

On the Argument of the Origin of Species:

The Art of Breeding and the Explanation of Nature

Darwin aims in the Origin of Species to displace the idea of the miraculous creation of plants and animals with a theory of their gradual, genealogical descent. He discusses, of course, the bearing of paleontology and comparative morphology on the question of the transformation of living things. But such evidence, concerning the basic fact of transformation, appears only in the last third or so of the work. Darwin is primarily interested in the causes of this continuous change. The idea of the evolution of life on earth, an evolution involving untold ages and unrecorded circumstances, will not be convincing, it will seem purely imaginary, without some notion of how this process takes place. Darwin proposes to show the principal mechanism of evolutionary development; and this demonstration constitutes the first and most important part of his book-long argument.

Crucial to the account of evolution given in the Origin are Darwin's reflections on a human, technical activity: the art of breeding domesticated animals and cultivated plants. In the Introduction, he declares his interest in this technique as the best guide to theorizing about the natural transformation of species. "At the commencement of my observations", he writes,

it seemed to me probable that a careful study of domesticated animals and of cultivated plants would offer the best chance of making out this obscure problem. Nor have I been disappointed... I may venture to express my conviction of the high value of such studies, although they have been very commonly neglected by naturalists.

Never before Darwin had the experience of breeding been made the basis of a theory of nature or transformation. Darwin was better acquainted with the subject than academic naturalists, having collected information from breeders of every sort, and having himself raised pigeons. "Few would readily believe", he remarked, "in the natural capacity and years of practice required to become even a skilful pigeon-fancier." Darwin was in an excellent position to unite this technical experience and the theoretical problem of organic evolution.

This is not to say that breeding had been wholly neglected by nineteenth-century naturalists, or that it was absent from previous arguments for the development of species. Indeed, the possibility of natural transformation of species was first given serious scientific consideration on account of the accomplishments of human cultivation. French botanists in the mid-eighteenth century had disputed, on the basis of horticultural experience, whether some plant species were recent developments. The great naturalist, Georges Buffon, accepted the idea that many modern species descended from earlier forms; and he, too, had entertained the idea in light of evidence from domesticated creatures: he had considered how

environment and induced habits produced constitutional reactions in beasts. The camel's knees, for example, became tough and knotty in its service to man. At the start of the nineteenth century, the zoologist Lamarck had relied on evidence from domestication to argue his complete theory of transformation: he emphasized how the habits acquired by domestic fowl altered their form, and how change in environment affected cultivated plants. Curiously, Lamarck's doctrine was itself criticized on the evidence of breeding: it was pointed out that transformation of organisms observed under domestication reached definite limits.

Darwin's originality did not lie, therefore, in bringing the subject of domestic creatures to the problem of evolution. Rather, it lay in bringing a clear analysis of what is responsible for distinct domestic races. Buffon and Lamarck, in considering changes in domestic organisms, perceived the results of new conditions or habituation. For Darwin, however, these causes do not account for the essential character of man-made varieties. "Some little effect," he says,

may...be attributed to the direct action of the external conditions of life, and some little to habit; but he would be a bold man who would account by such agencies for the differences of a dray and race horse, a greyhound and bloodhound, a carrier and tumbler pigeon.

The key to understanding change in organisms under domestication, he observes, is man's power of accumulative selection: nature gives successive variations; man adds them up in certain directions useful to him.

In this sense he may be said to make for himself useful breeds.

Selection, continued selection of preferred individuals from each generation, is the chief principle of the development of domestic varieties.

With the recognition of selection as a force in domestic transformations, a true technical principle of organic change was established.

Buffon and Lamarck had not focussed on the role of art, of man's manipulations, when they viewed the creatures close to man. For them, changes in domestic species were due, not to human art, but to natural causes everywhere the same. Domestication simply represented a domain in which the results of those natural causes were most easily observed. Darwin, however, emphasized an artful, external action upon the living things, the deliberate direction of Nature's course by man. The recognition of the true art of breeding would bring new possibilities to the study of Nature--and also new problems.

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Let us have before us a clear picture of the breeder's work. Like any artist or craftsman, the breeder acts for an end. He aims to develop some preferred character in his plants or animals. The peculiarity of this art, however, is that it is extraordinarily conditioned by the live material on which it works. The breeder cannot pursue any end he might desire--say,

a hen that lays golden eggs--but he must gradually discover what ends may reasonably be entertained. Now, the perfected state of the art of breeding Darwin calls "methodical selection". Here the potentialities of the natural materials are well understood and can be brought out thanks to the breeder's skill. The breeder selects those individuals that approach the desired end; he exercises considerable control so that a favored trait is not lost in an unhappy pairing or unhealthy circumstances. Intercrossing with more ordinary individuals must be prevented; special food and protection must often be provided. Choice and control are the breeder's means, and an accomplished breeder can work toward an ideal variety from even an ordinary stock. One English gentleman bragged of his talent with pigeons, saying he would produce any given feather in three years, but it would take him six years to obtain head and beak. It was doubtless such professionalism that originally impressed Darwin, for it was this high state of the art that produced and preserved countless domestic breeds.

This brief look into domestication might already enable us to see, with Darwin, a possible analogy with organic evolution. If man develops useful and delightful varieties through selective breeding, perhaps there exists a similar power in Nature, by which species have developed naturally. It is an inviting way to think about the origin of species. The stable, the kennel, the greenhouse and the garden, the barnyard-- all might be

seen as microcosms of the entire living world!

But how can the art of breeding illuminate a natural process? In the artistic activity, there is always an end that guides the human agent in his production of this or that variety. What external agency in nature can select, and so direct, the variation of organisms, to produce the diversity of life on earth? This is the problem that emerges from Darwin's original analogy.

One way in which Darwin tries to ease his task is through what he calls "unconscious selection". "Unconscious selection" represents a transition in his argument from the goal-oriented "methodical selection" of the professional breeder, to the blind process of nature, which he will call "natural selection". "Unconscious selection" refers, like "methodical selection", to the action of men which alters a species, but in this case the alteration is unintentional and unforseen. Consider, for example, man in a primitive state. "If there exist savages so barbarous," Darwin writes,

as never to think of the inherited character of the offspring of their domestic animals, yet any one animal particularly useful to them, for any special purpose, would be carefully preserved during famines and other accidents, to which savages are so liable, and such choice animals would thus generally leave more offspring than the inferior ones; so that in this case there would be a kind of unconscious selection going on.

Then, there are the more civilized owners of animals and plants who simply buy and breed the creatures that they prefer. "A man who intends keeping point-

ers," Darwin observes,

naturally tries to get as good dogs as he can, and afterwards breeds from his own best dogs, but he has no wish or expectation of permanently altering the breed. Nevertheless (he says) I cannot doubt that this process, continued during centuries, would improve and modify any breed...

"Unconscious selection" also occurs when professional breeders do not all work according to exactly the same standard, or when they fall short of perfection, and so change the future of a breed in unexpected ways. Selection pursued with King Charles' spaniel had been so imperfect, Darwin tells us, that were King Charles alive, he would probably not recognize his dog.

Darwin's idea of "unconscious selection" is indeed suggestive of something that happens by nature as well as by art. But it would be wrong to imagine that this "unconscious" process is not still ruled by human goals. Indeed, the name "unconscious selection" is misleading on this point. For choices are made by the savages, the buyers, and the breeders according to standards or purposes of which they are fully aware. Moreover, the goals that inform their choices are not unrelated to the developmental results, and so they are responsible for the nature of the transformation, even if the agents are ignorant of the consequences of their action. For example, the naturally rare, blue parakeet became a fashionable pet in Victorian England, after one was acquired by the prince; and so the Victorians are responsible for the development of that race, even though no single bird-

lover planned to change the ^{whole} domestic species. It would seem, in fact, that recognizable transformation in a domestic creature would take place only to the degree that a common end was pursued by its human keepers. "Unconscious selection", therefore, might well be effective, as Darwin says, but it must be slower ^{and more haphazard} than the breeder's "methodical selection". "Unconscious selection" reveals no hidden natural force, but rather the importance of some end in the external agents of the change.

Therefore, the problem of explaining Nature by comparing it to human action remains. However gradually the end operates, however unexpected its effect, it is always present when man transforms living things; and Darwin must find something that can imitate this purposive action to explain the transformation of beings in Nature.

Let us turn to Darwin's explanation. It is based indeed on the claim that there is, external to natural beings, some "thing" that can act on them, and act as if for an end. This "thing" is their environment, organic and inorganic. Darwin describes the external conditions of Nature, with a view to their formative power, in his chapter on "The Struggle for Existence". There he considers the high rate of mortality in Nature. Its causes are readily recognized: change of climate or physical environment, scarcity of food, and success of predators. These are external causes of the death of organisms; and they are said to act with discrimination. For the indi-

viduals of a species, or any individuals which come into competition for life, are endowed with slight heritable differences. Those individuals of each species which do survive in the natural struggle--those which manage to feed themselves, to escape danger, and reproduce more often--do so, Darwin maintains, because their individual character has favored them over others of their kind.

Darwin's examples of this external action on a species, although they allude to an original human influence, suggest how this process operates in Nature. When ^{several} varieties of wheat are sown together, climate and soil determine which will crowd out the rest and flourish. One variety of mountain sheep, he observes, will eventually starve out another in their competition for grazing ground. Darwin also stresses the complexity of cause and effect in the ecological system-- the slightest change in one part producing an imponderable sequence of alterations. Introduce cats into the neighborhood, he notes, and because of their relation to mice, and that of the mice to insects, ultimately, wild flowers may suddenly become conspicuous in the area! Thus the "struggle for existence" represents a complicated, many-sided battle in Nature, in which living things are always and everywhere tested for their inherent strength. The total surrounding environment affects the character of a species as if for the end of improving the species' ability to survive in it. The environment is thus comparable

to the human breeder: the breeder preserves individual creatures according to the usefulness of their features to man; in natural circumstances, individuals are preserved according to the usefulness of their features for survival. The preservation in Nature of the more viable individuals, and their offspring, Darwin calls "natural selection".

From Darwin's description of the selective action of the environment, it is not clear how much effect external causes have on specific form. He believes, nonetheless, that natural selection is the principal means of all transformation, that external conditions, throughout geographical space and geological time, have been the main factors in the evolution of living things. It is best to observe straightaway that this claim, for the immense power of the environment over organisms and organic change, constitutes the central difficulty of his argument. This difficulty of extending natural selection to encompass all organic transformation may be better appreciated if we examine the doctrine more closely, bearing in mind the analogy of the breeder and the question of how external forces can act for an end.

The theory of natural selection links the development of a species to its particular environment. The environment, we indicated, replaces the breeder's action for a special end in producing a variety. The purposeful action of an environment finds expression in Darwin's notion of a "place" in the natural economy--what would be called today an "ecological niche". For example, Darwin says that when some "place" in nature's polity is not

so perfectly occupied as it might be,

natural selection will always tend to preserve all the individuals varying in the right direction, though in different degrees, so as better to fill up the unoccupied place.

One may think of the "natural place" of a species as the fitting of its natural activity or way of life to all the circumstances on which it depends.

With this in mind, the selective action of Nature on the individuals or variations of a species is not difficult to conceive. Bees, for instance, demonstrate a tendency to economize both their time and their wax; and neighboring hives might have competed, during rigorous seasons, to perfect this behavior. Or flowers might be considered to vie with one another to attract the insects that cross-pollinate them. These examples are Darwin's, and, like many of his examples, they illustrate the relative improvement of a specific activity, the advancement of a variety according to circumstances.

But when one considers the origin of some form or activity, rather than its relative perfection, the action of an environment or "natural place" is harder to conceive. The creativity or inventiveness of Nature, apparent in any survey of living things, seems strongly to suggest action for an end; and yet no environment can act for such a purpose. New places in the economy of Nature do not exist prior to the creatures that fill them: they are created by the emerging species. The responsibility for any development that leads in a new direction falls entirely on the changes of the organisms

themselves. According to Darwin, the resources of such creative change lie in the same individual variations that contribute to relative improvements; those variations which lead to a new form or activity must each arise spontaneously. The environment permits novelty, but cannot promote it. The necessity of a shift in the account, from external to internal causes, is more evident if we consider any of those revolutions in the history of life that have opened up rich, future possibilities: for example, flying in birds, or intense social organization in insects, or sexual reproduction, or thinking. Nothing in a natural environment can select for a promising future. The events of true evolutionary import, according to Darwin, must be accidents of organization; and each step on the way to these developments must have been a relative success at survival. The extent of extrapolation by the theory is clear. For even a human breeder, who can act for some future goal, brings forward no trait hinting at a novel mode of life.

At this point, we might review the general predicament that arises from Darwin's comparison of the art of breeding and Nature. On the one hand are the phenomena of Nature, so much more impressive and creative than the products of art; and on the other hand is the artful breeder, so much more intent on creative development than sub-human, environmental causes. It would seem that there must be some equalization of causes and effects in the realm of Nature, if Nature is to be explained. Darwin apparently produces this equity

through a reduction of the natural phenomena. He does not consider luxury and ingenuity of form to be essential features of Nature. Instead, he claims that Nature's products do not surpass the requirements of survival under environmental conditions. All natural organic transformation consists of the fitting of living things to particular circumstances, so that they may merely live. All organic features are useful in the struggle for life, for only thus have they been able to arise. External natural causes appear effective in evolution, because the natural effects are defined as just what those causes can produce. As Darwin pursues his reasoning, from human art to natural selection, a utilitarian doctrine of life emerges. Beautiful and noble creatures become self-maintenance machines.

As man can produce and certainly has produced a great result by his methodical and unconscious selection, what may not nature effect? Man can act only on external and visible characters; nature cares nothing for appearances, except in so far as they may be useful to any living being. She can act...on the whole machinery of life.

The idea of external, natural selection becomes a new description as well as a new explanation of living form. The fact of the marvellous diversity of life--the existence of penguins and panthers, centipedes and seahorses--the fact that doubtless inspired Darwin's quest, becomes incidental to the principles of his theory.

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We have seen that Darwin meant his analogy of the breeder to explain the development of species by external causes. Yet his emphasis was not on the power of particular causes, but rather on the alleged effects of a universal natural process. But perhaps it would be helpful to look at the breeder and Nature from a different angle, to look at those causes in Nature which might be said to "select". From this angle, Darwin's picture of the "struggle for existence" might be seen to present not just the complexity and inconstancy of an organism's environment, but many definite things which act, one upon another. For instance, it might be said--though Darwin does not say it--that this soil "selects" that wheat, in a way truly analogous to the farmer. Why, indeed, should such a comparison not be made between the breeder and particular causes in Nature? Why should man, who is a single part of Nature, not be likened to another, identifiable part? This use of the breeding analogy might be made quite rigorous-- and might help illuminate the scope and sense of "natural selection".

Let us confine this new analogy to men and other animals. Restricting it in this way, we may draw inspiration from Darwin's broader teaching. Some of Darwin's finest insights concern the comparison of man to lower animals. His early notebooks contain numerous remarks on the likeness between human and animal behavior, observations incorporated into his later

writings on man. While the analogy of human and animal activity is not a major theme of the Origin of Species, examples of the analogy can be discovered there. Consider, for instance, this comparison of a caterpillar and a musician:

As in repeating a well-known song, so in instincts, one action follows another by a sort of rhythm; if a person be interrupted in a song, or in repeating anything by rote, he is generally forced to go back to recover the habitual train of thought: so P. Huber found it was with a caterpillar, which makes a very complicated hammock; for if he took a caterpillar which had completed its hammock up to, say, the sixth stage of construction, and put it into a hammock completed up only to the third stage, the caterpillar simply re-performed the fourth, fifth, and sixth stages of construction. If, however, a caterpillar were taken out of a hammock made up, for instance, to the third stage, and were put into one finished up to the sixth stage, so that much of its work was already done for it, far from feeling the benefit of this, it was much embarrassed, and, in order to complete its hammock, seemed forced to start from the third stage, where it had left off, and thus tried to complete the already finished work.

So, let us see what living things are comparable to the human breeder.

There are not many breeders in Nature, it is true. But insects, and especially ants, whose social networks seem like bizarre images of the human world, perform something reminiscent of domestication. There are "slave-making" ants, for example, that employ ants of another species in various duties supporting their nest. There is also a species of ant that domesticates aphids, in order to milk them. The ants draw off a sweet secretion from the smaller insects. These creatures are all mentioned in the Origin of Species. The aphid-milking ants illustrate especially well the similarity of an animal to a human keeper. Darwin does not bring out this aston-

ishing similarity, except accidentally, when he tells us of his own attempt to milk some aphids, by tickling and stroking them!

We might proceed from these insect-domesticators, to another natural relationship reminiscent of human breeders. Consider the many bees and other insects that feed on the nectar of flowers, and thus help fertilize the plants. These animals resemble, in a way, the human gardeners who further their favorite floral varieties by gathering choice pollen. Insects and flowers are just one example of the multitude of inter-species relationships in Nature. Any of these relationships might be compared to man's relation to domestic creatures. Human uses of plants and animals include a form of natural predation; and in every predatory relationship individual prey are continually chosen. The fox, renowned for his cunning, picks out the weakest rabbit, and is said thus to improve the group. How much he resembles the human keeper of a rabbit-hutch, destroying his inferior animals!

Comparing man and animals certainly puts human activity in a new light. It is curious if Darwin did not think of his own animal examples as particular analogues of the human breeder; but he does not employ them in this way. Observing the predation of wolves upon deer, for instance, he focusses his attention on the wolves' capacity to run. He compares their improvement through natural selection to man's breeding of faster greyhounds. Darwin does not mention the more vivid "selection" of the slower deer by the wolves;

and he avoids saying that the fleeing deer select their aggressors. Hence a definite analogy with a human breeder, actively eliminating individual animals, is lost from view.

Why did Darwin not pursue the analogy of the breeder with particular natural agents, with the animals or elements that play a part in the "struggle for existence". The answer would seem to lie with his theoretical intention to explain the entire history of life on earth. The analogy of the breeder with animals, while making "natural selection" particularly graphic, is not conducive to that universal explanation. On the contrary, the analogy with animals seems to limit the importance of external causes. It suggests only a means of relative change, between two existing specific groups-- whether it be wolves and deer, or man himself and the canine companion he has bred throughout history. It shows us the main factor in adjustments among living forms, but not the main cause of the existence of those forms themselves.

In order to explain the entire transformation of life, Darwin must look beyond the power of one species upon another, to a universal power affecting the whole living realm. The natural analogue of the human breeder must be, not some other animal, but an abstract agency shaping all particular beings. It is not surprising that Darwin should personify natural selection. At one point, he describes natural selection as

daily and hourly scrutinizing, throughout the world, every variation, even the slightest; rejecting that which is bad, preserving and adding up all that is good; silently and insensibly working, whenever and wherever opportunity offers, at the improvement of each organic being in relation to its organic and inorganic conditions of life.

The hypothesis of a supreme, creative being, over and above living things, follows clearly from Darwin's analogy of evolution with the art of breeding.

And the explanation of the phenomena of organic nature, indeed, calls for something like man's foresight in selective breeding, or ^{something} even more powerful.

But natural selection is neither an intelligence nor even a single being, but a blind and complicated process. Its great influence in the transformation of living things is more easily asserted than ascertained.

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The process of selection is only one side of the Darwinian story of evolutionary development. Selection is based, of course, on the presence of individual variants continually arising in a species. Darwin calls the natural variability of plants and animals "the foundation for the work" of selection. As we have only alluded to variation in discussing the analogy of man and Nature, we might turn our attention, finally, to this part of Darwin's theory.

However one approaches Darwin's doctrine, by reflecting on the achievements of the breeder, or the effects of the natural environment and struggle

for existence, variation indeed plays a fundamental role. According to the theory, the individual differences among organisms are the source of all the specific qualities that are preserved in the competition for life. Darwin maintains that variation is indefinite in direction and unlimited in quantity. It does not incline by itself, over generations, toward any new specific forms; but rather, individual differences in character emerge at random and are preserved in the struggle for life and accumulated in a species, if they prove useful. The important question would seem to be: how does Darwin establish his view of variation?

Darwin had available to him little information on variability of plants and animals in a natural state. In particular, he had to demonstrate that adequate variation occurred in Nature; since then-current opinion was that species varied less in the wild than under domestication. The second chapter of the Origin considers this subject.

The chapter "Variation under Nature" is mainly a study of the wild varieties of plants recorded in comprehensive botanical catalogues. There Darwin tries to show that the largest and most successful genera of classified plants include the greatest number of well-marked varieties; and he argues that these varieties have been successful because they have inherited the characteristics that favored the original generic type. The observation certainly suggests the fact of a gradual, evolutionary development; but it

does not necessarily contribute to the view of variation as filtered by natural selection. For the fully-established varieties, which Darwin employs and refers to as "incipient species", are too distinct to show that variability is a random process. Neither do they show the after-effects of natural selection: Darwin noted that these varieties were distinguished only by formal characters--characters of no vital necessity or utility in the struggle for life. He regarded the mere existence of these varieties as proving that slight differences within a group occur in Nature, differences which could be favored or disfavored by new conditions. He suspected, so he said, that the plants had not yet been weeded out by natural selection. But if Darwin thus showed the existence of significant natural variations, he inadvertently suggested the insignificance of natural selection. For his claim of the eventual possibility of an external, selective process is not actual evidence of one. Darwin did not seem to suspect that these varieties, or "incipient species", without the marks of natural selection, could equally support another view of organic change. They could well indicate that the development and diversity of life were substantially independent of the external conditions that governed mere survival.

Ultimately, Darwin relied on domesticated animals and cultivated plants, rather than classified wild specimens, to form his idea of the variation on which natural selection was supposed to work. But the evidence of domesti-

cation, too, was susceptible of differing interpretations. For domesticated creatures were the province not only of the naturalist, but also of the breeder. The variability of domestic species could be seen from a technical as well as from a philosophical viewpoint. Variation could be seen as something to be used, as well as something to be understood.

Darwin recognized that the variability of organisms followed "unknown laws", and that it was strangely influenced both by the conditions in which the organisms found themselves, and by the habits animals might acquire. But despite these factors, he did not see in variation any significant natural tendencies. He judged variation, in general, to be accidental with respect to the specific form in which it occurred, to be essentially a random activity. It is hard to avoid concluding that, here, Darwin assumed the technical perspective of the breeder, who is less interested in what Nature is, than that it can be changed. In evaluating variation as indefinite in direction and quantity, he seems simply to have taken his bearings from art. Variability, he argued, was plentiful enough for man to create great changes in organisms. The slight differences seized upon by pigeon-fanciers were surely not directed toward their particular desires! Variability was--in Darwin's word--"material" for man's selection. And similarly, in Nature, an amorphous "material" was supposed to be thrown up, to be "seized" and shaped by other forces of selection. Darwin thus defined vari-

ation in such a way that external action upon it appeared necessary for any specific forms ever to arise.

Hence, Darwin's idea of the natural process of variation seems bound to its counterpart in his theory of a selective force working upon plants and animals. Some of his contemporary critics tried, in effect, to remedy the possible technical bias of his account. The American botanist Asa Gray objected that variability was not chaotic, but revealed definite, natural dispositions. Variation indicated certain developmental tendencies inherent in species; and natural development might take place without the influence of selection. Another of Darwin's colleagues, St.-George Mivart, observed that variation had specific limits, and that human selection was effective in developing breeds only up to a certain point. Mivart argued that ordinary variation must be irrelevant to the problem of the natural origination of new animal types.

In the neo-Darwinian theory of the twentieth century, ordinary variation among individuals of a species is no longer considered the "foundation" of evolution by natural selection. Instead, natural selection is said to operate upon accidental changes in the hereditary substance, recombinations and mutations of genes. And there is no longer reference, in the neo-Darwinian theory, to the practice of breeders and their domestic varieties: the experimentation of researchers and the "domestic animals" of

the laboratory have assumed that place. Still, the question of the influence of art might well be raised today. How does the laboratory restrict the neo-Darwinian vision of Nature? Do the organic mutations that have been studied represent the whole story of the diversity of life? Or are they perhaps more relevant to current technique than to the true evolutionary process? Do other causes of transformation lie deeper near the roots of organization; are there even causes inaccessible to the grasp of experiment? Doubts about Darwinism, and especially about the meaning of mutations, are occasionally expressed in contemporary scientific literature. Perhaps it is well to bear in mind the assumptions of any inquiry into evolution. What is the place of art in the explanation of Nature?

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