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The Hindrance of Evolutionary Terminology to the Teaching of Science

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ABSTRACT

The present methods of teaching about evolution have resulted in a distorted understanding of science. This is reflected in the terminology used to expound supposed evolutionary events. These terms do not describe structure/function observations, but rather implied changes among non-observable progenic relationships. Presented below are representative samplings of the evolutionary terminology which is commonly used in children's, popular, college, and scientific sources.

The teaching of the scientific method and its resultant structure/function terminology is confused because of these evolutionary terms. It is imperative that this be corrected if science is to maintain and even regain its power as an objective investigative tool.

INTRODUCTION

The genesis of scientific terminology is a fascinating subject. Daly states, "it is conservative to estimate that as much as seventy-five per cent of the scientific element is of such origin" (Greek and Latin).[1] German, French and Arabic also make a contribution. This is in contrast to the general English vocabulary, which Daly states is fifty percent Greek and Latin derivation. The difference is due to the obvious attempt in recent times (approximately since the introduction of the scientific method in the 1500-1700's A.D.) by the scientific community to standardise its terminology. With an emphasis on empirical observations and a wealth of new structures to name, Greek and Latin compound words were developed. This has been very useful for scientists of all cultures. Thus, they have a common nomenclature that is independent of fluctuations in their own languages. It is also a structure/function — related terminology, ie., it describes an organ's function and/or its structure.

It must be noted that not all terminology has been systematically derived from such Latin and Greek roots. Indeed, investigators have often named structures after themselves or relatives, localities, or other things. An example is the loop of Henle. This loop is composed of "the straight portion of the proximal tubule, the thin segment, and ascending straight portion of the distal tubule" of the renal nephron.[2] Unfortunately, the name loop of Henle, while it honors Henle who discovered it, does not help the student in learning anatomy. It complicates the situation because he must now learn two terms instead of one, ie., proximal tubule etc. and loop of Henle. While it is important for the student to learn about the history of science, it is probably not advantageous for the learning of science that its terminology be sidetracked by such non-structure/function related terms.

The trend of abandoning structure/function terms has increased in recent times. Some evolutionists have begun to use evolutionary terms instead of the simple structure/function ones. Many of these terms are composed of Latin or Greek compounds, but what they describe is not usually empirically observable, and thus they are not true structure/function terms. This sort of terminology weaves the evolutionary theory (or rather philosophy) with scientific description, therefore misleading the student.

1. STRUCTURE/FUNCTION TERMS VERSUS EVOLUTIONARY TERMS

One great hindrance to the teaching of science is the replacement of terms that describe structure and function relationships with ones that describe supposed evolutionary relationships. This usually requires learning at least double the number of terms (i.e. structure/function and evolutionary) and correlating which terms are used as synonymous with the others. A certain amount of mental gymnastics is also necessary when text authors jump back and forth between the two forms.

Excellent examples of this are available from the field of neuroanatomy.[3,4] In describing the cerebellum, certain parts are referred to as the (1) vestibulocerebellum, (2) spinocerebellum, and (3) pontocerebellum. Not surprisingly, these structure/function terms describe major sources of nerve tracts to these parts of the cerebellum. For example, most neural connections of the vestibulocerebellum are with the vestibular nuclei (located in the medulla). Thus, the term describes conceptually what this area of the cerebellum is associated with. From this association, it can be remembered that the vestibulocerebellum is involved with balance since that is one of the prime functions of the vestibular nuclei.

The evolutionary term for this region is the archecerebellum, implying that it is the 'oldest' part of the cerebellum. Unfortunately, this term reveals nothing to the student about structure/function relationships. Thus the student must memorise that archecerebellum is synonymous with vestibulocerebellum. This difficulty is then compounded as more evolutionary terms are introduced. Paleocerebellum is synonomous with spinocerebellum, and neocerebellum with pontocerebellum, etc.. Since there are no discrete clues as to function or structure in the evolutionary terms, they are easy to confuse. And thus if a student, especially one new to the field, is reading a text that uses both terminologies intermittently, his or her reading speed and comprehension will be greatly impeded.

Some may say that the structure and function of an organ is really only understood by understanding its supposed evolution. This sort of thinking lacks empirical verification. An organ must be taken for what it is and not what it might have been.

Thus, especially for beginning students, scientists and educators should be encouraged to retain structure/function terminology. If certain terms become antiquated by new knowledge, then they should be replaced by revised structure/function terms.

2. MISCONCEPTIONS DUE TO EVOLUTIONARY TERMINOLOGY

Many evolutionary terms promote ideas that are conceptually incorrect. A few of these terms are listed below.

A. Vestigial Organs

This term is derived from the word vestige — "a trace or visible sign left by something vanished or lost."[5] It has been argued by many evolutionists that certain structures are nonfunctional vestiges of the ancestors of an organism. Stanfield stated in 1977, "Probably one of the most dramatic lines of evidence for evolution is seen in vestigial or rudimentary structures . . . The best known is the vermiform" ('wormlike') appendix, . . . In certain other mammals, such as the guinea pig and the horse, the homologue of this organ is a large caecum in which bacterial digestion of food occurs. Presumably the appendix functions similarly in the distant ancestors of humans."[6]

Crucial errors of logic occur in the above statements. It is wrong to assume that somewhat similar structures (so-called homologues) in different organisms should always function similarly, and that apparent lack of that function in one of them implies that it is vestigial. The human appendix has extensive lymphoid tissue and is involved in immunological responses to antigenic challanges. To say that it is a nonfunctional vestige is incorrect, and to compare its function to the guinea pig caecum may simply be inappropriate.

To know whether an organ is a true vestige would require a virtually complete understanding of an organism's functions, which has not been attained for any organism. To the evolutionist who is looking for change in organs and expects some to lose their functions during evolution, vestiges are expected. It would be tempting to classify as vestigial any organ in which an apparent lack of function existed. However, classifying an organ as vestigial based on incomplete information can be misleading and lead to its being regarded as unworthy of further research. Operations have been performed to unnessarily rid people of such tissues. Examples of such mistaken vestigial organs are the tonsils, appendix, and yolk (blood) sac of fetal humans. Each is now known to be important to the human body. The concept of evolutionary vestiges has actually hindered medical practice and, most likely, research as well.

B. Ontogeny Recapitulates Phylogeny

Stansfield states, "This simply means that the embryological development (ontogeny) of an organism repeats (recapitulates) the evolutionary history (phylogeny) of its species. . . . The 'biogenetic law' implies that embryos of higher animals pass through developmental stages comparable to the adult forms of lower animals. The development of gill pouches in a mammalian embryo does not mean that the embryo is an adult fish stage. The gill pouches of mammalian embryos never function in respiration as they do in adult fish. . . . Thus, we cannot expect to find the complete evolutionary history of any species revealed in the developmental sequences that constitute its embryology. . . . Haeckel's 'biogenetic law' is now thoroughly discredited."[7] Moore, in his well known college embryology text states "(The adjective 'branchial' is from the Greek bronchia, meaning 'gill'.) ... A branchial apparatus develops in human embryos, but no gills form.'[8] Both authors agree that human embryos do not form fish-like gills, in the usual sense of the word, yet both use the term gill or its Greek form 'branchial'. Commonly the gill is associated with the fish-like form. Therefore the idea of 'ontogeny recapitulates phylogeny' is promoted, even if unintentionally. This is even more suprising when it is realised that there is a better term for this anatomical region. Moore himself explains, "Because gills do not form in the human embryo, some authors prefer to use the term pharyngeal arch instead of branchial arch, but the term chosen in the *Nomina Embryologica* is the one used in this book."

The anatomically descriptive term pharyngeal (which is derived from the Greek *pharyng,* meaning throat) indicates where the arches are to be found. Thus, it is a helpful term for the student. However, Moore and Stansfield both chose the one with evolutionary overtones (branchial or gill) which has little associative value, and which tends to promote a discredited (even among evolutionists) evolutionary concept. This is an especially confusing situation: to reject a certain evolutionary concept and yet retain the terminology of it.

C. Primitive (lower), Advanced (higher)

Primitive is derived from a root meaning prime or original. Advanced can mean "far on in time or course".[5] When a bacterium is being investigated, can it be called primitive or advanced? In evolutionary terms the answer is yes, but in structure/function terms the answer is no because it is a complex, optimized functioning life form. Bacteria similar to today's organisms are present as fossilised forms. Bacteria replicate rapidly within hours. They have been subjected to experimentally increased mutation rates, and yet they remain in modified forms of what they were — bacteria. One only calls them primitive if a sort of progenic connection is assumed with mammals or other supposedly advanced organisms. This connection cannot be empirically observed, and in fact many observations argue against it, yet the terminology implies that it has been proven. This misleads the student. Other terms can be used when making comparisons between bacteria and mammals, etc., such as unicellular versus multicellular. These are descriptive terms which can help the student.

D. Conserved, Converged, Diverged

Halkerston has stated, "Histones have amino acid sequences conserved for more than an eon (1.2 x 10^9 years)". He says that the histone H4 from a cow or pea differs from each other by only 2 out of 10 residues.[9] What does the word 'conserve' mean? Webster's encyclopaedia defines it as "to keep in a safe or sound state". However, to use 'conserve' in the evolutionary fashion requires the acceptance of two non-empirical assumptions: (1) the cow and pea are related by progeny somehow, and (2) there is a vast age since the supposed divergence of the organisms. A more scientific and empirical way to present this data is to comment that histones in widely different forms of life have structural similarities and, therefore, may have similar functional properties. Further, these functions can be tested.

In like manner the terms converge and diverge are useless as functional terminology. They describe a supposed change with time of the homology or lack of homology between one or more parts of different organisms. The change is non-empirically assumed, and therefore interpretations vary widely concerning whether certain parts supposedly converge or diverge. The terms converge, diverge and conserve all distract the student from the truly scientific objectives which are the structure and function of parts of an individual organism. Comparative studies with other organisms are helpful within the confines of structure and function, but the evolutionary terms are a confusing addition.

E. Phylogeny

This compound Greek word comes from *phyl* (tribe or kind) and gen (originate). Thus, it literally means the origination of a kind. In and of itself it could be used as a proper term. For example, a phylogeny of various dogs is known to begin with wild wolves captured and domestically bred in the middle east several thousand years ago. But, to the evolutionist, this is not what the term means. Ridley says "Phylogenetic classification concentrates on certain kinds of characters which (so zoologists believe) are the best indicators of a phylogenetic relationship. . . . The backbone for instance is thought to be a phylogenetic character in vertebrates: something that each vertebrate has because it has derived it ultimately from a common ancestor."[10] Phylogeny used in this context describes an expected (to the evolutionist) but non-empirically observed event. For example, frogs are assumed to be related by progeny to monkeys even though this sort of transformation has never been observed. When phylogeny is used in the evolutionary context, it traps the uncritical student's mind into thinking that an evolutionary transformation has been observed. If however, phylogeny is used correctly, within the confines of testable science, then one could talk about the phylogeny of dogs, etc.

Terms that could be more accurately used in comparative studies between various kinds of organisms are the words phenotypic and genotypic. Phenotypic comes from the Greek *phen* (show, be seen) and *typ* (type) and refers to visible traits, eg. a frog's webbed feet or green skin. Genotypic is from the Greek gen (originate) and refers to the genetic material passed onto offspring from the parental organisms, that determines the phenotypic traits.

Both of these terms relate to structure/function relationships and can be empirically evaluated. One can then classify organisms, not on untested progenic assumptions, but on observed structure/function attributes. Classification is an area of science that can be tremendously ambiguous if phylogeny is used in the evolutionary sense of the word. For example, to the cladists (one group of evolutionary classifists) the lungfish is probably more closely related (of closer progenic origin) to the cow than the salmon. This is based primarily upon the similarity of breathing apparatus between the two organisms. Evolutionary systematists on the other hand say salmon and lungfish are more closely related, based on overall appearance.[11] How does one know which association is correct? Which attributes should be highlighted to evaluate the association? These sorts of classification schemes are very arbitrary and thus contradictory. This can be confusing to the student. It is also true that a classification scheme based on genotypic and phenotypic traits would involve arbitrary groupings. However, at least these groupings would be based on structure/function characteristics alone rather than on non-observable progenic associations. Because the term phylogeny has been incorrectly used in the past, future use of it might best be avoided. The terms phenotypic and genotypic are more definitive and understandable to the student.

3. REDEFINING OF STANDARDIZED TERMS TO HAVE EVOLUTIONARY IMPLICATIONS

A. Cell differentiation

Cell differentiation is simply "the sum of the processes whereby apparently indifferent cells, tissues, structures attain their adult form and function."[5] Bloom and Fawcett give the example of osteoclasts developing from monocytes, which they state "is a progressive and apparently irreversible specialisation in structure and function."[2] Developmental embryology essentially involves tracing the development of specialised tissues within an organism from the unspecialised tissues, eg., mesenchymal cells. This is cell differentiation. It can be observed, and manipulated, and hypotheses can be formed and tested concerning these sorts of developmental changes. For example, what effect does erythropoietin have on the development (differentiation) of red blood cells? This question can be empirically tested.

In contrast, Junqueira and Carneiro in their college text of histology give a totally different definition of cell differentiation which is based on evolutionary concepts. They state, "During the process of evolution, the cells of metazoan organisms gradually became modified and specialised resulting in increased efficiency of function. Through phylogenetic development, undifferentiated primitive cells exhibiting several functional activities, each with little efficiency, were transformed into a variety of differentiated cells that were collectively able to perform some specific functions with much greater efficiency. This process of cell specialisation is known as cell differentiation."[12]

It is true that an evolutionist might accept this definition, but it involves a fundamental shift in thinking. No longer is cell development confined to a single organism, but comparison is made between cells originating in widely different organisms. Such a comparison is difficult to make. Different organisms have different rates and modes of development. How does one correlate the cellular activities of an earthworm with those of a human being? What does increased or decreased efficiency mean when comparing widely different organisms? Many scientists would agree that ALL forms of life seem to have optimised structures for the functions they perform. Therefore, it would be more scientifically correct to simply state that one cell type in one organism as compared to that in another organism has certain relative rates of activity — nothing in reference to cell differentiation. This draws the student back to asking questions about structure and function, which is much more productive and scientifically accurate than attempting to conjecture about whether certain cells in worms are less efficient than those found in humans.

B. Evolution

Evolution means change. Business policies evolve. People's thinking may evolve. Evolution to describe a variety of changes in biological systems has become a common term. However, it has now been redefined by some into macro and microevolution. Macroevolution implies progenic change between major groups, eg. reptiles to mammals. Microevolution refers to progenic changes within a given group, eg. selective breeding of dogs. Microevolution has been used to replace the term variation. The use of macro and microevolution could be useful as descriptive terms if the two concepts were kept separated.

Unfortunately, microevolution (variation) within cells, dogs, cats, frogs, flies etc. is often written up as supportive of, or even the same process as macroevolution, which has not been proven. For example, Stansfield comments, 'The shifts in mean phenotypic values wrought by directional selection are the kinds of microevolutionary steps that form the core of Darwin's mechanistic theory."[13] Therefore, to avoid confusion between variation or microevolution which is empirically observable and macroevolution which is not; only the terms variation and evolution, or rather macroevolution, should be used. This will help the student to differentiate between observable and non-observable, but supposed, biological change.

C. Adaptation

This word is derived from a Latin or French root that means 'to fit'. As a scientific term it has been used by various scientists to describe the adjustment of various organisms to new environments. For example, the peppered moth is an example of adaptation where either the black or white form predominates under different environmental conditions. Adaptation used in this way reflects variation and is empirically verifiable.

It has also been used in recent times to describe events that are not verifiable — macroevolution. Luther Sunderland, a creationist, comments on this. He says, "Throughout their expositions, evolutionists refer to structures, features, and functions of living organisms as 'adaptations' that are 'adapted' to their present role. For example, they describe a wing as 'adapted' for flight or an eye as 'adapted' to see objects that reflect or emit light . . . What is implied when it is stated that an eye is adapted to see? Obviously, that the eye started as something else and came to be able to see. This sounds powerfully like evolution and, usually, is the intended meaning."[14]

Who has observed the 'adaptation' or development of an eye from an eyeless organ in response to an environmental stimulus? There are no experiments that reveal this type of adaptation. In fact, there are experiments that argue against it. For example, misplaced organs, such as an antenna growing out of a *Drosophila's* (fly) eye socket, are useless and harmful. They occur because of the expression of certain mutations during development. Also, there is little or no empirical evidence for the development of de novo organs.

To use adaptation in the macroevolutionary sense is incorrect. As Sunderland states, "Instead of using 'adaptation' when referring to a structure, capability, function, or purpose, it is better to use one of these latter four terms. For instance, in describing a wing, instead of saying 'A wing is a structure that is adapted for flight,' it is more accurate to say, 'A wing is a structure that provides an organism with the capability of flight.'" Adaptation can be used correctly to describe varied phenotypic and genotypic expression in response to environmental influences within given groups of organisms.

4. EVOLUTION TAUGHT AS FACT AND NOT AS THEORY OR PHILOSOPHY

Fact has been defined by Websters' dictionary as "A thing done in the quality of being actual ... an actual occurrence: event."[5]

Evolution is taught as fact at the children's, popular, college, and scientific level. For example, a children's book states "the first sharks lived more than 400 million years ago — 200 million years before the dinosaurs walked the earth. In fact, the first sharks swarmed in the ocean before animals of any kind walked on land."[15] R. Leakey (an anthropologist who is well known from **National Geographic** magazine articles) has stated, "The theory of evolution is not a theory any more. That's been solved."[16] In a scientific text, C. D. Stiles stated, "Our phylogenetic analysis showed that PDGF (platelet derived growth factor) appeared suddenly or changed suddenly with the first chordates and has been functionally conserved since that time."[17] In these quotes and in most, if not virtually all, evolutionary articles, evolution is NOT treated as a theory but as a given fact, even though it has not been shown to be 'a thing done.' Who has observed PDGF appearing suddenly or changing suddenly with the first chordates? How do we know which chordates appeared first — empirically? Certain non-testable assumptions are being made concerning the transition of one life form into another.

Berne and Levy in their well-known medical physiology text comment, "Mammalian sensory systems are complex combinations of interacting pathways. A great deal of the complexity of these pathways derives from their evolutionary history, and their organisation can more readily be grasped with some understanding of this evolution. Although the details of such an evolutionary history are not known, the general processes can be suggested."[18] (Note — they assume evolution to be true, even though the mechanisms of such macroevolutionary change are unknown.)

Many outstanding scientists have spoken out against teaching evolution as fact, even some evolutionists. Evolution is an explanation, philosophy, paradigm, or model for earth's origins. It is by and large not a testable theory (at least concerning past events). As a model adhered to by some scientists, it is understandable that they would desire to report the meaning of their experiments within the context of evolution. It is just as valid for a scientist to present his data within another model, eg. a creation model. For example, the evolutionist J.V. Hurley has stated, "Inflammation is best considered not as a single process but as a collection of distinct processes, each of which may have evolved for defence against injury ... ,"[19] A creationist could just as validly comment, "Inflammation is best considered not as a single process but as a collection of distinct processes, each of which God may have designed for defence against injury."

If students are taught to rote memorise evolution as fact, this will hinder their ability to think through problems. They need to consider the weaknesses and strengths of evolution, and other origins models like creation, along with basic assumptions made in science.

CONCLUSION

If one accepts the philosophical assumption that science simply involves observing and manipulating our physical surrounds, then its terminology should be descriptive of observable structure/function relationships. Evolutionary terminology describes supposed changes among non-observable progenic relationships rather than structure/function observations. It is therefore a hindrance to the teaching and comprehension of science.

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