

## CHAPTER XII.

## INHERITANCE.

WONDERFUL NATURE OF INHERITANCE—PEDIGREES OF OUR DOMESTICATED ANIMALS—INHERITANCE NOT DUE TO CHANCE—TRIFLING CHARACTERS INHERITED—DISEASES INHERITED—PECULIARITIES IN THE EYE INHERITED—DISEASES IN THE HORSE—LONGEVITY AND VIGOUR—ASYMMETRICAL DEVIATIONS OF STRUCTURE—POLYDACTYLISM AND REGROWTH OF SUPERNUMERARY DIGITS AFTER AMPUTATION—CASES OF SEVERAL CHILDREN SIMILARLY AFFECTED FROM NON-AFFECTED PARENTS—WEAK AND FLUCTUATING INHERITANCE: IN WEEPING TREES, IN DWARFNESS, COLOUR OF FRUIT AND FLOWERS—COLOUR OF HORSES—NON-INHERITANCE IN CERTAIN CASES—INHERITANCE OF STRUCTURE AND HABITS OVERBORNE BY HOSTILE CONDITIONS OF LIFE, BY INCESSANTLY RECURRING VARIABILITY, AND BY REVERSION—CONCLUSION.

THE subject of inheritance is an immense one, and has been treated by many authors. One work alone, 'De l'Hérédité Naturelle,' by Dr. Prosper Lucas, runs to the length of 1562 pages. We must confine ourselves to certain points which have an important bearing on the general subject of variation, both with domestic and natural productions. It is obvious that a variation which is not inherited throws no light on the derivation of species, nor is of any service to man, except in the case of perennial plants, which can be propagated by buds.

If animals and plants had never been domesticated, and wild ones alone had been observed, we should probably never have heard the saying, that "like begets like." The proposition would have been as self-evident as that all the buds on the same tree are alike, though neither proposition is strictly true. For, as has often been remarked, probably no two individuals are identically the same. All wild animals recognise each other, which shows that there is some difference between them; and when the eye is well practised, the shepherd knows each sheep, and man can distinguish a fellow-man out of millions on millions of other men. Some authors have gone so far as to maintain that the production of slight differences is as much a necessary function of the powers of

generation, as the production of offspring like their parents. This view, as we shall see in a future chapter, is not theoretically probable, though practically it holds good. The saying that "like begets like" has, in fact, arisen from the perfect confidence felt by breeders, that a superior or inferior animal will generally reproduce its kind; but this very superiority or inferiority shows that the individual in question has departed slightly from its type.

The whole subject of inheritance is wonderful. When a new character arises, whatever its nature may be, it generally tends to be inherited, at least in a temporary and sometimes in a most persistent manner. What can be more wonderful than that some trifling peculiarity, not primordially attached to the species, should be transmitted through the male or female sexual cells, which are so minute as not to be visible to the naked eye, and afterwards through the incessant changes of a long course of development, undergone either in the womb or in the egg, and ultimately appear in the offspring when mature, or even when quite old, as in the case of certain diseases? Or again, what can be more wonderful than the well-ascertained fact that the minute ovule of a good milking cow will produce a male, from whom a cell, in union with an ovule, will produce a female, and she, when mature, will have large mammary glands, yielding an abundant supply of milk, and even milk of a particular quality? Nevertheless, the real subject of surprise is, as Sir H. Holland has well remarked,<sup>1</sup> not that a character should be inherited, but that any should ever fail to be inherited. In a future chapter, devoted to an hypothesis which I have termed pangenesis, an attempt will be made to show the means by which characters of all kinds are transmitted from generation to generation.

Some writers,<sup>2</sup> who have not attended to natural history, have attempted to show that the force of inheritance has been much exaggerated. The breeders of animals would smile at such simplicity; and if they condescended to make any

<sup>1</sup> 'Medical Notes and Reflections,' 3rd edit., 1855, p. 267.

<sup>2</sup> Mr. Buckle, in his 'History of Civilisation,' expresses doubts on the subject, owing to the want of sta-

tistics. See also Mr. Bowen, Professor of Moral Philosophy, in 'Proc. American Acad. of Sciences,' vol. v. p. 102.

answer, might ask what would be the chance of winning a prize if two inferior animals were paired together? They might ask whether the half-wild Arabs were led by theoretical notions to keep pedigrees of their horses? Why have pedigrees been scrupulously kept and published of the Short-horn cattle, and more recently of the Hereford breed? Is it an illusion that these recently improved animals safely transmit their excellent qualities even when crossed with other breeds? have the Shorthorns, without good reason, been purchased at immense prices and exported to almost every quarter of the globe, a thousand guineas having been given for a bull? With greyhounds pedigrees have likewise been kept, and the names of such dogs, as Snowball, Major, &c., are as well known to coursers as those of Eclipse and Herod on the turf. Even with the Gamecock, pedigrees of famous strains were formerly kept, and extended back for a century. With pigs, the Yorkshire and Cumberland breeders "preserve and print pedigrees;" and to show how such highly-bred animals are valued, I may mention that Mr. Brown, who won all the first prizes for small breeds at Birmingham in 1850, sold a young sow and boar of his breed to Lord Ducie for 43 guineas; the sow alone was afterwards sold to the Rev. F. Thursby for 65 guineas; who writes, "She paid me very well, having sold her produce for 300*l.*, and having now four breeding sows from her."<sup>3</sup> Hard cash paid down, over and over again, is an excellent test of inherited superiority. In fact, the whole art of breeding, from which such great results have been attained during the present century, depends on the inheritance of each small detail of structure. But inheritance is not certain; for if it were, the breeder's art<sup>4</sup> would be reduced to a certainty, and there would be little scope left for that wonderful skill and perseverance shown by the men who have left an enduring monument of their success in the present state of our domesticated animals.

It is hardly possible, within a moderate compass, to impress

<sup>3</sup> For greyhounds, see Low's 'Domestic Animals of the British Islands,' 1845, p. 721. For game-fowls, see 'The Poultry Book,' by Mr. Tegetmeier, 1866, p. 123. For pigs, see

Mr. Sidney's edit. of 'Youatt, on the Pig,' 1860, pp. 11, 22.

<sup>4</sup> 'The Stud Farm,' by Cecil, p. 39.

on the mind of those who have not attended to the subject, the full conviction of the force of inheritance which is slowly acquired by rearing animals, by studying the many treatises which have been published on the various domestic animals, and by conversing with breeders. I will select a few facts of the kind, which, as far as I can judge, have most influenced my own mind. With man and the domestic animals, certain peculiarities have appeared in an individual, at rare intervals, or only once or twice in the history of the world, but have reappeared in several of the children and grandchildren. Thus Lambert, "the porcupine-man," whose skin was thickly covered with warty projections, which were periodically moulted, had all his children and two grandsons similarly affected.<sup>5</sup> The face and body being covered with long hair, accompanied by deficient teeth (to which I shall hereafter refer), occurred in three successive generations in a Siamese family; but this case is not unique, as a woman<sup>6</sup> with a completely hairy face who was exhibited in London in 1663, and another instance has recently occurred. Colonel Hallam<sup>7</sup> has described a race of two-legged pigs, "the hinder extremities being entirely wanting;" and this deficiency was transmitted through three generations. In fact, all races presenting any remarkable peculiarity, such as solid-hoofed swine, Mauchamp sheep, niata cattle, &c., are instances of the long-continued inheritance of rare deviations of structure.

When we reflect that certain extraordinary peculiarities have thus appeared in a single individual out of many millions, all exposed in the same country to the same general conditions of life, and, again, that the same extraordinary peculiarity has sometimes appeared in individuals living under widely different conditions of life, we are driven to conclude that such peculiarities are not directly due to the action of the surrounding conditions, but to unknown laws acting on the organisation or constitution of the individual;

<sup>5</sup> 'Philosophical Transactions,' 1755, p. 23. I have seen only second-hand accounts of the two grandsons. Mr. Sedgwick, in a paper to which I shall hereafter often refer, states that *four* generations were affected, and in each

the males alone.

<sup>6</sup> Barbara Van Beck, figured, as I am informed by the Rev. W. D. Fox, in Woodburn's 'Gallery of Rare Portraits,' 1816, vol. ii.

<sup>7</sup> 'Proc. Zoolog. Soc.,' 1833, p. 16.

—that their production stands in hardly closer relation to the conditions of life than does life itself. If this be so, and the occurrence of the same unusual character in the child and parent cannot be attributed to both having been exposed to the same unusual conditions, then the following problem is worth consideration, as showing that the result cannot be due, as some authors have supposed, to mere coincidence, but must be consequent on the members of the same family inheriting something in common in their constitution. Let it be assumed that, in a large population, a particular affection occurs on an average in one out of a million, so that the *à priori* chance that an individual taken at random will be so affected is only one in a million. Let the population consist of sixty millions, composed, we will assume, of ten million families, each containing six members. On these data, Professor Stokes has calculated for me that the odds will be no less than 8333 millions to 1 that in the ten million families there will not be even a single family in which one parent and two children will be affected by the peculiarity in question. But numerous instances could be given, in which several children have been affected by the same rare peculiarity with one of their parents; and in this case, more especially if the grandchildren be included in the calculation, the odds against mere coincidence become something prodigious, almost beyond enumeration.

In some respects the evidence of inheritance is more striking when we consider the reappearance of trifling peculiarities. Dr. Hodgkin formerly told me of an English family in which, for many generations, some members had a single lock differently coloured from the rest of the hair. I knew an Irish gentleman, who, on the right side of his head, had a small white lock in the midst of his dark hair: he assured me that his grandmother had a similar lock on the same side, and his mother on the opposite side. But it is superfluous to give instances; every shade of expression, which may often be seen alike in parents and children, tells the same story. On what a curious combination of corporeal structure, mental character, and training, handwriting depends! yet every one must have noted the occasional close similarity of the hand-

writing in father and son, although the father had not taught his son. A great collector of autographs assured me that in his collection there were several signatures of father and son hardly distinguishable except by their dates. Hofacker, in Germany, remarks on the inheritance of handwriting; and it has even been asserted that English boys when taught to write in France naturally cling to their English manner of writing; but for so extraordinary a statement more evidence is requisite.<sup>8</sup> Gait, gestures, voice, and general bearing are all inherited, as the illustrious Hunter and Sir A. Carlisle have insisted.<sup>9</sup> My father communicated to me some striking instances, in one of which a man died during the early infancy of his son, and my father, who did not see this son until grown up and out of health, declared that it seemed to him as if his old friend had risen from the grave, with all his highly peculiar habits and manners. Peculiar manners pass into tricks, and several instances could be given of their inheritance; as in the case, often quoted, of the father who generally slept on his back, with his right leg crossed over the left, and whose daughter, whilst an infant in the cradle, followed exactly the same habit, though an attempt was made to cure her.<sup>10</sup> I will give one instance which has fallen under my own observation, and which is curious from being a trick associated with a peculiar state of mind, namely, pleasureable emotion. A boy had the singular habit, when pleased, of rapidly moving his fingers parallel to each other, and, when much excited, of raising both hands, with the fingers still moving, to the sides of his face on a level with the eyes; when this boy was almost an old man, he could still hardly resist this trick when much pleased, but from its absurdity concealed it. He had eight children. Of these, a girl, when pleased, at the age of four and a half years, moved her fingers in exactly the same way, and what is still odder, when much excited, she raised both her hands, with her

<sup>8</sup> Hofacker, 'Ueber die Eigenschaften,' &c., 1828, s. 34. With respect to France, Report by Pariset in 'Comptes Rendus,' 1847, p. 592.

<sup>9</sup> Hunter, as quoted in Harlan's 'Med. Researches,' p. 530. Sir A.

Carlisle, 'Phil. Transact.,' 1814, p. 94.

<sup>10</sup> Girou de Buzareignues, 'De la Génération,' p. 282. I have given an analogous case in my book on 'The Expression of the Emotions.'

fingers still moving, to the sides of her face, in exactly the same manner as her father had done, and sometimes even still continued to do so when alone. I never heard of any one, excepting this one man and his little daughter, who had this strange habit; and certainly imitation was in this instance out of the question.

Some writers have doubted whether those complex mental attributes, on which genius and talent depend, are inherited, even when both parents are thus endowed. But he who will study Mr. Galton's able work on 'Hereditary Genius' will have his doubts allayed.

Unfortunately it matters not, as far as inheritance is concerned, how injurious a quality or structure may be if compatible with life. No one can read the many treatises<sup>11</sup> on hereditary disease and doubt this. The ancients were strongly of this opinion, or, as Ranchin expresses it, *Omnes Græci, Arabes, et Latini in eo consentiunt*. A long catalogue could be given of all sorts of inherited malformations and of predisposition to various diseases. With gout, fifty per cent. of the cases observed in hospital practice are, according to Dr. Garrod, inherited, and a greater percentage in private practice. Every one knows how often insanity runs in families, and some of the cases given by Mr. Sedgwick are awful,—as of a surgeon, whose brother, father, and four paternal uncles were all insane, the latter dying by suicide; of a Jew, whose father, mother, and six brothers and sisters were all mad; and in some other cases several members of the same family, during three or four successive generations, have committed suicide. Striking instances have been recorded of epilepsy, consump-

<sup>11</sup> The works which I have read and found most useful are Dr. Prosper Lucas's great work, 'Traité de l'Hérédité Naturelle,' 1847; Mr. W. Sedgwick, in 'British and Foreign Medico-Chirurg. Review,' April and July, 1861, and April and July, 1863: Dr. Garrod on Gout is quoted in these articles. Sir Henry Holland, 'Medical Notes and Reflections,' 3rd edit. 1855. Piorry, 'De l'Hérédité dans les Maladies,' 1840. Adams, 'A Philo-

sophical Treatise on Hereditary Peculiarities,' 2nd edit., 1815. Essay on 'Hereditary Diseases,' by Dr. J. Steinan, 1843. See Paget, in 'Medical Times,' 1857, p. 192, on the Inheritance of Cancer; Dr. Gould, in 'Proc. of American Acad. of Sciences,' Nov. 8, 1853, gives a curious case of hereditary bleeding in four generations. Harlan, 'Medical Researches,' p. 593.

tion, asthma, stone in the bladder, cancer, profuse bleeding from the slightest injuries, of the mother not giving milk, and of bad parturition being inherited. In this latter respect I may mention an odd case given by a good observer,<sup>12</sup> in which the fault lay in the offspring, and not in the mother: in a part of Yorkshire the farmers continued to select cattle with large hind-quarters, until they made a strain called "Dutch-buttocked," and "the monstrous size of the buttocks of the calf was frequently fatal to the cow, and numbers of cows were annually lost in calving."

Instead of giving numerous details on various inherited malformations and diseases, I will confine myself to one organ, that which is the most complex, delicate, and probably best-known in the human frame, namely, the eye, with its accessory parts.<sup>13</sup> To begin with the latter: I have received an account of a family in which one parent and the children are affected by drooping eyelids, in so peculiar a manner, that they cannot see without throwing their heads backwards. Mr. Wade, of Wakefield, has given me an analogous case of a man who had not his eyelids thus affected at birth, nor owed their state, as far as was known, to inheritance, but they began to droop whilst he was an infant after suffering from fits, and he has transmitted the affection to two out of his three children, as was evident in the photographs of the whole family sent to me together with this account. Sir A. Carlisle<sup>14</sup> specifies a pendulous fold to the eyelids, as inherited. "In a family," says Sir H. Holland,<sup>15</sup> "where the father had a singular elongation of the upper eyelid, seven or eight children were born with the same deformity; two or three other children having it not." Many persons, as I hear from Sir J. Paget, have two or three hairs in their eyebrows much longer than the others; and even so trifling a peculiarity as this certainly runs in families.

With respect to the eye itself, the highest authority in England, Mr. Bowman, has been so kind as to give me the following remarks on certain inherited imperfections. First, hypermetropia, or morbidly long sight: in this affection, the organ, instead of being spherical, is too flat from front to back, and is often altogether too small, so that the retina is brought too forward for the focus of the humours; consequently a convex glass is required for clear vision

<sup>12</sup> Marshall, quoted by Youatt in his work on Cattle, p. 284.

<sup>13</sup> Almost any other organ might have been selected. For instance, Mr. J. Tomes, 'System of Dental Surgery,' 2nd edit., 1873, p. 114, gives many instances with teeth, and

others have been communicated to me.

<sup>14</sup> 'Philosoph. Transact.,' 1814, p. 94.

<sup>15</sup> 'Medical Notes and Reflections,' 3rd edit., p. 33.



of near objects, and frequently even of distant ones. This state occurs congenitally, or at a very early age, often in several children of the same family, where one of the parents has presented it.<sup>16</sup> Secondly, myopia, or short-sight, in which the eye is egg-shaped and too long from front to back; the retina in this case lies behind the focus, and is therefore fitted to see distinctly only very near objects. This condition is not commonly congenital, but comes on in youth, the liability to it being well known to be transmissible from parent to child. The change from the spherical to the ovoidal shape seems the immediate consequence of something like inflammation of the coats, under which they yield, and there is ground for believing that it may often originate in causes acting on the individual affected,<sup>17</sup> and may thenceforward become transmissible. When both parents are myopic Mr. Bowman has observed the hereditary tendency in this direction to be heightened, and some of the children to be myopic at an earlier age or in a higher degree than their parents. Thirdly, squinting is a familiar example of hereditary transmission: it is frequently a result of such optical defects as have been above mentioned; but the more primary and uncomplicated forms of it are also sometimes in a marked degree transmitted in a family. Fourthly, *Cataract*, or opacity of the crystalline lens, is commonly observed in persons whose parents have been similarly affected, and often at an earlier age in the children than in the parents. Occasionally more than one child in a family is thus afflicted, one of whose parents or other relations, presents the senile form of the complaint. When cataract affects several members of a family in the same generation, it is often seen to commence at about the same age in each: *e.g.*, in one family several infants or young persons may suffer from it; in another, several persons of middle age. Mr. Bowman also informs me that he has occasionally seen, in several members of the same family, various defects in either the right or left eye; and Mr. White Cooper has often seen peculiarities of vision confined to one eye reappearing in the same eye in the offspring.<sup>18</sup>

The following cases are taken from an able paper by Mr. W. Sedgwick, and from Dr. Prosper Lucas.<sup>19</sup> Amaurosis, either congenital or coming on late in life, and causing total blindness, is often inherited; it has been observed in three successive generations. Congenital absence of the iris has likewise been transmitted for

<sup>16</sup> This affection, as I hear from Mr. Bowman, has been ably described and spoken of as hereditary by Dr. Donders of Utrecht, whose work was published in English by the Sydenham Society in 1864.

<sup>17</sup> M. Giraud-Teulon has recently collected abundant statistical evidence, 'Revue des Cours Scientifiques,' Sept., 1870, p. 625, showing that short

sight is due to the habit of viewing objects from a short distance, *c'est le travail assidu, de près.*

<sup>18</sup> Quoted by Mr. Herbert Spencer, 'Principles of Biology,' vol. i. p. 244.

<sup>19</sup> 'British and Foreign Medico-Chirurg. Review,' April, 1861, pp. 482-6; 'L'Héréd. Nat.,' tom. i. pp. 391-408.

three generations, a cleft-iris for four generations, being limited in this latter case to the males of the family. Opacity of the cornea and congenital smallness of the eyes have been inherited. Portal records a curious case, in which a father and two sons were rendered blind, whenever the head was bent downwards, apparently owing to the crystalline lens, with its capsule, slipping through an unusually large pupil into the anterior chamber of the eye. Day-blindness, or imperfect vision under a bright light, is inherited, as is night-blindness, or an incapacity to see except under a strong light: a case has been recorded, by M. Cunier, of this latter defect having affected eighty-five members of the same family during six generations. The singular incapacity of distinguishing colours, which has been called *Daltonism*, is notoriously hereditary, and has been traced through five generations, in which it was confined to the female sex.

With respect to the colour of the iris: deficiency of colouring matter is well known to be hereditary in albinos. The iris of one eye being of different colour from that of the other, and the iris being spotted, are cases which have been inherited. Mr. Sedgwick gives, in addition, on the authority of Dr. Osborne,<sup>20</sup> the following curious instance of strong inheritance: a family of sixteen sons and five daughters all had eyes "resembling in miniature the markings on the back of a tortoiseshell cat." The mother of this large family had three sisters and a brother all similarly marked, and they derived this peculiarity from their mother, who belonged to a family notorious for transmitting it to their posterity.

Finally, Dr. Lucas emphatically remarks that there is not one single faculty of the eye which is not subject to anomalies; and not one which is not subjected to the principle of inheritance. Mr. Bowman agrees with the general truth of this proposition; which of course does not imply that all malformations are necessarily inherited; this would not even follow if both parents were affected by an anomaly which in most cases was transmissible.

Even if no single fact had been known with respect to the inheritance of disease and malformations by man, the evidence would have been ample in the case of the horse. And this might have been expected, as horses breed much quicker than man, are matched with care, and are highly valued. I have consulted many works, and the unanimity of the belief by veterinaries of all nations in the transmission of various morbid tendencies is surprising. Authors who have had wide experience give in detail many singular cases, and assert that *contracted feet, with the numerous contingent evils, of ring-bones, curbs, splints, spavin, founder and weakness of the front*

<sup>20</sup> Dr. Osborne, Pres. of Royal College of Phys. in Ireland, published this case in the 'Dublin Medical Journal,' for 1835.

legs, roaring or broken and thick wind, melanosis, specific ophthalmia, and blindness (the great French veterinary Huzard going so far as to say that a blind race could soon be formed), crib-biting, jibbing and ill-temper, are all plainly hereditary. Youatt sums up by saying "there is scarcely a malady to which the horse is subject which is not hereditary;" and M. Bernard adds that the doctrine "that there is scarcely a disease which does not run in the stock, is gaining new advocates every day."<sup>21</sup> So it is in regard to cattle, with consumption, good and bad teeth, fine skin, &c. &c. But enough, and more than enough, has been said on disease. Andrew Knight, from his own experience, asserts that disease is hereditary with plants; and this assertion is endorsed by Lindley.<sup>22</sup>

Seeing how hereditary evil qualities are, it is fortunate that good health, vigour, and longevity are equally inherited. It was formerly a well-known practice, when annuities were purchased to be received during the life-time of a nominee, to search out a person belonging to a family of which many members had lived to extreme old age. As to the inheritance of vigour and endurance, the English race-horse offers an excellent instance. Eclipse begot 334, and King Herod 497 winners. A "cock-tail" is a horse not purely bred, but with only one-eighth, or one-sixteenth impure blood in his veins, yet very few instances have ever occurred of such horses having won a great race. They are sometimes as fleet for short distances as thoroughbreds, but as Mr. Robson, the

<sup>21</sup> These various statements are taken from the following works and papers:—Youatt on 'The Horse,' pp. 35, 220. Lawrence, 'The Horse,' p. 30. Karkeek, in an excellent paper in 'Gard. Chronicle,' 1853, p. 92. Mr. Burke, in 'Journal of R. Agricul. Soc. of England,' vol. v. p. 511. 'Encyclop. of Rural Sports,' p. 279. Girou de Buzareignues, 'Philosoph. Phys.,' p. 215. See following papers in 'The Veterinary;' Roberts, in vol. ii. p. 144; M. Marrimpoey, vol. ii. p. 387; Mr. Karkeek, vol. iv. p. 5; Youatt on Goitre in Dogs, vol. v. p.

483; Youatt in vol. vi. pp. 66, 348, 412; M. Bernard, vol. xi. p. 539; Dr. Samesreuther, on Cattle, in vol. xii. p. 181; Percivall, in vol. xiii. p. 47. With respect to blindness in horses, see also a whole row of authorities in Dr. P. Lucas's great work, tom. i. p. 399. Mr. Baker in 'The Veterinary,' vol. xiii. p. 721, gives a strong case of hereditary imperfect vision and of jibbing.

<sup>22</sup> Knight on 'The Culture of the Apple and Pear,' p. 34. Lindley's 'Horticulture,' p. 180.

great trainer, asserts, they are deficient in wind, and cannot keep up the pace. Mr. Lawrence also remarks, "perhaps no instance has ever occurred of a three-part-bred horse saving his '*distance*' in running two miles with thoroughbred racers." It has been stated by Cecil, that when unknown horses, whose parents were not celebrated, have unexpectedly won great races, as in the case of Priam, they can always be proved to be descended, on both sides, through many generations, from first-rate ancestors. On the Continent, Baron Cameronn challenges, in a German veterinary periodical, the opponents of the English race-horse to name one good horse on the Continent, which has not some English race-blood in his veins.<sup>23</sup>

With respect to the transmission of the many slight, but infinitely diversified characters, by which the domestic races of animals and plants are distinguished, nothing need be said; for the very existence of persistent races proclaims the power of inheritance.

A few special cases, however, deserve some consideration. It might have been anticipated, that deviations from the law of symmetry would not have been inherited. But Anderson<sup>24</sup> states that a rabbit produced in a litter a young animal having only one ear; and from this animal a breed was formed which steadily produced one-eared rabbits. He also mentions a bitch with a single leg deficient, and she produced several puppies with the same deficiency. From Hofacker's account,<sup>25</sup> it appears that a one-horned stag was seen in 1781 in a forest in Germany, in 1788 two, and afterwards, from year to year, many were observed with only one horn on the right side of the head. A cow lost a horn by suppuration,<sup>26</sup> and she produced three calves which had on the same side of the head, instead of a horn, a small bony lump attached

<sup>23</sup> These statements are taken from the following works in order:—Youatt on 'The Horse,' p. 48; Mr. Darvill, in 'The Veterinary,' vol. viii. p. 50. With respect to Robson, see 'The Veterinary,' vol. iii. p. 580; Mr. Lawrence on 'The Horse,' 1829, p. 9; 'The Stud Farm,' by Cecil, 1851.

Baron Cameronn, quoted in 'The Veterinary,' vol. x. p. 500.

<sup>24</sup> 'Recreations in Agriculture and Nat. Hist.,' vol. i. p. 68.

<sup>25</sup> 'Ueber die Eigenschaften,' &c., 1828, s. 107.

<sup>26</sup> Bronn's 'Geschichte der Natur,' Band ii. s. 132.

merely to the skin; but we here encroach on the subject of inherited mutilations. A man who is left-handed, and a shell in which the spire turns in the wrong directions, are departures from the normal asymmetrical condition, and they are well-known to be inherited.

*Polydactylism.*—Supernumerary fingers and toes are eminently liable, as various authors have insisted, to be inherited. Polydactylism graduates<sup>27</sup> by multifarious steps from a mere cutaneous appendage, not including any bone, to a double hand. But an additional digit, supported on a metacarpal bone, and furnished with all the proper muscles, nerves, and vessels, is sometimes so perfect, that it escapes detection, unless the fingers are actually counted. Occasionally there are several supernumerary digits; but usually only one, making the total number six. This one may be attached to the inner or outer margin of the hand, representing either a thumb or little finger, the latter being the more frequent. Generally, through the law of correlation, both hands and both feet are similarly affected. Dr. Burt Wilder has tabulated<sup>28</sup> a large number of cases, and finds that supernumerary digits are more common on the hands than on the feet, and that men are affected oftener than women. Both these facts can be explained on two principles which seem generally to hold good; firstly, that of two parts, the more specialised one is the more variable, and the arm is more highly specialised than the leg; and secondly that male animals are more variable than females.

The presence of a greater number of digits than five is a great anomaly, for this number is not normally exceeded by any existing mammal, bird, or reptile. Nevertheless, supernumerary digits are strongly inherited; they have been transmitted through five generations; and in some cases, after disappearing for one, two, or even three generations, have reappeared through reversion. These facts are rendered, as Professor Huxley has observed, more remarkable from its being known in most cases that the affected person has not married one similarly affected. In such cases the child of the fifth generation would have only 1-32nd part of the blood of his first sedigitated ancestor. Other cases are rendered remarkable by the affection gathering force, as Dr. Struthers has shown, in each generation, though in each the affected person married one not affected; moreover, such additional digits are often amputated soon after birth, and can seldom have been strengthened by use. Dr.

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<sup>27</sup> Vrolik has discussed this point at full length in a work published in Dutch, from which Sir J. Paget has kindly translated for me passages. See, also, Isidore Geoffroy St. Hilaire's 'Hist. des Anomalies,' 1832, tom. i.

p. 684.

<sup>28</sup> 'Massachusetts Medical Society,' vol. ii. No. 3; and 'Proc. Boston Soc. of Nat. Hist.,' vol. xiv., 1871, p. 154.

Struthers gives the following instance: in the first generation an additional digit appeared on one hand; in the second, on both hands; in the third, three brothers had both hands, and one of the brothers a foot affected; and in the fourth generation all four limbs were affected. Yet we must not over-estimate the force of inheritance. Dr. Struthers asserts that cases of non-inheritance and of the first appearance of additional digits in unaffected families are much more frequent than cases of inheritance. Many other deviations of structure, of a nature almost as anomalous as supernumerary digits, such as deficient phalanges,<sup>29</sup> thickened joints, crooked fingers, &c., are, in like manner, strongly inherited, and are equally subject to intermission, together with reversion, though in such cases there is no reason to suppose that both parents had been similarly affected.<sup>30</sup>

Additional digits have been observed in negroes as well as in other races of man, and in several of the lower animals, and have been inherited. Six toes have been described on the hind feet of the newt (*Salamandra cristata*), and are said to have occurred with the frog. It deserves notice, that the six-toed newt, though adult, preserved some of its larval characters; for part of the hyoidal apparatus, which is properly absorbed during the act of metamorphosis, was retained. It is also remarkable that in the case of man various structures in an embryonic or arrested state of development, such as a cleft-palate, bifid uterus, &c., are often accompanied by polydactylism.<sup>31</sup> Six toes on the hinder feet are known to have been inherited for three generations of cats. In several breeds of the fowl the hinder toe is double, and is generally transmitted truly, as is well shown when Dorkings are crossed with common

<sup>29</sup> Dr. J. W. Ogle gives a case of the inheritance of deficient phalanges during four generations. He adds references to various recent papers on inheritance, 'Brit. and For. Med.-Chirurg. Review,' Ap. 1872.

<sup>30</sup> For these several statements, see Dr. Struthers, 'Edinburgh New Phil. Journal,' July, 1863, especially on intermissions in the line of descent. Prof. Huxley, 'Lectures on our Knowledge of Organic Nature,' 1863, p. 97. With respect to inheritance, see Dr. Prosper Lucas, 'L'Hérédité Nat.,' tom. i. p. 325. Isid. Geoffroy, 'Anom.,' tom. i. p. 701. Sir A. Carlisle, in 'Phil. Transact.,' 1814, p. 94. A. Walker, on 'Intermarriage,' 1838, p. 140, gives a case of five generations; as does Mr. Sedgwick, in 'Brit. and Foreign Medico-Chirurg. Review,'

April, 1863, p. 462. On the inheritance of other anomalies in the extremities, see Dr. H. Dobell, in vol. xlvi. of 'Medico-Chirurg. Transactions,' 1863; also Mr. Sedgwick, in op. cit., April, 1863, p. 460. With respect to additional digits in the negro, see Prichard, 'Physical History of Mankind.' Dr. Dieffenbach ('Jour. Royal Geograph. Soc.,' 1841, p. 208) says this anomaly is not uncommon with the Polynesians of the Chatham Islands; and I have heard of several cases with Hindus and Arabs.

<sup>31</sup> Meckel and Isid G. St. Hilaire insist on this fact. See, also M. A. Roujou, 'Sur quelques Analogies du Type Humain,' p. 61; published, I believe, in the 'Journal of the Anthropolog. Soc. of Paris,' Jan. 1872.

four-toed breeds.<sup>32</sup> With animals which have properly less than five digits, the number is sometimes increased to five, especially on the front legs, though rarely carried beyond that number; but this is due to the development of a digit already existing in a more or less rudimentary state. Thus, the dog has properly four toes behind, but in the larger breeds a fifth toe is commonly, though not perfectly, developed. Horses, which properly have one toe alone fully developed with rudiments of the others, have been described with each foot bearing two or three small separate hoofs: analogous facts have been noticed with cows, sheep, goats, and pigs.<sup>33</sup>

There is a famous case described by Mr. White of a child, three years old, with a thumb double from the first joint. He removed the lesser thumb, which was furnished with a nail; but to his astonishment it grew again and reproduced a nail. The child was then taken to an eminent London surgeon, and the newly-grown thumb was removed by its socket-joint, but again it grew and reproduced a nail. Dr. Struthers mentions a case of the partial re-growth of an additional thumb, amputated when a child was three months old; and the late Dr. Falconer communicated to me an analogous instance. In the last edition of this work I also gave a case of the regrowth of a supernumerary little-finger after amputation; but having been informed by Dr. Bachmaier that several eminent surgeons expressed, at a meeting of the Anthropological Society of Munich, great doubt about my statements, I have made more particular inquiries. The full information thus gained, together with a tracing of the hand in its present state, has been laid before Sir J. Paget, and he has come to the conclusion that the degree of regrowth in this case is not greater than sometimes occurs with normal bones, especially with the humerus, when amputated at an early age. He further does not feel fully satisfied about the facts recorded by Mr. White. This being so, it is necessary for me to withdraw the view which I formerly advanced, with much hesitation, chiefly on the ground of the supposed regrowth of additional digits, namely, that their occasional development in man is a case of reversion to a lowly-organised progenitor provided with more than five digits.

I may here allude to a class of facts closely allied to, but somewhat different from, ordinary cases of inheritance. Sir H. Holland<sup>34</sup> states that brothers and sisters of the same

<sup>32</sup> 'The Poultry Chronicle,' 1854, p. 559.

<sup>33</sup> The statements in this paragraph are taken from Isidore Geoffroy St. Hilaire, 'Hist. des Anomalies,' tom. i. pp. 688-693. Mr. Goodman gives, 'Phil. Soc. of Cambridge,' Nov. 25, 1872, the case of a cow with three

well developed toes on each hind limb, besides the ordinary rudiments; and her calf by an ordinary bull had extra digits. This calf also bore two calves having extra digits.

<sup>34</sup> 'Medical Notes and Reflections,' 1839, pp. 24, 34. See, also, Dr. P. Lucas, 'L'Héréd. Nat.,' tom. ii. p. 33.

family are frequently affected, often at about the same age, by the same peculiar disease, not known to have previously occurred in the family. He specifies the occurrence of diabetes in three brothers under ten years old; he also remarks that children of the same family often exhibit, in common infantile diseases, the same peculiar symptoms. *My father mentioned to me the case of four brothers who died between the ages of sixty and seventy, in the same highly peculiar comatose state. An instance has already been given of supernumerary digits appearing in four children out of six in a previously unaffected family.* Dr. Devay states<sup>35</sup> that two brothers married two sisters, their first-cousins, none of the four nor any relation being an albino; but the seven children produced from this double marriage were all perfect albinos. Some of these cases, as Mr. Sedgwick<sup>36</sup> has shown, are probably the result of reversion to a remote ancestor, of whom no record had been preserved; and all these cases are so far directly connected with inheritance that no doubt the children inherited a similar constitution from their parents, and, from being exposed to nearly similar conditions of life, it is not surprising that they should be affected in the same manner and at the same period of life.

Most of the facts hitherto given have served to illustrate the force of inheritance, but we must now consider cases grouped as well as the subject allows into classes, showing how feeble, capricious, or deficient the power of inheritance sometimes is. When a new peculiarity first appears, we can never predict whether it will be inherited. If both parents from their birth present the same peculiarity, the probability is strong that it will be transmitted to at least some of their offspring. We have seen that variegation is transmitted much more feebly by seed, taken from a branch which had become variegated through bud-variation, than from plants which were variegated as seedlings. With most plants the power of transmission notoriously depends on some innate

<sup>35</sup> 'Du Danger des Mariages Consanguins,' 2nd edit., 1862, p. 103.

<sup>36</sup> 'British and Foreign Medico-

Chirurg. Review,' July, 1863, pp. 183, 189.



capacity in the individual: thus Vilmorin<sup>37</sup> raised from a peculiarly coloured balsam some seedlings, which all resembled their parent; but of these seedlings some failed to transmit the new character, whilst others transmitted it to all their descendants during several successive generations. So again with a variety of the rose, two plants alone out of six were found by Vilmorin to be capable of transmitting the desired character; numerous analogous cases could be given.

The weeping or pendulous growth of trees is strongly inherited in some cases, and, without any assignable reason, feebly in other cases. I have selected this character as an instance of capricious inheritance, because it is certainly not proper to the parent-species, and because, both sexes being borne on the same tree, both tend to transmit the same character. Even supposing that there may have been in some instances crossing with adjoining trees of the same species, it is not probable that all the seedlings would have been thus affected. At Moccas Court there is a famous weeping oak; many of its branches "are 30 feet long, and no thicker in any part of this length than a common rope:" this tree transmits its weeping character, in a greater or less degree, to all its seedlings; some of the young oaks being so flexible that they have to be supported by props; others not showing the weeping tendency till about twenty years old.<sup>38</sup> Mr. Rivers fertilized, as he informs me, the flowers of a new Belgian weeping thorn (*Cratægus oxyacantha*) with pollen from a crimson not-weeping variety, and three young trees, "now six or seven years old, show a decided tendency to be pendulous, but as yet are not so much so as the mother-plant." According to Mr. MacNab,<sup>39</sup> seedlings from a magnificent weeping birch (*Betula alba*), in the Botanic Garden at Edinburgh, grew for the first ten or fifteen years upright, but then all became weepers like their parent. A peach with pendulous branches, like those of the weeping willow, has been found capable of propagation by seed.<sup>40</sup> Lastly, a weeping or rather a prostrate yew (*Taxus baccata*) was found in a hedge in Shropshire; it was a male, but one branch bore female flowers, and produced berries; these, being sown, produced seventeen trees all of which had exactly the same peculiar habit with the parent-tree.<sup>41</sup>

These facts, it might have been thought, would have been sufficient

<sup>37</sup> Verlot, 'La Product. des Variétés,' 1865, p. 32.

<sup>38</sup> Loudon's 'Gard. Mag.,' vol. xii., 1836, p. 368.

<sup>39</sup> Verlot, 'La Product. des Variétés,' 1865, p. 94.

<sup>40</sup> Bronn's 'Geschichte der Natur,' o. ii. s. 121. Mr. Meehan makes a

similar statement in 'Proc. Nat. of Philadelphia,' 1872, p. 235.

<sup>41</sup> Rev. W. A. Leighton, 'Flora of Shropshire,' p. 497; and Charlesworth's 'Mag. of Nat. Hist.,' vol. i., 1837, p. 30. I possess prostrate trees produced from these seeds.

to render it probable that a pendulous habit would in all cases be strictly inherited. But let us look to the other side. Mr. MacNab<sup>42</sup> sowed seeds of the weeping beech (*Fagus sylvatica*), but succeeded in raising only common beeches. Mr. Rivers, at my request, raised a number of seedlings from three distinct varieties of weeping elm; and at least one of the parent-trees was so situated that it could not have been crossed by any other elm; but none of the young trees, now about a foot or two in height, show the least signs of weeping. Mr. Rivers formerly sowed above twenty thousand seeds of the weeping ash (*Fraxinus excelsior*), and not a single seedling was in the least degree pendulous: in Germany, M. Borchmeyer raised a thousand seedlings, with the same result. Nevertheless, Mr. Anderson, of the Chelsea Botanic Garden, by sowing seed from a weeping ash, which was found before the year 1780, in Cambridgeshire, raised several pendulous trees.<sup>43</sup> Professor Henslow also informs me that some seedlings from a female weeping ash in the Botanic Garden at Cambridge were at first a little pendulous, but afterwards became quite upright: it is probable that this latter tree, which transmits to a certain extent its pendulous habit, was derived by a bud from the same original Cambridgeshire stock; whilst other weeping ashes may have had a distinct origin. But the crowning case, communicated to me by Mr. Rivers, which shows how capricious is the inheritance of a pendulous habit, is that a variety of another species of ash (*F. lentiscifolia*), now about twenty years old, which was formerly pendulous, "has long lost this habit, every shoot being remarkably erect; but seedlings formerly raised from "it were perfectly prostrate, the stems not rising more than two inches above the ground." Thus the weeping variety of the common ash, which has been extensively propagated by buds during a long period, did not with Mr. Rivers, transmit its character to one seedling out of above twenty thousand; whereas the weeping variety of a second species of ash, which could not, whilst grown in the same garden, retain its own weeping character, transmitted to its character the pendulous habit in excess!

Many analogous facts could be given, showing how apparently capricious is the principle of inheritance. All the seedlings from a variety of the Barberry (*B. vulgaris*) with red leaves inherited the same character; only about one-third of the seedlings of the copper Beech (*Fagus sylvatica*) had purple leaves. Not one out of a hundred seedlings of a variety of the *Cerasus padus*, with yellow fruit, bore yellow fruit: one-twelfth of the seedlings of the variety of *Cornus mascula*, with yellow fruit, came true:<sup>44</sup> and lastly, all the trees raised by my father from a yellow-berried holly (*Ilex aquifolium*), found wild,

<sup>42</sup> Verlot, op. cit., p. 93.

1833, p. 597.

<sup>43</sup> For these several statements, see Loudon's 'Gard. Magazine, vol. x. 1834, pp. 408, 180; and vol. ix.,

<sup>44</sup> These statements are taken from Alph. De Candolle, 'Bot. Géograph., p. 1083.

produced yellow berries. Vilmorin<sup>45</sup> observed in a bed of *Saponaria calabrica* an extremely dwarf variety, and raised from it a large number of seedlings; some of these partially resembled their parent, and he selected their seed; but the grandchildren were not in the least dwarfed: on the other hand, he observed a stunted and bushy variety of *Tagetes signata* growing in the midst of the common varieties by which it was probably crossed; for most of the seedlings raised from this plant were intermediate in character, only two perfectly resembling their parent; but seed saved from these two plants reproduced the new variety so truly, that hardly any selection has since been necessary.

Flowers transmit their colour truly, or most capriciously. Many annuals come true: thus I purchased German seeds of thirty-four named sub-varieties of one *race* of ten-week stocks (*Matthiola annua*), and raised a hundred and forty plants, all of which, with the exception of a single plant, came true. In saying this, however, it must be understood that I could distinguish only twenty kinds out of the thirty-four named sub-varieties; nor did the colour of the flower always correspond with the name affixed to the packet; but I say that they came true, because in each of the thirty-six short rows every plant was absolutely alike, with the one single exception. Again, I procured packets of German seed of twenty-five named varieties of common and quilled asters, and raised a hundred and twenty-four plants; of these, all except ten were true in the above limited sense; and I considered even a wrong shade of colour as false.

It is a singular circumstance that white varieties generally transmit their colour much more truly than any other variety. This fact probably stands in close relation with one observed by Verlot,<sup>46</sup> namely, that flowers which are normally white rarely vary into any other colour. I have found that the white varieties of *Delphinium consolida* and of the Stock are the truest. It is, indeed, sufficient to look through a nurseryman's seed-list, to see the large number of white varieties which can be propagated by seed. The several coloured varieties of the sweet-pea (*Lathyrus odoratus*) are very true; but I hear from Mr. Masters, of Canterbury, who has particularly attended to this plant, that the white variety is the truest. The hyacinth, when propagated by seed, is extremely inconstant in colour, but "white hyacinths almost always give by seed white-flowered plants;"<sup>47</sup> and Mr. Masters informs me that the yellow varieties also reproduce their colour, but of different shades. On the other hand, pink and blue varieties, the latter being the natural colour, are not nearly so true: hence, as Mr. Masters has remarked to me, "we see that a garden variety may acquire a more permanent habit than a natural species;" but it should have been added, that this occurs under cultivation, and therefore under changed conditions.

<sup>45</sup> Verlot, *op. cit.*, p. 38.

<sup>46</sup> *Op. cit.*, p. 59.

<sup>47</sup> Alph. De Candolle, 'Géograph. Bot.,' p. 1082.

With many flowers, especially perennials, nothing can be more fluctuating than the colour of the seedlings, as is notoriously the case with verbenas, carnations, dahlias, cinerarias, and others.<sup>48</sup> I sowed seed of twelve named varieties of Snapdragon (*Antirrhinum majus*), and utter confusion was the result. In most cases the extremely fluctuating colour of seedling plants is probably in chief part due to crosses between differently-coloured varieties during previous generations. It is almost certain that this is the case with the polyanthus and coloured primrose (*Primula veris* and *vulgaris*), from their reciprocally dimorphic structure;<sup>49</sup> and these are plants which florists speak of as never coming true by seed: but if care be taken to prevent crossing, neither species is by any means very inconstant in colour; thus I raised twenty-three plants from a purple primrose, fertilised by Mr. J. Scott with its pollen, and eighteen came up purple of different shades, and only five reverted to the ordinary yellow colour: again, I raised twenty plants from a bright-red cowslip, similarly treated by Mr. Scott, and every one perfectly resembled its parent in colour, as likewise did, with the exception of a single plant, 72 grandchildren. Even with the most variable flowers, it is probable that each delicate shade of colour might be permanently fixed so as to be transmitted by seed, by cultivation in the same soil, by long-continued selection, and especially by the prevention of crosses. I infer this from certain annual larkspurs (*Delphinium consolida* and *ajacis*), of which common seedlings present a greater diversity of colour than any other plant known to me; yet on procuring seed of five named German varieties of *D. consolida*, only nine plants out of ninety-four were false; and the seedlings of six varieties of *D. ajacis* were true in the same manner and degree as with the stocks above described. A distinguished botanist maintains that the annual species of *Delphinium* are always self-fertilised; therefore I may mention that thirty-two flowers on a branch of *D. consolida*, enclosed in a net, yielded twenty-seven capsules, with an average of 17·2 seed in each; whilst five flowers, under the same net, which were artificially fertilised, in the same manner as must be effected by bees during their incessant visits, yielded five capsules with an average of 35·2 fine seed; and this shows that the agency of insects is necessary for the full fertility of this plant. Analogous facts could be given with respect to the crossing of many other flowers, such as carnations, &c., of which the varieties fluctuate much in colour.

As with flowers, so with our domesticated animals, no character is more variable than colour, and probably in no animal more so than with the horse. Yet, with a little care in breeding, it appears that races of any colour might soon be formed. Hofacker gives the result of matching two hundred and sixteen mares of four different colours

<sup>48</sup> See 'Cottage Gardener,' April 10, 1860, p. 18, and Sept. 10, 1861, p. 456; 'Gard. Chron.,' 1845, p. 102.

<sup>49</sup> Darwin, in 'Journal of Proc. Linn. Soc. Bot.' 1862, p. 94.

with like-coloured stallions, without regard to the colour of their ancestors; and of the two hundred and sixteen colts born, eleven alone failed to inherit the colour of their parents: Autenrieth and Ammon assert that, after two generations, colts of a uniform colour are produced with certainty.<sup>50</sup>

In a few rare cases peculiarities fail to be inherited, apparently from the force of inheritance being too strong. I have been assured by breeders of the canary-bird that to get a good jonquil-coloured bird it does not answer to pair two jonquils, as the colour then comes out too strong, or is even brown; but this statement is disputed by other breeders. So again, if two crested canaries are paired, the young birds rarely inherit this character:<sup>51</sup> for in crested birds a narrow space of bare skin is left on the back of the head, where the feathers are up-turned to form the crest, and, when both parents are thus characterised, the bareness becomes excessive, and the crest itself fails to be developed. Mr. Hewitt, speaking of Laced Sebright Bantams, says<sup>52</sup> that, "why this should be so I know not, but I am confident that those that are best laced frequently produce offspring very far from perfect in their markings, whilst those exhibited by myself, which have so often proved successful, were bred from the union of heavily-laced birds with those that were scarcely sufficiently laced."

It is a singular fact that, although several deaf-mutes often occur in the same family, and though their cousins and other relations are often in the same condition, yet their parents are rarely deaf-mutes. To give a single instance: not one scholar out of 148, who were at the same time in the London Institution, was the child of parents similarly affected. So again, when a male or female deaf-mute marries a sound person, their children are most rarely affected: in Ireland, out of 203 children thus produced one alone was mute. Even when both parents have been deaf-mutes, as in the case of forty-one marriages in the United States and of six in Ireland, only

<sup>50</sup> Hofacker, 'Ueber die Eigenschaften,' &c., s. 10.

<sup>51</sup> Bechstein, 'Naturgesch. Deutschlands,' b. iv. s. 462. Mr. Brent, a great breeder of canaries, informs me

that he believes that these statements are correct.

<sup>52</sup> 'The Poultry Book,' by W. B. Tegetmeier, 1866, p. 245.

two deaf and dumb children were produced. Mr. Sedgwick,<sup>53</sup> in commenting on this remarkable and fortunate failure in the power of transmission in the direct line, remarks that it may possibly be owing to "excess having reversed the action of some natural law in development." But it is safer in the present state of our knowledge to look at the whole case as simply unintelligible.

Although many congenital monstrosities are inherited, of which examples have already been given, and to which may be added the lately recorded case of the transmission during a century of hare-lip with a cleft-palate in the writer's own family,<sup>54</sup> yet other malformations are rarely or never inherited. Of these latter cases, many are probably due to injuries in the womb or egg, and would come under the head of non-inherited injuries or mutilations. With plants, a long catalogue of inherited monstrosities of the most serious and diversified nature could easily be given; and with plants, there is no reason to suppose that monstrosities are caused by direct injuries to the seed or embryo.

With respect to the inheritance of structures mutilated by injuries or altered by disease, it was until lately difficult to come to any definite conclusion. Some mutilations have been practised for a vast number of generations without any inherited result. Godron remarks<sup>55</sup> that different races of man have from time immemorial knocked out their upper incisors, cut off joints of their fingers, made holes of immense size through the lobes of their ears or through their nostrils, tattooed themselves, made deep gashes in various parts of their bodies, and there is no reason to suppose that these mutilations have ever been inherited.<sup>56</sup> Adhesions due to in-

<sup>53</sup> 'British and Foreign Med.-Chirurg. Review,' July, 1861, pp. 200-204. Mr. Sedgwick has given such full details on this subject, with ample references, that I need refer to no other authorities.

<sup>54</sup> Mr. Sproule, in 'British Medical Journal,' April 18, 1863.

<sup>55</sup> 'De l'Espèce,' tom. ii., 1859, p. 299.

<sup>56</sup> Nevertheless Mr. Wetherell states, 'Nature,' Dec. 1870, p. 168, that when he visited fifteen years ago the Sioux Indians, he was informed "by a physician, who has passed much of his time with these tribes, that sometimes a child was born with these marks. This was confirmed by the U. S. Government Indian Agent."

flammation and pits from the small-pox (and formerly many consecutive generations must have been thus pitted) are not inherited. With respect to Jews, I have been assured by three medical men of the Jewish faith that circumcision, which has been practised for so many ages, has produced no inherited effect. Blumenbach, however, asserts<sup>57</sup> that Jews are often born in Germany in a condition rendering circumcision difficult, so that a name is given them signifying "born circumcised;" and Professor Preyer informs me that this is the case in Bonn, such children being considered the special favourites of Jehovah. I have also heard from Dr. A. Newman, of Guy's Hospital, of the grandson of a circumcised Jew, the father not having been circumcised, in a similar condition. But it is possible that all these cases may be accidental coincidences, for Sir J. Paget has seen five sons of a lady and one son of her sister with adherent prepuces; and one of these boys was affected in a manner "which might be considered like that commonly produced by circumcision;" yet there was no suspicion of Jewish blood in the family of these two sisters. Circumcision is practised by Mahomedans, but at a much later age than by Jews; and Dr. Riedel, Assistant Resident in North Celebes, writes to me that the boys there go naked until from six to ten years old; and he has observed that many of them, though not all, have their prepuces much reduced in length, and this he attributes to the inherited effects of the operation. In the vegetable kingdom oaks and other trees have borne galls from primeval times, yet they do not produce inherited excrescences; and many other such facts could be adduced.

Notwithstanding the above several negative cases, we now possess conclusive evidence that the effects of operations are sometimes inherited. Dr. Brown-Séquard<sup>58</sup> gives the following summary of his observations on guinea-pigs; and this summary is so important that I will quote the whole:—

<sup>57</sup> 'Philosoph. Mag.' vol. iv., 1799, p. 5.

<sup>58</sup> 'Proc. Royal Soc.,' vol. x. p. 297. 'Communication to the Brit. Assoc.,' 1870. 'The Lancet,' Jan.

1875, p. 7. The extracts are from this last paper. It appears that Obersteiner, 'Stricker's Med. Jahrbücher,' 1875, No. 2, has confirmed Brown-Séquard's observations.

“1st. Appearance of epilepsy in animals born of parents having been rendered epileptic by an injury to the spinal cord.

“2nd. Appearance of epilepsy also in animals born of parents having been rendered epileptic by the section of the sciatic nerve.

“3rd. A change in the shape of the ear in animals born of parents in which such a change was the effect of a division of the cervical sympathetic nerve.

“4th. Partial closure of the eyelids in animals born of parents in which that state of the eyelids had been caused either by the section of the cervical sympathetic nerve or the removal of the superior cervical ganglion.

“5th. Exophthalmia in animals born of parents in which an injury to the restiform body had produced that protrusion of the eyeball. This interesting fact I have witnessed a good many times, and I have seen the transmission of the morbid state of the eye continue through four generations. In these animals, modified by heredity, the two eyes generally protruded, although in the parents usually only one showed exophthalmia, the lesion having been made in most cases only on one of the corpora restiformia.

“6th. Hæmatoma and dry gangrene of the ears in animals born of parents in which these ear-alterations had been caused by an injury to the restiform body near the nib of the calamus.

“7th. Absence of two toes out of the three of the hind leg, and sometimes of the three, in animals whose parents had eaten up their hind-leg toes which had become anæsthetic from a section of the sciatic nerve alone, or of that nerve and also of the crural. Sometimes, instead of complete absence of the toes; only a part of one or two or three was missing in the young, although in the parent not only the toes but the whole foot was absent (partly eaten off, partly destroyed by inflammation, ulceration, or gangrene).

“8th. Appearance of various morbid states of the skin and hair of the neck and face in animals born of parents having had similar alterations in the same parts, as effects of an injury to the sciatic nerve.”

It should be especially observed that Brown-Séguard has bred during thirty years many thousand guinea-pigs from animals which had not been operated upon, and not one of these manifested the epileptic tendency. Nor has he ever seen a guinea-pig born without toes, which was not the offspring of parents which had gnawed off their own toes owing to the sciatic nerve having been divided. Of this latter fact thirteen instances were carefully recorded, and a greater number were seen; yet Brown-Séguard speaks of such cases as one of the rarer forms of inheritance. It is a still more interesting fact—



“That the sciatic nerve in the congenitally toeless animal has inherited the power of passing through all the different morbid states which have occurred in one of its parents from the time of the division till after its reunion with the peripheric end. It is not therefore simply the power of performing an action which is inherited, but the power of performing a whole series of actions, in a certain order.”

In most of the cases of inheritance recorded by Brown-Séguard only one of the two parents had been operated upon and was affected. He concludes by expressing his belief that “what is transmitted is the morbid state of the nervous system,” due to the operation performed on the parents.

With the lower animals Dr. Proper Lucas has collected a long list of inherited injuries. A few instances will suffice. A cow lost a horn from an accident with consequent suppuration, and she produced three calves which were hornless on the same side of the head. With the horse, there seems hardly a doubt that exostoses on the legs, caused by too much travelling on hard roads, are inherited. Blumenbach records the case of a man who had his little finger on the right hand almost cut off, and which in consequence grew crooked, and his sons had the same finger on the same hand similarly crooked. A soldier, fifteen years before his marriage, lost his left eye from purulent ophthalmia, and his two sons were microphthalmic on the same side.<sup>59</sup> In all cases in which a parent has had an organ injured on one side, and two or more of the offspring are born with the same organ affected on the same side, the chances against mere coincidence are almost infinitely great. Even when only a single child is born having exactly the same part of the body affected as that of his injured parent, the chances against coincidence are great; and Professor Rolleston has given me two such cases which have fallen under his own observation,—namely of two men, one of whom had his knee and the other his cheek severely cut, and both had children

<sup>59</sup> This last case is quoted by Mr. Sedgwick in ‘British and Foreign Medico-Chirurg. Review,’ April, 1861, p. 484. For Blumenbach, see above-cited paper. See, also, Dr. P. Lucas, ‘Traité de l’Héréd. Nat.,’ tom. ii. p. 492. Also, ‘Transact. Linn. Soc.,’ vol.

ix. p. 323. Some curious cases are given by Mr. Baker in the ‘Veterinary,’ vol. xiii. p. 723. Another curious case is given in the ‘Annales des Scienc. Nat.,’ 1st series, tom. xi. p. 324.

born with exactly the same spot marked or scarred. Many instances have been recorded of cats, dogs, and horses, which have had their tails, legs, &c., amputated or injured, producing offspring with the same parts ill-formed; but as it is not very rare for similar malformations to appear spontaneously, all such cases may be due to coincidence. It is, however, an argument on the other side that "under the old excise laws the shepherd-dog was only exempt from tax when without a tail, and for this reason it was always removed;"<sup>60</sup> and there still exist breeds of the shepherd-dog which are always born destitute of a tail. Finally, it must be admitted, more especially since the publication of Brown-Séguard's observations, that the effects of injuries, especially when followed by disease, or perhaps exclusively when thus followed, are occasionally inherited.<sup>61</sup>

#### *Causes of Non-inheritance.*

A large number of cases of non-inheritance are intelligible on the principle, that a strong tendency to inheritance does exist, but that it is overborne by hostile or unfavourable conditions of life. No one would expect that our improved pigs, if forced during several generations to travel about and root in the ground for their own subsistence, would transmit, as truly as they now do their short muzzles and legs, and their tendency to fatten. Dray-horses assuredly would not long transmit their great size and massive limbs, if compelled to live on a cold, damp mountainous region; we have indeed evidence of such deterioration in the horses which have run wild on the Falkland Islands. European dogs in India often fail to transmit their true character. Our sheep in tropical countries lose their wool in a few generations. There seems also to be a close relation between certain peculiar pastures and the inheritance of an enlarged tail in fat-tailed sheep,

<sup>60</sup> 'The Dog,' by Stonehenge, 1867, p. 118.

<sup>61</sup> The Mot-mot habitually bites the barbs off the middle part of the two central tail-feathers, and as the barbs are congenitally somewhat

reduced on the same part of these feathers, it seems extremely probable, as Mr. Salvin remarks ('Proc. Zoolog. Soc.' 1873, p. 429), that this is due to the inherited effects of long-continued mutilation.

which form one of the most ancient breeds in the world. With plants, we have seen that tropical varieties of maize lose their proper character in the course of two or three generations, when cultivated in Europe; and conversely so it is with European varieties cultivated in Brazil. Our cabbages, which here come so true by seed, cannot form heads in hot countries. According to Carrière,<sup>62</sup> the purple-leaved beech and bárberry transmit their character by seed far less truly in certain districts than in others. Under changed circumstances, periodical habits of life soon fail to be transmitted, as the period of maturity in summer and winter wheat, barley, and vetches. So it is with animals: for instance, a person, whose statement I can trust, procured eggs of Aylesbury ducks from that town, where they are kept in houses and are reared as early as possible for the London market; the ducks bred from these eggs in a distant part of England, hatched their first brood on January 24th, whilst common ducks, kept in the same yard and treated in the same manner, did not hatch till the end of March; and this shows that the period of hatching was inherited. But the grandchildren of these Aylesbury ducks completely lost their habit of early incubation, and hatched their eggs at the same time with the common ducks of the same place.

Many cases of non-inheritance apparently result from the conditions of life continually inducing fresh variability. We have seen that when the seeds of pears, plums, apples, &c., are sown, the seedlings generally inherit some degree of family likeness. Mingled with these seedlings, a few, and sometimes many, worthless, wild-looking plants commonly appear, and their appearance may be attributed to the principle of reversion. But scarcely a single seedling will be found perfectly to resemble the parent-form; and this may be accounted for by constantly recurring variability induced by the conditions of life. I believe in this, because it has been observed that certain fruit-trees truly propagate their kind whilst growing on their own roots; but when grafted on other stocks, and by this process their natural state is manifestly affected, they produce seedlings which vary greatly,

<sup>62</sup> 'Production et Fixation des Variétés,' 1865, p. 72.

departing from the parental type in many characters.<sup>63</sup> Metzger, as stated in the ninth chapter, found that certain kinds of wheat brought from Spain and cultivated in Germany, failed during many years to reproduce themselves truly; but at last, when accustomed to their new conditions, they ceased to be variable,—that is, they became amenable to the power of inheritance. Nearly all the plants which cannot be propagated with any approach to certainty by seed, are kinds which have been long propagated by buds, cuttings, offsets, tubers, &c., and have in consequence been frequently exposed during what may be called their individual lives to widely diversified conditions of life. Plants thus propagated become so variable, that they are subject, as we have seen in the last chapter, even to bud-variation. Our domesticated animals, on the other hand, are not commonly exposed during the life of the individual to such extremely diversified conditions, and are not liable to such extreme variability; therefore they do not lose the power of transmitting most of their characteristic features. In the foregoing remarks on non-inheritance, crossed breeds are of course excluded, as their diversity mainly depends on the unequal development of character derived from either parent or their ancestors.

#### *Conclusion.*

It has been shown in the early part of this chapter how commonly new characters of the most diversified nature, whether normal or abnormal, injurious or beneficial, whether affecting organs of the highest or most trifling importance, are inherited. It is often sufficient for the inheritance of some peculiar character, that one parent alone should possess it, as in most cases in which the rarer anomalies have been transmitted. But the power of transmission is extremely variable. In a number of individuals descended from the same parents, and treated in the same manner, some display this power in a perfect manner, and in some it is quite deficient; and for this difference no reason can be assigned. The effects of injuries or mutilations are occasionally inherited; and we

<sup>63</sup> Downing, 'Fruits of America,' p. 5: Sageret, 'Pom. Phys.,' pp. 43, 72.

shall see in a future chapter that the long-continued use and disuse of parts produces an inherited effect. Even those characters which are considered the most fluctuating, such as colour, are with rare exceptions transmitted much more forcibly than is generally supposed. The wonder, indeed, in all cases is not that any character should be transmitted, but that the power of inheritance should ever fail. The checks to inheritance, as far as we know them, are, firstly, circumstances hostile to the particular character in question; secondly, conditions of life incessantly inducing fresh variability; and lastly, the crossing of distinct varieties during some previous generation, together with reversion or atavism—that is, the tendency in the child to resemble its grand-parents or more remote ancestors instead of its immediate parents. This latter subject will be discussed in the following chapter.

END OF VOL. I.