named plants, that they prefer cultivated ground, nitrogenous soil, and so forth; and this is no doubt true, but that they will flourish where no such advantages attend them, a very little observation shows; and that they do not continue to flourish elsewhere is due mainly to the fact that, being annuals, their room is taken as soon as they die, and the next year's seedling has no chance of success in the struggle with perennials.

For good instances of this rapid replacement of annuals by perennials, the new railroad embankments should be examined. Whence the plants come from, which spring up like magic in the cuttings, many feet below the surface of the soil, is a complete mystery, and reminds us of the so-called spontaneous generation of protozoa in newly-made infusions, or in distilled water. In the south of Scotland in 1840-50, and many parts of the north of England, the first plant that made its appearance was *Equisetum*

arvensis, which covered the new-formed banks, for miles and miles, with the most lovely green forest of miniature pines. In the following year comparatively few of these were to be seen, and coltsfoot, dandelions, and other biennials, especially Umbelliferæ, with a great number of annuals, presented themselves. For many successive years I had no opportunity of watching the struggle for life on these banks, but when I last saw them they were clothed with perennial grasses, docks, plantains, and other perennial rooted plants.

The destruction of native vegetations by introduced is a subject that has only lately attracted much attention, but it has already assumed an aspect that has startled the most careless observer. Some thirty years ago the fecundity of the horse and European cardoon in the Argentine provinces of South America, so graphically described by Sir Edmund Head, drew the attention of naturalists to the fact, that animals and plants did not necessarily thrive best where found in an indigenous condition; and the spread of the common Dutch clover, *Trifolium repens*, in North America, where it follows the footsteps of man through the pathless forests, has long afforded an equally remarkable instance of vegetable colonisation. Still more recently, in South Africa, Australia, and Tasmania, the Scotch thistle, briar rose, Xanthium, plantains, docks, &c., have all become noxious weeds; and this leads me to the last and most curious point to which I shall allude in this article, viz., that the same annuals and other weeds, that are held so well in check by the indigenous perennial plants of our country, when transplanted to others, show themselves superior to the perennial vegetation of the latter. Of this New Zealand furnishes the most conspicuous example,—it was first visited scarcely more than 100 years ago, and it is not yet fifty since the missionaries first settled in it, and scarce thirty since it received its earliest colonists. The Islands contain about 1,000 species of flowering plants, amongst which no fewer than 180 European weeds have been recorded as intruding themselves, and having become thoroughly naturalised; and probably double that number will yet be found, as they have never been systematically collected; but the most curious part of the history is this, that whereas of indigenous New Zealand plants scarcely any are annual, no less than half the naturalised European ones are annual.

Of the effect of these introduced European plants in destroying the native vegetation, I have given examples in an article that appeared in the *Natural History Review* (January, 1864), from which I quote the following:—

In Australia and New Zealand, the noisy train of English emigration is not more surely doing its work, than the stealthy tide of English weeds, which are creeping over the surface of

the waste, cultivated, and virgin soil, in annually increasing numbers of genera, species and individuals. Apropos of this subject, a correspondent (W. T. Locke Travers, Esq., F.L.S.)—a most active New Zealand botanist—writing from Canterbury, says: “You would be surprised at the rapid spread of European and other foreign plants in this country. All along the sides of the main lines of road through the plains, a *Polygonum (aviculare)*, called ‘cow-grass,’ grows most luxuriantly, the roots sometimes two feet in depth, and the plants spreading over an area from four to five feet in diameter. The dock (*Rumex obtusifolius* or *R. crispus*) is to be found in every river-bed, extending into the valleys of the mountain-rivers, until these become mere torrents. The sowthistle is spread all over the country, growing luxuriantly nearly up to 6,000 feet. The watercress increases in our still rivers to such an extent as to threaten to choke them altogether; in fact, in the Avon, a still deep stream running through Christ Church, the annual cost of keeping the river free for boat navigation and for purposes of drainage, exceeds 300*l.* I have measured stems twelve feet long and three quarters of an inch in diameter. In some of the mountain districts, where the soil is loose, the white clover is completely displacing the native grasses, forming a close sward. Foreign trees are also very luxuriant in growth. The gum-trees of Australia, the poplars and willows, particularly, grow most rapidly. In fact, the young native vegetation appears to shrink from competition with these more vigorous intruders.”

Dr. Haast, F.L.S., the eminent explorer and geologist, also writes to me as follows:—

“The native (Maori) saying is, ‘as the white man’s rat has driven away the native rat, as the European fly drives away our own, and the clover kills our fern, so will the Maoris disappear before the white man himself.’ It is wonderful to behold the botanical and zoological changes which have taken place since first Captain Cook set foot in New Zealand. Some pigs, which he and other navigators left with the natives, have increased and run wild in such a way that it is impossible to destroy them. There are large tracts of country where they reign supreme. The soil looks as if ploughed by their burrowing. Some station holders of 100,000 acres have had to make contracts for killing them at 6*d.* per tail, and as many as 22,000 on a single run have been killed by adventurous parties without any diminution being discernible. Not only are they obnoxious by occupying the ground which the sheep farmer needs for his flocks, but they assiduously follow the ewes when lambing, and devour the poor lambs as soon as they make their appearance. They do not exist on the western side of the Alps, and only on the lower grounds on the eastern side where snow seldom falls, so that

the explorer has not the advantage of profiting by their existence, where food is scarcest. The boars are sometimes very large, covered with long black bristles, and have enormous tusks, resembling closely the wild boar of the Ardennes, and they are equally savage and courageous.

“Another interesting fact, is the appearance of the Norwegian rat. It has thoroughly extirpated the native rat, and is to be found everywhere, even in the very heart of the Alps, growing to a very large size. The European mouse follows it closely, and, what is more surprising, where it makes its appearance, it drives, in a great degree, the Norway rat away. Amongst other quadrupeds, cattle, dogs, and cats are found in a wild state, but not abundantly.

“The European house-fly is another importation. When it arrives, it repels the blue-bottle of New Zealand, which seems to shun its company. But the spread of the European insect goes on very slowly, so that settlers, knowing its utility, have carried it in boxes and bottles to their new inland stations.”

But the most remarkable fact of all has been communicated to me since the above was printed, viz., that the little white clover, and other herbs, are actually strangling and killing outright the New Zealand flax (*Phormium tenax*), a plant of the coarsest, hardest, and toughest description, that forms huge matted patches of woody rhizomes, which send up tufts of sword-like leaves, six to ten feet high, and inconceivably strong in texture and fibre. I know of no English plant to which the New Zealand flax can be likened, so as to give any idea of its robust constitution and habit, to those who do not know it; in some respects the great matted tussocks of *Carex paniculata* approach it. It is difficult enough to imagine the possibility of white clover invading our bogs, and smothering the tussocks of this *Carex*, but this would be child's play in comparison with the resistance the *Phormium* would seem to offer.

The causes of this prepotency of the European weeds are probably many and complicated; one very powerful one is the nature of the New Zealand climate, which favours the duration of life in individuals, and hence gives both perennials and annuals a lengthened growing season, and, in the case of some, more than one seed crop in the year. This is seen in the tendency of mignonette and annual stocks to become biennial and even perennial, in the indigenous form of *Cardamine hirsuta* being perennial, and in the fact that many weeds that seed but once with us, seed during a greater part of the year in New Zealand. Another cause must be sought in the fact, that more of their seeds escape the ravages of birds and insects in New Zealand than in England; the granivorous birds and insects that follow cultivation not having been transported to the Antipodes with the weeds, or, at least, not in proportionate numbers.

Still the fact remains as yet unaccounted for, that annual weeds, which, except for the interference of man, would with us have no chance in the struggle with perennials, in New Zealand have spread in inconceivable quantities into the wildest glens, long before either white men or even their cattle and flocks penetrate to their recesses. Such is the testimony of Drs. Haast and Hector, and Mr. Travers, the original explorers of large areas of different parts of the almost uninhabited middle island, and who have sent to me, as native plants, from hitherto unvisited tracts, British weeds, that were not found in the island by the careful botanists (Banks, Solander, Forster, and Sparrmann) who accompanied Captain Cook in his voyages; and which were not found by the earlier missionaries, but which of late years have abounded on the low lands near every settlement.

This subject of the comparative great *vis-vitæ* of European plants, as compared with those of other countries, involves problems of the highest interest in botanical science, and the subject is as novel as it is interesting; it is quite a virgin one, and requires the calmest and most unprejudiced judgment to treat it well. It cannot be doubted that the progress of civilisation in Europe and Asia has, whilst it has led to the incessant harassing of the soil, led also to the abundant development of a class of plants, annual, biennial, and perennial, which increase more rapidly and obtain a greater development when transplanted to the Southern hemisphere, than they have hitherto done in the Northern, and that, in this respect, they contrast strikingly with the behaviour of plants of the Southern hemisphere when transplanted to the Northern; and hitherto no considerations of climate, soil, or circumstance, have sufficed to explain this phenomenon.