DETERMINATE EVOLUTION.¹

I. ORGANIC SELECTION.

Admitting the possible truth of either of the current doctrines of heredity, yet there are certain defects inherent in both of them. Natural Selection, considered merely as a principle of survival, is admitted by all. It fails, however, (1) to account for the lines of progress shown in evolution where the variations supposed to have been selected were not of importance enough at first to keep alive the creatures having them (*i. e.*, were not of 'selective value'). The examination of series of fossil remains, by the paleontologists, shows structures arising with very small and insignificant beginnings.² Further, (2) in cases where correlations of structures and functions are in question, as in the case of complex animal instincts, it is difficult to see what utility the partial correlations could have had which would necessarily precede the full rise of the instinct; and yet it is impossible to believe that these correlations could have arisen by the law of variation all at once as complete functions.³ These two great objections to the 'adequacy of natural selection' are so impressive that the Neo-Darwinians have felt obliged to deal with them. The first objection may be called that from 'determinate evolution,' and the latter that from 'correlated variations.'

On the other hand the doctrine of use-inheritance or Lamarckism is open to equally grave difficulties in my opinion. (1) It is a pure assumption that any such inheritance takes place. The direct evidence is practically nothing.⁴ No unequivocal case of the inheritance of the normal effects of use or disuse has yet been cited. Again (2) it proves too much, seeing that if it actually operated as a general principle it would hinder rather than advance evolution in its higher reaches. For, first, in the more variable functions of life it would produce conflicting lines of inheritance of every degree of advantage and disadvantage, and these would very largely neutralize one another, giving a sort of functional 'panmixia' of inherited habits analogous to the panmixia of variations which arises when natural selection is not operative. Again, in cases in which the functions or acquired habits are so widespread

¹ Matter added in the foreign editions of the author's 'Mental Development in the Child and the Race.'

² Cf. the statement of this objection by Osborn, *Amer. Naturalist*, March, 1891.

³ Cf. Romanes, *Darwin and after Darwin*, II., chap. 3.

⁴ See the candid statement of Romanes, *loc. cit.*; and Morgan, *Habit and Instinct*, Chap. XIII.

and constant as to produce similar 'set' habits in the individuals, the inheritance of these habits would produce, in a relatively constant environment, such a stereotyped series of functions, of the instinctive type, that the plasticity necessary to the acquirement of new functions to any great extent would be destroyed. This type of evolution is seen in the case of certain insects which live by complex instincts; and however these instincts may have been acquired, they may yet be cited to show the sort of creatures which the free operation of use-inheritance would produce. Yet just this state of things would again militate against continued use-inheritance, as a general principle of evolution; for as instinct increases, ability to learn decreases, and so each generation would have less acquisition to hand on by heredity. So use-inheritance would very soon run itself out. Further, (3) the main criticism of the principle of natural selection cited above from the paleontologists, *i. e.*, that from 'determinate evolution,' is not met by use-inheritance; since the determinate lines of evolution are frequently, as in the case of teeth and bony structures, in characters which in the early stages of their appearance are not modified in the direction in question, during the lifetime of the creatures which have them. And, finally, (4) if it can be shown that natural selection, which all admit to be in operation in any case, can be supplemented by any principle which will meet these objections better than that of use-inheritance, then such a principle may be considered in some degree a direct substitute for the Lamarckian factor.

There is another influence at work, I think, which is directly supplementary to natural selection, *i. e.*, *Organic Selection*.

Put very generally, this principle may be stated as follows: acquired characters, or modifications, or individual adaptations—all that we are familiar with in the earlier chapters under the term *Accommodations*—while not directly inherited, are yet influential in determining the course of evolution indirectly. For such modifications and accommodations keep certain animals alive, in this way screen the variations which they represent from the action of natural selection, and so allow new variations in the same directions to arise in the next and following generations; while variations in other directions are not thus kept alive and so are lost. The species will therefore make progress in the same directions as those first marked out by the acquired modifications, and will gradually 'pick up,' by congenital variation, the same characters which were at first only individually acquired. The result will be the same, as to these characters, as if they had been directly inherited, and the appearance of such heredity in these cases,

at least, will be fully explained. While the long continued operation of the principle will account for 'determinate' lines of change.

This principle comes to mediate to a considerable degree between the two rival theories, since it goes far to meet the objections to both of them. In the first place, the two great objections as stated above to the ordinary Natural Selection theory are met by it. (1) The 'determinate' direction in the evolution is secured by the indirect directive influence of Organic Selection, in all cases in which the direction which phylogenetic evolution takes is the same as that which was taken by individual modifications in earlier generations. For where the variations in the early stages of the character in question were not of selective value, there we may suppose the individual accommodations have supplemented them and so kept them in existence. An instance is seen in the fact that young chicks and ducks which have no instinct to take up water when they see it,¹ and would perish if dependent upon the congenital variations which they have, nevertheless imitate the mother fowl, and, thus by supplementing their congenital equipment, are so kept alive. In other fowls the drinking instinct has gone on to perfection and become self-acting. Here the accommodation secured by imitation saves the species—apart from their getting water at first accidentally—and directs its future development. Farther (2) in cases of 'correlated variations'—the second objection urged above to the exclusive operation of Natural Selection—the same influence of Organic Selection is seen. For the variations which are not adequate at first, or are only partially correlated, are supplemented by the adaptations which the creature makes, and so the species has the time to perfect its inadequate congenital mechanism. On this hypothesis it is no longer an objection to the general origin of complex instincts without use-inheritance, that these complex correlations could not have come into existence all at once; since this principle gives the species time to accumulate and perfect its organization of them.

Similarly, the objections cited above to the theory of use-inheritance can not be brought against Organic Selection. In the first place (1) the more trivial and varied experiences of individuals—such as bodily mutilations, etc.—which it is not desirable to inherit, whether good or bad in themselves, would not be perpetuated in the development of the race, since organic selection would set a premium only on the variations which were important enough to be of some material use or others which were correlated with them. These being of

¹ See Morgan, *Habit and Instinct*, pp. 44 f. and his citations from Eimer, Spalding, and Mills.

such importance, the species would accumulate the variations necessary to them, and the individuals would be relieved of the necessity of making the private adaptations over again in each generation. Again (2) there would be no tendency to the exclusive production of reflexes, as would be the case under use-inheritance; since in cases in which the continued accomplishment of a function by individual accommodation was of greater utility than its accomplishment by reflexes or instinct—in these cases the former way will be perpetuated by natural selection. In the case of intelligent adaptations, for example, the increase of the intelligence with the nervous plasticity which it requires is of the greatest importance; we find that creatures having intelligence continue to acquire their adaptations intelligently with the minimum of instinctive equipment.¹ There is thus a constant interplay between instinct and accommodation, as the emergencies of the environment require the survival of one type of function or the other. This is illustrated by the fact that in creatures of intelligence we find sometimes both the instinctive and also the intelligent performance of the same function; each serving a separate utility.²

(3). The remaining objection—and it holds equally of both the current views—is that arising from the cases of structures which begin in a very small way with no apparent utility, such as the bony protuberances in places where horns afterwards develop, and in certain small changes in the evolution of mammalian teeth; which afterwards progress regularly from one generation to another until they become of some utility. While it is not clear that Organic Selection completely accounts for these cases, yet it is quite possible that it aids us in the matter; for the assumption is admissible that in their small beginnings these characters were correlated with useful functions or variations, and that the Organic or Natural Selection of the latter in a progressive way has secured the accumulation of these characters also. The facts of correlation are so little known, while yet the correlation itself is so universal, that no dogmatism is justified on either side; the less, perhaps on the side of the paleontologists who assert that these cases can not be explained by Natural Selection even when supplemented by Organic Selection; for when we enquire into the state of the evidence for the so-called ‘determinate variations’ which are supposed in these cases, we find that it is very precarious.³

¹ Groos (*Die Spiele der Thiere*, p. 65 f.) has pointed out the function of imitation as aiding the growth of intelligence with the breaking up of instincts under the operation of natural selection.

² Baldwin, *Science*, Apl. 10, 1896.

³ For example, the only way to establish ‘determinate variations’ would

We come to the view, therefore, that evolution from generation to generation has probably proceeded by the operation of Natural Selection upon variations with the assistance of the Organic Selection of co-incident¹ variations (*i. e.*, those which reproduce congenitally the acquisitions of the individuals). And we derive a view of the relation of ontogeny to phylogeny all through the animal series. All the influences which work to assist the animal to make adaptations or accommodations will unite to give directive determination to the course of evolution. These influences we may call 'orthoplastic' or directive influences. And the general fact that evolution has a directive determination through organic selection we may call 'Orthoplasia.'²

As to detailed evidence of the action of Organic Selection, this is not the place to present it. It is well-nigh coextensive however with that for Natural Selection; for the cases where natural selection operates to preserve creatures because they adapt themselves to their environment are everywhere to be seen, and in all such cases Organic Selection is operative. Positive evidence in the shape of cases is however to be found in the papers of the writer and others on the subject.³

be to examine all the individuals of a given generation in respect to a given quality, and compare their mean with *the mean of their parents—not with the mean of all the individuals of the earlier generation*. For some influence, such as Organic Selection, might have preserved only a remnant of the earlier generation, and in this way the mean of the variations of the following generation may be shifted and give the appearance of being determinate, while the variations themselves remain indeterminate. And again, the paleontologists have no means of saying how old one of these fossil creatures had to be in order to develop the character in question. It may be that a certain age was necessary and that the variations which he finds lacking would have existed if their possessors had not fallen by natural selection before they were old enough to develop this character and deposit it with their bones.

¹A term suggested by Professor Lloyd Morgan.

²These terms are akin to 'orthogenic' and 'orthogenesis' used by Eimer (*Verh. der Deutsch. Zool. Gesell.*, 1895); his terms are not adopted by me however, for the exact meaning given above, since Eimer's view directly implicates use-inheritance and 'determinate variations' which are here rejected. On the use of these and other terms see *Science*, Apl. 23, and *Nature*, Apl. 15, 1897.

³It may be in place to recall something of the history of this suggestion as to Organic Selection and cite some of the publications bearing upon it. The present writer indicated it (only) in the first edition of this work (Feb. 1895), presented it fully with especial reference to the origin of instinct in *Science*, March 20, 1896, and developed it in many of its applications in an article entitled 'A New Factor in Evolution,' *American Naturalist*, June and July, 1896 (reprinted in *Princeton Contrib. to Psychology*, I., 4, September, 1896). Professor H. F. Osborn expressed similar views briefly in an abstract in *Science*, April 3, 1896, p. 530; and more fully in *Science*, November 27, 1896.

II. THE DIRECTIVE FACTOR.

We have now seen some reason for the reproduction of individual or ontogenetic accommodations in race progress. The truth of Organic Selection is quite distinct, of course, from the truth of any particular doctrine as to how the accommodations in the life of the individual are effected; it may be that there are as many ways of doing this as the usual language of daily life implies, *i. e.*, mechanical, nervous, intelligent, etc.

Yet when we come to weigh the conclusions to which our earlier discussions have brought us, and remember that the type of reaction, which is everywhere present in the individual's accommodation, is the 'circular reaction' working by functional selection from over-produced movements, we see where a real orthoplastic influence in biological progress lies. The individuals accommodate by such functional selection from over-produced movements; this keeps them alive while others die; the variations which are represented in them are thus kept in existence, and further variations are allowed in the same direction. This goes on until the accumulated variations become independent of the process of individual accommodation, as congenital instincts. Thus are added to the acquisitions of the species the accommodations secured by the individuals. So race progress shows a series of adaptations which corresponds to the series of individual accommodations.

It may be remarked also that when the intelligence has reached considerable development, as in the case of man, it will outrank all other means of individual accommodation. In Intelligence and Will (as will appear below)¹ the circular form of reaction becomes highly developed, and the result then is that the intelligence and the social life which it makes possible so far control the acquisitions of life as greatly to limit the action of natural selection as a law of evolution. This may be merely indicated here; the additional note below will take the subject further in the treatment of what then becomes the means of transmission from generation to generation, a form of handing down which, in contrast with physical heredity, we may call 'Social Heredity.'

Professor C. Lloyd Morgan also printed similar views, *Science*, November 20, 1896, and in his book, *Habit and Instinct*, November, 1896. The essential position was reached independently by each of these writers and has been developed by correspondence since their first publication of it.

¹ *I. e.* in the volume, Chaps. X. to XIII.

III. INTELLIGENT DIRECTION AND SOCIAL PROGRESS.

The view of biological evolution already brought out has led us to the opinion that the accommodations secured by the individuals of a species are the determining factor in the progress which the species makes, since, although we can not hold that these accommodations, or the modifications which are effected by them, are directly inherited from father to son, nevertheless by the working of Organic Selection with the subsequent accumulation of coincident variations the course of biological evolution is directed in the channels first marked out by individual adaptations. The means of accommodation were called above orthoplastic influences in view of the directive trend which they give to the progress of the species.

It was also intimated, in the earlier section, that when the intelligence once comes to play an important part in the accommodations of the individuals, then we should expect that it would be the controlling factor in race-progress. This happens in two ways which may now allow of brief statement.

1. The intelligence represents the highest and most specialized form of accommodation by 'circular reaction.' With it goes, on the active side, the great fact of volition which springs directly out of the imitative instinct of the child. It therefore becomes the goal of organic fitness to secure the best intelligence. On the organic side, intelligence is correlated with plasticity in brain structure. Thinking and willing stand for the opposite of that fixity of structure and directness of reaction which characterize the life of instinct. Progress in intelligence, therefore, represents readiness for much acquisition, together with very little congenital instinctive equipment.

It is easy to see the effects of this. The intelligence secures the widest possible range of personal adaptations, and by so doing widens the sphere of Organic Selection, so that the creature which thinks has a general screen from the action of natural selection. The struggle for existence, depending upon the physical qualities which the animals rely on, is largely done away with.

This means that with the growth of intelligence, creatures free themselves more and more from Natural Selection. Variations of a physical kind come to have within limits an equal chance to survive. Progress then depends on the one kind of variation which represents improved intelligence—variations in brain structure with the organic correlations which favor them—more than on other kinds.

2. The other consideration tends in the same direction. With

the intelligence comes the growth of sentiment, especially the great class of Social Sentiments, and their outcome the ethical and religious sentiments. We have seen in earlier chapters how the sense of personality or self, which is the kernel of intelligent growth involves the social environment and reflects it. Now this social sense also acts wherever it exists, as an 'orthoplastic' influence—a directive influence, through Organic Selection, upon the course of evolution. In the animal world it is of importance enough to have been seized upon and made instinctive: animal association acts to screen certain groups of creatures from the operation of Natural Selection.

In man the social sentiment keeps pace with his intelligence, and so enables him again to discount natural selection by coöperation with his brethren. From childhood up the individual is screened from the physical evils of the world by his fellows. So another reason appears for considering the course of evolution to be now dominated by the intelligence.

But, it may be asked, does not this render progress impossible, seeing that it is only through the operation of Natural Selection upon variations—even allowing for Organic Selection—that progress depends? This may be answered in the affirmative, so far as progress by physical heredity is concerned. Not only do we not find such progress, but the researches of Galton, Weismann and others show that there is probably little or no progress, even in intelligence, from father to son. The great man who comes as a variation does not have sons as great as he. Intermarriage keeps the level of intelligent endowment at a relatively stable quantity, by what Galton has called 'regression.'

Yet there is progress of another kind. With intelligence comes educability. Each generation is educated in the acquisitions of earlier generations. There is in every community a greater or less mass of so-called 'Tradition' which is handed down with constant increments, from one generation to another. The young creature grows up into this tradition by the process of imitative absorption which has been called above 'Social Heredity.'¹ This directly takes the place of physical heredity as a means of transmission of many of the acquisitions which are at first the result of private intelligence, and tends to free the species from the dependence upon variations—except intellectual variations—just as the general growth of intelligence and sentiment tends to free it from the law of natural selection.

¹P. 361 and 364 (as in the first edition). See article on 'Consciousness and Evolution,' *Science*, August 23, 1895, reprinted with discussion by Prof. E. D. Cope and the writer in the *Amer. Naturalist*, Nos. from April to July, 1896.

These general truths can not be expanded here; they belong to the theory of social evolution. Yet they should be noted for certain reasons which are pertinent to our general topic, and which I may briefly mention.

First, it should be said that this progress in emancipation from the operation of natural selection and from dependence upon variations, is not limited to human life. It arises from the operation of the principle which has all the while given direction to organic evolution; the principle that individual accommodations set the direction of evolution, by what is called Organic Selection. It is only a widening of the sphere of accommodation in the way which is called intelligent, with its accompanying tendency to social life, that has produced the deflection of the stream which is so marked in human development. And as to the existence of 'Tradition' and 'Social Heredity' among animals, recent biological research and observations are emphasizing them both. Wallace and Hudson have pointed out the great importance of imitation in carrying on the habits of certain species; Weismann shows the importance of tradition as against Spencer's claim that mental gains are inherited; Lloyd Morgan has observed in great detail the action of social heredity in actually keeping young fowls alive and so allowing the perpetuation of the species, and Wesley Mills has shown the imperfection of instinct in many cases with the accompanying dependence of the creatures upon social, imitative and intelligent action.

Second, it gives a transition from animal to human organization, and from biological to social evolution, which does not involve a break in the chain of influences already present in all the development of life.

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