CHAPTER XXVI.

LAWS OF VARIATION, *continued* —SUMMARY.

THE FUSION OF HOMOLOGOUS PARTS—THE VARIABILITY OF MULTIPLE AND HOMOLOGOUS PARTS—COMPENSATION OF GROWTH—MECHANICAL PRESSURE —RELATIVE POSITION OF FLOWERS WITH RESPECT TO THE AXIS, AND OF SEEDS IN THE OVARY, AS INDUCING VARIATION—ANALOGOUS OR PARALLEL VARIETIES—SUMMARY OF THE THREE LAST CHAPTERS.

The Fusion of Homologous Parts.—Geoffroy Saint-Hilaire formerly propounded what he called *la loi de l'affinité de soi pour soi*, which has been discussed and illustrated by his son, Isidore, with respect to monsters in the animal kingdom,[1] and by Moquin-Tandon, with respect to monstrous plants. This law seems to imply that homologous parts actually attract one another and then unite. No doubt there are many wonderful cases, in which such parts become intimately fused together. This is perhaps best seen in monsters with two heads, which are united, summit to summit, or face to face, or Janus-like, back to back, or obliquely side to side. In one instance of two heads united almost face to face, but a little obliquely, four ears were developed, and on one side a perfect face, which was manifestly formed by the fusion of two half-faces. Whenever two bodies or two heads are united, each bone, muscle, vessel, and nerve on the line of junction appears as if it had sought out its fellow, and had become completely fused with it. Lereboullet,[2] who carefully studied the development of double monsters in fishes, observed in fifteen instances the steps by which two heads gradually became united into one. In all such cases it is now thought by the greater number of capable judges that the homologous parts do not attract each other, but that in the words of Mr. Lowne:[3] "As union takes place before the differentia-

[1] 'Hist. des Anomalies,' 1832, tom. i. pp. 22, 537–556; tom. iii. p. 462.

[2] 'Comptes Rendus,' 1855, pp. 855, 1029.

[3] 'Catalogue of the Teratological Series in the Museum of the R. Coll. of Surgeons,' 1872, p. xvi.

"tion of distinct organs occurs, these are formed in continuity "with each other." He adds that organs already differentiated probably in no case become united to homologous ones. M. Dareste does not speak[4] quite decisively against the law of *soi pour soi*, but concludes by saying, "On se rend parfaitement "compte de la formation des monstres, si l'on admet que les "embryons qui se soudent appartiennent à un même œuf; "qu'ils s'unissent en même temps qu'ils se forment, et que la "soudure ne se produit que pendant la première période de la "vie embryonnaire, celle ou les organes ne sont encore con-"stitués que par des blastèmes homogènes."

By whatever means the abnormal fusion of homologous parts is effected, such cases throw light on the frequent presence of organs which are double during an embryonic period (and throughout life in other and lower members of the same class) but which afterwards unite by a normal process into a single medial organ. In the vegetable kingdom Moquin-Tandon[5] gives a long list of cases, showing how frequently homologous parts, such as leaves, petals, stamens, and pistils, flowers, and aggregates of homologous parts, such as buds, as well as fruit, become blended, both normally and abnormally, with perfect symmetry into one another.

The Variability of Multiple and Homologous Parts.—Isidore Geoffroy[6] insists that, when any part or organ is repeated many times in the same animal, it is particularly liable to vary both in number and structure. With respect to number, the proposition may, I think, be considered as fully established; but the evidence is chiefly derived from organic beings living under their natural conditions, with which we are not here concerned. Whenever such parts as the vertebræ or teeth, the rays in the fins of fishes, or the feathers in the tails of birds, or petals, stamens, pistils, or seeds, are very numerous, the number is generally variable. With respect to the structure of multiple parts, the evidence of variability is not so decisive; but the fact, as far as it may be trusted,

[4] 'Archives de Zoolog. Expér.,' Jan., 1874, p. 78.

[5] 'Tératologie Vég.,' 1841, livre iii.

[6] 'Hist. des Anomalies,' tom. iii. pp. 4, 5, 6.

probably depends on multiple parts being of less physiological importance than single parts; consequently their structure has been less rigorously guarded by natural selection.

Compensation of Growth, or Balancement.—This law, as applied to natural species, was propounded by Goethe and Geoffroy Saint-Hilaire at nearly the same time. It implies that, when much organised matter is used in building up some one part, other parts are starved and become reduced. Several authors, especially botanists, believe in this law; others reject it. As far as I can judge, it occasionally holds good; but its importance has probably been exaggerated. It is scarcely possible to distinguish between the supposed effects of such compensation, and the effects of long-continued selection which may lead to the augmentation of one part, and simultaneously to the diminution of another. Anyhow, there can be no doubt that an organ may be greatly increased without any corresponding diminution of an adjoining part. To recur to our former illustration of the Irish elk, it may be asked what part has suffered in consequence of the immense development of the horns?

It has already been observed that the struggle for existence does not bear hard on our domesticated productions, and consequently the principle of economy of growth will seldom come into play, so that we ought not to expect to find with them frequent evidence of compensation. We have, however, some such cases. Moquin-Tandon describes a monstrous bean,[7] in which the stipules were enormously developed, and the leaflets apparently in consequence completely aborted; this case is interesting, as it represents the natural condition of *Lathyrus aphaca*, with its stipules of great size, and its leaves reduced to mere threads, which act as tendrils. De Candolle[8] has remarked that the varieties of *Raphanus sativus* which have small roots yield numerous seed containing much oil, whilst those with large roots are not productive in oil; and so it is with *Brassica asperifolia*. The varieties of

[7] 'Tératologie Vég.,' p. 156. *See* also my book on 'The Movements and Habits of Climbing Plants,' 2nd edit, 1875, p. 202.

[8] 'Mémoires du Muséum,' &c., tom. viii. p. 178.

Cucurbita pepo which bear large fruit yield a small crop, according to Naudin; whilst those producing small fruit yield a vast number. Lastly, I have endeavoured to show in the eighteenth chapter that with many cultivated plants unnatural treatment checks the full and proper action of the reproductive organs, and they are thus rendered more or less sterile; consequently, in the way of compensation, the fruit becomes greatly enlarged, and, in double flowers, the petals are greatly increased in number.

With animals, it has been found difficult to produce cows which yield much milk, and are afterwards capable of fattening well. With fowls which have large top-knots and beards the comb and wattles are generally much reduced in size; though there are exceptions to this rule. Perhaps the entire absence of the oil-gland in fantail pigeons may be connected with the great development of their tails.

Mechanical Pressure as a Cause of Modifications.—In some few cases there is reason to believe that mere mechanical pressure has affected certain structures. Vrolik and Weber[9] maintain that the shape of the human head is influenced by the shape of the mother's pelvis. The kidneys in different birds differ much in form, and St. Ange[10] believes that this is determined by the form of the pelvis, which again, no doubt, stands in close relation with their power of locomotion. In snakes, the viscera are curiously displaced, in comparison with their position in other vertebrates; and this has been attributed by some authors to the elongation of their bodies; but here, as in so many previous cases, it is impossible to disentangle a direct result of this kind from that consequent on natural selection. Godron has argued[11] that the abortion of the spur on the inner side of the flowers in Corydalis, is caused by the buds at a very early period of growth whilst underground being closely pressed against one another and against the stem. Some botanists believe that the singular difference in the shape both of the seed and corolla, in the

9 Prichard, 'Phys. Hist. of Mankind,' 1851, vol. i. p. 324.

10 'Annales des Sc. Nat.,' 1st series, tom. xix. p. 327.

11 'Comptes Rendus,' Dec. 1864, p. 1039.

interior and exterior florets in certain Compositous and Umbelliferous plants, is due to the pressure to which the inner florets are subjected; but this conclusion is doubtful.

The facts just given do not relate to domesticated productions, and therefore do not strictly concern us. But here is a more appropriate case: H. Müller[12] has shown that in shortfaced races of the dog some of the molar teeth are placed in a slightly different position to that which they occupy in other dogs, especially in those having elongated muzzles; and as he remarks, any inherited change in the arrangement of the teeth deserves notice, considering their classificatory importance. This difference in position is due to the shortening of certain facial bones and the consequent want of space; and the shortening results from a peculiar and abnormal state of the embryonal cartilages of the bones.

Relative Position of Flowers with respect to the Axis, and of Seeds in the Ovary, as inducing Variation.

In the thirteenth chapter various peloric flowers were described, and their production was shown to be due either to arrested development, or to reversion to a primordial condition. Moquin-Tandon has remarked that the flowers which stand on the summit of the main stem or of a lateral branch are more liable to become peloric than those on the sides;[13] and he adduces, amongst other instances, that of *Teucrium campanulatum*. In another Labiate plant grown by me, viz. the *Galeobdolon luteum*, the peloric flowers were always produced on the summit of the stem, where flowers are not usually borne. In Pelargonium, a *single* flower in the truss is frequently peloric, and when this occurs I have during several years invariably observed it to be the central flower. This is of such frequent occurrence that one observer[14] gives the names of ten varieties flowering at the same time, in every one of which the central flower was peloric. Occasionally more than one flower in the truss is peloric, and then of course the additional ones must be lateral. These flowers are interesting as showing how the whole structure is correlated. In the common Pelargonium the upper sepal is produced into a nectary which coheres with the flower-peduncle; the two upper petals differ a little in shape from the three lower ones, and are marked with dark shades of colour; the stamens are graduated in length and upturned. In the peloric

[12] "Ueber fötale Rachites," 'Würzburger Medicin. Zeitschrift,' 1860, B. i. s. 265.

[13] 'Tératologie Vég.,' p. 192.

[14] 'Journal of Horticulture,' July 2nd, 1861, p. 253.

flowers, the nectary aborts; all the petals become alike both in shape and colour; the stamens are generally reduced in number and become straight, so that the whole flower resembles that of the allied genus Erodium. The correlation between these changes is well shown when one of the two upper petals alone loses its dark mark, for in this case the nectary does not entirely abort, but is usually much reduced in length.[15]

Morren has described[16] a marvellous flask-shaped flower of the Calceolaria, nearly four inches in length, which was almost completely peloric; it grew on the summit of the plant, with a normal flower on each side; Prof. Westwood also has described[17] three similar peloric flowers, which all occupied a central position on the flower-branches. In the Orchideous genus, Phalænopsis, the terminal flower has been seen to become peloric.

In a Laburnum-tree I observed that about a fourth part of the racemes produced terminal flowers which had lost their papilionaceous structure. These were produced after almost all the other flowers on the same racemes had withered. The most perfectly pelorised examples had six petals, each marked with black striæ like those on the standard-petal. The keel seemed to resist the change more than the other petals. Dutrochet has described[18] an exactly similar case in France, and I believe these are the only two instances of pelorism in the laburnum which have been recorded. Dutrochet remarks that the racemes on this tree do not properly produce a terminal flower, so that (as in the case of the Galeobdolon) their position as well as structure are both anomalies, which no doubt are in some manner related. Dr. Masters has briefly described another leguminous plant,[19] namely, a species of clover, in which the uppermost and central flowers were regular or had lost their papilionaceous structure. In some of these plants the flower-heads were also proliferous.

Lastly, Linaria produces two kinds of peloric flowers, one having simple petals, and the other having them all spurred. The two forms, as Naudin remarks,[20] not rarely occur on the same plant, but in this case the spurred form almost invariably stands on the summit of the spike.

The tendency in the terminal or central flower to become peloric more frequently than the other flowers, probably results from "the "bud which stands on the end of a shoot receiving the most sap; "it grows out into a stronger shoot than those situated lower

[15] It would be worth trial to fertilise with the same pollen the central and lateral flowers of the pelargonium, or of other highly cultivated plants, protecting them of course from insects: then to sow the seed separately, and observe whether the one or the other lot of seedlings varied the most.

[16] Quoted in 'Journal of Horticulture,' Feb. 24, 1863, p. 152.

[17] 'Gardener's Chronicle,' 1866, p. 612. For the Phalænopsis, *see* ibid., 1867, p. 211.

[18] Mémoires . . des Végétaux,' 1837, tom. ii. p. 170.

[19] 'Journal of Horticulture,' July 23, 1861, p. 311.

[20] 'Nouvelles Archives du Muséum,' tom. i. p. 137.

"down."[21] I have discussed the connection between pelorism and a central position, partly because some few plants are known normally to produce a terminal flower different in structure from the lateral ones; but chiefly on account of the following case, in which we see a tendency to variability or to reversion connected with the same position. A great judge of Auriculas[22] states that when one throws up a side bloom it is pretty sure to keep its character; but that if it grows from the centre or heart of the plant, whatever the colour of the edging ought to be, "it is just as "likely to come in any other class as in the one to which it properly "belongs." This is so notorious a fact, that some florists regularly pinch off the central trusses of flowers. Whether in the highly improved varieties the departure of the central trusses from their proper type is due to reversion, I do not know. Mr. Dombrain insists that, whatever may be the commonest kind of imperfection in each variety, this is generally exaggerated in the central truss. Thus one variety "sometimes has the fault of producing a little "green floret in the centre of the flower," and in central blooms these become excessive in size. In some central blooms, sent to me by Mr. Dombrain, all the organs of the flower were rudimentary in structure, of minute size, and of a green colour, so that by a little further change all would have been converted into small leaves. In this case we clearly see a tendency to prolification—a term which I may explain, for those who have never attended to botany, to mean the production of a branch or flower, or head of flowers, out of another flower. Now Dr. Masters[23] states that the central or uppermost flower on a plant is generally the most liable to prolification. Thus, in the varieties of the Auricula, the loss of their proper character and a tendency to prolification, also a tendency to prolification with pelorism, are all connected together, and are due either to arrested development, or to reversion to a former condition.

The following is a more interesting case; Metzger[24] cultivated in Germany several kinds of maize brought from the hotter parts of America, and he found, as previously described, that in two or three generations the grains became greatly changed in form, size, and colour; and with respect to two races he expressly states that in the first generation, whilst the lower grains on each head retained their proper character, the uppermost grains already began to assume that character which in the third generation all the grains acquired. As we do not know the aboriginal parent of the maize, we cannot tell whether these changes are in any way connected with reversion.

In the two following cases, reversion comes into play and is determined by the position of the seed in the capsule. The Blue Imperial pea is the offspring of the Blue Prussian, and has larger seed and

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21 Hugo von Mohl, 'The Vegetable Cell,' Eng. tr., 1852, p. 76.

22 The Rev. H. H. Dombrain, in 'Journal of Horticulture,' 1861, June 4th, p. 174; and June 25th, p. 234; 1862, April 29th, p. 83.

23 'Transact. Linn. Soc.,' vol. xxiii., 1861, p. 360.

24 'Die Getreidearten,' 1845, s. 208, 209.

broader pods than its parent. Now Mr. Masters, of Canterbury, a careful observer and a raiser of new varieties of the pea, states[25] that the Blue Imperial always has a strong tendency to revert to its parent-stock, and the reversion "occurs in this manner: the "last (or uppermost) pea in the pod is frequently much smaller "than the rest; and if these small peas are carefully collected and "sown separately, very many more, in proportion, will revert to "their origin, than those taken from the other parts of the pod." Again, M. Chaté[26] says that in raising seedling stocks he succeeds in getting eighty per cent. to bear double flowers, by leaving only a few of the secondary branches to seed; but in addition to this, "at the time of extracting the seeds, the upper portion of the pod "is separated and placed aside, because it has been ascertained "that the plants coming from the seeds situated in this portion of "the pod, give eighty per cent. of single flowers." Now the production of single-flowering plants from the seed of double-flowering plants is clearly a case of reversion. These latter facts, as well as the connection between a central position and pelorism and prolification, show in an interesting manner how small a difference—namely, a little greater or less freedom in the flow of sap towards one part of the plant—determines important changes of structure.

Analogous or Parallel Variation.—By this term I mean that similar characters occasionally make their appearance in the several varieties or races descended from the same species, and more rarely in the offspring of widely distinct species. We are here concerned, not as hitherto with the causes of variation, but with the results; but this discussion could not have been more conveniently introduced elsewhere. The cases of analogous variation, as far as their origin is concerned, may be grouped, disregarding minor subdivisions, under two main heads; firstly, those due to unknown causes acting on similarly constituted organisms, and which consequently have varied in a similar manner; and secondly, those due to the reappearance of characters which were possessed by a more or less remote progenitor. But these two main divisions can often be separated only conjecturally, and graduate, as we shall presently see, into each other.

Under the first head of analogous variations, not due to reversion, we have the many cases of trees belonging to quite different orders which have produced pendulous and fastigate varieties. The beech,

[25] 'Gardener's Chronicle,' 1850, p. 198.

[26] Quoted in 'Gardener's Chron.,' 1866, p. 74.

hazel, and barberry have given rise to purple-leaved varieties; and, as Bernhardi remarks,[27] a multitude of plants, as distinct as possible, have yielded varieties with deeply-cut or laciniated leaves. Varieties descended from three distinct species of Brassica have their stems, or so-called roots, enlarged into globular masses. The nectarine is the offspring of the peach; and the varieties of peaches and nectarines offer a remarkable parallelism in the fruit being white, red, or yellow fleshed—in being clingstones or freestones—in the flowers being large or small—in the leaves being serrated or crenated, furnished with globose or reniform glands, or quite destitute of glands. It should be remarked that each variety of the nectarine has not derived its character from a corresponding variety of the peach. The several varieties also of a closely allied genus, namely the apricot, differ from one another in nearly the same parallel manner. There is no reason to believe that any of these varieties have merely reacquired long-lost characters; and in most of them this certainly is not the case.

Three species of Cucurbita have yielded a multitude of races which correspond so closely in character that, as Naudin insists, they may be arranged in almost strictly parallel series. Several varieties of the melon are interesting from resembling, in important characters, other species, either of the same genus or of allied genera; thus, one variety has fruit so like, both externally and internally, the fruit of a perfectly distinct species, namely, the cucumber, as hardly to be distinguished from it; another has long cylindrical fruit twisting about like a serpent; in another the seeds adhere to portions of the pulp; in another the fruit, when ripe, suddenly cracks and falls into pieces; and all these highly remarkable peculiarities are characteristic of species belonging to allied genera. We can hardly account for the appearance of so many unusual characters by reversion to a single ancient form; but we must believe that all the members of the family have inherited a nearly similar constitution from an early progenitor. Our cereal and many other plants offer similar cases.

With animals we have fewer cases of analogous variation, independently of direct reversion. We see something of the kind in the resemblance between the short-muzzled races of the dog, such as the pug and bull-dog; in feather-footed races of the fowl, pigeon, and canary-bird; in horses of the most different races presenting the same range of colour; in all black-and-tan dogs having tan-coloured eye-spots and feet, but in this latter case reversion may possibly have played a part. Low has remarked [28] that several breeds of cattle are "sheeted,"—that is, have a broad band of white passing round their bodies like a sheet; this character is strongly inherited, and sometimes originates from a cross; it may be the first step in reversion to an early type, for, as was shown in the

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[27] 'Ueber den Begriff der Pflanzenart,' 1834, s. 14.

[28] 'Domesticated Animals,' 1845, p. 351.

third chapter, white cattle with dark ears, dark feet and tip of tail, formerly existed, and now exist in feral or semi-feral condition in several quarters of the world.

Under our second main division, namely, of analogous variations due to reversion, the best cases are afforded by pigeons. In all the most distinct breeds, sub-varieties occasionally appear coloured exactly like the parent rock-pigeon, with black wing-bars, white loins, banded tail, &c.; and no one can doubt that these characters are due to reversion. So with minor details; turbits properly have white tails, but occasionally a bird is born with a dark-coloured and banded tail; pouters properly have their primary wing-feathers white, but not rarely a "sword-flighted" bird appears, that is, one with the few first primaries dark-coloured; and in these cases we have characters proper to the rock-pigeon, but new to the breed, evidently appearing from reversion. In some domestic varieties the wing-bars, instead of being simply black, as in the rock-pigeon, are beautifully edged with different zones of colour, and they then present a striking analogy with the wing-bars in certain natural species of the same family, such as *Phaps chalcoptera*; and this may probably be accounted for by all the species of the family being descended from the same remote progenitor and having a tendency to vary in the same manner. Thus, also, we can perhaps understand the fact of some Laugher-pigeons cooing almost like turtle-doves, and for several races having peculiarities in their flight, since certain natural species (viz., *C. torquatrix* and *palumbus*), display singular vagaries in this respect. In other cases a race, instead of imitating a distinct species, resembles some other race; thus, certain runts tremble and slightly elevate their tails, like fantails; and turbits inflate the upper part of their œsophagus, like pouter-pigeons.

It is a common circumstance to find certain coloured marks persistently characterising all the species of a genus, but differing much in tint; and the same thing occurs with the varieties of the pigeon: thus, instead of the general plumage being blue, with the wing-bars black, there are snow-white varieties with red bars, and black varieties with white bars; in other varieties the wing-bars, as we have seen, are elegantly zoned with different tints. The Spot pigeon is characterised by the whole plumage being white, excepting a spot on the forehead and the tail; but these parts may be red, yellow, or black. In the rock-pigeon and in many varieties the tail is blue, with the outer edges of the outer feathers white; but in the sub-variety of the monk-pigeon we have a reversed style of coloration, for the tail is white, except the outer edges of the outer feathers, which are black.[29]

With some species of birds, for instance with gulls, certain coloured parts appear as if almost washed out, and I have observed exactly the same appearance in the terminal dark tail-bar in certain

[29] Bechstein, 'Naturgeschichte Deutschlands,' Band iv., 1795, s. 31.

pigeons, and in the whole plumage of certain varieties of the duck. Analogous facts in the vegetable kingdom could be given.

Many sub-varieties of the pigeon have reversed and somewhat lengthened feathers on the back part of their heads, and this is certainly not due to reversion to the parent-species, which shows no trace of such structure: but when we remember that sub-varieties of the fowl, turkey, canary-bird, duck, and goose, all have either topknots or reversed feathers on their heads; and when we remember that scarcely a single large natural group of birds can be named, in which some members have not a tuft of feathers on their heads, we may suspect that reversion to some extremely remote form has come into action.

Several breeds of the fowl have either spangled or pencilled feathers; and these cannot be derived from the parent-species, the *Gallus bankiva;* though of course it is possible that one early progenitor of this species may have been spangled, and another pencilled. But, as many gallinaceous birds are either spangled or pencilled, it is a more probable view that the several domestic breeds of the fowl have acquired this kind of plumage from all the members of the family inheriting a tendency to vary in a like manner. The same principle may account for the ewes in certain breeds of sheep being hornless, like the females of some other hollow-horned ruminants; it may account for certain domestic cats having slightly-tufted ears, like those of the lynx; and for the skulls of domestic rabbits often differing from one another in the same characters by which the skulls of the various species of the genus Lepus differ.

I will only allude to one other case, already discussed. Now that we know that the wild parent of the ass commonly has striped legs, we may feel confident that the occasional appearance of stripes on the legs of the domestic ass is due to reversion; but this will not account for the lower end of the shoulder-stripe being sometimes angularly bent or slightly forked. So, again, when we seen dun and other coloured horses with stripes on the spine, shoulders, and legs, we are led, from reasons formerly given, to believe that they reappear through reversion to the wild parent-horse. But when horses have two or three shoulder-stripes, with one of them occasionally forked at the lower end, or when they have stripes on their faces, or are faintly striped as foals over nearly their whole bodies, with the stripes angularly bent one under the other on the forehead, or irregularly branched in other parts, it would be rash to attribute such diversified characters to the reappearance of those proper to the aboriginal wild horse. As three African species of the genus are much striped, and as we have seen that the crossing of the unstriped species often leads to the hybrid offspring being conspicuously striped—bearing also in mind that the act of crossing certainly causes the reappearance of long-lost characters—it is a more probable view that the above-specified stripes are due to reversion, not to the immediate wild parent-horse, but to the striped progenitor of the whole genus.

I have discussed this subject of analogous variation at considerable length, because it is well known that the varieties of one species frequently resemble distinct species—a fact in perfect harmony with the foregoing cases, and explicable on the theory of descent. Secondly, because these facts are important from showing, as remarked in a former chapter, that each trifling variation is governed by law, and is determined in a much higher degree by the nature of the organisation, than by the nature of the conditions to which the varying being has been exposed. Thirdly, because these facts are to a certain extent related to a more general law, namely, that which Mr. B. D. Walsh[30] has called the "Law of *Equable Variability*," or, as he explains it, "if any given character is very variable in one species of a group, it will tend to be variable in allied species; and if any given character is perfectly constant in one species of a group, it will tend to be constant in allied species."

This leads me to recall a discussion in the chapter on Selection, in which it was shown that with domestic races, which are now undergoing rapid improvement, those parts or characters vary the most, which are the most valued. This naturally follows from recently selected characters continually tending to revert to their former less improved standard, and from their being still acted on by the same agencies, whatever these may be, which first caused the characters in question to vary. The same principle is applicable to natural species, for, as stated in my 'Origin of Species,' generic characters are less variable than specific characters; and the latter are those which have been modified by variation and natural selection, since the period when all the species belonging to the genus branched off from a common progenitor, whilst generic characters are those which have remained unaltered from a much more remote epoch, and accordingly are now less variable. This statement makes a near approach to Mr. Walsh's law of Equable Variability. Secondary sexual characters, it may be added, rarely serve to characterise distinct genera, for they usually differ much in the species of the same genus, and they are highly variable

[30] 'Proc. Entomolog. Soc. of Philadelphia,' Oct. 1863, p. 213.

in the individuals of the same species; we have also seen in the earlier chapters of this work how variable secondary sexual characters become under domestication.

Summary of the three previous Chapters on the Laws of Variation.

In the twenty-third chapter we saw that changed conditions occasionally, or even often, act in a definite manner on the organisation, so that all, or nearly all, the individuals thus exposed become modified in the same manner. But a far more frequent result of changed conditions, whether acting directly on the organisation or indirectly through the reproductive system, is indefinite and fluctuating variability. In the three last chapters, some of the laws by which such variability is regulated have been discussed.

Increased use adds to the size of muscles, together with the blood-vessels, nerves, ligaments, the crests of bone and the whole bones, to which they are attached. Increased functional activity increases the size of various glands, and strengthens the sense-organs. Increased and intermittent pressure thickens the epidermis. A change in the nature of the food sometimes modifies the coats of the stomach, and augments or decreases the length of the intestines. Continued disuse, on the other hand, weakens and diminishes all parts of the organisation. Animals which during many generations have taken but little exercise, have their lungs reduced in size, and as a consequence the bony fabric of the chest and the whole form of the body become modified. With our anciently domesticated birds, the wings have been little used, and they are slightly reduced; with their decrease, the crest of the sternum, the scapulæ, coracoids, and furculum, have all been reduced.

With domesticated animals, the reduction of a part from disuse is never carried so far that a mere rudiment is left; whereas we have reason to believe that this has often occurred under nature; the effects of disuse in this latter case being aided by economy of growth, together with the intercrossing of many varying individuals. The cause of this difference between organisms in a state of nature, and under domestication, probably is that in the latter case there has not been time sufficient for any very great change, and that the principle of economy of growth does not come into action. On the contrary, structures which are rudimentary in the parent-species, sometimes become partially redeveloped in our domesticated productions. Such rudiments as occasionally make their appearance under domestication, seem always to be the result of a sudden arrest of development; nevertheless they are of interest, as showing that rudiments are the relics of organs once perfectly developed.

Corporeal, periodical, and mental habits, though the latter have been almost passed over in this work, become changed under domestication, and the changes are often inherited. Such changed habits in an organic being, especially when living a free life, would often lead to the augmented or diminished use of various organs, and consequently to their modification. From long-continued habit, and more especially from the occasional birth of individuals with a slightly different constitution, domestic animals and cultivated plants become to a certain extent acclimatised or adapted to a climate different from that proper to the parent-species.

Through the principle of correlated variability, taken in its widest sense, when one part varies other parts vary, either simultaneously, or one after the other. Thus, an organ modified during an early embryonic period affects other parts subsequently developed. When an organ, such as the beak, increases or decreases in length, adjoining or correlated parts, as the tongue and the orifice of the nostrils, tend to vary in the same manner. When the whole body increases or decreases in size, various parts become modified; thus, with pigeons the ribs increase or decrease in number and breadth. Homologous parts which are identical during their early development and are exposed to similar conditions, tend to vary in the same or in some connected manner,—as in the case of the right and left sides of the body, and of the front and hind limbs. So it is with the organs of sight and hearing; for instance, white cats with blue eyes are almost always deaf. There is a manifest relation throughout the body between the skin and various dermal appendages, such as hair, feathers, hoofs, horns, and teeth. In Paraguay, horses with curly hair have hoofs like those of a mule; the wool and the horns of sheep often vary together; hairless dogs are deficient in their teeth; men with redundant hair have abnormal teeth, either by deficiency or excess. Birds with long wing-feathers usually have long tail-feathers. When long feathers grow from the outside of the legs and toes of pigeons, the two outer toes are connected by membrane; for the whole leg tends to assume the structure of the wing. There is a manifest relation between a crest of feathers on the head and a marvellous amount of change in the skull of various fowls; and in a lesser degree, between the greatly elongated, lopping ears of rabbits and the structure of their skulls. With plants, the leaves, various parts of the flower, and the fruit, often vary together to a correlated manner.

In some cases we find correlation without being able even to conjecture what is the nature of the connection, as with various monstrosities and diseases. This is likewise the case with the colour of the adult pigeon, in connection with the presence of down on the young bird. Numerous curious instances have been given of peculiarities of constitution, in correlation with colour, as shown by the immunity of individuals of one colour from certain diseases, from the attacks of parasites and from the action of certain vegetable poisons.

Correlation is an important subject; for with species, and in a lesser degree with domestic races, we continually find that certain parts have been greatly modified to serve some useful purpose; but we almost invariably find that other parts have likewise been more or less modified, without our being able to discover any advantage in the change. No doubt great caution is necessary with respect to this latter point, for it is difficult to overrate our ignorance on the use of various parts of the organisation; but from what we have seen, we may believe that many modifications are of no direct service, having arisen in correlation with other and useful changes.

Homologous parts during their early development often become fused together. Multiple and homologous organs are especially liable to vary in number and probably in form. As the supply of organised matter is not unlimited, the principle of compensation *sometimes comes into action*; so that, when one part is greatly developed, adjoining parts are apt to be reduced; but this principle is probably of much less importance than the more general one of the economy of growth. Through mere mechanical pressure hard parts occasionally affect adjoining parts. With plants the position of the flowers on the axis, and of the seeds in the ovary, sometimes leads, through a more or less free flow of sap, to changes of structure; but such changes are often due to reversion. Modifications, in whatever manner caused, will be to a certain extent regulated by that co-ordinating power, or so-called *nisus formativus*, which is in fact a remnant of that simple form of reproduction, displayed by many lowly organised beings in their power of fissiparous generation and budding. Finally, the effects of the laws which directly or indirectly govern variability, may be largely regulated by man's selection, and will so far be determined by natural selection that changes advantageous to any race will be favoured, and disadvantageous changes will be checked.

Domestic races descended from the same species, or from two or more allied species, are liable to revert to characters derived from their common progenitor; and, as they inherit a somewhat similar constitution, they are liable to vary in the same manner. From these two causes analogous varieties often arise. When we reflect on the several foregoing laws, imperfectly as we understand them, and when we bear in mind how much remains to be discovered, we need not be surprised at the intricate and to us unintelligible manner in which our domestic productions have varied, and still go on varying.