PRINCIPLES OF HEREDITY: A REVIEW.*

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THE subject of heredity is just now exciting general interest, and it is well that it should, for nothing in the whole realm of nature is fraught with larger issues, or more worthy patient, reverent study.

One of the chief additions to our knowledge of heredity since Darwin's time is the recognition of the fact that acquired characters are not inheritable. By an acquired character is meant one which does not develop as the result of unaided developmental force, but is impressed upon the individual by his environment. It is a moulding by environmental agencies of the individual after it has started on its developmental career. Thus, mutilations, hypertrophies of organs from abundant use, morbid effects produced by injurious agencies (such as pathogenic bacteria), the immunity acquired after measles or whooping-cough—all these are acquisitions, as are also the various items of individual knowledge. Now, it is certain that no such acquisitions are capable of being inherited, and although for some reasons this is greatly to be regretted, for other reasons it is very fortunate.

If all acquisitions were advantageous, their inheritance would lead to a continued improvement of species; then, indeed, evolution would march apace, and would attain to heights undreamed of in philosophy. The mental equipment, moral and intellectual, of the parents would descend to the children, and would thus necessarily be added to with every succeeding generation; individual knowledge would become limitless, and by assiduously cultivating the moral nature it might be possible to breed a race

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supreme in moral endowment. Similarly in regard to physical excellence: acquired excellences in the physical sphere would accumulate with each generation.

The Lamarckians assumed the inheritability of acquired excellences. According to them the giraffe's neck became long by being stretched through successive generations in the effort to reach the high branches of trees, and the feet of the duck became webbed from the continued attempt to oppose as large a surface as possible to the water.

If only beneficial acquisitions were inheritable, the arrangement would, I say, work for good; but, unfortunately, the individual often makes injurious acquisitions. Few animals, *e.g.*, can live their normal term of life without suffering some time or other from disease, and every attack of disease leaves its impress upon the tissues: in the case of civilized man, disease is quite common, and its total effect on the tissues considerable. Now, imagine what would happen if these morbid effects were inherited; it is evident that in a few generations they would accumulate to such an extent as to cause extinction. It is curious that the Lamarckians and the Neo-Lamarckians (including Spencer and Darwin) should have failed to realize that the doctrine of the inheritability of acquired characters, pushed to its logical conclusion, implies nothing less than this. The non-inheritability of acquisitions is, in fact, a fundamental necessity of biological evolution.

All biologists are now agreed as to the principle of natural selection. Individuals tend to vary about a specific mean; some of these variations are helpful in fitting the individual to its environment, others are the reverse; those manifesting the former tend to survive, and those manifesting the latter to succumb; and thus by a continual survival during successive generations of the fit, and the elimination of the unfit, species are evolved. Now, it is most important to understand that, from the point of view of evolution, such natural variations need to be sharply distinguished from mere acquisitions; it is obvious that the latter, not being inheritable, cannot be accumulated by natural selection; selection can only operate on *natural variations*; on acquisitions, or, as they are sometimes termed, *modifications*, it can have no effect. How, then, shall we define a natural

variation? It is a variation from the "specific mean," due, not to any environmental impress on the individual, but to the innate developmental tendency of the fertilized ovum; it takes its origin in the reproductive cells. Variations thus arising are inheritable; and it is on such that natural selection operates.

But what causes the reproductive elements to vary in their hereditary tendencies, so that marked variations may be observed in the members of one family, or even of the same litter? This is one of the most important questions agitating the minds of biologists at the present time.

Dr. Archdall Reid holds that variations arise spontaneously, that the germ and sperm tend of themselves to vary within certain narrow limits from the specific mean, for the express purpose of providing natural variations, and that they have evolved this property by means of natural selection. It is tempting to assume, as some have done, that these genetic, or germinal, variations are produced by the direct action of the environment on the reproductive cells. Dr. Reid argues against this view. He admits—as who could fail to do?—that these cells are capable, like all others, of being influenced by their environment; but he denies that their hereditary tendencies can to an appreciable extent be affected in this way. We seem, indeed, compelled to assume that the reproductive cells are, in respect of these tendencies, highly resistant to the action of the environment, for otherwise, not only would it be impossible for a species long to preserve its identity, but the offspring would always tend to be injuriously affected by parental disease, and this would lead to progressive racial degeneration. All individuals, certainly all civilized humans, tend to suffer at some time or other from blood defect; the blood-cells are often defective, as is also the plasma, whether in respect of nutritive constituents, internal secretions, excretory substances, or toxins bred of disease. Now, if the hereditary potentialities of the reproductive cells be affected by the enviroing plasma, then presumably those potentialities are injuriously affected by a defective plasma. We must, therefore, assume, with Dr. Reid, a high degree of resistance to their environment on the part of the reproductive cells.

Consider what is happening in the case of the West African negroes. Scarcely a single one escapes malaria, a disease in which

the blood is both impoverished and poisoned. The reproductive cells are therefore from generation to generation bathed in unhealthy plasma, and yet, far from degenerating, these people are actually undergoing evolution against the malaria parasite. For the same reason Dr. Reid dissents from the prevalent view as to the racial effects of slum life. Slum-bred people, he argues, do not suffer racial degeneration; rather do they tend to evolve against the injurious effects of slum life. In this connection we cannot but recall the fact that the Jews, who have been essentially a town-bred people for many centuries, are on the whole a healthy race, and there can be little doubt that they are much better adapted to town life than most other races.

Alcohol constitutes another form of injurious environment which has no power to cause racial degeneration, but, on the contrary, sets on foot an evolution against itself. Dr. Reid contends, in fact, that it is only under an injurious environment that evolution can occur. Make the conditions of life stringent, make the struggle for existence severe, and evolution proceeds apace. On the other hand, make the environment easy, remove the need for struggle, and retrogression sets in, as has happened in the case of many internal parasites. The truth of this principle is exemplified in the ordinary affairs of life: active competition makes for efficiency, monopoly favours an opposite condition of things.

It is admitted by all biologists that reproduction by double parentage leads to natural variations, the offspring not being exactly like either parent; and Weismann has long contended that the essential object of this mode of reproduction is to provide variations on which natural selection can operate. Dr. Reid, however, takes an entirely different view as to its purport. He insists that the variations thus resulting are *regressive*, that they are, in fact, of the nature of reversions, and that there is no tittle of evidence to show that they are *progressive*, that they provide, *i.e.*, new and additional characters on which selection may operate.

What part, then, does biparental reproduction play in the great scheme of evolution? Dr. Reid holds that its function is "to plane away" useless or injurious characters. Characters in which the parents differ tend to be left out in the offspring—thus, when

varieties of fancy pigeons are crossed, the offspring tend to revert to the ancestral blue pigeon—and hence, when natural selection ceases in regard to any character, this character tends to be gradually lost, owing to the ever-recurring union of parents presenting unlike characters.

Biparental reproduction thus provides an effective means of getting rid of useless or injurious characters. The atrophy of an organ resulting from disuse may be spoken of as a “disuse acquirement,” and being thus incapable of transmission, species cannot rid themselves of useless organs on the Lamarckian assumption. “Reverse selection”—*i.e.*, the survival of those individuals in whom a given character is least developed—may, indeed, lead to a gradual diminution of that character; but this method does not by itself appear adequate to rid a species of those countless characters which during the long process of evolution are continually needing elimination. This, however, according to Dr. Reid, biparental reproduction is competent to do. It is for biologists to put this daring conception to the test, and to determine whether the author has discovered a law second only in importance to that of natural selection itself. He has certainly made out a strong case.