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DARWIN ON THE EFFECTS OF CROSS AND SELF FERTILIZATION IN PLANTS.

It is impossible to finish the perusal of any of Mr. Charles Darwin's works without a genuine feeling of admiration, not only for the manner in which the investigator pursues every branch of the great principles he has enunciated to its minutest ramification, but for the almost inconceivable patience with which he accumulates grain after grain of proof, until his position is not only firmly established but seems possessed of even a superabundant support. For eleven years he has been conducting the difficult and delicate inquiry of which his recent volume is the record; and yet the result to be adduced, from the great mass of facts so slowly and laboriously gathered, is no strikingly novel discovery, although much is embodied that is new. It is rather a substantiation of opinions already enunciated, leading to their wider generalization. His conclusion is closely connected "with various important physiological problems, such as the benefit derived from slight changes in the conditions of life, and this stands in the closest connection with life itself. It throws light on the origin of the two sexes, and on their separation or union in the same individual, and lastly on the whole subject of hybridism, which is one of the greatest obstacles to the general acceptance and progress of the great principle of evolution."

In briefly reviewing Mr. Darwin's new work, or rather its conclusions, for we cannot attempt the consideration of his countless experiments, it is best to begin by the repetition of his own statement, made to avoid misapprehension, namely, that the term "crossed plant seedling, or seed," means one of crossed parentage, that is, one derived from a flower fertilized with pollen from a distinct plant of the same species. And a self-fertilized plant seedling, or seed, means one of self-fertilized parentage, that is, one derived from a flower fertilized with pollen from the same flower, or sometimes from another flower on the same plant.

From his observations on plants, and guided to a certain extent by the experience of breeders of animals, Mr. Darwin many years ago became convinced that it is a general law of Nature that flowers are adapted to be crossed at least occasionally by pollen from a distinct plant. It often occurred to him that it would be advisable to try whether seedlings from cross-fertilized flowers were in any way superior to those from self-fertilized flowers. It so happened that, without any thought of the above inquiry, he raised close together two large beds of self-fertilized and crossed seedlings from the same plant of *linaria vulgaris*. To his surprise, the crossed plants, when fully grown, were plainly taller and more vigorous than the self-fertilized ones. As it seemed quite incredible that the difference between the two beds of seedlings could have been due to a single act of self-fertilization, Mr. Darwin attributed the fact to some accidental cause; but in order to test the matter, he prepared two more beds from the carnation *dianthus caryophyllus*, which, like the *linaria*, is almost sterile when insects are excluded; and hence the inference may be drawn that the parent plants must have been intercrossed during every, or almost every, previous generation. Nevertheless, the self-fertilized seedlings were plainly inferior in height and vigor to the others. This was the starting point of Mr. Darwin's experiments, conducted with all the refinement and minuteness necessary for the most accurate of observations.

Of the conclusions reached, the first and most important is that cross-fertilization is generally beneficial, and self-fertilization injurious. This is shown by the difference in height, weight, constitutional vigor, and fertility of the offspring from crossed and self-fertilized flowers, and in the number of seeds produced by the parent plants. The advantages of cross-fertilization do not follow from some mysterious virtue in the mere union of two distinct individuals, but from such individuals having been subjected during previous generations to different conditions, or to their having varied in a manner commonly called spontaneous; so that in either case their sexual elements have in some degree differentiated. Again, the injury from self-fertilization follows from the want of such differentiation in the sexual elements. Thus when plants of the *ipomœa* and of the *mimulus*, which had been self-fertilized for the seven previous generations, and had been kept all the time under the same conditions, were intercrossed one with another, the offspring did not profit in the least by the cross. On the other hand, as showing that the benefit of a cross depends on the previous treatment of the progenitors, plants which had been self-fertilized for the eight previous generations were crossed with plants which had been intercrossed for the same number of generations, all having been kept under the same conditions as far as possible. Seedlings from this cross were grown in competition with others derived from the self-fertilized mother-plant crossed by a fresh stock; and the latter seedlings were to the former in height as 100 to 52, and in fertility as 100 to 4.

Under a practical point of view, agriculturists and horticulturists may learn much from the above conclusions. Thus it appears that the injury from the close breeding of animals and from the self-fertilization of plants does not necessarily depend on any tendency to disease or weakness common to the constitution of the related parents, and only indirectly on their relationship, in so far as they are apt to resemble each other in all respects, including their sexual nature; and secondly, that the advantages of cross-fertilization depend on the sexual elements of the parents having become in some degree differentiated by the exposure of their progenitors to different conditions, or from their having intercrossed with individuals thus exposed, or from spontaneous variation. Animals to be paired should therefore be kept under as different conditions as possible, and excellent results have been obtained from the interbreeding of individuals reared on distant and differently situated farms. With all species of plants which freely intercross, by the aid of insects or the wind, the best plan is to secure seeds of the required variety which have been raised for some generations under as different conditions as possible, and sow them in alternate rows with seeds matured in the old garden. The intercrossing of the stocks will yield far more favorable results than any mere exchange of seeds. Florists may learn that they have the power of fixing each fleeting variety of color, if they will fertilize the flowers of the desired kind with their own pollen for half a dozen generations, and from the seedlings under the same conditions. But a cross with any other individual of the same variety must be carefully prevented, as each has its own constitution. After a dozen generations of self-fertilization, the new variety will probably remain constant, even if grown under different conditions; and there is no longer any necessity of guarding against intercrossing.

With respect to mankind, Mr. George Darwin has concluded, from a statistical investigation which has already been reviewed in these columns, that the evidence of any evil due to the intermarriage of first cousins is conflicting, and on the whole points to the same being very small. Our author infers that, with mankind, the marriages of nearly related persons, some of whose parents and ancestors had lived under very different conditions, would be much less injurious than that of persons who had always lived in the same place and followed the same habits of life. He sees no reason to doubt that the widely different habits of life of men and women in civilized nations, especially amongst the upper classes, would tend to counterbalance any evil from marriages between healthy and somewhat closely related persons.

THE TRANSMISSION OF CORRECT TIME.

The public clocks in the city of Vienna, Austria, are at present driven by a pneumatic system, actuated at the Imperial Observatory by an automatic arrangement connected with an astronomical timepiece. The idea originated with an engineer named E. A. Mayrhope, who had long experimented with the transmission of time by means of electricity, and at last gave it up in favor of pneumatic transmission, which is free from the drawbacks and uncertainties connected with the use of electric batteries, insulated wires for transmission, delicate contact breakers, and other complicated arrangements. Such annoyances have occurred in the experiments made in this country, where electric arrangements for the transmission of time have thus far never been in use for any considerable period. Some years ago, a time ball in the New York Custom House, intended to be regulated by an electric current from the Dudley Observatory at Albany, soon failed, because of the constant attention required, which could only be expected from persons specially engaged and exclusively interested in electric transmissions. Therefore it is not to be expected that such an enterprise can be successful until telegraph companies take hold of the matter; and only in such case is there possibility of a regular working of electric timepieces.

The method of Mr. Mayrhope consists in originating a wave of compressed air, which is sent through airtight tubes laid along the street gas mains to all the public clocks. This wave is transmitted once every minute, when the minute hands of all the clocks move forward the required distance. It is intended to extend this system until it includes the clocks in all the schools, public institutions, hotels, railroad depots, and the houses of such persons as desire it.

There is no doubt that this method has the enormous advantage of simplicity, especially when applied to a great number of clocks. Such a pneumatic tube may have ever so many branches; and at the end of every branch the impulse must invariably reach the moving lever which, pushed by an elastic membrane, will propel the minute hand. It must, however, be borne in mind that, by this system, the clocks will not move so instantaneously as by the electric current. Electricity is transmitted over a telegraph wire with a velocity of from 4,000 to 12,000 miles per second, according to the perfection of the insulation; therefore the motion of the various clocks will be practically isochronous. But the wave of compressed air, transmitted by the elasticity of the atmosphere, moves only with the velocity of sound, which is, on an average, only 1,100 feet, or little over one fifth of a mile, per second, *minus* the resistance in the narrow tubes, which may reduce it somewhat; so that its velocity of transmission may vary from 25,000 to 70,000 times less than that of electricity. This, however, is of little practical importance, as it would only cause the clocks to be one second behind for every 1,100 feet distance from the central station; and if in some cases seconds had to be counted, the correction would be easily applied. Clocks at a mile distance would be about five seconds behind; and the correct amount having been determined by direct observation, a constant number would have to be added to the time indicated by each clock, in order to find the correct time to within a fraction of a second.

But if we go into such close calculations, the difference in time for difference in longitude ought not to be neglected. At the latitude of Vienna, the degrees of longitude are nearly forty-six miles long: that means that meridians drawn on whole numbers of degrees are nearly forty-six miles apart.

The sun crosses each meridian every four minutes; the time for the meridians to the east from the central station is therefore, for every degree, always four minutes earlier, and for meridians to the west four minutes later, than it is at the central station. Four minutes for 46 miles, or two hundred and forty seconds for 241,040 feet, is at the rate of 1,000 feet for one second: a velocity a little less than that of sound. So that the propulsion of the air wave, when going directly west, would slightly overtake the solar movement; and if sent at noon from the central station, it would arrive at a western station before the sun passed the meridian of such western station. If we make the calculation for the latitude of New York city, we come to the curious result that the wave of compressed air, or the sound wave, travels west at the same rate as the sun does; as, in our latitude, the degrees of longitude have a length of nearly 50 miles, which is passed over by the sun in four minutes, being at the rate of 262,000 feet in two hundred and forty seconds, or very nearly 1,100 feet per second. Therefore, if a pneumatic system of transmitting time were adopted here, the impulse would, in tubes running directly from east to west, be transmitted at the same rate as the solar motion, and a wave sent from Brooklyn at noon would arrive in five seconds in New York, where it would then be exactly noon; and it would arrive in Jersey City in another five seconds, where the sun would then cross the meridian, and so on, traveling west and keeping pace exactly with the solar time.

THE UTILIZATION OF RATS.

Most people have an instinctive aversion to rats, classing them with snakes, bedbugs, mosquitoes, and other evils of this world, allowed to exist by an inscrutable Providence for reasons past human discovery. Beyond having a vague knowledge that the heathen Chinee devours the murine tribe, and deems the unsavory-looking rodent a delicacy, the average thinker on the subject can perceive no utilization for the vagrant denizen of cellars and wharves, save (indirectly) in his furnishing an object to be caught by the multiplicity of ingenious traps which inventors have constructed, and serving as a source of perpetual nervousness to the wiry Scotch terrier who spends his days in searching for him under parlor sofas, behind furniture, and in every other shady corner where the illogical canine mind conceives a rat might possibly shelter himself. The fact of the case is that the rat is in reality a useful animal; and as we showed recently in a discussion on bedbugs, it is a violent assumption for anyone to suppose that any living thing does not serve, or may not be made to serve, a useful purpose. Moreover, it is equally erroneous to assert that a rat is a noxious beast. To be sure, he breeds with astonishing rapidity, and he has the failing of cannibalism toward his progeny. But so has his arch enemy, the well fed tom cat. He is pugnacious, but rarely attacks man save in defence of his life. On the other hand, he is scrupulously neat, even more so than the average male feline. As a scavenger, his labors are of great value in the filthy cities of the Orient; and his tail is a marvel of constructive design and a source of perpetual admiration to the anatomist. Unfortunately he is a pronounced kleptomaniac; and this, with his supposed proclivity to take refuge in the vicinity of female ankles, makes him a pariah and an outcast among four-footed things. Yet mark the inconsistency: On the fair hand of the damsel, who shrilly shrieks at the sight of that wonderfully constructed tail whisking into a friendly hole, may be a glove—or at least the thumb of it—made from that despised creature's skin, and called by courtesy a "kid." On the head of paterfamilias, who ruthlessly pursues the fugitive interloper with the kitchen poker, may be a felt hat made from the rat's fur, which exceeds in delicacy that of the beaver, and which is sought after by a large corporation, expressly organized for the purpose, in Paris. An eccentric Welshman once, in order to show how far the rat might be utilized for clothing, spent three years in collecting enough ratskins to make himself a complete dress, hat, neckerchief, coat, waistcoat, trousers, and even shoes; six hundred and seventy rats were immolated for this purpose, and the six hundred and seventy beautifully organized tails were strung together to form a tippet.

It is in Paris—that home of the utilization of everything—that the rat is turned to the greatest number of uses. He furnishes employment for an army of hunters, who pursue him in his sewer fastnesses for the sake of his skin. In the great abattoirs of the city rats exist by the million. One proprietor, on becoming nearly driven from his premises by the rodents, threw a dead horse in a walled inclosure, and then stopped up all means of escape, so that the rats, attracted by the bait, could not get out. In one night 2,650 rats were caught in the trap and killed by men armed with clubs; in a single month, 16,050 of the animals were thus destroyed. We note this case mainly in connection with a curious utilization of rats, wherein dead animals of all kinds are placed where they can get them as an easy way of disposing of the refuse flesh and securing the valuable bones. A regular pound, surrounded by a massive stone wall, is provided for this purpose by the city authorities of Paris, and it is the regular morning's work of those in charge to remove the beautifully polished skeletons.

Of course, when thus pampered, the rats multiply amazingly, and therefore once in a while a grand *battue* is necessary to reduce their numbers. The way in which this is conducted is curious. Horizontal holes are bored all around, in and at the foot of the inclosing walls, the depth and diameter being respectively the length and thickness of a rat's body. Upon the morning of the *battue*, men armed with tin pans, kettles, drums, and other objects for producing horrible noises, rush in at daybreak. The astonished rats precipitately rush for the nearest openings, which are those in the walls. But these, while large enough to contain their bodies, will not accommodate their tails, and the walls are soon ornamented with a vista of those anatomically superb members, whisking about like animated icicles. Then arrives the rat collector—a scientist in his way—who, with admirable dexterity, seizes the pendent tails, jerks forth the owner attached thereto, and deposits him in a bag worn over the left shoulder. The privilege of catching the rats is farmed out by the authorities, and a profitable business it is. The rats are sleek and fat, and fetch high prices for their fur, skins, and flesh—the latter doubtless appearing in the restaurants where one may have "dinner for one franc with wine, bread at discretion." Rat flesh is not bad eating, at least so say those who have tried it, our knowledge in the matter being limited. It is delicate, white, firm, tastes like chicken, and in China the soup made from it is considered to be equal to our well known oxtail. In the Celestial Kingdom rats are worth two dollars per dozen. In the West Indies the rats exist in enormous numbers on the sugar plantations, and work great damage by gnawing the growing sugar cane. Each plantation has its official ratcatcher, who is paid by piecework, that is, so much a dozen for tails brought in.

The credit of suggesting the most extensive utilization of rats is due to Mr. P. L. Simmonds, who has lately printed an admirable work on these and other undeveloped sources of profit—from which we have drawn many of the curious facts above given. Mr. Simmonds suggests that a profitable venture might be made from Kurrachee to Canton and Hong Kong of salted rats. About 7,000,000 could be cured and packed aboard a 400 ton ship. For the sake of curiosity we quote Mr. Simmond's estimate of profits: 7,000,000 rats at 6 cents per dozen, $35,000; salting, curing, etc., 60 per cent, $21,000; total cost, $76,000; and 7,000,000 rats sold at $2 per dozen, $1,166,666.66, shows a profit of $1,090,666.66. There! No one can charge us—thanks to Mr. Simmonds—with not having done our best to enrich our readers. Few journals can claim the proud laurel which we boldly now grasp, of having pointed out the way for anyone to become a millionaire.

A FIFTY THOUSAND DOLLAR BOTCH THAT THE PEOPLE PAID FOR.

There will be found, recounted with much detail, in the recently issued report of the Chief of Ordnance of the United States army, about as glaring and inexcusable an instance of waste of the people's money, through a series of mechanical blunders, as can probably be found in the already long category of expenditures for fruitless tests of military inventions. Fifty thousand dollars have been squandered in an attempt to manufacture one 9 inch cannon according to the plans of Mr. Alonzo Hitchcock. The story of the various botches and mistakes, which we summarize briefly below, would verge upon the laughable, were it not well calculated to render any thoughtful mechanic ashamed of the men who did the work, as well as of those who permitted it to continue in the manner recounted for a period of over two years.

The Hitchcock system of cannon making is based on the welding together of a number of wrought iron rings, which are seated on an anvil located upon the piston of a hydraulic press. The latter is lowered as the rings are added, and a furnace is provided for keeping the rings hot while being hammered. In this way a gun is gradually built. This description is very general, but it will serve to convey a sufficient idea of the invention to appreciate what follows. Early in February, 1873, Mr. Hitchcock was granted an appropriation of $50,000 for the manufacture of his gun at the Springfield armory, and given the supervision of the work; and every opportunity was afforded him for making the most careful studies. But so vague were his plans at the outset that he neglected even to have working drawings made of a part of his plans until the mechanics had actually begun labor thereon. The preparations consisted in blasting a pit 40 feet deep into the solid rock, lining it with concrete, and afterwards with a huge iron tank. Two months later, after a part of the ponderous machinery above this had been erected, Mr. Hitchcock concluded to cut the holes, which received his steam hammer supports, down four feet. This was then a very slow and difficult operation, as blasting, owing to the concrete, could not be resorted to. Finally, in August, 1874, the hammer was built, and steam was let on; but the machine refused to work. The hammer bound against the steam cylinder, and unlimited filing of shafts became necessary. "Had Mr. Hitchcock made a careful inspection of these machines when he visited the ironworks for that purpose," the reporter says, "this would not have happened." Then it was discovered that, through a blunder, the anvil pit was not deep enough, and more alterations had to be made.

By April, 1875, more than two years after the work had begun, the furnaces were furnished, and tested satisfactorily, and preparations were made to heat one of the gun disks. Prior to beginning work, tests were made of the water bottom on which the disks rest in the furnace; but through some stupidity, the exhaust valve of the same was closed, so that steam was generated, which drove back the water in the supply pipe. Thereupon "somebody," in a state of great excitement, opened the valve suddenly, relieved the steam pressure, in poured the cold water, and of course the water bottom cracked. The diary of the ordnance lieutenants engaged upon the work now becomes amusing reading. We quote a few extracts: "April 7. Mr. Hitchcock proposes to make a false bottom of sand." "April 8. Tried to resolve piece in heating furnace through the door with a wrench-shaped tool. Piece stuck on hearth, and gaspipe handle grew soft by heat, and bent. Hammer accidentally dropped on the furnace lid crane, which was standing directly under it. Mr. Hitchcock at the throttle." "3:25 P.M. The top piece" (suspended in hammer furnace) "is lowered; it strikes one of the corners of the cast iron center, melts the corner, and topples the piece over. 3:28 P.M. Fortunately by this time it is too cold to stick. 3:35 P.M. It is decided to draw fires." Mr. Hitchcock decides that a cast iron water bottom is essential; but two days later he changes his mind, and concludes to tinker the old cracked bottom with an iron hoop. This promptly burst on being used, and the inventor set about making a wrought iron water bottom, having a locomotive tire for a rim. This was made and inserted, and operations now progressed to the welding of several disks—not, however, without an interesting variety of accidents which we shall not recapitulate. The sixth piece to be added was accidentally dropped, and the unfortunate water bottom was again damaged, and caused to bulge and leak. The pieces welded were cut up and the welds found bad. More alterations of the machinery followed, and at last, in June, fires were again started; but, to quote the official report again, "Mr. Hitchcock dropped the hammer upon the first ring, and found himself unable to raise it again." The anvil had not been properly adjusted, the hammer fell too hard, and away went the cylinder head. Two weeks later, another attempt was made to weld together two large disks to form the breech of the gun. But "the hook at the end of the chain sustaining the transfer tongs became heated, and straightened out, allowing the upper disk to fall. Before the disk could be placed in proper position, it had become chilled, had to be reheated, and finally a weld was made; but this, on examination, was again found to be exceedingly bad."

We have given the above in some detail in order to exhibit to the reader the placid effrontery with which Mr. Hitchcock, in his letter dated June 24, 1875, declining to proceed further with his gun, explains the reasons for this grand series of botches and blunders. We quote *verbatim:* "Notwithstanding the machinery, all works satisfactorily; I find that, by practical operation, there is great danger of uncertainty about the old reverberatory furnaces, which we now have in the works. This was, however, well understood by the Ordnance Board; and all practical furnace men knew that there are better furnaces in use, as, for instance, the gas or Siemens' regenerative furnace; but simply for prudential motives, it was deemed sufficient to test my mechanical mode of welding up guns as I proposed, leaving the furnaces to future consideration if the machinery would do the work, as was promised. We are trying to make impossible things possible, and going squarely in the face of all known facts in science and practical knowledge that have been developed within the last ten or twelve years."

Mr. Hitchcock makes these statements after two years and nine months' experiment, and after the $50,000 of the people's money is all but exhausted. With reference to them, Colonel Benton says: "All parts of his gun machinery, including the furnaces, were designed by Mr. Hitchcock, and were constructed under his immediate supervision and without limitation in the selection of the nature of the furnace." Further comment is needless.

Explosive Compounds.

Two more instances of unexpected decomposition, accompanied with some degree of violence, have lately been brought to our notice. The first happened with iodide of strychnia: a bottle, in which some of the salt had been long kept, was held near the fire, to warm the glass and loosen the stopper. An explosion suddenly occurred, scattering the glass and badly wounding the hand. The other accident was related by Mr. B. F. McIntyre, at a meeting of the Alumni Association of the New York College of Pharmacy. On distilling essential oil of bitter almonds over nitrate of silver, to free it from prussic acid, toward the end of the operation the material in the retort violently exploded, breaking all the glass apparatus in the proximity, but doing no further damage. Neither explosion can be very easily explained; in fact, few explosions can, except in a general way. In regard to the iodide of strychnia, it is supposed that the substitution compound had formed, on decomposition, some iodide of nitrogen, in a somewhat similar manner to the production of that substance when iodine is treated with an excess of ammonia. As to the reaction which occurred between oil of bitter almonds and argentic nitrate, it may be said not to be altogether extraordinary, as the silver is known to readily form explosive compounds with a number of organic substances. The only wonder is that no mention has been made of it before this time, for the rectification of the essential oil over nitrate of silver is not an unfrequent operation, while it seldoms happens that one has occasion to heat old iodide of strychnia.

To Protect Molten Lead from Explosion.

Molten lead, when poured around a damp or wet joint, will often convert the water into steam so suddenly as to cause an explosion, scattering the hot metal in every direction. This trouble may, it is said, be avoided by putting into the ladle a bit of rosin the size of a man's thumb, and melting it before pouring.