Jean-Baptiste Lamarck, *Philosophie Zoologique* (1809)

Chapter 7: Concerning the Influence of Circumstances on the Actions and Habits of Animals, and the Influence of the Actions and Habits of these Living Bodies As Causes Which Modify Their Organic Structure and Their Parts

What we are now concerned with is not a rational speculation but the examination of a reliable fact, a more universal one than people think and something to which we have neglected to pay the attention it deserves. Undoubtedly this is the case because on most occasions it is very difficult to recognize. This fact consists of the influence which circumstances exert on the different living things subject to them.

In truth, for quite a long time now we have noticed the influence of the different states of our organic structure on our characteristics, inclinations, actions, and even our ideas. But it seems to me that no one has get made known the influence of our actions and habits on our own organic structure. Now, as these actions and habits are entirely dependent on the circumstances in which we usually find ourselves, I am going to try to show how great the influence is which these circumstances exert on the general form, the condition of the parts, and even on the organic structure of living things. Thus, this chapter is going to explore this very well established fact.

If we had not had numerous occasions to recognize quite clearly the effects of this influence on certain living bodies which we have transported into entirely new environments, very different from the ones where they used to live, and if we had not seen these effects and the changes resulting from them come to light in some way under our very eyes, the important fact under discussion would have always remained unknown to us.

The influence of circumstances is truly working always and everywhere on living bodies. But what makes this influence difficult for us to perceive is that its effects become perceptible or recognizable (especially in animals) only after a long passage of time.

Before laying out and examining the proofs for this noteworthy fact (something extremely important for *Zoological Philosophy*), let us summarize the thread of the ideas with which we started our analysis.

In the preceding paragraphs, we have seen that it is now an incontestable fact that, when we consider the animal scale in a sense opposite to the natural direction, we find that in the groups which form this scale there exists a sustained but irregular degradation in the organic structure of animals making up the groups, an increasing simplicity in the organization of living bodies and finally a corresponding diminution in the number of faculties in these beings.

This well known fact can provide us the greatest insights into the very order which nature followed in the production of all animals which she has brought into existence. But it does not show us why animals' organic structure, with its increasing complexity from the most imperfect right to the most improved, only displays an irregular gradation in which the range manifests a number of anomalies or gaps which have no apparent order amid their variety.

Now, in seeking out the reason for this peculiar irregularity in the growing complexity of animals' organic structure, if we consider the results of the influences which the infinitely various circumstances in all the regions of the earth exert on the general shape, parts, and even the organic structure of these animals, then everything will be clearly explained.

In fact, it will be quite clear that the condition in which we see every animal is, on the one hand, the product of the increasing complexity in organic structure which tends to create a regular gradation and, on the other hand, the product of influences of a multitude of very different circumstances which continuously tend to work against the regularity in the gradations of the growing complexity in organization.

Here it becomes necessary that I explain what I mean by the following expression: *Circumstances have an influence on the form and the organic structure of animals.* What this means is that by undergoing significant change, the circumstances proportionally alter, over time, both the form and the organic structure itself.

True, if someone takes these expressions literally, he would say I was making a mistake. For no matter what the circumstances can be, they do not work to bring about directly any modification whatsoever in the shape and organic structure in animals.

But significant changes in the circumstances lead, for animals, to great changes in their needs. Such changes in the needs necessarily lead to changes in their actions. Now, if the new needs become constant or last a long time, the animals then acquire new habits which are just as long lasting as the needs which brought them about. That is what is easy to demonstrate and, indeed, requires no detailed explanation to be understood.

Thus, it is clear that a significant change in circumstances, once it becomes constant for a race of animals, leads these animals to new habits.

Now, if new circumstances have become permanent for a race of animals and have given these animals new habits, that is, have driven them to new actions which have become customary, that will result in the preferential use of one part over another and, in some cases, in the total disuse of some part which has become useless.

None of this should be considered a hypothetical or odd opinion. It is, by contrast, a truth which requires, to make it perfectly clear, nothing but attentive observation of facts.

We will see shortly through references to known facts which attest to these matters, on the one hand, that once new needs make some part essential, they effectively, by a sequence of efforts, give rise to that part; later its sustained use gradually strengthens and develops it, and finally finishes up by increasing its size considerably. On the other hand, we shall see that in some cases, the new circumstances and needs made some part totally useless. The total lack of use of this part brought it about that it gradually ceased undergoing the development experienced by the other parts. Thus, it grew smaller and weaker gradually, and finally, when this lack of use had been complete for a long time, the part in question ended up disappearing. All that is reliable fact. I propose to give the most convincing proofs of this point.

In the plants where there are no actions and consequently, strictly speaking, no habits, significant changes in circumstances nonetheless lead to significant differences in the development of their parts. As a result, these different circumstances give rise to and

develop certain parts, while they weaken several other parts and lead to their disappearance. But here everything exerts its effect through changes undergone in what the plant uses for nourishment, in what it absorbs and breathes, in the quality of heat, light, air, and humidity which the plant customarily then receives, and, finally, through the superiority which some of these various vital movements can gain over others.

Among individuals of the same species, if some are continually well nourished in circumstances favourable to their total development, while others find themselves in opposite circumstances, then there is produced a difference between the conditions of these individuals which gradually becomes very noticeable. How many examples I could cite concerning animals and plants which confirm the basis for this idea! Now, if circumstances remain the same, making the condition of the poorly nourished individuals habitual and constant, with suffering and malnourishment, their interior organic structure is finally changed. Reproduction among the individuals in question preserves the acquired modifications and ends up by giving rise to a race very different from the one made up of individuals who find themselves constantly in circumstances favourable to their development.

A very dry spring causes prairie grasses to grow very little, to remain thin and scrawny, to flower and bear fruit, although they have grown very little.

A spring mixed with hot days and rainy days brings about in these same grasses a generous growth, and the harvest of hay is then excellent.

But if with these plants some causes perpetuate unfavourable circumstances, they will vary proportionally, at first in their bearing or their general condition, and later in several specific characteristics.

For example, if a grain of some prairie grass or other is carried into a high place, onto a dry, arid, and rocky patch of land very exposed to the wind and can germinate there, the plant which can live in this place will always find itself malnourished, and if the individuals which it produces continue to exist in these poor circumstances, there will result a race truly different from the one which lives in the prairie (which is, however, the origin of the second race). The individuals of this new race will be small, scrawny in their parts, and some of their organs, having undergone more development than others, will then manifest strange proportions.

Those who have observed a great deal and consulted large collections have been convinced that as the conditions in the environment, exposure, climate, nourishment, way of life, and so on undergo changes, the characteristics of height, shape, proportions among the parts, colour, consistency, agility, and industry (for the animals) correspondingly change.

What nature does with a great deal of time, we do every day, when on our own we suddenly change the conditions in which a living plant and all the individuals of its species are found.

All botanists know that the plants which they take from the place where they were born to the gardens where they are cultivated undergo there gradual changes which end up making them unrecognizable. Many naturally very hairy plants in this way become smooth, or almost so; a number of those which were low and trailing straighten up their stem; others lose their thorns or protrusions; still others in our climate change from the woody and perennial stem conditions which they had in the hot climates where they used to be, to a herbaceous state,

and among them several are nothing more than annuals. Finally, in our gardens the dimensions of these plants' parts themselves undergo very significant changes. The effects of these changed circumstances are so well recognized that botanists do not like to describe their garden plants until they are no longer recent cultivations.

Is not cultivated wheat (*triticum sativum*) a plant brought by man to the condition in which we see it today? Can anyone tell me in what country a similar plant lives naturally, that is, without being the result of its cultivation in some place near by?

Where do we find in nature our cabbage, lettuce, and so on, in the state where we produce them in our vegetable gardens? Is the case not the same with respect to the number of animals which domestication has changed or considerably modified?

How many different races of chickens and domestic pigeons we have acquired by raising them in different circumstances and different countries! How futile it is now to seek to find such animals in nature!

Those which are the least changed (undoubtedly because their domestication is more recent and because they do not live in a climate foreign to them) in some of their parts display differences no less significant through the habits which we have made them acquire. Thus our domestic ducks and geese find their type again in wild ducks and geese, but ours have lost the ability to rise up into the high regions of the sky and to fly across large territories. Finally a real change has occurred in their parts in comparison with the parts of the animals of the race from which they originated.

Who is not familiar with the fact that when some bird from our climate raised in a cage and living there five or six consecutive years is after that returned to nature, that is, given back its liberty, it is then no longer in a condition to fly like those similar to it which have always been at liberty? The slight change of circumstances working on this individual has, in truth, only diminished its capacity for flying and, undoubtedly, has not brought about any alteration in the shape of its parts. But if many successive generations of individuals of the same race were held in captivity over a long period of time, there is no doubt that even the shape of the parts of these individuals would have gradually undergone noticeable changes. This would be all the more reasonable if, in place of keeping them in a simple captivity constantly maintained, this circumstance had been simultaneously accompanied by a change into a very different climate and if these individuals had grown accustomed, by degrees, to other forms of nourishment and to other actions for obtaining it. It is certain that these combined circumstances, once they become constant, would then create imperceptibly a new and totally special race.

Where do we see now in nature the many races of dogs which, as a result of the domesticity to which we have reduced these animals, we have brought into existence in the form they are today? Where do we find these mastiffs, greyhounds, water spaniels, spaniels, lap dogs, and so on and so on, races which display among themselves greater differences than those which we acknowledge as specific differences among animals of the same genus living freely in nature?

Undoubtedly, some first unique race, at the time very close to the wolf (if that is not in itself the true type), was domesticated by man at some epoch or other. This race, which did not then manifest any differences among its individuals, was gradually dispersed with human

beings into different countries and climates. After some length of time, these same individuals experienced the influences of their surroundings and of their various habits which they had been made to acquire in each territory, underwent some remarkable changes, and formed different special races. Now, human beings, who, for trade or for some other sort of interest, move over very considerable distances, carried different races of dogs formed in countries far away into densely inhabited places, like great capital cities. At that time the crossbreeding of these races through reproduction thus gave rise successively to all those which we know about nowadays.

The following fact proves (with respect to plants) how much a change in some important circumstance has an influence on changing the parts of living organisms.

Whenever the plant *ranunculus aquatis*[1] is immersed in water, its leaves are all markedly serrated and finely divided. But when the stem of this plant reaches the surface of the water, the leaves which develop in the air are enlarged, round, and simply lobed. If some feet of this plant succeed in pushing into a soil which is only humid, without being underwater, their stems then are short and none of their leaves is divided up into tiny sections. This example gives rise to the plant *ranunculus hedereaceus*, which botanists, when they encounter it, consider a species.

There is no doubt that, so far as animals are concerned, important changes in the circumstances where they usually live produce similar changes in their parts. But here the changes are much slower manifesting themselves than in the plants. Consequently, they are less perceptible to us and their cause less recognizable.

As for the circumstances which have the most power to change the organs in living bodies, the most influential is undoubtedly the diversity in the locations where the animals live. But, in addition, there are many others which later have a considerable influence in producing the effects we are discussing.

We know that different places have a different nature and quality, on account of their positions, compositions, and climates. That is easy to notice as we go through different places differentiated by specific qualities. Here is one cause of variation in the animals and plants which live in these different places. But what we do not understand sufficient well and what people even generally refuse to believe is that each place itself changes, over time, in exposure, climate, nature, and quality, although so slowly in comparison with our extents of time that we attribute to that place a perfect stability.

Now, in both cases, these altered locations change correspondingly the circumstances relevant to living things who live there. And these circumstances then produce other influences on these living things themselves.

From that we perceive that if there are extremes in such changes, there are also slight modifications, that is to say, intermediate degrees which fill up the gap between the extremes. Consequently, there are also modulations in the differences which distinguish what we call species.

Thus, it is evident that all the surface of the earth displays in the nature and the situation of the materials which make up its different points a diversity of circumstances which

[1] Now *Ranunculus aquatilis*, the common water crowfoot.

throughout is allied to the diversity in the forms and the parts of animals, independent of the special diversity which results necessarily from the progress in the complexity of organic structure in each animal.

Everywhere where animals can live, the circumstances which create there an order of things remain the same for a long time and do not really change except with such an excessive slowness that man is not capable of perceiving it directly. He is obliged to consult the monuments to recognize that in each of these places the order in things which he finds there has not always been the same and to sense that it will change once again.

The races of animals living in each of these places must thus preserve their habits for quite a long time; hence the apparent permanence to us of what we call species, a permanence which has given rise in us to the idea that these races are as old as nature.

But in the different habitable locations on the surface of the earth, the nature and situation of territories and climates there constitute for animals, as for plants, circumstances different to all sorts of degrees. The animals inhabiting these different places must therefore be different from each other not only because of the state of complexity in the organic structure of each race but also because of the habits which the individuals of each race have been forced to acquire there. Moreover, as the naturalist traversing parts of the earth's surface sees conditions change in a slightly perceptible way, he always then sees the characteristics of species changing proportionately.

Now, the true order of things relevant to consider in all this consists in recognizing the following:

1. All slightly remarkable changes later maintained in circumstances where each race of animals is located works to create in that race a real change in its needs.

2. All changes in animals' needs require of them alternative actions to satisfy the new needs and, consequently, alternative habits.

3. Since the satisfaction of every new need demands new actions, it requires from the animal experiencing that need either the more frequent use of some of its parts which previously it used less often (something which develops and makes that part grow), or the use of new parts which the needs imperceptibly bring forth in the animal by the efforts of its interior feeling. This I will establish very soon by known facts.

Thus, to reach an understanding of the true causes of so many diverse forms and so many different habits, examples of which the known animals manifest to us, we must take into account the fact that the infinitely diversified and slowly changing conditions in which the animals of each race are successively located have led, in each of them, to new needs and necessarily to changes in their habits. Now, once this truth, which one cannot contest, is recognized, it will be easy to see how animals have been able to satisfy the new needs and to acquire new habits, if we give some attention to the two following laws of nature, which observation has always confirmed.

First Law

In every animal which has not exceeded the limit of its development, the more frequent and sustained use of any organ gradually strengthens this organ, develops it,

makes it larger, and gives it a power proportional to the duration of this use; whereas, the constant lack of use of such an organ imperceptibly weakens it, makes it deteriorate, progressively diminishes it faculties, and ends by making it disappear.

Second Law

Everything which nature has made individuals acquire or lose through the influence of conditions to which their race has been exposed for a long time and, consequently, through the influence of the predominant use of some organ or by the influence of the constant disuse of this organ, nature preserves by reproduction in the new individuals arising from them, provided that the acquired changes are common to the two sexes or to those who have produced these new individuals.

These are the two constant truths which cannot be overlooked except by those who have never observed nor followed nature in her work or by those who have let themselves be led into the error which I am going to contest.

Once naturalists noticed that the forms of animals' parts are always linked to the use of these parts, they thought that the forms and the condition of the parts had led to the usage. Now, there is the mistake. For it is easy to demonstrate through observation that, by contrast, it is the needs and the use of the parts which have developed them, factors which even produced the parts at a time when they did not exist and which, consequently, gave rise to the condition in which we see them in each animal.

In order for that not to be the case, it would have been necessary for nature to create for the animal parts as many forms as required by the diversity of circumstances in which they have to live and that these forms, as well as the circumstances, never change.

That is certainly not the natural order which exists. If it had ever really been like that, we would not have race horses in the form of those in England; we would not have our large draught horses, so heavy and different from these race horses, for nature on her own did not produce anything like them. For the same reason we would not have basset hounds with crooked limbs, such swift-running greyhounds, water spaniels, and so on. We would not have tailless hens, fantail pigeons, and so on. Finally, we would be able to cultivate wild plants as much as we liked in the rich fertile soil of our gardens, without fear of seeing them change through long cultivation.

In this matter, for a long time we have had a feeling for what is really the case, because we developed the following sentence, which has become proverbial and universally known: *habits form a second nature.*

To be sure, if habits and the nature of every animal were incapable of ever changing, the proverb would be false, would not have arisen, and would not have been able to be preserved in the event someone had proposed it.

If one considers seriously everything which I have just revealed, one will sense that I grounded my views rationally when in my work entitled *Research Into Living Bodies* (p. 50), I laid down the following proposition:

"It is not the organs, that is, the nature and the form of the animal's body parts, which have given rise to its habits and special faculties, but, by contrast, its habits, manner of life, and circumstances of the individuals from which the animal comes to possess, over time, the

form of its body, the number and condition of its organs, and finally the faculties which it enjoys."

Let people consider well this proposition and bring to it all the observations which nature and the state of things enable us to make all the time. Then its importance and reliability will become for us the most significant evidence.

Favourable times and circumstances are, as I have already said, the two main means employed by nature to bring into existence all her productions. We know that time has no limits for her and that, as a result, she always has time to spare.

As to the circumstances which she needed and which she still uses every day to vary everything which she continues to produce, we can say that circumstances are, in some way, for her inexhaustible.

The main circumstances arise from the influence of climates, various temperatures in the atmosphere and all the environmental surroundings, the variety of places and their exposure, habits, the most ordinary movements, the most frequent actions, finally the means of self-preservation, reproduction, and so on.

Now, as a result of these various influences, the faculties expand and grow stronger through use. With new habits preserved over a long time they diversify. Imperceptibly the arrangement, consistency, in a word, the nature and the condition of the parts, as well as the organs, undergo the consequences of all these influences, preserving and propagating themselves in reproduction.

These truths, which are only the consequences of the two natural laws set forth above, are, in every case, amply confirmed by the facts. They indicate clearly the march of nature in the variety of her productions.

But instead of contenting ourselves with generalities which we could consider hypothetical, let us examine the facts directly. Let us consider in animals what is produced by the use or lack of use of their organs on these very organs, according to the habits which each race has been compelled to acquire.

Now, I am going to prove that the constant lack of exercise with respect to an organ at first reduces its faculties, then gradually shrinks it, and ends up by making it disappear or even destroying it, if this lack of use continues for a long time in a sequence of successive generations of animals of the same race.

Then I will reveal how, by contrast, the habit of exercising an organ, in every animal which has not reached the limit in the diminution of its faculties, not only improves this organ's faculties and makes it grow, but also makes it develop and acquire dimensions which imperceptibly change it, so that in time it makes it quite different from the same organ examined in another animal which exercises it much less.

The lack of use of an organ, once it has become constant because of the habits which one has taken up, gradually diminishes that organ and ends up by making it disappear and even destroying it.

Since such a claim cannot be accepted without demonstrations (and not by a simple declaration), let us try to set out evidence by citing the major known facts which constitute the basis for it.

The vertebrate animals, in all of whom the design of the organic structure is almost the same, although they manifest much diversity in their parts, have their jaws equipped with teeth. However, in those among them in which circumstances have developed the habit of swallowing the objects on which they feed without previously chewing them at all, we find that their teeth have not undergone any development. Thus, these teeth either have remained hidden between the bony layers of the jaws, without being capable of appearing on the outside, or have even been destroyed right down to their basic elements.

In the whale, which we thought entirely without teeth, M. Geoffroy has found them hidden in the jaws of the fetus of the animal. This professor has also located in birds the groove where the teeth must have been placed. But we do not see them there any more.

Even in the class of mammals, which includes the most perfect animals, mainly those in which the design of the organic structure of vertebrates has been effected most completely, not only does the whale have no more teeth to use, but we also find there in the same class the anteater (*Myrmecophaga*) in which the habit of not chewing has been introduced and preserved for a long time in the species.

Having eyes in the head is characteristic of a large number of various animals and is an essential part of the design in the organic structure of vertebrates.

Nevertheless, the mole which, through its habits, makes very little use of sight, has only very small eyes, hardly apparent, because the animal makes use of this organ very rarely.

The *aspalax*[2] of Olivier (*Voyage in Egypt and in Persia*, II, pl. 28, f. 2), which lives underground, like the mole, and which probably exposes itself to the light of day even less than that animal, has completely lost the use of sight. Moreover, it manifests no more than vestiges of the organ which is the seat of sight. In addition, these vestiges are completely hidden under the skin and under some other parts which cover them over and do not provide any more the least access to light.

The *Proteus*,[3] an aquatic reptile related (by its affinities) to the salamanders and living in deep and dark cavities under the water, like the *aspalax*, has only vestiges of the organs of sight, vestiges which are covered and hidden in the same manner.

Here is a decisive consideration concerning the question which I am at present raising.

Light does not penetrate everywhere. Consequently, animals who habitually live in the places where there is no light lack the opportunity to exercise the organ of sight, if nature has furnished them with one. Now, the animals which are part of a structural design in which the eyes are necessarily a part must have had them in their origins. However, since we find among these animals ones which are without the use of this organ and which have only hidden and covered vestiges of it, it becomes evident that the diminution and even the disappearance of the organ in question are the results, for this organ, of a constant lack of exercise.

What proves the point is the fact that the organ of the ear is never like this. We always find

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[2] Blind mole rats (modern genus *Spalax*) of the Middle East and central Asia. Not closely related to the naked mole rat and other mole rats of southern Africa (family Bathyergidae).

[3] *Proteus* is a nearly blind, cave-dwelling salamander, found only in Slovenia, closely related to the American mudpuppy (genus *Necturus*).

it in those animals in which the nature of their organic structure requires that the ear be present. Here is the reason.

The material of sound, which is set in motion by the shock or the vibration of bodies, transfers to the organ of hearing the impression which it has received, penetrates everywhere, and moves through every medium, even the masses of the densest bodies. The result is that every animal which is part of an organic structural design in which the ear is an essential part always has the opportunity to exercise this organ in whatever place it dwells. Thus, among the vertebrate animals we do not witness any which lack the organ of the ear, and after that point, when this same organ is lacking, we do not find it again later in any of the animals of the later classes.

Such is not the case with the organ of sight, for we see this organ disappear, reappear, and disappear once more, as a result of the possibility or the impossibility of the animal's making use of it.

In the acephalid mollusks,[4] the great development of the mantle has made their eyes and even their head entirely useless. Although these organs are part of a structural plan which should include them, they have therefore had to disappear and die out through a constant lack of use.

Finally, part of the organic structural design of reptiles, as in other vertebrate animals, includes having four limbs dependent on their skeleton. Consequently, snakes should have four of them, especially since they do not make up the last order of reptiles and since they are more distant from the fish than are the batrachians (frogs, salamanders, and so on).

However, snakes took up the habit of crawling on the ground and hiding in the grass. Thus, their body, as a result of constant and repeated efforts to extend itself, so as to pass into narrow spaces, acquired a considerable length, totally disproportionate to its size. Now, limbs would have been really useless to these animals and consequently remained unused (for extended limbs would have been an impediment to their need to crawl, and very short limbs, necessarily four in number, would have been incapable of moving their bodies). Thus the lack of use of these parts, remaining constant for the races of this animal, made these very parts disappear entirely, although the limbs were actually in the design of the organic structure of animals of their class.

Many insects which, according to the natural characteristics of their order and even their genus, should have wings, lack them more less completely, because they do not use them. A number of coleoptera, orthoptera, hymenoptera, and hemiptera,[5] and so on give us examples of this fact. The habits of these animals never put them in situations where they used their wings.

But it is not sufficient to provide an explanation for the cause which has led to the state of the organs of different animals, a condition which we observe is always the same in those of the same species. In addition, it is necessary to make known the alterations brought about in the organs of a single individual during its lifetime,. solely as the product of a great mutation in the habits unique to the individuals of its species. The following extremely remarkable fact will complete the proof of the influence of habits on the condition of the organs and

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[4] acephalid = "headless"; Lamarck probably means clams.

[5] Coleoptera = beetles; Orthoptera = crickets; Hymenoptera = ants, bees, wasps; Hemiptera = true bugs.

establish how much sustained changes in the habits of an individual lead to changes in the condition of the organs which are brought into action during the exercise of these habits.

Mr. Tenon, member of the Institute, has made known to the Class of Sciences, that he examined the intestinal canal of several men who had been passionate drinkers for a large part of their lives. He constantly found the organ shortened by an extraordinary amount in comparison with the same organ in all those who had not picked up the same habit.

We know that great drinkers, or those who have been addicted to drinking, eat very little solid food, that they eat almost nothing, and that the drink which they consume in abundance and frequently is sufficient to nourish them.

Now, since the alimentary fluids, especially spirit drinks, do not stay for long either in the stomach or in the intestine, among drinkers the stomach and the rest of the intestinal canal lose the habit of being distended, just as the stomachs of sedentary persons constantly busy with intellectual work who are accustomed to eating only a little gradually over time contract, and their intestines grow shorter.

This matter is not at all a question of a shrinking and a contraction brought about by a gathering in of the parts which would allow for an ordinary extension if these internal organs were filled, rather than undergoing a sustained emptiness. It is rather a question of a real and considerable shrinkage and contraction such that these organs would break rather than yield suddenly to causes which demand an ordinary extension.

Compare, at entirely similar ages, a man who, in order to free himself for studies and habitual intellectual work, has acquired the habit of eating very little with another who habitually takes plenty of exercise, frequently goes out of his house, and eats well. The stomach of the first will have very little capacity and will be filled by a very small quantity of nourishment, while the stomach of the second will have preserved and even increased its capacity.

There we have an organ strongly modified in its dimensions and capacity by the single cause of a change in habits over the lifetime of an individual.

The frequent use of an organ, once it becomes constant and habitually, increases the capacities of this organ, develops it, and makes it acquire dimensions and an active power which the organ does not possess in the animals which exercise it less.

It has just been shown that the lack of use of an organ which ought to exist modifies it, diminishes it, and ends up destroying it.

Now I am going to establish that the continuous use of an organ, along with the efforts made to derive from it a substantial benefit in circumstances which demand it, fortifies the organ, extends and enlarges it, or makes new organs from it which can carry out functions which have become essential.

The bird drawn to water by the need to find prey there, which sustains its life, extends the digits on its feet with which it wishes to strike the water and move on the surface. The skin which unites these digits at their base, because of these constantly repeated separations of the digits, acquires the habit of stretching itself. Thus, over time, the large membranes which link the digits of ducks, geese, and so on are formed just as we see them. The same efforts made for swimming, that is, to push the water in order to advance and move in this

liquid have in the same manner extended the membranes between the digits of frogs, sea-tortoises, otter, beaver, and so on.

By contrast, the bird whose way of living accustoms it to perching in trees and which descends from individuals which have all acquired this habit, necessarily has longer digits on its feet shaped in a different way from those of the aquatic animals which I have just cited. Its claws, over time, grow longer, sharper, and hook-like to grasp the branches on which the animal rests so often.

In the same way, we see that the shore bird which has no inclination to swim but which nevertheless needs to approach the water's edge to find its prey constantly runs the risk of sinking down in the mud. Now, this bird, wishing to act in such a way that its body does not sink in liquid, makes every effort to extend and lengthen its feet. From that it follows that the long habit which this bird and all those of its race acquire of extending and lengthening their feet brings it about that the individuals of this race find themselves elevated as if on stilts, having gradually developed long bare legs, that is, legs without feathers up to the thighs and often further than that. *Système des Animaux sans vertèbres*, p. 14.

We also know that the same bird, wishing to fish without getting its body wet, is required to make continual efforts to lengthen its neck. Now, the consequences of these habitual efforts in this individual and in those of its race must have, over time, lengthened their necks remarkably, a point which is, in fact, confirmed by the long neck of all shore birds.

If some swimming birds, like the swan and the goose, in which the legs are short, have nonetheless a very long neck, the reason is that these birds, while moving along on the water, are accustomed to plunge their heads down into it as deeply as they can to take from there the aquatic larvae and different animalcules on which they feed. They make no effort to lengthen their limbs.

If an animal, in order to satisfy its needs, makes repeated efforts to lengthen its tongue, that organ will acquire a considerable length (anteater, green woodpecker). If the animal needs to seize something with this same organ, then its tongue will divide and become forked. The tongue of the humming birds, who seize things with their tongue, and that of lizards and snakes, who use their tongues to feel and recognize the bodies in front of them prove what I am proposing.

Needs, always induced by circumstances, and the later efforts maintained to satisfy those needs are not limited in the results of their modifications, that is, in increasing or diminishing the extent and the capacities of organs. But they also succeed in removing these same organs, when certain of these needs are not essential.

The fish which customarily swim in large bodies of water have a need to see laterally. They, in fact, have their eyes placed on the sides of their heads. Their bodies, more or less flattened, depending on the species, have their edges perpendicular to the plane of the water, and their eyes are placed in such away that there is one eye on each flat side. But those fish whose habits require them constantly to come close to the shore, particularly to shores slightly inclined or with a gentle slope, have been forced to swim on their flattened side, in order to be able to approach more closely the edges of the water. In this situation, receiving more light from above than below and having a special need to be always attentive to what is found above them, their need has induced one of their eyes to undergo a sort of

displacement and to occupy the very remarkable position that we know about in soles, turbots, dabs, and so on (the *Pleuronectes* and *Achirus*). The location of these eyes is no longer symmetrical, because it results from an incomplete mutation. Now, this mutation is completely realized in the skates, where the transverse flattening of the body is totally horizontal, as well as the head. Thus, the eyes of rays, both placed on the upper surface, have become symmetrical again.

The snakes, which crawl on the surface of the earth, need mainly to see elevated objects which are above them. This need must have influenced the placement of the organ of sight in these animals. In fact, they have their eyes situated in the lateral and upper part of the head, in such a way that they can easily perceive what is above them or beside them. But they hardly see at all what is in front of them a very short distance away. However, forced to make up for this defect of vision for understanding the bodies which are in front of their heads and which might injure them if they moved forward, they were not able to perceive these bodies except with their tongue, which they were obligated to extend with all their force. This habit not only helped to make this tongue thin, very long, and contractile, but also it has also forced the tongue to divide itself in the majority of species in order to feel several objects at once. It even permitted them to form an opening on the edge of their muzzle, so that they could move the tongue through it without separating their jaws.

Nothing is more noteworthy than what is produced by the habits of the herbivorous mammals.

The quadrupeds in which circumstances and the needs created by these over a long period of time have developed (in it as well as in the individuals of the race) the custom of grazing on grass, moves only on the ground, and finds itself obliged to remain their on its four feet for most of its life, not generally carrying out much movement (or only moderate movement). The large amount of time this sort of animal is required to use each day to fill itself up with a single form of nourishment to which it is accustomed brings it about that it exercises itself very little by moving around and that it uses its limbs only to hold it up on the earth, to move or to run, and it never makes use of its limbs to cling to and climb up trees.

From this habit of consuming, every day, huge volumes of material for nourishment, which distends the organs taking it in, and from the habit of only carrying out moderate movements the result is that the bodies of these animals have grown considerably thicker, have become heavy and huge, and have acquired a really large volume, as we see in elephants, rhinoceroses, oxen, buffaloes, horses, and so on.

The habit of staying upright on four feet for the greater part of the day in order to graze has given rise to a thick horn which envelops the digits of their feet. And since these digits have rested without being exercised by any movement and since they have not served any other purpose than to hold the animals up (just like the rest of the foot) most of these digits have shrunk, dwindled, and have finally disappeared. Thus, in the pachyderms,[6] some have on their feet five digits enveloped in horn and, consequently, their hoof is divided into five parts; others have only four and still others have only three. But in the ruminants, which appear to be the oldest of the mammals limited to sustaining themselves only on land, there

[6] *Pachydermata,* meaning "thick-skinned ones", is an obsolete grouping of mammals that included elephants, rhinos, hippos, pigs, and horses.

are no longer more than two digits on the feet, and in the solipeds[7] there is only one (horses, donkeys).

However, among the herbivorous animals, and particularly among the ruminants, it happens that there are some which, due to circumstances in the desert countries which they inhabit, are ceaselessly in danger of being the prey of carnivorous animals and which can find safely only in sudden flight. Necessity has thus forced them to practice rapid running. From the habit which they have acquired from that, their bodies have become more svelte and their limbs much more slender. We see examples of them in antelopes, gazelles, and so on.

In our climate, other dangers continually expose the red deer, roe deer, and fallow deer to the mortal peril of hunting by human beings and reduce the animals to the same need, force upon them similar habits, and have given rise to the same productions with respect to them.

Ruminant animals can make use of their feet only to hold themselves up. Since they have little power in their jaws, which are exercised only by cutting and browsing on grass, they cannot fight each other except with blows of the head, aiming the crown of their heads against each other.

In their fits of anger (which are frequent, above all among the males), their inner feeling, in these efforts, very strongly direct the fluids towards this part of their heads and there create a secretion of horny material in some and in others a bony material mixed with horny material. This gives rise to solid protuberances. Hence, the origin of horns and antlers, with which the heads of the majority of these animals are armed.

In this matter of habits, it is remarkable to observe the result in the peculiar form and height of the giraffe (*camelo-pardalis*). We know that this animal, the largest of the mammals, lives in the interior of Africa and dwells in those places where the earth, almost always arid and without grass, requires the animal to browse on the foliage of trees and constantly to try hard to reach that foliage. As a result of this habit, maintained for a long time in all the individuals of its race, the animal's front limbs have become longer than those at the back, and its neck has grown longer to such an extent that the giraffe, without rearing up on its hind legs, lifts its head and reaches up to six metres in height (close to twenty feet).

Among the birds, the ostriches, lacking the capacity to fly and elevated on very high limbs, probably owe their remarkable form to analogous circumstances.

The result of habits is just as noteworthy in the carnivorous mammals as it is in the herbivores. But it manifests effects of a different sort.

In fact, among these mammals those who are accustomed, along with their race, to climb, to scratch away in order to dig a hole in the ground, or to rip apart other animals which they attack and kill for prey have a need to use the digits on their feet. Now, this custom has favored the separation of their digits and has formed the claws with which we see them equipped.

But among the carnivores, there are those which are obliged to run in order to catch their prey. Now, among these animals those in which need (and consequently custom) has made

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[7] *Solipeda* is an obsolete grouping of mammals with a single, not cloven hoof; equal to the the horse family (modern Equidae)

it necessary every day for them to rip with their claws and to push them deep into the body of another animal in order to hang on to it and finally to make an effort to tear out the part they have seized must have, through repeated efforts, acquired for these claws a size and curved shape which would have then made them very awkward for walking or running on stony ground. In this case, what happened was that the animal was obliged to make other efforts to push back these excessively projecting curved claws which got in its way. From this gradually resulted the formation of these remarkable sheaths in which cats, tigers, lions, and so on withdraw their claws when they are of no use.

Thus, efforts made in any direction whatever, if maintained for a long time or habitually made by certain parts of a living body to satisfy needs demanded by nature or circumstances enlarge these parts and make them acquire dimensions and a shape which they would never have attained if these efforts had not become the habitual action of the animals which carried them out. Observations undertaken on all the known animals provide examples of this everywhere.

Is it possible that there is a more striking one than the kangaroo? This animal, which carries its little ones in the pouch which it has under its abdomen, has acquired the habit of holding itself upright, balanced only on its back feet and its tail, and it does not move except with the help of a series of leaps in which it maintains its upright posture so as not to upset its young. From this come the following:

1. Its front limbs, of which it makes very little use and on which it leans only in the moment when it abandons its upright posture, have never undergone a development proportional to that of the other parts and have remained thin, very small, and almost without force.

2. The back limbs, almost constantly in action, whether to hold up all the body or to carry out its jumps, have, by contrast, undergone a considerable development and have become very large and very powerful.

3. Finally, the tail which we see here used a great deal to hold the animal up and for carrying out its principal movements has acquired at its base an extremely remarkable thickness and power.

These well known facts are surely very relevant to show what results from the habitual use among animals of an organ or any part whatever. And if, when one observes in an animal, an organ noticeably developed, strong, and powerful, people maintain that habitual exercise has done nothing to bring that about, that its sustained lack of use would not take anything away, and that finally this organ has always been just as it is now ever since the creation of the species to which this animal belongs, I will enquire why our domestic ducks cannot fly any more like wild ducks. In a word, I will cite a multitude of examples directly relevant to us which point to the different results of the exercise or the lack of exercise of any of our organs, although these differences might not be maintained in individuals who come later through reproduction.

I will make known in the second part that, when will power determines that an animal carry out some action or other, the organs which must execute this action are immediately stimulated to it by the inflow of subtle fluids (the nervous fluids) which become there the determining cause of the movements which the action in question demands. A multitude of

observations confirms this fact, which people cannot now doubt.

From this it follows that multiple repetitions of these actions of the organic structure strengthen, extend, develop, and even create organs essential for these actions. It is only necessary to observe attentively what happens everywhere in this matter to become convinced of the basis for this cause of developments and organic alterations.

Now, every change acquired in an organ by a habitual use sufficient to have brought it about then preserves the change by reproduction, if it is common to individuals which, in the act of reproduction, come together for the propagation of their race. Finally, this change passes itself on and thus is transmitted to all the individuals which come after and which are subject to the same circumstances, without being obliged to acquire the change in the same way it was actually created.

Moreover, in the reproductive unions, the blending of individuals who have different qualities and forms is necessarily opposed to the constant propagation of these qualities and forms. In man, who is subjected to so many diverse influential circumstances, that is what prevents the accidental qualities or defects which he happens to acquire from preserving and propagating themselves by reproduction. If we have a case where two individuals with remarkable shapes or any defects always couple together, they will reproduce the same particular features, and if later generations limit themselves to similar unions, a particularly distinct race will then be formed from them. But constant interbreeding among individuals who do not have the same distinctive features will erase all distinctive particularities acquired by distinctive circumstances. Hence, we can be assured that if the distance between their dwelling places did not separate human beings, the reproductive mixing would do away with the general characteristics which distinguish the different nations.

If I wished here to review all the classes, all the orders, all the genera, and all the species of animals which exist, I could show that the structure of individuals and their parts, their organs, their capacities, and so on and so on, are everywhere uniquely the result of the circumstances which each race finds itself subjected to by nature and of the habits which the individuals making up a race have been obliged to acquire. I could show that these are not the result of a form existing in primitive times which has forced animals into those habits which we know about.

We know that the animal called the ai, or the sloth (*bradypus tridactylus*) is constantly in a feeble state, so much so that it carries out only very slow and very limited movements and that it moves on the ground with difficulty. Its movements are so slow that people allege that it can make only fifty paces in a single day. We also know that the organic structure of this animal is entirely linked to its feeble condition or its inability to move and that if it wished to make movements different from those which we have seen it carry out, it would not be able to.

Hence, by assuming that this animal had received from nature the organic structure which we know about, people said that this organization forced upon it the habits and the sorry condition in which it finds itself.

I am a long way from believing this. For I am convinced that the habits which individuals of the sloth family were forced to acquire originally must necessarily have led to its present

condition.

If continual dangers had in earlier times brought it about that individuals of this species took refuge in the trees, habitually lived there, and derived nourishment from their leaves, then it is clear that they would have had to forgo a multitude of movements which animals living on the ground are in a position to carry out. All the needs of the ai would thus have been reduced to hanging from branches, crawling or dragging themselves along there to catch leaves, and finally remaining in the tree in an inactive state so as to avoid falling down. Moreover, this style of inactivity would have been constantly fostered by the hot climate, because among warm-blooded animals heat encourages rest rather than movement.

Now, over a long period of time, the individuals of the sloth family would have continued the habit of remaining in the trees and not moving there other than slowly and with little variety, in a way which could meet their needs. Their organic structure gradually would have accorded itself to their new habits. From that, the following will result:

> (1) the arms of these animals, by making constant efforts to hold readily onto the tree branches, would have grown longer;
>
> (2) the nails on their digits would have acquired considerable length and a hooked shape, through the sustained efforts of the animal to hold onto its position;
>
> (3) since their digits would never be exercised with remarkable movements, they would have lost all their mobility, grown together, and preserved only the ability to clench or unclench all together;
>
> (4) since their thighs would continually wrap around the trunk or the large tree branches, they would have acquired a customary space between them, something which would help to enlarge the pelvis and to push the cotyloid cavities[8] towards the back;
>
> (5) finally, a large number of their bones would have fused together and several parts of their skeletons would have taken on an arrangement and a shape corresponding to the animals' habits, something different from what they would have to have for other habits.

There we have what people will never be able to doubt, because, in fact, nature, in a thousand different cases, always shows us analogous facts, in the power of circumstances on the habits and of habits on shapes, arrangements, and proportions of animals.

Since a greater number of references is quite unnecessary, here we have what the point of this discussion comes down to.

The fact is that the various animals all have, in accordance with their genus and their species,

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[8] The *cotyloid cavities* are hip sockets (usually called *acetabula* in human anatomy today).

particular customs and always an organic structure which accords perfectly with these customs.

From a consideration of this fact, it seems that we are free to admit that either one or the other of the two following conclusions and that neither of them can be proven.

> **Conclusion Accepted Up Until Today:** Nature (or its author), in creating the animals, anticipated all the possible sorts of circumstances in which they would have to live and gave to each species a fixed organic structure, as well as a determined and invariable form for its parts, which forces each species to live in those places and climates where it is located and to maintain there the habits which we know it has.
>
> **My Personal Conclusion:** Nature, by producing in succession all the animal species and beginning with the most imperfect or the simplest, gradually made the organic structure more complicated; as these animals generally spread out into all the habitable regions of the world, from the influence of the circumstances which each species encountered, it acquired the habits which we know in it and the modifications in its parts which observation reveals to us in that species.

The first of these conclusions is the one which people have drawn up to the present time, that is to say, that it has been just about universal. It assumes in each animal a constant organic structure and parts which have never varied and which will never vary; it further assumes that the circumstances in the places where each species of animals dwells never varies in these locations; for if they did vary, the same animals would no longer be alive and the possibility of finding other similar circumstances and of transporting themselves there would be forbidden to them.

The second conclusions is my own. It assumes that through the influence of circumstances on habits and later the influence of habits on the condition of the parts and even on the condition of the organic structure, each animal can undergo in its parts and organic structure modifications capable of becoming really significant. This has given rise to the condition in which we find all the animals.

To establish that this second conclusion is groundless, it is first necessary to prove that each point on the surface of the earth never varies its nature, exposure, lofty or low elevation, its climate, and so on and so on, and, beyond that, to show that no part of animals undergoes, even with the passage of a great deal of time, any modification occasioned by a change in its circumstances and by the necessity which forces them to a style of life and action different from what is habitual to them.

Now, if a single fact confirms that an animal which has been domesticated for a long time differs from the wild species from which it originated and if, in such a domesticated species, we find a great structural differences between individuals which we have subjected to some habit and those whom we have forced into different habits, then it will be certain that the first conclusion does not conform at all to natural laws and that, by contrast, the second is perfectly in accordance with them.

Thus, everything comes together to establish my assertion, namely, that it is not the form (whether of the body or the parts) which gives rise to the habits and the manner of living in animals, but that, by contrast, it is the habits, the manner of life, and all the other influential circumstances which have, over time, shaped the form of the body and the parts of animals. With new shapes, new faculties were acquired, and gradually nature came to the point of creating the animals such as we see them now.

Could there be in natural history a more important conclusion, one to which we ought to give more attention, than the one with I have just revealed?

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