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Letter

# On the Necessity of Banning the Term “Heavy Metal” from the Scientific Literature

Olivier Pourret 

AGHYLE, UniLaSalle, 60026 Beauvais, France; olivier.pourret@unilasalle.fr; Tel.: +33-3-44-06-89-79

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Many terms are increasingly improperly used by scientists. The term “heavy metal” is increasingly used, especially in multidisciplinary studies. Even if a debate exist as recently outlined by Ali and Khan [1] or Pourret and Bollinger [2], in 1980 Nieboer and Richardson [3] had already proposed the replacement of this nondescript term by biologically and chemically significant classification. Moreover, according to the International Union of Pure and Applied Chemistry, the term “heavy metal” is considered imprecise at best, and meaningless and misleading at worst [4]. The Union discourages the use of this term. Indeed, no standardized definition of this term currently exists. Nevertheless, nothing has really changed: the term is still widely used by part of the scientific community. Taking a journal like *Sustainability* as an illustrative example: 45 articles out of 7849 published that used the term “heavy metal” in their title or keywords were published these last five years (as determined from the mdpi website, using “heavy metal\*” search, data accessed on July 26, 2018), including three review papers. Moreover, three special issues considering the “heavy metal” term in their topic were also proposed.

As a reviewer and now as an editor of *Sustainability*, I have the responsibility to spread the word and this letter is an effective demonstration of why this term should be removed from our vernacular. Among the numerous testimonies I collected and exchanges I experienced with colleagues after the publication of the letter co-written with my colleague Jean-Claude Bollinger [2], and more generally with the scientific community, the major reason for the persistence of the use of the term “heavy metal” is mostly due to the ignorance of Nieboer and Richardson’s proposition [3]. The term “heavy metal” is based on categorization by density (and some metals have a relatively low density, e.g., zinc). It is often used as a group name for metals and metalloids (i.e., arsenic) that are associated with contamination and potential toxicity. However, the assumption that all so-called “heavy metals” and their compounds have relatively high toxicity are not always supported by facts: chromium and its alloys can be used securely in medicine (e.g., prostheses), even though chromate is recognized as a carcinogen [4]. The “heavy metals” list is not clearly defined and often mixes metals and metalloids without clear definition. Eventually, the pejorative connotation of “heavy” associated with the toxicity of metal induces a kind of fear amongst society. Nonetheless, metals are not always toxic and some are in fact essential: a given metal can be essential and toxic, depending on the dosage and exposure levels and the receiving organism/population. Even the presence of some metals at relatively low levels in the environment are needed for life. Take the examples of zinc and cobalt. Zinc is the second-most abundant metal in organisms and close to half the world population is deficient in zinc [5]. Likewise, cobalt is essential in the coenzyme cobalamin (Vitamin B12), acting as a dietary supplement as a factor against pernicious anemia [6].

To be consistent, researchers should only use well-accepted definitions. In the case of “heavy metal”, this term should be replaced by “metal”, “metalloid”, or “trace metal”. As proposed by Chapman [7], this term should only be used for musical terminology (i.e., heavy metal is a genre of rock

music). The best way to describe the studied elements is clearly to name them or consider them as a group of elements (metals or metalloids) [2].

Overall, reserve the term “heavy metal” for music, not for science!

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