CHAPTER IX.

CULTIVATED PLANTS: CEREAL AND CULINARY PLANTS.

PRELIMINARY REMARKS ON THE NUMBER AND PARENTAGE OF CULTIVATED PLANTS — FIRST STEPS IN CULTIVATION — GEOGRAPHICAL DISTRIBUTION OF CULTIVATED PLANTS.

CEREALIA.—DOUBTS ON THE NUMBER OF SPECIES.——WHEAT: VARIETIES OF—INDIVIDUAL VARIABILITY—CHANGED HABITS—SELECTION—ANCIENT HISTORY OF THE VARIETIES.——MAIZE: GREAT VARIATION OF—DIRECT ACTION OF CLIMATE ON.

CULINARY PLANTS.—CABBAGES: VARIETIES OF, IN FOLIAGE AND STEMS, BUT NOT IN OTHER PARTS—PARENTAGE OF—OTHER SPECIES OF BRASSICA.——PEAS: AMOUNT OF DIFFERENCE IN THE SEVERAL KINDS, CHIEFLY IN THE PODS AND SEED—SOME VARIETIES CONSTANT, SOME HIGHLY VARIABLE — DO NOT INTERCROSS. —— BEANS. —— POTATOES: NUMEROUS VARIETIES OF—DIFFERING LITTLE, EXCEPT IN THE TUBERS—CHARACTERS INHERITED.

I SHALL not enter into so much detail on the variability of cultivated plants, as in the case of domesticated animals. The subject is involved in much difficulty. Botanists have generally neglected cultivated varieties, as beneath their notice. In several cases the wild prototype is unknown or doubtfully known; and in other cases it is hardly possible to distinguish between escaped seedlings and truly wild plants, so that there is no safe standard of comparison by which to judge of any supposed amount of change. Not a few botanists believe that several of our anciently cultivated plants have become so profoundly modified that it is not possible now to recognise their aboriginal parent-forms. Equally perplexing are the doubts whether some of them are descended from one species, or from several inextricably commingled by crossing and variation. Variations often pass into, and cannot be distinguished from, monstrosities; and monstrosities are of little significance for our purpose. Many varieties are propagated solely by grafts, buds, layers, bulbs, &c., and frequently it is not known how far their peculiarities can be transmitted by seminal generation. Nevertheless.

some facts of value can be gleaned: and other facts will hereafter be incidentally given. One chief object in the two following chapters is to show how many characters in our cultivated plants have become variable.

Before entering on details a few general remarks on the origin of cultivated plants may be introduced. M. Alph. De Candolle[1] in an admirable discussion on this subject, in which he displays a wonderful amount of knowledge, gives a list of 157 of the most useful cultivated plants. Of these he believes that 85 are almost certainly known in their wild state; but on this head other competent judges[2] entertain great doubts. Of 40 of them, the origin is admitted by M. De Candolle to be doubtful, either from a certain amount of dissimilarity which they present when compared with their nearest allies in a wild state, or from the probability of the latter not being truly wild plants, but seedlings escaped from culture. Of the entire 157, 32 alone are ranked by M. De Candolle as quite unknown in their aboriginal condition. But it should be observed that he does not include in his list several plants which present ill-defined characters, namely, the various forms of pumpkins, millet, sorghum, kidney-bean, dolichos, capsicum, and indigo. Nor does he include flowers; and several of the more anciently cultivated flowers, such as certain roses, the common Imperial lily, the tuberose, and even the lilac, are said[3] not to be known in the wild state.

From the relative numbers above given, and from other arguments of much weight, M. De Candolle concludes that plants have rarely been so much modified by culture that they cannot be identified with their wild prototypes. But on this view, considering that savages probably would not have chosen rare plants for cultivation, that useful plants are generally conspicuous, and that they could not have been the inhabitants of deserts or of remote and recently discovered

[1] 'Géographie botanique raisonnée,' 1855, pp. 810 to 991.

[2] Review by Mr. Bentham in 'Hort. Journal,' vol. ix. 1855, p. 133, entitled, 'Historical Notes on cultivated Plants,' by Dr. A. Targioni-Tozzetti. *See* also 'Edinburgh Review,' 1866, p. 510.

[3] 'Hist. Notes,' as above, by Targioni-Tozzetti.

islands, it appears strange to me that so many of our cultivated plants should be still unknown or only doubtfully known in the wild state. If, on the other hand, many of these plants have been profoundly modified by culture, the difficulty disappears. The difficulty would also be removed if they have been exterminated during the progress of civilisation; but M. De Candolle has shown that this probably has seldom occurred. As soon as a plant was cultivated in any country, the half-civilised inhabitants would no longer have need to search the whole surface of the land for it, and thus lead to its extirpation; and even if this did occur during a famine, dormant seeds would be left in the ground. In tropical countries the wild luxuriance of nature, as was long ago remarked by Humboldt, overpowers the feeble efforts of man. In anciently civilised temperate countries, where the whole face of the land has been greatly changed, it can hardly be doubted that some plants have become extinct; nevertheless De Candolle has shown that all the plants historically known to have been first cultivated in Europe still exist here in the wild state.

MM. Loiseleur-Deslongchamps[4] and De Candolle have remarked that our cultivated plants, more especially the cereals, must originally have existed in nearly their present state; for otherwise they would not have been noticed and valued as objects of food. But these authors apparently have not considered the many accounts given by travellers of the wretched food collected by savages. I have read an account of the savages of Australia cooking, during a dearth, many vegetables in various ways, in the hopes of rendering them innocuous and more nutritious. Dr. Hooker found the half-starved inhabitants of a village in Sikhim suffering greatly from having eaten arum-roots,[5] which they had pounded and left for several days to ferment, so as partially to destroy their poisonous nature; and he adds that they cooked and ate many

[4] 'Considérations sur les Céréales,' 1842, p. 37. 'Géographie Bot.,' 1855, p. 930. "Plus on suppose l'agriculture ancienne et remontant à une époque d'ignorance, plus il est probable que les cultivateurs avaient choisi des espèces offrant à l'origine même un avantage incontestable."

[5] Dr. Hooker has given me this information. *See*, also, his 'Himalayan Journals,' 1854, vol. ii. p. 49.

other deleterious plants. Sir Andrew Smith informs me that in South Africa a large number of fruits and succulent leaves, and especially roots, are used in times of scarcity. The natives, indeed, know the properties of a long catalogue of plants, some having been found during famines to be eatable, others injurious to health, or even destructive to life. He met a party of Baquanas who, having been expelled by the conquering Zulus, had lived for years on any roots or leaves which afforded some little nutriment and distended their stomachs, so as to relieve the pangs of hunger. They looked like walking skeletons, and suffered fearfully from constipation. Sir Andrew Smith also informs me that on such occasions the natives observe as a guide for themselves, what the wild animals, especially baboons and monkeys, eat.

From innumerable experiments made through dire necessity by the savages of every land, with the results handed down by tradition, the nutritious, stimulating, and medicinal properties of the most unpromising plants were probably first discovered. It appears, for instance, at first an inexplicable fact that untutored man, in three distant quarters of the world, should have discovered, amongst a host of native plants, that the leaves of the tea-plant and mattee, and the berries of the coffee, all included a stimulating and nutritious essence, now known to be chemically the same. We can also see that savages suffering from severe constipation would naturally observe whether any of the roots which they devoured acted as aperients. We probably owe our knowledge of the uses of almost all plants to man having originally existed in a barbarous state, and having been often compelled by severe want to try as food almost everything which he could chew and swallow.

From what we know of the habits of savages in many quarters of the world, there is no reason to suppose that our cereal plants originally existed in their present state so valuable to man. Let us look to one continent alone, namely, Africa: Barth[6] states that the slaves over a large part of the

[6] 'Travels in Central Africa,' Eng. translat. vol. i. pp. 529 and 390; vol. ii. pp. 29, 265, 270. Livingstone's 'Travels,' p. 551.

central region regularly collect the seeds of a wild grass, the *Pennisetum distichum;* in another district he saw women collecting the seeds of a Poa by swinging a sort of basket through the rich meadow-land. Near Tete, Livingstone observed the natives collecting the seeds of a wild grass, and farther south, as Andersson informs me, the natives largely use the seed of a grass of about the size of canary-seed, which they boil in water. They eat also the roots of certain reeds, and every one has read of the Bushmen prowling about and digging up with a fire-hardened stake various roots. Similar facts with respect to the collection of seeds of wild grasses in other parts of the world could be given.[7]

Accustomed as we are to our excellent vegetables and luscious fruits, we can hardly persuade ourselves that the stringy roots of the wild carrot and parsnip, or the little shoots of the wild asparagus, or crabs, sloes, &c., should ever have been valued; yet, from what we know of the habits of Australian and South African savages, we need feel no doubt on this head. The inhabitants of Switzerland during the Stone-period largely collected wild crabs, sloes, bullaces, hips of roses, elderberries, beechmast, and other wild berries and fruit.[8] Jemmy Button, a Fuegian on board the *Beagle*, remarked to me that the poor and acid black-currants of Tierra del Fuego were too sweet for his taste.

The savage inhabitants of each land, having found out by many and hard trials what plants were useful, or could be rendered useful by various cooking processes, would after a time take the first step in cultivation by planting them near their usual abodes. Livingstone[9] states that the savage Batokas sometimes left wild fruit-trees standing in their gardens, and occasionally even planted them, "a practice

[7] For instance, in both North and South America. Mr. Edgeworth ('Journal Proc. Linn. Soc.,' vol vi. Bot., 1862, p. 181) states that in the deserts of the Punjab poor women sweep up, "by a whisk into straw baskets," the seeds of four genera of grasses, namely, of Agrostis, Panicum, Cenchrus, and Pennisetum, as well as the seeds of four other genera belonging to distinct families.

[8] Prof. O. Heer, 'Die Pflanzen der Pfahlbauten, 1866, aus dem Neujahr. Naturforsch. Gesellschaft,' 1866; and Dr. H. Christ, in Rütimeyer's 'Die Fauna der Pfahlbauten,' 1861, s. 226.

[9] 'Travels,' p. 535. Du Chaillu, 'Adventures in Equatorial Africa,' 1861, p. 445.

seen nowhere else amongst the natives." But Du Chaillu saw a palm and some other wild fruit-trees which had been planted; and these trees were considered private property. The next step in cultivation, and this would require but little forethought, would be to sow the seeds of useful plants; and as the soil near the hovels of the natives[10] would often be in some degree manured, improved varieties would sooner or later arise. Or a wild and unusually good variety of a native plant might attract the attention of some wise old savage; and he would transplant it, or sow its seed. That superior varieties of wild fruit-trees occasionally are found is certain, as in the case of the American species of hawthorns, plums, cherries, grapes, and hickories, specified by Professor Asa Gray.[11] Downing also refers to certain wild varieties of the hickory, as being "of much larger size and finer flavour than the common species." I have referred to American fruit-trees, because we are not in this case troubled with doubts whether or not the varieties are seedlings which have escaped from cultivation. Transplanting any superior variety, or sowing its seeds, hardly implies more forethought than might be expected at an early and rude period of civilisation. Even the Australian barbarians "have a law that no plant bearing seeds is to be dug up after it has flowered;" and Sir G. Grey[12] never saw this law, evidently framed for the preservation of the plant, violated. We see the same spirit in the superstitious belief of the Fuegians, that killing water-fowl whilst very young will be followed by "much rain, snow, blow much."[13] I may add, as showing forethought in the lowest barbarians, that the Fuegians when they find a stranded whale bury large portions in the sand, and during the often-recurrent famines travel from great distances for the remnants of the half-putrid mass.

It has often been remarked[14] that we do not owe a single

[10] In Tierra del Fuego the spot where wigwams had formerly stood could be distinguished at a great distance by the bright green tint of the native vegetation.

[11] 'American Acad. of Arts and Sciences,' April 10th, 1860, p. 413, Downing, 'The Fruits of America,' 1845, p. 261.

[12] 'Journals of Expeditions in Australia,' 1841, vol. ii. p. 292.

[13] Darwin's 'Journal of Researches,' 1845, p. 215.

[14] De Candolle has tabulated the facts in the most interesting manner in his 'Géographie Bot.,' p. 986.

useful plant to Australia or the Cape of Good Hope,—countries abounding to an unparalleled degree with endemic species,—or to New Zealand, or to America south of the Plata; and, according to some authors, not to America northward of Mexico. I do not believe that any edible or valuable plant, except the canary-grass, has been derived from an oceanic or uninhabited island. If nearly all our useful plants, natives of Europe, Asia, and South America, had originally existed in their present condition, the complete absence of similarly useful plants in the great countries just named would be indeed a surprising fact. But if these plants have been so greatly modified and improved by culture as no longer closely to resemble any natural species, we can understand why the above-named countries have given us no useful plants, for they were either inhabited by men who did not cultivate the ground at all, as in Australia and the Cape of Good Hope, or who cultivated it very imperfectly, as in some parts of America. These countries do yield plants which are useful to savage man; and Dr. Hooker [15] enumerates no less than 107 such species in Australia alone; but these plants have not been improved, and consequently cannot compete with those which have been cultivated and improved during thousands of years in the civilised world.

The case of New Zealand, to which fine island we as yet owe no widely cultivated plant, may seem opposed to this view; for, when first discovered, the natives cultivated several plants; but all inquirers believe, in accordance with the traditions of the natives, that the early Polynesian colonists brought with them seeds and roots, as well as the dog, which had been wisely preserved during their long voyage. The Polynesians are so frequently lost on the ocean that this degree of prudence would occur to any wandering party: hence the early colonists of New Zealand, like the later European colonists, would not have had any strong inducement to cultivate the aboriginal plants. According to De Candolle we owe thirty-three useful plants to Mexico, Peru, and Chile; nor is this surprising when we remember the civilized state of the inhabitants, as shown by the fact of

[15] 'Flora of Australia,' Introduction, p. cx.

their having practised artificial irrigation and made tunnels through hard rocks without the use of iron or gunpowder, and who, as we shall see in a future chapter, fully recognised, as far as animals were concerned, and therefore probably in the case of plants, the important principle of selection. We owe some plants to Brazil; and the early voyagers, namely, Vespucius and Cabral, describe the country as thickly peopled and cultivated. In North America[16] the natives cultivated maize, pumpkins, gourds, beans, and peas, "all different from ours," and tobacco; and we are hardly justified in assuming that none of our present plants are descended from these North American forms. Had North America been civilized for as long a period, and as thickly peopled, as Asia or Europe, it is probable that the native vines, walnuts, mulberries, crabs, and plums, would have given rise, after a long course of cultivation, to a multitude of varieties, some extremely different from their parent-stocks; and escaped seedlings would have caused in the New, as in the Old World, much perplexity with respect to their specific distinctness and parentage.[17]

Cerealia.—I will now enter on details. The cereals cultivated in Europe consist of four genera—wheat, rye, barley, and oats. Of wheat the best modern authorities[18] make four or five, or even seven distinct species; of rye, one; of barley, three; and of oats, two, three, or four species. So that altogether our cereals are ranked by different authors under from ten to fifteen distinct species. These have given rise to a multitude of varieties. It is a remarkable fact that botanists are not universally agreed on the aboriginal parent-form of any one cereal plant. For instance, a

[16] For Canada, *see* J. Cartier's Voyage in 1534; for Florida, *see* Narvaez and Ferdinand de Soto's Voyages. As I have consulted these and other old Voyages in more than one general collection of Voyages, I do not give precise references to the pages. *See* also, for several references, Asa Gray, in the 'American Journal of Science,' vol. xxiv. Nov. 1857, p. 441. For the traditions of the natives of New Zealand, *see* Crawfurd's 'Grammar and Dict. of the Malay Language,' 1852, p. cclx.

[17] *See*, for example, Mr. Hewett C. Watson's remarks on our wild plums and cherries and crabs: 'Cybele Britannica,' vol. i. pp. 330, 334, &c. Van Mons (in his 'Arbres Fruitiers,' 1835, tom. i. p. 444) declares that he has found the types of all our cultivated varieties in wild seedlings, but then he looks on these seedlings as so many aboriginal stocks.

[18] *See* A. De Candolle, 'Géograph. Bot.,' 1855, p. 928 *et seq.* Godron, 'De l'Espèce,' 1859, tom. ii. p. 70; and Metzger, 'Die Getreidearten,' &c., 1841.

high authority writes in 1855,[19] "We ourselves have no hesitation in stating our conviction, as the result of all the most reliable evidence, that none of these Cerealia exist, or have existed, truly wild in their present state, but that all are cultivated varieties of species now growing in great abundance in S. Europe or W. Asia." On the other hand, Alph. De Candolle[20] has adduced abundant evidence that common wheat (*Triticum vulgare*) has been found wild in various parts of Asia, where it is not likely to have escaped from cultivation: and there is some force in M. Godron's remark, that, supposing these plants to be escaped seedlings,[21] as they have propagated themselves in a wild state for several generations, their continued resemblance to cultivated wheat renders it probable that the latter has retained its aboriginal character. But the strong tendency to inheritance, which most of the varieties of wheat evince, as we shall presently see, is here greatly undervalued. Much weight must also be attributed to a remark by Professor Hildebrand,[22] that when the seeds or fruit of cultivated plants possess qualities disadvantageous to them as a means of distribution, we may feel almost sure that they no longer retain their aboriginal condition. On the other hand, M. De Candolle insists strongly on the frequent occurrence in the Austrian dominions of rye and of one kind of oats in an apparently wild condition. With the exception of these two cases, which however are rather doubtful, and with the exception of two forms of wheat and one of barley, which he believes to have been found truly wild, M. De Candolle does not seem fully satisfied with the other reported discoveries of the parent-forms of our other cereals. With respect to oats, according to Mr. Buckmann,[23] the wild English *Avena fatua* can be converted by a few years of careful cultivation and selection into forms almost identical with two very distinct cultivated races. The whole subject of the origin and specific distinctness of the various cereal plants is a most difficult one; but we shall perhaps be able to judge a little better after considering the amount of variation which wheat has undergone.

Metzger describes seven species of wheat, Godron refers to five,

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[19] Mr. Bentham, in his review, entitled 'Hist. Notes on cultivated Plants,' by Dr. A. Targioni-Tozzetti, in 'Journal of Hort. Soc.,' vol. ix. (1855), p. 133. He informs me that he still retains the same opinion.

[20] 'Géograph. Bot.,' p. 928. The whole subject is discussed with admirable fulness and knowledge.

[21] Godron, 'De l'Espèce,' tom. ii. p. 72. A few years ago the excellent, though misinterpreted, observations of M. Fabre led many persons to believe that wheat was a modified descendant of Ægilops; but M. Godron (tom. i. p. 165) has shown by careful experiments that the first step in the series, viz. *Ægilops triticoides*, is a hybrid between wheat and *Æ. ovata*. The frequency with which these hybrids spontaneously arise, and the gradual manner in which the *Æ. triticoides* becomes converted into true wheat, alone leave any doubt with respect to M. Godron's conclusions.

[22] 'Die Verbreitungsmittel der Pflanzen, 1873, p. 129.

[23] Report to British Association for 1857, p. 207.

and De Candolle to only four. It is not improbable that, besides the kinds known in Europe, other strongly characterised forms exist in the more distant parts of the world; for Loiseleur-Deslongchamps[24] speaks of three new species or varieties, sent to Europe in 1822 from Chinese Mongolia, which he considers as being there indigenous. Moorcroft[25] also speaks of Hasora wheat in Ladakh as very peculiar. If those botanists are right who believe that at least seven species of wheat originally existed, then the amount of variation in any important character which wheat has undergone under cultivation has been slight; but if only four or a lesser number of species originally existed, then it is evident that varieties have arisen so strongly marked, that they have been considered by capable judges as specifically distinct. But the impossibility of deciding which forms ought to be ranked as species and which as varieties, makes it useless to specify in detail the differences between the various kinds of wheat. Speaking generally, the organs of vegetation differ little;[26] but some kinds grow close and upright, whilst others spread and trail along the ground. The straw differs in being more or less hollow, and in quality. The ears[27] differ in colour and in shape, being quadrangular, compressed, or nearly cylindrical; and the florets differ in their approximation to each other, in their pubescence, and in being more or less elongated. The presence or absence of barbs is a conspicuous difference, and in certain Graminæ serves even as a generic character;[28] although, as remarked by Godron,[29] the presence of barbs is variable in certain wild grasses, and especially in those such as *Bromus secalinus* and *Lolium temulentum*, which habitually grow mingled with our cereal crops, and which have thus unintentionally been exposed to culture. The grains differ in size, weight, and colour; in being more or less downy at one end, in being smooth or wrinkled, in being either nearly globular, oval, or elongated; and finally in internal texture, being tender or hard, or even almost horny, and in the proportion of gluten which they contain.

Nearly all the races or species of wheat vary, as Godron[30] has remarked, in an exactly parallel manner,—in the seed being downy or glabrous, and in colour,—and in the florets being barbed or not barbed, &c. Those who believe that all the kinds are descended from a single wild species may account for this parallel variation by the inheritance of a similar constitution, and a consequent tendency to vary in the same manner; and those who believe in the general theory of descent with modification may extend this

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[24] 'Considérations sur les Céréales,' 1842–43, p. 29.

[25] 'Travels in the Himalayan Provinces,' &c., 1841, vol. i. p. 224.

[26] Col. J. Le Couteur on the 'Varieties of Wheat,' pp. 23, 79.

[27] Loiseleur-Deslongchamps, 'Consid. sur les Céréales,' p. 11.

[28] *See* an excellent review in Hooker's 'Journ. of Botany,' vol. viii. p. 82, note.

[29] 'De l'Espèce,' tom. ii. p. 73.

[30] Ibid., tom. ii. p. 75.

view to the several species of wheat, if such ever existed in a state of nature.

Although few of the varieties of wheat present any conspicuous difference, their number is great. Dalbret cultivated during thirty years from 150 to 160 kinds, and excepting in the quality of the grain they all kept true; Colonel Le Couteur possessed upwards of 150, and Philippar 322 varieties.[31] As wheat is an annual, we thus see how strictly many trifling differences in character are inherited through many generations. Colonel Le Couteur insists strongly on this same fact. In his persevering and successful attempts to raise new varieties, he found that there was only one "secure mode to "ensure the growth of pure sorts, namely, to grow them from single "grains or from single ears, and to follow up the plan by afterwards "sowing only the produce of the most productive so as to form a "stock." But Major Hallett[32] has gone much farther, and by the continued selection of plants from the grains of the same ear, during successive generations, has made his 'Pedigree in Wheat' (and other cereals) now famous in many quarters of the world. The great amount of variability in the plants of the same variety is another interesting point, which would never have been detected except by an eye long practised to the work; thus Colonel Le Couteur relates[33] that in a field of his own wheat, which he considered at least as pure as that of any of his neighbours, Professor La Gasca found twenty-three sorts; and Professor Henslow has observed similar facts. Besides such individual variations, forms sufficiently well marked to be valued and to become widely cultivated sometimes suddenly appear: thus Mr. Shirreff has had the good fortune to raise in his lifetime seven new varieties, which are now extensively grown in many parts of Britain.[34]

As in the case of many other plants, some varieties, both old and new, are far more constant in character than others. Colonel Le Couteur was forced to reject some of his new sub-varieties, which he suspected had been produced from a cross, as incorrigibly sportive. On the other hand Major Hallett[35] has shown how wonderfully constant some varieties are, although not ancient ones, and although cultivated in various countries. With respect to the tendency to vary, Metzger[36] gives from his own experience some interesting facts: he describes three Spanish sub-varieties, more especially one

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[31] For Dalbret and Philippar, *see* Loiseleur-Deslongchamps, 'Consid. sur les Céréales,' pp. 45, 70. Le Couteur on Wheat, pp. 6, 14–17.

[32] See his Essay on 'Pedigree in Wheat,' 1862; also paper read before the British Association, 1869, and other publications.

[33] 'Varieties of Wheat,' Introduction, p. vi. Marshall, in his 'Rural Economy of Yorkshire,' vol. ii. p. 9, remarks that "in every field of corn there is as much variety as in a herd of cattle."

[34] 'Gardener's Chron.' and 'Agricult. Gazette,' 1862, p. 963.

[35] 'Gardener's Chron.' Nov. 1868, p. 1199.

[36] 'Getreidearten,' 1841, s. 66, 91 92, 116, 117.

known to be constant in Spain, which in Germany assumed their proper character only during hot summers; another variety kept true only in good land, but after having been cultivated for twenty-five years became more constant. He mentions two other sub-varieties which were at first inconstant, but subsequently became, apparently without any selection, accustomed to their new homes, and retained their proper character. These facts show what small changes in the conditions of life cause variability, and they further show that a variety may become habituated to new conditions. One is at first inclined to conclude with Loiseleur-Deslongchamps, that wheat cultivated in the same country is exposed to remarkably uniform conditions; but manures differ, seed is taken from one soil to another, and, what is far more important, the plants are exposed as little as possible to struggle with other plants, and are thus enabled to exist under diversified conditions. In a state of nature each plant is confined to that particular station and kind of nutriment which it can seize from the other plants by which it is surrounded.

Wheat quickly assumes new habits of life. The summer and winter kinds were classed by Linnæus as distinct species; but M. Monnier[37] has proved that the difference between them is only temporary. He sowed winter-wheat in spring, and out of one hundred plants four alone produced ripe seeds; these were sown and resown, and in three years plants were reared which ripened all their seed. Conversely, nearly all the plants raised from summer-wheat, which was sown in autumn, perished from frost; but a few were saved and produced seed, and in three years this summer-variety was converted into a winter-variety. Hence it is not surprising that wheat soon becomes to a certain extent acclimatised, and that seed brought from distant countries and sown in Europe vegetates at first, or even for a considerable period,[38] differently from our European varieties. In Canada the first settlers, according to Kalm,[39] found their winters too severe for winter-wheat brought from France, and their summers often too short for summer-wheat; and they thought that their country was useless for corn crops until they procured summer-wheat from the northern parts of Europe, which succeeded well. It is notorious that the proportion of gluten differs much under different climates. The weight of the grain is also quickly affected by climate: Loiseleur-Deslongchamps[40] sowed near Paris 54 varieties, obtained from the South of France and from the Black Sea, and 52 of these yielded seed from 10 to 40 per cent. heavier than the parent-seed. He then

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[37] Quoted by Godron, 'De l'Espèce,' vol. ii. p. 74. So it is, according to Metzger ('Getreidearten,' s. 18), with summer and winter barley.

[38] Loiseleur-Deslongchamps, 'Céréales,' part ii. p. 224. Le Couteur, p. 70. Many other accounts could be added.

[39] 'Travels in North America,' 1753–1761, Eng. translat., vol. iii. p. 165.

[40] 'Céréales,' part ii. pp. 179–183.

sent these heavier grains back to the South of France, but there they immediately yielded lighter seed.

All those who have closely attended to the subject insist on the close adaptation of numerous varieties of wheat to various soils and climates even within the same country; thus Colonel Le Couteur[41] says, "It is the suitableness of each sort to each soil that will enable the farmer to pay his rent by sowing one variety, where he would be unable to do so by attempting to grow another of a seemingly better sort." This may be in part due to each kind becoming habituated to its conditions of life, as Metzger has shown certainly occurs, but it is probably in main part due to innate differences between the several varieties.

Much has been written on the deterioration of wheat; that the quality of the flour, size of grain, time of flowering, and hardness, may be modified by climate and soil, seems nearly certain; but that the whole body of any one sub-variety ever becomes changed into another and distinct sub-variety, there is no reason to believe. What apparently does take place, according to Le Couteur,[42] is, that some one sub-variety out of the many which may always be detected in the same field is more prolific than the others, and gradually supplants the variety which was first sown.

With respect to the natural crossing of distinct varieties the evidence is conflicting, but preponderates against its frequent occurrence. Many authors maintain that impregnation takes place in the closed flower, but I am sure from my own observation that this is not the case, at least with those varieties to which I have attended. But as I shall have to discuss this subject in another work, it may be here passed over.

In conclusion, all authors admit that numerous varieties of wheat have arisen; but their differences are unimportant, unless, indeed, some of the so-called species are ranked as varieties. Those who believe that from four to seven wild species of Triticum originally existed in nearly the same condition as at present, rest their belief chiefly on the great antiquity of the several forms.[43] It is an important fact, which we have recently learnt from the admirable researches of Heer,[44] that the inhabitants of Switzerland, even so early

[41] 'On the Varieties of Wheat,' Introduct., p. vii. *See* Marshall, 'Rural Econ. of Yorkshire,' vol. ii. p. 9. With respect to similar cases of adaptation in the varieties of oats, *see* some interesting papers in the 'Gardener's Chron. and Agricult. Gazette,' 1850, pp. 204, 219.

[42] 'On the Varieties of Wheat,' p. 59. Mr. Shirreff, and a higher authority cannot be given ('Gard. Chron. and Agricult. Gazette,' 1862, p. 963), *says*, "*I have never seen grain* which has either been improved or degenerated by cultivation, so as to convey the change to the succeeding crop.

[43] Alph. De Candolle, 'Géograph. Bot.,' p. 930.

[44] 'Pflanzen der Pfahlbauten,' 1866.

as the Neolithic period, cultivated no less than ten cereal plants, namely, five kinds of wheat, of which at least four are commonly looked at as distinct species, three kinds of barley, a panicum, and a setaria. If it could be shown that at the earliest dawn of agriculture five kinds of wheat and three of barley had been cultivated, we should of course be compelled to look at these forms as distinct species. But, as Heer has remarked, agriculture even at the Neolithic period, had already made considerable progress; for, besides the cereals, peas, poppies, flax, and apparently apples, were cultivated. It may also be inferred, from one variety of wheat being the so called Egyptian, and from what is known of the native country of the panicum and setaria, as well as from the nature of the weeds which then grew mingled with the crops, that the lake-inhabitants either still kept up commercial intercourse with some southern people or had originally proceeded as colonists from the South.

Loiseleur-Deslongchamps [45] has argued that, if our cereal plants have been greatly modified by cultivation, the weeds which habitually grow mingled with them would have been equally modified. But this argument shows how completely the principle of selection has been overlooked. That such weeds have not varied, or at least do not vary now in any extreme degree, is the opinion of Mr. H. C. Watson and Professor Asa Gray, as they inform me; but who will pretend to say that they do not vary as much as the individual plants of the same sub-variety of wheat? We have already seen that pure varieties of wheat, cultivated in the same field, offer many slight variations, which can be selected and separately propagated; and that occasionally more strongly pronounced variations appear, which, as Mr. Shirreff has proved, are well worthy of extensive cultivation. Not until equal attention be paid to the variability and selection of weeds, can the argument from their constancy under unintentional culture be of any value. In accordance with the principles of selection we can understand how it is that in the several cultivated varieties of wheat the organs of vegetation differ so little; for if a plant with peculiar leaves appeared, it would

[45] 'Les Céréales,' p. 94.

be neglected unless the grains of corn were at the same time superior in quality or size. The selection of seed-corn was strongly recommended [46] in ancient times by Columella and Celsus; and as Virgil says,—

> "I've seen the largest seeds, tho' view'd with care,
> Degenerate, unless th' industrious hand
> Did yearly cull the largest."

But whether in ancient times selection was methodically pursued we may well doubt, when we hear how laborious the work has been found by Le Couteur and Hallett. Although the principle of selection is so important, yet the little which man has effected, by incessant efforts [47] during thousands of years, in rendering the plants more productive or the grains more nutritious than they were in the time of the old Egyptians, would seem to speak strongly against its efficacy. But we must not forget that at each successive period the state of agriculture and the quantity of manure supplied to the land will have determined the maximum degree of productiveness; for it would be impossible to cultivate a highly productive variety, unless the land contained a sufficient supply of the necessary chemical elements.

We now know that man was sufficiently civilized to cultivate the ground at an immensely remote period; so that wheat might have been improved long ago up to that standard of excellence which was possible under the then existing state of agriculture. One small class of facts supports this view of the slow and gradual improvement of our cereals. In the most ancient lake-habitations of Switzerland, when men employed only flint-tools, the most extensively cultivated wheat was a peculiar kind, with remarkably small ears and grains.[48] "Whilst the grains of the modern forms are in section from seven to eight millimètres in length, the larger grains from the lake-habitations are six, seldom seven, and the smaller ones only four. The ear is thus much narrower,

[46] Quoted by Le Couteur, p. 16.

[47] A. De Candolle, 'Géograph. Bot.,' p. 932.

[48] O. Heer, 'Die Pflanzen der Pfahlbauten,' 1866. The following passage is quoted from Dr. Christ, in 'Die Fauna der Pfahlbauten, von Dr. Rütimeyer,' 1861, s. 225.

and the spikelets stand out more horizontally, than in our present forms." So again with barley, the most ancient and most extensively cultivated kind had small ears, and the grains were "smaller, shorter, and nearer to each other, than in that now grown; without the husk they were 2½ lines long, and scarcely 1½ broad, whilst those now grown have a length of three lines, and almost the same in breadth." [49] These small-grained varieties of wheat and barley are believed by Heer to be the parent-forms of certain existing allied varieties, which have supplanted their early progenitors.

Heer gives an interesting account of the first appearance and final disappearance of the several plants which were cultivated in greater or less abundance in Switzerland during former successive periods, and which generally differed more or less from our existing varieties. The peculiar small-eared and small-grained wheat, already alluded to, was the commonest kind during the Stone period; it lasted down to the Helvetico-Roman age, and then became extinct. A second kind was rare at first, but afterwards became more frequent. A third, the Egyptian wheat (*T. turgidum*), does not agree exactly with any existing variety, and was rare during the Stone period. A fourth kind (*T. dicoccum*) differs from all known varieties of this form. A fifth kind (*T. monococcum*) is known to have existed during the Stone period only by the presence of a single ear. A sixth kind, the common *T. spelta*, was not introduced into Switzerland until the Bronze age. Of barley, besides the short-eared and small-grained kind, two others were cultivated, one of which was very scarce, and resembled our present common *H. distichum*. During the Bronze age rye and oats were introduced; the oat-grains being somewhat smaller than those produced by our existing varieties. The poppy was largely cultivated during the Stone period, probably for its oil; but the variety which then existed is not now known. A peculiar pea with small seeds lasted from the Stone to the Bronze age, and then became extinct; whilst a peculiar bean, likewise having small seeds, came in at the Bronze period and lasted to the time of the Romans. These details sound like the descriptions

[49] Heer, as quoted by Carl Vogt, 'Lectures on Man,' Eng. translat. p. 355.

given by palæontologists of the first appearance, the increasing rarity, and final extinction or modification of fossil species, embedded in the successive stages of a geological formation.

Finally, every one must judge for himself whether it is more probable that the several forms of wheat, barley, rye, and oats are descended from between ten and fifteen species, most of which are now either unknown or extinct, or whether they are descended from between four and eight species, which may have either closely resembled our present cultivated forms, or have been so widely different as to escape identification. In this latter case we must conclude that man cultivated the cereals at an enormously remote period, and that he formerly practised some degree of selection, which in itself is not improbable. We may, perhaps, further believe that, when wheat was first cultivated the ears and grains increased quickly in size, in the same manner as the roots of the wild carrot and parsnip are known to increase quickly in bulk under cultivation.

Maize or Indian Corn: Zea mays.—Botanists are nearly unanimous that all the cultivated kinds belong to the same species. It is undoubtedly [50] of American origin, and was grown by the aborigines throughout the continent from New England to Chili. Its cultivation must have been extremely ancient, for Tschudi [51] describes two kinds, now extinct or not known in Peru, which were taken from tombs apparently prior to the dynasty of the Incas. But there is even stronger evidence of antiquity, for I found on the coast of Peru [52] heads of maize, together with eighteen species of recent sea-shell, embedded in a beach which had been upraised at least 85 feet above the level of the sea. In accordance with this ancient cultivation, numerous American varieties have arisen. The aboriginal form has not as yet been discovered in the wild state. A peculiar kind,[53] in which the grains, instead of being naked, are

[50] *See* Alph. De Candolle's long discussion in his 'Géograph. Bot.,' p. 942. With respect to New England, *see* Silliman's 'American Journal,' vol. xliv. p. 99.

[51] 'Travels in Peru,' Eng. translat., p. 177.

[52] 'Geolog. Observ. on S. America,' 1846, p. 49.

[53] This maize is figured in Bonafous' magnificent work, 'Hist. Nat. du Mais, 1836, Pl. v. bis, and in the 'Journal of Hort. Soc.,' vol. i., 1846, p. 115, where an account is given of the result of sowing the seed. A young Guarany Indian, on seeing this kind of maize, told Auguste St. Hilaire (*see* De Candolle, 'Géograph. Bot.,' p. 951) that it grew wild in the humid forests of his native land. Mr. Teschemacher, in 'Proc. Boston Soc. Hist.,' Oct. 19th, 1842, gives an account of sowing the seed.

concealed by husks as much as eleven lines in length, has been stated, but on insufficient evidence, to grow wild in Brazil. It is almost certain that the aboriginal form would have had its grains thus protected;[54] but the seeds of the Brazilian variety produce, as I hear from Professor Asa Gray, and as is stated in two published accounts, either common or husked maize; and it is not credible that a wild species, when first cultivated, should vary so quickly and in so great a degree.

Maize has varied in an extraordinary and conspicuous manner. Metzger,[55] who paid particular attention to the cultivation of this plant, makes twelve races (unter-art) with numerous sub-varieties; of the latter some are tolerably constant, others quite inconstant. The different races vary in height from 15–18 feet to only 16–18 inches, as in a dwarf variety described by Bonafous. The whole ear is variable in shape, being long and narrow, or short and thick, or branched. The ear in one variety is more than four times as long as in a dwarf kind. The seeds are arranged in the ear in from six to even twenty rows, or are placed irregularly. The seeds are coloured—white, pale-yellow, orange, red, violet, or elegantly streaked with black;[56] and in the same ear there are sometimes seeds of two colours. In a small collection I found that a single grain of one variety nearly equalled in weight seven grains of another variety. The shape of the seed varies greatly, being very flat, or nearly globular, or oval; broader than long, or longer than broad; without any point, or produced into a sharp tooth, and this tooth is sometimes recurved. One variety (the rugosa of Bonafous, and which is extensively cultivated in the United States as sweet corn) has its seeds curiously wrinkled, giving to the whole ear a singular appearance. Another variety (the cymosa of Bon.) carries its ears so crowded together that it is called *maïs à bouquet*. The seeds of some varieties contain much glucose instead of starch. Male flowers sometimes appear amongst the female flowers, and Mr. J. Scott has lately observed the rarer case of female flowers on a true male panicle, and likewise hermaphrodite flowers.[57] Azara describes [58] a variety in Paraguay the grains of which are very tender, and he states that several varieties are fitted for being cooked in various ways. The varieties also differ greatly in precocity, and have different powers of resisting dryness and the action of violent wind.[59] Some of the foregoing differences would certainly be considered of specific value with plants in a state of nature.

Le Comte Ré states that the grains of all the varieties which he

[54] Moquin-Tandon, 'Eléments de Tératologie,' 1841, p. 126.

[55] 'Die Getreidearten,' 1841, s. 208. I have modified a few of Metzger's statements in accordance with those made by Bonafous in his great work, 'Hist. Nat. du Maïs,' 1836.

[56] Godron 'De l'Espèce,' tom. ii. p. 80; Al. De Candolle, ibid., p. 951.

[57] 'Transact. Bot. Soc. of Edinburgh,' vol. viii. p. 60.

[58] 'Voyages dans l'Amérique Méridionale,' tom. i. p. 147.

[59] Bonafous' 'Hist. Nat. du Maïs,' p. 31.

cultivated ultimately assumed a yellow colour. But Bonafous[60] found that most of those which he sowed for ten consecutive years kept true to their proper tints; and he adds that in the valleys of the Pyrenees and on the plains of Piedmont a white maize has been cultivated for more than a century, and has undergone no change.

The tall kinds grown in southern latitudes, and therefore exposed to great heat, require from six to seven months to ripen their seed; whereas the dwarf kinds, grown in northern and colder climates, require only from three to four months.[61] Peter Kalm,[62] who particularly attended to this plant, says, that in the United States, in proceeding from south to north, the plants steadily diminish in bulk. Seeds brought from lat. 37° in Virginia, and sown in lat. 43°-44° in New England, produce plants which will not ripen their seed, or ripen them with the utmost difficulty. So it is with seed carried from New England to lat. 45°-47° in Canada. By taking great care at first, the southern kinds after some years' culture ripen their seed perfectly in their northern homes, so that this is an analogous case with that of the conversion of summer into winter wheat, and conversely. When tall and dwarf maize are planted together, the dwarf kinds are in full flower before the others have produced a single flower; and in Pennsylvania they ripen their seeds six weeks earlier than the tall maize. Metzger also mentions a European maize which ripens its seed four weeks earlier than another European kind. With these facts, so plainly showing inherited acclimatisation, we may readily believe Kalm, who states that in North America maize and some other plants have gradually been cultivated further and further nothward. All writers agree that to keep the varieties of maize pure they must be planted separately so that they shall not cross.

The effects of the climate of Europe on the American varieties is highly remarkable. Metzger obtained seed from various parts of America, and cultivated several kinds in Germany. I will give an abstract of the changes observed[63] in one case, namely, with a tall kind (Breit-korniger mais, *Zea altissima*) brought from the warmer parts of America. During the first year the plants were twelve feet high, and a few seeds were perfected; the lower seeds in the ear kept true to their proper form, but the upper seeds became slightly changed. In the second generation the plants were from nine to ten feet in height, and ripened their seed better; the depression on the outer side of the seed had almost disappeared, and the original beautiful white colour had become duskier. Some of the seeds had even become yellow, and in their now rounded form they approached common European maize. In the third generation nearly all resemblance to the original and very distinct American parent-

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[60] Ibid, p. 31.

[61] Metzger, 'Getreidearten,' s. 206.

[62] 'Description of Maize,' by P. Kalm, 1752, in 'Swedish Acts,' vol. iv. I have consulted an old English MS. translation.

[63] 'Getreidearten,' s. 208.

form was lost. In the sixth generation this maize perfectly resembled a European variety, described as the second sub-variety of the fifth race. When Metzger published his book, this variety was still cultivated near Heidelberg, and could be distinguished from the common kind only by a somewhat more vigorous growth. Analogous results were obtained by the cultivation of another American race, the "white-tooth corn," in which the tooth nearly disappeared even in the second generation. A third race, the "chicken-corn," did not undergo so great a change, but the seeds became less polished and pellucid. In the above cases the seeds were carried from a warm to a colder climate. But Fritz Müller informs me that a dwarf variety with small rounded seeds (papagaien-mais), introduced from Germany into S. Brazil, produces plants as tall, with seeds as flat, as those of the kind commonly cultivated there.

These facts afford the most remarkable instance known to me of the direct and prompt action of climate on a plant. It might have been expected that the tallness of the stem, the period of vegetation, and the ripening of the seed, would have been thus affected; but it is a much more surprising fact that the seeds should have undergone so rapid and great a change. As, however, flowers, with their product the seed, are formed by the metamorphosis of the stem and leaves, any modification in these latter organs would be apt to extend, through correlation, to the organs of fructification.

Cabbage (*Brassica oleracea*).—Every one knows how greatly the various kinds of cabbage differ in appearance. In the Island of Jersey, from the effects of particular culture and of climate, a stalk has grown to the height of sixteen feet, and "had its spring shoots at the top occupied by a magpie's nest:" the woody stems are not unfrequently from ten to twelve feet in height, and are there used as rafters [64] and as walking-sticks. We are thus reminded that in certain countries plants belonging to the generally herbaceous order of the Cruciferæ are developed into trees. Every one can appreciate the difference between green or red cabbages with great single heads; Brussel-sprouts with numerous little heads; broccolis and cauliflowers with the greater number of their flowers in an aborted condition, incapable of producing seed, and borne in a dense corymb instead of an open panicle; savoys with their blistered and wrinkled leaves; and borecoles and kails, which come nearest to the wild parent-form. There are also various

[64] 'Cabbage Timber, 'Gardener's Chron.,' 1856, p, 744, quoted from Hooker's 'Journal of Botany.' A walking-stick made from a cabbage-stalk is exhibited in the Museum at Kew.

frizzled and laciniated kinds, some of such beautiful colours that Vilmorin in his Catalogue of 1851 enumerates ten varieties which are valued solely for ornament. Some kinds are less commonly known, such as the Portuguese Couve Tronchuda, with the ribs of its leaves greatly thickened; and the Kohlrabi or choux-raves, with their stems enlarged into great turnip-like masses above the ground; and the recently formed new race[65] of the choux-raves, already including nine sub-varieties, in which the enlarged part lies beneath the ground like a turnip.

Although we see such great differences in the shape, size, colour, arrangement, and manner of growth of the leaves and stem, and of the flower-stems in the broccoli and cauliflower, it is remarkable that the flowers themselves, the seed-pods and seeds, present extremely slight differences or none at all.[66] I compared the flowers of all the principal kinds; those of the Couve Tronchuda are white and rather smaller than in common cabbages; those of the Portsmouth broccoli have narrower sepals, and smaller, less elongated petals; and in no other cabbage could any difference be detected. With respect to the seed-pods, in the purple Kohlrabi alone, do they differ, being a little longer and narrower than usual. I made a collection of the seeds of twenty-eight different kinds, and most of them were undistinguishable; when there was any difference it was excessively slight; thus, the seeds of various broccolis and cauliflowers, when seen in mass, are a little redder; those of the early green Ulm savoy are rather smaller; and those of the Breda kail slightly larger than usual, but not larger than the seeds of the wild cabbage from the coast of Wales. What a contrast in the amount of difference is presented if, on the one hand, we compare the leaves and stems of the various kinds of cabbage with their flowers, pods, and seeds, and on the other hand the corresponding parts in the varieties of maize and wheat! The explanation is obvious; the seeds alone are valued in our cereals, and their variations have been selected; whereas the seeds, seed-pods, and flowers have been utterly neglected in the cabbage, whilst many useful variations in their leaves and stems have been noticed and preserved from an extremely remote period, for cabbages were cultivated by the old Celts.[67]

It would be useless to give a classified description[68] of the numerous races, sub-races, and varieties of the cabbage; but it may be mentioned that Dr. Lindley has lately proposed[69] a system founded on the state of development of the terminal and lateral

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[65] 'Journal de la Soc. Imp. d'Horticulture,' 1855, p. 254, quoted from 'Gartenflora,' Ap. 1855.

[66] Godron, 'De l'Espèce,' tom. ii. p. 52; Metzger, 'Syst. Beschreibung der Kult. Kohlarten,' 1833, s. 6.

[67] Regnier, 'De l'Economie Publique des Celtes,' 1818, p. 438.

[68] *See* the elder De Candolle, in 'Transact. of Hort. Soc.,' vol. v.; and Metzger 'Kohlarten,' &c.

[69] 'Gardener's Chronicle,' 1859, p 992.

leaf-buds. Thus: I. All the leaf-buds active and open, as in the wild-cabbage, kail, &c. II. All the leaf-buds active, but forming heads, as in Brussel-sprouts, &c. III. Terminal leaf-bud alone active, forming a head as in common cabbages, savoys, &c. IV. Terminal leaf-bud alone active, and open, with most of the flowers abortive and succulent, as in the cauliflower and broccoli. V. All the leaf-buds active and open, with most of the flowers abortive and succulent, as in the sprouting-broccoli. This latter variety is a new one, and bears the same relation to common broccoli, as Brussel-sprouts do to common cabbages; it suddenly appeared in a bed of common broccoli, and was found faithfully to transmit its newly-acquired and remarkable characters.

The principal kinds of cabbage existed at least as early as the sixteenth century,[70] so that numerous modifications of structure have been inherited for a long period. This fact is the more remarkable as great care must be taken to prevent the crossing of the different kinds. To give proof of this: I raised 233 seedlings from cabbages of different kinds, which had purposely been planted near each other, and of the seedlings no less than 155 were plainly deteriorated and mongrelized; nor were the remaining 78 all perfectly true. It may be doubted whether many permanent varieties have been formed by intentional or accidental crosses; for such crossed plants are found to be very inconstant. One kind, however, called "Cottager's Kail," has lately been produced by crossing common kail and Brussel-sprouts, recrossed with purple broccoli,[71] and is said to be true; but plants raised by me were not nearly so constant in character as any common kind of cabbage.

Although most of the kinds keep true if carefully preserved from crossing, yet the seed-beds must be yearly examined, and a few seedlings are generally found false; but even in this case the force of inheritance is shown, for, as Metzger has remarked[72] when speaking of Brussel-sprouts, the variations generally keep to their "unter art," or main race. But in order that any kind may be truly propagated there must be no great change in the conditions of life; thus cabbages will not form heads in hot countries, and the same thing has been observed with an English variety grown during an extremely warm and damp autumn near Paris.[73] Extremely poor soil also affects the characters of certain varieties.

Most authors believe that all the races are descended from the wild cabbage found on the western shores of Europe; but Alph. De Candolle[74] forcibly argues, on historical and other grounds, that it is more probable that two or three closely allied forms, generally ranked as distinct species, still living in the Mediterranean region,

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[70] Alph. De Candolle, 'Géograph. Bot.' pp. 842 and 989.

[71] 'Gardener's Chron.,' Feb. 1858, p. 128.

[72] 'Kohlarten,' s. 22.

[73] Godron, 'De l'Espèce,' tom. ii. p 52; Metzger, 'Kohlarten,' s. 22.

[74] 'Géograph. Bot.,' p. 840.

are the parents, now all commingled together, of the various cultivated kinds. In the same manner as we have often seen with domesticated animals, the supposed multiple origin of the cabbage throws no light on the characteristic differences between the cultivated forms. If our cabbages are the descendants of three or four distinct species, every trace of any sterility which may originally have existed between them is now lost, for none of the varieties can be kept distinct without scrupulous care to prevent intercrossing.

The other cultivated forms of the genus Brassica are descended, according to the view adopted by Godron and Metzger,[75] from two species, *B. napus* and *rapa*; but according to other botanists from three species; whilst others again strongly suspect that all these forms, both wild and cultivated, ought to be ranked as a single species. *Brassica napus* has given rise to two large groups, namely, Swedish turnips (believed to be of hybrid origin)[76] and Colzas, the seeds of which yield oil. *Brassica rapa* (of Koch) has also given rise to two races, namely, common turnips and the oil-giving rape. The evidence is unusually clear that these latter plants, though so different in external appearance, belong to the same species; for the turnip has been observed by Koch and Godron to lose its thick roots in uncultivated soil; and when rape and turnips are sown together they cross to such a degree that scarcely a single plant comes true.[77] Metzger by culture converted the biennial or winter rape into the annual or summer rape,—varieties which have been thought by some authors to be specifically distinct.[78]

In the production of large, fleshy, turnip-like stems, we have a case of analogous variation in three forms which are generally considered as distinct species. But scarcely any modification seems so easily acquired as a succulent enlargement of the stem or root—that is, a store of nutriment laid up for the plant's own future use. We see this in our radishes, beet, and in the less generally known "turnip-rooted" celery, and in the finocchio, or Italian variety of the common fennel. Mr. Buckman has lately proved by his interesting experiments how quickly the roots of the wild parsnip can be enlarged, as Vilmorin formerly proved in the case of the carrot.[79]

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[75] Godron, 'De l'Espèce,' tom. ii. p. 54; Metzger, 'Kohlarten,' s. 10.

[76] 'Gardener's Chron. and Agricult. Gazette,' 1856, p. 729. *See*, more especially, ibid., 1868, p. 275: the writer asserts that he planted a variety of cabbage (*B. oleracea*) close to turnips (*B. rapa*) and raised from the crossed seedlings true Swedish turnips. These latter plants ought, therefore, to be classed with cabbages or turnips, and not under *B. napus*.

[77] 'Gardener's Chron. and Agricult. Gazette,' 1855, p. 730.

[78] Metzger, 'Kohlarten,' s. 51.

[79] These experiments by Vilmorin have been quoted by many writers. An eminent botanist, Prof. Decaisne, has lately expressed doubts on the subject from his own negative results, but these cannot be valued equally with positive results. On the other hand, M. Carrière has lately stated ('Gard. Chronicle,' 1865, p. 1154),

This latter plant, in its cultivated state, differs in scarcely any character from the wild English carrot, except in general luxuriance and in the size and quality of its roots; but ten varieties, differing in the colour, shape, and quality of the root, are cultivated in England and come true by seed.[80] Hence with the carrot, as in so many other cases, for instance with the numerous varieties and sub-varieties of the radish, that part of the plant which is valued by man, falsely appears alone to have varied. The truth is that variations in this part alone have been selected; and the seedlings inheriting a tendency to vary in the same way, analogous modifications have been again and again selected, until at last a great amount of change has been effected.

With respect to the radish, M. Carrière, by sowing the seed of the wild *Raphanus raphanistrum* in rich soil, and by continued selection during several generations, raised many varieties, closely like the cultivated radish (*R. sativus*) in their roots, as well as the wonderful Chinese variety, *R. caudatus:* (see 'Journal d'Agriculture pratique,' t. i., 1869, p. 159; also a separate essay, 'Origine des Plants Domestiques,' 1869.) *Raphanus raphanistrum* and *sativus* have often been ranked as distinct species, and owing to differences in their fruit even as distinct genera; but Professor Hoffman ('Bot. Zeitung,' 1872, p. 482) has now shown that these differences, remarkable as they are, graduate away, the fruit of *R. caudatus* being intermediate. By cultivating *R. raphanistrum* during several generations (ibid., 1873, p. 9), Professor Hoffman also obtained plants bearing fruits like those of *R. sativus.*

Pea (*Pisum sativum*).—Most botanists look at the garden-pea as specifically distinct from the field-pea (*P. arvense*). The latter exists in a wild state in Southern Europe; but the aboriginal parent of the garden-pea has been found by one collector alone, as he states, in the Crimea.[81] Andrew Knight crossed, as I am informed by the Rev. A. Fitch, the field-pea with a well-known garden variety, the Prussian pea, and the cross seems to have been perfectly fertile. Dr. Alefeld has recently studied[82] the genus with care, and, after having cultivated about fifty varieties, concludes that certainly they all belong to the same species. It is an interesting fact already alluded to, that, according to O. Heer,[83] the peas found in the lake-habitations of Switzerland of the Stone and Bronze ages, belong to an extinct variety, with exceedingly small

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that he took seed from a wild carrot, growing far from any cultivated land, and even in the first generation the roots of his seedlings differed in being spindle-shaped, longer, softer, and less fibrous than those of the wild plant. From these seedlings he raised several distinct varieties.

[80] Loudon's 'Encyclop. of Gardening,' p. 835.

[81] Alph. De Candolle, 'Géograph. Bot.,' 960. Mr. Bentham ('Hort. Journal,' vol. ix. (1855), p. 141) believes that garden and field peas belong to the same species, and in this respect he differs from Dr. Targioni.

[82] 'Botanische Zeitung,' 1860, s. 204.

[83] 'Die Pflanzen der Pfahlbauten, 1866, s. 23.

seeds, allied to *P. arvense* or the field-pea. The varieties of the common garden-pea are numerous, and differ considerably from one another. For comparison I planted at the same time forty-one, English and French varieties. They differed greatly in height,—namely from between 6 and 12 inches to 8 feet,[84]—in manner of growth, and in period of maturity. Some differ in general aspect even while only two or three inches in height. The stems of the *Prussian* pea are much branched. The tall kinds have larger leaves than the dwarf kinds, but not in strict proportion to their height:—*Hair's Dwarf Monmouth* has very large leaves, and the *Pois nain hatif*, and the moderately tall *Blue Prussian*, have leaves about two-thirds of the size of the tallest kind. In the *Danecroft* the leaflets are rather small and a little pointed; in the *Queen of Dwarfs* rather rounded; and in the *Queen of England* broad and large. In these three peas the slight differences in the shape of the leaves are accompanied by slight differences in colour. In the *Pois géant sans parchemin*, which bears purple flowers, the leaflets in the young plant are edged with red; and in all the peas with purple flowers the stipules are marked with red.

In the different varieties, one, two, or several flowers in a small cluster, are borne on the same peduncle; and this is a difference which is considered of specific value in some of the Leguminosæ. In all the varieties the flowers closely resemble each other except in colour and size. They are generally white, sometimes purple, but the colour is inconstant even in the same variety. In *Warner's Emperor*, which is a tall kind, the flowers are nearly double the size of the *Pois nain hatif*; but *Hair's Dwarf Monmouth*, which has large leaves, likewise has large flowers. The calyx in the *Victoria Marrow* is large, and in *Bishop's Long Pod* the sepals are rather narrow. In no other kind is there any difference in the flower.

The pods and seeds, which with natural species afford such constant characters, differ greatly in the cultivated varieties of the pea; and these are the valuable, and consequently the selected parts. *Sugar peas*, or *Pois sans parchemin*, are remarkable from their thin pods, which, whilst young, are cooked and eaten whole; and in this group, which, according to Mr. Gordon includes eleven sub-varieties, it is the pod which differs most; thus *Lewis's Negro-podded pea* has a straight, broad, smooth, and dark-purple pod, with the husk not so thin as in the other kinds; the pod of another variety is extremely bowed; that of the *Pois géant* it much pointed at the extremity; and in the variety "*à grands cosses*" the peas are seen through the husk in so conspicuous a manner that the pod, especially when dry, can hardly at first be recognised as that of a pea.

In the ordinary varieties the pods also differ much in size;—in colour, that of *Woodford's Green Marrow* being bright-green

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[84] A variety called the Rounciva attains this height, as is stated by Mr. Gordon in 'Transact. Hort. Soc.' (2nd series), vol. i., 1835, p. 374, from which paper I have taken some facts

when dry, instead of pale brown, and that of the purple-podded pea being expressed by its name;—in smoothness, that of *Danecroft* being remarkably glossy, whereas that of the *Ne plus ultra* is rugged; in being either nearly cylindrical, or broad and flat;—in being pointed at the end, as in *Thurston's Reliance*, or much truncated, as in the *American Dwarf*. In the *Auvergne pea* the whole end of the pod is bowed upwards. In the *Queen of the Dwarfs* and in *Scimitar peas* the pod is almost elliptic in shape. I here give drawings of the four most distinct pods produced by the plants cultivated by me.

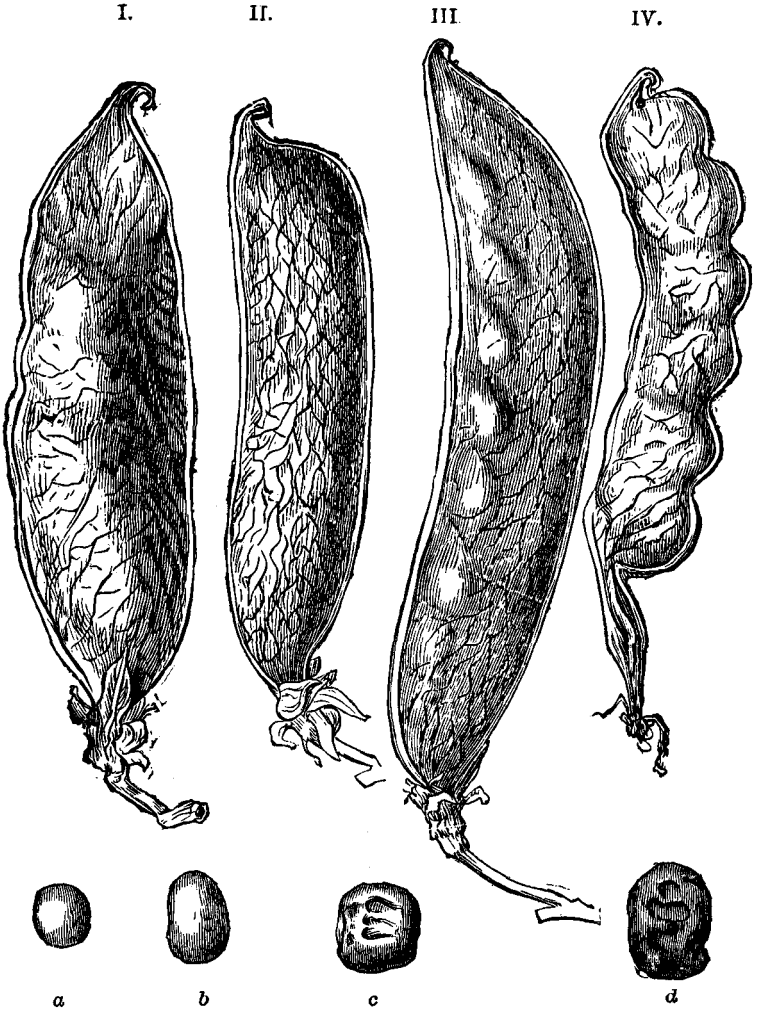

Fig. 41.—Pods and Peas. I. Queen of Dwarfs. II. American Dwarf. III. Thurston's Reliance.—IV. Pois Géant sans parchemin. *a*. Dan O'Rourke Pea. *b*. Queen of Dwarfs Pea. *c*. Knight's Tall White Marrow. *d*. Lewis's Negro Pea.

In the pea itself we have every tint between almost pure white, brown, yellow, and intense green; in the varieties of the *sugar peas* we have these same tints, together with red passing through fine purple into a dark chocolate tint. These colours are either uniform or distributed in dots, striæ, or moss-like marks; they depend in some cases on the colour of the cotyledons seen through the skin, and in other cases on the outer coats of the pea itself. In the different varieties, the pods contain, according to Mr. Gordon, from eleven or twelve to only four or five peas. The largest peas are nearly twice as much in diameter as the smallest; and the latter are not always borne by the most dwarfed kinds. Peas differ much in shape, being smooth and spherical, smooth and oblong, nearly oval in the *Queen of the Dwarfs*, and nearly cubical and crumpled in many of the larger kinds.

With respect to the value of the differences between the chief varieties, it cannot be doubted that, if one of the tall *Sugar-peas*, with purple flowers, thin-skinned pods of an extraordinary shape, including large, dark-purple peas, grew wild by the side of the lowly *Queen of the Dwarfs*, with white flowers, greyish-green, rounded leaves, scimitar-like pods, containing oblong, smooth, pale-coloured peas, which became mature at a different season: or by the side of one of the gigantic sorts, like the *Champion of England*, with leaves of great size, pointed pods, and large, green, crumpled, almost cubical peas,—all three kinds would be ranked as distinct species.

Andrew Knight[85] has observed that the varieties of peas keep very true, because they are not crossed by insects. As far as the fact of keeping true is concerned, I hear from Mr. Masters of Canterbury, well known as the originator of several new kinds, that certain varieties have remained constant for a considerable time,—for instance, *Knight's Blue Dwarf*, which came out about the year 1820.[86] But the greater number of varieties have a singularly short existence: thus Loudon remarks[87] that "sorts which were highly approved in 1821, are now, in 1833, nowhere to be found;" and on comparing the lists of 1833 with those of 1855, I find that nearly all the varieties have changed. Mr. Masters informs me that the nature of the soil causes some varieties to lose their character. As with other plants, certain varieties can be propagated truly, whilst others show a determined tendency to vary; thus two peas differing in shape, one round and the other wrinkled, were found by Mr. Masters within the same pod, but the plants raised from the wrinkled kind always evinced a strong tendency to produce round peas. Mr. Masters also raised from a plant of another variety four distinct sub-varieties, which bore blue and round, white and round, blue and wrinkled, and white and

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[85] 'Phil. Tract.' 1799, p. 196.

[86] 'Gardener's Magazine,' vol. i., 1826, p. 153.

[87] 'Encyclopædia of Gardening,' p 823.

wrinkled peas; and although he sowed these four varieties separately during several successive years, each kind always reproduced all four kinds mixed together!

With respect to the varieties not naturally intercrossing, I have ascertained that the pea, which in this respect differs from some other Leguminosæ, is perfectly fertile without the aid of insects. Yet I have seen humble-bees whilst sucking the nectar depress the keel-petals, and become so thickly dusted with pollen, that it could hardly fail to be left on the stigma of the next flower which was visited. Nevertheless, distinct varieties growing closely together rarely cross; and I have reason to believe that this is due to their stigmas being prematurely fertilised in this country by pollen from the same flower. The horticulturists who raise seed-peas are thus enabled to plant distinct varieties close together without any bad consequences; and it is certain, as I have myself found, that true seed may be saved during at least several generations under these circumstances.[88] Mr. Fitch raised, as he informs me, one variety for twenty years, and it always came true, though grown close to other varieties. From the analogy of kidney-beans I should have expected[89] that varieties thus circumstanced would have occasionally crossed; and I shall give in the eleventh chapter two cases of this having occurred, as shown (in a manner hereafter to be explained) by the pollen of the one variety having acted directly on the seeds of the other. Whether many of the new varieties which incessantly appear are due to such occasional and accidental crosses, I do not know. Nor do I know whether the short existence of almost all the numerous varieties is the result of mere change of fashion, or of their having a weak constitution, from being the product of long-continued self-fertilisation. It may, however, be noticed that several of Andrew Knight's varieties, which have endured longer than most kinds, were raised towards the close of the last century by artificial crosses; some of them, I believe, were still vigorous in 1860; but now, in 1865, a writer, speaking[90] of Knight's four kinds of marrows, says, they have acquired a famous history, but their glory has departed.

With respect to Beans (*Faba vulgaris*), I will say but little. Dr. Alefeld has given[91] short diagnostic characters of forty varieties. Everyone who has seen a collection must have been struck with the great difference in shape, thickness, proportional length and breadth, colour, and size which beans present. What a contrast between a Windsor and Horse-bean! As in the case of the pea, our existing varieties were preceded during the Bronze age in

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[88] *See* Dr. Anderson to the same effect in the 'Bath Soc. Agricultural Papers,' vol. iv. p. 87.

[89] I have published full details of experiments on this subject in the 'Gardener's Chronicle,' 1857, Oct. 25.

[90] 'Gardener's Chronicle,' 1865, p. 387.

[91] 'Bonplandia,' x., 1862, s. 348.

Switzerland[92] by a peculiar and now extinct variety producing very small beans.[93]

Potato (*Solanum tuberosum*).—There is little doubt about the parentage of this plant; for the cultivated varieties differ extremely little in general appearance from the wild species, which can be recognised in its native land at the first glance.[94] The varieties cultivated in Britain are numerous; thus Lawson[95] gives a description of 175 kinds. I planted eighteen kinds in adjoining rows; their stems and leaves differed but little, and in several cases there was as great a difference between the individuals of the same variety as between the different varieties. The flower varied in size, and in colour between white and purple, but in no other respect, except that in one kind the sepals were somewhat elongated. One strange variety has been described which always produces two sorts of flowers, the first double and sterile, the second single and fertile.[96] The fruit or berries also differ, but only in a slight degree.[97] The varieties are liable in very different degree to the attack of the Colorado potato-beetle.[98]

The tubers, on the other hand, present a wonderful amount of diversity. This fact accords with the principle that the valuable and selected parts of all cultivated productions present the greatest amount of modification. They differ much in size and shape, being globular, oval, flattened, kidney-like, or cylindrical. One variety from Peru is described[99] as being quite straight, and at least six inches in length, though no thicker than a man's finger. The eyes or buds differ in form, position, and colour. The manner in which the tubers are arranged on the so-called roots or rhizomes is different; thus, in the *gurken-kartoffeln* they form a pyramid with the apex downwards, and in another variety they bury themselves deep in the ground. The roots themselves run either near the surface or deep in the ground. The tubers also differ in smoothness

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[92] Heer, 'Die Pflanzen der Pfahlauten,' 1866, s. 22.

[93] Mr. Bentham informs me that in Poitou and the adjoining parts of France, varieties of *Phaseolus vulgaris* are extremely numerous, and so different that they were described by Savi as distinct species. Mr. Bentham believes that all are descended from an unknown eastern species. Although the varieties differ so greatly in stature and in their seeds, "there is a remarkable sameness in the neglected characters of foliage and flowers, and especially in the bracteoles, an insignificant character in the eyes even of botanists."

[94] Darwin, 'Journal of Researches,' 1845, p. 285. Sabine, in 'Transact Hort. Soc.,' vol. v. p. 249.

[95] 'Synopsis of the Vegetable Products of Scotland,' quoted in Wilson's 'British Farming,' p. 317.

[96] Sir G. Mackenzie, in 'Gardener's Chronicle,' 1845, p. 790.

[97] Putsche und Vertuch, 'Versuch einer Monographie der Kartoffeln,' 1819, s. 9, 15. *See* also Dr. Anderson's 'Recreations in Agriculture,' vol. iv. p. 325.

[98] Walsh, 'The American Entomologist,' 1869, p. 160. Also S. Tenney, 'The American Naturalist,' May, 1871, p. 171.

[99] 'Gardener's Chronicle,' 1862, p. 1052.

and colour, being externally white, red, purple, or almost black, and internally white, yellow, or almost black. They differ in flavour and quality, being either waxy or mealy; in their period of maturity, and in their capacity for long preservation.

As with many other plants which have been long propagated by bulbs, tubers, cuttings, &c., by which means the same individual is exposed during a length of time to diversified conditions, seedling potatoes generally display innumerable slight differences. Several varieties, even when propagated by tubers, are far from constant, as will be seen in the chapter on Bud-variation. Dr. Anderson[100] procured seed from an Irish purple potato, which grew far from any other kind, so that it could not at least in this generation have been crossed, yet the many seedlings varied in almost every possible respect, so that "scarcely two plants were exactly alike." Some of the plants which closely resembled each other above ground, produced extremely dissimilar tubers; and some tubers which externally could hardly be distinguished, differed widely in quality when cooked. Even in this case of extreme variability, the parent-stock had some influence on the progeny, for the greater number of the seedlings resembled in some degree the parent Irish potato. Kidney potatoes must be ranked amongst the most highly cultivated and artificial races; nevertheless their peculiarities can often be strictly propagated by seed. A great authority, Mr. Rivers,[101] states that "seedlings from the ash-leaved kidney always bear a strong resemblance to their parent. Seedlings from the fluke-kidney are still more remarkable for their adherence to their parent stock, for, on closely observing a great number during two seasons, I have not been able to observe the least difference, either in earliness, productiveness, or in the size or shape of their tubers."

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[100] 'Bath Society Agricult. Papers,' vol. v. p. 127. And 'Recreations in Agriculture,' vol. v. p. 86.

[101] 'Gardener's Chronicle,' 1863, p. 643.