carefully by reflected light, it is seen that the ground-tone of the Mongolian is bluish, while that of the American is reddish.

Of positive cranial characteristics of the red race, I call attention to the interparietal bone (or *os Incæ*), which is found in its extreme development in the American, in its greatest rarity among the Mongolians; also to the form of the glabella, found most prominent in American crania, least prominent in Altaic or northern Mongoloid crania; and the peculiar American characteristics of the occipital bone, flattened externally, and internally presenting in nearly forty per cent of cases the 'Aymarian depression,' as it has been termed, instead of the internal occipital protuberance (HERVELACQUE et HERVÉ, *Anthropologie*, pp. 231, 234, 236).

The shape of the skull has been made another ground of race-distinction; and, although we have learned of late years that its value was greatly over-estimated by the earlier craniologists, we have also learned that in the average, and throughout large numbers of peoples, it is a most persistent characteristic, and one potently indicative of descent or relationship. Now, of all the peoples of the world, the Mongols, especially the Turanian branch, are the most brachycephalic; they have the roundest heads; and it is in a high degree noteworthy that precisely the American nation dwelling nearest to these, having undoubted contact with them for unnumbered generations, are long-headed, or dolichocephalic, in a marked degree. I mean the Eskimo, and I cannot but be surprised that such an eminent anthropologist as Virchow (in *Verhandlungen der Berliner Anthrop. Gesellschaft*, 1881–82), in spite of this anatomical fact, and in defiance of the linguistic evidence, should have repeated the assertion that the Eskimo are of Mongolian descent.

Throughout the American continent generally, the natives were not markedly brachycephalic. This was abundantly illustrated more than twenty years ago by the late Prof. James Aitkins Meigs, in his 'Observations on the Cranial Forms of the American Aborigines.' They certainly, in this respect, show no greater Mongoloid affinities than do their white successors on the soil of the United States.

If color, hair, and crania are thus shown to present such feeble similarities, what is it that has given rise to a notion of the Mongoloid origin of the American Indian? Is it the so-called Mongolian eye, the oblique eye, with a seeming droop at its inner canthus? Yes, a good deal has been made of this by certain writers, especially by travellers who are not anatomists. The distinguished ethnologist Topinard says the Chinese are very often found without it, and I can confirm this opinion by those I have seen in this country. It is, indeed, a slight deformity, affecting the skin of the eyebrow only, and is not at all infrequent in the white race. Surgeons know it under the name *epicanthus*, and, as with us it is considered a disfigurement, it is usually removed in infancy by a slight operation. In a few American tribes it is rather prevalent, but in most of the pure Indians I have seen, no trace of it was visible. It certainly does not rank as a racial characteristic.

The nasal index has been recommended by some anatomist as one of the most persistent and trustworthy of racial indications. The Mongolian origin of the red race derives faint support from this quarter. From the measurements given in the last edition of Topinard's work (*Elements d'Anthropologie*, p. 1003), the Mongolian index is 80, while that of the Eskimo and tribes of the United States and Canada, as far as observed, is 70, that of the average Parisian of to-day being 69 (omitting fractions). According to this test, the American is much closer to the white than to the yellow race.

Most of the writers (for instance, Avé-Lallemant, St. Hilaire, Peschel, and Virchow) who have argued for the Mongoloid character of the Americans have quoted some one tribe who, it is asserted, shows marked Chinese traits. This has especially been said of the natives of three localities, — the Eskimo, the tribes of the North Pacific coast, and the Botocudo of Brazil. So far as the last-mentioned are concerned, the Botocudo, any such similarity has been categorically denied by the latest and most scientific traveller who has visited them, Dr. Paul Ehrenreich. It is enough if I refer you to his paper in the *Zeitschrift für Ethnologie* for 1887, where he dismisses, I should say once for all, the notion of any such resemblance existing. I have already pointed out that the Eskimo are totally un-Mongolian in cranial shape, in nasal index, and in linguistic character. They do possess in some instances a general physiognomical similarity, and this is all; and this is not worth much as against the dissimilarities mentioned. The same is true of the differences and similarities of some tribes of the north-west coast. In estimating the value of any resemblances observed in this part of our continent, we should remember that we have sufficient evidence to believe that for many generations some slight intercourse has been going on between the adjacent mainlands and islands of the two continents in the regions of their nearest proximity. The same train of events led to a blending of the negro and the white races along the shores of the Red Sea; but any one who recognizes the distinction of races at all — and I am aware that certain eccentric anthropologists do not — will not, on that account, claim that the white race is negroid. With just as little reason, it seems to me, has it been argued that the native Americans as a race are Mongoloid.

ON THE CAUSES OF VARIATION IN ORGANIC FORMS.[1]

THE fundamental principle of organic evolution is natural selection, which is based on individual variation and the struggle for existence, the effect of which is the preservation of the most competent. It is extremely difficult to get at the immediate cause or causes of this individual variation, and for this reason Darwin considered it promiscuous and aimless, though he wisely avoided calling it lawless. There is no more fascinating or profitable field of investigation than that leading to the proximate cause or causes of variation. We are not content to rest the case where Darwin did by recognizing variation as an inherent principle in organic forms, or to beg the question by saying that it is as much a necessity of life as natural selection itself. Let us, therefore, discuss these causes in the light of recent experience and experiment.

We soon find that they admit of a certain amount of classification, the minor divisions of which, as in all systems of classification, more or less fully interlock or blend. They fall, however, into two chief categories: viz., (1) external conditions or environment, which are, at bottom, physical; and (2) internal tendencies or promptings, which are, at bottom, psychical.

By external conditions or environment, we include all influences on organisms which act from without; and in carefully considering them we shall find it difficult to draw the line between those which are really external and independent of any motive or inherent tendency in the organism, and those which are not. Hence the general term 'external conditions' is resolvable into various minor factors.

No one can well study organic life, especially in its lower manifestations, without being impressed with the great power of the environment. Joseph LeConte speaks of the organic kingdom lying, as it were, "passive and plastic in the moulding hands of the environment." In Semper's 'Animal Life' we have the best systematized effort to bring together the direct causes of variation; and no one who has read through its pages can doubt the direct modifying influences of nutrition, light, temperature, water at rest and in motion, atmosphere still or in motion, etc., or question his conclusion that no power which is able to act only as a selective and not as a transforming influence can ever be exclusively put forth as a *causa efficiens* of the phenomena.

It is among the vital or organic conditions of variation that natural selection has fullest sway; and, as they have been so ably expounded by Darwin and others, I will at once pass to a consideration of the second class of causes, to which the study of the interaction of organisms leads, — the internal conditions.

First of these we will consider the physiological causes. Genesis itself is the first and most fundamental of all causes of variation. The philosophy of sex may, indeed, be sought in this differentiation, as the accumulated qualities in separate entities, when suddenly conjoined or commingled, inevitably lead to aggregation and heterogeneity; in other words, to plasticity or capacity to vary. Genesis,

[1] Abstract of an address before the Section of Biology of the American Association for the Advancement of Science, at Cleveland, O., Aug. 15–22, 1888, by C. V. Riley, vice-president of the section.

as a fundamental factor in evolution, may be more intelligently considered under some of its subordinate phases, as heredity, physiological selection, sexual selection, primogenital selection, sexual differentiation including philoprogeneity, hybridity, etc.

Heredity, as expounded by the ablest biologists and as exemplified in life, is a puissant factor in evolution, and, though essentially conservative, must, through the marvellous power of atavism, tend to increase individual variability.

Physiological selection, as suggested by Mr. Catchpool and as expounded by Romanes, is undoubtedly an important factor in evolution. Romanes believes that wherever there has been modification of the reproductive organs introducing incompatibility between two individuals, even where there has been no other change or variation, we have a valid cause of differentiation which in its consequences must be important. Compatibility or fertility between individuals is of the very essence of selection. Natural selection implies that this sexual divergence is subsequent to or coincident with divergences in other directions; physiological selection, that it antecedes them. This theory implies variation in the reproductive organs, or departure from the parental type, in at least two individuals of opposite sex simultaneously; and with this admission, for which we are justified in facts, physiological selection will preserve many peculiarities which need have no necessary connection with the exigencies of life.

Sexual selection may be said to act in two ways, — by conflict of the males for possession of the female, or by attractiveness; the former being most conspicuous among mammals, the latter among birds, and both coming conspicuously into play among insects. It is rather difficult to define the limit of sexual selection as a factor in evolution; but I would not confound it with another factor, not hitherto generally recognized, but which I think must be all-powerful, namely, sexual differentiation.

It seems evident that the mere differentiation of sex in itself has been an important element in variation. This principle elaborated by Brooks as a modification of the theory of pangenesis is a good one, and in the main the male may be said to be the more complex and to represent the progressive, and the female the more simple and to represent the conservative, element in nature. When the conditions of life are favorable, the female preponderates, and exercises a conservative influence. When the conditions are unfavorable, the males preponderate, and, with their greater tendency to vary, induce greater plasticity in the species, and hence greater power of adaptation. Sexual differentiation may, I think, be used to include many other variations and differentiations not otherwise satisfactorily accounted for, and to express the law of the interaction of the sexes upon one another, inducing great differentiation entirely apart from the struggle of the males for the possession of the females, or the struggle for existence.

Last of all I mention hybridity, which has been fully discussed by many, and by no one more ably than by Darwin himself.

Among the psychical conditions, the use and disuse of an organ and its effect upon the offspring of the individual is of prime importance. That functionally produced modifications are inherited was the great assumption upon which Lamarck founded his theory of evolution. Many able naturalists have insisted on it, and in my judgment there should no longer be any doubt whatever of the fact. The influence of emotion on the individual is closely connected with this category, as strong mental effort may be made to affect special parts of the body.

An interesting problem is the influence of the emotion of a mother on her offspring. It is still doubtful whether such influence really exists; but, this theory once established, its bearing on evolution as a prime cause of variation must at once be manifest; for it gives not only tangibility to the Lamarckian idea of desire influencing modification, but also a conception of how infinite mind in nature may act through the finite in directing such modification. In my judgment, this factor acts only when, from whatever cause, and particularly under the spur of necessity, the emotions are exceptionally intensified, or the desire strongly centred in some particular object.

These psychical factors which we have been considering are substantially Lamarckian; and in proportion as we consider them, and get to understand the other direct causes of variation, must we give importance to the ideas of Lamarck, and, conversely, less importance to the ideas of Darwin.

There are certain important laws which have influenced modification, but in no sense can be looked upon as causes of variation. They are laws or principles of evolution by which we may account for the formation of types, acting, just as natural selection does, in differentiating rather than in originating the variation. Acceleration and retardation belong to this class. This law is an attempt to give expression and form to a set of facts to which paleontology undoubtedly points, and which ontogeny substantiates; viz., that certain types may attain perfection in time, and then retrogress and finally become extinct, and that existing types which are dying out or degenerating exhibit ontogenically the culmination of force and complexity, followed by decadence, corresponding to the phylogenic history of the type. This law may, perhaps, be substantially stated in this wise: that certain groups acquire some characters rapidly, while corresponding groups acquire the same characters more slowly, or never acquire them at all; and this brings us to another important factor of evolution which serves to give force to the law. It is the acceleration by primogeniture which has been elaborated by Hubrecht. He shows, that, in organisms in which the reproductive period covers many years, accelerated development by primogeniture (i.e., as between the first-born and the last-born of any pair and of their posterity) will in time produce differentiation. The series of the first-born will in the course of time involve many generations at short distances from each other whereas the series of the last-born will, on the contrary, consist of a much smaller number of terms, each separated from its predecessor by a more considerable distance. Any tendency to variation from external or internal influences must needs find more numerous occasions to act in the series of the first-born, not only because these have a more composite ancestry, but because they necessarily become the most numerous.

We are thus led to what have been called 'saltations' in evolution. Although the history of paleontology has continually added to our knowledge of past forms, and helped to fill up many gaps in the evolutional series, and although during the last quarter of a century it has particularly vindicated Darwin's prophecy that many links would yet be found, the substantial truth remains, that gaps still occur, and that progress, so far as present knowledge indicates, has been made by occasional saltations. There have been, it would seem, periods of rapid movement, and of comparative repose, or re-adjustment of equilibrium. Cope concludes that "genera and higher categories have appeared in geologic history by more or less abrupt transitions or *expression-points*, rather than by uniform gradual successions."

The forces of nature are constant, but the phenomena induced are often paroxysmal. The progressive forces accumulate, while the conservative forces resist until at last resistance gives way with comparative suddenness. There is every reason to believe that the life-movement, in its ascending complexity, has shared this common law. How far the rhythmic tendency in the development of animal life may be explained by the rapid change of climate, by migration and the loss of record, or upon the general law that while there has been progress of the whole there has not necessarily been progress of every part, it would take us too far to discuss in this connection. I think we are safe in saying, however, that the facts justify belief that in the evolution of animal life, as in the evolution of every thing else, progress has often been made by waves.

Having thus considered some of the proximate causes of variation and some of the more general laws of evolution, we are naturally led, in conclusion, to consideration of original or infinite cause. Far be it from me to try your patience with any prolonged speculation upon the more profound problems of life and of futurity, which have been dealt with by able men of all times, and with such conflicting and varying results. I shall content myself, in closing, with a few words upon those themes which, as biologists, we cannot ignore, and to which the subjects we have been considering inevitably lead.

Mind as exhibited in organic evolution, however simple or complex may be its manifestations, is in essence one and the same force. There is an undoubted gradation from simple sensitiveness

and volition to the more complex instinctive and reasoning faculties of higher animals.

Where, then, shall we draw the line in the evolution of mind between the high degrees of consciousness in animals, and self-consciousness, which is believed to be a peculiarly human attribute, and at the foundation of all that constitutes con-science and makes him a moral and responsible being? The beginnings of self-consciousness are traceable in animals, since many of the phenomena of sexual selection and the well-known sense of shame in our domestic associates could scarcely have resulted without it; and it seems to me illogical to argue, as some of our best writers on evolution have done, that self-consciousness is an attribute that must have been breathed into man by special, supernatural act.

From the consideration of the general subject of mind in nature, we are brought inevitably to the question of design. There can be no doubt that the tendency of evolution has been to remove further and further the idea of an infinite first cause. The argument for design, however, as Asa Gray has so well set forth, rests on the fact that the designed and the contingent can never be accurately discriminated, and that limitation, in the very nature of the case, is inconceivable. It seems to me that the evidences of design in nature are so overwhelming that its advocates have an immense advantage over those who would discard it. A fortuitous cosmos is, to most persons, utterly inconceivable; yet there is no other alternative than a designed cosmos.

The most philosophic view is probably that which, while recognizing an intelligent creative power, or mind, which has worked and is yet working through ordained laws, yet leaves the detailed manifestations to secondary causes and finite action. Limiting conditions or laws, since law is but a limiting condition and nature an active power, may act together in producing secondary causes, but the great and infinite cause may be looked upon as that which upholds the universe.

I have ventured just within the question of design, because of the prevalent belief that evolution eliminates it from our conception, and because I have felt that as between the extreme schools the middle ground chosen by our late lamented Gray is far the more satisfactory and philosophical. On the other great question of what life is, or how it originated, I commend the candor of Marsh in closing his address as president of the association in 1877 with the words, "In this long history of life I have said nothing of what life is; and for the best of reasons, because I know nothing." The genesis or formation of individual life, in spite of saint and sage, is yet a mystery, and probably always will be.

All that evolution recognizes is the transmutability — the generic identity — of the forces of nature, which, in their aggregate action, may properly be defined as omnipresent energy. We know, as a matter of the simplest observation, that this combined force or energy is essential to the continuance of life, not only upon our planet, but, deductively, in the universe. We are justified in inferring that it is capable, under fit conditions, of originating life from what we know as non-living matter. Evolution, in fact, inevitably leads to the inference that vital force is transmutable into, and derivable from, physical and chemical force.

SCHOOL OF BIOLOGY, UNIVERSITY OF VIRGINIA.

THIS school is founded upon the gift of one hundred thousand dollars by the late Samuel Miller of Lynchburg, Va., who provided that the income from this fund should be expended for "the advancement of agriculture as a science and as a practical art by the instruction therein, and in the sciences connected therewith, of the youth of the country."

A part of the income is used to maintain the work in agricultural chemistry, carried on in connection with the chemical department of the university, under the direction of Professors Mallet and Dunnington.

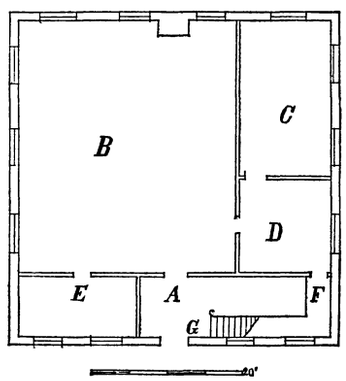
The residue, and the larger portion of the income, is to be expended in promoting instruction and research in biology. One floor of the medical hall (42 by 42 feet) is now being fitted up for a biological laboratory, including, as in the annexed plan, a laboratory-room for students, a private laboratory for the professor, a photographic room, and storerooms.

The equipment has already been ordered, and will consist of microscopes and dissecting-instruments for the students, microtomes, apparatus for staining and mounting preparations, photographic apparatus, instruments of precision for advanced researches, and a working library, and a file of periodical literature.

The instruction will be by lectures, with associated laboratory-work, and will cover general biology, zoölogy and comparative anatomy, and biology applied to agriculture.

PROF. ALBERT H. TUTTLE OF THE UNIVERSITY OF VIRGINIA.

The professor-elect is Mr. Albert H. Tuttle, recently professor of biology in the Ohio State University at Columbus. He was born in Summit County, O., in 1844, was graduated from the State College of Pennsylvania, taught for two years (1868–70) in the First State Normal College of Wisconsin, was graduate student and instructor in microscopy in the Harvard Museum of Zoölogy under Professor Agassiz (1870–72), travelled and studied in Europe (1872–74), and was professor in Ohio State University (1874–88). During one year of this period he was absent on leave as graduate student in the biological laboratory of Johns Hopkins University.



PLAN OF BIOLOGICAL LABORATORY.

A, hall; *B*, student's laboratory (29′ × 34′); *C*, private laboratory (12′ 6″ × 21′); *D*, photographic room (12′ × 12′ 6″); *E*, storeroom (8′ 6″ × 16′); *F*, closet; *G*, stairway to physiological room.