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Astrobiology from early-career scientists' perspective

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Abstract: What is astrobiology? Which fields does it comprise and what makes an astrobiologist? Ask five scientists and you may end up with six different definitions. This issue was raised at the first symposium of the European network of Astrobiology Graduates (AbGradE), held last year in Edinburgh, when discussing whether the attendees' fields of study were represented in the astrobiology community.

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Inquiry into life beyond Earth started more than 2000 years ago, and the term 'astrobiology' appeared at the beginning of the last century. However, around the Millennium, there was a '*rebirth of a field*' as mentioned by Cockell (2001). More and more researchers became aware that what they perceived as narrow research topics could be part of the 'astrobiology net' (see also collection of astrobiology review papers in Gee *et al.* 2001). National Aeronautics and Space Administration (NASA) even partnered up with a number of universities to create the National Astrobiology Institute (NAI) in the hope of better defining and exploring this 'broad canvas' of research. Astrobiology has therefore mainly developed in the past 15–20 years (Gee *et al.* 2001; Morrison 2001; Wynn-Williams 2002), and can be seen as a relatively young scientific field. As a consequence, modern astrobiology is a field in its teens and sometimes has to fight to be taken seriously in the adult world of science.

Nevertheless, early-career scientists such as ourselves were 'scientifically' born into an astrobiology world and see it as an established field. '*Astrobiology? That's old news*', some might even say. The founding of an early-career scientists network, AbGradE (Samuels *et al.* 2015), as an addition to the already existing European Astrobiology network EANA (Brack 2005) demonstrates that we are passionate about astrobiology and believe in its potential. Our perspective may differ from that of the pioneers in astrobiology, or from those that separate themselves from the idea of this overarching, interdisciplinary field, where everything comes together. '*Tell me what you study and I tell you what you are – an astrobiologist!*'

At the AbGradE symposium we discussed such questions as: '*What exactly is astrobiology? Which disciplines does it include? Do we really need the field of astrobiology, or rather more specific subfields? And is astrobiology actually the right name for it?*'

The discussion strongly suggested that astrobiology should not be seen as a research field in the classical sense. While astrobiology is classically defined as the study of life in the Universe (Gee *et al.* 2001), '*astrobiology is an application-based name, whereas physics for example is a content-based name*', is tossed in by one participant – they cannot be compared with each other. One may also say: '*Astrobiology is the umbrella of the fields where the actual science comes from*'. But then, does it really make sense to attend astrobiology conferences in addition to the field-specific conferences? Yes, since it is uncommon that '*a planetary mineralogist and an extremophile microbiologist get the chance to talk at a microbiology conference or a planetary science conference*', and these types of interactions are often where astrobiology research breaks new ground.

Thus, astrobiology allows us to put our research into the greater context of the field, and to discuss under its roof with a broad range of scientists. Combining specific disciplines together into one functional science field can lead to a better understanding of an inter-disciplinary problem. For instance, global climate change is an example of astrobiology: a phenomenon in which the whole concept put together is greater than the sum of parts (the different disciplines involved). Also, in some fields, astrobiology can even become the main

driving force for new scientific subfields – as planetary habitability became one of the main focuses in exoplanet research.

Nonetheless, there is a catch. 'Astrobiology' is often used as a buzzword (Lazcano & Hand 2012) – together with 'interdisciplinarity'. Both sell – from public outreach to funding proposals. Almost every funded or proposed space mission now names 'astrobiology', 'life' or 'habitability'. Is this a great success or not? If the word 'astrobiology' appears everywhere – can it still be taken seriously?

Astrobiology is not only an umbrella term, but also a bridge between different fields. It is a concept, but also a community. Does it feel sometimes as if its definition is too broad? Or as if it mainly consists of applied biology and maybe just little more? Changing the name could solve this problem, but would also lead to confusion, as the label 'astrobiology' is now accepted and appreciated within the community.

However, the meaning of 'astrobiology' is still debated. For example, whether astrobiology differed from exobiology is not universally agreed on. Many critics of astrobiology choose to dismiss 'astrobiology' as simply an updated name for '*goods long past their sell-by date*', i.e. 'exobiology' (Gee *et al.* 2001). An AbGradE participant suggested that astrobiology largely encompasses the study of life on Earth (its origin, evolution and repartition) as well as anywhere else in the Universe, whereas terrestrial life is not a focus of exobiology (apart from possible analogues to non-terrestrial life). This view is consistent with the most common definitions of exobiology in the USA, where it is generally considered as biology '*elsewhere in the Universe*' (NASA NAI website) in conformity with its original definition of '*the evolution of life beyond our own planet*' (Lederberg 1960). George G. Simpson for example wrote that exobiology '*has yet to demonstrate that its subject matter exists*' (Simpson 1964).

To understand the origin of the word 'astrobiology', we have to go further back. The term was already used as early as in the 1940s by Lafleur (1941), who is often considered as having coined the term (see for instance NRC 2008). However, in 1935, the term 'astrobiology' was written in a French popular science magazine (Sternfeld 1935), which has been suggested as the first use of the term (Briot 2012). Even earlier, it can be found in a Science-Fiction book published in 1903 (Sweven 1903):

The 1903 use is anecdotal and Sweven did not provide any definition of the term. As far as we know, the first definition was thus given by Sternfeld, who started a paragraph with a sentence that translates as '*the development of both the natural and astronomical sciences has led to birth of a new science whose main objective is to assess the habitability of the other worlds, this science is called* astrobiology'. Later, Lafleur defined it as '*the consideration of life elsewhere than on Earth*'. It is then Wesley Huntress, founder of the NASA Astrobiology program, who made the term popular and introduced it in its modern meanings.

In 1996, the word astrobiology was used for the first time in an agency document as part of the NASA Strategic Plan. Astrobiology then became the 'study of the living universe'. The change between exobiology and astrobiology was the 'inclusion of Earth sciences and life sciences as part of the portfolio' by establishing new synergies between Earth sciences and space sciences or Earth sciences and life sciences that had not occurred in previous Exobiology programmes (Dick & Strick 2004). A large part of astrobiology thus focuses on the only planet we know so far that hosts life. On the other hand, the definition by Catling (2013) sets a bigger role for astronomers and planetary scientists, suggesting that the modern usage of 'astrobiology' puts a stronger emphasis than 'exobiology' to the origin and evolution of planets in the context of life. The definition of astrobiology, therefore, differs further between the different sub-fields.

Despite the fact that the term 'astrobiology' redefined and broadened the previous concept of 'exobiology' (Gee et al. 2001), in some European countries – given the cultural and linguistic diversity – the word 'astrobiology' simply replaced 'exobiology'; in others they are both used interchangeably. One AbGradE participant adds that for him '*exobiology appears more correct when considering habitability and life outside of Earth*', and that the term appears to be taken more seriously than the buzzword astrobiology. There is thus still no universally agreed-upon definition or preference of usage for astro- or exo-biology.

This ambiguity leads to the problem that some of the different subfields (as planetary sciences or pre-biotic chemistry) do not seem to be equally considered as astrobiology-relevant fields compared with more historical subfields (e.g. microbiology). Some scientists are not yet convinced that they are, indeed, astrobiologists, just because they do not work in a laboratory with extremophilic microorganisms. Nevertheless, we would like to emphasize that astrobiology has links to all of the disciplines of natural sciences, and all these fields are interconnected and influence each other. For instance, it would be impossible to try to explain the composition of the Earth's atmosphere without the effects of life on it (e.g. the great oxidation event), or to investigate the origin and evolution of life without understanding the chemical processes and the delivery/availability of the building blocks of life. Astrobiology is defined by its goals, rather than by a limited set of fields.

The development of a truly interconnected, interdisciplinary network of scientists, which fosters the cooperation among different fields, is essential for the progress of astrobiology – but we should also avoid over – and misusing the term.

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References

Brack, A. (2005). Astrobiology in Europe: The European Astrobiology Network Association. *Astrobiology* **5**(5), 576–578.

Briot, D. (2012). A possible first use of the word astrobiology? *Astrobiology* **12**(12), 1154–1156.

Catling, D.C. (2013). *Astrobiology: A Very Short Introduction*. Oxford University Press, Oxford, UK.

Cockell, C.S. (2001). 'Astrobiology' and the ethics of new science. *Interdiscipl. Sci. Rev*. **26**(2), 90–96.

Dick, S.J. & Strick, J.E. (2004). *The Living Universe. NASA and the Development of Astrobiology*. Rutgers University Press, New Brunswick, New Jersey, and London, Chapter 9, Renaissance. From Exobiology to Astrobiology.

Gee, H., Surridge, C. & Allen, L. (eds.) (2001). Astrobiology. *Nature insight* **409**(6823), 1079–1122.

Lafleur, L. (1941). Astrobiology. *Leaflet Astron. Soc. Pac*. **3**, 333.

Lazcano, A. & Hand, K.P. (2012). Astrobiology: frontier or fiction. *Nature* **488**, 160–161.

Lederberg, J. (1960). Exobiology: approaches to life beyond the earth. *Science* **132**, 393–400.

Morrison, D. (2001). The NASA Astrobiology Program. *Astrobiology* **1**(1), 3–13.

NASA NAI WEBSITE. retrieved 21 May 2015 from https://astrobiology.nasa.gov/nai/about/

NRC (2008). National Research Council: *Assessment of the NASA Astrobiology Institute*. National Research Council: Washington, DC: The National Academies Press.

Samuels, T., Noack, L., Verseux, C. & Serrano, P. (2015). A new network for astrobiology in Europe. *Astron. Geophys*. **56**, 2.15–2.17.

Simpson, G.G. (1964). The non-prevalence of humanoids. *Science*. **143** (3608), 769–775.

Sternfeld, A.J. (1935). La vie dans l'Univers, La Nature. *Masson et Cie Eds*. **2956**, 1–12.

Sweven, G. (1903). *Limanora: The Island of Progress*, 1st edn, G.P. Putnam's Sons, New York and London, pp. 309, 320, 684.

Wynn-Williams, D.D. (2002). The International Journal of Astrobiology. *The Int. J. Astrobiol*. **1**(1), 1–2.

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