Title: The Variation of Animals and Plants under Domestication

Author: Charles Darwin

Release Date: May 22, 2019 [EBook #3332]
[Most recently updated: June 19, 2020]

Language: English

Character set encoding: UTF-8

The Variation of Animals and Plants under Domestication

by Charles Darwin
M.A., F.R.S., ETC.

VOLUMES ONE AND TWO

CONTENTS.

LIST OF ILLUSTRATIONS

FOREWORD

Harriet Ritvo

Charles Darwin wrote *On the Origin of Species* in a hurry. He had, it was true, been formulating his ideas and arguments for several decades—since his round-the-world *Beagle* voyage of 1831-1836. These ideas and arguments had been slow to take definitive shape; Darwin had nurtured and reworked them, amassing evidence for what he projected to be a weighty magnum opus. Although he had shared his developing evolutionary speculations with his closest professional colleagues, Darwin was reluctant to publish them on several grounds. He was aware that his theory of evolution by natural selection (or descent with modification) was complex, that it rested on vast but not incontrovertible evidence, and that the chain of his reasoning was not uniformly strong. Further, his conclusions challenged not only the scientific assumptions of many fellow specialists but also the theological convictions of a much wider circle of fellow citizens.

In 1859, Darwin did not feel quite ready to expose his cherished theory to the harsh light of public scrutiny. In the introduction to the *Origin* he confessed that although his work on evolution by natural selection was "nearly finished," he would need "two or three more years to complete it." The *Origin* was, he suggested, merely a stopgap, a schematic "abstract" of a much longer and more fully supported treatise yet to come. He had been moved to preview his labors in this way, he explained, because his health was "far from strong" and, perhaps more importantly, because Alfred Russel Wallace, a younger naturalist working in isolation in southeast Asia, had sent a paper to the Linnean Society of London in which he "arrived at almost exactly the same general conclusions that I have on the origin of species." If Darwin had not gone public with his theory at this point, he would have risked losing credit for the work of many years.

As its reception showed immediately and has continued to show, the *Origin* benefited from the succinctness imposed by circumstances. Darwin himself may have appreciated this point; at any rate, he never produced the massive treatise, although he repeatedly issued revised editions of the *Origin.* But he did not abandon his intention to buttress his initial schematic presentation with additional evidence. In the course of the next two decades he published several full-length elaborations of topics summarily discussed in the *Origin: The Variation of Animals and Plants under Domestication; The Descent of Man, and Selection in Relation to Sex;* and *The Expression of the Emotions in Man and Animals.* In addition to fleshing out the *Origin,* these subsequent studies bolstered its arguments and responded to questions raised by critical readers, especially pragmatic questions about the way that descent with modification actually operated.

In *The Variation of Animals and Plants under Domestication,* which appeared first in 1868 and in a revised edition in 1875, Darwin developed a theme to which he had accorded great rhetorical and evidentiary significance. He had begun the *Origin* with a description of artificial selection as practiced by farmers, stock breeders, and pet fanciers, thus using a reassuringly homely example—one recognizable by the general public as well as by members of the scientific community—to introduce the most innovative component of his evolutionary theory. In addition, domesticated animals and plants, because they were numerous and available for constant observation, provided a readily available body of evidence.

Reassuring as it was, the analogy between natural and artificial selection was far from perfect. The point of Darwin's analogy was to make the idea of natural selection seem plausible by characterizing it as a grander version of a well-known process while emphasizing its efficiency and shaping power. He noted, for example, that some of the prize birds bred by London pigeon fanciers diverged so strikingly in size, plumage, beak shape, flying technique, vocalizations. bone structure, and many other attributes, that if they had been presented to an ornithologist as wild specimens, they would unquestionably have been considered to represent distinct species, perhaps even distinct genera. Darwin argued that if the relatively brief and constrained selective efforts of human breeders had produced such impressive

results, it was likely that the more protracted and thorough-going efforts of nature would work still more efficaciously.

But as Darwin acknowledged, there were some fairly obvious reasons why the two processes might diverge. The superior power of natural selection—"Man can act only on external and visible characters: nature . . . can act on . . . the whole machinery of life. Man selects only for his own good; Nature only for that of the being which she tends" (*Origin,* chap. 5)—might constitute a difference of kind rather than of degree, as might the much greater stretches of time available for natural selection. Further, although the mechanism of the two processes appeared superficially similar, their outcomes tended to be rather different. Natural selection produced a constantly increasing and diversifying variety of forms; it never reversed or exactly repeated itself. Anyone familiar with artificial selection would have realized that, although new breeds were constantly being developed and although neither improved wheat nor improved cattle showed any tendency to revert to the condition of their aboriginal wild ancestors, the strains produced by human selection were neither as prolific nor as durable as those produced by nature. Indeed, the animals and plants celebrated as the noblest achievements of the breeder's art were especially liable to delicacy and infertility. Highly bred strains, long isolated from others of their species to preserve their genealogical purity, far from serving as a springboard for further variation, often had to be revivified with infusions of less-rarefied blood. Yet any relaxation of reproductive boundaries threatened subsidence into the common run of conspecifics.

Darwin firmly connected *Variation* to the *Origin* by devoting its introduction to an overview of his theory of evolution by natural selection. In particular, the two volumes of *Variation,* cumbersomely organized and packed with zoological and botanical detail, addressed some of the difficulties inherent in the attractive but paradoxical analogy between natural selection and artificial selection. For selection of any sort to operate, diversity already had to exist. With wild populations living under natural conditions, however, diversity was difficult to discern. It was widely believed that a heightened propensity to vary (at least in ways obvious to human observers) was one of the few general characteristics that differentiated domestic animals as a group from their wild relatives. This point was conventionally illustrated with reference to coat color and design. American bison, for example, were, on the whole, brown, and all Burchell's zebras shared similar black and white stripes. A single herd of either *Bos tauras* or *Equus caballus* (domestic cattle or horses), on the other hand, could display colors ranging from white through yellow, red, and brown to black, as well as a variety of spotted and blotched patterns.

In order to demonstrate that such populations spontaneously produced sufficient variation to support artificial selection, Darwin devoted most of the first volume of *Variation* to a species-by-species survey of domesticated plants and animals. He began with the dog, the breeds of which differed so greatly in size, shape, disposition, talents, and every other characteristic that Darwin attributed its exemplary plasticity to its derivation from several different species of wild canines. Domestic cats, on the other hand, differed relatively little from one another, at least, their variation tended to be individual, rather than consolidated into breeds. Darwin attributed this to the minimal influence exerted by cat owners over the mating behavior of their animals, so that, alone among fully domesticated animals, cats could not be said to have undergone a genuine process of artificial selection.

Farmyard ungulates, however, had all proved more susceptible to human manipulation, whether through the gradual enhancement of inherent tendencies, such as the relatively early maturation that distinguished shorthorn cattle, or through the preservation of spontaneously arising monstrosities, such as the short, broad foreheads and protruding lower jaws of the niata cattle of South America, the bulldogs of the bovine world. Among animals, fancy pigeons, with their short generations, devoted breeders, and lack of any pragmatic constraints on their extravagant deformations, provided Darwin with his most abundant material. He allotted less space to his survey of domesticated plants, although, with the exception of trees, they tended to he much shorter lived and more variable even than pigeons. For example, as Darwin pointed out, a single long-cultivated species —*Brassica oleracea,* the ordinary cabbage—had given rise to strains as distinctive as Brussels sprouts, cauliflower, broccoli, and kohl-rabi.

Darwin crammed in so much information of this sort that, in order to confine *Variation* to two volumes of manageable size, less crucial evidence was relegated to a smaller typeface. And so compendious was his survey of domesticates that he felt

constrained to deny that it was intended to he an exhaustive catalog. After all, many such catalogs, devoted merely to the accumulation of species- or breed-specific data, existed already; Darwin cited them generously in his footnotes. The material included in *Variation* had been chosen to fulfill a more focused argumentative purpose. Darwin's theory of descent with modification required something further than the simple demonstration that abundant variation existed among domesticated animals and plants. The accumulated experience of naturalists and breeders offered no clear explanation of the causes of variation; indeed, no consensus existed on this issue. Variation under domestication was frequently attributed to accidental external influences, especially climate and food. But environmentally induced variation was not of much use to Darwin. Instead, he sought evidence not only that the tendency to vary was inherent in domesticated animals and plants but also that specific variations were inherited.

As a result, Darwin's wealth of detail in *Variation* disproportionately featured strong—as well as puzzling, problematic, or even questionable—versions of inheritance, in addition to the unsurprising, if still not completely understood, likelihood that children would resemble their parents. For example, he devoted an entire chapter to what he termed "atavism" or "reversion"—that is, the tendency for offspring to manifest traits apparently derived from their grandparents, collateral relations, or even remote ancestors, rather than from their mothers or their fathers. The existence of this tendency in the lineages of individuals, he argued, incontrovertibly demonstrated the fact of heritability; and in an extended or exaggerated version it also demonstrated evolutionary relations between species. Thus, many breeds of domesticated chickens revealed their ultimate ancestry by producing occasional sports with the red and orange plumage of the original *Callus bankiva,* or jungle fowl.

Like many other naturalists of his time, Darwin was receptive to the idea of telegony, also known as "the influence of the previous sire." He retailed the famous story of Lord Morton's mare, a chestnut of seven-eighths Arabian blood, whose first foal had been sired by a quagga (a now-extinct relative of the zebra) her owner was attempting to domesticate. It was not surprising that the young hybrid faintly echoed his father's stripes, but the fact that her next two foals, both sired by a black Arabian horse, also seemed to resemble the quagga in this regard, was more remarkable. Darwin pointed out that atavism offered one possible explanation of this phenomenon—infant horses and donkeys often showed evanescent striping, which might indicate the pattern of their ancient shared progenitor—but he was also drawn to the notion that the first male to impregnate a female left some permanent, heritable trace of himself behind. He offered analogous examples from the vegetable kingdom, where the pollen of related varieties of apples, corn, or orchids, could not only produce hybrid offspring but occasionally also physically alter the reproductive tract of the female. Plants also, and more regularly, demonstrated a kind of variability that could arise independently of sexual reproduction, such as "bud variation," whereby what Darwin called a "monstrosity" might appear on a single branch or flower and then be transmitted, sexually or asexually, to future generations.

As he documented the profusion of variation among domesticated animals and plants, and the tendency of organisms to transmit these variations down the generations, Darwin did more than demonstrate that there was ample grist for the mill of natural selection. He also addressed the most serious weakness in the argument of the *Origin.* Despite the incompleteness of the fossil record, plenty of evidence suggested that evolution had taken place; indeed the idea of evolution had been current in one form or another for a century before 1859. Darwin's explanation of the way that natural selection should operate was also widely persuasive. The competitive metaphors with which he characterized it, especially the "struggle for life" prominently featured in the *Origin*'s subtitle, fit well with Victorian understandings about how things worked in the human arenas of industry, commerce, and geopolitics. There was, however, a problem that troubled those inclined to sympathize with Darwin's reasoning as well as those inclined to reject it. The efficacy of natural selection, like that of artificial selection, depended on the inheritance of particular traits. But before the modern understanding of genetics became available, no satisfactory mechanism had been adduced to explain this phenomenon. No consensus yet existed about the way that sexual reproduction worked, so there was also disagreement about which characteristics were inherited and which were the result of environment, and what could he contributed by the male as opposed to the female parent, let alone why offspring sometimes resembled

a grandparent or some more distant relative rather than their parents. The special difficulty of accounting for the sudden emergence of monstrosities, or even less dramatically novel traits, led Darwin, in later editions of the *Origin* as well as in *Variation,* to become increasingly receptive to the notion that characteristics acquired by one generation might he inherited by the next.

In the penultimate chapter of *Variation,* Darwin attempted to strengthen the weak link in his chain of argument by proposing a mechanism for inheritance. He called his theory "pangenesis," and he claimed that it explained not only ordinary inheritance—the influence of parents on their children—but also reversion, telegony, the regeneration of amputated limbs in some kinds of animals, the inheritance of acquired characteristics, and the relationship between sexual and asexual modes of reproduction and inheritance. The operation of pangenesis depended on the posited existence of unobservable units that Darwin called "gemmules," tiny granules that were thrown off by individual cells and then circulated through the body. They had, however, an affinity for each other, which led to their aggregation in the reproductive organs or in parthenogenetic buds. They could remain latent for years, until an organism reached a certain stage of development, or for generations, until they encountered other gemmules to which they bore some special relationship. In this way a long-dormant greatgrandparental gemmule might suddenly manifest itself in a child. Since gemmules could he altered by environmental influences, they could convert acquired characteristics into the stuff of heredity. And since they were vulnerable to error, they could occasionally make mistakes, causing organs, such as limbs or tails or even heads, to develop in inappropriate numbers or in the wrong places.

It has doubtless been fortunate for Darwin's reputation that his theory of pangenesis is not as well remembered as his theory of evolution by natural selection. As vague in detail as it was ambitious and comprehensive in scope, it was unpersuasive at the time and has since been proven completely wrong. But like *Variation* as a whole, which similarly illustrated the limitations of its author as well as his strengths, pangenesis does not therefore lack interest or significance. Despite recent excellent and well-appreciated studies of his entire life and extended *oeuvre* (Janet Browne, *Charles Darwin: Voyaging* [New York: Knopf, 1995] and Adrian Desmond and James Moore, *Darwin* [London: Michael Joseph, 1991], Darwin is known primarily as the author of the *Origin,* which is unrepresentative in its economy of structure, argument, and evidence, as well as on account of its historical notoriety. Its enforced streamlining has helped to preserve the *Origin*'s accessibility, but its relative paucity of examples was particularly uncharacteristic of Darwin. *Variation,* with its accumulation of evidence about everything from the webbing between dogs' toes to the weight of gooseberries, was much more typical; in addition, it placed Darwin firmly—indeed, irretrievably—within his time, rather than in an achronological limbo reserved for intellectual heroes. As a graduate student from the People's Republic of China told me several years ago, after having participated in a seminar that read excerpts from *Variation* and *The Expression of the Emotions,* if the leaders of his government knew that Darwin had written such books, he would not be officially admired.

In science as in politics the victors tend to write the history books. As a result, the record of the past is edited, intentionally or unintentionally, so that it focuses mainly on the precursors of contemporary orthodoxy. Such a focus may accurately represent the genealogy of modem ideas, but it almost inevitably misrepresents the historical experience of their progenitors. Viewed without the benefit of hindsight, the marketplace of Victorian ideas seemed much more competitive than it does to us. Even the powerful, persuasive, and ultimately triumphant theory of evolution by natural selection required not only defense, but repeated buttressing and revision. *Variation* showed Darwin hard at work on this rearguard action, using the materials he had at hand—for the most part, homely details about the domesticated animals and plants with which his audience was most familiar. His information was gleaned from the observations of fanciers, breeders, and amateur naturalists, as well as from the treatises of those on the cutting edge of zoology and botany. As hindsight narrows the historical spotlight, it imposes its own sense of hierarchy on the preoccupations of the past. But Darwin was interested in all of these topics, valued all of these sources, and belonged, to a greater or lesser extent, to all of these communities.

The author of *Variation* was a Victorian country gentleman, a lover of dogs and horses, a breeder of pigeons and peas. He was also, and equally, the author of *On the Origin of Species.*

PREFACE TO THE SECOND EDITION

During the seven years which have elapsed since the publication in 1868 of the first edition of this Work, I have continued to attend to the same subjects, as far as lay in my power; and I have thus accumulated a large body of additional facts, chiefly through the kindness of many correspondents. Of these facts I have been able here to use only those which seemed to me the more important. I have omitted some statements, and corrected some errors, the discovery of which I owe to my reviewers. Many additional references have been given. The eleventh chapter, and that on Pangenesis, are those which have been most altered, parts having been remodelled; but I will give a list of the more important alterations for the sake of those who may possess the first edition of this book.

TABLE OF PRINCIPAL ADDITIONS AND CORRECTIONS IN SECOND EDITION

First Edition Vol. I	Second Edition Vol. I	
Page	*Chapter*	
34	I	Dr. Burt Wilder's observations on the brains of different breeds of the Dog.
38	I	Degeneracy of Dogs imported into Guinea.
51	II	Difference in the number of lumbar vertebræ in the races or species of the Horse.
102	III	Hairy appendages to the throats of Goats.
162	V	Sexual differences in colour in the domestic Pigeon.
217	VI	Movements like those of the Tumbler-pigeon, caused by injury to the brain.
290	VIII	Additional facts with respect to the Black-shouldered Peacock.
296	VIII	Ancient selection of Gold-fish in China.
314	IX	Major Hallett's 'Pedigree Wheat.'
326	IX	The common radish descended from *Raphanus raphanistrum.*
374	XI	Several additional cases of bud-variation given.
396	XI	An abstract of all the cases recently published of graft-hybrids in the potato, together with a general summary on graft-hybridisation.
399	XI	An erroneous statement with respect to the pollen of the date-palm affecting the fruit of the Chamærops omitted.
400	XI	New cases of the direct action of pollen on the mother-plant.
404	XI	Additional and remarkable instances of the actions of the male parent on the future progeny of the female.

Vol.II		
14	XII	An erroneous statement corrected, with respect to the regrowth of supernumerary digits after amputation.
23	XII	Additional facts with respect to the inherited effects of circumcision.
23	XII	Dr. Brown-Séquard on the inherited effects of operations on the Guinea-pig.
24	XII	Other cases of inherited mutilations.
	Vol. II	
43	XIII	An additional case of reversion due to a cross.
72	XIV	Inheritance as limited by sex.
105	XVI	Two varieties of maize which cannot be crossed.
120	XVII	Some additional facts on the advantages of cross-breeding in animals.
123	XVII	Discussion on the effects of the close interbreeding in the case of man.
135 to 141	XVII	Additional cases of plants sterile with pollen from the same plant.
149	XVIII	Mr. Sclater on the infertility of animals under confinement.
152	XVIII	The Aperea a distinct species from the Guinea-pig.
230	XXI	Prof. Jäger on hawks killing light-coloured pigeons.
273	XXIII	Prof. Wisemann on the effects of isolation in the development of species.
281	XXIII	The direct action of the conditions of life in causing variation.
317	XXIV	Mr. Romanes on rudimentary parts.
324 to 328	XXV	Some additional cases of correlated variability.
339	XXVI	On Geoffrey St. Hilaire's law of *"soi pour soi."*
357 to 404	XXVII	The chapter on Pangenesis has been largely altered and re-modelled; but the essential principles remain the same.

INTRODUCTION

The object of this work is not to describe all the many races of animals which have been domesticated by man, and of the plants which have been cultivated by him; even if I possessed the requisite knowledge, so gigantic an undertaking would be here superfluous. It is my intention to give under the head of each species only such facts as I have been able to collect or observe, showing the amount and nature of the changes which animals and plants have undergone whilst under man's dominion, or which bear on the general principles of variation. In one case alone, namely in that of the domestic pigeon, I will describe fully all the chief races, their history, the amount and nature of their differences, and the probable steps by which they have been formed. I have selected this case, because, as we shall hereafter see, the materials are better than in any other; and one case fully described will in fact illustrate all others. But I shall also describe domesticated rabbits, fowls, and ducks, with considerable fulness.

The subjects discussed in this volume are so connected that it is not a little difficult to decide how they can be best arranged. I have determined in the first part to give, under the heads of the various animals and plants, a large body of facts, some of which may at first appear but little related to our subject, and to devote the latter part to general discussions. Whenever I have found it necessary to give numerous details, in support of any proposition or conclusion, small type has been used. The reader will, I think, find this plan a convenience, for, if he does not doubt the conclusion or care about the details, he can easily pass them over; yet I may be permitted to say that some of the discussions thus printed deserve attention, at least from the professed naturalist.

It may be useful to those who have read nothing about Natural Selection, if I here give a brief sketch of the whole subject and of its bearing on the origin of species.[1] This is the more desirable, as it is impossible in the present work to avoid many allusions to questions which will be fully discussed in future volumes.

From a remote period, in all parts of the world, man has subjected many animals and plants to domestication or culture. Man has no power of altering the absolute conditions of life; he cannot change the climate of any country; he adds no new element to the soil; but he can remove an animal or plant from one climate or soil to another, and give it food on which it did not subsist in its natural state. It is an error to speak of man "tampering with nature" and causing variability. If a man drops a piece of iron into sulphuric acid, it cannot be said strictly that he makes the sulphate of iron, he only allows their elective affinities to come into play. If organic beings had not possessed an inherent tendency to vary, man could have done nothing.[2] He unintentionally exposes his animals and plants to various conditions of life, and variability supervenes, which he cannot even prevent or check. Consider the simple case of a plant which has been cultivated during a long time in its native country, and which consequently has not been subjected to any change of climate. It has been protected to a certain extent from the competing roots of plants of other kinds; it has generally been grown in manured soil; but probably not richer than that of many an alluvial flat; and lastly, it has been exposed to changes in its conditions, being grown sometimes in one district and sometimes in another, in different soils. Under such circumstances, scarcely a plant can be named, though cultivated in the rudest manner, which has not given birth to several varieties. It can hardly be maintained that during the many changes which this earth has undergone, and during the natural migrations of plants from one land or island to another, tenanted by different species, that such plants will not often have been subjected to changes in their conditions analogous to those which almost inevitably cause cultivated plants to vary. No doubt man selects varying individuals, sows their seeds, and again selects their varying offspring. But the initial variation on which man works, and without which he can do nothing, is caused by slight changes in the conditions of life, which must often have occurred under nature. Man, therefore, may be said to have been trying an experiment on a gigantic scale; and it is an experiment which nature during the long lapse of time has incessantly tried. Hence it follows that the principles of domestication are important for us. The main result is that organic beings thus treated have varied largely, and the variations have been inherited. This

has apparently been one chief cause of the belief long held by some few naturalists that species in a state of nature undergo change.

I shall in this volume treat, as fully as my materials permit, the whole subject of variation under domestication. We may thus hope to obtain some light, little though it be, on the causes of variability,—on the laws which govern it, such as the direct action of climate and food, the effects of use and disuse, and of correlation of growth,—and on the amount of change to which domesticated organisms are liable. We shall learn something of the laws of inheritance, of the effects of crossing different breeds, and on that sterility which often supervenes when organic beings are removed from their natural conditions of life, and likewise when they are too closely interbred. During this investigation we shall see that the principle of Selection is highly important. Although man does not cause variability and cannot even prevent it, he can select, preserve, and accumulate the variations given to him by the hand of nature almost in any way which he chooses; and thus he can certainly produce a great result. Selection may be followed either methodically and intentionally, or unconsciously and unintentionally. Man may select and preserve each successive variation, with the distinct intention of improving and altering a breed, in accordance with a preconceived idea; and by thus adding up variations, often so slight as to be imperceptible by an uneducated eye, he has effected wonderful changes and improvements. It can, also, be clearly shown that man, without any intention or thought of improving the breed, by preserving in each successive generation the individuals which he prizes most, and by destroying the worthless individuals, slowly, though surely, induces great changes. As the will of man thus comes into play, we can understand how it is that domesticated breeds show adaptation to his wants and pleasures. We can further understand how it is that domestic races of animals and cultivated races of plants often exhibit an abnormal character, as compared with natural species; for they have been modified not for their own benefit, but for that of man.

In another work I shall discuss, if time and health permit, the variability of organic beings in a state of nature; namely, the individual differences presented by animals and plants, and those slightly greater and generally inherited differences which are ranked by naturalists as varieties or geographical races. We shall see how difficult, or rather how impossible it often is, to distinguish between races and sub-species, as the less well-marked forms have sometimes been denominated; and again between sub-species and true species. I shall further attempt to show that it is the common and widely ranging, or, as they may be called, the dominant species, which most frequently vary; and that it is the large and flourishing genera which include the greatest number of varying species. Varieties, as we shall see, may justly be called incipient species.

But it may be urged, granting that organic beings in a state of nature present some varieties,—that their organisation is in some slight degree plastic; granting that many animals and plants have varied greatly under domestication, and that man by his power of selection has gone on accumulating such variations until he has made strongly marked and firmly inherited races; granting all this, how, it may be asked, have species arisen in a state of nature? The differences between natural varieties are slight; whereas the differences are considerable between the species of the same genus, and great between the species of distinct genera. How do these lesser differences become augmented into the greater difference? How do varieties, or as I have called them incipient species, become converted into true and well-defined species? How has each new species been adapted to the surrounding physical conditions, and to the other forms of life on which it in any way depends? We see on every side of us innumerable adaptations and contrivances, which have justly excited the highest admiration of every observer. There is, for instance, a fly (Cecidomyia)[3] which deposits its eggs within the stamens of a Scrophularia, and secretes a poison which produces a gall, on which the larva feeds; but there is another insect (Misocampus) which deposits its eggs within the body of the larva within the gall, and is thus nourished by its living prey; so that here a hymenopterous insect depends on a dipterous insect, and this depends on its power of producing a monstrous growth in a particular organ of a particular plant. So it is, in a more or less plainly marked manner, in thousands and tens of thousands of cases, with the lowest as well as with the highest productions of nature.

This problem of the conversion of varieties into species,—that is, the augmentation of the slight differences characteristic of varieties into the greater differences characteristic of species and genera, including the admirable adaptations of each being to its complex organic and inorganic conditions of life,—has been

briefly treated in my ‘Origin of Species.’ It was there shown that all organic beings, without exception, tend to increase at so high a ratio, that no district, no station, not even the whole surface of the land or the whole ocean, would hold the progeny of a single pair after a certain number of generations. The inevitable result is an ever-recurrent Struggle for Existence. It has truly been said that all nature is at war; the strongest ultimately prevail, the weakest fail; and we well know that myriads of forms have disappeared from the face of the earth. If then organic beings in a state of nature vary even in a slight degree, owing to changes in the surrounding conditions, of which we have abundant geological evidence, or from any other cause; if, in the long course of ages, inheritable variations ever arise in any way advantageous to any being under its excessively complex and changing relations of life; and it would be a strange fact if beneficial variations did never arise, seeing how many have arisen which man has taken advantage of for his own profit or pleasure; if then these contingencies ever occur, and I do not see how the probability of their occurrence can be doubted, then the severe and often-recurrent struggle for existence will determine that those variations, however slight, which are favourable shall be preserved or selected, and those which are unfavourable shall be destroyed.

This preservation, during the battle for life, of varieties which possess any advantage in structure, constitution, or instinct, I have called Natural Selection; and Mr. Herbert Spencer has well expressed the same idea by the Survival of the Fittest. The term “natural selection” is in some respects a bad one, as it seems to imply conscious choice; but this will be disregarded after a little familiarity. No one objects to chemists speaking of “elective affinity;” and certainly an acid has no more choice in combining with a base, than the conditions of life have in determining whether or not a new form be selected or preserved. The term is so far a good one as it brings into connection the production of domestic races by man’s power of selection, and the natural preservation of varieties and species in a state of nature. For brevity sake I sometimes speak of natural selection as an intelligent power;—in the same way as astronomers speak of the attraction of gravity as ruling the movements of the planets, or as agriculturists speak of man making domestic races by his power of selection. In the one case, as in the other, selection does nothing without variability, and this depends in some manner on the action of the surrounding circumstances on the organism. I have, also, often personified the word Nature; for I have found it difficult to avoid this ambiguity; but I mean by nature only the aggregate action and product of many natural laws,—and by laws only the ascertained sequence of events.

It has been shown from many facts that the largest amount of life can be supported on each area, by great diversification or divergence in the structure and constitution of its inhabitants. We have, also, seen that the continued production of new forms through natural selection, which implies that each new variety has some advantage over others, inevitably leads to the extermination of the older and less improved forms. These latter are almost necessarily intermediate in structure, as well as in descent, between the last-produced forms and their original parent-species. Now, if we suppose a species to produce two or more varieties, and these in the course of time to produce other varieties, the principal of good being derived from diversification of structure will generally lead to the preservation of the most divergent varieties; thus the lesser differences characteristic of varieties come to be augmented into the greater differences characteristic of species, and, by the extermination of the older intermediate forms, new species end by being distinctly defined objects. Thus, also, we shall see how it is that organic beings can be classed by what is called a natural method in distinct groups—species under genera, and genera under families.

As all the inhabitants of each country may be said, owing to their high rate of reproduction, to be striving to increase in numbers; as each form comes into competition with many other forms in the struggle for life,—for destroy any one and its place will be seized by others; as every part of the organisation occasionally varies in some slight degree, and as natural selection acts exclusively by the preservation of variations which are advantageous under the excessively complex conditions to which each being is exposed, no limit exists to the number, singularity, and perfection of the contrivances and co-adaptations which may thus be produced. An animal or a plant may thus slowly become related in its structure and habits in the most intricate manner to many other animals and plants, and to the physical conditions of its home. Variations in the organisation will in some cases be

aided by habit, or by the use and disuse of parts, and they will be governed by the direct action of the surrounding physical conditions and by correlation of growth.

On the principles here briefly sketched out, there is no innate or necessary tendency in each being to its own advancement in the scale of organisation. We are almost compelled to look at the specialisation or differentiation of parts or organs for different functions as the best or even sole standard of advancement; for by such division of labour each function of body and mind is better performed. And as natural selection acts exclusively through the preservation of profitable modifications of structure, and as the conditions of life in each area generally become more and more complex from the increasing number of different forms which inhabit it and from most of these forms acquiring a more and more perfect structure, we may confidently believe, that, on the whole, organisation advances. Nevertheless a very simple form fitted for very simple conditions of life might remain for indefinite ages unaltered or unimproved; for what would it profit an infusorial animalcule, for instance, or an intestinal worm, to become highly organised? Members of a high group might even become, and this apparently has often occurred, fitted for simpler conditions of life; and in this case natural selection would tend to simplify or degrade the organisation, for complicated mechanism for simple actions would be useless or even disadvantageous.

The arguments opposed to the theory of Natural Selection, have been discussed in my 'Origin of Species,' as far as the size of that work permitted, under the following heads: the difficulty in understanding how very simple organs have been converted by small and graduated steps into highly perfect and complex organs; the marvellous facts of Instinct; the whole question of Hybridity; and, lastly, the absence in our known geological formations of innumerable links connecting all allied species. Although some of these difficulties are of great weight, we shall see that many of them are explicable on the theory of natural selection, and are otherwise inexplicable.

In scientific investigations it is permitted to invent any hypothesis, and if it explains various large and independent classes of facts it rises to the rank of a well-grounded theory. The undulations of the ether and even its existence are hypothetical, yet every one now admits the undulatory theory of light. The principle of natural selection may be looked at as a mere hypothesis, but rendered in some degree probable by what we positively know of the variability of organic beings in a state of nature,—by what we positively know of the struggle for existence, and the consequent almost inevitable preservation of favourable variations,—and from the analogical formation of domestic races. Now this hypothesis may be tested,—and this seems to me the only fair and legitimate manner of considering the whole question,—by trying whether it explains several large and independent classes of facts; such as the geological succession of organic beings, their distribution in past and present times, and their mutual affinities and homologies. If the principle of natural selection does explain these and other large bodies of facts, it ought to be received. On the ordinary view of each species having been independently created, we gain no scientific explanation of any one of these facts. We can only say that it has so pleased the Creator to command that the past and present inhabitants of the world should appear in a certain order and in certain areas; that He has impressed on them the most extraordinary resemblances, and has classed them in groups subordinate to groups. But by such statements we gain no new knowledge; we do not connect together facts and laws; we explain nothing.

It was the consideration of such large groups of facts as these which first led me to take up the present subject. When I visited during the voyage of H.M.S. *Beagle,* the Galapagos Archipelago, situated in the Pacific Ocean about 500 miles from South America, I found myself surrounded by peculiar species of birds, reptiles, and plants, existing nowhere else in the world. Yet they nearly all bore an American stamp. In the song of the mocking-thrush, in the harsh cry of the carrion-hawk, in the great candlestick-like opuntias, I clearly perceived the neighbourhood of America, though the islands were separated by so many miles of ocean from the mainland, and differed much in their geological constitution and climate. Still more surprising was the fact that most of the inhabitants of each separate island in this small archipelago were specifically different, though most closely related to each other. The archipelago, with its innumerable craters and bare streams of lava, appeared to be of recent origin; and thus I fancied myself brought near to the very act of creation. I often asked myself how these many peculiar animals and plants had been produced: the simplest answer seemed to be that the inhabitants of the several islands had descended from each other, undergoing modification in the

course of their descent; and that all the inhabitants of the archipelago were descended from those of the nearest land, namely America, whence colonists would naturally have been derived. But it long remained to me an inexplicable problem how the necessary degree of modification could have been effected, and it would have thus remained for ever, had I not studied domestic productions, and thus acquired a just idea of the power of Selection. As soon as I had fully realised this idea, I saw, on reading Malthus on Population, that Natural Selection was the inevitable result of the rapid increase of all organic beings; for I was prepared to appreciate the struggle for existence by having long studied the habits of animals.

Before visiting the Galapagos I had collected many animals whilst travelling from north to south on both sides of America, and everywhere, under conditions of life as different as it is possible to conceive, American forms were met with—species replacing species of the same peculiar genera. Thus it was when the Cordilleras were ascended, or the thick tropical forests penetrated, or the fresh waters of America searched. Subsequently I visited other countries, which in all their conditions of life were incomparably more like parts of South America, than the different parts of that continent are to each other; yet in these countries, as in Australia or Southern Africa, the traveller cannot fail to be struck with the entire difference of their productions. Again the reflection was forced on me that community of descent from the early inhabitants of South America would alone explain the wide prevalence of American types throughout that immense area.

To exhume with one's own hands the bones of extinct and gigantic quadrupeds brings the whole question of the succession of species vividly before one's mind; and I found in South America great pieces of tesselated armour exactly like, but on a magnificent scale, that covering the pigmy armadillo; I had found great teeth like those of the living sloth, and bones like those of the cavy. An analogous succession of allied forms had been previously observed in Australia. Here then we see the prevalence, as if by descent, in time as in space, of the same types in the same areas; and in neither the case does the similarity of the conditions by any means seem sufficient to account for the similarity of the forms of life. It is notorious that the fossil remains of closely consecutive formations are closely allied in structure, and we can at once understand the fact if they are closely allied by descent. The succession of the many distinct species of the same genus throughout the long series of geological formations seems to have been unbroken or continuous. New species come in gradually one by one. Ancient and extinct forms of life are often intermediate in character, like the words of a dead language with respect to its several offshoots or living tongues. All these facts seemed to me to point to descent with modification as the means of production of new species.

The innumerable past and present inhabitants of the world are connected together by the most singular and complex affinities, and can be classed in groups under groups, in the same manner as varieties can be classed under species and sub-varieties under varieties, but with much higher grades of difference. These complex affinities and the rules for classification, receive a rational explanation on the theory of descent, combined with the principle of natural selection, which entails divergence of character and the extinction of intermediate forms. How inexplicable is the similar pattern of the hand of a man, the foot of a dog, the wing of a bat, the flipper of a seal, on the doctrine of independent acts of creation! how simply explained on the principle of the natural selection of successive slight variations in the diverging descendants from a single progenitor! So it is with certain parts or organs in the same individual animal or plant, for instance, the jaws and legs of a crab, or the petals, stamens, and pistils of a flower. During the many changes to which in the course of time organic beings have been subjected, certain organs or parts have occasionally become at first of little use and ultimately superfluous; and the retention of such parts in a rudimentary and useless condition is intelligible on the theory of descent. It can be shown that modifications of structure are generally inherited by the offspring at the same age at which each successive variation appeared in the parents; it can further be shown that variations do not commonly supervene at a very early period of embryonic growth, and on these two principles we can understand that most wonderful fact in the whole circuit of natural history, namely, the close similarity of the embryos within the same great class—for instance, those of mammals, birds, reptiles, and fish.

It is the consideration and explanation of such facts as these which has convinced me that the theory of descent with modification by means of natural selection is in the main true. These facts have as yet received no explanation on the theory of independent Creation; they cannot be grouped together under one point of view, but

each has to be considered as an ultimate fact. As the first origin of life on this earth, as well as the continued life of each individual, is at present quite beyond the scope of science, I do not wish to lay much stress on the greater simplicity of the view of a few forms or of only one form having been originally created, instead of innumerable miraculous creations having been necessary at innumerable periods; though this more simple view accords well with Maupertuis's philosophical axiom of "least action."

In considering how far the theory of natural selection may be extended, —that is, in determining from how many progenitors the inhabitants of the world have descended,—we may conclude that at least all the members of the same class have descended from a single ancestor. A number of organic beings are included in the same class, because they present, independently of their habits of life, the same fundamental type of structure, and because they graduate into each other. Moreover, members of the same class can in most cases be shown to be closely alike at an early embryonic age. These facts can be explained on the belief of their descent from a common form; therefore it may be safely admitted that all the members of the same class are descended from one progenitor. But as the members of quite distinct classes have something in common in structure and much in common in constitution, analogy would lead us one step further, and to infer as probable that all living creatures are descended from a single prototype.

I hope that the reader will pause before coming to any final and hostile conclusion on the theory of natural selection. The reader may consult my 'Origin of Species' for a general sketch of the whole subject; but in that work he has to take many statements on trust. In considering the theory of natural selection, he will assuredly meet with weighty difficulties, but these difficulties relate chiefly to subjects—such as the degree of perfection of the geological record, the means of distribution, the possibility of transitions in organs, etc.—on which we are confessedly ignorant; nor do we know how ignorant we are. If we are much more ignorant than is generally supposed, most of these difficulties wholly disappear. Let the reader reflect on the difficulty of looking at whole classes of facts from a new point of view. Let him observe how slowly, but surely, the noble views of Lyell on the gradual changes now in progress on the earth's surface have been accepted as sufficient to account for all that we see in its past history. The present action of natural selection may seem more or less probable; but I believe in the truth of the theory, because it collects, under one point of view, and gives a rational explanation of, many apparently independent classes of facts.[4]

REFERENCES

[1] To any one who has attentively read my 'Origin of Species' this Introduction will be superfluous. As I stated in that work that I should soon publish the facts on which the conclusions given in it were founded, I here beg permission to remark that the great delay in publishing this first work has been caused by continued ill-health.

[2] M. Pouchet has recently ('Plurality of Races,' Eng. Translat., 1864, p. 83, etc.) insisted that variation under domestication throws no light on the natural modification of species. I cannot perceive the force of his arguments, or, to speak more accurately, of his assertions to this effect.

[3] Léon Dufour in 'Annales des Science. Nat.' (3rd series, Zoolog.), tom. v. p. 6.

[4] In treating the several subjects included in the present and my other works I have continually been led to ask for information from many zoologists, botanists, geologists, breeders of animals, and horticulturists, and I have invariably received from them the most generous assistance. Without such aid I could have effected little. I have repeatedly applied for information and specimens to foreigners, and to British merchants and officers of the Government residing in distant lands, and, with the rarest exceptions, I have received prompt, open-handed, and valuable assistance. I cannot express too strongly my obligations to the many persons who have assisted me, and who, I am convinced, would be equally willing to assist others in any scientific investigation.

CHAPTER I.
DOMESTIC DOGS AND CATS.

ANCIENT VARIETIES OF THE DOG—RESEMBLANCE OF DOMESTIC DOGS IN VARIOUS COUNTRIES TO NATIVE CANINE SPECIES—ANIMALS NOT ACQUAINTED WITH MAN AT FIRST FEARLESS—DOGS RESEMBLING WOLVES AND JACKALS—HABIT OF BARKING ACQUIRED AND LOST—FERAL DOGS—TAN-COLOURED EYE-SPOTS—PERIOD OF GESTATION—OFFENSIVE ODOUR—FERTILITY OF THE RACES WHEN CROSSED—DIFFERENCES IN THE SEVERAL RACES IN PART DUE TO DESCENT FROM DISTINCT SPECIES—DIFFERENCES IN THE SKULL AND TEETH—DIFFERENCES IN THE BODY, IN CONSTITUTION—FEW IMPORTANT DIFFERENCES HAVE BEEN FIXED BY SELECTION—DIRECT ACTION OF CLIMATE—WATER-DOGS WITH PALMATED FEET—HISTORY OF THE CHANGES WHICH CERTAIN ENGLISH RACES OF THE DOG HAVE GRADUALLY UNDERGONE THROUGH SELECTION—EXTINCTION OF THE LESS IMPROVED SUB-BREEDS.

CATS, CROSSED WITH SEVERAL SPECIES—DIFFERENT BREEDS FOUND ONLY IN SEPARATED COUNTRIES—DIRECT EFFECTS OF THE CONDITIONS OF LIFE—FERAL CATS—INDIVIDUAL VARIABILITY.

The first and chief point of interest in this chapter is, whether the numerous domesticated varieties of the dog have descended from a single wild species, or from several. Some authors believe that all have descended from the wolf, or from the jackal, or from an unknown and extinct species. Others again believe, and this of late has been the favourite tenet, that they have descended from several species, extinct and recent, more or less commingled together. We shall probably never be able to ascertain their origin with certainty. Palæontology[1] does not throw much light on the question, owing, on the one hand, to the close similarity of the skulls of extinct as well as living wolves and jackals, and owing, on the other hand, to the great dissimilarity of the skulls of the several breeds of the domestic dogs. It seems, however, that remains have been found in the later tertiary deposits more like those of a large dog than of a wolf, which favours the belief of De Blainville that our dogs are the descendants of a single extinct species. On the other hand, some authors go so far as to assert that every chief domestic breed must have had its wild prototype. This latter view is extremely improbable: it allows nothing for variation; it passes over the almost monstrous character of some of the breeds; and it almost necessarily assumes that a large number of species have become extinct since man domesticated the dog; whereas we plainly see that wild members of the dog-family are extirpated by human agency with much difficulty; even so recently as 1710 the wolf existed in so small an island as Ireland.

The reasons which have led various authors to infer that our dogs have descended from more than one wild species are as follows.[2] Firstly, the great difference between the several breeds; but this will appear of comparatively little weight, after we shall have seen how great are the differences between the several races of various domesticated animals which certainly have descended from a single parent-form. Secondly, the more important fact, that, at the most anciently known historical periods, several breeds of the dog existed, very unlike each other, and closely resembling or identical with breeds still alive.

We will briefly run back through the historical records. The materials are remarkably deficient between the fourteenth century and the Roman classical period.[3] At this latter period various breeds, namely hounds, house-dogs, lapdogs, etc, existed; but, as Dr. Walther has remarked, it is impossible to recognise the

greater number with any certainty. Youatt, however, gives a drawing of a beautiful sculpture of two greyhound puppies from the Villa of Antoninus. On an Assyrian monument, about 640 B.C., an enormous mastiff[4] is figured; and according to Sir H. Rawlinson (as I was informed at the British Museum), similar dogs are still imported into this same country. I have looked through the magnificent works of Lepsius and Rosellini, and on the Egyptian monuments from the fourth to the twelfth dynasties (i.e. from about 3400 B.C. to 2100 B.C.) several varieties of the dog are represented; most of them are allied to greyhounds; at the later of these periods a dog resembling a hound is figured, with drooping ears, but with a longer back and more pointed head than in our hounds. There is, also, a turnspit, with short and crooked legs, closely resembling the existing variety; but this kind of monstrosity is so common with various animals, as with the ancon sheep, and even, according to Rengger, with jaguars in Paraguay, that it would be rash to look at the monumental animal as the parent of all our turnspits: Colonel Sykes[5] also has described an Indian pariah dog as presenting the same monstrous character. The most ancient dog represented on the Egyptian monuments is one of the most singular; it resembles a greyhound, but has long pointed ears and a short curled tail: a closely allied variety still exists in Northern Africa; for Mr. E. Vernon Harcourt[6] states that the Arab boar-hound is “an eccentric hieroglyphic animal, such as Cheops once hunted with, somewhat resembling the rough Scotch deer-hound; their tails are curled tight round on their backs, and their ears stick out at right angles.” With this most ancient variety a pariah-like dog coexisted.

We thus see that, at a period between four and five thousand years ago, various breeds, viz. pariah dogs, greyhounds, common hounds, mastiffs, house-dogs, lapdogs, and turnspits, existed, more or less closely resembling our present breeds. But there is not sufficient evidence that any of these ancient dogs belonged to the same identical sub-varieties with our present dogs.[7] As long as man was believed to have existed on this earth only about 6000 years, this fact of the great diversity of the breeds at so early a period was an argument of much weight that they had proceeded from several wild sources, for there would not have been sufficient time for their divergence and modification. But now that we know, from the discovery of flint tools embedded with the remains of extinct animals in districts which have since undergone great geographical changes, that man has existed for an incomparably longer period, and bearing in mind that the most barbarous nations possess domestic dogs, the argument from insufficient time falls away greatly in value.

Long before the period of any historical record the dog was domesticated in Europe. In the Danish Middens of the Neolithic or Newer Stone period, bones of a canine animal are embedded, and Steenstrup ingeniously argues that these belonged to a domestic dog; for a very large proportion of the bones of birds preserved in the refuse consists of long bones, which it was found on trial dogs cannot devour.[8] This ancient dog was succeeded in Denmark during the Bronze period by a larger kind, presenting certain differences, and this again during the Iron period, by a still larger kind. In Switzerland, we hear from Prof. Rütimeyer,[9] that during the Neolithic period a domesticated dog of middle size existed, which in its skull was about equally remote from the wolf and jackal, and partook of the characters of our hounds and setters or spaniels (Jagdhund und Wachtelhund). Rütimeyer insists strongly on the constancy of form during a very long period of time of this the most ancient known dog. During the Bronze period a larger dog appeared, and this closely resembled in its jaw a dog of the same age in Denmark. Remains of two notably distinct varieties of the dog were found by Schmerling in a cave;[10] but their age cannot be positively determined.

The existence of a single race, remarkably constant in form during the whole Neolithic period, is an interesting fact in contrast with what we see of the changes which the races underwent during the period of the successive Egyptian monuments, and in contrast with our existing dogs. The character of this animal during the Neolithic period, as given by Rütimeyer, supports De Blainville’s view that our varieties have descended from an unknown and extinct form. But we should not forget that we know nothing with respect to the antiquity of man in the warmer parts of the world. The succession of the different kinds of dogs in Switzerland and Denmark is thought to be due to the immigration of conquering tribes bringing with them their dogs; and this view accords with the belief that different wild canine animals were domesticated in different regions. Independently of the immigration of new races of man, we know from the wide-spread presence of bronze, composed of an alloy of tin, how much commerce there must have been

throughout Europe at an extremely remote period, and dogs would then probably have been bartered. At the present time, amongst the savages of the interior of Guiana, the Taruma Indians are considered the best trainers of dogs, and possess a large breed which they barter at a high price with other tribes.[11]

The main argument in favour of the several breeds of the dog being the descendants of distinct wild stocks, is their resemblance in various countries to distinct species still existing there. It must, however, be admitted that the comparison between the wild and domesticated animal has been made but in few cases with sufficient exactness. Before entering on details, it will be well to show that there is no a priori difficulty in the belief that several canine species have been domesticated. Members of the dog family inhabit nearly the whole world; and several species agree pretty closely in habits and structure with our several domesticated dogs. Mr. Galton has shown[12] how fond savages are of keeping and taming animals of all kinds. Social animals are the most easily subjugated by man, and several species of Canidæ hunt in packs. It deserves notice, as bearing on other animals as well as on the dog, that at an extremely ancient period, when man first entered any country, the animals living there would have felt no instinctive or inherited fear of him, and would consequently have been tamed far more easily than at present. For instance, when the Falkland Islands were first visited by man, the large wolf-like dog (*Canis antarcticus*) fearlessly came to meet Byron's sailors, who, mistaking this ignorant curiosity for ferocity, ran into the water to avoid them: even recently a man, by holding a piece of meat in one hand and a knife in the other, could sometimes stick them at night. On a island in the Sea of Aral, when first discovered by Butakoff, the saigak antelopes, which are "generally very timid and watchful, did not fly from us, but on the contrary looked at us with a sort of curiosity." So, again, on the shores of the Mauritius, the manatee was not at first in the least afraid of man, and thus it has been in several quarters of the world with seals and the morse. I have elsewhere shown[13] how slowly the native birds of several islands have acquired and inherited a salutary dread of man: at the Galapagos Archipelago I pushed with the muzzle of my gun hawks from a branch, and held out a pitcher of water for other birds to alight on and drink. Quadrupeds and birds which have seldom been disturbed by man, dread him no more than do our English birds, the cows, or horses grazing in the fields.

It is a more important consideration that several canine species evince (as will be shown in a future chapter) no strong repugnance or inability to breed under confinement; and the incapacity to breed under confinement is one of the commonest bars to domestication. Lastly, savages set the highest value, as we shall see in the chapter on Selection, on dogs: even half-tamed animals are highly useful to them: the Indians of North America cross their half-wild dogs with wolves, and thus render them even wilder than before, but bolder: the savages of Guiana catch and partially tame and use the whelps of two wild species of *Canis,* as do the savages of Australia those of the wild Dingo. Mr. Philip King informs me that he once trained a wild Dingo puppy to drive cattle, and found it very useful. From these several considerations we see that there is no difficulty in believing that man might have domesticated various canine species in different countries. It would indeed have been a strange fact if one species alone had been domesticated throughout the world.

We will now enter into details. The accurate and sagacious Richardson says, "The resemblance between the Northern American wolves (*Canis lupus,* var. *occidentalis*) and the domestic dogs of the Indians is so great that the size and strength of the wolf seems to be the only difference. I have more than once mistaken a band of wolves for the dogs of a party of Indians; and the howl of the animals of both species is prolonged so exactly in the same key that even the practised ear of the Indian fails at times to discriminate them." He adds that the more northern Esquimaux dogs are not only extremely like the grey wolves of the Arctic circle in form and colour, but also nearly equal them in size. Dr. Kane has often seen in his teams of sledge-dogs the oblique eye (a character on which some naturalists lay great stress), the drooping tail, and scared look of the wolf. In disposition the Esquimaux dogs differ little from wolves, and, according to Dr. Hayes, they are capable of no attachment to man, and are so savage that when hungry they will attack even their masters. According to Kane they readily become feral. Their affinity is so close with wolves that they frequently cross with them, and the Indians take the whelps of wolves "to improve the breed of their dogs." The half-bred wolves sometimes (Lamare-Picquot) cannot be tamed, "though this case is rare;" but they do not become thoroughly well broken in till the second or third

generation. These facts show that there can be but little, if any, sterility between the Esquimaux dog and the wolf, for otherwise they would not be used to improve the breed. As Dr. Hayes says of these dogs, "reclaimed wolves they doubtless are."[14]

North America is inhabited by a second kind of wolf, the prairie-wolf (*Canis latrans*), which is now looked at by all naturalists as specifically distinct from the common wolf; and is, according to Mr. J.K. Lord, in some respects intermediate in habits between a wolf and a fox. Sir J. Richardson, after describing the Hare Indian dog, which differs in many respects from the Esquimaux dog, says, "It bears the same relation to the prairie-wolf that the Esquimaux dog does to the great grey wolf." He could, in fact, detect no marked difference between them; and Messrs. Nott and Gliddon give additional details showing their close resemblance. The dogs derived from the above two aboriginal sources cross together and with the wild wolves, at least with the *C. occidentalis,* and with European dogs. In Florida, according to Bartram, the black wolf-dog of the Indians differs in nothing from the wolves of that country except in barking.[15]

Turning to the southern parts of the new world, Columbus found two kinds of dogs in the West Indies; and Fernandez[16] describes three in Mexico: some of these native dogs were dumb—that is, did not bark. In Guiana it has been known since the time of Buffon that the natives cross their dogs with an aboriginal species, apparently the *Canis cancrivorus.* Sir R. Schomburgk, who has so carefully explored these regions, writes to me, "I have been repeatedly told by the Arawaak Indians, who reside near the coast, that they cross their dogs with a wild species to improve the breed, and individual dogs have been shown to me which certainly resembled the *C. cancrivorus* much more than the common breed. It is but seldom that the Indians keep the *C. cancrivorus* for domestic purposes, nor is the Ai, another species of wild dog, and which I consider to be identical with the *Dusicyon silvestris* of H. Smith, now much used by the Arecunas for the purpose of hunting. The dogs of the Taruma Indians are quite distinct, and resemble Buffon's St. Domingo greyhound." It thus appears that the natives of Guiana have partially domesticated two aboriginal species, and still cross their dogs with them; these two species belong to a quite different type from the North American and European wolves. A careful observer, Rengger,[17] gives reasons for believing that a hairless dog was domesticated when America was first visited by Europeans: some of these dogs in Paraguay are still dumb, and Tschudi[18] states that they suffer from cold in the Cordillera. This naked dog is, however quite distinct from that found preserved in the ancient Peruvian burial-places, and described by Tschudi, under the name of *Canis ingæ,* as withstanding cold well and as barking. It is not known whether these two distinct kinds of dog are the descendants of native species, and it might be argued that when man first migrated into America he brought with him from the Asiatic continent dogs which had not learned to bark; but this view does not seem probable, as the natives along the line of their march from the north reclaimed, as we have seen, at least two N. American species of Canidæ.

Turning to the Old World, some European dogs closely resemble the wolf; thus the shepherd dog of the plains of Hungary is white or reddish-brown, has a sharp nose, short, erect ears, shaggy coat, and bushy tail, and so much resembles a wolf that Mr. p.t, who gives this description, says he has known a Hungarian mistake a wolf for one of his own dogs. Jeitteles, also, remarks on the close similarity of the Hungarian dog and wolf. Shepherd dogs in Italy must anciently have closely resembled wolves, for Columella (vii. 12) advises that white dogs be kept, adding, "pastor album probat, ne pro lupo canem feriat." Several accounts have been given of dogs and wolves crossing naturally; and Pliny asserts that the Gauls tied their female dogs in the woods that they might cross with wolves.[19] The European wolf differs slightly from that of North America, and has been ranked by many naturalists as a distinct species. The common wolf of India is also by some esteemed as a third species, and here again we find a marked resemblance between the pariah dogs of certain districts of India and the Indian wolf.[20]

With respect to Jackals, Isidore Geoffroy Saint-Hilaire[21] says that not one constant difference can be pointed out between their structure and that of the smaller races of dogs. They agree closely in habits: jackals, when tamed and called by their master, wag their tails, lick his hands, crouch, and throw themselves on their backs; they smell at the tails of other dogs, and void their urine sideways; they roll on carrion or on animals which they have killed; and, lastly, when in high spirits, they run round in circles or in a figure of eight, with their tails between their legs.[22] A number of excellent naturalists, from the time of Güldenstädt to that of Ehrenberg, Hemprich, and Cretzschmar, have expressed themselves in the strongest

terms with respect to the resemblance of the half-domestic dogs of Asia and Egypt to jackals. M. Nordmann, for instance, says, “Les chiens d’Awhasie ressemblent étonnamment à des chacals.” Ehrenberg[23] asserts that the domestic dogs of Lower Egypt, and certain mummied dogs, have for their wild type a species of wolf (*C. lupaster*) of the country; whereas the domestic dogs of Nubia and certain other mummied dogs have the closest relation to a wild species of the same country, viz. *C. sabbar,* which is only a form of the common jackal. Pallas asserts that jackals and dogs sometimes naturally cross in the East; and a case is on record in Algeria. [24] The greater number of naturalists divide the jackals of Asia and Africa into several species, but some few rank them all as one.

I may add that the domestic dogs on the coast of Guinea are fox-like animals, and are dumb.[25] On the east coast of Africa, between latitude 4° and 6° south, and about ten days’ journey in the interior, a semi-domestic dog, as the Rev. S. Erhardt informs me, is kept, which the natives assert is derived from a similar wild animal. Lichtenstein[26] says that the dogs of the Bosjemans present a striking resemblance even in colour (excepting the black stripe down the back) with the *C. mesomelas* of South Africa. Mr. E. Layard informs me that he has seen a Caffre dog which closely resembled an Esquimaux dog. In Australia the Dingo is both domesticated and wild; though this animal may have been introduced aboriginally by man, yet it must be considered as almost an endemic form, for its remains have been found in a similar state of preservation and associated with extinct mammals, so that its introduction must have been ancient.[27]

From this resemblance of the half-domesticated dogs in several countries to the wild species still living there,—from the facility with which they can often be crossed together,—from even half-tamed animals being so much valued by savages,—and from the other circumstances previously remarked on which favour their domestication, it is highly probable that the domestic dogs of the world are descended from two well-defined species of wolf (viz. *C. lupus* and *C. latrans),* and from two or three other doubtful species (namely, the European, Indian, and North African wolves); from at least one or two South American canine species; from several races or species of jackal; and perhaps from one or more extinct species. Although it is possible or even probable that domesticated dogs, introduced into any country and bred there for many generations, might acquire some of the characters proper to the aboriginal Canidæ of the country, we can hardly thus account for introduced dogs having given rise to two breeds in the same country, resembling two of its aboriginal species, as in the above-given cases of Guiana and of North America.[28]

It cannot be objected to the view of several canine species having been anciently domesticated, that these animals are tamed with difficulty: facts have been already given on this head, but I may add that the young of the *Canis primævus* of India were tamed by Mr. Hodgson,[29] and became as sensible of caresses, and manifested as much intelligence, as any sporting dog of the same age. There is not much difference, as we have already shown and shall further see, in habits between the domestic dogs of the North American Indians and the wolves of that country, or between the Eastern pariah dogs and jackals, or between the dogs which have run wild in various countries and the several natural species of the family. The habit of barking, however, which is almost universal with domesticated dogs, forms an exception, as it does not characterise a single natural species of the family, though I am assured that the *Canis latrans* of North America utters a noise which closely approaches a bark. But this habit is soon lost by dogs when they become feral and is soon reacquired when they are again domesticated. The case of the wild dogs on the island of Juan Fernandez having become dumb has often been quoted, and there is reason to believe[30] that the dumbness ensued in the course of thirty-three years; on the other hand, dogs taken from this island by Ulloa slowly reacquired the habit of barking. The Mackenzie-river dogs, of the *Canis latrans* type, when brought to England, never learned to bark properly; but one born in the Zoological Gardens[31] “made his voice sound as loudly as any other dog of the same age and size.” According to Professor Nillson,[32] a wolf-whelp reared by a bitch barks. I. Geoffroy Saint-Hilaire exhibited a jackal which barked with the same tone as any common dog.[33] An interesting account has been given by Mr. G. Clarke[34] of some dogs run wild on Juan de Nova, in the Indian Ocean; “they had entirely lost the faculty of barking; they had no inclination for the company of other dogs, nor did they acquire their voice” during a captivity of several months. On the island they “congregate in vast packs, and catch sea-birds with as much address as foxes could display.” The feral dogs of La Plata have not become dumb; they are of large size, hunt singly or

in packs, and burrow holes for their young.[35] In these habits the feral dogs of La Plata resemble wolves and jackals; both of which hunt either singly or in packs, and burrow holes.[36] These feral dogs have not become uniform in colour on Juan Fernandez, Juan de Nova, or La Plata.[37] In Cuba the feral dogs are described by Poeppig as nearly all mouse-coloured, with short ears and light-blue eyes. In St. Domingo, Col. Ham. Smith says[38] that the feral dogs are very large, like greyhounds, of a uniform pale blue-ash, with small ears, and large light-brown eyes. Even the wild Dingo, though so anciently naturalised in Australia, "varies considerably in colour," as I am informed by Mr. P.P. King: a half-bred Dingo reared in England[39] showed signs of wishing to burrow.

From the several foregoing facts we see that reversion in the feral state gives no indication of the colour or size of the aboriginal parent-species. One fact, however, with respect to the colouring of domestic dogs, I at one time hoped might have thrown some light on their origin; and it is worth giving, as showing how colouring follows laws, even in so anciently and thoroughly domesticated an animal as the dog. Black dogs with tan-coloured feet, whatever breed they may belong to, almost invariably have a tan-coloured spot on the upper and inner corners of each eye, and their lips are generally thus coloured. I have seen only two exceptions to this rule, namely, in a spaniel and terrier. Dogs of a light-brown colour often have a lighter, yellowish-brown spot over the eyes; sometimes the spot is white, and in a mongrel terrier the spot was black. Mr. Waring kindly examined for me a stud of fifteen greyhounds in Suffolk: eleven of them were black, or black and white, or brindled, and these had no eye-spots; but three were red and one slaty-blue, and these four had dark-coloured spots over their eyes. Although the spots thus sometimes differ in colour, they strongly tend to be tan-coloured; this is proved by my having seen four spaniels, a setter, two Yorkshire shepherd dogs, a large mongrel, and some fox-hounds, coloured black and white, with not a trace of tan-colour, excepting the spots over the eyes, and sometimes a little on the feet. These latter cases, and many others, show plainly that the colour of the feet and the eye-spots are in some way correlated. I have noticed, in various breeds, every gradation, from the whole face being tan-coloured, to a complete ring round the eyes, to a minute spot over the inner and upper corners. The spots occur in various sub-breeds of terriers and spaniels; in setters; in hounds of various kinds, including the turnspit-like German badger-hound; in shepherd dogs; in a mongrel, of which neither parent had the spots; in one pure bulldog, though the spots were in this case almost white; and in greyhounds,—but true black-and-tan greyhounds are