CHAPTER XV.

ON CROSSING.

FREE INTERCROSSING OBLITERATES THE DIFFERENCES BETWEEN ALLIED BREEDS—WHEN THE NUMBERS OF TWO COMMINGLING BREEDS ARE UNEQUAL, ONE ABSORBS THE OTHER—THE RATE OF ABSORPTION DETERMINED BY PREPOTENCY OF TRANSMISSION, BY THE CONDITIONS OF LIFE, AND BY NATURAL SELECTION—ALL ORGANIC BEINGS OCCASIONALLY INTERCROSS; APPARENT EXCEPTIONS—ON CERTAIN CHARACTERS INCAPABLE OF FUSION; CHIEFLY OR EXCLUSIVELY THOSE WHICH HAVE SUDDENLY APPEARED IN THE INDIVIDUAL—ON THE MODIFICATION OF OLD RACES, AND THE FORMATION OF NEW RACES, BY CROSSING—SOME CROSSED RACES HAVE BRED TRUE FROM THEIR FIRST PRODUCTION—ON THE CROSSING OF DISTINCT SPECIES IN RELATION TO THE FORMATION OF DOMESTIC RACES.

IN the two previous chapters, when discussing reversion and prepotency, I was necessarily led to give many facts on crossing. In the present chapter I shall consider the part which crossing plays in two opposed directions,—firstly, in obliterating characters, and consequently in preventing the formation of new races; and secondly, in the modification of old races, or in the formation of new and intermediate races, by a combination of characters. I shall also show that certain characters are incapable of fusion.

The effects of free or uncontrolled breeding between the members of the same variety or of closely allied varieties are important; but are so obvious that they need not be discussed at much length. It is free intercrossing which chiefly gives uniformity, both under nature and under domestication, to the individuals of the same species or variety, when they live mingled together and are not exposed to any cause inducing excessive variability. The prevention of free crossing, and the intentional matching of individual animals, are the corner-stones of the breeder's art. No man in his senses would expect to improve or modify a breed in any particular manner, or keep an old breed true and distinct, unless he

separated his animals. The killing of inferior animals in each generation comes to the same thing as their separation. In savage and semi-civilised countries, where the inhabitants have not the means of separating their animals, more than a single breed of the same species rarely or never exists. In former times, even in the United states, there were no distinct races of sheep, for all had been mingled together.[1] The celebrated agriculturist Marshall[2] remarks that "sheep that "are kept within fences, as well as shepherded flocks in open "countries, have generally a similarity, if not a uniformity, "of character in the individuals of each flock;" for they breed freely together, and are prevented from crossing with other kinds; whereas in the unenclosed parts of England the unshepherded sheep, even of the same flock, are far from true or uniform, owing to various breeds having mingled and crossed. We have seen that the half-wild cattle in each of the several British parks are nearly uniform in character; but in the different parks, from not having mingled and crossed during many generations, they differ to a certain small extent.

We cannot doubt that the extraordinary number of varieties and sub-varieties of the pigeon, amounting to at least one hundred and fifty, is partly due to their remaining, differently from other domesticated birds, paired for life once matched. On the other hand, breeds of cats imported into this country soon disappear, for their nocturnal and rambling habits render it hardly possible to prevent free crossing. Rengger[3] gives an interesting case with respect to the cat in Paraguay: in all the distant parts of the kingdom it has assumed, apparently from the effects of the climate, a peculiar character, but near the capital this change has been prevented, owing, as he asserts, to the native animal frequently crossing with cats imported from Europe. In all cases like the foregoing, the effects of an occasional cross will be augmented by the increased vigour and fertility of the crossed offspring, of which fact evidence will hereafter be given; for

[1] 'Communications to the Board of Agriculture,' vol. i. p. 367.

[2] 'Review of Reports, North of England,' 1808, p. 200.

[3] 'Säugethiere von Paraguay. 1830, s. 212.

this will lead to the mongrels increasing more rapidly than the pure parent-breeds.

When distinct breeds are allowed to cross freely, the result will be a heterogeneous body; for instance, the dogs in Paraguay are far from uniform, and can no longer be affiliated to their parent-races.[4] The character which a crossed body of animals will ultimately assume must depend on several contingencies,—namely, on the relative members of the individuals belonging to the two or more races which are allowed to mingle; on the prepotency of one race over the other in the transmission of character; and on the conditions of life to which they are exposed. When two commingled breeds exist at first in nearly equal numbers, the whole will sooner or later become intimately blended, but not so soon, both breeds being equally favoured in all respects, as might have been expected. The following calculation[5] shows that this is the case: if a colony with an equal number of black and white men were founded, and we assume that they marry indiscriminately, are equally prolific, and that one in thirty annually dies and is born; then "in 65 years the number of "blacks, whites, and mulattoes would be equal. In 91 years "the whites would be 1-10th, the blacks 1-10th, and the "mulattoes, or people of intermediate degrees of colour, "8-10ths of the whole number. In three centuries not "1-100th part of the whites would exist."

When one of two mingled races exceed the other greatly in number, the latter will soon be wholly, or almost wholly, absorbed and lost.[6] Thus European pigs and dogs have been largely introduced in the islands of the Pacific Ocean, and the native races have been absorbed and lost in the course of about fifty or sixty years;[7] but the imported races no doubt were favoured. Rats may be considered as semi-domesticated animals. Some snake-rats (*Mus alexandrinus*) escaped in the Zoological Gardens of London, "and for a long time after-

[4] Rengger, 'Säugethiere,' &c., s. 154.

[5] White, 'Regular Gradation in Man,' p. 146.

[6] Dr. W. F. Edwards, in his 'Caractères Physiolog. des Races Humaines,' p. 24, first called attention to this subject, and ably discussed it.

[7] Rev. D. Tyerman and Bennett, 'Journal of Voyages,' 1821–1829, vol. i. p. 300.

"wards the keepers frequently caught cross-bred rats, at "first half-breds, afterwards with less of the character of the "snake-rat, till at length all traces of it disappeared.[8] On the other hand, in some parts of London, especially near the docks, where fresh rats are frequently imported, an endless variety of intermediate forms may be found between the brown, black, and snake rat, which are all three usually ranked as distinct species.

How many generations are necessary for one species or race to absorb another by repeated crosses has often been discussed;[9] and the requisite number has probably been much exaggerated. Some writers have maintained that a dozen or score, or even more generations, are necessary; but this in itself is improbable, for in the tenth generation there would be only 1-1024th part of foreign blood in the offspring. Gärtner found,[10] that with plants, one species could be made to absorb another in from three to five generations, and he believes that this could always be effected in from six to seven generations. In one instance, however, Kölreuter[11] speaks of the offspring of *Mirabilis vulgaris*, crossed during eight successive generations by *M. longiflora*, as resembling this latter species so closely, that the most scrupulous observer could detect "vix aliquam notabilem differentiam" or, as he says, he succeeded, "ad plenariam fere transmutationem." But this expression shows that the act of absorption was not even then absolutely complete, though these crossed plants contained only the 1-256th part of *M. vulgaris*. The conclusions of such accurate observers as Gärtner and Kölreuter are of far higher worth than those made without scientific aim by breeders. The most precise account which I have met with is given by Stonehenge,[12] and is illustrated by photographs. Mr. Hanley crossed a greyhound bitch with a bulldog; the offspring in each succeeding generation being recrossed with first-rate greyhounds. As Stonehenge remarks,

[8] Mr. S. J. Salter, 'Journal Linn. Soc.,' vol. vi., 1862, p. 71.

[9] Sturm, 'Ueber Racen, &c.,' 1825, s. 107. Bronn, 'Geschichte der Natur,' b. ii. s. 170, gives a table of the proportions of blood after successive crosses. Dr. P. Lucas, 'L'Hérédité Nat.,' tom. ii. p. 308.

[10] 'Bastarderzeugung,' s. 463, 470.

[11] 'Nova Acta Petrop.,' 1794, p. 393: *see* also previous volume.

[12] 'The Dog,' 1867, pp. 179–184.

it might naturally be supposed that it would take several crosses to get rid of the heavy form of the bulldog; but Hysterics, the gr-gr-granddaughter of a bulldog, showed no trace whatever of this breed in external form. She and all of the same litter, however, were "remarkably deficient in "stoutness, though fast as well as clever." I believe clever refers to skill in turning. Hysterics was put to a son of Bedlamite, "but the result of the fifth cross is not as yet, I "believe, more satisfactory than that of the fourth." On the other hand, with sheep, Fleischmann [13] shows how persistent the effects of a single cross may be: he says "that the original "coarse sheep (of Germany) have 5500 fibres of wool on a "square inch; grades of the third or fourth Merino cross "produced about 8000, the twentieth cross 27,000, the per-"fect pure Merino blood 40,000 to 48,000." So that common German sheep crossed twenty times successively with Merino did not by any means acquire wool as fine as that of the pure breed. But in all cases, the rate of absorption will depend largely on the conditions of life being favourable to any particular character; and we may suspect that there would be a constant tendency to degeneration in the wool of Merinos under the climate of Germany, unless prevented by careful selection; and thus perhaps the foregoing remarkable case may be explained. The rate of absorption must also depend on the amount of distinguishable difference between the two forms which are crossed, and especially, as Gärtner insists, on prepotency of transmission in the one form over the other. We have seen in the last chapter that one of two French breeds of sheep yielded up its character, when crossed with Merinos, very much more slowly than the other; and the common German sheep referred to by Fleischmann may be in this respect analogous. In all cases there will be more or less liability to reversion during many subsequent generations, and it is this fact which has probably led authors to maintain that a score or more of generations are requisite for one race to absorb another. In considering the final result of the commingling of two or more breeds, we must not forget that

[13] As quoted in the 'True Principles of Breeding,' by C. H. Macknight and Dr. H. Madden, 1865, p. 11.

the act of crossing in itself tends to bring back long-lost characters not proper to the immediate parent-forms.

With respect to the influence of the conditions of life on any two breeds which are allowed to cross freely, unless both are indigenous and have long been accustomed to the country where they live, they will, in all probability, be unequally affected by the conditions, and this will modify the result. Even with indigenous breeds, it will rarely or never occur that both are equally well adapted to the surrounding circumstances; more especially when permitted to roam freely, and not carefully tended, as is generally the case with breeds allowed to cross. As a consequence of this, natural selection will to a certain extent come into action, and the best fitted will survive, and this will aid in determining the ultimate character of the commingled body.

How long a time it would require before such a crossed body of animals would assume a uniform character within a limited area, no one can say; that they would ultimately become uniform from free intercrossing, and from the survival of the fittest, we may feel assured; but the characters thus acquired would rarely or never, as may be inferred from the previous considerations, be exactly intermediate between those of the two parent-breeds. With respect to the very slight differences by which the individuals of the same sub-variety, or even of allied varieties, are characterised, it is obvious that free crossing would soon obliterate such small distinctions. The formation of new varieties, independently of selection, would also thus be prevented; except when the same variation continually recurred from the action of some strongly predisposing cause. We may therefore conclude that free crossing has in all cases played an important part in giving uniformity of character to all the members of the same domestic race and of the same natural species, though largely governed by natural selection and by the direct action of the surrounding conditions.

On the possibility of all organic beings occasionally intercrossing.—But it may be asked, can free crossing occur with hermaphrodite animals and plants? All the higher animals, and the few insects which have been domesticated, have separate

sexes, and must inevitably unite for each birth. With respect to the crossing of hermaphrodites, the subject is too large for the present volume, but in the 'Origin of Species,' I have given a short abstract of the reasons which induce me to believe that all organic beings occasionally cross, though perhaps in some cases only at long intervals of time.[14] I will merely recall the fact that many plants, though hermaphrodite in structure, are unisexual in function;—such as those called by C. K. Sprengel *dichogamous*, in which the pollen and stigma of the same flower are matured at different periods; or those called by me *reciprocally dimorphic*, in which the flower's own pollen is not fitted to fertilise its own stigma; or again, the many kinds in which curious mechanical contrivances exist, effectually preventing self-fertilisation. There are, however, many hermaphrodite plants which are not in any way specially constructed to favour intercrossing, but which nevertheless commingle almost as freely as animals with separated sexes. This is the case with cabbages, radishes, and onions, as I know from having experimented on them: even the peasants of Liguria say that cabbages must be prevented "from falling in love" with each other. In the orange tribe, Gallesio[15] remarks that the amelioration of the various kinds is checked by their continual and almost regular crossing. So it is with numerous other plants.

On the other hand, some cultivated plants rarely or never intercross, for instance, the common pea and sweet-pea (*Lathyrus odoratus*); yet their flowers are certainly adapted for cross fertilisation. The varieties of the tomato and aubergine (*Solanum*) and the pimenta (*Pimenta vulgaris?*) are said[16] never to cross, even when growing alongside one another. But it should be observed that these are all exotic plants, and we do not know how they would behave in their native country when visited by the proper insects. With

[14] With respect to plants, an admirable essay on this subject (Die Geschlechter-Vertheilung bei den Pflanzen: 1867) has been published by Dr. Hildebrand, who arrives at the same general conclusions as I have done. Various other treatises have since appeared on the same subject, more especially by Hermann Müller and Delpino.

[15] 'Teoria della Riproduzione Vegetal,' 1816, p. 12.

[16] Verlot, 'Des Variétés,' 1865, p. 72.

respect to the common pea, I have ascertained that it is rarely crossed in this country owing to premature fertilisation. There exist, however, some plants which under their natural conditions appear to be always self-fertilised, such as the Bee Ophrys (*Ophrys apifera*) and a few other Orchids; yet these plants exhibit the plainest adaptations for cross-fertilisation. Again, some few plants are believed to produce only closed flowers, called cleistogene, which cannot possibly be crossed. This was long thought to be the case with the *Leersia oryzoides*,[17] but this grass is now known occasionally to produce perfect flowers, which set seed.

Although some plants, both indigenous and naturalised, rarely or never produce flowers, or if they flower never produce seeds, yet no one doubts that phanerogamic plants are adapted to produce flowers, and the flowers to produce seed. When they fail, we believe that such plants under different conditions would perform their proper function, or that they formerly did so, and will do so again. On analogous grounds, I believe that the flowers in the above specified anomalous cases which do not now intercross, either would do so occasionally under different conditions, or that they formerly did so—the means for affecting this being generally still retained—and will again intercross at some future period, unless indeed they become extinct. On this view alone, many points in the structure and action of the reproductive organs in hermaphrodite plants and animals are intelligible,—for instance, the fact of the male and female organs never being so completely enclosed as to render access from without impossible. Hence we may conclude that the most important of all the means for giving uniformity to the individuals of the same species, namely, the capacity of occasionally intercrossing, is present, or has been formerly present, with all organic beings, except, perhaps, some of the lowest.

On certain Characters not blending.—When two breeds are crossed their characters usually become intimately fused together; but

[17] Duval Jouve, 'Bull. Soc. Bot. de France,' tom. x., 1863, p. 194. With respect to the perfect flowers setting seed, see Dr. Ascherson in 'Bot. Zeitung,' 1864, p. 350.

some characters refuse to blend, and are transmitted in an unmodified state either from both parents or from one. When grey and white mice are paired, the young are piebald, or pure white or grey, but not of an intermediate tint; so it is when white and common collared turtle-doves are paired. In breeding Game fowls, a great authority, Mr. J. Douglas, remarks, "I may here state a "strange fact: if you cross a black with a white game, you get "birds of both breeds of the clearest colour." Sir R. Heron crossed during many years white, black, brown, and fawn-coloured Angora rabbits, and never once got these colours mingled in the same animal, but often all four colours in the same litter.[18] From cases like these, in which the colours of the two parents are transmitted quite separately to the offspring, we have all sorts of gradations, leading to complete fusion. I will give an instance: a gentleman with a fair complexion, light hair but dark eyes, married a lady with dark hair and complexion: their three children have very light hair, but on careful search about a dozen black hairs were found scattered in the midst of the light hair on the heads of all three.

When turnspit dogs and ancon sheep, both of which have dwarfed limbs, are crossed with common breeds, the offspring are not intermediate in structure, but take after either parent. When tailless or hornless animals are crossed with perfect animals, it frequently, but by no means invariably, happens that the offspring are either furnished with these organs in a perfect state, or are quite destitute of them. According to Rengger, the hairless condition of the Paraguay dog is either perfectly or not at all transmitted to its mongrel offspring; but I have seen one partial exception in a dog of this parentage which had part of its skin hairy, and part naked, the parts being distinctly separated as in a piebald animal. When Dorking fowls with five toes are crossed with other breeds, the chickens often have five toes on one foot and four on the other. Some crossed pigs raised by Sir R. Heron between the solid-hoofed and common pig had not all four feet in an intermediate condition, but two feet were furnished with properly divided, and two with united hoofs.

Analogous facts have been observed with plants: Major Trevor

[18] Extract of a letter from Sir R. Heron, 1838, given me by Mr. Yarrell. With respect to mice, *see* 'Annal. des Sc. Nat.,' tom. i. p. 180; and I have heard of other similar cases. For turtle-doves, Boitard and Corbié, 'Les Pigeons,' &c., p. 238. For the Game fowl, 'The Poultry Book,' 1866, p. 128. For crosses of tailless fowls, *see* Bechstein, 'Naturges. Deutsch.' b. iii. s. 403. Bronn, 'Geschichte der Natur,' b. ii. s. 170, gives analogous facts with horses. On the hairless condition of crossed South American dogs, *see* Rengger, 'Säugethiere von Paraguay,' s. 152: but I saw in the Zoological Gardens mongrels, from a similar cross, which were hairless, quite hairy, or hairy in patches, that is, piebald with hair. For crosses of Dorking and other fowls, *see* 'Poultry Chronicle,' vol. ii. p. 355. About the crossed pigs, extract of letter from Sir R. Heron to Mr. Yarrell. For other cases, *see* P. Lucas, 'L'Héréd. Nat.' tom. i. p. 212.

Clarke crossed the little, glabrous-leaved, annual stock (*Mathiola*), with pollen of a large, red-flowered, rough-leaved, biennial stock, called *cocardeau* by the French, and the result was that half the seedlings had glabrous and the other half rough leaves, but none had leaves in an intermediate state. That the glabrous seedlings were the product of the rough-leaved variety, and not accidentally of the mother-plant's own pollen, was shown by their tall and strong habit of growth.[19] In the succeeding generations raised from the rough-leaved crossed seedlings, some glabrous plants appeared, showing that the glabrous character, though incapable of blending with and modifying the rough leaves, was all the time latent in this family of plants. The numerous plants formerly referred to, which I raised from reciprocal crosses between the peloric and common Antirrhinum, offer a nearly parallel case; for in the first generation all the plants resembled the common form, and in the next generation, out of one hundred and thirty-seven plants, two alone were in an intermediate condition, the others perfectly resembling either the peloric or common form. Major Trevor Clarke also fertilised the above-mentioned red-flowered stock with pollen from the purple Queen stock, and about half the seedlings scarcely differed in habit, and not at all in the red colour of the flower, from the mother-plant, the other half bearing blossoms of a rich purple, closely like those of the paternal plant. Gärtner crossed many white and yellow-flowered species and varieties of Verbascum; and these colours were never blended, but the offspring bore either pure white or pure yellow blossoms; the former in the larger proportion.[20] Dr. Herbert raised many seedlings, as he informed me, from Swedish turnips crossed by two other varieties, and these never produced flowers of an intermediate tint, but always like one of their parents. I fertilised the purple sweet-pea (*Lathyrus odoratus*), which has a dark reddish-purple standard-petal and violet-coloured wings and keel, with pollen of the painted lady sweet-pea, which has a pale cherry-coloured standard, and almost white wings and keel; and from the same pod I twice raised plants perfectly resembling both sorts; the greater number resembling the father. So perfect was the resemblance, that I should have thought there had been some mistake, if the plants which were at first identical with the paternal variety, namely, the painted-lady, had not later in the season produced, as mentioned in a former chapter, flowers blotched and streaked with dark purple. I raised grandchildren and great-grandchildren from these crossed plants, and they continued to resemble the painted-lady, but during later generations became rather more blotched with purple, yet none reverted completely to the original mother-plant, the purple

[19] 'Internat. Hort. and Bot. Congress of London,' 1866.

[20] 'Bastarderzeugung,' s. 307. Kölreuter ('Dritte Fortsetszung,' s. 34, 39), however, obtained intermediate tints from similar crosses in the genus Verbascum. With respect to the turnips, *see* Herbert's 'Amaryllidaceæ,' 1837, p. 370.

sweet-pea. The following case is slightly different, but still shows the same principle: Naudin[21] raised numerous hybrids between the yellow *Linaria vulgaris* and the purple *L. purpurea*, and during three successive generations the colours kept distinct in different parts of the same flower.

From cases such as the foregoing, in which the offspring of the first generation perfectly resemble either parent, we come by a small step to those cases in which differently coloured flowers borne on the same root resemble both parents, and by another step to those in which the same flower or fruit is striped or blotched with the two parental colours, or bears a single stripe of the colour or other characteristic quality of one of the parent-forms. With hybrids and mongrels it frequently or even generally happens that one part of the body resembles more or less closely one parent and another part the other parent; and here again some resistence to fusion, or, what comes to the same thing, some mutual affinity between the organic atoms of the same nature, apparently comes into play, for otherwise all parts of the body would be equally intermediate in character. So again, when the offspring of hybrids or mongrels, which are themselves nearly intermediate in character, revert either wholly or by segments to their ancestors, the principle of the affinity of similar, or the repulsion of dissimilar atoms, must come into action. To this principle, which seems to be extremely general, we shall recur in the chapter on pangenesis.

It is remarkable, as has been strongly insisted upon by Isidore Geoffroy St. Hilaire in regard to animals, that the transmission of characters without fusion occurs very rarely when species are crossed; I know of one exception alone, namely, with the hybrids naturally produced between the common and hooded crow (*Corvus corone* and *cornix*), which, however, are closely allied species, differing in nothing except colour. Nor have I met with any well-ascertained cases of transmission of this kind, even when one form is strongly prepotent over another, when two races are crossed which have been slowly formed by man's selection, and therefore resemble to a certain extent natural species. Such cases as puppies in the same litter closely resembling two distinct breeds, are probably due to superfœtation,—that is, to the influence of two fathers. All the characters above enumerated, which are transmitted in a perfect state to some of the offspring and not to others, —such as distinct colours, nakedness of skin, smoothness of leaves, absence of horns or tail, additional toes, pelorism, dwarfed structure, &c.,—have all been known to appear suddenly in individual animals and plants. From this fact, and from the several slight, aggregated differences which distinguish domestic races and species from one another, not being liable to this peculiar form of transmission, we may conclude that it is in some way connected with the sudden appearance of the characters in question.

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[21] 'Nouvelles Archives du Muséum,' tom. i. p. 100.

On the Modification of old Races and the Formation of new Races by Crossing.—We have hitherto chiefly considered the effects of crossing in giving uniformity of character; we must now look to an opposite result. There can be no doubt that crossing, with the aid of rigorous selection during several generations, has been a potent means in modifying old races, and in forming new ones. Lord Orford crossed his famous stud of greyhounds once with the bulldog, in order to give them courage and perseverance. Certain pointers have been crossed, as I hear from the Rev. W. D. Fox, with the foxhound, to give them dash and speed. Certain strains of Dorking fowls have had a slight infusion of Game blood; and I have known a great fancier who on a single occasion crossed his turbit-pigeons with barbs, for the sake of gaining greater breadth of beak.

In the foregoing cases breeds have been crossed once, for the sake of modifying some particular character; but with most of the improved races of the pig, which now breed true, there have been repeated crosses,—for instance, the improved Essex owes its excellence to repeated crosses with the Neapolitan, together probably with some infusion of Chinese blood.[22] So with our British sheep: almost all the races, except the Southdown, have been largely crossed; "this, in fact, has been the history of our principal breeds."[23] To give an example, the "Oxfordshire Downs" now rank as an established breed.[24] They were produced about the year 1830 by crossing "Hampshire and in some instances Southdown ewes with Cotswold rams:" now the Hampshire ram was itself produced by repeated crosses between the native Hampshire sheep and Southdowns; and the long-woolled Cotswold were improved by crosses with the Leicester, which latter again is believed to have been a cross between several long-woolled sheep. Mr. Spooner, after considering the various cases

[22] Richardson, 'Pigs,' 1847, pp. 37, 42; S. Sidney's edition of 'Youatt on the Pig,' 1860, p. 3.

[23] *See* Mr. W. C. Spooner's excellent paper on Cross-Breeding, 'Journal Royal Agricult. Soc.,' vol. xx., part ii.: *see* also an equally good article by Mr. Ch. Howard, in 'Gardener's Chronicle,' 1860, p. 320.

[24] 'Gardener's Chronicle,' 1857, pp. 649, 652.

which have been carefully recorded, concludes, "that from a judicious pairing of cross-bred animals it is practicable to establish a new breed." On the continent the history of several crossed races of cattle and of other animals has been well ascertained. To give one instance: the King of Wurtemburg, after twenty-five years' careful breeding, that is, after six or seven generations, made a new breed of cattle from a cross between a Dutch and a Swiss breed, combined with other breeds.[25] The Sebright bantam, which breeds as true as any other kind of fowl, was formed about sixty years ago by a complicated cross.[26] Dark Brahmas, which are believed by some fanciers to constitute a distinct species, were undoubtedly formed[27] in the United States, within a recent period, by a cross between Chittagongs and Cochins. With plants there is little doubt that the Swede-turnip originated from a cross; and the history of a variety of wheat, raised from two very distinct varieties, and which after six years' culture presented an even sample, has been recorded on good authority.[28]

Until lately, cautious and experienced breeders, though not averse to a single infusion of foreign blood, were almost universally convinced that the attempt to establish a new race, intermediate between two widely distinct races, was hopeless: "they clung with superstitious tenacity to the "doctrine of purity of blood, believing it to be the ark in "which alone true safety could be found."[29] Nor was this conviction unreasonable: when two distinct races are crossed, the offspring of the first generation are generally nearly uniform in character; but even this sometimes fails to be the case, especially with crossed dogs and fowls, the young of which from the first are sometimes much diversified. As cross-bred animals are generally of large size and vigorous, they have been raised in great numbers for immediate consumption. But for breeding they are found utterly useless;

[25] 'Bulletin de la Soc. d'Acclimat.,' 1862, tom. ix. p. 463. *See* also, for other cases, MM. Moll and Gayot, 'Du Bœuf,' 1860, p. xxxii.

[26] 'Poultry Chronicle,' vol. ii., 1854, p. 36.

[27] 'The Poultry Book,' by W. B. Tegetmeier, 1866, p. 58.

[28] 'Gardener's Chronicle,' 1852, p. 765.

[29] Spooner, in 'Journal Royal Agricult. Soc.,' vol. xx., part ii.

for though they may themselves be uniform in character, they yield during many generations astonishingly diversified offspring. The breeder is driven to despair, and concludes that he will never form an intermediate race. But from the cases already given, and from others which have been recorded, it appears that patience alone is necessary; as Mr. Spooner remarks, "nature opposes no barrier to successful admixture; in the course of time, by the aid of selection and careful weeding, it is practicable to establish a new breed." After six or seven generations the hoped-for result will in most cases be obtained; but even then an occasional reversion, or failure to keep true, may be expected. The attempt, however, will assuredly fail if the conditions of life be decidedly unfavourable to the characters of either parent-breed.[30]

Although the grandchildren and succeeding generations of cross-bred animals are generally variable in an extreme degree, some curious exceptions to the rule have been observed both with crossed races and species. Thus Boitard and Corbié [31] assert that from a Pouter and a Runt "a Cavalier will appear, which we have classed amongst pigeons of pure race, because it transmits all its qualities to its posterity." The editor of the 'Poultry Chronicle' [32] bred some bluish fowls from a black Spanish cock and a Malay hen; and these remained true to colour "generation after generation." The Himalayan breed of rabbits was certainly formed by crossing two sub-varieties of the silver-grey rabbit; although it suddenly assumed its present character, which differs much from that of either parent-breed, yet it has ever since been easily and truly propagated. I crossed some Labrador and Penguin ducks, and recrossed the mongrels with Penguins; afterwards most of the ducks reared during three generations were nearly uniform in character, being brown with a white crescentic mark on the lower part of the breast, and with some white spots at the base of the beak; so that by the aid of a little selection a new breed might easily have been formed. With

[30] *See* Colin's 'Traité de Phys. Comp. des Animaux Domestiques,' tom. ii. p. 536, where this subject is well treated.

[31] 'Les Pigeons,' p. 37.

[32] Vol. i., 1854, p. 101.

regard to crossed varieties of plants, Mr. Beaton remarks[33] that "Melville's extraordinary cross between the Scotch kale and an early cabbage is as true and genuine as any on record;" but in this case no doubt selection was practised. Gärtner[34] has given five cases of hybrids, in which the progeny kept constant; and hybrids between *Dianthus armeria* and *deltoides* remained true and uniform to the tenth generation. Dr. Herbert likewise showed me a hybrid from two species of Loasa which from its first production had kept constant during several generations.

We have seen in the first chapter, that the several kinds of dogs are almost certainly descended from more than one species, and so it is with cattle, pigs and some other domesticated animals. Hence the crossing of aboriginally distinct species probably came into play at an early period in the formation of our present races. From Rütimeyer's observations there can be little doubt that this occurred with cattle; but in most cases one form will probably have absorbed and obliterated the other, for it is not likely that semi-civilized men would have taken the necessary pains to modify by selection their commingled, crossed, and fluctuating stock. Nevertheless, those animals which were best adapted to their conditions of life would have survived through natural selection; and by this means crossing will often have indirectly aided in the formation of primeval domesticated breeds. Within recent times, as far as animals are concerned, the crossing of distinct species has done little or nothing towards the formation or modification of our races. It is not yet known whether the several species of silk-moth which have been recently crossed in France will yield permanent races. With plants which can be multiplied by buds and cuttings, hybridisation has done wonders, as with many kinds of Roses, Rhododendrons, Pelargoniums, Calceolarias, and Petunias. Nearly all these plants can be propagated by seed, most of them freely; but extremely few or none come true by seed.

Some authors believe that crossing is the chief cause of variability,—that is, of the appearance of absolutely new

[33] 'Cottage Gardener,' 1856, p. 110.

[34] 'Bastarderzegung,' s. 553.

characters. Some have gone so far as to look at it as the sole cause; but this conclusion is disproved by the facts given in the chapter on Bud-variation. The belief that characters not present in either parent or in their ancestors frequently originate from crossing is doubtful; that they occasionally do so is probable; but this subject will be more conveniently discussed in a future chapter on the causes of Variability.

A condensed summary of this and of the three following chapters, together with some remarks on Hybridism, will be given in the nineteenth chapter.