Two Darwinian enigmas : The nature of species and the nature of life

M.H.V. Van Regenmortel – Biotechnology School of the University of Strasbourg, CNRS, 67400 Illkirch, France

The intellectual revolution generated by Darwin's *On the Origin of Species* published in 1859 caused the overthrow of some of the most basic beliefs of his age. Darwin replaced the belief in the individual creation of unchanging species by the concept that all life descended from a common ancestor and that humans were not separate from the rest of life nor were the special products of a benevolent deity (Mayr 1991). The theory of evolution, based on common descent from a remote ancestor and on the natural selection of accidental variants endowed with a reproductive advantage, became widely accepted as a better explanatory concept than supernatural design by a Creator. Although unrelenting adepts of the creationist credo : "*God did it*" are still found today, for instance in the intelligent design movement, they certainly lack any scientific credibility (Shermer 2006).

Although evolution implies speciation, i.e. changes from one species to another, Darwin never clarified what he meant by species and he took the view that species were only artificial combinations made for convenience. It is remarkable that even today, the nature of species remains a highly controversial issue in biology (Stamos 2003).

According to species nominalism, species are not objectively real but are man-made groupings that exist only in the mind. Only individual organisms and populations of organisms really exist while species are viewed as conceptual tools useful for organizing biological diversity.

According to another view, species are cluster classes where each class is defined by a set of properties, with no property being necessary or sufficient for membership in the class. Some biologists regard a cluster class as an abstract concept while others think of it in terms of what the concept refers to, i.e. its concrete referents namely organisms in the real world of space-time. Some philosophers do not accept that a biological species could be both an abstract idea as well as the set of objects that the idea refers to (i.e. its extension) and they proposed instead that species were "concrete individuals" rather than immutable abstract classes unable to evolve. Various other definitions of the species concept exist and will be discussed (Stamos 2003).

Although Darwin accepted that all organisms on Earth descended from a single origin of life, he never discussed the nature of living organisms. Life is not a material entity, a force, a property but a concept which has as its referents all living systems, past, present and future. All living systems possess the property of being alive and the concept « life » corresponds to the abstract, mental representation of this property. Instead of analyzing the concept « life », it is more interesting to ask what are the characteristics of living organisms that give them the property of being alive.

The class of living agents is a cluster concept defined by a set of properties, some of which can be absent in individual members of the class. These properties are:
1. compositional and structural properties
2. functional properties such as the capacity to grow and develop, reproduce, and repair themselves
3. properties such as metabolism and environmental adaptation that arise from the interaction of the living agent with its environment.

Any agent, in order to be living, must necessarily possess a sufficient subset of this cluster of properties, although it need not possess them all. Living organisms must be distinguished from living agents such as organs like hearts or kidneys which are alive. In addition to having many of the properties of living agents, organisms must also belong to a reproductive lineage characterized by a life cycle. Living organisms must also possess a functional autonomy which allows them to exercise control over themselves and to be at least partly independent from other organisms and environmental influences.

Not all defining properties of organisms must be present simultaneously. For instance, sterile organisms that do not reproduce or plant seeds with a completely dormant metabolism can nevertheless be included in the class of living organisms. The organelles and biochemical constituents of cells (DNA, proteins, lipids etc) are neither living agents nor organisms. Viruses, although they are biological systems, are neither living nor living microorganisms (Van Regenmortel 2008).

References :

Mayr, E. (1993) One Long Argument. Charles Darwin and the Genesis of Modern Evolutionary Thought. Penguin Books, 195 pp.

Shermer, M. (2006) Why Darwin Matters. The Case Against Intelligent Design. Henry Holt, New-York, 199 pp.

Stamos, D.N. (2003) The Species Problem. Lexington Books, Oxford, 380 pp.

Van Regenmortel MH.V. (2008) The Nature of Viruses. In : Encyclopedia of Virology, 3rd edition, Mahy BWJ & Van Regenmortel MHV eds, Elsevier, Oxford, vol 3, pp 398-402.