Species are actual, not virtual

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An alternative view of species, challenging currently held ideas on the issue, has been presented in a recent Points of View paper in this journal (Maze & al., 2005a). I will argue here that this new look at species is not needed, moreover, that it is fundamentally flawed.

The paper by Maze and co-authors that I cited above bears the title "The Virtual Mode: a different look at species". This is not the first presentation of this alternative view: it appeared for the first time in the journal *Biosystems* (Maze & al., 2003). I suppose that the authors repeated their ideas in a condensed form in *Taxon* (Maze & al., 2005a) to inform systematic biologists. These form only part of the audience of the journal where the virtual code (I will explain below why I call this a virtual code and not a mode, as in the Maze & al., 2005a paper) was discussed first. Below, I will first summarise the background and implications of the species as a "virtual code". After that, I will present counter-arguments, which to my view render the Virtual Code Concept invalid.

Why virtual species? — Maze & al. (2003, 2005a) employ amongst others the following arguments to argue that species are "virtual": those that I mention below are, according to me, the most important to their concept.

(1) If a species is viewed within a classificatory framework, as was done traditionally, it is defined according to the properties it has. This view, in which a species is equated with the properties we perceive it to have at present, does not enable one to investigate its changing and historical nature.

(2) Hence, views of species concepts that take into account their evolution and cohesion over time, do a better job of circumscribing species.

(3) However, this approach does not explain which mechanisms lie behind the historical continuity of species as defined in point 2. Species are there understood to be gene pools that have diversified over time (following Handler, 1970: 500). But are genes indeed the agents through which evolutionary changes happen? It seems to be thought that this is so (following Dawkins, 1989). However, Maze & al. (2003) follow rather Polanyi's (1976) way of thinking and therefore assert that genes only define the boundaries within which the real change-inducing agents act.

(4) Processes such as random genetic mutation cannot effectively deal with the demands that a changing environment puts on the evolvable organisms. This trial-and-error mechanism implies a waste of energy and material (Maze & al., 2005a, Taborsky, pers. comm.)

(5) Organisms are generally viewed in two ways: singularity (focus on the individual) and plurality (the aggregations of individuals). Besides that, to explain the processes of continuity in aggregates of individuals, a third "reality" should be recognised. This follows from philosophies of Kant and Aristotle (Maze & al., 2005a). This third, invisible term is the essence of the species that causes its morphology, its continuity over space and time, and makes evolution happen. It is an intangible information system that works like a computer program producing individuals, and persists in time through historical cohesion (Maze & al., 2003, 2005b). This concept of species is termed a virtual code in Maze & al. (2003). For reasons unknown to me Maze & al. (2005a) named this a virtual mode, only to revert back to code in a later paper (Maze & al., 2005b). Any specific virtual code exists within and between all the (groupings of) individuals that form the limits of, and are the embodiment of, a virtual reality called species. In a virtual code, evolution can happen immediately without waste of organic material and time, because the information system can either adapt itself immediately to changing environments, or produce the correct solution from its historical memory (Maze & al., 2003, 2005b).

The authors mentioned above do not only propose a new theory, they have also tested it. I refer the reader for more information to the paper in which they present their results (Maze & al., 2005b); I will describe that work only briefly here. The subjects of their experiment were four species of grasses. Averages of within-group variation in integration of these species were calculated under different models of species (as individuals, as a collection of populations, as a virtual code). The Spearman rank order correlation between within-lineage variation and phyletic variation was the highest when species were viewed as a virtual code.

Why species are not virtual. — I will address all points made in the previous section one by one.

(1) The notion that species are "only" units of a classification has by no means died out; see e.g., Dupré (1999, 2001).

(2) Whether or not species are the units of classification or evolving lineages, let us take the second option as the point where Maze & al. (2003) have gone from next, and discuss whether their arguments against that view of species are valid.

(3) Scientific literature and textbooks of biology and palaeontology are full of examples of evolutionary phenomena that can be explained well within the framework of natural selection and/or random mutation. It goes beyond the scope of this paper to enumerate references here, but I am convinced that a glance in any scientific text will illustrate this point. The notion that mutation and natural selection drive evolution and speciation is also accepted in philosophy (see, e.g., Dennett, 1995). The above shows that, at least here, adherence to Polanyi (1976) is mistaken.

(4) I do not think it is a question whether natural selection and random mutation can deal with the demands of changing environments, but whether they do this effectively, as stated by Maze & al. (2005a). What determines when there is a waste of material and time here? Within a scientific framework, one cannot presuppose that nature has a mind, vision or opinion. Only if it has the aforementioned attributes, nature itself can decide what amounts to waste of material. Even though Darwinian mechanisms lead to "failed" or short-lived experiments, this is not wrong, it is just the way it works. Within a (Neo)-Darwinian framework evolution is a slow process, but unsuccessful new varieties are, to the standards of the long periods of time involved, quickly doomed to extinction, and successful varieties (equally?) quickly expand their territory. Thus, a large amount of organisms all "acting the same way" is no evidence of an invisible code that drives evolution (Maze, pers. comm.). On an evolutionary timescale, then, there is little waste of time and energy.

(5) Hence, Maze & al. provide no evidence that genes do not code what species are, and neither do they disprove that they are an essential factor in determining the continuity and evolution of species. What, then constitutes the third reality, that to Maze & al. is the virtual nature of a species? As mentioned above, this was derived from philosophies of Aristotle and Kant, both of which, as far as I know, contain elements that are no longer recognised. The "third reality" has been discussed within philosophy, but has no application in biology that I know of, and neither has it been observed empirically within that science. It is interesting to note here that Maze & al. (2005b) envisage that reactions to species (having always been known as actual) being treated in a novel, unusual way (as a virtual entity) could be negative. Because of the oddity of their view, it could all too easily be considered an idea from metaphysics or mysticism. Whether that would be a fair comment or not, I do find that virtual species have no sound scientific basis. If species were a virtual code that can evolve immediately, they would be advantageous over actual species evolving in accordance with Neo-Darwinism. Since there is no evidence for this code (see also next paragraph), we can only recognise slow evolution in the sense it is still generally understood.

Even though the above seems to invalidate a virtual view of species at all fronts, it could be argued that Maze & al. (2005b) demonstrated empirically that an invisible reality does operate as a species. However, the results presented in that work are not that robust. Since the virtual species code is invisible, the authors used the proxy of inter-lineage variation to test the existence of this code. The Spearman rank order correlation between within-lineage variation and phyletic variation was the highest when species were viewed as a virtual code, which seems an encouraging result in favour of the virtual code model. However, there is an almost equally strong correlation in inter-lineage variation coefficients between species viewed as a collection of populations and species viewed as virtual codes (Maze & al., 2005b: Table 3). According to Maze & al. (2005b), this is evidence that environment and ontogenetic effects during development can impact the expression of virtual codes. However, one can conclude equally that a Virtual Code Concept "operates" in the same way as species viewed as a collection of populations. If that were true, the virtual code would not add anything to existing knowledge. Maze & al. (2005b) realise that further research is needed to investigate the virtual nature of species. The results they presented so far do not contain robust evidence either for or against their hypothesis. Maze & al.'s (2005b) conclusions were based on nonparametric tests of their data. If they will publish results of parametric tests that correlate well under the virtual code model, this view of species should be reconsidered. I do not expect that test results which can be explained solely by the virtual code model will appear in print, based on the above points in this section.

Why species are actual. — I will not discuss here whether species are units of classification or evolving lineages (or the various sub-concepts thereof). If they are units of classification, species are certainly actual. But what is the nature of species it they are evolving lineages? One cannot hold a lineage in one's hand, but I argue nonetheless that species viewed as lineages are also actual. On the basis of individuals that form a stage in the historic line of the species, and by comparison to extant relatives and to fossil representatives of the same or related lineages, the lineage can be reconstructed and

phylogenetic relationships can be hypothesised. This is historical science. Though we cannot hold the whole lineage in our hands, it can be reconstructed, information about it can be passed to others, and we can physically hold a representative of any lineage. I argue that species in that sense are actual as well.

The above has brought no solution to the "species problem", because I have not argued which of the many views of species is to be the preferred one. That was, however, not my intention here, and this on-going discussion will certainly continue elsewhere. What I want to argue is that the new virtual view of species is not necessary to include further within this discussion. Whatever the correct way of looking at species is, they are not virtual, but actual.

ACKNOWLEDGEMENTS

I thank Jack Maze, Edwina Taborsky and Cy Finnegan for sharing their views and papers with me, and for reading a draft of this paper. I take full responsibility for the views presented here.

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