the germ-cells in this altered individual, which were originally continuous with the germ-cell from which the individual itself developed, remain entirely unaffected by the action of the conditions on the body, and when they begin to develop have exactly the same properties as the germ-cell in the generation preceding.

Heredity, then, according to Weismann, is simply the property possessed by a germ to develop into exactly the same type in each successive generation. He says: "Ich stelle mir vor, dass die Vererbung darauf beruht, dass von der wirksamen Substanz des Keimes, dem Keimplasma, stets ein Minimum unverändert bleibt." &c.

As the action of conditions can give rise to no hereditary individual differences, these must be due to some other cause. This cause, Weismann says, is to be found in sexual, or, as Haeckel calls it, amphigynous, reproduction. Sexual reproduction consists in the fusion of two complementary germ-cells or of their nuclei: each of these germ-cells has a specific molecular structure, on which depend the hereditary tendencies of the organism whence the germ-cell is derived. Thus, in fertilization, two hereditary tendencies are mingled, and thus the offspring does not resemble exactly either of its parents, but combines the characters of each together.

In order that there shall be no ambiguity about his argument, Weismann precisely states what, according to his view, and, as he believes, in actual fact, occurs in monogynous reproduction, *i.e.* in parthenogenesis, where there is only one parent instead of two. If, in a species reproducing parthenogenetically, all the individuals were perfectly similar, all the descendants throughout any number of generations would continue similar, leaving aside evanescent differences due to conditions, and which are not hereditary. In such a case no selection, Weismann says, would be possible, and therefore no evolution in any direction.

"Processes of selection in the proper sense of the word, those which produce new characters by the gradual increase of characters already present, are not possible in species which reproduce asexually."

"If it were once proved that a species reproducing itself solely by parthenogenesis had been transformed into a new species, thereby it would be proved at the same time that other causes of modification exist than processes of selection, for by selection the new species could not have been formed."

But with sexual reproduction it is quite otherwise. Weismann points out that no two individuals of different generations could ever be similar where reproduction is sexual, and even the individuals of one family, born of the same two parents, would not be similar, because the various tendencies in the parents are present in different intensities at different times, though he gives no reason for this assumption.

According to Weismann, the individual hereditary differences so produced are the basis on which selection acts; and these differences thus explained, summed up or combined in different ways by selection, give a complete and satisfactory explanation of all organic evolution.

Now, let us examine this theory a little. For the sake of simplicity we will in most cases consider the effect of the supposed processes on one organ. In the first place, what ground is there for assuming that *Vermischung* would ever cause an increased development in the offspring of an organ possessed by the parents? Heredity, as understood by Weismann, is nothing more than the property in the germ-cell of developing into an individual like that from which it was derived. If each parent possessed a given organ in the same degree of development, a degree unaffected by external conditions, then both the ovum and the spermatozoon will, on this view of heredity, have the property of developing into an individual with the same organ developed to the same degree. When the two properties are combined by fertilization, the fertilized ovum ought to have the property of developing this character with still greater certainty, but why should it have the property of developing the character to a higher degree than that reached in either parent? By *Vermischung*, in its literal sense, the union of the two hereditary powers cannot have this effect. If by *Vermischung* it is meant that the offspring is intermediate between the two parents, then the mean of two equal characters is the same character again. And if this is what Weismann means by *Vermischung*, then a character developed to a certain degree in one parent, and not at all in the other, would in the offspring be developed to exactly half the degree in which it existed in

the one. And so on. But it is obvious that in this way no increase of any character could ever occur.

But of course *Vermischung* may mean something else. It may mean that the hereditary powers of ovum and spermatozoon are added together, that the result of copulation between the germ-cells is not the mean, but the sum, of the properties of both. In this case, evolution would be extremely rapid, for each child would be equal to both its parents rolled into one. If each parent, say, among cattle, had horns equally well developed, the offspring would have horns twice as big. And it is obvious that in this way no decrease could ever occur, for if one parent had an organ developed and the other had no trace of it, the offspring would have it in the same degree as the one.

Now, it seems to me that, if *Vermischung* does not mean either of these things, there is only one other meaning it can have, and that is, that the hereditary powers of the copulating germ-cells reinforce one another to some extent, but not to such an extent that the result is equal to their sum. If this be the meaning, then there can never be any decrease in a character once formed. For, if every individual of a species possesses a certain organ, let us take the hind-legs in a mammal, then if two individuals which have these organs less developed than any other individuals in the species, copulate, the offspring resulting must have hind-legs better developed than either of them. Thus the whale could never have been evolved.

It follows, therefore, that, on Weismann's theory of variation, evolution is impossible. And as acquired characters are not inherited, no other theory of variation can be discovered. Therefore evolution is impossible altogether: the extremes meet, and the Darwinian principle overstrained goes rather to prove the fixity of species than their plasticity.

J. T. CUNNINGHAM.

Mr. Howorth on the Variation of Colour in Birds.

ALLOW me to assure Mr. Howorth that I have no theory to maintain. I simply called attention (*supra*, p. 318) to an overlooked hypothesis, propounded long ago, and, so far as I know, still unrefuted. Neither have I any wish to argue the question. Indeed, controversy about it is happily almost impossible, since he admits the chief fact of which I reminded him to be what he now terms (*supra*, p. 365) "an elementary postulate"—an expression far stronger than I should venture to use; but had he before shown any disposition to recognize it, my remarks had not been written. On the contrary, he implied (*supra*, p. 294) that it was a recent discovery, as it certainly appears to have been to him. I trust he will excuse me for having pointed out its want of novelty, just as he seems to excuse Prof. Geikie for pointing out the antiquity of his views as to the former climate of Siberia; and at the same time I have to ask Mr. Howorth's pardon for demurring to some of the assertions in his last communication, especially that as to the avifauna of Siberia having been "worked out from end to end." I dare not hope to see the day when this shall be done; but then I am not of a sanguine temperament.

I take this occasion to mention that in line 3 of the second paragraph of my former letter (p. 318) the word "Russian" was omitted before "explorers and naturalists." Of course it will be understood to cover Poles, as well as all those foreigners who were employed by the Russian Government.

ALFRED NEWTON.

Magdalene College, Cambridge, February 16.

Currents and Coral Reefs.

MAY I be allowed space to call attention to a remarkable fact relating to the growth of coral reefs, which has apparently (as far as I can ascertain) had no explanation, and which might assist materially in the elucidation of some problems relating to ocean currents about which—although the broad facts are known—a great deal of doubt exists? It might also give us some idea of the flow of submarine currents, the direction of which it is very difficult to determine.

It will be observed that in all coral formations there are in some places remarkable extensions of them from the land, which is not accountable for by supposing the depths only to be shallower in those directions, and the only alternative we have then is that the food supply must come chiefly from that direction, and this supply could only be kept up by currents striking the reef at these points. To give an instance of this, I might