EMBO reports

correspondence

Comment on "There shall be order"

I admire Carolus Linnaeus and his historic achievements, and therefore read Marta Paterlini's article about the significance of Linnaeus's work for modern molecular biology eagerly (Paterlini, 2007). However, the conclusion that, "the *Linnaean Systema* of giving structure to the living world is as important and relevant today as it was 250 years ago", seemed to be too limited a summary of this great scientist. I would therefore like to add to the praise for Linnaeus by highlighting another aspect of his idea of using the reproductive organs of plants to define biological entities, which modern molecular biologists might also find interesting.

It is correct to say that the 'structure' that Linnaeus's *Systema* gave to the living world was "based on their [plants] reproductive organs". Yet, the association to his five children does not pinpoint the origin of the idea. In fact, Linnaeus invented the 'sexual system'—later published as *Praeludium Sponsaliae Plantarum*—long before he was married, probably before the age of 20. His rationale was the discovery that all living beings come from living beings—*omne vivo ex ovo*—and that eggs and sperm carry the 'essence' of a biological species from generation to generation. Although 'essence' was meant in a strictly philosophical sense—referring to Aristotle's concept of substance and form—it is true that, although stems, leaves and roots die with a plant, its reproductive cells do not; they become the next generation.

If we assume that biological species do not change over time—as Linnaeus and his contemporaries did—it is just a short step to the realization that germ cells have conserved the essence of a species since its creation by God. Having described the matter analytically, Linnaeus wrote in the proverbial: "In Eve's ovary all past, present and future generations were preformed" (Linnaeus, 1746). This idea of immortal cells that survive generations provides a convenient link to modern molecular biology, as we search for our ancestry by sequencing mitochondrial DNA and Y chromosomes. In fact, we believe that the real human Eve lived a few tens of thousands of years ago in Africa, owing to the conservation of her mitochondrial genes.

Historically, Linnaeus was probably the first to link inheritance and the concept of a species; Darwin's model of evolving species would not have been possible without this link. Thus, Linnaeus unknowingly prepared the ground for a theory of evolution—in his later lectures he even doubted that biological species are invariable.

Linnaeus's idea of connecting inheritance and the species concept is also the prerequisite for the Consortium for the Barcode of Life (CBOL) project; it does no more than link species defined by classical means to cytochrome *c* sequences. Although this approach uses the categories—species, genus, class and so on—defined by Linnaeus and his predecessors and successors, the modern concept of a species differs from Linnaeus's understanding; we now work with quantitative distances between species calculated, among other methods, by the degree of sequence similarity. This quantitative concept reveals, for example, that two species of higher plants resemble each other much more closely than two species of fungi. Hence, the term 'species' loses its universal meaning and is no longer a scientific paradigm but rather a pragmatic device. This, I think, is a main difference between a modern species and Linnaeus's concept of the same.

Linnaeus was well aware of such conceptual problems in taxonomy, probably more so than many of us today. He wondered whether we would ever be able to devise a truly natural system. He considered his own system a natural one at the level of species and genus, but did not dare to think that he would come close to a natural system at any higher level. Today, he might have approached this goal by a molecular characterization of taxonomic entities. A 'new Linnaeus' would need the old Linnaeus's outstanding curiosity, memory and intuitive understanding of plants; his feeling for classification, names and naming things; and a profound knowledge of molecular biology to bridge the gap that still exists between traditional and molecular taxonomists.

REFERENCES

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