SCIENCE

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WEISMANN ON GERMINAL SELECTION.

THIS last contribution of Prof. Weismann to his system of inheritance and evolution hypotheses was presented to the International Congress of Zoölogists at Leyden last September. It was published in German at the beginning of the current year, and has just appeared in English as No. 19 of the Religion of Science Series (Open Court Publishing Co., Chicago).

It is evident from many expressions throughout the paper that Prof. Weismann considers this one of the most important of all his contributions on the evolution problem, and even those who cannot accept this most advanced and in some respects most speculative of all his hypotheses will nevertheless be inclined to regard the paper as important in marking some fundamental changes in Weismann's position.

During the long continued discussion between Weismann, Spencer and others there was a feeling in certain quarters that something was wrong with the methods employed and that the deadlock of opinion could not be broken by inductive reasoning alone. Weismann's present paper, however, gives evidence that many of the objections raised by his opponents have taken deep hold upon him, and have, in fact, convinced him that his former position was untenable. "The real aim of the present essay," says Weismann, "is to rehabilitate the principle of selection. If I should suc-

ceed in reinstating this principle in its emperilled rights it would be a source of extreme satisfaction to me." To hear the author of 'Die Allmacht der Naturzüchtung' speak of 'rehabilitating' and 'reinstating' the principle of selection betokens a revolution of opinion scarcely less sudden and wonderful than that manifested in a certain historic conversion on the way to Damascus.

In this paper Weismann expressly makes the following concessions: 1. "The principle of panmyxia is not alone sufficient for a full explanation of the phenomena (of degeneration). My opponents in advancing this objection are right to the extent indicated and as I expressly acknowledge." 2. "The Lamarckians were right when they maintained that the factor for which hitherto the name of natural selection had been exclusively reserved, viz., *personal* selection, was insufficient for the explanation of the phenomena" (of the disappearance of useless parts). 3. "The fact of a simultaneous, functionally concordant yet essentially diversified modification of numerous parts points conclusively to the circumstance that *something is still wanting to the selection of Darwin and Wallace which it is obligatory on us to discover if we possibly can*, and without which selection as yet offers no complete explanation of the phyletic processes of transformation. There is a hidden secret to be unriddled here before we can obtain a satisfactory insight into the phenomena in question. *We must seek to discover why it happens that the useful variations are always present.*"

These are most fundamental concessions, yet it must not be supposed that they necessarily lead to the Lamarckian position. The insufficiency of natural selection to explain all the phenomena of phyletic transformation Weismann attributes to the fact that this principle has been unduly limited in its field of operation; it has heretofore been regarded as applicable only to *persons;* it should be considered as applicable to every organic unit, whether visible or invisible, even down to the hypothetical biophores.

Natural selection occurs among all orders of individuality, colonies, persons, organs and tissues, determinants and biophores, and corresponding to these different units Weismann recognizes "three principal stages of selection: That of *personal* selection as it was ennunciated by Darwin and Wallace; that of *histonal* selection as it was established by Wilhelm Roux in the form of a 'struggle of the parts,' and finally that of *germinal* selection whose existence and efficacy," he says, "I have endeavored to substantiate in this article—these are the factors which have cöoperated to maintain the forms of life in a constant state of variability and to adapt them to their conditions of life." In brief, natural selection is still omnipotent if only it be regarded as omnipresent.

Germinal selection consists in an extension of this principle of selection to the determinants and biophores and it may be reduced to the following propositions:

1. "Every independently and hereditarily variable part is represented in the germ by a determinative group of vital units, whose size and power of assimilation correspond to the size and vigor of the part."

2. Variations in the size of determinants (some being larger, some smaller and some the same size as the maternal determinants) are caused by 'the inevitable fluctuations of the nutritient supply.' *The ultimate cause of all inherited variations in size is, therefore, to be found in the influence of nutrition on the determinants.*

3. The *quality* of a determinant depends upon the numerical proportion of the biophores which it contains. If that proportion is altered so also is the *character* of the determinant. The struggle for nutriment, with its subsequent preference of the strong-

est, must take place between the various species of biophores as well as between the species of determinants. By the continued weakening of a biophore until it ultimately disappeared the quality of the determinant to which it belonged would be changed. *The ultimate cause of all variations in kind is, therefore, due to the varying amount of nutriment supplied to the biophores.*

4. "Every determinant battles stoutly with its neighbors for food."

5. The weaker determinant "will be unable to obtain the full quantum of food * * * * and the result will be that its progeny will be weakened still more * * * and inevitably the average strength of this determinant must slowly but constantly diminish."

6. The stronger determinants "oppose a relatively more powerful front to their neighbors, that is, actively absorb more nutriment, and upon the whole increase in vigor and produce more robust descendants."

7. The plus and minus variations may go on simultaneously and independently in many groups of determinants. When in any case they have reached selection value they may be checked or increased by personal selection. "In this manner it becomes intelligible how a large number of modifications, varying in kind and far more so in degree, can be guided *simultaneously* by personal selection."

The possible application of some of these principles is illustrated by cases of mimicry shown in the wings of butterflies, and the necessity of retaining the principle of natural selection to explain mimicry and adaptations in general is ably shown. In conclusion the author says: "We had applied the principle of natural selection to a part of the natural units engaged in struggle. If we apply the principle throughout we reach a satisfactory explanation. Selection of *persons* alone is not sufficient to explain the phenomena; *germinal* selection must be added. Germinal selection is the last consequence of the application of the principle of Malthus to living nature." * * * "This proposition seems to me to round off the whole theory of selection and to give it that degree of inner perfection and completeness which is necessary to protect it against the many doubts which have gathered around it on all sides like so many lowering thunder clouds."

Regarding Weismann's recent concessions to his opponents, it should be observed that he does not make them until having gotten a new foothold on the principle of germinal selection he can afford to yield these points. He nowhere makes adequate acknowledgment of the force of the facts urged against natural selection, nor the insufficiency of the latter until he feels sure that he can save his pet theory by another theory. In short, it would appear that with him the all-sufficiency of natural selection is a foregone conclusion, and however weighty the arguments may be which are brought against his position he disregards them until he is able to explain them in conformity with his theory.

This new hypothesis of germinal selection is a bold attempt to explain the causes of *all* variations and the usefulness, or adaptive character, of many variations upon the selection principle. With such high aims it is an extremely important contribution, whatever may be thought of its probability. To the writer it seems that Weismann fails to recognize that the 'selection' which he predicates of determinants and biophores is a wholly different principle from the natural selection of Darwin and Wallace. Both natural and artificial selection signify that in the struggle for existence certain individuals and races are *selected* and others *rejected*. If the unfit should survive and leave as many offspring as the fit there would certainly be no such thing as natural selec-

tion. Germinal selection, however, signifies that certain germinal units grow larger through increased nutrition; that this purely acquired character is transmitted to their descendants, and that these stronger determinants leave no *more* progeny, but simply *stronger* progeny; the weaker determinants leave no *fewer*, but simply *weaker* descendants. In short, the process is wholly and simply the continued inheritance of an acquired character. In the whole process there is no *selection* or *rejection*, but merely a continuance of individual determinants with the transmission of characters acquired by them to their descendants. How very different this is from the usual meaning of the term *selection* Professor Weismann, perhaps better than any other, could explain.

As to the evidence for germinal selection Weismann frankly avows that he "can adduce nothing except that it is at present the only explanation that can be given," and in this regard it should be observed that it stands upon a distinctly different basis from *personal* selection or *histonal* selection, each of which is directly supported by a very large number of observations and is a legitimate deduction from the facts, whereas germinal selection is confessedly merely an inductive speculation.

Evidence should be the crucial test for this as for any theory, and yet it is at this very point that it is weakest. Not a particle of evidence is adduced in proof of a single proposition named. Apart from the fundamental conception of determinants, which is still a mere matter of speculation and upon which the gravest doubts exist in the minds of many eminent men, some evidence may be adduced against certain of the propositions named:

1. The idea that the size of a determinant corresponds to the size and vigor of the part to which it gives rise, or the *determinate* as Weismann calls it, is neither a necessary conclusion nor indeed a highly probable one. If space permitted, much evidence might be brought forward, based on a study of precocious development and larval organs, to show that the size of the cell or region of the egg which gives rise to a certain part does not generally correspond to the *size* of the part, but rather to the *time* of its formation. To be sure cells and regions of the egg are not determinants in Weismann's sense, but they are frequently the *Anlagen* of organs, and as such are the nearest approach to the determinants of Weismann which may be recognized by observation. Judging the unseen therefore by the seen, there is a certain amount of evidence that the longevity of a determinant and the rapidity of the transformations which it is able to undergo, rather than its size, stands in direct relation to the size and vigor of the determinate, and it may well be that the simpler and smaller determinants, and not the larger ones, possess the greatest stability and longevity.

2. "Every determinant battles stoutly with its neighbors for food." I suppose Professor Weismann must regard this as a mere figure of speech, in fact not only the battle and the means of warfare, but the combatants and the cause of battle must all be figurative, as they are all imaginary. But what evidence or probability is there that there is not food enough for every determinant to live on and grow fat? Do the determinants increase in geometrical ratio; does each species require a different kind of food, and must we after all suppose that with divine prescience nature has taken care to supply less food to the determinants than they need in order that they may battle with each other? Such questions are asked in good faith, though one shrinks from asking them lest he may be classed by Weismann with 'the hotspurs of biology, who clamor to know forthwith how the molecules behave, * * * * * * * forgetful that all our

knowledge is and remains throughout provisional.' But inasmuch as Weismann has undertaken to teach us 'just how the molecules behave,' and since this is the *only* aim of his essay, it would seem that all such clamorings are entitled to some recognition. Unless the food of determinants is 'Ein ganz besonderes Saft,' one would think that the soma might be able to supply it in quantities large enough to cause the hungry determinants and biophores to stop their fighting. In all seriousness, it seems to me that to class such a purely figurative and imaginary 'struggle' along with Darwin's principle, as Weismann does, is to wholly disregard the importance of evidence.

3. The greatest objection to the all-sufficiency of natural selection, which Weismann, along with many others, recognizes, is 'the fact of a simultaneous, functionally concordant yet essentially diversified modification of numerous parts.' This objection Weismann thinks he has removed by assuming that the determinants may vary simultaneously and independently, and may increase or decrease in size through germinal selection. This does remove some of the difficulties; it furnishes, *ex hypotheso*, the individual variations for personal selection, but the one great difficulty remains untouched, viz., the *combination* of these individual variations into a functionally concordant system. This difficulty, which is really the only important one in this connection, remains just where it was before Weismann proposed his doctrine of germinal selection.

Weismann ably argues that there is in certain quarters an evident tendency to under-estimate the relative importance of theories as compared with facts, and he points out the great value of having symbols or mental images of natural processes, even though these symbols may not correspond to reality. Whether there are any such things as biophores, determinant, germinal selection and the like, or not, it is at least evident that a mental symbol is better than mental vacuity, and that to have conceived a process by which the details of evolution and inheritance can be explained, even if it be a false conception, is better than no conception at all. Prof. Weismann is right when he says that there is no just cause for criticism of his system on the ground that it is purely imaginary, *provided it is always so treated and understood.* It is only when he says that certain imaginary processes *must be so*, as he does in this as well as in former essays, that it is pertinent to remind him that we are dealing, not with a system of necessities, but only with a series of mental images, each one of which may or may not correspond to reality.

I think it may well be doubted whether such speculations are at present the most profitable method of approaching the problems under discussion. Induction and the test of conceivability are distinctly inferior as scientific instruments to observation, experiment and deduction. Speculation is valuable only as it is verified by observation and experiment and while the solution of such recondite problems must be approached from all possible sides, yet it may be doubted whether it is more profitable for one to continue to start more speculations than a whole generation can run down rather than to take part in hunting down and verifying or rejecting his own speculations.

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THE SMEETH SEPARATING APPARATUS.

THE tube devised by Harada for using heavy liquids in separating the mineral constituents of rocks has been modified by Broegger, so as to obviate difficulties arising from the adherence of light and heavy particles desired to be separated. This ap-