the most striking fashion how crude and inadequate are the suppositions which we entertained before the world of gametes was revealed. The appearance of the plant tells us little or nothing of these things. In Mendelism, we learnt to appreciate the implication of the fact that the organism is a double structure, containing ingredients derived from the mother and from the father respectively. We have now to admit the further conception that between the male and female sides of the same plant these ingredients may be quite differently apportioned, and that the genetical composition of each may be so distinct that the systematist might without extravagance recognise them as distinct specifically. If then our plant may by appropriate treatment be made to give off two distinct forms, why is not that phenomenon a true instance of Darwin's origin of species? In Darwin's time it must have been acclaimed as supplying all and more than he ever hoped to see. We know that that is not the true interpretation for that which comes out is no new creation.

Only those who are keeping up with these new developments can appreciate fully their vast significance or anticipate the next step. That is the province of the geneticist. Nevertheless, I am convinced that biology would gain greatly by some co-operation among workers in the several branches. I had expected that genetics would provide at once common ground for the systematist and the laboratory worker. This hope has been disappointed. Each still keeps apart. Systematic literature grows precisely as if the genetical discoveries had never been made, and the geneticists more and more withdraw each into his special "claim"—a most lamentable result. Both are to blame. If we cannot persuade the systematists to come to us, at least we can go to them. They too have built up a vast edifice of knowledge which they are willing to share with us, and which we greatly need. They too have never lost that longing for the truth about evolution which to men of my date is the salt of biology, the impulse which made us biologists. It is from them that the raw materials for our researches are to be drawn, which alone can give catholicity and breadth to our studies. We and the systematists have to devise a common language.

Both we and the systematists have everything to gain by a closer alliance. Of course we must specialise, but I suggest to educationists that, in biology at least, specialisation begins too early. In England certainly, harm is done by a system of examinations discouraging to that taste for field natural history and collecting, spontaneous in so many young people. How it may be on this side, I cannot say, but with us attainments of that kind are seldom rewarded, and are too often despised as trivial in comparison with the stereotyped biology which can be learned from text-books. Nevertheless, given the aptitude, a very wide acquaintance with nature and the diversity of living things may be acquired before the age at which more intensive study must be begun, and is the best preparation for research in any of the branches of biology.

The separation between the laboratory men and the systematists already imperils the work, I might almost say the sanity, of both. The systematists will feel the ground fall from beneath their feet, when they learn and realise what genetics has accomplished, and we, close students of specially chosen examples, may find our eyes dazzled and blinded when we look up from our work-tables to contemplate the brilliant vision of the natural world in its boundless complexity.

I have put before you very frankly the considerations which have made us agnostic as to the actual mode and processes of evolution. When such confessions are made the enemies of science see their chance. If we cannot declare here and now how species arose, they will obligingly offer us the solutions with which obscurantism is satisfied. Let us then proclaim in precise and unmistakable language that our faith in evolution is unshaken. Every available line of argument converges on this inevitable conclusion. The obscurantist has nothing to suggest which is worth a moment's attention. The difficulties which weigh upon the professional biologist need not trouble the layman. Our doubts are not as to the reality or truth of evolution, but as to the origin of *species*, a technical, almost domestic, problem. Any day that mystery may be solved. The discoveries of the last twenty-five years enable us for the first time to discuss these questions intelligently and on a basis of fact. That synthesis will follow on an analysis, we do not and cannot doubt.

## Alternating-Current Mineral Separation.[1]

By PROF. S. J. TRUSCOTT, Imperial College (Royal School of Mines), South Kensington.

INVESTIGATION of the possible use of alternating current in magnetic separation, either in the direction of obtaining a rotary field by polyphase currents, or otherwise, has hitherto not resulted in any useful discovery. Recently, however, Mr. W. M. Mordey, past president of the Institution of Electrical Engineers, by arranging poles energised by two-phase currents to follow one another across the stream, has succeeded in driving iron minerals and iron compounds in that direction. This effect is not one of ordinary magnetic attraction and repulsion, but apparently a display of "hysteretic repulsion," a repulsion consequent upon the magnetism residual after each alternation, and made continuous by the moving field contributed by polyphase current.

A laminated alternating-current magnet behaves towards magnetite or iron-filings much like a direct-current magnet, in that tufts of these materials form at the poles, from which lines of force radiate. On the other hand, towards such a feebly magnetic mineral as hæmatite no attraction appears to be exercised but a decided repulsion is witnessed, for example, when a dish containing powdered hæmatite is laid upon an upturned pole. This repulsion is continuous when the dish spans a number of poles and these are energised by polyphase current. Similar repulsion of magnetite occurs at a lower excitation or when the dish is lifted sensibly off the poles.

[1] W. M. Mordey, Transactions South African Institute of Electrical Engineers, December 1921.

From the foregoing it seems probable that ordinary magnetic attraction and hysteretic repulsion determine between them the behaviour of particles in the field of an alternating-current magnet. Of these two factors the former is fairly understood; it remains to indicate one or two points concerning the latter. Hysteretic repulsion is low and attraction relatively high when the frequency of alternation is low, and *vice versa*; Mr. Mordey found that, with an increase of frequency from 25 to 75 periods, the speed at which the material was repelled increased approximately as the square of the increase in frequency. At higher frequencies, however, repulsion appears to be again inactive; Mr. Mordey, for example, found that both at 150 periods and at 350, repulsion was not manifest but attraction, even hæmatite remaining over the poles. He used relatively low inductions, 560 to 2000, these being more proper to alternating current than the higher inductions associated with direct current in ordinary magnetic separation.

The continuous repulsion of the ferriferous particles across the stream is forceful and unhesitating, whether these particles be dry or borne in water; it is assisted by an upward repulsion which frees them from entanglement with associated gangue, and gives them power to climb an inclination or even the sides of the container. At the same time, however, these particles, and particularly those of magnetite, tend to be held strongly in the plane of their movement, so that unless the field be properly adjusted transverse walls or banks form such as hinder the escape of gangue.

To make use of this discovery Mr. Mordey has in mind a shallow inclined launder down which the material would flow in the condition of an ore-pulp. With poles running the length of this launder the ferriferous particles would be driven to one side, to be collected separately at the bottom, the gangue particles keeping a straight path.

It is interesting that only iron minerals have so far been found capable of making the transverse movement, such moderately magnetic minerals as ilmenite and wolframite not moving; it is also of interest that, though magnetite moves more strongly, hæmatite can hardly be said to be outclassed; further, a small contamination with iron oxide causes other minerals to move, wolframite and cassiterite, for instance.

Obviously, therefore, though magnetic susceptibility is doubtless involved it does not enter unfettered; as already stated, it is associated with hysteretic repulsion. That the repulsion may be due to eddy currents set up in the particles appears to be excluded by the fact that the conductivity of hæmatite is not high enough to permit any pronounced development of such currents; moreover, particles of metallic aluminium, the conductivity of which is very high, are not repelled.

It is to be hoped that this process of magnetic separation may so develop that deposits, such as that at Dunderland, Norway, which contain much hæmatite in addition to magnetite, and others consisting largely of granular hæmatite, may be successfully treated. In view of the many deposits coming within these descriptions, and of the fact that the present means of magnetic separation, good as they are for dry work, fail entirely to separate feebly-magnetic minerals from a water-borne pulp, any endeavours to realise this hope will be viewed by all with the greatest sympathy and interest. The ordinary magnetic concentration of magnetite is not an expensive treatment, but the treatment outlined by Mr. Mordey, being simplicity itself, would cost still less.

## Obituary.

### PROF. J. C. BRANNER.

PROF. JOHN CASPER BRANNER, president emeritus of Stanford University, California, died at Palo Alto, California, on March 1, in his seventy-second year. He was a geologist of stimulating activity, and was attracted to Brazil as a young man in 1874 through his master at Cornell, C. F. Hartt. In 1875 he succeeded Hartt as director of the Imperial Geological Commission in Brazil, and, on the establishment of the republic, continued his observations in that country on various expeditions from time to time. In 1885 he was appointed professor of geology in Indiana University, and in 1892 to the similar post in the newly founded Stanford University. He won a considerable position as an economic botanist, and his geological papers cover a wide and practical field. His "Outlines of the Geology of Brazil," the second edition of which was published in the Bulletin of the Geological Society of America as recently as 1920, has been noticed in NATURE, vol. 106, p. 58. This very useful summary includes a geological map of the whole country on the scale of 1 : 5,000,000.

Many European geologists will remember Branner at the International Geological Congress in Zürich in 1894, and all who met him must have been won by his strong personality and his equally strong and manly presence. It is characteristic of his outlook that in his most recent treatise he hopes that his work may be of service to the Brazilian people, "to whom I am strongly attached, and in whose welfare I am deeply interested."

We owe some of the facts and dates in the foregoing notice to an appreciative article by Dr. David Starr Jordan in *Science* for March 31, and to an obituary notice in the *American Journal of Science* for April.

### DR. ANDREW MCWILLIAM, C.B.E.

THE death of Dr. Andrew McWilliam, which occurred on April 5, came as a shock to a large circle of friends and former pupils, and deprives the steel world of a metallurgist of great knowledge and wide experience. A native of Galloway, Dr. McWilliam was educated at Allan Glen's School, Glasgow, and at the Royal School of Mines, of which he became an Associate. On leaving South Kensington, he entered the Sheffield Technical School, afterwards incorporated with the University of Sheffield, but later he left to take up in succession several outside posts. Returning to Sheffield, he was first appointed lecturer, and then assistant professor,