

## BIROn - Birkbeck Institutional Research Online

Crawford, Ian (2021) Widening perspectives: the intellectual and social benefits of Astrobiology, Big History, and the exploration of space. In: Crawford, Ian (ed.) Expanding Worldviews: Astrobiology, Big History and Cosmic Perspectives. Astrophysics and Space Science Proceedings 58. Springer, pp. 341-365. ISBN 9783030704810.

Downloaded from: <https://eprints.bbk.ac.uk/id/eprint/47491/>

*Usage Guidelines:*

Please refer to usage guidelines at <https://eprints.bbk.ac.uk/policies.html>  
contact [lib-eprints@bbk.ac.uk](mailto:lib-eprints@bbk.ac.uk).

or alternatively

# Widening Perspectives

## The Intellectual and Social Benefits of Astrobiology, Big History, and the Exploration of Space

Ian A. Crawford

[Published as Chapter 18 in “Expanding Worldviews: Astrobiology, Big History and Cosmic Perspectives,” I.A. Crawford (ed.), *Astrophysics and Space Science Proceedings*, 58, pp. 341-365, (2021). Springer, Cham. <https://doi.org/10.1007/978-3-030-70482-7>]

**Abstract** Astrobiology is the field of science devoted to searching for life elsewhere in the Universe. It is inherently interdisciplinary, integrating results from multiple fields of science, and in this respect has strong synergies with 'big history'. I argue that big history and astrobiology are both acting to widen human perspectives in intellectually and socially beneficial directions, especially by enhancing public awareness of cosmic and evolutionary worldviews. I will further argue that these perspectives have important implications for the social and political organisation of humanity, including the eventual political unification of our planet. Astrobiology and big history are also concerned with the future of humanity, and I will argue that this future will be culturally and intellectually enriched if it includes the exploration of the universe around us.

It is only when the different scientific disciplines and the different specialities choose to interact, and only when all cultures and states recognize that they have common interests, that humanity can evolve towards one single co-operative society (Aerts et al. 1994, p. 20)

### 1 Introduction

Astrobiology and ‘big history’ are two relatively new intellectual disciplines, the former focussed on searching for life elsewhere in the universe and the latter on integrating human history with the wider history of the cosmos. Despite some differences in emphasis these two disciplines share much in common, not least their interdisciplinarity and the cosmic and evolutionary perspectives that they both engender. In this chapter I will explore the relationships between astrobiology and big history and argue that both are acting to widen human perspectives in intellectually and socially beneficial directions. These include stimulating the (partial) re-integration of scientific disciplines after a period of extreme specialisation, and the (again partial) breaking down of barriers that exist between the sciences and the humanities. In addition, both disciplines act to enhance public awareness of cosmic and evolutionary perspectives which, I will argue, constitute a strong, if implicit, argument for the

---

Ian A. Crawford  
Department of Earth and Planetary Sciences  
Birkbeck College, University of London  
London, UK  
e-mail: i.crawford@bbk.ac.uk

eventual political unification of humanity. Astrobiology and big history are also concerned with the *future* of humanity, and I will make the case that the future will be culturally and intellectually richer if it includes an ambitious programme of space exploration. Not only will the exploration of space further reinforce socially beneficial cosmic perspectives, but ultimately it may be the only way for human (and post-human) societies to avoid the intellectual stagnation once predicted for the 'End of History'.

## 2 Astrobiology and Big History

The intellectual case for 'big history' was first made by David Christian (1991) and, although still controversial in some quarters, it has now established itself as a distinct academic discipline. The International Big History Association (IBA 2020; see also Rodrigue 2017) adopts the following working definition:

Big History seeks to understand the integrated history of the cosmos, Earth, life and humanity, using the best available evidence and scholarly methods.

This is strikingly similar to a common working definition of the comparably recent discipline of astrobiology (NASA 2020):

Astrobiology is the study of the origins, evolution, distribution, and future of life in the universe. This interdisciplinary field requires a comprehensive, integrated understanding of biological, geological, planetary, and cosmic phenomena.

Although the term "astrobiology" dates from the first half of the twentieth century (Lingam and Loeb 2020)<sup>1</sup>, it is only in the last 25 years or so that it has become firmly established as a scientific discipline, with the appearance of dedicated textbooks, journals, and university courses. The field is inherently interdisciplinary because any serious attempt to understand the prevalence and distribution of life in the universe requires familiarity with, at least, the established scientific disciplines of astronomy, biology, chemistry and geology (as well as established interdisciplinary combinations among these sciences, e.g., astrophysics, biochemistry, evolutionary biology, geochemistry, palaeontology, and planetary science). In order to illustrate the interdisciplinary nature of astrobiology more clearly, Table 1 summarises the syllabus of the undergraduate module "Introduction to Astrobiology" that the author has taught at Birkbeck College, University of London, since 2004.

---

<sup>1</sup> And perhaps earlier – see the discussion by Mukesh Bhatt elsewhere in this volume.

**Table 1** Syllabus of the Birkbeck College Introduction to Astrobiology module (each week comprises three hours of face-to-face teaching; Birkbeck College 2020).

Week	Topic	Most relevant scientific field(s)
1	Origin and distribution of the chemical elements	Astronomy/Astrophysics
2	Conditions in the early Solar System	Astronomy, Planetary science
3	Earliest evidence for life on Earth	Geology, Palaeontology
4	Biological basics	Biology, Biochemistry
5	Pre-biological chemical evolution/Origin of life	Geochemistry, Biology, Biochemistry
6	History of life on Earth	Palaeontology/Evolutionary biology
7	Requirements for life	Biology/Biochemistry/Geochemistry
8	Prospects for life on Mars	Planetary science/Geochemistry/Biology
9	Life elsewhere in the Solar System	Planetary science/Geochemistry/Biology
10	Detection and habitability of exoplanets	Astronomy/Planetary science
11	Search for extraterrestrial intelligence	Astronomy

A glance at Table 1 indicates that approximately half of this undergraduate astrobiology module could equally be described as big history. With the exception of the material covered in Week 4, which is included to ensure that non-biology students are familiar with at least the basics of biological knowledge, the material covered in Weeks 1-6 is all essentially ‘historical’ in nature (albeit invoking a range of scientific disciplines) and is invariably covered in the first few chapters of standard big history texts (e.g. Christian, 2004, 2018; Brown, 2007; Christian et al., 2014; Spier, 2015). The overlap with big history has also been noted from an astrobiology perspective by Dick (2018, pp. 169, 235, 311). Of course, at some point in their respective curricula astrobiology diverges from big history, branching out to search for life elsewhere in the Universe, while big history continues the historical narrative to include the evolution of *Homo sapiens*, human societies and human culture.

The links between astrobiology and big history may be further illustrated by means of a personal anecdote: the first half of the astrobiology syllabus outlined in Table 1 is based on an earlier course entitled “Cosmic Perspectives for World History” that I devised for the City University’s adult education programme in 1994 (see Figure 1). At the time I was unaware of big history as such, although Christian (1991) had already coined the term. However, as Figure 1 reveals, I was partly inspired by Kutter’s (1986) book *The Universe and Life*, which is often identified as a big history precursor (Rodrigue 2017). In retrospect, it is clear that this early ‘Cosmic Perspectives’ course, which in time led to the Birkbeck College undergraduate module in astrobiology, was big history in all but name. This anecdote reinforces observations already made by others that the early years of big history were characterised by individuals and small groups working independently. It seems that by the late 20<sup>th</sup> century big history was an idea whose ‘time had come’, although of course the subject has much deeper roots (see, e.g., Spier 2015; Rodrigue 2017; Katerberg 2018).

## COSMIC PERSPECTIVES FOR WORLD HISTORY

**TUTOR:** Dr Ian Crawford

**4A.05.04** 10 meetings, weekly from Monday 10 October 1994, 6.30-8.30 £36.00

This course will present a short scientific history of the world from the Big Bang to the dawn of civilisation on Planet Earth some 5000 years ago. It is therefore intended to lay a foundation for subsequent studies of world history, and to provide a perspective which is often lacking in such studies. Topics to be covered will include:

- The Big Bang and the Origin of the Universe.
- Stars and the origin of the chemical elements.
- The formation of the solar system and Planet Earth.
- A discussion of what is currently known about the origin of life.
- A summary of biological evolution, with particular reference to the evolution of the vertebrates through the successive stages of fish, amphibians, reptiles and mammals.
- The evolution of Homo Sapiens, and of culture, agriculture and civilisation.

The course will consist of ten lectures, illustrated with the aid of slides and overhead projector notes.

### Recommended Reading

*The Universe and Life*, by G.S. Kutter, Jones & Bartlett (1987).

*Wonderful Life*, by Stephen J. Gould, Penguin (1989).

*Major Events in the History of Life*, by J.W. Schopf, Jones & Bartlett (1992).

### Tutor Information

Dr Ian Crawford is an astronomer in the Department of Physics & Astronomy at University College, London. His research interests are concerned with studies of the great 'clouds' of gas and dust which exist between the stars of our Galaxy, and from which, ultimately, new stars and planets are formed.

Course for Adults, City University, Northampton Square, London EC1V 0HB  
Tel: 071-477 8268

**Figure 1.** The syllabus of a course on "Cosmic Perspectives for World History" taught by the author at the City University, London, in the academic years 1994-95 and 1995-96. Image by the author.

Katerberg (2018) has recently argued that the academic fields closest to big history are deep history (where 'deep' here refers to human pre-history), evolutionary history, and ecological economics. Based on the discussion above, however, I suggest that astrobiology is an even closer match, both in terms of content and perspective (where there is considerable overlap),

but also in the way both disciplines have struggled, eventually successfully, for academic recognition over the last quarter of a century.

More important than the intellectual origins of interdisciplinary subjects like astrobiology and big history, however, is the extent to which they can produce lasting intellectual and societal benefits, to which we now turn.

### 3 Intellectual Benefits of Big History and Astrobiology<sup>2</sup>

The main academic and intellectual benefits of both astrobiology and big history (and related disciplines) arise from their inherent interdisciplinarity. In the case of astrobiology these benefits have already been noted by several authors (e.g., Connell et al. 2000; Race et al. 2012), and mostly result from interactions between scientific disciplines. For example, astrobiology encourages astronomers to work with biologists and geologists in the pursuit of finding life elsewhere in the universe. By producing well-rounded scientists, familiar with multiple aspects of the natural world, astrobiology is therefore helping to re-unify the sciences after a long period of intense specialization. Moreover, by considering questions related to the philosophical and cultural implications of the discovery (or non-discovery) of extraterrestrial life, astrobiology is also stimulating intellectual activity outside the normal scope of the physical sciences, including theoretical work in anthropology, ethics, linguistics, philosophy, and theology (e.g., Bertka 2009; Dick & Lupisella 2009; Race et al. 2012; Dunér et al. 2013; Impey et al. 2013; Vakoch 2013, 2014; Dick 2018; Peters et al. 2018). To this extent, astrobiology is well-suited to help close the gap between science and the humanities identified over sixty years ago by C.P. Snow in his 1959 Rede Lecture at the University of Cambridge (Snow 1963) and more recently by Wilson (1998).<sup>3</sup>

Similar arguments have been advanced for big history, although there are some differences in emphasis (e.g. Christian, this volume). Big history clearly has the potential to stimulate research activity in the natural sciences, on which it relies for much of its historical narrative, but in origin, and perhaps especially in outlook, big history is closer to the humanities than interdisciplinary natural sciences such as astrobiology. To my mind, this strengthens the synergies between them, not least because it means that big history is even better placed to bridge Snow's "two cultures" divide.

The synergies between big history and astrobiology are perhaps most apparent when it comes to interdisciplinary education, and this may indeed prove to be one of the most important legacies of both disciplines. Snow himself explicitly recognized the importance of interdisciplinary education when he returned to the problem of the "two cultures" with *Two Cultures: A Second Look* (Snow 1963; p. 61):

In the conditions of our age, or any age which we can foresee, Renaissance man is not possible. But we can do something. The chief means open to us is education. ... There is no excuse for letting another generation be as vastly ignorant, or as devoid of understanding and sympathy, as we are ourselves.

---

<sup>2</sup> The astrobiology side of this discussion draws on an earlier publication (Crawford 2018a).

<sup>3</sup> Interestingly, in 1992 the cultural anthropologist Ben Finney made exactly this point in the context of the Search for Extraterrestrial Intelligence (SETI), itself an important component of astrobiology, when he asked "could it be that SETI is a project that could help bridge intellectual gulfs within our own species, as well as extraterrestrial ones?" (Finney 1992).

Interestingly, in the same year as Snow's *Second Look* appeared, the astronomer Harlow Shapley also made a powerful plea for interdisciplinary education. Shapley went as far as to characterise the 'vertical' separation of academic disciplines as "education-defeating" (Shapley 1963; p. 134) and proposed that an ideal undergraduate historical curriculum would

present the history of the universe and mankind as deduced from geology, cosmogony, paleontology, anthropology, comparative neurology, political history, and so on. ... wide integration is the essential key (Shapley 1963; pp. 135-6).

In 2009, the art historian Martin Kemp contributed an article in *Nature* to mark the 50th anniversary of Snow's original lecture. He concluded that the main problem was not so much a division between "two monolithic 'cultures' of science and humanities", but the "narrow specialisation of all disciplines." As he put it (Kemp 2009):

It is the perceived need for intense specialization of any kind – in history or physics, in languages or biology – that needs to be tackled. .... What is needed is an education that inculcates a broad mutual understanding of the nature of the various fields of research.

This line of thinking has been taken up by others. For example, in an article stressing the desirability of producing scientifically minded citizens, Erika Offerdahl (2013) observed:

The structure of undergraduate curricula and courses tends to compartmentalize science into discrete disciplines that focus on particular questions rather than an integrated, interdisciplinary way of understanding the world, let alone any discussion of the societal implications of the science.

If nothing else, big history (and related interdisciplinary subjects such as astrobiology) can provide precisely this kind of interdisciplinary education, and do so in a manner that students of all ages find very engaging (e.g., Chaisson 2014; Katerberg 2018; Voros 2018; Bohan, this volume). As Snow (1963, p. 61) himself noted, this will necessitate revising school and university curricula around the world, but the benefits of doing so are likely to be considerable (e.g., Katerberg 2018; Bohan, this volume; Christian, this volume).

## 4 Expanding Worldviews

Transcending the academic, intellectual, and even practical benefits of a broadly-educated citizenry, the *perspectives* provided by astrobiology and big history may result in positive influences over a wide range of societal and political concerns. In an earlier article (Crawford 2018a), I argued that wider public engagement with, and knowledge of, the topics covered by astrobiology (Table 1) would lead to beneficial social and political consequences. Based on the discussion above, it seems clear that these arguments are even stronger in the case of big history, which covers much of the same ground while explicitly articulating an evolutionary perspective rooted in deep time.

The key point relates to the broadening and deepening of worldviews resulting from increased public awareness of cosmic and evolutionary perspectives. Here, I adopt the definition of a worldview given by Diederik Aerts and colleagues in their excellent and important monograph on *World Views: From Fragmentation to Integration* (Aerts et al. 1994; p. 9):

A world view is a system of co-ordinates or a frame of reference in which everything presented to us by our diverse experiences can be placed. It is a symbolic system of representation that allows us to integrate everything we know about the world and ourselves into a global picture, one that illuminates reality as it is presented to us within a certain culture.

Aerts et al. (p. 8) also note that:

World views .... have a strongly motivating and inspiring function. A socially shared view of the whole gives a culture a sense of direction, confidence and self-esteem.

Unfortunately, at present, and in some quarters increasingly, the worldviews of many people are dominated by narrow nationalistic and religious ideologies. Although historically some of these restrictive, and often mutually exclusive, worldviews may have had (local) societal benefits, and a propensity to hold them may have evolved naturally through group selection in humanity's distant past (e.g. Wallace 1871, p. 313; Darwin 1874, p. 64; Wilson and Wilson 2007; Wilson 2012)<sup>4</sup>, they are potentially disastrous at a time of growing global interdependence. Our world faces many global problems (including, but not limited to, proliferation of weapons of mass destruction, climate change, pollution, loss of biodiversity, over exploitation of the 'global commons', and insufficient provision of food, water and sanitation for millions of people) that can only be satisfactorily addressed through concerted global action. However, meaningful global action will be, and is being, impeded by nationalistic and other essentially tribal worldviews, in which a sense of global identity and responsibility is lacking (or even denied). As Kwame Appiah (2006, p. xi) put it in his influential essay on cosmopolitanism:

The challenge, then, is to take minds and hearts formed over long millennia of living in local groups and equip them with ideas and institutions that allow us to live together as the global tribe we have become.

Aerts et al. (1994, p. 5) had already identified global worldview formation to be central to meeting this challenge:

It is our conviction that the time has come to make a conscious effort towards the construction of global world views, in order to overcome this situation of fragmentation. ... It is precisely because we lack such global views of the world that our ability even to start looking for lasting solutions to these problems is limited.

There is therefore a pressing need to find unifying cosmopolitan perspectives that can counter the divisive and exclusionary worldviews of the past. In identifying such unifying worldviews, it will be essential that they are based on factual foundations that everyone can accept, and this is where big history and related disciplines are well-placed to help.

Spier (2016) has argued that big history should not be taken as an all-embracing worldview from which ethical implications can legitimately be drawn. He is undoubtedly correct that normative considerations cannot logically be derived from a factual history of the Universe such as big history seeks to provide. However, this does not mean that big history cannot provide a worldview (or, at least, part of a worldview) in the sense developed by Aerts et al. (1994), and that this worldview, once grasped, will not influence human behaviour. Indeed, the recognition that fact-based universal histories have ethical, and even political, implications has long been a significant motivation for constructing them. For example, in 1844 Robert Chambers published (anonymously) his *Vestiges of the Natural History of Creation*, which is perhaps the first serious attempt to create a science-based (pre-Darwinian) evolutionary history of the Universe and humanity's place within it. Chambers himself certainly saw it as such, writing (p. 388):

---

<sup>4</sup> For a scholarly discussion of the various controversies associated with the concept of group selection, and other evolutionary influences on human behaviour, see Segerstråle (2000).

as far as I am aware [my book] is the first attempt to connect the natural sciences to a history of creation. ... My sincere desire in the composition of the book was to give the true view of the history of nature.

*Vestiges* caused a huge sensation at the time (Secord, 2000), and the following year Chambers felt the need to offer some ‘Explanations’ (Chambers, 1845). In the course of this (p. 184) he explicitly drew the ethical implication that the “new view of nature” articulated in *Vestiges* could contribute to:

establishing the universal brotherhood and social communion of man. And not only this, but it extends the principle of humanity to the other meaner creatures also. Life is everywhere ONE.

This quotation is especially significant because it shows that Chambers was concerned not just with laying a foundation for “the universal brotherhood and social communion of man”, but also his expectation that a proper understanding of cosmic and evolutionary perspectives would have ethical implications for relations with other living things (and to this extent anticipates Peter Singer’s (1981) concept of an ‘expanding circle’ of ethical progress).<sup>5</sup>

The year following the publication of *Vestiges*, Alexander von Humboldt (1845) published his first volume of *Cosmos*, which also combined many different aspects of knowledge into an integrated view of humanity’s place in the universe (albeit without the evolutionary emphasis of *Vestiges*). There is little doubt that Humboldt was fully aware of the unifying societal implications of this perspective because, in the Conclusion to Volume I of *Cosmos* (p. 358), he quotes from one of his brother Wilhelm’s works on language to the effect that:

If we would indicate an idea which, throughout the whole course of history, has ever more and more widely extended its empire ... it is that of establishing our common humanity – of striving to remove the barriers which prejudice and limited views of every kind have erected among men, and to treat all mankind, without reference to religion, nation, or color, as one fraternity, one great community.

This perspective was not lost on at least some of Humboldt’s contemporaries. The American physician and author James Whelpley (1846) noted in his review of *Cosmos* that “the individual is made to feel that he is connected, by the very nature and substance of his body, with every part of the universe”, and drawing the implication (p. 603) that:

If the world is ever to be harmonized it must be through a community of knowledge, for there is no other universal or non-exclusive principle in the nature of man.

It appears that what Whelpley took from *Cosmos* was a sense that humanity might be able to “harmonize” itself socially and politically if it could only agree on a common integrated worldview of the kind Humboldt had developed.

Several twentieth century advocates for what we might today call a ‘big historical’ worldview have likewise drawn attention to the societal benefits of the resulting cosmopolitan perspectives. H.G. Wells’ *The Outline of History*, written in the appalling aftermath of the First

---

<sup>5</sup> *Vestiges* had a major influence on Winwood Reade, another Victorian writer of an evolutionary universal history, *The Martyrdom of Man* (1872), who in turn influenced Wells (see Hesketh 2015). Reade also sensed the ethical and political implications of the evolutionary perspective, arguing that it pointed to a future in which “our enlightened posterity will look back on us who eat oxen and sheep just as we look back upon cannibals” (p. 513) and that “[t]he whole world will be united by the same sentiment which united the primeval clan, and which made its members think, feel and act as one. Men will look upon this star [i.e. planet] as their fatherland” (p.514).

World War, is arguably the foremost example, and Wells (1920, p. v) left no doubt about his reasons for writing it (emphasis in the original):

The need for a common knowledge of the general facts of human history throughout the world has become very evident during the tragic happenings of the last few years .... *There can be no common peace and prosperity without common historical ideas.* Without such ideas to hold them together in harmonious co-operation, with nothing but narrow, selfish, and conflicting nationalist traditions, races and peoples are bound to drift towards conflict and destruction.

These considerations famously led Wells to conclude (p. 608) that “human history becomes more and more a race between education and catastrophe.” He was convinced that every thinking person should do what they can to help win this race, and that finding a common historical perspective was the key (p. 603, emphasis in the original):

The essential task of men of goodwill in all states and countries remains the same, it is an educational task, and its very essence is to bring to the minds of all men everywhere, as a necessary basis for world cooperation, *a new telling and interpretation, a common interpretation of history.*

Other examples of arguments for the societal benefits of big historical/astrobiological perspectives include works by the astronomers Harlow Shapley and Hubert Reeves. Shapley, in particular, dedicated much of his career to popularising the cultural benefits of a cosmic perspective (see Palmeri, 2009) and began the preface of his book *The View from a Distant Star* (Shapley 1963; p. 5) by noting:

Mankind is made of star stuff, ruled by universal laws. The thread of cosmic evolution runs through his history.

The phrase “Mankind is made of star stuff” is often attributed to Carl Sagan but, as far as I am aware, Shapley was the first to use it. He argued that this vast perspective could, indeed *should*, “incite orientating thoughts” (see pp. 38, 93, 161) that would, among other benefits, help “take us through the present and future predicaments” (p. 97) facing humanity.

In his book *The Hour of Our Delight: Cosmic Evolution, Order and Complexity*, Reeves (1991) was similarly motivated by potential societal benefits arising from a knowledge of cosmic evolution and by the hope that the resulting “sense of wonder” would help turn humanity away from violence, conflict, and, especially, nuclear war. Reflecting on the contrast between the wonder of cosmic evolution revealed by modern science, and the often absurd pointlessness of human conflict, he wrote “The awakening of a sense of wonder and delight is the best antidote to absurdity at all levels” (Reeves, 1991; p. 8), and went on to propose that an understanding of cosmic evolution evokes an argument for human solidarity and dignity (p. 185, emphasis in the original):

A new vision of humanity emerges from contemporary scientific knowledge. Though mankind can no longer pretend to be the center of the world, our new position gives us our real dignity. ... we occupy the top level of the pyramid of nature’s organised entities. We reached this level after a gestation period of fifteen billion years, in which all of the cosmic phenomena participated. *All human beings, regardless of their origin, have an equal claim to this dignity.* The respect for human rights implies also an awareness of the importance of every individual in the history of the universe.

Perhaps the clearest recent enunciation of why the perspectives provided by big history and related disciplines have the potential to help unite humanity was made by the biologist Ursula Goodenough in her 1998 book *The Sacred Depths of Nature* (p. xvi):

Any global tradition needs to begin with a shared worldview: a culture-independent, globally accepted consensus as to how things are. ... our scientific account of nature, an account that can be called The Epic of Evolution. ... this is the story, the one story, that has the potential to unite us, because it happens to be true.

Although the title of Goodenough's book suggests a theistic outlook, her actual perspective is one of 'religious naturalism' which combines a naturalistic worldview with emotional and ethical perspectives normally associated with religion (e.g., Hogue 2010). It seems important to recognize that if the 'Epic of Evolution' (aka big history) is perceived to be consistent with at least some religious worldviews that may aid its wider acceptance, although big history itself is probably better seen as a secular 'origin story' anchored in scientific knowledge (e.g., Christian 2018).

## 5 Geopolitical Implications

The importance of developing a planetary perspective as a prerequisite for effectively tackling planetary-scale problems has long been recognized in the professional international relations community (e.g. Morgenthau 1948; Herz 1962; Ward 1966). The potential role of big history in developing this perspective, with geopolitical implications, has recently been noted by Jo Leinen and Andreas Bummel (2018) in their book *A World Parliament: Governance and Democracy in the 21st Century* (p.361):

Big history provides an account of the origin of all existence and of life on Earth on a strictly scientific basis. The cosmological worldview thus helps us on the path to an integral consciousness and creates an important frame of reference for planetary identity.

The need for such a perspective is also developed in the *Planet Politics Manifesto* advanced by Anthony Burke and colleagues (2016). They argue that the existing, state-centric, political organisation of the world is "failing the reality of the planet", and seek to reorientate the study of international relations to answer the question "Can we match the planet with our politics?" They conclude that:

Our fundamental image of the world must be revolutionised. Our existence is neither international nor global, but planetary. Our anthropocentric, state-centric, and capital-centric image of international relations and world politics is fundamentally wrong; it perpetuates the wrong reality, the wrong commitments and purposes, the wrong 'world-picture'.

Importantly, they stress that in order to make progress "we don't need more reports or policy debates. We need new practices, new ideas, stories and myths." By providing a common, scientifically robust, "origin story" (or, viewed another way, a "myth" describing humanity's place in the universe that is as true as modern science can make it), big history and related disciplines can help satisfy the last two of Burke et. al.'s prerequisites for progress, while in parallel stimulating interdisciplinary advances in the first two.

It is interesting to consider the potential longer-term political implications of a "planetary identity" engendered (in part) by big history. Spier (2015) has drawn attention to the fact that academic history in its modern form emerged in the 19<sup>th</sup> century, largely to support the formation and consolidation of nation-states, and that this nationalistic imperative has led to the downplaying of integrated human, or universal, histories. This then leads him (Spier 2015, p. 12) to make the following observation:

the study of human history as a whole has only rarely been practiced up to the present. This remarkable situation may be linked to the fact that to do so would produce global identities, which are not directly associated with any presently viable state society.

This raises the question, already alluded to in the title of Leinen and Bummel's book quoted above, of whether the creation of "global identities" through the promulgation of big history and related perspectives could help in the development of global political institutions above the level of the nation-state. Both Wells and Shapley were convinced of this, and both devoted chapters of their books to making the case for world government. Moreover, although authors like Wells and Shapley might easily be dismissed as overly idealistic and lacking in professional expertise in the field of international relations, essentially the same conclusion was reached by such leading 'realist' international relations scholars as Hans Morgenthau (1948) and John Herz (1962). Daniel Deudney (2018a) has recently summarised Morgenthau's position as follows: "humanity thus faces a tragic impasse: it needs a world state for security, but lacks a sufficiently thick sense of common identity both to make it possible and to prevent it from being threatening." Morgenthau himself (1948, p. 419) appears to have viewed this as a challenge to be overcome:

If the world state is unattainable in our world, yet indispensable for the survival of that world, it is necessary to create the conditions under which it will not be impossible from the outset to establish a world state.

Morgenthau saw the way forward through international diplomacy, but was clearly aware that developing a sense of common identity would be a prerequisite for success, just as "the community of the American people antedated the American state ... a world community must antedate a world state" (Morgenthau 1948, p. 406).

This is not the place to reiterate all the arguments for or against the creation of a world government, or the various forms such a government might take. There is a large literature on this topic to which the interested reader can refer (e.g., Kant 1795; Russell 1916; Laski 1925; Reves 1946; Toynbee 1972; Kerr 1990; Hamer 1998; Wendt 2003, 2015; Yunker 2007, 2018; Cabrera 2011; Leinen and Bummel 2018; Lu 2018), and comprehensive historical overviews of world government proposals have been provided by Wynner and Lloyd (1944), Heater (1996), and Baratta (2004). My own view (e.g. Crawford 2015, pp. 206-209) is that a federal world government, implementing the principle of subsidiarity on a global scale, would be the most appropriate institutional response to tackling the many planetary-scale problems that human civilisation will face in the 21st century. That said, I find myself in agreement with Morgenthau and others that such geopolitical developments, while desirable, may be impractical until humanity develops a greater sense of its common identity, what Herz (1962, p. 317) termed a "planetary mind", Anderson (1991, p. 6) a sense of "imagined community", and Ward (1966, p. 148) "a patriotism for the world itself".<sup>6</sup>

It seems to me that the temporal and evolutionary perspectives provided by big history and astrobiology, combined with the spatial ('cosmic') perspectives provided by the exploration of space (discussed below), will play a valuable, and perhaps essential, role in forging the common

---

<sup>6</sup> Barbara Ward's slim book "Spaceship Earth" (1966), based on her George P. Pegram lectures at Columbia University, contains much of interest to the present discussion; of particular importance is her insistence on the need to build global institutions for planetary management.

human identity likely to be a prerequisite for the evolution of a future world government (see also Crawford 2018b; Leinen and Bummel 2018, pp. 351-365; Deudney 2018b; Som 2019<sup>7</sup>).

## 6 Space Exploration: Augmenting the Cosmic Perspective

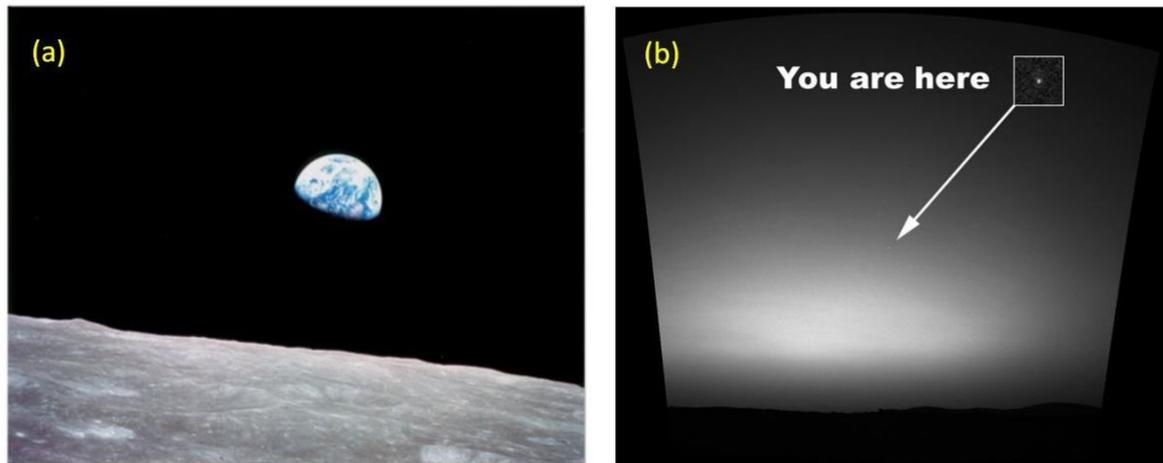
Big history and astrobiology are both concerned with the *future* of humanity as well as the past, and, barring some unforeseen calamity, it seems likely that the exploration of space will be a part of this future. Certainly, if some of the more ambitious aspirations to make humanity a multi-planet species are realised, space exploration and development could become a very large part of the human (and post-human) future. Even if these aspirations are never fully realised, it seems likely that we will continue to explore our Solar System with robotic space probes, and probably also with astronauts. In this section I will therefore briefly examine the synergies, as I see them, between astrobiology, big history, and the exploration of space. Of course, space exploration is already an important component of astrobiology, because space probes are required to search for life on other planets, and discoveries made by space probes and space telescopes also inform big history. However, beyond these essentially practical synergies, I contend that important socio-political benefits will also result from an ambitious programme of space exploration, and that these will reinforce the societal benefits of big history and astrobiology discussed above.

Most importantly, space exploration provides a *spatial* perspective on human affairs which complements the temporal and evolutionary perspectives of big history. Any society that is rigorously exploring the Solar System, can hardly fail to be aware that Earth is a very small planet when viewed in its cosmic setting (Figure 2). The social, cultural and psychological importance of this perspective has been noted by multiple authors (e.g. Clarke 1946, 1951a; Hoyle 1950; Ward 1966; Sagan 1994; Poole 2008; White 2014; Deudney 2018b; Som 2019). For example, even before any images of Earth from space had been obtained, the astronomer Fred Hoyle (1950, p. 9) wrote that:

Once a photograph of the Earth, taken from the outside, is available, we shall, in an emotional sense, acquire an additional dimension ... once let the sheer isolation of the Earth becomes plain to every man, whatever his nationality or creed, and a new idea as powerful as any in history will be let loose.

---

<sup>7</sup> I should stress that Som (2019) does not discuss the concept of world government, and indeed the tenor of his article seems opposed to such institutional innovations. Rather, he argues that cosmic perspectives can help cement a common human identity, and that this will enhance the survival chances of human civilisation without the need to develop new institutions. My own view is closer to that of Ward (1966) in that I think a common human identity, in part induced by the cosmic perspective, will prove to be of practical value by providing the psychological foundations on which global institutions may be built.



**Figure 2** The cosmic perspective: (a) Earthrise over the lunar surface, photographed by the crew of Apollo 8 in December 1968. (b) The Earth photographed from the surface of Mars by the Mars Exploration Rover Spirit in March 2004. Such images powerfully reinforce a ‘cosmic perspective’ that can have a unifying influence on human affairs. Images courtesy of NASA.

There is certainly persuasive evidence that images of the Earth from space have raised environmental awareness, and thus contributed to popular movements for the reduction of pollution and the preservation of biodiversity (e.g., Zimmerman, 1998; Poole, 2008; Henry and Taylor 2009; Spier 2019). For example, Zimmerman (1998, p. 275) reproduces a diagram from Balzhiser (1990) which shows a dramatic growth in US environmental legislation in the late 1960s, and while not proving a causal link to images of the Earth from space the timing is suggestive. Spier (2019) has drawn attention to the differences in cultural impact of the original Apollo 8 ‘Earthrise’ image (Fig. 1(a) above) in the United States and Europe, and argues that although the immediate impact, especially outside of the US, may not have been as great as is often assumed, its legacy has proved lasting and influential. It is true that the cosmic perspective of ‘Spaceship Earth’ (Ward 1966; Fuller 1969) has yet to trigger a sufficiently strong global response to solve our environmental problems, but raising awareness of their planetary scale is nevertheless an important contribution of space exploration and a prerequisite for political action.

Similar observations can be made regarding the geopolitical implications of the cosmic perspective. Even before the space age, the science fiction author and space visionary Arthur C. Clarke (1946, p. 72) had noted that:

It is not easy to see how the more extreme forms of nationalism can long survive when men begin to see the Earth in its true perspective as a single small globe among the stars.

Hoyle (1950, p. 9) echoed this sentiment a few years later, when he noted that this new perspective “must increasingly have the effect of exposing the futility of nationalistic strife.” By the 1960s, when images of the Earth from space had been obtained, the implications were not lost on at least some professional diplomats. For example, Adlai Stevenson, then US Ambassador to the United Nations, expressed his view that “we can never again be a squabbling band of nations before the awful majesty of outer space” (Stevenson 1965).

More recently, Deudney (2018b, pp. 273-4) has argued that images of the Earth from space have led to widening recognition of a “practical geography of Planetary Earth” where “the Earth

as a whole is now a place” and that this “type of Earth-place sensibility amounts to a kind of Earth nationalism”.<sup>8</sup> Deudney (p. 257) sees this shift in perspective as being helpful for what he terms “the ‘terrapolitan project,’ the project of building a polity suited to the ... circumstances of the Earth as a place”, a place with multiple common interests and facing a wide range of existential threats.

This perspective is, understandably, much more visceral for people who have actually seen our planet from outside (White 2014), and it is worth quoting one such observation here:

You look down there and you can't imagine how many borders and boundaries you cross, again and again and again, and you don't even see them. There you are – hundreds of people in the Mid-East killing each other over some imaginary line that you're not even aware of .... And from where you see it the thing is a whole, and it's so beautiful. You wish you could take one in each hand, one from each side in the various conflicts, and say, 'Look. Look at it from this perspective....' (Schweickart 1977).

It has to be admitted, as Deudney (2020) has pointed out (see also Dark 2007; Bjørnvig 2013, and Schwartz 2020), that to-date the cosmic perspective provided by space exploration has had little practical effect on the worst manifestations of human tribalism. Still, as space exploration proceeds more people will be exposed to this perspective, both in person and vicariously, and the more it is likely to diffuse through society.<sup>9</sup> Such an enlargement of perspective may be expected to strengthen the sense of planetary identity inherent in big historical and astrobiological worldviews (see also the discussion by Som 2019). Indeed, images of Earth from space, and especially personal experiences of this perspective, are likely to be even more effective in this regard because they prompt an instinctive, emotional, appreciation of ‘one worldness’ that the more intellectual perspectives provided by big history, astrobiology, and related academic disciplines cannot. We may hope that this perspective will gradually gnaw at the minds of political leaders (as it clearly did for Adlai Stevenson), and the minds of the wider public, until it leads to the emotional realisation that human activities affecting the planet as a whole need, and *ought*, to be organised collectively (e.g., Crawford 2017). Only space exploration can provide this perspective, which has led White (2014, p. 102) to argue that:

It is time for the influence of space exploration on human consciousness to be seen as a legitimate justification for investing in it.

## 7 Cultural Benefits of Space Exploration

In addition to providing a valuable, and uniquely compelling, spatial perspective on human existence, an ambitious future programme of space exploration will also result in a range of additional social and cultural benefits. Leaving aside the strictly scientific benefits, to which

---

<sup>8</sup> Compare with Barbara Ward's (1966) concept of “a patriotism for the world itself.” Deudney (2018b, p. 257) draws the political conclusion that managing the common interests of “Earth as a place” will “almost certainly require the erection of some version of substantial world government.”

<sup>9</sup> Schwartz (2020, p. 141) is concerned that what White (2014) terms the “overview effect” is based on anecdotal reports of astronauts and has not been tested in a controlled manner. Such experimental tests would be desirable and may be possible using virtual reality (see the chapters by Annahita Nezami et al. and Daniela de Paulis and Frank White elsewhere in this volume). Despite his scepticism on this point, Schwartz nevertheless notes “that does not mean we are wrong to suspect that the experience of the space environment will alter our beliefs and values in important ways.” Bjørnvig's (2013) criticism is based largely on what he sees as an overly ‘religious’ element to some aspects of White's conception of the “overview effect”; he doesn't present any evidence against its validity as a psychological phenomenon.

the whole history of space exploration can attest, I think we can also identify potential cultural benefits of space exploration under the broad headings of ‘art’, ‘philosophy’, and, albeit in the more distant future, ‘diversity’. As argued in earlier publications (e.g., Crawford 1993, 2014), which I summarise here, these wider aspects of space activities may even help prevent the future stagnation of human civilisation.

### **7.1 Art**

William McLaughlin (1993) considered the potential impact of space exploration on the fine arts and concluded that the influence is likely to be considerable. At one level it seems obvious that new space scenes, and novel space events and experiences, must inspire new works of space art. It is difficult to see how this could be otherwise. However, the potential long-term artistic impact of space exploration is likely to be more profound owing to the increasing dominance of the cosmic perspective on human thought. Not only will it be necessary to find ways of portraying and communicating human (and human-derived) values in the face of a universe whose strangeness will likely become ever more apparent as exploration proceeds, but the human (and post-human) mind is itself likely to become increasingly ‘cosmized’ (Finney 1988) in a way that can hardly fail to be reflected in artistic and cultural evolution. Indeed, Clarke (1951b) anticipated this in a fictional work published before the dawn of the space age, suggesting, from the perspective of the far future, that:

space travel was one of the best things that ever happened to art. Travel, exploration, contact with other cultures – that’s the great stimulus for all intellectual activity.

Twenty years later, once space exploration was a reality, the American literary scholar Joseph Campbell (1972, p. 233) made a similar point:

For although our voyage is to be outward, it is also to be inward, to the sources of all great acts, which are not out there, but in here, in us all, where the muses dwell.

And, further (p. 236):

All the old bindings are broken. Cosmological centers now are any- and everywhere...all poetry now is archaic that fails to match the wonder of this view.

### **7.2 Philosophy**

If anything, the stimulus that space exploration will provide for the philosophical disciplines may be even more profound. In Table 2, I summarise some philosophical issues that are likely to be stimulated as humanity (and post-humanity) moves out into the Solar System, and perhaps beyond. I have made a distinction between natural, moral and political philosophy, but we must also expect that the vast and mysterious universe in which we live very likely contains the seeds of entirely new fields of philosophical investigation waiting to be discovered.

**Table 2** Some philosophical issues that are likely to arise as space exploration proceeds.

Natural Philosophy	Moral and Ethical Philosophy <sup>a</sup>	Political Philosophy
How secure is our basic physical understanding of the universe?	Extension of environmental ethics to other planets	Consideration of the ownership of extraterrestrial resources
Can we define ‘life’ in a cosmic context? Is this even important?	What are the moral and ethical relationships between humanity and extraterrestrial life (should any be encountered)?	Consideration of appropriate forms of planetary and interplanetary governance
If life can be defined, how common is it in the universe? What are the ultimate constraints on the origin of life and its distribution?	What are the ethical implications of spreading Earth-life through the Solar System and the Galaxy?	Consideration of political relationships with advanced extraterrestrial societies (if any); what limits would <i>biological</i> differences place on developing political institutions?

<sup>a</sup> For a more detailed discussion on specifically ethical philosophical issues related to astrobiology and space exploration, see, e.g., Green (2014), Randolph and McKay (2014), and Vidal (2014, Ch. 10).

### 7.3 Diversity

In the longer term, one of the most important socio-cultural contributions of space exploration may be the opportunities it will provide for increasing human (and post-human) cultural diversity. This will be especially true if colonisation of other locations in the Solar System, or even beyond, proves possible<sup>10</sup>. In the nineteenth century, John Stuart Mill drew attention to the benefits of what he termed different “experiments of living” (Mill 1859, p. 120), but such experiments are becoming increasingly difficult in today’s globalizing world. The idea that the expansion of humanity beyond Earth might help in maintaining, and expanding, cultural diversity was actually proposed a decade before the dawn of the space age by the philosopher Olaf Stapledon (1948) when he expressed the view that:

The goal for the solar system would seem to be that it should become an interplanetary community of very diverse worlds each inhabited by its appropriate race of intelligent beings, its characteristic “humanity” ... Through the pooling of this wealth of experience, through this ‘commonwealth of worlds’ new levels of mental and spiritual development should become possible, levels at present quite inconceivable to man.<sup>11</sup>

---

<sup>10</sup> The term ‘colonisation’ is sometimes felt to be problematic due to its historical ties to European imperialism and exploitation (I am grateful to Lewis Dartnell for this observation). These concerns have much less force when applied to prospective human colonisation of lifeless extraterrestrial environments, but may still stimulate philosophical discussion (see Section 7.2). Of course, any attempt by humanity (or post-humanity) to colonise locations where indigenous life already exists would raise enormous ethical concerns, not least because it would violate the ‘Cosmic Golden Rule’ proposed by Randolph and McKay (2014).

<sup>11</sup> Much of Stapledon’s thought is relevant to big historical and astrobiological perspectives, and I recommend especially his science fiction novel *Star Maker* (Stapledon 1937); for a more detailed discussion of Stapledon’s ideas in the context of space exploration, see Crawford (2012).

#### 7.4 Avoiding the 'End of History'

Thirty years ago, the American political philosopher Francis Fukuyama (1989, 1992) argued that increasing global political and cultural homogenization may lead to political and cultural stagnation. Following Hegel (1832), Fukuyama infamously termed this perceived endpoint in human cultural evolution the 'End of History'. Subsequent events suggest that this process is proceeding more slowly than Fukuyama perhaps envisaged, but some of the trends he identified seem likely to continue. Although, as I have argued above (Section 5), increasing *political* unification of humanity is positively desirable, Fukuyama's concerns regarding cultural stagnation in a politically unifying world do need to be taken seriously. He was especially concerned that:

The end of history will be a very sad time. The struggle for recognition, the willingness to risk one's life for a purely abstract goal, the worldwide ideological struggle that called forth daring, courage, imagination, and idealism, will be replaced by economic calculation, the endless solving of technical problems, environmental concerns, and the satisfaction of sophisticated consumer demands. In the post-historical period, there will be neither art nor philosophy, just the perpetual caretaking of the museum of human history (Fukuyama 1989, p. 18).

It seems clear that, if we are to avoid this rather dismal view of humanity's future, we will need to find new sources of cultural and intellectual stimuli, and space exploration may be one of the few options left open to us. Indeed, the possibility that an ambitious programme of space exploration could help prevent just this kind of cultural and intellectual stagnation was recognized by Clarke (1946, p. 72) when he wrote:

Interplanetary travel is the only form of 'conquest and empire' now compatible with civilisation. Without it, the human mind, compelled to circle forever in its planetary goldfish bowl, must eventually stagnate.

Human expansion into the Solar System, and eventually beyond, will certainly present a vast new field of human activity, with literally infinite potential for discovery and intellectual stimulation on multiple levels. As Dunér (2013, p. 13) has argued more recently:

Encounters with the unknown outer space will ... change our thinking, conceptions, categories, belief systems, culture and meanings of things. What we have come to believe so far through science and human cognition will face anomalies. The old categories, systems, and beliefs will fall short when we try to understand these new unfamiliar things. Our thinking, science, and belief systems will then have to be revised.

For these reasons, as White (2014, p. 84) succinctly puts it, "a society firmly committed to space exploration would find it difficult to stagnate."

Whichever way one views it, there seems little doubt that a future in which space exploration plays a significant role will provide a far richer range of cultural and intellectual stimulation than we could ever hope to experience if we never leave our home planet. Sagan (1994, p. 285) perhaps expressed it as well as anyone:

We're the kind of species that needs a frontier – for fundamental biological reasons. Every time humanity stretches itself and turns a new corner, it receives a jolt of productive vitality that can carry it for centuries.

In the long run, the exploration of space may help us avoid Fukuyama's 'End of History' by keeping history *open* while simultaneously helping to unite human cultures on Earth. That said, the exploration and colonisation of space will also create additional risks: we don't want to unite the Earth only to live in a politically anarchic Solar System where colossal energies would

be available to anyone (or anything) minded to use them destructively (e.g., Baxter and Crawford 2015; Deudney 2016, 2020). For this reason, care will have to be given to developing appropriate interplanetary institutions able to mitigate these risks (Crawford 2015). Fortunately, as argued in Sections 5 and 6, the cosmic and evolutionary perspectives provided by astrobiology, big history, and space exploration itself, may help lay the psychological foundations on which such institutions could be built.

## 8 Conclusions

The twin, and closely related, academic disciplines of big history and astrobiology have the potential to yield a wide range of social and intellectual benefits. Indeed, intellectual enrichment is already resulting from the interdisciplinary research agendas of both astrobiology and big history, which involve scholars from a wide range of sciences and the humanities working closely together. More importantly, both disciplines rely on, and naturally engender, cosmic and evolutionary perspectives which, I argue, ought to form part of the worldview of every educated person (see also Elise Bohan's chapter in this volume).

By powerfully reinforcing the fact that all human beings, and all human societies, exist on the same small planet, and are related by a common evolutionary history, I have argued that cosmic and evolutionary perspectives strengthen intellectual and emotional arguments for the eventual political unification of humanity. My own view is that a federal world government would be an appropriate institutional framework for a united humanity, and that a world government of some kind may be necessary if serious global problems are to be properly managed. However, such a political outcome is only likely to become realistic if humanity develops a greater sense of its common identity, what Barbara Ward (1966, p. 148) called "a patriotism for the world itself." The perspectives provided by big history, astrobiology and space exploration can all help achieve this objective. That said, I also agree with Fukuyama (1989) that a politically homogenised world may lack sufficient sources of intellectual stimulation to maintain a vibrant culture, and I have argued that an ambitious programme of space exploration would help in this respect. Needless-to-say, the exploration of space will also yield new knowledge about the universe, informing both the science of astrobiology and the ever-evolving big historical worldview.

**Acknowledgements** An earlier version of this chapter was originally published in the *Journal of Big History*, Vol. III(3), pp. 205-224, 2019. I am grateful to the Editor of JBH, Dr Lowell Gustafson, for permission to reproduce large sections of that article here. The earlier version was drafted while I held a Visiting Fellowship at the Humanities Research Centre at the Australian National University in 2018 and I thank the HRC, especially Professor Will Christie and Ms Penny Brew, for their hospitality during my stay. I am grateful to Lewis Dartnell for comments on this version that have improved it.

## References

- Aerts, D., Apostel, L., de Moor, B., Hellemans, S., Maex, E., Van Belle, H., Van der Veken, J.: *World Views: From Fragmentation to Integration*. VUB Press, Brussels.  
<http://www.vub.ac.be/CLEA/pub/books/worldviews.pdf> (1994). Accessed 1 July 2020
- Anderson, B.: *Imagined Communities*. Revised edition, Verso, London (1991)
- Appiah, K.A.: *Cosmopolitanism: Ethics in a World of Strangers*. Penguin, London (2006)

- Balzhiser, R.E.: Meeting the Near-Term Challenge for Power Plants. *Tech. Forecast. Soc. Change* 38, 349-362 (1990)
- Baratta, J.P.: *The Politics of World Federation*. Praeger Publishers, Westport (2004)
- Baxter, S., Crawford, I.A.: The lethality of interplanetary warfare: A fundamental constraint on extraterrestrial liberty. In: Cockell, C.S. (ed.) *The Meaning of Liberty Beyond Earth*, pp. 187-198. Springer, Heidelberg (2015)
- Bertka, C.M. (ed.): *Exploring the Origin, Extent and Nature of Life: Philosophical, Ethical and Theological Perspectives*. Cambridge University Press, Cambridge (2009)
- Birkbeck College: Introduction to Astrobiology. <http://www.bbk.ac.uk/study/modules/easc/EASC064H5> (2020). Accessed 4 July 2020
- Bjørnvig, T.: Outer space religion and the overview effect: a critical inquiry into a classic of the pro-space movement. *Astropolitics* 11,4–24 (2013)
- Brown, C.S.: *Big History: From the Big Bang to the Present*. New Press, New York (2007)
- Burke, A., Fishel, S., Mitchell, A., Dalby, S., Levine, D.J.: Planet politics: A manifesto from the end of IR. *Millennium* 44, 499-523 (2016)
- Cabrera, L. (ed.): *Global Governance, Global Government: Institutional Visions for an Evolving World System*. State University of New York Press, Albany (2011)
- Campbell, J.: *Myths to Live By*. Viking, New York (1972)
- Chaisson, E.J.: Big History's Risk and Challenge. *Expositions* 8.1, 85-95 (2014)
- Chambers, R.: *Vestiges of the Natural History of Creation*. John Churchill, London (1844)
- Chambers, R.: *Explanations: A Sequel to Vestiges of the Natural History of Creation*. John Churchill, London (1845)
- Christian, D.: The Case for 'Big History'. *J. World Hist.* 2, 223-238 (1991)
- Christian, D.: *Maps of Time: An Introduction to Big History*. University of California Press, Berkeley (2004)
- Christian, D.: *Origin Story: A Big History of Everything*. Penguin, London (2018)
- Christian, D., Brown, C.S., Benjamin, C.: *Big History: Between Nothing and Everything*. McGraw Hill, New York (2014)
- Clarke, A.C.: The Challenge of the Spaceship. *JBIS* 6, 66-78 (1946)
- Clarke, A.C.: *The Exploration of Space*. Temple Press, London (1951a)
- Clarke, A.C.: Seeker of the Sphinx. In: *Two Complete Science Adventure Books*, Vol. 1(2), pp. 106-142 (1951b). Reprinted as: The Road to the Sea, in Clarke, A.C. (ed.) *The Collected Stories*, pp. 263-300. Gollancz, London (2000)
- Connell, K., Dick, S.J., Rose, K., Harrison, A.A.: Workshop on the Societal Implications of Astrobiology: Final Report, NASA Technical Memorandum. <http://www.astrosociology.org/Library/PDF/NASA-Workshop-Report-Societal-Implications-of-Astrobiology.pdf> (2000). Accessed 1 June 2020
- Crawford, I.A.: Space, World Government, and 'The End of History'. *JBIS* 46, 415-420 (1993)
- Crawford, I.A.: Stapledon's 'Interplanetary Man': A commonwealth of worlds and the ultimate purpose of space colonisation." *JBIS* 65, 13-19 (2012)
- Crawford, I.A.: Avoiding intellectual stagnation: The starship as an expander of minds. *JBIS* 67, 253-257 (2014)
- Crawford, I.A.: Interplanetary federalism: Maximising the chances of extraterrestrial peace, diversity and liberty. In: C.S. Cockell (ed.) *The Meaning of Liberty Beyond Earth*, pp. 199-218. Springer, Heidelberg (2015)

- Crawford, I.A.: Space, world Government, and a 'vast future' for humanity. *World Orders Forum*. <http://wgresearch.org/space-world-government-vast-future-humanity/> (2017). Accessed 1 July 2020.
- Crawford, I.A.: Widening perspectives: The intellectual and social benefits of astrobiology (regardless of whether extraterrestrial life is discovered or not). *Internat. J. Astrobiol.* 17, 57-60 (2018a)
- Crawford, I.A.: Can 'big history' help lay the foundations for world government? *World Orders Forum*. <http://wgresearch.org/can-big-history-help-lay-the-foundations-for-world-government> (2018b). Accessed 1 July 2020
- Dark, T.: Reclaiming the future: space advocacy and the idea of progress. In: Dick, S., Launius, R. (eds.) *Societal Impact of Spaceflight*, pp. 555–571. NASA, SP-2007-4801 (2007)
- Darwin, C.: *The Descent of Man*. Second ed., John Murray, London (1874)
- Deudney, D.H.: On Wells, world government, and our possibly dystopian space future. *World Orders Forum*. <http://wgresearch.org/an-interview-with-daniel-h-deudney> (2016). Accessed 1 July 2020
- Deudney, D.H.: Going critical: Toward a modified nuclear one worldism. *J. Internat. Pol. Theory* 15, 367-385 (2018a)
- Deudney, D.H.: All together now: Geography, the three cosmopolitanisms, and planetary Earth. In: Cabrera, L. (ed.) *Institutional Cosmopolitanism*, pp. 253-276. Oxford University Press, Oxford (2018b)
- Deudney, D.H.: *Dark Skies: Space Expansionism, Planetary Geopolitics and the Ends of Humanity*. Oxford University Press, Oxford (2020)
- Dick, S.J.: *Astrobiology, Discovery, and Societal Impact*. Cambridge University Press, Cambridge (2018)
- Dick S.J., Lupisella, M.L. (eds.): *Cosmos & Culture: Cultural Evolution in a Cosmic Context*. NASA SP-2009-4802 (2009)
- Dunér, D.: Extraterrestrial life and the human mind. In: Dunér, D., Parthemore, J., Persson, E., Holmberg, G. (eds.) *The History and Philosophy of Astrobiology*, pp. 1-25. Cambridge Scholars, Newcastle upon Tyne (2013)
- Dunér, D., Parthemore, J., Persson, E., Holmberg, G. (eds.): *The History and Philosophy of Astrobiology*. Cambridge Scholars, Newcastle upon Tyne (2013)
- Finney, B.R.: Solar system colonization and interstellar migration. *Acta Astronautica* 18, 225-230 (1988)
- Finney, B.R.: SETI and the two terrestrial cultures. *Acta Astronautica* 26, 263-265 (1992)
- Fukuyama, F.: The End of History? *Nat. Interest* 16, 3-18 (1989)
- Fukuyama, F.: *The End of History and the Last Man*. Hamish Hamilton, London (1992)
- Fuller, R.B.: *Operating Manual for Spaceship Earth* (1969)
- Goodenough, U.: *The Sacred Depths of Nature*. Oxford University Press, Oxford (1998)
- Green, B.P.: Ethical approaches to astrobiology and space exploration: Comparing Kant, Mill and Aristotle. *Ethics: Contemporary Issues* 2(1), 29-44 (2014)
- Hamer, C.J.: *A Global Parliament: Principles of World Federation*. CreateSpace (1998)
- Heater, D.: *World Citizenship and Government*. Macmillan Press, Basingstoke (1996)
- Hegel, G.W.F.: *Philosophy of History* (1832). In: Sibree, J. (trans.) *The Philosophy of History*, pp. Dover, New York (1956).
- Henry, H., Taylor, A.: Re-thinking Apollo: Envisioning environmentalism in space. *Sociological Rev.* 57(Suppl. 1), 190-203 (2009)
- Herz, J.H.: *International Politics in the Atomic Age*. Columbia University Press, New York (1962)

- Hesketh, I.: A good Darwinian? Winwood Reade and the making of a late Victorian evolutionary epic. *Stud. Hist. Phil. Biol. Biomed. Sci.* 51, 44-52 (2015)
- Hogue, M.S.: *The Promise of Religious Naturalism*. Rowman & Littlefield, Lanham (2010)
- Hoyle, F.: *The Nature of the Universe: A Series of Broadcast Lectures*. Blackwell, Oxford (1950)
- Humboldt, A. von: *Cosmos: A Sketch of a Physical Description of the Universe* (1845). In: Otté, E.C. (trans.) Harper & Brothers, New York (1850)
- IBA: International Big History Association. <https://bighistory.org> (2020). Accessed 4 July 2020
- Impey, C., Spitz, A.H., Stoeger, W. (eds.): *Encountering Life in the Universe: Ethical Foundations and Social Implications of Astrobiology*. University of Arizona Press, Tucson (2013)
- Kant, I.: To perpetual peace: A philosophical sketch (1795). In: Humphrey, T. (trans.) *Perpetual Peace and Other Essays*, pp. 107-143. Hackett Publishing Company, Indianapolis (1983)
- Katerberg, W.: Is big history a movement culture? *J. Big Hist.* 2, 63-72 (2018)
- Kemp, M.: Dissecting the two cultures. *Nature* 459, 32-33 (2009)
- Kerr, P. (Lord Lothian): *Pacifism Is Not Enough*. Lothian Foundation Press, London (1990)
- Kutter, G.S.: *The Universe and Life*. Jones & Bartlett, Burlington (1987)
- Laski, H.J.: *A Grammar of Politics*. Allen and Unwin, London (1925)
- Leinen, J., Bummel, A.: *A World Parliament: Governance and Democracy in the 21<sup>st</sup> Century*. Democracy Without Borders, Berlin (2018)
- Lingam, M., Loeb, A.: What's in a name: The etymology of astrobiology. *Internat. J. Astrobiol.* 19, 379-385 (2020)
- Lu, C.: Cosmopolitan justice, democracy, and the world state. In: Cabrera, L. (ed.) *Institutional Cosmopolitanism*, pp. 232-252. Oxford University Press, Oxford (2018b)
- McLaughlin, W.I.: The potential of space exploration for the fine arts. *JBIS* 46, 421-430 (1993)
- Mill, J.S.: *On Liberty* (1859). In: Himmelfarb, G. (ed.) Penguin Books, London (1974)
- Morgenthau, H.J.: *Politics Among Nations: The Struggle for Power and Peace*. Alfred Knopf, New York (1948)
- NASA: NASA Astrobiology Institute. <https://astrobiology.nasa.gov/nai/about/> (2020). Accessed 4 July 2020
- Offerdahl, E.: A scientifically minded citizenry: The ethical responsibility of all scientists. In: Impey, C., Spitz, A.H., Stoeger, W. (eds.): *Encountering Life in the Universe: Ethical Foundations and Social Implications of Astrobiology*, pp. 222-235. University of Arizona Press, Tucson (2013)
- Palmeri, J.: Bringing cosmos to culture: Harlow Shapley and the uses of cosmic evolution. In: Dick, S.J., Lupisella, M.L. (eds.) *Cosmos and Culture: Cultural Evolution in a Cosmic Context*, pp. 489-521. NASA: SP-2009-4802 (2009)
- Peters, T., Hewlett, M., Moritz, J.M., Russell, R.J. (eds.): *Astrotheology: Science and Theology Meet Extraterrestrial Life*. Cascade Books, Eugene (2018)
- Poole, R.: *Earthrise: How Man First Saw the Earth*. Yale University Press, New Haven (2008)
- Race, M., Denning, K., Bertka, C.M., Dick, S.J., Harrison, A.A., Impey, C., Mancinelli, R.: Astrobiology and society: Building an interdisciplinary research community. *Internat. J. Astrobiol.* 12, 958-965 (2012)
- Randolph, R.O., McKay, C.P.: Protecting and expanding the richness and diversity of life, an ethic for astrobiology research and space exploration. *Internat. J. Astrobiol.* 13, 28-34 (2014)
- Reade, W.: *The Martyrdom of Man*. Tübner, London (1872)

- Reves, E.: *The Anatomy of Peace*. Harper, New York (1946)
- Reeves, H.: *The Hour of our Delight: Cosmic Evolution, Order, and Complexity*. W.H. Freeman, New York (1991)
- Rodrigue, B.H.: The study of all existence: Big history, universal studies and the global conjuncture. *Internat. J. Transform. Consciousness* 3, 15-34 (2017)
- Russell, B.: *Principles of Social Reconstruction*. Allen and Unwin, London (1916)
- Sagan, C.: *Pale Blue Dot: A Vision of the Human Future in Space*. Random House, New York (1994)
- Schwartz, J.S.J.: *The Value of Science in Space Exploration*. Oxford University Press, Oxford (2020)
- Schweickart, R.: No frames, no boundaries. In: Katz, M., Marsh, W.P., Thompson, G.G. (eds.) *Earth's Answer*, pp. 11-12. Harper and Row, New York (1977)
- Secord, J.A.: *Victorian Sensation: The Extraordinary Publication, Reception, and Secret Authorship of 'Vestiges of the Natural History of Creation'*. University of Chicago Press, Chicago (2000)
- Seegerstråle, U.: *Defenders of the Truth: The Battle for Science in the Sociobiology Debate and Beyond*. Oxford University Press, Oxford (2000)
- Shapley, H.: *The View from a Distant Star: Man's Future in the Universe*. Dell Publishing, New York (1963)
- Singer, P.: *The Expanding Circle: Ethics, Evolution, and Moral Progress*. Princeton University Press, Princeton (1981)
- Snow, C.P.: *The Two Cultures and a Second Look*. Cambridge University Press, Cambridge (1963)
- Som, S.M.: Common identity as a step to civilizational longevity. *Futures* 106, 37-43 (2019)
- Spier, F.: *Big History and the Future of Humanity*. Second ed., Wiley-Blackwell, Chichester (2015)
- Spier, F.: Big history is not an all-encompassing world view. *Origins* VI:2, 3-5. [https://bighistory.org/Origins/Origins\\_VI\\_02.pdf](https://bighistory.org/Origins/Origins_VI_02.pdf) (2016). Accessed 19 November 2018).
- Spier, F.: On the social impact of the Apollo 8 Earthrise photo, or the lack of it? *J. Big. Hist.* III(3), 157-189 (2019)
- Stapledon, O.: *Star Maker* (1937). Reprinted as SF Masterworks #21, Gollancz Books, London (1999).
- Stapledon, O.: Interplanetary man? *JBIS* 7, 213-233 (1948)
- Stevenson, A.: Strengthening the International Development Institutions. Speech before the United Nations Economic and Social Council, Geneva, Switzerland July 9, 1965. [http://www.adlaitoday.org/articles/connect2\\_geneva\\_07-09-65.pdf](http://www.adlaitoday.org/articles/connect2_geneva_07-09-65.pdf) (1965). Accessed 1 December 2018).
- Toynbee, A.: *A Study of History*. One-volume edition, Thames and Hudson, London (1972)
- Vakoch, D.A. (ed.): *Astrobiology, History, and Society*. Springer-Verlag, Berlin (2013)
- Vakoch, D.A. (ed.): *Extraterrestrial Altruism: Evolution and Ethics in the Cosmos*. Springer-Verlag, Berlin (2014)
- Vidal, C.: *The Beginning and the End: The Meaning of Life in a Cosmological Perspective*. Springer, Cham (2014)
- Voros, J.: Big history as a scaffold for futures education. *World Futures Rev.* 10, 263-278 (2018)
- Wallace, A.R.: *Contributions to the Theory of Natural Selection*. Second ed., Macmillan, New York <http://www.gutenberg.org/files/22428/22428-h/22428-h.htm> (1871). Accessed 2 July 2020).
- Ward, B.: *Spaceship Earth*. Columbia University Press, New York (1966)

Wells, H.G.: *The Outline of History: Being a Plain History of Life and Mankind*. Waverley Book Company, London (1920)

Wendt, A.: Why a world state is inevitable. *Euro. J. Internat. Rel.* 9, 491-542 (2003)

Wendt, A.: Why a world state is democratically necessary. *World Orders Forum*, Available on-line at <http://wgresearch.org/why-a-world-state-is-democratically-necessary> (2015). Accessed 2 July 2020

Whelpley, J.D.: Review of 'Cosmos'. *Am. Rev.* 3, 598-610 (1846)

White, F.: *The Overview Effect: Space Exploration and Human Evolution*. American Institute of Aeronautics and Astronautics, Reston (2014)

Wilson, E.O.: *Consilience: The Unity of Knowledge*. Little, Brown and Company, New York (1998)

Wilson, E.O.: *The Social Conquest of Earth*. Liveright Publishing, New York (2012)

Wilson, D.S., Wilson, E.O.: Rethinking the theoretical foundation of sociobiology. *Quart. Rev. Biol.* 82, 327-348 (2007)

Wynner, E., Lloyd, G.: *Searchlight on Peace Plans: Choose Your Road to World Government*. Dutton and Company, New York (1944)

Yunker, J.A.: *Political Globalization: A New Vision of Federal World Government*. University Press of America, Lanham (2007)

Yunker, J.A.: *Evolutionary World Government: A Pragmatic Approach to Global Federation*. Hamilton Books, Lantham (2018)