

CHAPTER XXV.

LAWS OF VARIATION, *continued* — CORRELATED VARIABILITY.

EXPLANATION OF TERM CORRELATION—CONNECTED WITH DEVELOPMENT—MODIFICATIONS CORRELATED WITH THE INCREASED OR DECREASED SIZE OF PARTS—CORRELATED VARIATION OF HOMOLOGOUS PARTS—FEATHERED FEET IN BIRDS ASSUMING THE STRUCTURE OF THE WINGS—CORRELATION BETWEEN THE HEAD AND THE EXTREMITIES—BETWEEN THE SKIN AND DERMAL APPENDAGES—BETWEEN THE ORGANS OF SIGHT AND HEARING—CORRELATED MODIFICATIONS IN THE ORGANS OF PLANTS—CORRELATED MONSTROSITIES—CORRELATION BETWEEN THE SKULL AND EARS—SKULL AND CREST OF FEATHERS—SKULL AND HORNS—CORRELATION OF GROWTH COMPLICATED BY THE ACCUMULATED EFFECTS OF NATURAL SELECTION—COLOUR AS CORRELATED WITH CONSTITUTIONAL PECULIARITIES.

ALL parts of the organisation are to a certain extent connected together; but the connection may be so slight that it hardly exists, as with compound animals or the buds on the same tree. Even in the higher animals various parts are not at all closely related; for one part may be wholly suppressed or rendered monstrous without any other part of the body being affected. But in some cases, when one part varies, certain other parts always, or nearly always, simultaneously vary; they are then subject to the law of correlated variation. The whole body is admirably co-ordinated for the peculiar habits of life of each organic being, and may be said, as the Duke of Argyll insists in his 'Reign of Law,' to be correlated for this purpose. Again, in large groups of animals certain structures always co-exist: for instance, a peculiar form of stomach with teeth of peculiar form, and such structures may in one sense be said to be correlated. But these cases have no necessary connection with the law to be discussed in the present chapter; for we do not know that the initial or primary variations of the several parts were in any way related: slight modifications or individual differences may have been preserved, first in one and then in another part, until the final and perfectly co-adapted structure was

acquired ; but to this subject I shall presently recur. Again, in many groups of animals the males alone are furnished with weapons, or are ornamented with gay colours ; and these characters manifestly stand in some sort of correlation with the male reproductive organs, for when the latter are destroyed these characters disappear. But it was shown in the twelfth chapter that the very same peculiarity may become attached at any age to either sex, and afterwards be exclusively transmitted to the same sex at a corresponding age. In these cases we have inheritance limited by both sex and age ; but we have no reason for supposing that the original cause of the variation was necessarily connected with the reproductive organs, or with the age of the affected being.

In cases of true correlated variation, we are sometimes able to see the nature of the connection ; but in most cases it is hidden from us, and certainly differs in different cases. We can seldom say which of two correlated parts first varies, and induces a change in the other ; or whether the two are the effects of some common cause. Correlated variation is an important subject for us ; for when one part is modified through continued selection, either by man or under nature, other parts of the organisation will be unavoidably modified. From this correlation it apparently follows that with our domesticated animals and plants, varieties rarely or never differ from one another by a single character alone.

One of the simplest cases of correlation is that a modification which arises during an early stage of growth tends to influence the subsequent development of the same part, as well as of other and intimately connected parts. Isidore Geoffroy Saint-Hilaire states¹ that this may constantly be observed with monstrosities in the animal kingdom ; and Moquin-Tandon² remarks, that, as with plants the axis cannot become monstrous without in some way affecting the organs subsequently produced from it, so axial anomalies are almost always

¹ 'Hist. des Anomalies,' tom. iii. p. 392. Prof. Huxley applies the same principle in accounting for the remarkable, though normal, differences in the arrangement of the nervous system in the Mollusca, in his paper

on the Morphology of the Cephalous Mollusca, in 'Phil. Transact.,' 1853, p. 56.

² 'Éléments de Tératologie Vég., 1841, p. 13.

accompanied by deviations of structure in the appended parts. We shall presently see that with short-muzzled races of the dog certain histological changes in the basal elements of the bones arrest their development and shorten them, and this affects the position of the subsequently developed molar teeth. It is probable that certain modifications in the larvæ of insects would affect the structure of the mature insects. But we must be careful not to extend this view too far, for during the normal course of development, certain species pass through an extraordinary course of change, whilst other and closely allied species arrive at maturity with little change of structure.

Another simple case of correlation is that with the increased or decreased dimensions of the whole body, or of any particular part, certain organs are increased or diminished in number, or are otherwise modified. Thus pigeon-fanciers have gone on selecting pouters for length of body, and we have seen that their vertebræ are generally increased not only in size but in number, and their ribs in breadth. Tumblers have been selected for their small bodies, and their ribs and primary wing-feathers are generally lessened in number. Fantails have been selected for their large widely-expanded tails, with numerous tail-feathers, and the caudal vertebræ are increased in size and number. Carriers have been selected for length of beak, and their tongues have become longer, but not in strict accordance with the length of beak. In this latter breed and in others having large feet, the number of the scutellæ on the toes is greater than in the breeds with small feet. Many similar cases could be given. In Germany it has been observed that the period of gestation is longer in large than in small breeds of cattle. With our highly-improved breeds of all kinds, the periods of maturity and of reproduction have advanced with respect to the age of the animal; and, in correspondence with this, the teeth are now developed earlier than formerly, so that, to the surprise of agriculturists, the ancient rules for judging of the age of an animal by the state of its teeth are no longer trustworthy.³

³ Prof. J. B. Simonds, on the Age of the Ox, Sheep, &c., quoted in 'Gard. Chronicle,' 1854, p. 588.

Correlated Variation of Homologous Parts.—Parts which are homologous tend to vary in the same manner; and this is what might have been expected, for such parts are identical in form and structure during an early period of embryonic development, and are exposed in the egg or womb to similar conditions. The symmetry, in most kinds of animals, of the corresponding or homologous organs on the right and left sides of the body, is the simplest case in point; but this symmetry sometimes fails, as with rabbits having only one ear, or stags with one horn, or with many-horned sheep which sometimes carry an additional horn on one side of their heads. With flowers which have regular corollas, all the petals generally vary in the same manner, as we see in the complicated and symmetrical pattern, on the flowers, for instance, of the Chinese pink; but with irregular flowers, though the petals are of course homologous, this symmetry often fails, as with the varieties of the *Antirrhinum* or snapdragon, or that variety of the kidney-bean (*Phaseolus*) which has a white standard-petal.

In the Vertebrata the front and hind limbs are homologous, and they tend to vary in the same manner, as we see in long and short legged, or in thick and thin legged races of the horse and dog. Isidore Geoffroy⁴ has remarked on the tendency of supernumerary digits in man to appear, not only on the right and left sides, but on the upper and lower extremities. Meckel has insisted⁵ that, when the muscles of the arm depart in number or arrangement from their proper type, they almost always imitate those of the leg; and so conversely the varying muscles of the leg imitate the normal muscles of the arm.

In several distinct breeds of the pigeon and fowl, the legs and the two outer toes are heavily feathered, so that in the trumpeter pigeon they appear like little wings. In the feather-legged bantam the "boots" or feathers, which grow from the outside of the leg and generally from the two outer toes, have, according to the excellent authority of Mr. Hewitt,⁶

⁴ 'Hist. des Anomalies,' tom. i. p. 674. tom. i. p. 635.

⁶ 'The Poultry Book,' by W. B.

⁵ Quoted by Isid. Geoffroy, *ibid.*, Tegetmeier, 1866, p. 250.

been seen to exceed the wing-feathers in length, and in one case were actually nine and a half inches long! As Mr. Blyth has remarked to me, these leg-feathers resemble the primary wing-feathers, and are totally unlike the fine down which naturally grows on the legs of some birds, such as grouse and owls. Hence it may be suspected that excess of food has first given redundancy to the plumage, and then that the law of homologous variation has led to the development of feathers on the legs, in a position corresponding with those on the wing, namely, on the outside of the tarsi and toes. I am strengthened in this belief by the following curious case of correlation, which for a long time seemed to me utterly inexplicable, namely, that in pigeons of any breed, if the legs are feathered, the two outer toes are partially connected by skin. These two outer toes correspond with our third and fourth toes.⁷ Now, in the wing of the pigeon or of any other bird, the first and fifth digits are aborted; the second is rudimentary and carries the so-called "bastard-wing;" whilst the third and fourth digits are completely united and enclosed by skin, together forming the extremity of the wing. So that in feather-footed pigeons, not only does the exterior surface support a row of long feathers, like wing-feathers, but the very same digits which in the wing are completely united by skin become partially united by skin in the feet; and thus by the law of the correlated variation of homologous parts we can understand the curious connection of feathered legs and membrane between the two outer toes.

Andrew Knight⁸ has remarked that the face or head and the limbs usually vary together in general proportions. Compare, for instance, the limbs of a dray and race horse, or of a greyhound and mastiff. What a monster a greyhound would appear with the head of a mastiff! The modern bulldog, however, has fine limbs, but this is a recently-selected character. From the measurements given in the sixth

⁷ Naturalists differ with respect to the homologies of the digits of birds; but several uphold the view above advanced. See on this subject Dr. E. S. Morse in 'Annals of the

Lyceum of Nat. Hist. of New York,' vol. x., 1872, p. 16.

⁸ A. Walker on Intermarriage, 1838, p. 160.

chapter, we see that in several breeds of the pigeon the length of the beak and the size of the feet are correlated. The view which, as before explained, seems the most probable is, that disuse in all cases tends to diminish the feet, the beak becoming at the same time shorter through correlation; but that in some few breeds in which length of beak has been a selected point, the feet, notwithstanding disuse, have increased in size through correlation. In the following case some kind of correlation is seen to exist between the feet and beak: several specimens have been sent to Mr. Bartlett at different times, as hybrids between ducks and fowls, and I have seen one; these were, as might be expected, ordinary ducks in a semi-monstrous condition, and in all of them the swimming-web between the toes was quite deficient or much reduced, and in all the beak was narrow and ill-shaped.

With the increased length of the beak in pigeons, not only the tongue increases in length, but likewise the orifice of the nostrils. But the increased length of the orifice of the nostrils perhaps stands in closer correlation with the development of the corrugated skin or wattle at the base of the beak, for when there is much wattle round the eyes, the eyelids are greatly increased or even doubled in length.

There is apparently some correlation even in colour between the head and the extremities. Thus with horses a large white star or blaze on the forehead is generally accompanied by white feet.⁹ With white rabbits and cattle, dark marks often co-exist on the tips of the ears and on the feet. In black and tan dogs of different breeds, tan-coloured spots over the eyes and tan-coloured feet almost invariably go together. These latter cases of connected colouring may be due either to reversion or to analogous variation,—subjects to which I shall hereafter return,—but this does not necessarily determine the question of their original correlation. Mr. H. W. Jackson informs me that he has observed many hundred white-footed cats, and he finds that all are more or less conspicuously marked with white on the front of the neck or chest.

⁹ 'The Farrier and Naturalist,' vol. i., 1828, p. 456. A gentleman who has attended to this point, tells

me that about three-fourths of white-faced horses have white legs.

The lopping forwards and downwards of the immense ears of fancy rabbits seems partly due to the disuse of the muscles, and partly to the weight and length of the ears, which have been increased by selection during many generations. Now, with the increased size and changed direction of the ears not only has the bony auditory meatus become changed in outline, direction, and greatly in size, but the whole skull has been slightly modified. This could be clearly seen in "half-lops"—that is, in rabbits with only one ear lopping forward—for the opposite sides of their skulls were not strictly symmetrical. This seems to me a curious instance of correlation, between hard bones and organs so soft and flexible, as well as so unimportant under a physiological point of view, as the external ears. The result no doubt is largely due to mere mechanical action, that is, to the weight of the ears, on the same principle that the skull of a human infant is easily modified by pressure.

The skin and the appendages of hair, feathers, hoofs, horns, and teeth, are homologous over the whole body. Every one knows that the colour of the skin and that of the hair usually vary together; so that Virgil advises the shepherd to look whether the mouth and tongue of the ram are black, lest the lambs should not be purely white. The colour of the skin and hair, and the odour emitted by the glands of the skin, are said¹⁰ to be connected, even in the same race of men. Generally the hair varies in the same way all over the body in length, fineness, and curliness. The same rule holds good with feathers, as we see with the laced and frizzled breeds both of fowls and pigeons. In the common cock the feathers on the neck and loins are always of a particular shape, called hackles: now in the Polish breed, both sexes are characterised by a tuft of feathers on the head, and through correlation these feathers in the male always assume the form of hackles. The wing and tail-feathers, though arising from parts not homologous, vary in length together; so that long or short winged pigeons generally have long or short tails. The case of the Jacobin-pigeon is more curious, for the wing and tail feathers are remarkably long; and this apparently has arisen

¹⁰ Godron, 'Sur l'Espèce,' tom. ii. p. 217.

in correlation with the elongated and reversed feathers on the back of the neck, which form the hood.

The hoofs and hair are homologous appendages; and a careful observer, namely Azara,¹¹ states that in Paraguay horses of various colours are often born with their hair curled and twisted like that on the head of a negro. This peculiarity is strongly inherited. But what is remarkable is that the hoofs of these horses "are absolutely like those of a mule." The hair also of their manes and tails is invariably much shorter than usual, being only from four to twelve inches in length; so that curliness and shortness of the hair are here, as with the negro, apparently correlated.

With respect to the horns of sheep, Youatt¹² remarks that "multiplicity of horns is not found in any breed of much value; "it is generally accompanied by great length and coarseness "of the fleece." Several tropical breeds of sheep which are clothed with hair instead of wool, have horns almost like those of a goat. Sturm¹³ expressly declares that in different races the more the wool is curled the more the horns are spirally twisted. We have seen in the third chapter, where other analogous facts have been given, that the parent of the Mauchamp breed, so famous for its fleece, had peculiarly shaped horns. The inhabitants of Angora assert¹⁴ that "only "the white goats which have horns wear the fleece in the "long curly locks that are so much admired; those which "are not horned having a comparatively close coat." From these cases we may infer that the hair or wool and the horns tend to vary in a correlated manner.¹⁵ Those who have tried hydropathy are aware that the frequent application of cold water stimulates the skin; and whatever stimulates the skin

¹¹ 'Quadrupèdes du Paraguay,' tom. ii. p. 333.

¹² On Sheep, p. 142.

¹³ 'Ueber Racen, Kreuzungen,' &c., 1825, s. 24.

¹⁴ Quoted from Conolly, in 'The Indian Field,' Feb. 1859, vol. ii. p. 266.

¹⁵ In the third chapter I have said that "the hair and horns are so closely related to each other, that they are

apt to vary together." Dr. Wilckens ("Darwin's Theorie," 'Jahrbuch der Deutschen Viehzucht,' 1866, 1. Heft) translates my words into "lang- und grobhaarige Thiere sollen geneigter sein, lange und viele Hörner zu bekommen," and he then justly disputes this proposition; but what I have really said, in accordance with the authorities just quoted, may, I think, be trusted.

tends to increase the growth of the hair, as is well shown in the abnormal growth of hair near old inflamed surfaces. Now, Professor Low¹⁶ is convinced that with the different races of British cattle thick skin and long hair depend on the humidity of the climate which they inhabit. We can thus see how a humid climate might act on the horns—in the first place directly on the skin and hair, and secondly by correlation on the horns. The presence or absence of horns, moreover, both in the case of sheep and cattle, acts, as will presently be shown, by some sort of correlation on the skull.

With respect to hair and teeth, Mr. Yarrell¹⁷ found many of the teeth deficient in three hairless "Egyptian dogs," and in a hairless terrier. The incisors, canines, and the premolars suffered most, but in one case all the teeth, except the large tubercular molar on each side, were deficient. With many several striking cases have been recorded¹⁸ of inherited baldness with inherited deficiency, either complete or partial, of the teeth. I may give an analogous case, communicated to me by Mr. W. Wedderburn, of a Hindoo family in Scinde, in which ten men, in the course of four generations, were furnished, in both jaws taken together, with only four small and weak incisor teeth and with eight posterior molars. The men thus affected have very little hair on the body, and become bald early in life. They also suffer much during hot weather from excessive dryness of the skin. It is remarkable that no instance has occurred of a daughter being thus affected; and this fact reminds us how much more liable men are in England to become bald than women. Though the daughters in the above family are never affected, they transmit the tendency to their sons; and no case has occurred of a son transmitting it to his sons. The affection thus appears only in alternate generations, or after longer intervals. There is a similar connection between hair and teeth, according to Mr. Sedgwick,

¹⁶ 'Domesticated Animals of the British Islands,' pp. 307, 368. Dr. Wilckens argues ('Landwirth. Wochenblatt,' Nr. 10, 1869) to the same effect with respect to domestic animals in Germany.

¹⁷ 'Proceedings Zoolog. Soc.,' 1833 p. 113.

¹⁸ Sedgwick, 'Brit. and Foreign Medico-Chirurg. Review,' April, 1863, p. 453.

in those rare cases in which the hair has been renewed in old age, for this has "usually been accompanied by a renewal of the teeth." I have remarked in a former part of this volume that the great reduction in the size of the tusks in domestic boars probably stands in close relation with their diminished bristles, due to a certain amount of protection; and that the reappearance of the tusks in boars, which have become feral and are fully exposed to the weather, probably depends on the reappearance of the bristles. I may add, though not strictly connected with our present point, that an agriculturist¹⁹ asserts that "pigs with little hair on their bodies are most liable to lose their tails, showing a weakness of the tegumental structure. It may be prevented by crossing with a more hairy breed."

In the previous cases deficient hair, and teeth deficient in number or size, are apparently connected. In the following cases abnormally redundant hair, and teeth either deficient or redundant, are likewise connected. Mr. Crawford²⁰ saw at the Burmese Court a man, thirty years old, with his whole body, except the hands and feet, covered with straight silky hair, which on the shoulders and spine was five inches in length. At birth the ears alone were covered. He did not arrive at puberty, or shed his milk teeth, until twenty years old; and at this period he acquired five teeth in the upper jaw, namely, four incisors and one canine, and four incisor teeth in the lower jaw; all the teeth were small. This man had a daughter who was born with hair within her ears; and the hair soon extended over her body. When Captain Yule²¹ visited the Court, he found this girl grown up; and she presented a strange appearance with even her nose densely covered with soft hair. Like her father, she was furnished with incisor teeth alone. The King had with difficulty bribed a man to marry her, and of her two children, one, a boy fourteen months old, had hair growing out of his ears, with a beard and moustache. This strange peculiarity has, therefore, been inherited for three generations, with the

¹⁹ 'Gard. Chronicle,' 1849, p. 205.

²⁰ 'Embassy to the Court of Ava,'
vol. i. p. 320.

²¹ 'Narrative of a Mission to the
Court of Ava in 1855,' p. 94.

molar teeth deficient in the grandfather and mother; whether these teeth would likewise fail in the infant could not then be told.

A parallel case of a man fifty-five years old, and of his son, with their faces covered with hair, has recently occurred in Russia. Dr. Alex. Brandt has sent me an account of this case, together with specimens of the extremely fine hair from the cheeks. The man is deficient in teeth, possessing only four incisors in the lower and two in the upper jaw. His son, about three years old, has no teeth except four lower incisors. The case, as Dr. Brandt remarks in his letter, no doubt is due to an arrest of development in the hair and teeth. We here see how independent of the ordinary conditions of existence such arrests must be, for the lives of a Russian peasant and of a native of Burmah are as different as possible.²²

Here is another and somewhat different case communicated to me by Mr. Wallace on the authority of Dr. Purland, a dentist: Julia Pastrana, a Spanish dancer, was a remarkably fine woman, but she had a thick masculine beard and a hairy forehead; she was photographed, and her stuffed skin was exhibited as a show; but what concerns us is, that she had in both the upper and lower jaw an irregular double set of teeth, one row being placed within the other, of which Dr. Purland took a cast. From the redundancy of teeth her mouth projected, and her face had a gorilla-like appearance. These cases and those of the hairless dogs forcibly call to mind the fact, that the two orders of mammals—namely, the Edentata and Cetacea—which are the most abnormal in their dermal covering, are likewise the most abnormal either by deficiency or redundancy of teeth.

The organs of sight and hearing are generally admitted to be homologous with one another and with various dermal appendages; hence these parts are liable to be abnormally affected in conjunction. Mr. White Cowper says "that in all " cases of double microphthalmia brought under his notice he

²² I owe to the kindness of M. Chauman, of St. Petersburg, excellent photographs of this man and his son,

both of whom have since been exhibited in Paris and London.

“ has at the same time met with defective development of “ the dental system.” Certain forms of blindness seem to be associated with the colour of the hair; a man with black hair and a woman with light-coloured hair, both of sound constitution, married and had nine children, all of whom were born blind; of these children, five “ with dark hair “ and brown iris were afflicted with amaurosis; the four “ others, with light-coloured hair and blue iris, had amaurosis “ and cataract conjoined.” Several cases could be given, showing that some relation exists between various affections of the eyes and ears; thus Liebreich states that out of 241 deaf-mutes in Berlin, no less than fourteen suffered from the rare disease called pigmentary retinitis. Mr. White Cowper and Dr. Earle have remarked that inability to distinguish different colours, or colour-blindness, “ is often associated “ with a corresponding inability to distinguish musical “ sounds.”²³

Here is a more curious case: white cats, if they have blue eyes, are almost always deaf. I formerly thought that the rule was invariable, but I have heard of a few authentic exceptions. The first two notices were published in 1829, and relate to English and Persian cats: of the latter, the Rev. W. T. Bree possessed a female, and he states, “ that of the offspring “ produced at one and the same birth, such as, like the mother, “ were entirely white (with blue eyes) were, like her, invari- “ ably deaf; while those that had the least speck of colour on “ their fur, as invariably possessed the usual faculty of “ hearing.”²⁴ The Rev. W. Darwin Fox informs me that he has seen more than a dozen instances of this correlation in English, Persian, and Danish cats; but he adds “ that, if one

²³ These statements are taken from Mr. Sedgwick, in the ‘*Medico-Chirurg. Review*,’ July, 1861, p. 198; April, 1863, pp. 455 and 458. Liebreich is quoted by Professor Devay, in his ‘*Mariages Consanguins*,’ 1862, p. 116.

²⁴ Loudon’s ‘*Mag. of Nat. Hist.*,’ vol. i., 1829, pp. 66, 178. See also Dr. P. Lucas, ‘*L’Héréd. Nat.*,’ tom. i. p. 428, on the inheritance of deafness

in cats. Mr. Lawson Tait states (‘*Nature*,’ 1873, p. 323) that only male cats are thus affected; but this must be a hasty generalisation. The first case recorded in England by Mr. Bree related to a female, and Mr. Fox informs me that he has bred kittens from a white female with blue eyes, which was completely deaf; he has also observed other females in the same condition.

“ eye, as I have several times observed, be not blue, the cat “ hears. On the other hand, I have never seen a white cat “ with eyes of the common colour that was deaf.” In France Dr. Sichel²⁵ has observed during twenty years similar facts; he adds the remarkable case of the iris beginning, at the end of four months, to grow dark-coloured, and then the cat first began to hear.

This case of correlation in cats has struck many persons as marvellous. There is nothing unusual in the relation between blue eyes and white fur; and we have already seen that the organs of sight and hearing are often simultaneously affected. In the present instance the cause probably lies in a slight arrest of development in the nervous system in connection with the sense-organs. Kittens during the first nine days, whilst their eyes are closed, appear to be completely deaf; I have made a great clanging noise with a poker and shovel close to their heads, both when they were asleep and awake, without producing any effect. The trial must not be made by shouting close to their ears, for they are, even when asleep, extremely sensitive to a breath of air. Now, as long as the eyes continue closed, the iris is no doubt blue, for in all the kittens which I have seen this colour remains for some time after the eyelids open. Hence, if we suppose the development of the organs of sight and hearing to be arrested at the stage of the closed eyelids, the eyes would remain permanently blue and the ears would be incapable of perceiving sound; and we should thus understand this curious case. As, however, the colour of the fur is determined long before birth, and as the blueness of the eyes and the whiteness of the fur are obviously connected, we must believe that some primary cause acts at a much earlier period.

The instances of correlated variability hitherto given have been chiefly drawn from the animal kingdom, and we will now turn to plants. Leaves, sepals, petals, stamens, and pistils are all homologous. In double flowers we see that the stamens and pistils vary in the same manner, and assume the form and colour of the petals. In the double columbine (*Aquilegia vulgaris*), the successive whorls of stamens are con-

²⁵ ‘Annales des Sc. Nat.’ Zoolog., 3rd series, 1847, tom. viii. p. 239.

verted into cornucopias, which are enclosed within one another and resemble the true petals. In hose-in-hose flowers the sepals mock the petals. In some cases the flowers and leaves vary together in tint: in all the varieties of the common pea, which have purple flowers, a purple mark may be seen on the stipules.

M. Faivre states that with the varieties of *Primula sinensis* the colour of the flower is evidently correlated with the colour of the under side of the leaves; and he adds that the varieties with fimbriated flowers almost always have voluminous, balloon-like calyces.²⁶ With other plants the leaves and fruit or seeds vary together in colour, as in a curious pale-leaved variety of the sycamore, which has recently been described in France,²⁷ and as in the purple-leaved hazel, in which the leaves, the husk of the nut, and the pellicle round the kernel are all coloured purple.²⁸ Pomologists can predict to a certain extent, from the size and appearance of the leaves of their seedlings, the probable nature of the fruit; for, as Van Mons remarks,²⁹ variations in the leaves are generally accompanied by some modification in the flower, and consequently in the fruit. In the Serpent melon, which has a narrow tortuous fruit above a yard in length, the stem of the plant, the peduncle of the female flower, and the middle lobe of the leaf, are all elongated in a remarkable manner. On the other hand, several varieties of Cucurbita, which have dwarfed stems, all produce, as Naudin remarks, leaves of the same peculiar shape. Mr. G. Maw informs me that all the varieties of the scarlet Pelargoniums which have contracted or imperfect leaves have contracted flowers: the difference between "Brilliant" and its parent "Tom Thumb" is a good instance of this. It may be suspected that the curious case described by Risso,³⁰ of a variety of the Orange which produces on the young shoots rounded leaves with winged petioles, and afterwards elongated leaves on long but wingless petioles, is connected with the

²⁶ 'Revue des Cours Scientifiques,' June 5, 1869, p. 430.

²⁷ 'Gardener's Chron.,' 1864, p. 1202.

²⁸ Verlot gives several other in-

stances, 'Des Variétés,' 1865, p. 72.

²⁹ 'Arbres Fruitières,' 1836, tom. ii. pp. 204, 226.

³⁰ 'Annales du Muséum,' tom. xx. p. 188.

remarkable change in form and nature which the fruit undergoes during its development.

In the following instance we have the colour and the form of the petals apparently correlated, and both dependent on the nature of the season. An observer, skilled in the subject, writes,³¹ "I noticed, during the year 1842, that every "Dahlia of which the colour had any tendency to scarlet, "was deeply notched—indeed, to so great an extent as to "give the petals the appearance of a saw; the indentures "were, in some instances, more than a quarter of an inch "deep." Again, Dahlias which have their petals tipped with a different colour from the rest of the flower are very inconstant, and during certain years some, or even all the flowers, become uniformly coloured; and it has been observed with several varieties,³² that when this happens the petals grow much elongated and lose their proper shape. This, however, may be due to reversion, both in colour and form, to the aboriginal species.

In this discussion on correlation, we have hitherto treated of cases in which we can partly understand the bond of connection; but I will now give cases in which we cannot even conjecture, or can only very obscurely see, the nature of the bond. Isidore Geoffroy Saint-Hilaire, in his work on Monstrosities, insists,³³ "que certaines anomalies "coexistent rarement entr'elles, d'autres fréquemment, d'autres "enfin presque constamment, malgré la différence très-grande "de leur nature, et quoiqu'elles puissent paraître *complètement* "*indépendantes* les unes des autres." We see something analogous in certain diseases: thus in a rare affection of the renal capsules (of which the functions are unknown), the skin becomes bronzed; and in hereditary syphilis, as I hear from Sir J. Paget, both the milk and the second teeth assume a peculiar and characteristic form. Professor Rolleston, also, informs me that the incisor teeth are sometimes

³¹ 'Gardener's Chron.,' 1843, p. 877.

³² Ibid., 1845, p. 102.

³³ 'Hist. des Anomalies,' tom. iii.

p. 402. See also M. Camille Daresté, 'Recherches sur les Conditions,' &c., 1863, pp. 16, 48.

furnished with a vascular rim in correlation with intrapulmonary deposition of tubercles. In other cases of phthisis and of cyanosis the nails and finger-ends become clubbed like acorns. I believe that no explanation has been offered of these and of many other cases of correlated disease.

What can be more curious and less intelligible than the fact previously given, on the authority of Mr. Tegetmeier, that young pigeons of all breeds, which when mature have white, yellow, silver-blue, or dun-coloured plumage, come out of the egg almost naked; whereas pigeons of other colours when first born are clothed with plenty of down? White Pea-fowls, as has been observed both in England and France,³⁴ and as I have myself seen, are inferior in size to the common coloured kind; and this cannot be accounted for by the belief that albinism is always accompanied by constitutional weakness; for white or albino moles are generally larger than the common kind.

To turn to more important characters: the *niata* cattle of the Pampas are remarkable from their short foreheads upturned muzzles, and curved lower jaws. In the skull the nasal and premaxillary bones are much shortened, the maxillaries are excluded from any junction with the nasals, and all the bones are slightly modified, even to the plane of the occiput. From the analogous case of the dog, hereafter to be given, it is probable that the shortening of the nasal and adjoining bones is the proximate cause of the other modifications in the skull, including the upward curvature of the lower jaw, though we cannot follow out the steps by which these changes have been effected.

Polish fowls have a large tuft of feathers on their heads; and their skulls are perforated by numerous holes, so that a pin can be driven into the brain without touching any bone. That this deficiency of bone is in some way connected with the tuft of feathers is clear from tufted ducks and geese likewise having perforated skulls. The case would probably be considered by some authors as one of balancement or compensation. In the chapter on Fowls, I have shown that

³⁴ Rev. E. S. Dixon, 'Ornamental Poultry,' 1848, p. 111; Isidore Geoffroy, 'Hist. Anomalies,' tom. i. p. 211.

with Polish fowls the tuft of feathers was probably at first small; by continued selection it became larger, and then rested on a fibrous mass; and finally, as it became still larger, the skull itself became more and more protuberant until it acquired its present extraordinary structure. Through correlation with the protuberance of the skull, the shape and even the relative connection of the premaxillary and nasal bones, the shape of the orifice of the nostrils, the breadth of the frontal bone, the shape of the post-lateral processes of the frontal and squamosal bones, and the direction of the bony cavity of the ear, have all been modified. The internal configuration of the skull and the whole shape of the brain have likewise been altered in a truly marvellous manner.

After this case of the Polish fowl it would be superfluous to do more than refer to the details previously given on the manner in which the changed form of the comb has affected the skull, in various breeds of the fowl, causing by correlation crests, protuberances, and depressions on its surface.

With our cattle and sheep the horns stand in close connection with the size of the skull, and with the shape of the frontal bones; thus Cline³⁵ found that the skull of a horned ram weighed five times as much as that of a hornless ram of the same age. When cattle become hornless, the frontal bones are "materially diminished in breadth towards the "poll;" and the cavities between the bony plates "are not so "deep, nor do they extend beyond the frontals."³⁶

It may be well here to pause and observe how the effects of correlated variability, of the increased use of parts, and of the accumulation of so-called spontaneous variations through natural selection, are in many cases inextricably commingled. We may borrow an illustration from Mr. Herbert Spencer, who remarks that, when the Irish elk acquired its gigantic horns, weighing above one hundred pounds, numerous co-ordinated changes of structure would have been indispensable,—namely, a thickened skull to carry the horns; strengthened cervical

³⁵ 'On the Breeding of Domestic Animals,' 1829, p. 6.

³⁶ Youatt on Cattle, 1854, p. 283.

vertebræ, with strengthened ligaments; enlarged dorsal vertebræ to support the neck, with powerful fore-legs and feet; all these parts being supplied with proper muscles, blood-vessels, and nerves. How then could these admirably co-ordinated modifications of structure have been acquired? According to the doctrine which I maintain, the horns of the male elk were slowly gained through sexual selection,—that is, by the best-armed males conquering the worse-armed, and leaving a greater number of descendants. But it is not at all necessary that the several parts of the body should have simultaneously varied. Each stag presents individual characteristics, and in the same district those which had slightly heavier horns, or stronger necks, or stronger bodies, or were the most courageous, would secure the greater number of does, and consequently have a greater number of offspring. The offspring would inherit, in a greater or less degree, these same qualities, would occasionally intercross with one another, or with other individuals varying in some favourable manner; and of their offspring, those which were the best endowed in any respect would continue multiplying; and so onwards, always progressing, sometimes in one direction, and sometimes in another, towards the excellently co-ordinated structure of the male elk. To make this clear, let us reflect on the probable steps, as shown in the twentieth chapter, by which our race and dray horses have arrived at their present state of excellence; if we could view the whole series of intermediate forms between one of these animals and an early unimproved progenitor, we should behold a vast number of animals, not equally improved in each generation throughout their entire structure, but sometimes a little more in one point, and sometimes in another, yet on the whole gradually approaching in character to our present race or dray horses, which are so admirably fitted in the one case for fleetness and in the other for draught.

Although natural selection would thus ³⁷ tend to give to

³⁷ Mr. Herbert Spencer ('Principles of Biology,' 1864, vol. i. pp. 452, 468) takes a different view; and in one place remarks: "We have seen reason to think that, as fast as essential

"faculties multiply, and as fast as
 "the number of organs that co-
 "operate in any given function
 "increases, indirect equilibration
 "through natural selection becomes

the male elk its present structure, yet it is probable that the inherited effects of use, and of the mutual action of part on part, have been equally or more important. As the horns gradually increased in weight the muscles of the neck, with the bones to which they are attached, would increase in size and strength; and these parts would react on the body and legs. Nor must we overlook the fact that certain parts of the skull and the extremities would, judging by analogy, tend from the first to vary in a correlated manner. The increased weight of the horns would also act directly on the skull, in the same manner as when one bone is removed in the leg of a dog, the other bone, which has to carry the whole weight of the body, increases in thickness. But from the fact given with respect to horned and hornless cattle, it is probable that the horns and skull would immediately act on each other through the principle of correlation. Lastly, the growth and subsequent wear and tear of the augmented muscles and bones would require an increased supply of blood, and consequently increased supply of food; and this again would require increased powers of mastication, digestion, respiration, and excretion.

Colour as Correlated with Constitutional Peculiarities.

It is an old belief that with man there is a connection between complexions and constitution; and I find that some of the best authorities believe in this to the present day.³⁸ Thus Dr. Beddoe by his tables shows³⁹ that a relation exists between liability to consumption and the colour of the hair, eyes, and skin. It has been affirmed⁴⁰ that, in the French army which invaded Russia, soldiers having a dark complexion from the southern parts of Europe, withstood the intense

“less and less capable of producing specific adaptations; and remains fully capable only of maintaining the general fitness of constitution to conditions.” This view that natural selection can do little in modifying the higher animals surprises me, seeing that man’s selection has undoubtedly effected much with

our domesticated quadrupeds and birds.

³⁸ Dr. Prosper Lucas apparently disbelieves in any such connection; ‘L’Héréd. Nat.,’ tom. ii. pp. 88-94.

³⁹ ‘British Medical Journal,’ 1862, p. 433.

⁴⁰ Boudin, ‘Géograph. Médicale,’ tom. i. p. 406.

cold better than those with lighter complexions from the north; but no doubt such statements are liable to error.

In the second chapter on Selection I have given several cases proving that with animals and plants differences in colour are correlated with constitutional differences, as shown by greater or less immunity from certain diseases, from the attacks of parasitic plants and animals, from scorching by the sun, and from the action of certain poisons. When all the individuals of any one variety possess an immunity of this nature, we do not know that it stands in any sort of correlation with their colour; but when several similarly coloured varieties of the same species are thus characterised, whilst other coloured varieties are not thus favoured, we must believe in the existence of a correlation of this kind. Thus, in the United States purple-fruited plums of many kinds are far more affected by a certain disease than green or yellow-fruited varieties. On the other hand, yellow-fleshed peaches of various kinds suffer from another disease much more than the white-fleshed varieties. In the Mauritius red sugar-canes are much less affected by a particular disease than the white canes. White onions and verbenas are the most liable to mildew; and in Spain the green-fruited grapes suffered from the vine-disease more than other coloured varieties. Dark-coloured pelargoniums and verbenas are more scorched by the sun than varieties of other colours. Red wheats are believed to be hardier than white; and red-flowered hyacinths were more injured during one particular winter in Holland than other coloured varieties. With animals, white terriers suffer most from the distemper, white chickens from a parasitic worm in their tracheæ, white pigs from scorching by the sun, and white cattle from flies; but the caterpillars of the silkmoth which yield white cocoons suffered in France less from the deadly parasitic fungus than those producing yellow silk.

The cases of immunity from the action of certain vegetable poisons, in connexion with colour, are more interesting, and are at present wholly inexplicable. I have already given a remarkable instance, on the authority of Professor Wyman, of all the hogs, excepting those of a black colour, suffering severely in Virginia from eating the root of the *Lachnanthes*

tinctoria. According to Spinola and others,⁴¹ buckwheat (*Polygonum fagopyrum*), when in flower, is highly injurious to white or white-spotted pigs, if they are exposed to the heat of the sun, but is quite innocuous to black pigs. According to two accounts, the *Hypericum crispum* in Sicily is poisonous to white sheep alone; their heads swell, their wool falls off, and they often die; but this plant, according to Lecce, is poisonous only when it grows in swamps; nor is this improbable, as we know how readily the poisonous principle in plants is influenced by the conditions under which they grow.

Three accounts have been published in Eastern Prussia, of white and white-spotted horses being greatly injured by eating mildewed and honeydewed vetches; every spot of skin bearing white hairs becoming inflamed and gangrenous. The Rev. J. Rodwell informs me that his father turned out about fifteen cart-horses into a field of tares which in parts swarmed with black aphides, and which no doubt were honeydewed, and probably mildewed; the horses, with two exceptions, were chestnuts and bays with white marks on their faces and pasterns, and the white parts alone swelled and became angry scabs. The two bay horses with no white marks entirely escaped all injury. In Guernsey, when horses eat fool's parsley (*Æthusa cynapium*) they are sometimes violently purged; and this plant "has a peculiar effect on the nose and lips, causing deep cracks and ulcers, particularly on horses with white muzzles."⁴² With cattle, independently of the action of any poison, cases have been published by Youatt and Erdt of cutaneous diseases with much constitutional disturbance (in one instance after exposure to a hot sun) affecting every single point which bore a white hair, but completely passing over other parts of the body. Similar cases have been observed with horses.⁴³

⁴¹ This fact and the following cases, when not stated to the contrary, are taken from a very curious paper by Prof. Heusinger, in 'Wochenschrift für Heilkunde,' May, 1846, s. 277. Settegast ('Die Thierzucht,' 1868, p. 39) says that white or white-spotted sheep suffer like pigs, or even die from

eating buckwheat; whilst black or dark-woolled individuals are not in the least affected.

⁴² Mr. Mogford, in the 'Veterinarian,' quoted in 'The Field,' Jan. 22, 1861, p. 545.

⁴³ 'Edinburgh Veterinary Journal,' Oct. 1860, p. 347.

We thus see that not only do those parts of the skin which bear white hair differ in a remarkable manner from those bearing hair of any other colour, but that some great constitutional difference must be correlated with the colour of the hair; for in the above-mentioned cases, vegetable poisons caused fever, swelling of the head, as well as other symptoms, and even death, to all the white, or white-spotted animals.