13. The principle of associative inheritance—linkage.
    Discovery by Bateson in sweet peas.—Elaboration by Morgan and others in Drosophila.—Extension to other plants and animals by various workers.—The chiasmatype theory as an explanation of the mechanism of linkage and crossing over.—Illustrations of various linkage phenomena.
14. The inheritance of quantitative characters.
    The facts.—The interpretations that have been offered.—The multiple factor hypothesis.
15. The statistical study of variation.
    Calculation and uses of the ordinary biometrical constants.
16. Correlation.
    Calculation and uses of the coefficient of correlation.
17. The pure line concept.
    Johannsen's selection experiments and conclusions.—Confirmation and extension by other workers.
18. The role of selection in plant and animal breeding.
    Effect of selection in populations of self-fertilized and cross-fertilized plants and with animals under various systems of mating.—Selection from the point of view of the animal breeder.—Modifying factors.
19. Inbreeding and outbreeding.
    The conflict of views.—Experimental evidence in both plants and animals.—Interpretation of the results of inbreeding.—Heterosis and its utilization in plant and animal production.
20. Non-Mendelian inheritance.
    Cytoplasmic and maternal inheritance.—Chimeras.
21. The mutation concept.
    The DeVriesian view.—The modern view.—Point or factor mutations and multiple allelomorphs.—Regional mutations.—Chromosome aberrations.—Bud variations.—Attempts to induce mutations.
22. The mode of evolution from the mutation point of view.
23. Eugenics.
    The application of genetic principles to race improvement.—Limitations.

C. B. HUTCHISON

CORNELL UNIVERSITY

LAMARCK, MIRBEL AND THE CELL THEORY

IT seems to have escaped the notice of writers of text books on biology and the history of science, even in France, that the cell theory in broad outlines was taught in Paris at the very opening of the nineteenth century, forty years before Schleiden and Schwann published their famous epoch-making work.

Lamarck stated clearly in his "Philosophie Zoologique," 1809, that all plants and animals are composed essentially of cellular tissue, without which "no living body would be able to exist nor could have been formed." "Since 1796," he says, "I have been accustomed to set forth these principles in the first lessons of my course."

Lamarck's clear and positive statement of the fundamental importance of cellular tissue, like his theory of evolution, unfortunately was not supported by an array of well authenticated published facts. Lamarck's conception was that cellular tissue (epidermal and connective), enclosing the organism and its parts, is the matrix in which the fluid living matter is shaped into organs, by physico-chemical forces acting upon it from without.

Mirbel, his younger colleague at the museum, adopted the cellular tissue theory, and brought to its support from the field of botany a splendid body of facts, to which long afterwards both Schleiden and Schwann allude. To Mirbel plants are made of a folded membranous cellular tissue, with slow circulation of fluid among the cells through intervening pores.

Dutrochet, in 1824, introduced into the theory the idea of the individuality of the cell, of which all plants and animals are composed, but unfortunately he had no standard by which to decide what is, or what is not, a cell in the animal. The universally present nucleus had not yet been discovered and the cell thus, so to speak, standardized. Hence in matters of detail, he went somewhat astray, but he was a most enthusiastic supporter of the cell theory as he knew it.

Robert Brown, as a by-product of a work on fertilization in Orchids and Milkweeds, described the universal occurrence of cell nuclei.

This made the cell theory of Schleiden and Schwann a possibility.

Without detracting at all from the epoch-making work of these two men, and with great admiration for that of Schwann, who accurately described for the first time many types of animal cells, the present writer finds himself unable to give them sole credit for a theory that had been taught forty years earlier in France.

Not one of these pioneers knew how new cells originate. It was the deep secret that most intrigued the active minds of the two Germans. They made their guess, and guessed wrongly, but their observations in confirmation of Robert Brown's important discovery, and Schwann's clear pictures of animal cells, have given them the distinguished place that they deserve among the founders of the cell theory. Whether they should be given exclusive credit for the theory that had been taught in Paris forty years earlier by Lamarck, and admirably supported by beautiful plates prepared by Mirbel showing plant structures, the reader may judge for himself by reading a review of the whole situation in the current number of *The Scientific Monthly*[1], and, better, by perusing the original books and papers to which reference is therein made.

Reviewed now, after the lapse of a century, the different methods and temperaments of the various writers are thrown into bold relief, and one is forcibly reminded of the folly of unchecked speculation and the wisdom of guarding the indispensable imagination by keen, untiring observation and experiment.

JOHN H. GEROULD

DARTMOUTH COLLEGE

SCIENTIFIC EVENTS

DISINTEGRATION OF ELEMENTS[1]

I HAVE been asked to say a few words about a telegram in the *Times* of March 14 giving an account of a paper communicated to the American Chemical Society at Chicago by Dr. G. Wendt and Mr. C. E. Iron. It reported that, when a powerful condenser discharge at 100,000 volts was sent through a very fine tungsten wire, the filament exploded with a "deafening report," producing a flash estimated to correspond to a temperature of at least 50,000° F. The telegram states: "After the flash he (Dr. Wendt) found atoms of tungsten decomposed into simpler atoms and the result was the change of metallic tungsten into gaseous helium." The experiments were made to investigate whether any atomic disintegration can be effected by such high temperature discharges, and apparently the authors believe that they have obtained positive results.

We must await a much fuller account of the experiments before any definite judgment can be formed; but it may be of interest to direct attention to one or two general points. During the last ten years many experiments have been recorded in which small traces of helium have been liberated in vacuum tubes in intense electric discharges, and it has been generally assumed that this helium has been in some way occluded in the bombarded material. On modern views, we should anticipate that the disintegration of a heavy atom into lighter atoms, *e. g.*, into atoms of helium, would be accompanied by a large evolution of energy. Indeed, it is to be anticipated that the additional heating effect due to this liberated energy would be a much more definite and more delicate test of disintegration of heavy atoms into helium than the spectroscope.

Our common experience of the large effect of temperature in ordinary chemical reactions tends to make us take a rather exaggerated view of the probable effects of high temperatures on the stability of atoms. While it seems quite probable that momentary temperatures of 50,000° F. can be obtained under suitable conditions in condenser discharges, it should be borne in mind that the average energy of the electrons in temperature equilibrium with the atoms at this temperature corresponds to a fall of potential of only 6 volts. In many physical experiments we habitually employ streams of electrons of much higher energy and yet no certain trace of disintegration has been noted. In particular, in Coolidge tubes an intense stream of electrons of energy about 100,000 volts is

[1] The Dawn of the Cell Theory, *Scientific Monthly*, Vol. XIV, No. 3, pp. 268-277, March, 1922.

[1] Sir Ernest Rutherford, in *Nature*.