That this high excess positive velocity appears only in these particular southern groups and is absent in the northern groups of the brightest and nearest stars, and is also completely absent in all B stars fainter than 5.5 visual magnitude, shows conclusively that the mysterious K term has no particular relation to the B type stars, is not due to any physical displacement of the spectral lines or to erroneous wavelengths and does not require the elaborate explanation of von Pahlen and Freundlich, but is probably caused entirely by an unsymmetrical distribution of the residual velocities, by a preponderance of high recessional group velocities in the Vela-Lupus region.

The average peculiar motion of the B stars, the mean residual velocity without regard to sign, after the removal of the effects due to solar motion and galactic rotation, is found to be somewhat greater than that obtained by Campbell, and varies between 9 km per second for the bright B stars to about 12 km for those fainter than the seventh magnitude. It is still considerably less than the average peculiar velocity of stars of other spectral types, and the stars of the spectral class B0–B5 may be considered as relatively slow-moving stars, as having smaller peculiar or random velocities than any other spectral class.

In conclusion, this investigation of the motions of the B0 to B5 stars has shown that their general residual velocities, the velocities with respect to the stellar system, agree very closely with those that would be produced by a rotation of the galactic system around a very distant and massive center, thus increasing the probability of such a rotation. It has further shown that the excess positive residual of about 5 km per second found by Campbell and others has entirely disappeared, when the effects of the galactic rotation have been removed, for all the B0 to B5 stars fainter than 5.5 magnitude. Although the K term still remains for the stars brighter than 5.5 visual magnitude an analysis of the residual velocities shows conclusively that this final residual of 5 kms is mainly due to the high positive group or cluster motions of the brightest and nearest B type stars in the sky in the Vela-Lupus region and is no general characteristic of the B type stars as a class. Finally, the investigation has shown that the average residual random or peculiar motions of the B0 to B5 stars varies from about 9 km for the brighter to 12 km per sec. for the fainter stars. While considerably higher than values previously deduced, the peculiar velocities of the Bs are still less than those of any other spectral class.

It gives me pleasure to acknowledge the effective collaboration of Mr. J. A. Pearce with the writer in the observation and measurement of the spectrograms and in the calculation of the results.

ORGANIC EVOLUTION[1]

ITS PROBLEMS AND PERPLEXITIES

By Dr. ALEŠ HRDLIČKA

AFTER cosmogony, the greatest phenomenon in nature is organic evolution.

There is no need any more of attempting to substantiate this great process. Natural history teems with its evidence. And this evidence is so convincing that some scores of thousands of men of science, who represent the most critical minds of the present human society, are without exception deeply convinced of its reality.

This does not mean, however, that this most comprehensive and complex subject is as yet well known in all its details, or understood. What the workers in natural sciences are deeply conscious of is the substantiality of this all-pervading phenomenon. They further feel that gradually they are learning its accomplishments, and some of its principles. But they are also deeply aware that they are still far from knowing all its details or processes and especially far from comprehending its essential causes and significance.

[1] Address of the retiring president of the Washington Academy of Sciences, Washington, January 14, 1930.

Let us survey briefly some at least of the dark areas of the field and some of its perplexities.

We may as well begin by trying to define evolution —and we are at once in serious difficulties.

There have been many attempts at such a definition; they have all failed. How even now they fail may be appreciated from two of the latest attempts.

For H. S. Jennings (1928), "The doctrine of organic evolution is the doctrine that animals and plants are slowly transforming, producing new kinds"; while for David Starr Jordan (1928), evolution is merely "the universal process of orderly change." How inadequate are these expressions, how partial; yet it seems impossible for the present to do much better.

The fact is that the totality of the great subject is not yet graspable. Every worker sees it mainly from his angle, while the phenomenon as a whole is as comprehensive as that of life itself—the two may even be synonymous, or one the discharge of the other.

An approach towards the understanding of organic evolution lies necessarily in ever-progressing, intensive research and study; research and study of its

manifestations through time, of its processes to-day; and on the basis of these of its laws and principles.

As matters stand now, what seem to be the more obvious of such laws or principles?

The first such apparent law seems to tell us that every organic unit has and can be derived only from a closely related previous unit. This is the principle of related parentage. It is a much more important principle than may at first be appreciated. It implies that there are no new without previous closely related forms. There are mutations but no free saltations, no unconnected origins. This law, if it proves fully to be such, implies the principle of organic continuity, of the continuity of the organic with the suborganic world, and of the continuity of this with the inorganic. And it implies the great principle of heredity or transmission of the bulk of parental characters.

The next fundamentality is that every organic unit differs congenitally more or less from every other unit, and that such differences tend to be transmitted to the progeny. These are the important laws or principles of variation, and of inheritance of new characters.

The inborn variations of characters—physical, physiological or mental—differ in their value to their bearer. Under given environmental or individual conditions some may be favorable, some effectless and some unfavorable to the organism. In the long run, the units or groups with favorable variations will tend to prevail—which is Darwin's famous, and now as true as ever, principle or law of natural selection.

Every organic unit is plastic or impressionable, and reactive or accommodable. Use and disuse of parts or the whole, and environmental agencies, cause alterations that, if the causes persist long enough, will pass from temporary to habitual, and eventually to permanent changes that will be inheritable. The principles here involved are adaptation and the fixing of adaptations. The latter is the main and undoubtedly correct principle of Lamarckism and neo-Lamarckism. It is not opposed to but cooperative with natural selection and other factors of evolution. It should more properly be known, however, as the fixing of adaptations, rather than by the old term of "inheritance of acquired characters."

And a progression or differentiation of a filial group, with the additional aid of the important factors of sex, hybridization, isolation, etc., until every member of it can be distinguished from those of the parental group, and until a return to the parental group becomes impossible (A. H.), constitutes speciation or particular evolution.

So far, all is relatively easy sailing, and in well-traveled waters. The processes involved are, in the main, fairly understandable. There is thus some grasp of what may be designated especial, individualized or particular evolution.

But when we contemplate the organic world as a whole and from its beginnings, we are confronted with a far greater phenomenon, which is a general progressive evolution.

Here is something immeasurably more difficult to comprehend. It is no less than the sequential formation, the systematic building up, of the entire organic kingdom. And its causes and meaning are elusive.

What is that something that has led to the development of organic forms from the inorganic, and that within the organic realm has led unceasingly to progress in diversity, complexity, sensibility, effectiveness, until there was reached the culmination in a genus of creatures that are self-conscious, rationally directive, relentlessly striving for more knowledge, power, for co-creation even—the creatures we know as the humans?

This general progressive evolution may really be likened to a double-stemmed vast tree, rooted in the suborganic matter and the inorganic earth. One of these stems represents the vegetal, the other, statelier, the animal kingdom. As this latter stem, which concerns us more especially, grew upward, innumerable branches of it withered and were shed off, but the main stem never ceased rising and branching anew, until it reached the present highly differentiated crown and its human summit.

Here is before us an all-pervading something in living nature to which to apply the terms of accidental or incidental would be utterly trivial and absurd. Yet if not such then what? Then it must have been inevitable, and somehow predetermined in the organization of things. General organic evolution can only be, it seems, nature's function, resultant from nature's own potentialities, organization and evolution.

But we know very little as yet about these basic potentialities, organization and evolution.

General organic evolution, we feel strongly, is as natural a process as is the particular evolution of individual varieties and species. There is no indication within the process of anything except the natural. But "nature" (which may perhaps be crudely and somewhat metaphorically defined as the earth with all it stands for fertilized by the sun and the rest of the universe), in the light of organic evolution, assumes far greater riches and importance than it has hitherto been credited with.

We may now proceed to some of the more detailed problems and perplexities of the subject.

We may as well begin with the term "evolution." Is this a correct or the best term for the great process under consideration?

(1) The word "evolution," it is well known, means merely unraveling, unfolding. This would imply that all the potentialities, all the eventual results, of organic evolution lay already fixed in the most ancestral

units of the living kingdoms, in the earliest cells, and even in their predecessors.

General organic evolution under such conditions would be merely general ontogeny. If these concepts are followed far enough they lead to the absurd. The incongruity of the term "evolution" has been felt by many workers. There are those who prefer the term "transformism," which falls short. Morgan has coined "emergent evolution," which does not improve matters. Osborn suggests "creative evolution," which obscures rather than clears. There is but one term that would appear adequate to the speaker. In harmony with "cosmogony," general organic evolution, the greatest of organic phenomena, deserves the term of "biogeny."

(2) Did organic evolution begin with a cell? We used to believe it. Many who perhaps have not had the chance to go more intensively into the subject believe it still. But those who know the cell can not believe that the cell is the beginning of organic life. The cell is already a great accomplishment in organic evolution. It is a little cosmos of its own. It is extremely complex and full of highly differentiated activities. It is a carrier of all sorts of ancestral things. It would seem that a long road in biogeny had already been covered when there was reached the first full-fledged cell.

To-day it is known, moreover, that there are whole classes of ultra-microscopic existences which seem to behave like living beings and produce definite lines of results. There are a number of them already known, as shown recently by Flexner, in pathology, and there are probably many others in nature, non-pathological and perhaps, as in the case with many micro-organisms, even helpful. Shall these ultramicroscopic somethings be called cells? They seem too minute to deserve such appellation, too minute to possess the regular cell characters. If they are organic units, they are units of a lower order than that of the cells proper. They disclose what may be designated as a suborganic kingdom. These suborganic existences must be derived from something still simpler which, it would seem, could only be peculiar aggregates of organic molecules. And such aggregates of molecules would constitute the last link between the organic and the inorganic world. Much of this is still hypothetical, but progressing studies on the colloids, ferments, enzymes, viruses and other substances are yielding many suggestions.

(3) Has origin of organic life taken place but once, or has the earth indefinite capacities in this direction?

Are there possibilities of the arising of new classes of organisms and perhaps of new lines of evolution? It would be wrong to deny either of these propositions.

It is impossible to deny a continuous potency of nature to produce from the inorganic the suborganic, and from this the organic. But it is impossible as yet to show this, to prove it.

Sometimes we are confronted with the statement that there can not be any new "creation" for nothing of that sort has ever been witnessed. To this may be replied that a new suborganic or inorganic object would have, under present conditions, practically no chance of surviving. The world throughout is filled with forms that are eager for food. What chance of survival under such conditions would have a new limited generation of beings? That there is a possibility of such a development can not be denied. There may even be felt some apprehension. There might arise new scourges. Perhaps some of the scourges of the past could be explained thus. But even if this happened at this moment, a recognition of the new form as such would be exceedingly difficult.

It is quite probable that the biogenic powers of nature are still potent enough to produce new primordial forms that, if conditions were favorable, could in time develop into recognizable new phyla, but they could prevail only if sufficiently numerous and destructive to overcome already existing interfering forms.

As to whether any new major lines of organic beings may still develop, it seems impossible either to deny or assert. These processes are very gradual and observations of them are very difficult; and belief or disbelief alone count but little.

(4) Does evolution proceed in all organisms, and does it proceed with anything like a definite rate as to time?

All organisms are known to be impressionable. There is no organism that can not be affected by new stimuli or by changes of the old influence that acted upon it. So long as these conditions exist, so long will there be a capacity of further development, a capacity of evolution. It all depends upon the stimuli as to whether an organism will or will not evolve any further.

As to the rate at which organisms evolve, that, it is definitely known, differs greatly. There are organisms such as the medusae, ants, many other insects, some mollusks and still others that are known to have changed but little since the Cambrian, the Devonian or the earlier Tertiary times. On the other hand there are forms, of which man is one of the best examples, that have changed rapidly even since the last ice invasion. The rate of evolution therefore differs widely. There seems some possibility of an explanation of these differences. When an organism,

even man himself, gets fully or nearly fully adapted to its environment, then, until something new happens, some new factors come into play, that organism will simply keep on, like a light that keeps burning evenly. But turn on a greater supply of oxygen or furnish some other suitable stimulus, and the light will flare up with renewed life and activity. The rate of evolution in any given organic line is commensurate with the influences that act upon such line.

(5) Does evolution ever reverse itself?

Here is a problem which does not seem to be difficult to answer. There is no case known in which a fully developed species has reverted to an ancestral species. But single parts, and even whole variants, can and do revert. And a progress in efficiency may be accompanied by simplification of structure. Something of this nature seems, for example, to have happened in the diatoms.

The differentiation in given phyla or organisms is led by what may be termed the chief object of such organisms. The structural parts accommodate themselves to this chief requirement. The accommodation may be partly by growth, partly by simplification. And simplification is effected by degeneration of useless or interfering parts and their eventual elimination. Man is full of examples of all this. The living system does not favor anything that has ceased to be useful, whether it is an indolent human brain or an effete appendix; it weakens, reduces and eventually eliminates in one way or another.

(6) What are the relative rôles of mutation, or sudden jumps in evolution, and of gradual changes?

When de Vries discovered mutations in his Oenotherae, it seemed as if a new principle had been discovered in organic developments. To-day, when looked at more soberly, it is perceived that mutations and the more gradual changes are merely differing steps, differing rates, of the same process, except where mutations may be accidental, as they are time and again due to poisons, rays and mechanical causes.

Mutations, as seen to-day, are not as desirable as more gradual changes. They demand much greater accommodation of the organism to them, which may not always be "healthy" or even possible. A mutation may be of such a nature as to demand a substantial change of the organism. Accommodations to lesser changes are always easier. But mutations are not changes of a distinct order.

(7) In observing general organic evolution, do we perceive in the species, genera, families, orders, kingdoms anything like life cycles?

The life cycle, in its essentials, is a universal attribute of polycellular, if not all, organisms. It is something very fundamental and general. Is it limited to individuals—or does it extend also to the species and higher groups?

Some observers are inclined to see such group life cycles (*e.g.*, in mollusks), and to explain it as in the individual by a progressively diminishing capacity of oxidation.

It is impossible to say as yet anything definite on this point. There are slowly growing indications to the effect that there are in nature factors that act simultaneously on whole groups, whole varieties, whole species, and that such groups behave in unison, as sorts of superindividuals. But all this, as so much of what preceded, is still full of uncertainties and can be decided only by future investigations. We sense that there is something in this direction but can not yet be sure.

(8) The last problem I am able to approach in the time available is one that is essentially human. How far can man hope eventually to control biogeny—biogeny of plants and animals, biogeny of his own genus?

The promise is warm, if not yet glowing. We are gradually learning the ways of nature, and how to use its powers. There is a steady advance also in understanding as to what is and what is not desirable. Nature's chemical and physical laboratories, as well as our own, are ever more effectively at our disposal. Genetics and experimental science are already trying their hands in the biogenic fields, with as yet not large but growing results. When man shall have reached so far in knowledge as clearly to distinguish the right ways, the means to proceed along these will soon follow. With the advance in the scientific knowledge of nature there can be set no limit to man's possibilities. He may confidently be expected to become an enlightened coworker with nature. But this will not be greatly achieved in our nor yet the next generation.

OBITUARY

MEMORIAL TO PROFESSOR EDWARD S. MORSE[1]

FROM a Japanese friend I have notice of an event which may be of interest to the readers of SCIENCE who knew the late Professor Edward S. Morse. The following is in part adapted from the account which appeared in the *Japan Advertiser* early in November.

On the afternoon of Sunday, the third of last November, some two hundred scientists and scholars assembled at the shell-mound near the station at Omori for the ceremony of unveiling a monument in

[1] We learn with regret that the author of this contribution died suddenly on January 28.