TESTING LAMARCK'S THEORY

CASPER L. REDFIELD, CHICAGO, ILL.

The first clear and distinct theory of evolution was advanced by the French scientist, Jean Baptiste de Lamarck. With the exception of that of Darwin, the theory of Lamarck has been discussed more than any other, and it is the least understood of any theory which has been discussed at all. Considering the vast literature and almost total lack of understanding, Lamarck's theory presents what is perhaps the most remarkable case in the history of science.

The causes leading to the misunderstanding of this theory would fill a book, so we will confine ourselves here to explaining what the misunderstanding is rather than the causes which led to it. To make the matter clear it will be necessary not only to state what the theory is, but to point out what it is not.

Lamarck's theory is stated in his Zoological Philosophy published in 1809, when Lamarck was sixty-five years of age. A partial translation of this work was made by A. S. Packard and published in 1901. A complete translation was made later by Hugh Elliot and was published in 1914. It is to these translations we must go for an understanding of the theory. At this point it may be noted that neither translator clearly understood the theory he was translating. In their comments, both translators make statements which are contradicted by the texts which they translated. When the translators themselves misconstrue what they translate, it is not surprising that others should do the same.

About thirty years ago many cases of supposed inheritance of mutilations were advanced as evidence of the truth of Lamarck's theory. This was attacked successfully by August Weismann, who cut off the tails of mice for many generations in succession and found that tails grew just the same as before. This was looked upon as a full refutation of Lamarck's theory, and a great many persons so consider it at the present time.

It happens that Lamarck discussed mutilations under the term of "accidental defects", and he states that they are not inherited. He says:—"Hence it is that in man, who is exposed to so great a diversity of environment, the accidental qualities or defects which he acquires are not preserved and propagated by reproduction." (Packard's translation, pages 246, 319; Elliot's translation, page 124.)

Here we see that the long and acrimonious dispute over the supposed inheritance of mutilations was based on a misunderstanding which orginated no one knows where, and which had no bearing on Lamarck's theory. As we shall see later, the idea that mutilations might be inherited is entirely foreign to the theory and had no excuse for existence.

Darwin advanced the theory that by selecting variations, changes might be brought about which would result in the production of new species. He did not explain the origin of variations but said that with variations in existence, selection would accomplish wonderful results. The often repeated statement that selection does so-and-so has come to mean, even among biologists, that selection is the real and actual cause. They forget that the variation must come into existence before it can be selected, and that the cause of the variation must be something other than the subsequent selection.

The same kind of confusion of ideas has come into the popular consideration of Lamarck's theory in regard to environment. The idea that the environment may cause modifications has been popular since before Lamarck's time, and is so now. Even the biologists of the present time subject guinea-pigs, rats, mice, rabbits, etc. to environmental actions in efforts to produce heritable modifications. Among the things done has been subjecting animals to prolonged applications of alcohol, to X-rays, to radium emanations, to injection of the juice of eye lens, to rotation in cages, and so on.

Lamarck had a great deal to say about the environment, but he did not claim that the environment caused

change any more than Darwin claimed that his selection produced the things selected. Lamarck said that animals lived in the environment, and that the environment directed the actions of the animal, but that it did nothing of itself to produce a change. To make his meaning clear, Lamarck said:

> "Here it becomes necessary for me to explain the meaning I attach to the expression *circumstances influencing the form and structure of animals*—namely, that in becoming very different they change, with time, both their form and organization by proportionate modifications. Assuredly, if these expressions should be taken literally, I should be accused of an error; for whatever may be the circumstances they do not directly cause any modifications in the form and structure of animals." (Packard's translation, page 294; Elliot's translation, page 107.)

Here we have a clear statement which shows that Lamarck was not an environmentalist, and the other parts of his writings bear out that statement. It is not what is done *to* the animal by the environment, but, as we shall see, it is what the animal *does* of itself to itself, which counts. The environment is that which is outside of and surrounds the animal. What the animal does represents something occurring within the protoplasm of the cells which compose the animal. It is a misconception to refer to the action of an animal as being in the same class of things as the environment. The two things stand in contradistinction to each other.

Lamarck was a contemporary with the later life of Linnaeus, and was one of the pioneers in the classification of plants and animals. In fact, he was the originator of a considerable part of the classification as it now exists. After he had spent twenty-five years as a botanist, largely in classifying the largest botanical collections then existing, he was placed in charge of the largest zoological collection in the world. Here he spent more years in classification, and among other things he was the first to distinguish vertebrate from invertebrate animals by the presence of the vertebral column. "The

problem of taxonomy has never been put more philosophically than put by him."

In doing this work, Lamarck became impressed with the fact that the classification of species and genera was artificial. He, and not a Creator, was determining what constituted species and genera, and what were their limits. He was impressed also with the fact that the distinctions between one species and another were trivial in the extreme, and that intergrades frequently obliterated those distinctions. For the purpose of making this matter clear, and for laying a foundation for his new theory, he devotes the first chapter of his book to "Artificial Devices in Dealing with the Productions of Nature." After referring to the "artificial aids" of classification, which he says are necessary in dealing with such masses of material, he goes on to say:

> "Nature has made nothing of this kind: and instead of deceiving ourselves into confusing our works with hers, we should recognize that classes, orders, families, genera and nomenclatures are weapons of our own invention. * * * We may rest assured that among her productions nature has not really formed either classes, orders, families, genera or constant species, but only individuals which succeed one another and resemble those from which they sprung."

From his consideration of these things he got a new idea. That idea was that the "order of nature" was determined by what animals *did,* and not by what they *looked like.* He knew that species were not real things in nature, and that animals changed. From what he observed he could see that certain changes were brought about by the manner in which animals lived and acted, and not by reason of the existence of any particular environment. Hence, he conceived the idea that animals evolved by the *inside forces* developed within them by their own actions and efforts, and not by the *outside forces* of the environment. His theory is condensed into two laws, as follows:

FIRST LAW

"In every animal which has not passed the limit of its development, the more frequent and continuous use of any organ gradually strengthens, develops and enlarges that organ, and gives it a power proportional to the length of time it has been so used; while the continuous disuse of any organ imperceptably weakens and deteriorates it, and progressively diminishes its functional capacity."

SECOND LAW

"All of the acquisitions and losses wrought in individuals by the predominant use or permanent disuse of any organ are preserved by reproduction in the new individuals which descend from those which have acquired the modifications."

(Packard's translation, page 303; Elliott's translation, page 113. The above statement of these laws is a composite of the two translations, and is simplified by the omission of parenthetical matter.)

It is not enough to glance at these two laws, and then pass on to something else. They should be examined carefully and critically to see what they mean. They should be examined as a lawyer examines the wording of a contract. The failure to give them such careful consideration is undoubtedly the primary cause of the wide spread misinformation as to what Lamarck's theory is.

We all know that exercising any organ, as a muscle, increases the power of that organ, but Lamarck refers to "frequent and continuous" exercise, and says that the acquired development in the individual is "proportional to the length of time" that the organ is exercised. The "frequent and continuous" exercise means continued activity of some kind, and the "length of time" necessarily involves the age of the animal, if we are to make any measurements of what the acquirements are. That any test of Lamarck's theory necessarily involves determining the degree of activity of the animal, and its age at the time of reproducing, is evident from the second

law which says that "all of the acquisitions and losses" are preserved by reproduction on the part of those individuals which have gained by exercise or lost by idleness.

Lamarck says that this development of powers by exercise occurs in "every animal which has not passed the limit of its development," but he does not state where that limit is. He simply assumes that it continues for some time but furnishes no evidence as to how long that time is. However, I have furnished that evidence in my "Human Heredity," in my article in Volume XIII, page 59, of the Transactions of the Illinois State Academy of Science (1920), and in numerous other contributions. Under continuous exercise, powers continue to develop up to practically the end of life; and under lack of exercise, powers continue to degenerate as long as the lack of exercise continues. While the observed gains and losses are irregular, there is much evidence to indicate that the real gains are directly proportional to the degree of activity above the normal, and the length of time that excess activity continues. Also. that the losses are directly proportional to the deficiency of activity and the length of time that deficiency is continued.

This theory is known as the theory of the inheritance of acquired characters, or, as I usually term it, the inheritance of acquirements. Power in the organs of an individual is a character which existed before, but the increase of the amount of such power is an acquirement. To be technical, the verb *to acquire* means to obtain something by effort, exertion or the performance of work on the part of the individual which makes the acquirement. In amputating the tails of mice, the acquirement is in the muscles of the amputator, and not in the taillessness of the mice. Taillessness means the loss of something, and the verb to acquire does not mean to lose.

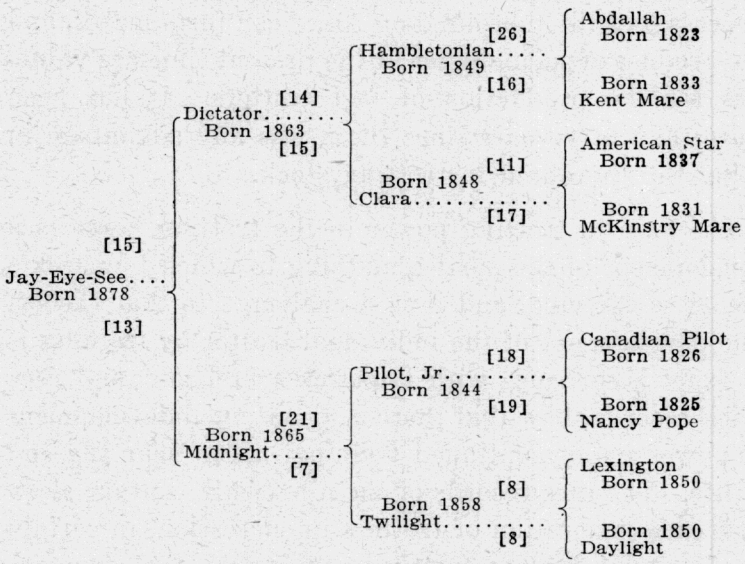
The American trotter is the product of the nineteenth century and represents what is probably the most remarkable example of the rapid development of powers in any animal. A hundred years ago the highest trotting speed was a mile in three minutes. Now the extreme

speed is better than a mile in two minutes. This improvement in trotting power has been nearly but not quite uniform during the intervening years. It will not do to say that this improvement is due to improved tracks, sulkies and training. The trotting breed started in crosses of the thorobred on American farm mares, and the product of such crosses at the present time are valueless for the production of fast trotters. It has been more than fifty years since there was any advantage in using the thorobred in trotting stock.

The gain in trotting power in the trotting horse is a development of the particular thing to which Lamarck's theory is directed, and it is a challenge to that theory. The development of the individual trotter by training is in exact accordance with Lamarck's first law, and race track records show that there is a continued development of power under continued training, up to near the end of life. The race records of the nineteenth century show that each generation of trotters in succession, in certain lines, inherited more trotting power than their parents inherited. Did that gain in inherited power come in accordance with Lamarck's second law, or in some other way? That is a question of fact to be determined by examining the records, and for the purpose of showing the process of testing Lamarck's theory there is provided a pedigree of the first horse to trot a mile in two minutes and ten seconds.

The first time a horse ever trotted a mile in two minutes and thirty seconds was in 1845, and that horse is not in this pedigree. By examining the dates when the great-grandparents of Jay-Eye-See were born, it will be seen that they came from ancestors, no one of which was capable of trotting a mile in 2:30. The pedigree therefore covers all of the animals involved in a very considerable

increase in inherited power. The trotting power which had no previous existence in the breed had its origin somewhere among these animals. It could not come from the environment because trotting power is something which does not exist in the environment.



Pedigree of the First 2.10 Trotter.

The figures in brackets between parents and offspring are Lamarck's factor of "length of time". Thus, there are 15 years between the birth of Dictator and the birth of his son Jay-Eye-See. These figures mean nothing of themselves, but we begin to see a significance when we compare them with the average age of parents in normal breeding, which is 10.4 years for sires and about 8.5 years for dams. As sires less than 7 years of age are as common in normal breeding as are sires more than 14, it will be seen that for the parents in all of the generations in this pedigree, Lamarck's factor for "length of time" is high.

There is a life history of nearly all of the animals in this pedigree, and from this history we can determine, approximately, Lamarck's factor of activity, and hence can determine whether there was a gain in the parents by "frequent and continuous" exercise before reproduction,

or a loss from "continuous disuse". Thus, Dictator "was driven a good deal" when young, and "was worked considerably at Mr. Durkee's farm" up to the year before Jay-Eye-See was conceived. After that he was used for breeding purposes solely, and not worked. Very much the same story is told for the other animals in the pedigree, all of which show that in each pair at the time of reproduction there was a considerable excess development coming from "frequent and continuous" exercise for an unusual "length of time".

We will not go into the details of these histories because of the lack of space, and because it would be wearisome, but there is one matter which throws a flood of light upon the case. Dictator was not only the sire of the champion Jay-Eye-See, but he was full brother of Dexter, one of the most famous of all champion trotters. The reader will conclude naturally that Dictator was of choice selected stock and that the improvement came through selection, but there is a damper on that idea. Both Dexter and Jay-Eye-See were geldings. The fact that Dexter was sterilized shows that the breeders did not consider the Hambletonian-Clara combination as valuable at the time he was born, and the fact that Jay-Eye-See was sterilized shows that they did not consider the Dictator-Midnight combination valuable when Jay-Eye-See was born. Of the sires in this pedigree, Hambletonian is the only one used much for breeding purposes before the age at which he here appears, and he had harness work all his life. Daylight first went to the breeding ranks at the age of six, Midnight first went there at the age of eight, Clara first went there at ten, the Kent Mare first went there at the age of fifteen, and the McKinstry Mare was a famous road mare for many years before Clara was born. On this point there is no available record for the other two mares. Carefully selected brood mares usually go into the breeding ranks at about three years of age, and those which do not go early have to work for a living.

It has been said that my work on the trotters and other animals is nothing but statistics, but that is not true. Applying the Lamarckian factors of activity and age to the progenitors, one at a time, in the pedigree of Jay-Eye-

See for the purpose of testing the application of Lamarck's theory to the known improvement, is not statistics. Neither does that kind of work become statistics when it is applied to the different animals individually in a second pedigree, or to the animals in a thousand pedigrees. Statistics have been used in this work, but the demonstration of the accuracy of Lamarck's laws does not come from statistics. Neither does it come from the detailed examination of a case like that of Jay-Eye-See. And it does not come from finding a large number of cases of the same kind. It comes from a series of things.

1. The fact that gain in inherited power in offspring is never found in any case except those in which the immediate ancestors made excess acquirements in accordance with Lamarck's first law.

2. The fact that a reduction of either of the factors of activity or age in parents so that the product of those factors at the time of reproduction is less than the average for the breed, invariably results in a decrease in inherited power in offspring.

3. The fact that when a considerable number of cases are taken and tested out one at a time, and are compared with each other, it is found that the amount of gain or loss per generation in the inherited power is always proportional to the product of the Lamarckian factors, within the limits of unavoidable errors.

On this third point, just refer back to Lamarck's laws. The first law says that when there is "frequent and continuous use" of an organ, the development is "*proportional* to the length of time" of such use. The second law says that "*all* of the acquisitions and losses wrought in individuals by the predominant use or permanent disuse of any organ are preserved by reproduction".

Lamarck stated his theory so that it might be tested by the methods of exact science.