council to elect each year three additional members to serve for a term of three years. Those so elected would probably be among the most efficient members of the council. The council would thus be considerably enlarged, but its authority would be greatly increased. It is of course understood that the real work of legislative bodies is done by committees, and the committees of the council should be organized with special care.

The executive officer of the Association is the permanent secretary, and his influence should be very great. He should either be paid a reasonable salary, say $5,000, and devote his whole time to the Association and the organization of science in America, or should be, as our present secretary, a man of unusual executive ability, having under him one or two assistant secretaries who should devote themselves to the work. The secretaries of the sections should be among the most efficient members of the sections, and should be elected for a term of three years and reeligible.

The meetings should be more thoroughly organized in advance, more authority being vested in the permanent secretary and council. As suggested above, public lectures and discussions on the important advances and current problems of general interest should be arranged. For example, this year there should be reports on the relation of mosquitoes to disease, on the newly established Bureau of Standards, on the conduct of a national observatory, on the natural history and resources of the West Indies and the Philippines, and, in view of the place of meeting, on mining and irrigation.

The time of meeting has always interfered with success. Men of science will not and and can not come together at midsummer. If a week can be set aside at the beginning of the year, it is probable that the scientific character and weight of the meetings will be greatly forwarded. The importance of obtaining a convocation week in midwinter has been emphasized in a recent editorial (April 26, 1901), and we are now able to report that, of the fourteen universities comprising the Association of American Universities, all but two either already have no exercises at the time or have altered their calendars in the direction of setting aside the week in which New Year's Day falls for the meetings of scientific and learned societies. It might, however, be well to have, say once in three years, a summer meeting in which the social and excursion elements should be emphasized. It must be remembered that the National Educational Association can bring together 10,000 members in this way. Or perhaps, it will be found with experience that the winter meeting is so advantageous that the summer meetings can be omitted altogether. Meanwhile there might be suggested a special meeting at Chicago next year at Christmas time in conjunction with the Naturalists and affiliated societies, the usual meeting at Pittsburg in midsummer, and a meeting of unusual importance at Washington at the end of the year.

*A KINETIC THEORY OF EVOLUTION.**

IN 1895† the opinion was expressed that the differentiation existing in certain fami-

* Read before the Biological Society of Washington, May 4, 1901.

† *Proc. U. S. Nat. Museum*, 1895, 18 : 64.

lies of Chilopoda represents the results of variation accumulated without the interference of natural selection. In the next year* the same proposition was applied to the class Diplopoda, and studies in other groups, such as the termites, fungi, hepaticæ, mosses, ferns and flowering plants have led to the belief that there is little ground for the supposed stability of organic form and structure which furnished the basis of the doctrine of the separate creation of species, and which still figures as an important postulate in theories of evolution through natural selection. The Diplopoda are one of the many classes of animals and plants in which ecologic relations are essentially different from those of the mammals, birds, and other highly specialized groups upon which evolutionary studies have largely been based. Among the Diplopoda are to be found very few of the adaptations so numerous among the true insects; Diplopoda do not eat each other, and are not eaten by other animals;† their food requirements are not specialized, and decaying vegetable matter is generally abundant far in excess of their needs. There is seldom a suggestion of a struggle for existence or of other conditions indicating an active principle of selection. At the same time there is no lack of morphological differences, and while the present or past absence of selective influence in any particular character cannot, of course, be demonstrated, the phylogenetic, biologic and ecologic unity of the group, when contrasted with its structural and evolutionary diversity, seems to justify the opinion that in this class, at least, evolution is a kinetic phenomenon or active process of organic change, instead of the result of a passive subjection to external interference in otherwise stable conditions.

* *American Naturalist*, 1896, 30 : 682.

† Science, N. S., Vol. XII., October 5, 1900, p. 518.

EVOLUTION BY INTEGRATION.

Examples of groups of characters which it seems impossible to look upon as of selective origin have been noticed in another place.* Moreover, it is scarcely necessary to detail particular instances, since for a proposition partaking of the nature of a general law every biologist should find ample supporting evidence inside the field of his own specialty. Kinetic evolution is, indeed, nothing new, and requires for its formal recognition little beyond the most obvious facts of natural history; doubtless it would have been appreciated and accepted years ago had not makers of static theories protected themselves against so simple an inference by inventing the so-called principle of panmixia, under which it is argued that spontaneous progressive change is impossible in a large group of individuals, because fortuitous variations occurring simultaneously in all directions are brought back to a stable average by intercrossing.

In reality, however, this proposition is worthy of little of the deference due to a mathematical axiom; biologically it rests on unproved and apparently unprovable assumptions. We have by no means ascertained that the individuals of a species tend to vary equally in all directions with respect to all their characters; on the contrary, some variations are much more common than others. We have not ascertained that the crossing of individuals showing different variations always results in average offspring; we know instead that the next generation often exceeds both its parents in the accentuation of some new characteristic. In its logical development panmixia, if true, would constitute a demonstration that individual variation acting through heredity cannot contribute to the evolutionary progress of a species; it is as

* 'The Diplopod Family Oxydesmidae,' a paper prepared for the Proceedings of the U. S. National Museum.

though individual influence were a wave raised by a pebble, and not a permanent elevation of level. Individual differences could in this view affect the evolution of species only when interbreeding is prevented by some form of isolation, a supposition which has received apparent support from the finding of many distinct species in small islands or other circumscribed localities. That isolation tends to the rapid *differentiation of specific types* affords, however, no proof that *progressive change* is due to isolation, geographical or selectional. That a certain peculiarity is manifest in all the individuals of an insular or strictly circumscribed species may mean, not that all the individuals are descended from a single peculiar ancestor, but that the change tendencies which have originated in this locality have been confined to it, and have not been able to propagate themselves beyond the natural barriers.* In the absence of such limits specific differentiation might not have taken place, but evolutionary progress might have been greater by reason of access to more varied developmental tendencies. Specific differentiation thus affords but little indication of the rate or nature of evolutionary progress, which often appears not to be the result of isolation at all, but rather of the aggregation and integration of individual variations welcome to the organic constitution. In this aspect of the subject isolation may be viewed as the absence, rather than as the result, of selection.

* The stability or fixity of type which has been ascribed to small segregations of plants and animals is only relative, even under careful artifical selection, and from the standpoint of biological history is to be interpreted as uniformity rather than as permanence. Among the molluscs, which have been supposed to furnish examples of great permanence, very diverse animals are now known to inhabit shells of extreme similarity. Evidently the external skeleton is not an adequate index of evolutionary status: in some families variation seems to have principally affected the shells, in others the softer parts.

Species, which have been thought to support the opinion that selection brings about evolution by inducing various degrees and kinds of isolation, can often be much more rationally interpreted as instances of the manifestation of spontaneous developmental tendencies. Groups like the Diplopoda illustrate the infinity of combinations of characters possible without the assistance of any of the influences commonly invoked to explain the specializations of the more adaptive organisms, and thus permit us to realize that evolution is one of the causes, instead of a result, of biological isolation, the effects of which are probably limited to specific differentiation.

To have confidence in organic evolution accomplished by selection and isolation in the presence of an efficient panmixia would require at least double the credulity needed to equip the earth from the original pairs of the Garden of Eden or of Noah's Ark, since the ancient accounts provided two parents for each species while the modern begins with one, the offspring of which must be placed under such conditions that they are prevented from mixing with the parental type, either by means of geographical separation or through circumstances which give the variety immediate and exclusive advantage over the older forms. The only alternative would involve the origin of species from sports so extremely divergent that their offspring would remain distinct after considerable dilution with the parent form. The maintenance of such differences through the prepotency of new types, in accordance with the kinetic view, could not, of course, be invoked under theories accepting panmixia.

Moreover, it should not be forgotten that all segregations of small numbers of individuals involve the necessity of close breeding, which has been found in domesticated animals and plants to lead in many instances directly toward abnormal and even pathological characteristics, and which is also commonly recognized as weakening vitality and vegetative strength. Thus many high-bred varieties of plants are nearly or quite seedless, while in others the germinating power of the seed is very low, facts that afford a strong indication that general evolutionary progress has not been greatly favored by segregation.

Although the breeding of domestic animals and plants has generally been directed toward the accentuation of some one feature or limited group of characteristics desirable for economic reasons, it should be remembered that, in nature, evolutionary progress must carry with it improvement in total organic efficiency, which in turn depends upon almost an infinity of morphological and physiological coordinations, the perfection of which would be assisted rather than hindered by the access to a great variety of evolutionary tendencies or suggestions.

From the evolutionary standpoint a species is not a definition or a complex of characters, more or less important, but a group of organic individuals which stand in a definite biological relation of reproductive accessibility. Species do not arise and are not separated in nature primarily by the degree or amount of difference which may exist between individuals; in some groups species contain greater diversities than appear elsewhere between genera, families or orders. Interbreeding prevents the subdivision of species, but at the same time conduces to variety instead of maintaining stability. Species become distinct in nature not only when the component individuals are separated by geographical or other forms of isolation, but accumulated variations may themselves bring about isolation when evolutionary tendencies become so divergent that further coordination is difficult, and interbreeding ceases. Evolution is thus a process of integration rather than of segregation, and organic progress, like intellectual and social advancement, is not an individual phenomenon, but the accumulated result of individual contributions which are not lost, but saved, by interbreeding or communication to others. Isolation permits the accentuation of individual peculiarities, but does not on that account conduce to intellectual or social development; selection may encourage specialization, but it often limits the field of subsequent changes and adaptations necessary for the perpetuation and continued welfare of the species.

The various forms of selection and isolation represent, as it were, the outside of evolution, the points at which it is affected by external accidents. Organic development is not, however, a passive, but an intensely active process; selection and isolation have not caused evolution, but are among the conditions under which it sometimes proceeds.

The crossing of geographically distinct species often results, not merely in the production of intermediate forms, but in new types having characters not represented in either of the parents, and since the same result often follows the crossing of divergent forms of the same species, we have a further reason for believing that progressive change is not dependent upon, but may even be impeded by, selection and isolation, and that interbreeding rather than segregation is favorable to evolutionary progress. Static theories have thus reversed the true functions and effects of panmixia and isolation.

DARWINISM AS A STATIC THEORY.

Phylogeny and ecology were combined by Darwin as different sides of the same phenomenon, and environment was held at once to cause variation and to produce indefinitely extensive changes by means of it —a theory here described as static because it predicates the normal stability of organic series.*

The configuration of a valley may determine the banks of a river which flows through it, but the valley does not cause the water to run down hill. In the absence of this property of water valleys would be quite powerless to 'give rise' to rivers. Similarly, it is true that environment influences organic evolution; it may accelerate or retard, deflect or even set absolute barriers to change, but these facts afford no reason for believing that selection represents a biological force. The vital river, when unconfined, is in motion; change is a law of organic succession; evolution is a property of protoplasm.

Some rivers have direct courses, deep channels and swift currents; the water reaches the sea without much loss of time; with such streams is comparable the evolution of the organic groups which an active selection has kept well within the lines of utility, whose functional organization is so perfect that a useless structure or an unprotective color is looked upon as an anomaly requiring special explanation. There are, however, other rivers the waters of which give no suggestion of haste: they meet innumerable turns, eddies and backsets, they are divided by islands, and often overflow the land. With such rivers may be compared the evolution of groups like the Diplopoda, not confined by too exact requirements of utility, and hence the better able to manifest the natural tendency to indefinite change.

Darwin and Wallace recognized the fact that a species does not constitute a single morphological point, but that the projection of its characters requires a surface of appreciable area. And assuming that there is a tendency or law by which such an area remains even approximately constant in size, they found that it could be given a progressive motion by taking away from one side while permitting the other to grow out. Thus it appeared possible by predicating external causes to explain evolutionary progress with but a slight readjustment of the traditional static view of organic

*"But let the external conditions of a country alter * * * the original inhabitants must cease to be as perfectly adapted to the changed conditions as they were originally * * * such changes of external conditions would, from their acting on the reproductive system, probably cause the organization of those beings which are most affected to become, as under domestication, plastic. Now, can it be doubted, from the struggle each individual has to obtain subsistence, that any minute variation in structure, habits or instincts, adapting that individual better to the new conditions, would tell upon its vigor and health? * * * Each new variety or species, when formed, will generally take the place of, and thus exterminate, its less well fitted parent. This I believe to be the origin of the classification and affinities of organic beings at all times; for organic beings always *seem* to branch and sub-branch like the limbs of a tree from a common trunk, the flourishing and diverging twigs destroying the less vigorous, the dead and lost branches rudely representing extinct genera and families."

Quite as definitely did Wallace state the same proposition in controverting the somewhat more narrowly static idea that the variations of species are limited, as it were, to fixed points beyond which they cannot go in nature, or to which they must return if differentiated from the wild type by artificial selection.

"But * * * there is a general principle in nature which will cause many *varieties* to survive the parent species, and to give rise to successive variations departing further and further from the original type, and which also produces in domesticated animals the tendency of varieties to return to the parent form. * * * Granted, therefore, a 'tendency' to reproduce the original type of the species, still the variety must ever remain preponderant in numbers, and under adverse physical conditions *again alone survive.* But this new, improved, and populous race might itself, in course of time, give rise to new varieties, exhibiting several diverging modifications of form, any one of which, tending to increase the facilities for preserving existence, must, by the same general law, in their turn become predominant. Here, then, we have *progression and continued divergence* deduced from the general laws which regulate the existence of animals in a state of nature, and from the undisputed fact that varieties do frequently occur."

life, a view which thus persisted and is still generally held.

Subsequently, both Darwin and Wallace admitted progressive variation without natural selection, which was considered to be but one of several factors contributing to evolution. The original statement, however, continues to represent Darwinism in the scientific world, and, as has been well said,* "The biologist of to-day is more Darwinian than Darwin, and explains on the Darwinian hypothesis even those cases which had presented difficulties to Darwin's own mind." This tendency signifies that the inadequacy of all other explanations has become more and more thoroughly realized, thus causing a return to Darwin as the author of the only real contribution to the study of biological causes. The static or selective theory of evolution has, however, attained its present popularity, not because it has been shown to have any universal application in nature, but because it has remained the only suggested explanation which seemed to be supported by definite and particularized phenomena.

VARIATION AND CONJUGATION AS KINETIC PHENOMENA.

It is probable that in the study of biological motion it will be found desirable to distinguish at least four types of variation or kinds of differences between closely related organisms. Some modifications may be described as mere chemical or physical reactions to definite substances, forces or conditions; † some are more clearly pathological and are the result of inherent weakness or derangement of the organism; while others are normal vibrations or fluctuations of form, size, color or other characteristics having, perhaps, no very definite single cause, nor any pronounced tendency to repeat themselves. Essentially different, though often confused with one or the other of the above, are the peculiarities which represent lines of change or divergence, upon which the organic series if unhindered may proceed with no diminution, but rather with an increase of structural and physiological efficiency, and often with persistence and rapidity. To this class belong the 'sports' which come true to seed and yet show no signs of debility, and which, though crossed with the parental type, impress their characters upon a large majority of the offspring. In other words, variations of this kind are prepotent because they open avenues of advance and adjustment welcome to the organism and necessary to the maintenance of the efficiency of protoplasmic structure and function.

Variation and conjugation may thus be supposed to minister to the same requirement of the protoplasmic organization. There is little or no warrant for the current belief that variation and heredity are phenomena essentially connected with sexual reproduction, and thus explainable through a knowledge of the structure and mechanism of conjugating cells. In final analysis reproduction is not a sexual but a vegetative process. Because in some groups the conjugation of nuclei is an indispensable preliminary to reproduction,* the most

* Haycraft, 'Darwinism and Race Progress,' London, 1900, 28.

† According to Professor Osborne: "When the pale *Proteus* is taken from the Austrian caves, placed in the sunlight, and in the course of a month becomes darkly pigmented, there are two interpretations of this pigmentation; either that we have revived a latent character, or that we have created a new character." *American Naturalist*, May, 1899, p. 431. It would seem, however, that this experiment may prove neither of these alternatives, but merely that the skin of *Proteus* is capable of the photic reaction which generally influences the formation of pigment.

* SCIENCE, N. S., 1900, XII., pp. 940–946. In this presentation of Professor Hertwig's views the issue is still obscured by a residue of the former terminology. Thus on page 943 we read that "the sexual reproduction of Metazoa is a continuation of the method of reproduction in the Protozoa, while the budding and

intimate of causal relations have been inferred, in spite of the existence of many forms of reproduction not so preceded. From the morphological standpoint there is every gradation from parthenogenesis or the development without fertilization of cells which are normally fertilized, to the simplest case of plants multiplied by branching root-stocks. From the evolutionary standpoint such differences are of comparatively little moment; all organisms seem to be variable, whatever their methods of reproduction. There is, however, a general law that the more specialized the organism and its reproductive processes the smaller are the probabilities that conjugation can be dispensed with. It is as though complexity of organization required a higher tension of the protoplasmic structure which could not be maintained without conjugation, rest or change. Thus among animals of high organization there are but two conspicuous instances of normal parthenogenesis, the bees and the plant-lice, and in both of these the generations, sexes or castes produced without conjugation are inferior, specialized and unable to maintain the existence of the species. The relative frequency with which parthenogenesis and asexual reproduction are maintained among the lower animals and plants, in connection with parasitic or saprophytic habits suggests the further possibility that protoplasmic compounds of high complexity may be utilized as partial or complete substitutes for conjugation. Cytologists might thus find it worth while to ascertain, if possible, the exact nature of the protoplasmic relations between parasite and host.

fission of Metazoa are adjustments having only an outward resemblance to the budding and fission of Protozoa." While processes, like organisms, must have a common origin if genuine homologies are to be established, it seems obvious that on the plane of Professor Hertwig's discussion conjugation and reproduction are directly comparable throughout organic nature. Current errors are not so much in the direction of mistaking the nature of the processes, as in failing to observe that what is termed 'asexual reproduction' in simple organisms is generally called 'growth' in the more complex. From the cytological standpoint there are two sets of phenomena in both plants and animals, conjugation or fertilization and fission or growth by cell multiplication. The association and specialization of cells in compound organisms (Metazoa and Metaphyta) have given rise to a great variety of independently acquired reproductive adaptations superposed upon conjugation and fission, but different in category, and having neither phylogeny nor homology with those processes.

CHEMICAL AND MECHANICAL THEORIES.

Chemical theory has advanced to the point where different qualities of compounds are explained by reference to positional relations between the component atoms, but behind this lies the question of the nature and qualities of the elemental substances themselves. By common consent the molecular constitution of protoplasm is admitted to be almost unimaginably complex and still utterly inaccessible and intractable from the chemical side. Nevertheless, we recognize that the qualitative or potential differences of protoplasm extend not only to species, but actually to individuals, and yet some biologists are attempting to grasp these ultimate differences before solving the problem of the physical and the chemical groundwork of protoplasmic structure.

A solution of evolutionary problems on this basis can be expected only by those who remain regardless of the fact that the already insurmountable physical and chemical difficulties would be, as it were, multiplied by infinity under theories which imply that not only the complexities of the organic constitution, but also the endless details of individual difference, are symbolized, materialized or predetermined by positional or other relations of atoms, to say nothing of the chromosomes or granules which some have taken to be the actual organs of protoplasmic foreordination. Similar theories invented by theologians have been set aside by biologists as crudely anthropomorphic. In reality the immediate causes or mechanisms of evolution are as completely unknown as those of the other spontaneous or active properties of protoplasm. Until more light can be shed upon the physical and chemical how and why of assimilation, growth, irritability, motility and reproduction, we can scarcely expect to attain an adequate comprehension of the process which represents a continuous summary of these organic activities.

The center of activity or citadel of the protoplasm of cells is located, evidently, in the nucleus, and there are also reasons for believing that the number, position or other relations of the chromatin bands have important functions in the processes of cell division, and possibly also in determining the relative preponderance of the parental influences. But such facts are very far from proving that either heredity, variation or the resultant evolutionary motion is controlled by purely cytological processes, or that there is any such thing as a 'hereditary mechanism.'* Developed to their logical conclusions, theories of determinants coincide with Nägeli's attempted deduction of the organic universe from the chemical and physical structure of protoplasm, in ignoring the fact that even in the highest organisms cells are still cells, and that from the cytological standpoint they are not improved, but degraded by specialization. A complex organism is more than the component cells, and evolution is not only a cytological, but a social and supercellular process. Life itself is the 'unknown factor,' or neglected cause, which vitiates the theories of those who expect a complete expression of organic phenomena in terms of current conceptions of matter and molecular and atomic forces.

Under cytological or intracellular theories the evolution of unicellular organisms must involve principles fundamentally distinct from those required in multicellular groups, with a similar gap intervening when compound individuals and social units are being dealt with. But if we look upon evolution as a normal property of protoplasm no such complications need be met, higher acquirements being added by gradual superposition. In nature, moreover, there are no breaks in the chain which connects simple and complex types of individuality. Beginning with the absolute individuality of some unicellular organisms where each cell may compete directly with every other cell, we have all grades of association and adhesion; also when the individual compacted of similar and equivalent cells is traced to the point where it begins to manifest increasing differentiation of parts into special tissues and organs. Equally perfect is the series of social adaptations and instincts, through simple aggregations or flocks, to the complex caste differentiations of the highly organized colonies of the social hymenoptera and termites.

A general law of biological evolution must embrace the morphology, physiology, ecology, psychology, ethnology and sociology of the entire organic series, to say nothing of still more general or philosophical applications. But while any process of gradual change and readjustment would bear the teleological interpretation of natural selection, that theory does not furnish an adequate explanation or supply causal connection for the succession of phenomena encountered in any department of biological study.

* The well-known phenomena of asexual reproduction, parthenogenesis and replacement of lost parts should have saved us from theories of localized and mechanical heredity, but if further proof is needed it is now available in the experiments of Loeb in artificial parthenogenesis, those of Delage and others with enucleated fragments of eggs, and those of Mr. A. J. Pieters in growing normal plants from pieces of cotyledons.

COROLLARIES AND CONCLUSIONS.

It will readily be understood that the center of gravity of evolutionary theories will appear to change on admitting the correctness of a kinetic view, and this not only in strictly biological, but in other related lines of thought. Time and space are alike wanting for the canvass of such readjustments; it is possible in the way of summary and conclusion only to notice in a brief and disconnected manner a few of the corollaries and subsidiary theories accommodated or suggested by the belief that evolution is a general property of protoplasm, and not the function of a special mechanism or a reaction to external stimuli.

The differentiation of species is a phenomenon distinct from evolutionary progress; isolation may conduce to the former while retarding the latter.

Selection, acting through isolation, affects evolution by influencing the direction and rate of progress with respect to particular characters; that species may originate through natural selection does not, however, prove that selection is a cause of organic change or of evolution.

Variation furnishes the differentials of which evolution is the integration; selection and isolation may affect the equation either as positive or as negative quantities. Specific differentiation is a direct function of selection and isolation, but evolutionary progress is often an inverse function.

Groups having large, complex and variable species, or numerous closely related species, are in a state of active evolution, while those in which species and genera are few, small and uniform have passed the zenith of their evolutionary history. Thus the compositae and hymenoptera are prosperous, while the cycads and diplopods are on the decline. Primitive characters are to be sought in insular or circumscribed species rather than among related continental or widely distributed types. Static theories would compel contrary inferences.

In large and widely extended species uniformity or diversity of characters depends upon relative facility of distribution; the more rapidly new characters can be disseminated the greater the uniformity of the species. Such uniformity should not, however, be interpreted as stability, which may be relatively greater in locally diversified species.

That diversity is not conditioned upon segregation, but is distinctly favored inside the limits of species, also seems obvious from the differentiations of sex, caste, dimorphism and other similar specializations. Moreover, these phenomena do not represent a single device or adaptation, but have appeared independently in many natural groups.

The relative importance of natural selection has differed greatly in the evolution of the various natural groups; in a general way it may be thought of as proportional to ecological diversity.

Evolution is not a special process or function, but appears in all types of individuals from the unicellular through the various grades of polycellular and compound organisms to the caste-differentiated colonies of the social insects; it accompanies both sexual and asexual methods of reproduction, seedless plants and insects derived from unfertilized eggs continuing to vary and differentiate.

Evolution is both cellular or cytologic and supercellular or organic; the former appears in simple types and in the component cells of higher groups; the latter is a social phenomenon having no obvious or necessary connection with cytological processes.

In some groups it has been ascertained that evolutionary characters or conditions which first appeared in the adult are subsequently passed back into preliminary or embryonic stages; such facts do not, however, establish a general law of retrogression or recapitulation, since the metamorphoses of insects and other similar phenomena show that evolutionary deviations and adaptations may occur at any stage in the life histories of organisms.

The adaptability of an organism is in general inversely proportional to the degree of ecological specialization already attained. Accordingly, highly specialized types tend to become restricted and to disappear, while the more primitive may persist and give repeated demonstrations of the evolutionary tendencies or variational possibilities of the group.

Parallel evolution is thus not necessarily adaptive or mimetic, and may often be interpreted as an indication that a tendency to a particular variation may outlive specific differentiation and become similarly accentuated, even in groups in which long separation has permitted the accumulation of many differences in other characters.

From the standpoint of a kinetic theory the inheritance of acquired characters becomes a purely formal question ; indeed, it may be said that the origination and inheritance of characters are but different statements of the same fact, since characters originate and are extended because of the same inherent tendency to change.

The continued differentiation of vestigial organs and structures shows that there is no essential connection between evolution and use. The vast majority of variations and specific differences are also obviously non useful ; they arise, are prepotent and are perpetuated because they are different and new, rather than through any external influence or necessity.

All hereditary characters are acquired, but not all acquired characters are hereditary. There is no reason to believe that any are hereditary which have not been acquired through the assistance of normal variation. Mere mutilations or reactions to external conditions are not hereditary. Evolution is essentially a process of acquiring characters, but no direct nexus between environment and heredity has been demonstrated, and none is necessary under a kinetic theory.

A kinetic theory enables us, in short, to recognize the varied facts of evolution without doing violence to any of them. While holding that all evolutionary changes are essentially the same in having an internal and spontaneous origin, we are still not compelled to deny that adaptations have been influenced by external agencies. Selection represents, however, not the causes, but the external incidents of evolution. Persistent variation should be compared with the main spring, selection to the balance-wheel, of an organic creation which progresses because new characters and powers are welcome, rather than because old types are exterminated.

O. F. Cook.

Washington, D. C.

THE LATE MILES ROCK.

Miles Rock, a notable scientist, born at Ephrata, Lancaster county, Pennsylvania, October 10, 1840, died on January 29, 1901, in his sixty-first year.

During boyhood he attended the public schools of Ephrata, and later the Lancaster High School, fitting himself for Franklin and Marshall College. At the outbreak of the Civil War he was pursuing his studies at this college ; but love of country and the trend of public spirit at the time prompted him to join the Pennsylvania Volunteers and proceed to the seat of war. He remained a soldier at the front until the close of the war ; and it is significant of his character that he carried in his knapsack a copy of Gray's 'Manual of Botany,' and employed his leisure in collecting and analyzing the plants observed in the campaign.