Letter to the Editor

The Limb Limps: A Response to Eric Scerri

by Thomas Vogt

I do not agree with Scerri's claim that it does not matter whether a scientist is right or wrong. In the next paragraph in his response to my book review (Vogt 2017) he acknowledges that "The new idea, theory, and so on will then be subjected to experimental tests and will either stand or fall" (Scerri 2018). Isn't that judging the theory, model, or experiment right or wrong? Scerri uses a biological analogy of the growth of a new limb and states: "My point is that one would not regard such a development as being right or wrong. What one might say is that if the limb confers an evolutionary advantage to the species then its members will continue to reproduce and flourish." If the role of "the environment in the case of biological growth is now played by the realm of experimentation", as he states then, why not judge such a development and those who created it as right or wrong? Scerri writes: "By denying that a particular scientist is right or wrong I am not denying that science as a whole might have arrived at the best possible description of the world at any particular epoch." We can describe the world today without evoking the experimentally debunked concept of 'cold fusion', but should we 'deny' that the two electrochemists Fleischmann and Pons were wrong? The important self-correcting epistemology of science relies on 'judging the limb' in the light of empirical evidence, logical or mathematical errors. It is dangerous to overburden scientific theories and models with non-empirical, metaphysical ontic biases such as beauty, harmony, simplicity, and in Scerri's case 'organic'.

Scerri claims that I "fully support the standard Kuhnian line" and correctly states that I regard the 'isotope crisis' at the beginning of the 20th century as a scientific revolution. I agree with Brad Wray that changes in science can be both evolutionary *and* revolutionary and invoked the metaphor of 'punctuated equilibrium' in my review. In his review of Scerri's book Brad Wray (2017) also cites the 'isotope crisis' as an example of a revolutionary change of theory:

> Intimately tied with this discovery of the significance of atomic number as key to classifying chemical elements was the discovery of isotopes, variants of the

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> same element that had different atomic weights. Importantly, such 'things' were incompatible with the earlier way of classifying elements. That is, if elements are identified by their atomic weight, then no two samples of the same chemical elements can differ in their atomic weights. So, even though, the process by which various important discoveries that contributed to this change of theory are aptly described as evolutionary in nature, the net result is aptly described as revolutionary.

To emphasize the importance of perspective when judging evolutionary and revolutionary scientific changes, Brad Wray reminds us of Kuhn's allegorical question whether the bend in the road belongs to the road leading up to it or after it. To convey a similar point I had used Bohr's statement that when we understand quantum mechanics our meaning of understanding has also changed. Many revolutionary ideas in science are put forward reluctantly and their impact grows with time as others use them and build the 'road after the bend'. Brad Wray, whom Scerri attempts to enlist for his position on evolutionary epistemology, recently wrote an article in which he unequivocally states that the 'isotope crisis' is "a classic case of a Kuhnian revolution" (Brad 2018).

Despite the fact that both the periodic system and chemical elements are – as Kragh (2000) writes and Scerri re-emphasizes – "conceptually robust chemical entities" and point "to the value of retaining older theoretical notions, at least in a correspondence-like manner and up to a point", a radical redefinition of chemical elements away from Cannizzaro and Dalton's 'same mass' to Moseley, Paneth, Hevesy, and Van den Broek's 'same nuclear charge' qualifier occurred. This new paradigm disbanded with the one-to-one correspondence between atoms and chemical elements and introduced a degree of physical heterogeneity that some chemists (*i.e.* Fajans) at that time resisted since important quantities in thermodynamics such as entropy and specific heat depend on mass. In his article Kragh also recalls the discovery of a monoatomic gas with atomic weight near 39.8 a.u. which resulted in what Kuhn would call initially an 'anomaly' and became an 'incommensurability' as it called for abandoning either the kinetic gas theory or the period table. The 'conceptually robust' periodic table after the isotope crisis now has eight groups and the 'trouble maker' Argon turned into the 'poster child' of the new periodic table and the re-definition of a chemical element. Other 'Kuhnian anomalies' such as the positioning of Te-I and Co-Ni in the periodic table are mentioned in Wray 2017. Scerri's reading of Kragh's article, "So much for the occurrence of Kuhnian gestalt switches or anything of the kind", should be contrasted by his own writing regarding the complications assessing how many elements are missing in the mass-based periodic table (Scerri 2011, p. 80):

> This complication disappeared when the switch was made to using atomic number. Now the gaps between successive elements became perfectly regular, namely one unit of atomic number."

Switch – another *façon de parler* I assume? In conclusion, I agree with Brad Wray (2017) that "there are significant disruptions in science, disruptions that truly warrant being described as revolutionary" and that the reconceptualization of the chemical element was such a scientific revolution despite maintaining "robust chemical concepts". Einstein's reconceptualization of mass in special and general relativity did not get rid of mass conceptually but radically distinguished it from Newton's concept. Therefore I still regard Bohr's statement that as we gain new understanding (and of course not just in quantum mechanics!) our meaning of understanding also changes as a good litmus test for a scientific revolution. We radically changed our chemical vocabulary with the concept of isotopy and did more than merely 'grow a limb'.

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