all of whose roots are real, and to polynomial solutions of linear differential equations.

Before leaving this phase of our subject we may note, with Laguerre, that similar theorems hold for each of the successive polars of a binary form with respect to a point. An interesting field hardly touched as yet is that of separation theorems for the successive polars of a form with respect to a sequence of points defined as the roots of another form. By taking the two forms in a special case where they are apolar Grace has proved (Proceedings of the Cambridge Philosophical Society, Vol. 11 (1901), p. 35) a result equivalent to this: *If the distance apart of two roots* α_1, α_2 *of a polynomial* $f(x)$ *of degree* n *is* 2a, *there is at least one root of* f'(x) *on or in the circle whose radius is a cot* $\frac{\pi}{n}$, *and whose center is* $\frac{1}{2}(a_1 + a_2)$. In this paper lack of references indicates ignorance of Laguerre's work. The same result was proved later by Heawood (*Quarterly Journal of Mathematics,* Vol. 38 (1907), p. 84) by allowing all the other roots of $f(x)$ to vary suitably. Here, again, there is no reference to any other work in this field.

To return to more recent work on the vanishing of the Jacobian of two forms f_1 and f_2, we note two very interesting papers by Walsh in the Transactions of the American Mathematical Society, in which are discussed cases where the roots of the ground-forms are in three circles, instead of two. An added interest is shown to attach to the Jacobian because the numerator of the derivative of a rational function

$$\frac{u(x)}{v(x)} = \frac{f_1(x_1, x_2)}{f_2(x_1, x_2)}$$

is x_2^2 multiplied by the Jacobian of f_1 and f_2. Separation theorems for the Jacobian are then interpretable in terms of this derivative. The results of these papers are, of course, only a first step to the consideration of still more general separation theorems. The field is the more interesting in that its investigation involves a combination of mechanical, algebraical, and geometrical considerations.

I must close with only a mention of certain extensions of the problem we have so far considered. Thus Bôcher, generalizing a method due to Stieltjes, considers the positions of equilibrium of a system of free particles of equal mass in a field of force due not only to a number of fixed repelling particles, but also to their own mutual repulsions according to the same law. If the total mass of fixed and moving particles is 1, the positions of equilibrium of the free particles are determined by the vanishing of covariants, of which some examples are given by Bôcher. These results, as well as some obtained by adding a force function $K[f(x)]$, are useful in the study of polynomial solutions of differential equations. We must regret that Bôcher was never able to fulfill the hope twice expressed in this paper that he might be able to return in detail to these problems which he had merely sketched. Their investigation requires considerable skill, but, if successful, would add a new and important chapter to algebra, with a striking application of invariant theory.

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WILLIAM BATESON ON DARWINISM

ASIDE from the fine impression created by the admirable series of papers and addresses in biology, zoology and genetics in Toronto at the Naturalists' meeting, a very regrettable impression was made by a number of passages in the addresses of Professor William Bateson, the distinguished representative of Cambridge University and British biology. On the morning following his principal address the Toronto *Globe* (December 29, 1921) published, in large letters: "Bateson Holds That Former Beliefs Must Be Abandoned. Theory of Darwin Still Remains Unproved and Missing Link Between Monkey and Man Has Not Yet Been Discovered by Science. Claims Science Has Outgrown Theory of Origin of Species." In intermediate type it announced: "Distinguished Biologist from Britain Delivers Outstanding Address on Failure of Science to Support Theory That Man Arrived on Earth Through Process of Natural Selection and Evolution of Species. Have Traced Man Far Back but Still He Remains Man," and, in smaller type: The missing link is still missing, and the Dar-

winian theory of the origin of species is not proved. This was the verdict of one of the foremost British scientists, Professor William Bateson, director of the John Innes Horticultural Institute, Surrey, England, in the course of an epoch-making address on "Evolutionary Faith and Modern Doubts" at the general session of the American Association for the Advancement of Science, held in Convocation Hall last evening. While declaring that his faith in evolution was unshaken, he frankly admitted that he was "agnostic as to the actual mode and process of evolution." Believing in evolution in "dim outline," he pronounced the cause of origin of species as utterly mysterious.

The speaker then reiterated views expressed in previous addresses. Again quoting the *Globe:*

Referring to the variations occurring in the different species, Dr. Bateson stated that there was no evidence of any one species acquiring new faculties, but that there were plenty of examples of species losing faculties. Species lose things, but do not add to their possessions. "Biological science has returned to its rightful place," said Dr. Bateson, "namely, the investigation of the structure and properties of the concrete of our visible world. We cannot see how the differentiation into species came about. Variation, of many kinds, often considerable, we daily witness, but no origin of species. Distinguishing what is known from what may be believed, we have absolute certainty that new forms of life, new orders and new species have arisen in the earth, but even this has been questioned. It has been asked, for instance, 'How do you know that there were [no] mammals in palæozoic times? May there not have been mammals somewhere on earth though no vestige of them has come down to us?' We may feel confident there were no mammals then, but are we sure? In very ancient rocks most of the great orders of animals are represented. The absence of the others might by no great stress of the imagination be ascribed to accidental circumstances."

It is not surprising that the next day the *Globe* published a signed letter, under the caption, "The Collapse of Darwinism," of which the following is an abstract:

To an audience rarely paralleled in Canada for scientific eminence and influence, the famous Professor Bateson, with amazing frankness, removed one by one the props that have been considered the very pillars of Darwinism. A scientist of international repute, one of the leading, if not the leading evolutionist, of the day, he exposed the weakness of many of the leading planks in the "Origin of Species," and ruthlessly tore down one by one the once fondly believed links in the great chain of Darwinian evolution.

These citations cannot be dismissed as mere newspaper talk of no import. They are called forth by the fact that many of the statements in Bateson's address as cited below are inaccurate and misleading, especially those relating to the origin of species, natural selection, and infertility between species.

It is not true that we do not know how species originate. The *mode* of the origin of species has long been known—in fact, it was very clearly stated by the German paleontologist Waagen in the year 1869, a statement which has been absolutely confirmed beyond a possibility of doubt in the fifty years of subsequent research. It is also true that we know the modes of origin of the human species; our knowledge of human evolution has reached a point not only where a number of links in the chain are thoroughly known but the characters of the missing links can be very clearly predicated. The *cause* of the origin of species is another matter and has been sought in all branches of biology and biological research without an adequate solution having been found. Charles Darwin's theory of selection forms a partial solution of causation and, so far from being discarded, now rests upon much stronger evidence than it did when Darwin enunciated it.

The broad impression conveyed to my mind by the brilliant series of papers in the division of Genetics at Toronto is that genetics is essentially a branch of morphology. It is a running comparison between the morphology of the germ cell and the morphology of the adult. It is in this field, to which Professor Bateson has lent such distinction, that he fails to find either the mode or the cause of the origin of species.

Referring again to the ethical question of the dissemination of scientific truth, I am reminded of the precaution pressed upon me by Huxley from his own experience. He once

told me that before delivering any of his popular addresses he very carefully wrote out every word he intended to say, lest in the heat of enthusiasm at the moment he might say something which would give a wrong impression of the truth. We men of science are far too careless in the application of this Huxleyan advice, especially in our popular addresses, which are eagerly read by the public. We must state the truth so clearly that it cannot be misunderstood and when we give voice to our own opinions we should clearly indicate them as our opinions and not as facts. Bateson's attitude towards Darwinism has been patronizing ever since he began his evolutionary studies. When he refers epigrammatically in a previous address to reading his Darwin as he would read his Lucretius he is indirectly stating an untruth which is calculated to do untold harm. In his Toronto address he *does not clearly distinguish between his own personal opinions based on his own field of observation* and the great range of firmly established fact that is now within reach of every student of evolution who surveys the world of life under natural conditions.

Since writing the above there has come to hand a copy of Professor Bateson's address[1], from which the following excerpts may be made:

Discussions of evolution came to an end primarily because it was obvious that no progress was being made. Morphology having been explored in its minutest corners, we turned elsewhere. . . . We became geneticists in the conviction that there at least must evolutionary wisdom be found. . . . The unacceptable doctrine of the secular transformation of masses by the accumulation of impalpable changes became not only unlikely but gratuitous. . . . Less and less was heard about evolution in genetical circles, and now the topic is dropped. When students of other sciences ask us what is now currently believed about the origin of species we have no clear answer to give. Faith has given place to agnosticism. . . .

. . . But if we for the present drop evolutionary speculation it is in no spirit of despair. . .

Biological science has returned to its rightful place, investigation of the structure and properties of the concrete and visible world. We can not see how the differentiation into species came about. Variation of many kinds, often considerable, we daily witness, but no origin of species. . .

. . . But that particular and essential bit of the theory of evolution which is concerned with the origin and nature of *species* remains utterly mysterious. We no longer feel as we used to do, that the process of variation, now contemporaneously occurring, is the beginning of a work which needs merely the element of time for its completion; for even time can not complete that which has not yet begun. . . .

. . . Meanwhile, though our faith in evolution stands unshaken, we have no acceptable account of the origin of "species." . . .

. . . The survival of the fittest was a plausible account of evolution in broad outline, but failed in application to specific difference. . . . The claims of natural selection as the chief factor in the determination of species have consequently been discredited. . . .

. . . Even in Drosophila, where hundreds of genetically distinct factors have been identified, very few new dominants, that is to say positive additions, have been seen, and I am assured that none of them are of a class which could be expected to be viable under natural conditions. I understand even that none are certainly viable in the homozygous state. . . .

Analysis has revealed hosts of transferable characters. . . . Yet critically tested, we find that they are not distinct species and we have no reason to suppose that any accumulations of characters of the same order would culminate in the production of distinct species. . . .

Twenty yars ago, de Vries made what looked like a promising attempt to supply this so far as *Œnothera* was concerned. . . . but in application to that phenomenon the theory of mutation falls. We see novel forms appearing, but they are no new species of *Œnothera*, nor are the parents which produce them pure or homozygous forms. . . 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 exactly 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. . . .

. . . If we cannot persuade the systematists to come to us, at least we can go to them. They

[1] Bateson, William: Evolutionary Faith and Modern Doubts. SCIENCE, January 20, 1922.

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. . . .

The separation between the laboratory men and the systematists already imperils the work, I might almost say the sanity, of both. . . .

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. . . . 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. . . . That synthesis will follow on an analysis, we do not and cannot doubt.

These passages seem to me to do great credit to Professor Bateson in so far as they contain a frank expression of his opinion that up to the present time neither the causes nor the mode of origin of species have been revealed by the older study of Variation, the newer study of Mutation, or the still more modern study of Genetics. If this opinion is generally accepted as a fact or demonstrated truth, the way is open to search the causes of evolution along other lines of inquiry.

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JANUARY 21, 1922

SCIENCE IN THE PHILIPPINES

EVER since returning from the Philippines in 1919, after a four-year stay, I have had in mind the writing of a brief account of conditions as I found them, especially those conditions which are of interest to the research man, who has wondered how the general status of his profession, and working conditions in the tropics compare with conditions in a large city in the northern part of the United States. My own experience in the tropics is limited to Manila and vicinity, but from my reading and from conversation with others I am of the opinion that conditions in the Philippines, Cuba, Panama, India, Java and other places in the tropics are somewhat similar, independent of the longitude. I have purposely delayed setting down my ideas, because I wished to wait until I could have a fair perspective in comparing experiences in the Philippines with experiences in the United States both before and after my stay there.

There are so many advantages and so many disadvantages to be taken into account that it is difficult to say which location is the more satisfactory for scientific work, and of course, the delights and new interests, and the broadening of one's horizon that come about from travel in the Orient are not to be overlooked. I shall mention only a few points to be considered without making any attempt to give them in the order of their importance.

Climatic conditions are unfavorable in so far as their effect on physical and mental efficiency is concerned. The high temperature and high relative humidity have a tendency to cut down productiveness. To accomplish a given result requires much more energy and determination than in a temperate climate. With the thermometer around 95 to 100 degrees Fahrenheit and the relative humidity between 90 and 100 per cent., the average individual is not so keen about performing his daily activities, especially those which require mental effort.

The general slowing up suffered by the average individual coming to the tropics from a temperate climate is so well understood by old Spanish residents of the Philippines that they divide all foreigners into three classes. There are the *Ricien Nacidos,* those who have been in the islands not to exceed two or three years, or literally, the "recently born." The middle class consists of those who have been there for five to ten years, and are beginning to become modified by the environment. The last class is called the *Platinos,* or "bananos." This class is supposed to have eaten so many bananas that they have become sleepy and torpid, have lost much of the industry of a temperate climate and have settled down and become a part of the general scheme of life in the tropics.

The separation from scientific societies and the opportunity to discuss problems and compare notes with others of the same profession