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EDITORIAL

Classifying life

Observation and classification are at the heart of science. Biology is a pre-eminent example of a discipline where classification is a central theme, conjuring up visions of Charles Darwin meticulously documenting his observations in the Galapagos islands. Darwin's grand synthesis, of course, stands as one of the most remarkable intellectual achievements of the millennium. Chemistry too is science where cataloguing and classification have been key elements for progress. Mendeleev and his periodic table, the cornerstone of chemistry, are a constant reminder that gathering and sifting through scattered and disparate facts can often provide intuitive insights that herald a revolution. Physicists have generally looked down upon the 'classifiers'. Gathering facts without a clearly defined predetermined purpose, by observation and painful experiment, can be an intellectually sterile exercise. Ernest Rutherford was at his dismissive best when he said that there are two kinds of science – physics and stamp collecting. But, the physicists too have been furtive classifiers, accumulating evidence for an increasing number of subatomic particles whose final purpose will be revealed when we have a 'grand theory of everything'. However, it is in biology, even more than philately that collection and cataloguing assume critical importance. Biodiversity, a common buzzword nowadays, clearly underscores the view that variability of the species is biology's dominant theme.

The remarkable progress of molecular biology over the last few decades, has pushed classical biology to a corner, where taxonomists and microbiologists (who can identify and classify organisms) are rapidly becoming extinct. Gene cloning and manipulation have become so widespread that classicism may be as rare in biology today, as in music or literature. Ironically, the growth of modern techniques of nucleic acid analysis provide a new opportunity for the revival of taxonomy, now clothed in the garb of comparitive genomics. Evolutionary connections between organisms have, in recent years, been traced by molecular relationships, which appear to provide firmer clues to common ancestral origins, than the apparently gross morphological approach of classical biology.

At the heart of biological classification is the imperative to group organisms into classes (families). After all, are we not interested in the relationships between mice, monkeys and men? Biology becomes a great leveller when we consider common origins; imagined evolutionary superiority quickly evaporates when confronted with molecular genealogies. The sharp distinctions between plants and animals are exemplified by the sometimes unbridgeable gap between botany and zoology departments. Microorganisms, generally unseen, occupy a more shadowy position. Fungi, originally studied in botany departments are now thought to be closer to animals than plants. A more universally appealing classification of organisms is based on whether their cells are ennucleated or not, leading to the two kingdoms of eukaryotes and prokaryotes. The latter of course contain the entire world of bacteria. The discovery of bacteria which live in hot sulfur springs at high temperatures in inhospitable environments about twenty years ago – named archaebacteria by Carl Woese – marked a turning point in classification. Woese proposed that the 'tree of life' possessed a third branch, which he christened Archaea. Ever since biological classification has been the centre of major controversy. Is life best described by two or three kingdoms?

Ernst Mayr, arguably one of the most influential figures in comparative biology, has fired the most recent salvo in the battle to decide whether there are 'two empires or three'. In a provocatively written article (*Proc. Natl. Acad. Sci. USA*, 1998, 95, 9720-9723), Mayr examines the systems of ordering in biology and asks – '*What is the objective of classification?*' In Mayr's view, '*a classification is an information storage and retrieval system*', which permits an item to be located with a minimum of effort and loss of time. Librarians who preside over chaotic libraries would do well to note Mayr's dictum that what '*is true for a classification of books in a library*' is true '*for taxa of organisms*'. He

argues that '*one of the basic principles of good classification is the principle of balance, which states that retrieval of information is greatly facilitated if the taxa at a given categorical rank are, as far as possible, of equal size and degree of diversity*'. It is this principle of balance that appears violated in Woese's proposal of a three kingdom classification of life. To Mayr, 175 different archaebacterial groups and approximately 10,000 named eubacteria appear dwarfed by the number of species of eukaryotes; 30 million in his estimation. Insect lovers (and haters) would of course testify that biological diversity is at its best in the insect world – reminding us of Haldane's remark that God loves beetles. Woese's classification of the living world into three major kingdoms was to a great extent based on the small though important part of the genome that archaebacteria share with eukaryotes. But to Mayr, this argument is less than compelling. He points to the fact that this similarity extends to only a tiny fraction of the eukaryotic genome. In Mayr's view, the most wonderful characteristics of the eukaryotic genome include '*not only the genetic program for the nucleus and mitosis, but the capacity for sexual reproduction and meiosis, and ability to produce the wonderful organic diversity represented by jellyfish, butterflies, dinosaurs, hummingbirds, yeasts, giant kelp and giant sequoias*'. How then can we claim that the difference between the two kinds of bacteria (eubacteria and archaebacteria) '*is of the same weight as the difference between prokaryotes and the extraordinary world of eukaryotes*'. Mayr concludes by emphatically asserting that only a '*two empire classification correctly reflects the structure of the living world*'. The intense debate on classification and the growing interest in biodiversity suggests that taxonomy may indeed return to centre stage, even in this molecular age.

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