THE GULSTONIAN LECTURES, ON THE STERILITY OF WOMEN,

Delivered at the Royal College of Physicians, February 1883.

By J. MATTHEWS DUNCAN, M.D., LL.D., ETC.,
Physician-Accoucheur and Lecturer on Midwifery at St. Bartholomew's Hospital.

LECTURE II: PART I.—ITS THEORY OR CAUSATION.

MR. PRESIDENT, VICE-PRESIDENT, AND GENTLEMEN,—In studying the theory or inquiring into the causes of sterility in women, it is advantageous to keep in mind the corresponding condition in plants and in the lower animals, for in all living beings there is more or less similarity of the sexual organs and offices, and disturbance of function in one division will throw light on disturbance in another. On this subject I have made many, but only casual, observations and have had the privilege of conversation with gardeners and breeders, classes of men in whom are found many of remarkable intelligence and acuteness of observation. But the great storehouse of facts and references on which I rely is Darwin's *Variation of Animals and Plants under Domestication*. Plants, and some animals, propagate otherwise than by sexual generation, but it is only the sterility arising from disturbance of the regular course and consequences of sexual union that has a direct or nearly direct bearing on the present inquiry. The sterility of hybrids, which, considering the theory he is supporting, forms naturally the main study of Darwin, is of comparatively little interest to us, and will not be hereafter referred to, but many of the principles of sterility find strong support in the special sterility of hybrids.

Viewing the subject generally, we may anticipate a great result by pointing out the paramount prevalence and paramount potency of constitutional conditions as causes of sterility. Such are cold and heat, overfeeding and underfeeding, youth and old age, degradation of general health, confinement, and interbreeding.

Local conditions occur in plants that are quite sufficient to account for or cause sterility. Such are contabescence of anthers, monstrous flowers, double flowers, seedless fruit. These local conditions are the result of the general or constitutional conditions of the individuals in which they occur; and they have their place rather in the results of sterility, or of the conditions producing sterility, than in the causes of sterility. They have their analogues in such abortions, dead fetuses, unhealthy offspring, or monstrous products of animals, as are believed to be results of what may be called the sterile diathesis. The causes of sterility are causes of these imperfections, and for that reason they are referred to the sterile tendency. They do, indeed, constitute the sterility to be accounted for. Thus, to wander into hybridism for an example, it is an observation of Gärtner that hybridism in plants, a great cause of sterility, produces also a strong tendency in flowers to become double.

In the vegetable kingdom, everyone has observed that source of sterility which may be, no doubt nearly truly, designated a degradation of general health. A plant covered with flowers is brought from a house where its fertility has been stimulated to the highest degree, and placed as an ornament in a sitting-room, where it remains till its charms are lost, and the result is such an injury to its constitutional vigour, that it is sterile, or nearly sterile, for one or for several subsequent seasons. Its fertility may never be restored, or only after several years of the medical care of a skilful gardener. The scarlet geraniums which are brought from their healthy homes in full bloom to adorn the houses of inhabitants of densely populated cities soon show the injurious influence of their new surroundings, however well they may be cared for; their flowers become less numerous, or are altogether wanting; then their leafage diminishes greatly in quantity, and their existence becomes a mere lingering. A rose-garden, lately in a suburban position near London, becomes surrounded by the growing city, and gradually, as the buildings increase, the fertility of the roses diminishes; the garden becomes useless. Some of our finest forest trees, and among them some plants, grow beautifully in our squares, producing wood in even exaggerated quantity, and a clothing of leaves sufficient for ornament; but there is no wealth of leaves, and there is no seed.

In some cases, an exception makes the rule more striking, as when a cherry-tree in the heart of the city of London lately produced flowers and matured its fruit, so far as maturity is indicated by beauty, size, and taste.

Practical gardeners attribute sexual injury to overstimulation by manure, or what they call overfeeding. This ordinarily produces great growth of the tissues; and, when this is restrained by judicious pruning, it forces out a large or excessive crop of flowers and subsequent fruit. In the language of Spencer, there is produced by overfeeding an excess of individuation, the restraint of which results in excess of genesis. The natural tendency of the overfeeding of plants is to produce a degree of relative sterility; and this may show itself in a paucity of flowers, or it may show itself in the production of those double, or monstrous, or abortive flowers which are so much admired. The opposite result is produced by moderate or full feeding. Then, in mature plants, there is not great growth of tissues, but rather a production of fruit. Sometimes, the plant, without assignable cause, but especially if underfed, has an exaggerated production, and is said to run to seed; and, from whatever it may arise, it, in a reflex manner, injures the plant, which consequently becomes blighted, and often dies. Excessive production here seems to take the place of sterility.

The following is an interesting illustration of the effect of overfeeding and of moderately feeding or underfeeding a vine; and it is important because it specifies a particular local condition or disease which is apparently the cause of the infecundity of the overfed plants, and so indicates a line of investigation which may with advantage be pursued in other examples of sterility. In a recent letter from Mr. Thomson, the well-known vine-cultivator, he writes: "A circumstance has arisen in my own experience that I have never seen noticed in print. A vine called the Alnwick seedling, if grown vigorously in rich soil, fails to set its fruit even when aided. This failure is caused by the exudation from the female organ of a dewdrop of sap, which moistens the pollen, and it does not descend through the pistil and impregnate the ova. When the vine is grown in poor soil the dewdrop does not appear, and impregnation takes place; seeds are formed in perfection, but the pulp for which the grape is grown is almost absent. I know," he adds, "no other grape affected in the same way or subject to the same influences."

I know no good account of the sterility of plants as regulated by age, but the influence of age is well recognised. A young fruit-tree bears no fruit, or very little, and that little imperfect; and the careful gardener does not permit it to bear much, or even a little, believing that fruit-bearing injures growth and diminishes future fertility. The influence of old age and decay in fruit-bearing trees is also well known: the fruit is ill-developed, and there is little of it.

"All know," says Spencer, "that a pear-tree continues to increase in size for years before it begins to bear, and that, producing but few pears at first, it is long before it fruits abundantly. A young mulberry, branching out luxuriantly season after season, but covered with nothing but leaves, at length blossoms sparingly, and sets some small and imperfect berries, which it drops while they are green; and it makes these futile attempts time after time before it succeeds in ripening any seeds. But these multiaxial plants, or aggregates of individuals, some of which continue to grow while others become arrested and transformed into seed-bearers, show us the relation less definitely than certain plants that are substantially, if not literally, uniaxial. Of these, the cocoa-nut may be instanced. For some years it goes on shooting up without making any sign of becoming fertile. About the sixth year it flowers, but the flowers wither without result. In the seventh year it flowers and produces a few nuts, but these prove abortive, and drop. In the eighth year it ripens a moderate number of nuts, and afterwards increases the number, until, in the tenth year, it comes into full bearing. Meanwhile, from the time of its first flowering, its growth begins to diminish, and goes on diminishing till the tenth year, when it ceases."

The evil influence of interbreeding is a subject too extensive to enter upon at any length. In plants, it is corroborated by the well-known advantage of crossing of varieties. But it needs no confirmation; for there are self-impotent plants, plants more thoroughly fertilised by a nearly allied species than by pollen of their own species; and there are the wonders of dimorphism with sterility arising from union of individuals not only of the same species, but of the same form. In the works of horticulturists it is to be found ample evidence that interbreeding of plants tends to weakness, malformation, and sterility.

The influence of heat and cold is, in plants, well illustrated by the failure of most Alpine species to produce flowers and fruit in lowland gardens, and by the same failure of lowland plants as the

ascend the sides of mountains. A walk in the highlands will show the pines thriving on the hill-sides and well covered with cones; but, as greater altitudes are reached, the trees are observed to become stunted, and the fruit entirely to fail.

The abortion-like sterility of plants is illustrated by the bearing of double flowers, of flowers whose seeds do not ripen, or whose seeds, though apparently perfect, are incapable of germination and growth. In some of the cases of seedless fruit, and of fruit with few seeds, or with one seed, or with imperfect seed, we have also abortion, and at the same time a fine illustration of the working, locally, of the opposition between individuation and genesis. The whole plant, as the vine or the pear-tree, may have the appearance of health, and its fruit alone is unnatural. The tissues of the fruit-capsule are enormously developed, while the seeds have disappeared, or are reduced to one or a small number. The luscious pear or the juicy grape are masses of hypertrophy or myxomatous-like degeneration, while the seeds are the subject of extreme hypoplasia. Gardeners generally ascribe these results to overfeeding and overstimulation by manures and heat; but Darwin is more cautious, and in most cases does not analyse the causes farther than is implied in "unnatural conditions of life." No one, according to Lindley and Darwin, has produced double flowers by promoting the perfect health of the plant.

Before leaving vegetable physiology, I would point out the frequent occurrence in plants of seeds which, though apparently perfect, will not germinate; they cannot be distinguished from their neighbours otherwise than by their incapacity for growing. The same failure to grow is often observed, under closely similar circumstances, in the eggs of fowls and of other birds; they cannot be hatched, although no imperfection is discoverable in them. That there are such ova in other animals and in woman is highly probable, but in them the completeness of the demonstration is unattainable.

Very little is known of the sterility of animals, and it is easily understood that reliable observations can only, with great difficulty, be made on them, especially in a state of nature. Many authors, and latterly Darwin and his collaborators, have paid much attention to the great subject of the sterility of hybrid animals. Observations and experiments in this department are made chiefly on domestic animals, or on wild animals in confinement, and each experiment has a high value. But the sterility of ordinary domestic animals has been little studied. In herds of fine heifers and cows, and in mares, it is occasionally exhibited, but I have no data as to its frequency; and in cattle, at least, observations are imperfect, the animal that, by sterility of one season, disappoints its owner, being generally at once fattened for the butcher.

It is a well-known belief among breeders, which may be historically traced to ancient times, that when the female of any kind is made to breed when very young, she does so at the expense of permanently preventing her own growth to perfection, and she will be likely to produce offspring that is not of the best quality. This failure is well illustrated in the case of the common fowl and of the turkey, the progeny of chickens and of turkeys one year old being not the best of their kind, and specially difficult to rear. Fanciers breed these animals from a female two years and a male three years old. The occurrence of sterility in early and in elderly life is clearly seen, and its degree easily made out in pluriparous mammals, as the dog and pig, and in birds whose broods can be counted, and whose yearly production of eggs can be also numbered. This subject will be discussed fully when we come to consider pluriparity in woman.

Overfeeding, or the production of fatness or of obesity in the female, is well known to be hostile to fertility, to be an illustration of the opposition of individuation to genesis. By special feeding and fattening turkeys and common fowls, the henwife arrests almost completely the production of eggs. They may also be made fewer by starving the birds, and not fewer only, but also smaller. These birds, when highly fed, sometimes exhibit excessive productiveness, two eggs being laid daily, an instance of great intensity of fertility; but this is not regarded with favour, having, I am told by a turkey-fancier, an injurious influence in their case, by delay of the commencement of laying in the season following that of the excessive production. The breeder of cattle prevents, by careful management, the fattening of the females.

In respect of feeding, comparisons are made between the relative sterility of wild animals and the comparative fertility of domesticated or confined animals of the same species, but the comparisons are not quite satisfactory, from the intermixture of the influences of food, and of domestication or confinement; and again, in the comparisons of animals fed on rich and on poor pasture, sufficient care

is not taken to insure that the compared animals are of the same breed. With this previous reflection, I subjoin an interesting passage from Spencer's chapter on nutrition and genesis: "Clear proof," says he, "that abundant nutriment raises the rate of multiplication (and *vice versa*) occurs among mammals. Compare the litters of the dog with the litters of the wolf and the fox. Whereas those of the one range in number from six to fourteen, the others contain respectively five or six, or occasionally seven, and four or five, or rarely six. Again, the wild cat has four or five kittens, but the tame cat has five or six kittens two or three times a year. So, too, is it with the weasel tribe. The stoat has five young ones once a year. The ferret has two litters yearly, each containing from six to nine, and this, notwithstanding that it is the larger of the two. Perhaps the most striking contrast is that between the wild and tame varieties of the pig. While the one produces, according to its age, from four to eight or ten young ones once a year, the other produces as many as seventeen in a litter; or, in other cases, will bring up five litters of ten each in two years, a rate of reproduction that is unparalleled in animals of as large a size. And let us not omit to note that this excessive fertility occurs where there is the greatest inactivity—where there is plenty to eat and nothing to do. There is no less distinct evidence that, among domesticated mammals themselves, the well-fed individuals are more prolific than the ill-fed individuals. On the high and comparatively infertile Cotswolds, it is unusual for ewes to have twins, but they very commonly have twins in the adjacent rich valley of the Severn. Similarly, among the barren hills of the west of Scotland, two lambs will be born by about one ewe in twenty; whereas, in England, something like one ewe in three will bear two lambs. Nay, in rich pastures, twins are more frequent than single births; and it occasionally happens that, after a genial autumn and consequent good grazing, a flock of ewes will next spring yield double their number of lambs—the triplets balancing the uniparæ. So direct is the relation, that I have heard a farmer assert his ability to foretell, from the high, medium, or low condition of an ewe in the autumn, whether she will next spring bear two, or one, or none."

An interesting department of the sterility of animals is that which results from confinement. This seems specially to affect what are vaguely designated the noble animals. Those which are sterile show great variations; some disdain to cohabit, or have lost sexual desire; others have increase of sexual appetite, and cohabit freely or excessively, but without impregnation resulting, or with the result very rarely following. Some, if impregnated, bring forth only abortions, or young which are born dead, or, if alive, feeble and ill-formed. There is, for instance, as Shorthouse has pointed out, a common occurrence of cleft palate in the lions' cubs born in the Zoological Gardens.

Among birds in confinement, there are many good examples of change of sexual habits and of sterility. In some cases, they have no eggs, or, if they produce, they have only comparatively few, or they may neglect the eggs when produced, or the eggs duly cared for may be incapable of being hatched. This abortive sterility arising from imperfection of eggs as a result of confinement is well proved by experiments made in France on the common fowl. When these birds were allowed considerable freedom, 20 per cent. of the eggs failed to be hatched; when less freedom was allowed, 40 per cent. failed; when closely confined, 60 per cent. were not hatched.

The power of temperatures that are not according to an animal's nature to induce sterility, is no doubt very great. Darwin mentions that Mr. Miller, a former superintendent of the Zoological Gardens, believed that the sterility of the carnivora there was increased by increase of exposure to air and cold. In winter, inadequately sheltered cows either cease to give milk, or give it in diminished quantity. "And," says Spencer, "though giving milk is not the same thing as bearing a young one, yet, as milk is part of the material from which a young one is built up, it is part of the outlay for reproductive purposes, and diminution of it is a loss of reproductive power." Failure to maintain the cow's heat may entail such reduction in the supply of milk as to cause the death of the calf. Hard living, says Darwin, retards the period at which animals conceive, for it has been found disadvantageous in the northern highlands of Scotland to allow cows to bear calves before they are four years old. Roulin found that, in the hot valleys of the equatorial Cordilleras, sheep were not fully fecund.

The common fowl will not breed in Greenland or Northern Siberia. "In this country, it is fed," says Spencer, "through the cold months; but nevertheless, in midwinter, it either wholly leaves off laying, or lays very sparingly. And then we have the further evidence that, if it lays sparingly, it does so only on condition that the heat, as well

as the food, is artificially maintained. Hens lay in cold weather only when they are kept warm. To which fact may be added the kindred one that, when pigeons receive artificial heat, they not only continue to hatch longer in autumn, but will recommence in spring sooner than they would otherwise do."

On the subject of the interbreeding of animals, there is a vast body of opinion as well as of facts showing its power in producing monstrosity and its ally, sterility. "If we were," says Darwin, "to pair brothers and sisters in the case of any pure animal, which from any cause had the least tendency to sterility, the breed would assuredly be lost in a few generations." Elsewhere, he shows that "long continued close interbreeding between the nearest relations diminishes the constitutional vigour, size, and fertility of the offspring; and occasionally leads to malformations, but not necessarily to general deterioration of form or structure. This failure of fertility shows that the evil results of interbreeding are independent of the augmentation of morbid tendencies common to both parents, though this augmentation no doubt is often highly injurious. Our belief that evil follows from close interbreeding rests to a large extent on the experience of practical breeders, especially of those who have seen many animals of the kind which can be propagated quickly; but it likewise rests on several carefully recorded experiments. With some animals, close interbreeding may be carried on for a long period with impunity, by the selection of the most vigorous and healthy individuals; but, sooner or later, evil follows. The evil, however, comes on so slowly and gradually, that it easily escapes observation, but can be recognised by the almost instantaneous manner in which size, constitutional vigour, and fertility are regained when animals that have long been interbred are crossed with a distinct family."

Regarding the very remarkable subject of sterility of sexual connection with special individuals only, Darwin says: "It is by no means rare to find certain males and females which will not breed together, though both are known to be perfectly fertile with other males and females. We have no reason to suppose that this is caused by these animals having been subjected to any change in their habits of life.....The cause apparently lies in an innate sexual incompatibility of the pair which are matched. Several instances have been communicated to me by Mr. W. C. Spooner (well known for his essay on Cross-breeding), by Mr. Eytton of Eytton, by Mr. Wicksted, and other breeders, and especially by Mr. Waring of Chelsfield, in relation to horses, cattle, pigs, foxhounds, other dogs, and pigeons. In these cases, females which either previously or subsequently were proved to be fertile, failed to breed with certain males, with whom it was particularly desired to match them. A change in the constitution of the female may sometimes have occurred before she was put to the second male; but in other cases the explanation is hardly tenable, for a female known not to be barren has been unsuccessfully paired seven or eight times with the same male, likewise known to be perfectly fertile. With cart-mares, which sometimes will not breed with stallions of pure blood, but subsequently have bred with cart-stallions, Mr. Spooner is inclined to attribute the failure to the lesser sexual power of the racehorse; but I have heard, from the greatest breeder of racehorses at the present day, through Mr. Waring, that it frequently occurs with the mare to be put several times during one or two seasons to a particular stallion of acknowledged power, and yet prove barren, the mare afterwards breeding at once with some other horse. These facts are worth recording, as they show, like so many previous facts, on what slight constitutional differences the fertility of an animal often depends."

Before leaving the subject of the causes of sterility of animals, I quote a passage from Darwin regarding the results of confinement. "Sufficient evidence," says he, "has now been advanced to prove that animals, when first confined, are eminently liable to suffer in their reproductive systems. We feel at first naturally inclined to attribute the result to loss of health, or at least to loss of vigour; but this view can hardly be admitted, when we reflect how healthy, long-lived, and vigorous many animals are under captivity, such as parrots, and hawks when used for hawking, cheetahs when used for hunting, and elephants. The reproductive organs themselves are not diseased, and the diseases from which animals in menageries usually perish are not those which in any way affect their fertility. No domestic animal is more subject to disease than the sheep, yet it is remarkably prolific. The failure of animals to breed under confinement has been sometimes attributed exclusively to a failure in their sexual instincts. This may occasionally come into play; but there is no obvious reason why this instinct should be specially liable to be affected with perfectly tamed animals, except, indeed,

indirectly, through the reproductive system itself being disturbed. Moreover, numerous cases have been given of various animals which couple freely under confinement, but never conceive, or, if they conceive and produce young, these are fewer in number than is natural to the species. In the vegetable kingdom, instinct, of course, can play no part; and we shall presently see (he says) that plants, when removed from their natural conditions, are affected in nearly the same manner as animals. Change of climate cannot be the cause of the loss of fertility; for, whilst many animals imported into Europe from extremely different climates breed freely, many others, when confined in their native land, are completely sterile. Change of food cannot be the chief cause, for ostriches, ducks, and many other animals, which must have undergone a great change in this respect, breed freely. Carnivorous birds, when confined, are extremely sterile; whilst most carnivorous mammals, except plantigrades, are moderately fertile. Nor can the amount of food be the cause; for a sufficient supply will certainly be given to valuable animals; and there is no reason to suppose that much more food would be given to them than to our choice domestic productions, which retain their full fertility. Lastly, we may infer, from the case of the elephant, cheetah, various hawks, and of many animals which are allowed to lead an almost free life in their native land, that want of exercise is not the sole cause. It would appear that any change in the habits of life, whatever these habits may be, if great enough, tends to affect in an inexplicable manner the powers of reproduction. The result depends more on the constitution of the species than on the nature of the change; for certain whole groups are affected more than others; but exceptions always occur, for some species in the most fertile groups refuse to breed, and some in the most sterile groups breed freely. Those animals which usually breed freely under confinement, rarely breed, as I was assured, in the Zoological Gardens, within a year or two of their first importation. When an animal which is generally sterile under confinement happens to breed, the young, apparently, do not inherit this power; for, had this been the case, various quadrupeds and birds which are valuable for exhibition would have become common. Dr. Broca even affirms that many animals in the Jardin des Plantes, after having produced young for three or four successive generations, become sterile; but this may be the result of too close interbreeding. It is a remarkable circumstance, that many mammals and birds have produced hybrids under confinement quite as readily as, or even more readily than, they have procreated their own kind. Of this fact, many instances have been given; and we are thus reminded of those plants which, when cultivated, refuse to be fertilised by their own pollen, but can easily be fertilised by that of a distinct species. Finally, we must conclude, limited as the conclusion is, that changed conditions of life have an especial power of acting injuriously on the reproductive system. The whole case is quite peculiar; for those organs, though not diseased, are thus rendered incapable of performing their proper functions, or perform them imperfectly."

THE METEOROLOGICAL SOCIETY.—The usual monthly meeting of this Society was held on Wednesday evening, the 21st February; Mr. J. K. Laughton, F.R.A.S., President, in the chair. The following papers were read—1. "Notice of a remarkable land fog bank, 'The Larry,' that occurred at Teignmouth, on October 9th, 1882," by G. W. Ormerod, M.A., F.M.S. The "Larry" is a dense mass of rolling white land fog, and is confined to the bottom of the Teign valley, differing therein from the sea fog which rises above the tops of the hills; it appears about daybreak, and has an undulating but well defined upper edge, which leaves the higher part of the hill sides perfectly clear. The author gave an account, illustrated by photographs, of the remarkable fog bank that occurred at Teignmouth on the morning of October 9th. 2. "Barometric depressions between the Azores and the continent of Europe," by Captain J. C. de Brito Capello. The author gave the tracks of several depressions from the Azores to Europe, and showed that if there had been a telegraphic cable, nearly every one of them could have been foretold in England. 3. "Weather-forecasts and storm-warnings on the coast of South Africa," by Captain C. M. Hepworth. 4. "Note on the reduction of barometric readings to the gravity of latitude 45°, and its effects on secular gradients and the calculated height of the neutral plane of pressure in the tropics," by Professor E. D. Archibald.