group of Anophelines to be proved susceptible to experimental infection with malaria plasmodia.

JAMES STEVENS SIMMONS
ARMY MEDICAL RESEARCH BOARD
ANCON, C. Z.

EROSION ON THE UPPER RIO GRANDE

IN view of the rapid developments in the field of watershed management, including the handling of lands to prevent destructive floods and accelerated erosion, it is desirable to briefly report outstanding results of a recent survey of the Upper Rio Grande watershed in New Mexico. The study was conducted by the U. S. Forest Service, which has been assigned primary responsibility for research relating to forest and range lands by the Secretary of Agriculture.

On 40 per cent. of the watershed in New Mexico above Elephant Butte Dam, deterioration of the natural vegetation has reached an extreme stage, and the lands are excessively eroded. On 35 per cent. of the area, the plant cover is in a medium stage of deterioration, and erosion is advanced. Evidences of accelerated erosion were found on parts of all the major vegetation-type areas, principally where utilization was uncontrolled.

The natural vegetation has deteriorated as the result of man's activities, principally overgrazing, timber cutting, fire and injudicious dry farming. As a result, accelerated erosion and silt-bearing floods are imperiling land resources and human welfare. Many settlers who formerly made a living by farming are being driven to depend more and more on the grazing of live stock. This has speeded up deterioration of the remaining forage resources and has unloosed a deluge of silt, which threatens to destroy irrigation agriculture in the Middle Rio Grande Valley and to displace the water storage capacity of Elephant Butte Reservoir within the century.

That surface run-off and soil erosion were controlled by natural vegetation for centuries is shown by the good condition of the ground surface of areas that still have protective cover. If land resources are to be preserved the lands must have a protective cover of vegetation. The vegetation on depleted lands must be restored by regulation of use and by artificial revegetation so as to rebuild watershed protective values.

A complete presentation of the results and their relation to land resources and human welfare will be published later this year.

C. K. COOPERRIDER
B. A. HENDRICKS
U. S. FOREST SERVICE

THE OCCURRENCE OF THE AMERICAN BISON IN ALABAMA AND FLORIDA

HORNADAY, in his monograph "The Extermination of the American Bison,"[1] calls attention to the lack of any records of the observation of the American Bison (*Bison Americanus*) in the state of Alabama, although it had been observed in Georgia and Mississippi. The discovery of authentic records of the occurrence of this animal in southern Alabama and adjacent Florida is of considerable interest.

I am indebted to Dr. C. E. Castañeda, of the Latin-American Library of the University of Texas, for transcripts of old Spanish documents relating to the expedition of Marcos Delgado from Apalachee to the Creek country in 1686. The expedition was sent out in an endeavor to discover the rumored colony of La Salle on the Gulf Coast and was perhaps the first penetration of this region since De Soto's time.

Delgado's description of the route of his outward journey is clear and permits quite close identification of his course. Writing of a portion of his path across the present Jackson County, Florida, in an area I identify as lying south of Russ Creek and northwest of Marianna, he says: "Y Caminando al norueste 2 leguas esta un barial que atolla que no lo podran pasar Cauallos en tiempo de aguas que alli Comencan a aber *Cibolas* q son un Genero de animales Como bacas."

And further writing of his passage across what I identify as the vicinity of the Little Choctawhatchee River, probably east of Beaver Creek in the westward extension of Houston County, Alabama, he says: "Caminando al norte Costeando Vn monte Grueso de Castanales Y aCevales Y laureles Y en medio tiene un Rio de 6 bracas de ancho Y dos bracas largas de hondo Y tiene el monte de travesia mas de un quarto de legua Y tiene muchas *Sibolas* Y osos."

MARK F. BOYD
TALLAHASSEE, FLORIDA

[1] Report, U. S. National Museum, 1887, p. 380.

SCIENTIFIC BOOKS

EVOLUTION

Evolution. By A. FRANKLIN SHULL. McGraw-Hill Book Company, N. Y. 312 pp., 64 illustrations. 1936.

The Variation of Animals in Nature. By G. C. ROBSON and O. W. RICHARDS. Longmans, Green and Company, London, New York and Toronto. 425 pp. Two colored plates and 30 illustrations in the text. 1936.

THE topic of these books is fundamentally the same, although the first considers both plants and animals, the second only animals. The title of the second book does not do it justice, since it includes extensive discussions of natural selection and other theories of evolution, a chapter on adaptation and other matters pertinent to a book of the widest scope. Shull's book, intended to be used in college courses, has the eighteen chapters carefully divided into sections, each dealing with a special topic, set forth as clearly and logically as the nature of the subject may permit, in the present state of our knowledge. The Robson-Richards book, with more than a hundred more pages, goes into more detail and includes a vast amount of interesting information. Owing to the illness of one of the authors, its publication was delayed, and no references to literature later than 1933 are included. Robson and Richards remark (p. 124) that "it has been usual in the past (and the practice is difficult to avoid) to construct all embracing theories on the basis of selected species or genera which supply favorable data; the theories based on the genetics of *Drosophila* or of *Oenothera* are cases in point." To avoid this bias they bring in evidence from many sources, relating to many diverse organisms, but as they do so, the weakness of this material is only too apparent. As suggesting hypotheses, and indicating promising lines for investigation, it is most valuable; but over and over again, upon critical consideration, the authors are obliged to dismiss it as inadequate or inconclusive. It comes to this, that the living organism as a whole has to be considered, in all its relationships, and a true picture can not be obtained except by intensive and long-continued work. It is undoubtedly true that different animals and plants must be studied if we are to present a true picture of the processes of nature, and without the information thus obtained many discussions are essentially sterile. At the same time, there are certain broad considerations which should not be lost sight of in the mass of detail. Shull says (p. 13): "In the difference between two species of the same genus it is usually impossible to see any adaptation." Robson and Richards (p. 314) discuss this matter at great length, and conclude that "a survey of the characters which differentiate species (and to a lesser extent genera) reveals that in the vast majority of cases the specific characters have no known adaptive significance." They give an analysis of the characters of the species of Psammocharid wasps, and I naturally turn to the wild bees, with which I am familiar through long years of study. When I consider the bees, I realize at the outset that we are very ignorant concerning many details of their life history, and thus very incompetent as a rule to state how they may be adapted to their environment. But the fact remains, that the many species have a definite range, whereas, considering their known powers of reproduction, they might be expected to rapidly spread over the country. Some are indeed widely distributed, even beyond the limits of a continent, but many more are restricted to certain regions. This is not a matter of "age and area," it is clearly due to adaptation to particular environments. Not rarely it is found that a species gets its food only from a certain type of plant, or it may be that a special condition makes it possible for it to nest successfully. One who does not believe in adaptation as shown by specific characters may go to my papers and find descriptions of size, proportions of parts, markings, color and what not, and ask what these peculiarities have to do with the life of the species. But these are the "outward and visible signs," as the church catechism says, of a real diversity of the living creatures, a diversity which is obviously connected with the circumstances of their lives. Robson and Richards protest against the appeal to ignorance, saying: "We can not too strongly insist on the point already made that it is no use to attempt to smuggle these facts of specific differentiation into the proof of natural selection by an appeal to ignorance, or by an assumption of correlation, or by pointing out a few cases that seem explicable on very slender and unverified evidence" (p. 274). In reply to this, it seems fair to ask, what are the true specific characters? Surely, they are those which separate the species, and no one can doubt that many such characters are invisible in museum specimens. The species do not remain separate without cause, and although this may be physical isolation, as on islands or mountain ranges, it is more usually some adaptation to a special mode of life or special environment. As I write this, there comes to my desk the *Bulletin of Entomological Research,* July, 1936. It contains several articles on the physiological adaptations of insects to their environment, particularly temperature and moisture. Thus (Ullyett, p. 195) "It has been realized for some considerable time that a zone of optimum atmospheric humidity exists for any one [species of] insect, wherein, under favorable conditions of temperature, functional activities are at their maximum." There is, however, a possible source of confusion concerning the meaning of the word adaptation, as a result of the survival of the fittest. Is there any advantage to a species of bee to be obliged to get its food from a particular kind of flower? Presumably not, as those species which are not so restricted are more widely distributed and more numerous in individuals. Thus the origin of species may result from kinds of isolation which are by no means advantageous in themselves, but they do function to promote evolution, and the so-called adaptive characters serve to maintain the species as distinct. In the long run, no doubt the diversity of nature does provide for a much greater abundance of life than would be possible without it. In both books the question of the efficacy of natural selection is considered at length. Shull has a chapter entitled "Decline and Revival of Natural Selection." On the last page of this chapter he says: "And so the theory of natural selection is coming back. Perhaps one should say that it has returned. But it gives signs of being a different doctrine. . . . If the doctrine can emerge minus its sexual selection, its warning colors, its mimicry and its signal colors, the reaction over the end of the century will have been a distinct advantage." Robson and Richards say (p. 316): "In short, we do not believe that natural selection can be disregarded as a possible factor in evolution. Nevertheless, there is so little positive evidence in its favor, so much that appears to tell against it, and so much that is as yet inconclusive, that we have no right to assign to it the main causative rôle in evolution." It seems to me that these statements are unsatisfactory. As I see it, natural selection is under normal conditions a conservative force. When studies are made of a mutating animal, such as *Drosophila,* it is seen that in general the mutations are disadvantageous, if not lethal. Natural selection then hews to the line, and tends to keep the wild types within specific bounds. If it was true that all organisms presented heritable variations of every sort, considering the elimination which goes on in every generation, evolution would be so rapid as to defeat itself. As a matter of fact, it is in general extremely slow, as may be seen by the study of fossils. But there is no probability that its rate is uniform, and when a shift to a new norm does occur, it may be rapid. In California certain scale-insects, subjected to poisonous fumes by the horticulturists, have by a process of the survival of the fittest developed resistant races, not distinguishable by any morphological characters. This sort of thing can occur in the wild, where it will probably escape observation. The phenomena of parasitism are now being studied intensively, and we see how there is a continual game of hide-and-seek, the parasites becoming adjusted to particular hosts and particular conditions. But just as with the bees and flowers, some insect parasites have an amazingly wide range of hosts, while others are so particular that they enable us to distinguish between host species which to our eyes are almost alike. On the other hand, the hosts (plant or animal) develop powers of resistance.

With regard to that bone of contention, "mimicry," it must be said that the resemblances can not be purely accidental. But parallel or convergent variation, together with what has been called emergent evolution, will provide plenty of material which may be selected and preserved when of value to the animals. There are indeed cases which almost suggest some unknown magic, some mysterious influences at present undiscovered. Such a one is that of the minute parasitic *Solenopsia* (Brues, *Psyche,* March, 1936), which lives with the ant *Solenopsis,* and even has the base of the abdomen modified after the manner of an ant. I have imagined a possible reason for this, but the hypothesis is so fanciful, so little supported by evidence, that I do not venture to put it in print.

Robson and Richards urge that many more observations, especially of the living insects and their enemies, are needed. They conclude that "it is probable that selection has played some part in establishing mimetic resemblances," but how large a part, they are not prepared to say. It must always be remembered that, just as the adult insects we see represent only a small fraction of those hatched from the egg, so also the existing species must be regarded as the surviving fragments of a potentially much greater fauna. Their ancestors must have survived periods of "depression," very many of their relatives must have become extinct. The operating causes must have been many and diverse; as difficult to explain as the fact that, contrary to all statistical expectations, not one of the ancestors of the present writer ever died in infancy.

Robson and Richards conclude with the words: "We have to admit that, if we were to relegate survival value to a subordinate rôle in the causation of evolution, the element of design and purposefulness has to be explained. It is not likely that the mere interaction of developing parts and their reciprocal effects on one another could produce the ordered and purposeful designs which we see in adaptation. For those who believe that all organization is produced by the material processes envisaged by the traditional theories, the scheme of evolution must seem to be clear, at least in outline. For those with whom the difficulties we have outlined in this work have any weight it must remain to attempt a clearer definition of the purposeful activity with which we seem confronted."

Shull concludes that "evolution has presumably been all along a mixture of opposing influences. Many of them have been at work simultaneously. The net result of their operation has been an enormous number of types rather sharply defined from one another, most of them rather stable, but all capable of some change. Within each group, among the higher organisms at least, there is the capacity for interbreeding, so that future generations have access to the genes of all present individuals. These groups have constantly within them the sources of variation, consequently evolution must be expected to continue in all of them. There is no group, not even the highest, in which there is reason to think this evolution has come to an end." A weak point in both books is the neglect of paleontology. The enormous importance of the past as a key to the present seems hardly to be appreciated. Even the scanty allusions of the subject are not altogether reliable. In Shull's chapter IV, dealing with fossils, we are informed that bees, wasps, ants and butterflies are known from the Jurassic. This is not at all the case. We read that fossil insects of the Cenozoic era "are not very numerous," in spite of the readily accessible literature describing thousands of species. The statement about the ants of the Sicilian amber in Robson and Richards (p. 131) is wrong, and appears to result from confusion with the Baltic amber.

The real appeal of these books must be to the rising generation. The young naturalists of to-day have an enormous advantage over their predecessors. Much of the necessary taxonomic work, preliminary to everything else, has been done. The science of genetics has been made over, and its contributions illuminate every biological problem. Paleontology, the description, classification and discussion of fossils, has shown astonishing progress. Morphology and physiology are escaping from their traditional isolation, and becoming more and more part of general biology. Chemistry and physics have made their rich contributions, in spite of the little appreciation of biological problems shown by the majority of specialists in these subjects. The museums have piled up vast quantities of materials, waiting to be studied by those who have the time and the skill. Expeditions go all over the earth, and travel to many formerly inaccessible regions is now easy. What an opportunity to go to work and, instead of arguing as I have done in this review, reveal the actual facts of nature in all their wonderful and beautiful complexity!

T. D. A. COCKERELL

UNIVERSITY OF COLORADO

SPECIAL ARTICLES

THE PRODUCTION OF COSMIC RAY SHOWERS

THE evidence derived from experiments on small bursts[1] indicates that a shower is produced at a single act. A plausible explanation of this result is the following: a high energy electron produces at a nuclear encounter a large number of photons simultaneously. Each of these photons subsequently gives rise to a pair or a Compton electron. Now the classical electrodynamics of point charges is unable to predict anywhere near the number of sprays of photons that is actually observed. Thus either the theory of electrodynamics is wrong or the concept of point charges is so restricted in its scope that it excludes this phenomenon.

In a paper on the annihilation of the proton,[2] the writer introduced the idea that a proton does not exist at all times as a point charge but has a finite probability of dissolving into a positron, a neutrino and a neutron. (That paper then dealt with the problem of the excitation of the β field in a collision with another nucleus.) We know now, however, that the ordinary interaction of the β ray theory is inadequate to explain fully the properties of the β field in the neighborhood of the nucleus. Some new assumption must be made concerning this fictitious charge distribution. Since the properties of the Born system of electrodynamics are similar to those derived from the Dirac-Heisenberg theory of the negative energy states, it is of interest to develop the consequences of the Born theory in this connection. In the close collision of an electron with a nucleus of atomic number Z, there appears in addition to the charge distribution of the electron and nucleus a new distribution of charge density. This polarization of the medium arises as a consequence of the non-linearity of the Born system of electrodynamical equations. If we now make the additional assumption which is explicitly contained in the theory, that the polarization charge scatters radiation with the same probability as the true charge density, then we find that the ratio of the probability of the emission of $n+1$ photons at one collision to the probability of the emission of n photons is of the order of 1 to 12 on the average. This result only holds when the energy of the colliding electron $\varepsilon\, m\, c^2$ is such that ε lies within the limits $2\times10^3/Z$ to $2\times10^4/Z$. Outside of this energy range, shower production on the Born theory should be absent.[3]

It is the purpose of this paper to present a semi-empirical formulation of the β field which leads to a similar result. From studies of the interaction of protons and neutrons and from the endeavor of physicists to explain the magnetic moment of the proton in terms of the β field, the following empirical distribution of the field has been advanced.[4] On the average the proton is dissolved into a neutron, a positron and a neutrino during 1/10 of the time. During its brief life the positron has an energy of the order of 100 M.E.V. On the basis of this assumption it is possible to develop a theory of shower formation. If a high energy electron $\varepsilon > 137$ collides with this system during the time that the proton is dissolved into a neutron,

[1] C. G. and D. D. Montgomery, *Phys. Rev.*, Abstracts, Rochester meeting, 1936.

[2] Bramley, *Phys. Rev.*, 46: 438, 1934.

[3] Bramley, SCIENCE, November 8, 1935.

[4] Bethe and Bacher, *Rev. of Mod. Phys.*, 8: 205, 1936.