Response to *Nature* editorial for February 3, 2011.

Highlighting a need for better communication.

Despite the existence of journals such as *Astrobiology* and *The International Journal of Astrobiology*, and ongoing conferences and workshops, scientists commenting on the field of planetary habitability may sometimes reveal perceptions that are some years (occasionally decades!) behind the state of the art. This is perhaps not surprising in an area that draws on the skills of workers from diverse disciplines. It does, however, highlight a need to improve communications between workers in planetary habitability research, with other sections of the scientific community, and, of course, with the public at large.

We respond here to a prominent example of miscommunication, which appeared in an editorial for the prestigious international journal *Nature*. *Nature* editorials are not insignificant in framing the opinions of the scientific community. It is unfortunate that in this instance, the piece from an unnamed editor, and citing no work backing up its conclusions, did not live up to the journal's long-standing reputation for quotable definitive comment, and instead, can only have muddied the waters.

The editorial accompanied a news feature (Reich, E. S. [2011]. Beyond the stars. *Nature* **470** 24-26) which discussed the implications of NASA's *Kepler* project, on which one of us (L. R. Doyle) has been a participating scientist.

The editorial "*Earth 2.0*" alerted readers that "*The hunt is on for a distant planet similar to our own. Astronomers should decide just how similar it needs to be, before the candidates start pouring in.*" The question of what constitutes a truly Earth-like planet is one of the principal areas in which the Ecospheres Project collaborators have been involved, together with colleagues at various institutions. The habitability of planets of red dwarf stars has been a particular focus of our work, since such stars are the most numerous stars in the Galaxy.

The editorial noted the possibility of a rocky planet orbiting in the narrow classic Habitable Zone of a red dwarf star and asked "*Would that be the first Earth-like planet?*" Following a *status quo* which had actually been outgrown by the mid-1990s, it concluded, "*Probably not if, as seems likely, it were to be tidally locked so that one side faced permanently towards the star.*"

After discussion with our colleagues on our 1999 paper, which had re-examined the possibility of habitable conditions on planets in tidal lock around red dwarfs, we submitted an item to *nature*'s *Scientific correspondence* section. The journal declined to publish our piece correcting the editorial, on grounds of limited space and a need to prioritise, but we post the text of our response below to clarify how advances in this area have modified perspectives since the mid-1990s.

M. J. Heath thanks Amy Burles for assistance with condensing an initial draft to a more manageable size.

We provide more detailed discussions about the habitability of planets of M dwarf stars, with full references, in the accompanying sections of our website.

Red Dwarf-Star Habitable Zones More Hopeful.

Re. url: http://www.nature.com/nature/journal/v470/n7332/full/470005a.html

A *Nature* editorial (Feb. 3, 2011) argued that if astronomers set the bar too high for claims of a truly Earth-like planet, then, "*a planet that meets the strict criteria may not emerge at all*" thus "*the Kepler mission would risk being viewed as a failure – which it most certainly is not.*" The same piece, however, dismissed the possibility of habitable planets around M-dwarf stars, the most numerous stars in the galaxy (~75%), because their planets would probably be tidally locked, keeping one face permanently pointed at their parent stars. Ironically, this too sets the bar too high.

Traditionally, it was thought that the atmospheres of tidally locked planets orbiting M-dwarfs would freeze out on their permanently dark hemispheres. However, many studies using both energy balance frameworks[1,2] and three dimensional climate models[3,4,5] have demonstrated that this paradigm is mistaken. We able to clarify[6] that a dark-side ice sheet could be compatible with a vigorous hydrological cycle, and challenged perceptions that the quantity of photosynthetically active radiation in M-dwarf sunlight is too low to sustain significant photosynthetic productivity, or that M-dwarfs' high rate of flare activity would preclude life (see refs 7 and 8 for discussion of flares and atmospheric chemistry). A 2005 NASA-funded workshop on M-star habitability at the SETI Institute adopted positive conclusions in a comprehensive review paper[9]. Subsequent work[10,11] reinforced optimism about photosynthetic production. Other authors[21,13,14] have examined the threat of intense stellar winds sweeping atmospheres from planets which might be expected to have small (or nonexistent) protective magnetic fields because of their low tidally-locked rotation rates, although a more recent study[15] concluded that these dangers had been exaggerated. In summary, a substantial literature shows that the case for habitable planets around M-dwarfs remains open; Nature's editorial was too pessimistic.

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