# Mediating Gaia

## Literature, Space, and Cybernetics in the Dissemination of Gaia Discourse

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## Introduction

One of science fiction's most striking tropes is the alien gaze upon human life.[1] The alien gaze is at once an irresistible fictive lure and a transparent self-projection, a reverse affirmation of the human and its earthly self-reference. The notion of alien life is already an outward displacement of earthly conditions, and the alien gaze is the return or reflex of that displacement. H. G. Wells's 1898 novel The War of the Worlds opens with an eyewitness character narrating a retrospective overview of his account to follow. For this prologue, he constructs an image of the prior, covetous gaze of the now vanquished Martian invaders:

> No one would have believed in the last years of the nineteenth century that human affairs were being watched keenly and closely by intelligences greater than man's and yet as mortal as his own; that as men busied themselves about their affairs they were scrutinized and studied, perhaps almost as narrowly as a man with a microscope might scrutinize the transient creatures that swarm and multiply in a drop of water.[2]

**1** | Parts of this chapter are based on »Mediations of Gaia,« in Astroculture: Figurations of Cosmology in Media and Arts, ed. Sonja Neef, Henry Sussman, and Dietrich Boschung (Wilhelm Fink, 2014): 119-41. I would like to dedicate this essay to the late Sonja Neef.

**2** | Wells 2003, 41.

Wells's brainy Martians inhabit a dying planet: they are gazing upon human affairs so intently not out of disinterested scientific motives but because they are seeking to avoid extinction by finding a new world to inhabit: »And looking across space […] they see […] a morning star of hope, our own warmer planet, green with vegetation and gray with water, with a cloudy atmosphere eloquent of fertility, with glimpses through its drifting cloud-wisps of broad stretches of populous country and narrow navy-crowded seas.«[3]

Envisioning the Martians' envious gaze at an unsuspecting Earth, Wells's narrator prefigures two major signatures of Gaia theory. The first, to which we will return in more detail later, is the planetary role of the microbes – »the transient creatures that swarm and multiply in a drop of water.«[4] Even while advancing the pre-Gaian prejudice that treats microbes as fungible, needless beings, dispensable pests to be exterminated by the hygienic advancement of a scientific civilization, this novel will show an inkling of Gaian intuition: its denouement will give the planetary role of the microbes a proto-Gaian evolutionary twist. The second signature is the image around which this collection is arranged: the earth – »a morning star of hope, our warmer planet«[5] – seen from space. The image of Earth observed from beyond its own precincts can morph from a geographical artifice or science-fiction trope into a Gaian marker once it becomes possible to withdraw the figurative projection and literally attain the gaze from space.

**3** | Ibid, 42.

**4** | Ibid.

**5** | Ibid.

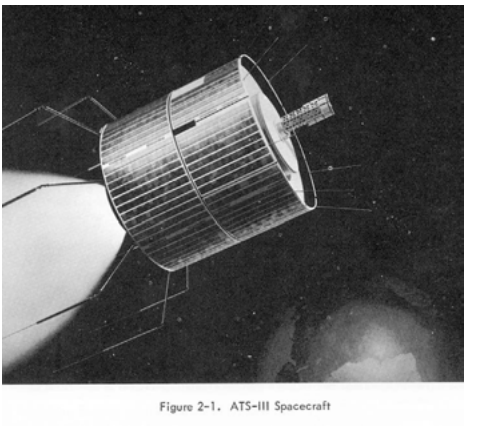


*Fig. 1: The NASA ATS-III weather satellite*

Gaia theory becomes possible in the same moment that the agent of a gaze taking Earth as its object may return from fictive aliens to human observers applying technological prostheses. A NASA weather satellite transmits the first image of the whole earth at the end of 1967.

*Fig. 2: The first color photograph of the whole Earth (western Hemisphere), shot from the ATS-III satellite on 10 November 1967*

Media studies' mantra since McLuhan is that the medium encompasses the message. Information per se is constituted and modulated by its mode of transmission.[6] For a narrative instance, in The War of the

**6** | Cf. Peters 2015.

Worlds, it makes all the difference to the form and effect of the story that its narrator – the transmitter of its discourse – is a character-bound eyewitness and not a disembodied voice. And in the field of literature and science more broadly, echoes of the media mantra determine rigorous considerations of mediatic conditions, directing the study of scientific and technological practices to their modes of textuality and transmission in relation to the extra-scientific textures of their cultural reconstructions and repercussions, for instance, in novels. This essay maps some prominences within the cultural universe of Gaia theory by placing its putative scientific components in relation to a number of technological, discursive, and iconic mediations.

However, with Gaia in question, especially as refracted through its mediations, the first question has to be, which Gaia? Its contemporary guises are many; they are not necessarily incoherent, taken one by one; nonetheless, as a conceptual whole, they do not cohere. Thus, to begin with, I will state that the Gaia that centers this discussion is the application of this name to an idea the British inventor and atmospheric chemist James Lovelock first conceived in the 1960s, that through a planetary system of negative feedback cycles the biota altogether modulate climatic and geological processes in favor of life's continuation. In 1971, on the suggestion of his colleague at the time, Carl Sagan, Lovelock then submitted his ideas to Sagan's ex-wife, the evolutionary microbiologist Lynn Margulis, who filled in her own formulations for the biological infrastructures implied by Lovelock's scheme. Lovelock and Margulis then co-wrote the first set of papers on the Gaia hypothesis, the first draft of a Gaian science that, under many other, later names, has revolutionized our understanding of the systematic integration of Earth and life.[7]

I will divide my discussion of Gaia's discursive mediations into several categories. The sum of reasonably thoughtful and informed transmissions and receptions of standard Gaian ideas I will call Gaia discourse. On one side of Gaia discourse one can then place Gaia theory, those more technical discussions specifically rooted in the evolving disciplinary claims of Lovelock and Margulis, and so acknowledging some criterion of scientificity. On the other side of Gaia discourse lie what I will call Gaia notions, amateur formulations typical of popular usage and open to the fortuitous cultural associations ultimately arising from

**7** | Cf. Clarke 2015.

the mythological substrata from which the name of Gaia was requisitioned for scientific duty.

For instance, on the Internet there are any number of Gaia notions advanced by persons who appear to have little or no detailed grasp of Gaia discourse or theory and yet still want to attach some mention of Gaia to their matter of concern. In these instances, a kind of diffuse popular scientism mediates Gaia for an audience unlikely to be abreast of the scientific headwinds against which the Gaia hypothesis has always had to negotiate its bona fides. Here are two such examples. The first is from the Web site of the magazine Motorcyclist:

> I don't know if there's anything to the Gaia theory – that the world is one living organism with a conscience. But I do know this: The day I rode my Honda VFR home for the first time, the weeds in my garden were doing high-fives. I'm not saying I've neglected *everything* since getting my long-awaited bike, but I'm pretty sure my motorcycle has a lot more hours on it than my lawnmower.[8]

A second is from the Web site of a South African business magazine:

> James Lovelock's Gaia theory – that earth and its entire species constitute one living organism – is applicable to South Africa. Though of different races and cultural origins, we are one big family. If one member of the family is not well, the whole family suffers.[9]

In the first example, a motorcycling homeowner apologizing for neglecting his lawn has a Gaian vision of his weeds as they celebrate their Earthly reprieve. That the idea of Gaia is taken here to say, »the world is one living organism with a conscience,« is classic – a precise articulation of a broadly popular Gaia notion. This manner of moralizing the idea of Gaia is rarely stated so explicitly. And the same conscientious meme recurs in the South African example. Riven by »different races and cultural origins,« human beings cannot feel their »natural« oneness with each other, let alone with the rest of nature. »Gaia« stands in for the principle of a human unity that humanity can never achieve in its actual behavior.

**8** | Anderson 2011.

**9** | Ntyintyane 2011.

In a portion of the popular mind, then, »Gaia« has come to represent the all-purpose notion of a wholly holistic world. Stress falls on an idea of total unity: it must be »a single organism«; or, as here, »one living organism« taken as »one big family.« The members of this totality, the parts of the holy whole in this Gaia notion, are typically composed entirely of 1) humanity, and 2) »Earth.« Other members of the biotic guild need not apply. All that this popular conception can seem to make out of Gaia is an amorphous planetized human essence that, from some transcendentalized immanent afar, some nearby heaven just beyond the weather, admonishes our selfish squabbling. And the ubiquitous »oneness of Gaia« also finds its way into scholarly conversation, for instance, in a 2004 essay discussing social-systems theorist Niklas Luhmann in relation to the social psychology of the emotions. We read that, »emotional communications have become more and more fundamental to the operations of late modern social systems […]. Even scientists are striving to present themselves as humane and engaged observers of the oneness of Gaia, and to avoid the rational stereotypes of Mr. Spock and Dr. Strangelove.«[10] Even if delivered tongue in cheek, once again the same popular Gaia notion emerges: Gaia is a principle of oneness; to »observe Gaia« is to affirm one's moral humanity. Once again, Lovelock and Margulis' secular Gaia concept undergoes a vulgar theomorphosis, »observed« like a holy day, swaddled in romantic sanctity.[11] It is no wonder that so many otherwise thoughtful people observe Gaia by dismissing the whole notion as so much ersatz religiositude, so much sentimental twaddle.

## The Name of Gaia

Nothing could have been farther from the mind of James Lovelock in 1965 when, by his own account, he has his initial intuition of the entity he came to call Gaia. As we noted before, Gaian science begins just as the space technology arrives to enable the making of technical images of our own planet against its cosmic background. Throughout the sixties, technological developments associated with the U.S. space program

**10** | Stenner 2004, 182f.

**11** | On »secular Gaia«, cf. Latour 2013.

incubate the science of Gaia.[12] The British contractor Lovelock had been involved with NASA since 1961. At the Jet Propulsion Laboratory (JPL) he assisted projects to engineer life-detection instrumentation for Mars landers: »At this time scientists still seemed to think that life flourished on Mars. I recall Carl Sagan enthusing over the wave of darkness that crosses Mars when winter ends. He and many others saw this phenomenon as indicative of the growth of vegetation […] This image of Mars sustained their belief in biological life-detection techniques.«[13] Lovelock refers here to the devices favored at JPL by his biologist colleagues, who assumed that Mars would have Earth-style life in a watery medium, the detection of which demanded probes making contact with Mars' surface. By 1964 a completely different principle stands under his own life-detection scheme – the search for an entropy-reduction, that is, for a signature of some counter-entropic ordering commensurate with the living organization of matter and energy. Entropy is a thermodynamic concept that straddles physics and information theory, so the title of Lovelock's first paper directly on the way to Gaia, A Physical Basis for Life-Detection Experiments, declares an alternative to biological life-detection techniques.[14] Where and how was such a signature to be found?

His next proto-Gaia paper, co-written with philosopher Dian Hitchcock, states the answer explicitly: Life Detection by Atmospheric Analysis.[15] Hitchcock and Lovelock's life-detection argument makes a crucial move out of normal science at JPL. At mid-20th century, Earth's atmosphere is assumed to be almost entirely a geological and hence a fundamentally abiotic phenomenon.[16] Lovelock will venture the countervailing idea – now universally accepted – that the atmosphere of a planet on which life exists will be to a significant extent the product of those living processes – enough so for that atmosphere to present signs of life to be detected and deciphered as such. The brilliance of his scheme, now normal astrobiology, is its economy. One need not go to Mars or any other planet to apply it. For the exoplanets that have been detected in succeeding decades as well as for the planets of our own solar system,

**12** | Cf. Strick 2015.

**13** | Lovelock 2000, 248.

**14** | Cf. Lovelock 1965.

**15** | Hitchcock/Lovelock 1967.

**16** | Lovelock/Lodge 1972 gives an overview of these doctrinal commitments.

spectrographic analysis here on Earth can assess their atmospheres.[17] The crucial turn toward Gaia proper comes in September 1965 when Lovelock encounters – newly acquired from the 42-inch telescope NASA had installed at the Pic du Midi Observatory in the Pyrenees – infrared spectrographs of the atmospheres of Venus and Mars. They show atmospheric entropies off the charts. Dominated by $CO_2$, both planets' atmospheres are near maximum entropy, that is, virtually at thermodynamic equilibrium. Chemically inert, whatever combustion or reduction of (lower-entropy) chemical potential had ever been possible there has long since burnt out. According to Lovelock's scheme, the verdict is obvious: Mars harbors no life. When Viking explorers land there a decade later, their probes find what Lovelock predicted – no life.

Born of that prediction of the lifelessness of Mars is a theory regarding the self-regulating nature of a ›living Earth.‹ Lovelock first conceives it in 1965 by turning his atmospheric interrogation of Venus and Mars – as it were, his »alien gaze« – back upon Earth. Now he notes with new eyes how our atmosphere is at a cosmically improbable chemical disequilibrium, and that evidence is abundant for the overall constancy of that imbalance over geological time.[18] Earth's atmosphere has been a highly combustible mixture of reactive gases for hundreds of millions of years, but rather than burning out, it has maintained its low entropy. The idea of Gaia as a self-regulating system responsible for maintaining Earth's atmosphere in a low-entropy state is ignited in the vessel of this conceptual conundrum over atmospheric chemistry, a conundrum largely unrecognized as such before Lovelock does so in the mid-1960s. Then a second problem in cosmic evolution arose for which, Lovelock again surmised, the notion of planetary self-regulation could offer a plausible solution.

In the course of responding skeptically to his colleague's earliest Gaian intuitions, Carl Sagan also informed Lovelock about the »faint young sun paradox.« When the Earth formed, the sun's luminosity (the light it radiates and thus the heat it generates) was up to 30% less than it is now. Nonetheless, during all that time, confronting the sun's normal

**17** | In the twenty-second century story world of the novel Fiasco, Stanislaw Lem composed in 1986, this is settled science: »Life-producing planets are recognized by the composition of their atmospheres«. (Lem 1988, 106).

**18** | Cf. Lovelock 2000, 253.

evolution toward stronger output, the mean temperature of Earth's surface has never fluctuated so severely as even to threaten to kill it all off. Despite significant extinction events along the way, life has persisted and proliferated for 3500 million years. In the geological scheme of things, while the sun's intensity has increased by a third, the Earth's climate has actually cooled quite significantly. Again, as with the composition of Earth's atmosphere at least since its oxygenation around 2 billion years ago, what can account for such climatic constancy and viability over geological time?

> It dawned on me that somehow life was regulating climate as well as chemistry. Suddenly the image of the Earth as a living organism able to regulate its temperature and chemistry at a comfortable steady state emerged in my mind. At such moments, there is not time or place for such niceties as the qualification ›of course it is not alive – it merely behaves as if it were.‹[19]

If a temporally minimal meteorological event such as a hurricane merits its own name to acknowledge the violent if momentary distinctness by which this weather system cuts itself out of the circumambient atmosphere, then giving his planetary entity a proper name would give due recognition to a vastly more complex and geologically persistent systemic personhood.

By the later 1960s, then, »a planet-sized entity, albeit hypothetical, had been born, with properties which could not be predicted from the sum of its parts. It needed a name.«[20] Still, the science in question could have developed without any title or come forward under some drab and unevocative appellation, perhaps »the planetary climate and atmospheric chemistry self-regulation hypothesis.« Lovelock has told the ensuing story many times, with different emphases, but I think never so charmingly as mediated by a TV interview with Canadian science broadcaster David Suzuki. The incident hangs on the circumstance that at the time, Lovelock's neighbor in the south of England was the novelist William Golding. On a stroll one afternoon in 1967, they were conversing about Lovelock's planetary hypotheses:

**19** | Lovelock 2000, 253f.

**20** | Lovelock 1979, 10.

William Golding said: »If you're going to have a big idea like that you'd better give it a proper name.« So I said, »Good, what would you call it?« He said, »I'd call it Gaia.« […] And we went on walking for twenty minutes, talking at complete cross-purposes, because I didn't have a classical education. I didn't know anything about Gaia, the Greek goddess. But I did know about g-y-r-e, gyre, the great whirl in the ocean or in the atmosphere, and this made sense of course, this was a fed-back system, and this is what he's talking about. And he said, »No no no no no, I mean the Greek goddess of the earth.« And then it clicked, of course. I'm a bit slow in the uptake.[21]

Lovelock accepted Golding's gift horse of this archaic name and in due time affixed it to his idea of Earth and its biosphere supporting a homeostatic system holding »climate as well as chemistry« within viable parameters. The public debut of the name of Gaia is in 1972, in an two-page letter to the editor of the journal Atmospheric Environment, titled Gaia as Seen through the Atmosphere.[22] He defines it here as »a biological cybernetic system able to homeostat the planet for an optimum physical and chemical state appropriate to its current biosphere.«[23] Two years later, with Lovelock as first author co-writing with Margulis, this basic description receives a more felicitous but also more problematic phrasing:

This paper examines the hypothesis that the total ensemble of living organisms which constitute the biosphere can act as a single entity to regulate chemical composition, surface pH and possibly also climate. The notion of the biosphere as an active adaptive control system able to maintain the Earth in homeostasis we are calling the ›Gaia‹ hypothesis […]. Henceforward the word Gaia will be used to describe the biosphere and all of those parts of the Earth with which it actively interacts to form the hypothetical new entity with properties, that could not be predicted from the sum of its parts.[24]

This presentation manifests a primary conceptual tension in Gaia discourse – an alternation between a cybernetic and a holistic description of Gaia, an oscillation of emphasis between the multiplicity and the unity of the assembled system. Notions about the »oneness of Gaia« certainly

**21** | Suzuki 2002.

**22** | Lovelock 1972b.

**23** | Ibid., 579. For more on the interplay between Lovelock and Margulis at this time, cf. Clarke 2012a.

**24** | Lovelock/Margulis 1974a, 3.

have adequate warrant in the annals of the Gaia hypothesis. What has proved to be problematic is the way that placing the stress on the singularity of this »hypothetical new entity« has tended to trivialize the complexity of Gaia's planetary aggregation and to blur the manifold of elemental cycles and ecological subsystems needed to buffer the operations of the »whole system.«[25] The »singleness« of Gaia derives not from any essential holistic status as an ontological unit of being but rather from the emergent cybernetic action of a systemic ensemble: »the biosphere can act as a single entity…as an active adaptive control system.« Lovelock and Margulis state the cybernetic contingency of Gaia's systemic self-constitution, but at the same time, open the door for the holistic reification of the mythic personification already on offer in the name of Gaia. Thus it is helpful to be aware of Lovelock's initial ignorance, by his own admission, of Gaia's classical provenance when Golding first pronounced that name in his presence. It just means that the name of Gaia is a strictly rhetorical mediation. The story of Gaia is a classic case of the mediation becoming the message, the signifier overtaking the signified. Even while the name of Gaia has been powerfully effective as a branding device, nevertheless, it is of very little use for understanding Lovelock and Margulis' concept of Gaia. For that, one must study the details of their discourse.

## Gaia Discourse

Gaia's disparate discursive mediations constitute a literature for which the Earth seen from space remains the foremost icon and mandala. Just as the Gaia hypothesis was taking its baby steps, several years before its formal introduction in 1972, the Whole Earth Catalog (WEC) began its initial four-year run from 1968-71.[26] In hindsight, by celebrating a self-referential cosmology of the Earth as seen in the newly-arriving space photographs, the WEC performed a kind of premediation of the idea of Gaia.[27] The outside covers of nearly every iteration of the WEC presented a NASA image of Earth seen from space.

**25** | An effective corrective in this regard is Volk 2003.

**26** | A small wave of *WEC* scholarship has crested in the last decade. Cf. Turner 2006; Kirk 2007; Poole 2008; Clarke 2011; Diederichsen/Franke 2013.

**27** | On premediation cf. Grusin 2010.

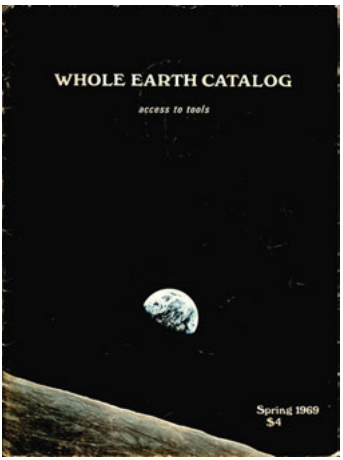


*Fig. 3: The outside front cover of the Whole Earth Catalog for Fall 1969*

Moreover, in parallel with nascent Gaian science, the WEC was also dedicated to a holistic appreciation of cybernetic thinking. Its every iteration began with or contained a section on ›whole systems‹, under which rubric it retailed reams of first-rate information about systems ranging from biological, mechanical, and computational cybernetics to social-scientific and humanistic applications of systems theory.[28] Both Gaia and the WEC are rooted in a space-oriented technoculture of systems thinking. And given its intense resonance with the WEC's editor Stewart Brand's own interests in cybernetics, systems theory, and ecology, the Gaia hypothesis will make several appearances during the eleven-year span (1974-84) of the WEC's next incarnation, CoEvolution Quarterly (CQ).[29] The outside front cover of the first number of CQ also premediated the unfolding of Gaia's coevolutionary cosmology. While its point of self-reference remained the human observer, in this image the Earth seen from space is exploded into a planetary or cosmic visage made up of microbes and galaxies and everything in between.

**28** | Cf. Clarke 2011.

**29** | Lovelock 1981a and 1981b; Lovelock/Whitfield 1981; Lovelock 1983.

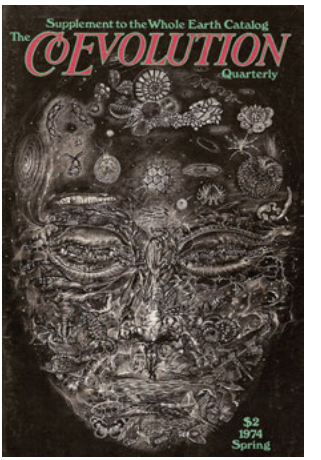


*Fig. 4: The outside front cover of the first number of CoEvolution Quarterly (Spring 1974)*

A year later, CQ published the first article on Gaia to appear in a non-scientific journal, Margulis and Lovelock's The Atmosphere as Circulatory System of the Biosphere: The Gaia Hypothesis.[30] Previously Lovelock had published recognizably Gaian work mostly in second-tier scientific periodicals.[31] Similarly, his collaborative articles with Margulis, which began to appear shortly after he went public with the name of Gaia in 1972, were rejected by Science and Nature and placed instead in the relatively minor outlets Tellus, Icarus, and Origins of Life.[32] As we learn from the draft of a letter to Lovelock written on board a flight to a speaking engagement in St. Louis, »where I have to discuss the origin & evolution of everything in about ½ hour,« Margulis welcomed the opportunity to publicize the Gaia hypothesis through popular media:

Dear Jim: […] Good news – & I'll need a quick response (sorry to hassle you further) I've spoken today to Alan Ternes, editor of Natural History (a classy glossy job with a circulation of 370,000). He's apparently a friend of Stewart Brand, editor of the *Co-evolution Quarterly*. Brand, who has been pressuring me mightily, claims his

**30** | Margulis/Lovelock 1975.

**31** | Lovelock/Giffin 1969; Lovelock/Lodge 1972.

**32** | Lovelock/Margulis 1974a, 1974b, 1974c. *Icarus* was edited by Carl Sagan, hardly a disinterested referee.

mag. has a circulation of only 17,000. They apparently are in agreement that Nat. Hist. will publish the Gaia II & that appearance (even prior appearance) in Coev. Q. will not jeopardize a full article in Nat. Hist. […] [Brand] is claiming that his journal is responsible and responsive, refuses to compartmentalize science and that my accusation that he's into food faddism & astrology is totally unfounded. At any rate, what he wants from us is permission to excerpt apparently nearly all Gaia II with the statement that [it] is from a full article coming out in Nat. History. I told him that I could not give him permission unilaterally but must consult you. Since he now has a definite commitment from Ternes at Nat. Hist. and since after reading CQ I find myself sympathetic to his goals, I would hope you will agree to this plan.[33]

As matters turned out, the article in question – ›Gaia II‹, which abbreviation may indicate the second Gaia article for which Margulis was the lead author – gets the royal treatment in the low-circulation countercultural outlet CQ but short shrift from the glossy mainstream outlet Natural History. It did appear there, over a year later, not expanded but condensed and reframed, under the obfuscating title »Is Mars a spaceship, too?«[34] Perhaps Natural History turned averse to putting the unscientific name of Gaia into the article's title; in any event, it boxed the presentation of the Gaia hypothesis back into the context of alien life-detection then on the public's mind due to the imminent arrival on Mars that summer of two Viking landers. Margulis and Lovelock's concluding remarks put the best face on a high-circulation debut somewhat muffled for general consumption. Turning Lovelock's original logic around, they note that if the landers do find life on Mars (if that planet is ›a spaceship‹), then that outcome will disprove his circumstantial claim in favor of Gaia, that the presence of active life must leave a detectable signature in the atmosphere of a planet that possesses it:

Failure of the Viking mission to find life on Mars will not prove the existence of Gaia, but it will add support to the hypothesis. Most scientific experiments are designed to disprove a hypothesis; when they fail the hypothesis is thereby strengthened. At great cost and effort, a rare planetary experiment for the Gaia hypothesis is now speeding toward a conclusion.[35]

**33** | Margulis to Lovelock, April 29th, 1975.

**34** | Margulis/Lovelock 1976.

**35** | Ibid., 90.

And put in this fashion, as anticipated, the Viking non-result left the Gaia hypothesis intact.

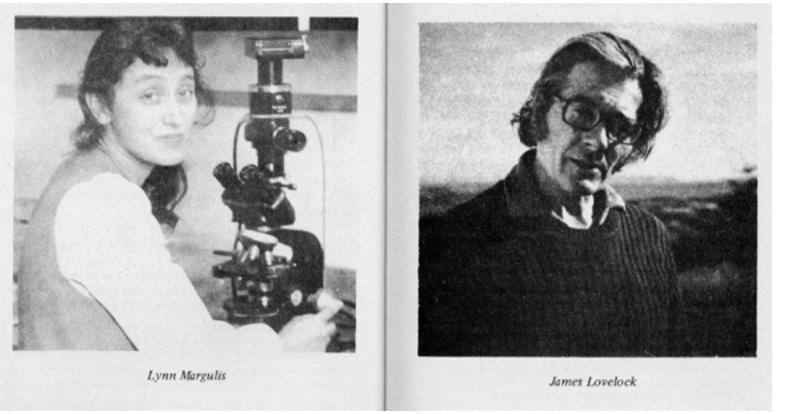


*Fig. 5: Lynn Margulis and James Lovelock, from CoEvolution Quarterly (Summer 1975)*

Back in the summer of 1975, however, CQ welcomed the Gaia hypothesis with no such muted exposition. The Atmosphere as Circulatory System of the Biosphere: The Gaia Hypothesis sprawls over ten pages including graphics, diagrams, and excerpts from previously published articles. It anchors an »Understanding Whole Systems« section that also includes Earth-seen-from-space articles by Carl Sagan and former astronaut Rusty Schweickart, a glowing review of Margulis' first book, Origin of Eukaryotic Cells, by beat poet Michael McClure, a substantial introduction to and extract from Ramón Margalef's 1968 text Perspectives in Ecological Theory, the resonance of which with the Gaia article that precedes it is captured by its opening section The ecosystem as a cybernetic system.[36] The exposition lead-authored by Margulis is detailed and technical throughout. It breaks the argument for the Gaia hypothesis down into elemental cycles and their relation to living systems. It is worth noting that the original Gaia arguments do not bear on the biosphere as a whole but specifically on the planetary atmosphere enveloping the biosphere as both source and sink for metabolic processes. In this presentation, the complexity and multiplicity of the phenomena under review render all statements toward

**36** | Sagan 1975; Schweickart 1975; McClure 1975; Margalef 1975.

a Gaian synthesis hypothetical. For the »major biological elements« (carbon, nitrogen, oxygen, hydrogen, sulphur, and phosphorus), the

> cycling times must be short because biological growth is based on continual cell division that requires the doubling of cell masses in periods of time that are generally less than months and typically, days or hours. On lifeless planets there is no particular reason to expect this phenomenon of atmospheric cycling, nor on the earth is it expected that gases of elements that do not enter metabolism as either metabolites or poisons will cycle rapidly […] Because biological solutions to problems tend to be varied, redundant, and complex, it is likely that all of the mechanisms of atmospheric homeostasis will involve complex feedback loops.[37]

However, the granular rehearsal of Gaian complications can always give way to the same smooth space in which the concrete complexity and numerical immensity of biological forms yield to an encompassing top-down vision of ›life‹. So it is at the beginning of Stewart Brand's headnote to this article, which directly seizes the holistic or ›whole earth‹ potential of the argument. Gaia »treats the anomalous Earth atmosphere as an artifact of life and comprehends the planet itself as a single life.«[38] As editor, Brand reinforced this mode of appreciation a page later by interpolating underneath the main article an excerpt from a philosophical meditation co-authored by Lovelock and Sydney Epton, »The Quest for Gaia,« published earlier in 1975 in The New Scientist. This text bundles together the extreme claims of the early Gaia hypothesis – co-operation, totality, optimality, ›control‹ transferred from the abiotic environment to the biota – that gave fits to the scientific establishment of that moment:

> Prima facie, the atmosphere looked like a contrivance put together co-operatively by the totality of living systems to carry out certain necessary control functions. This led us to the formulation of the proposition that living matter, the air, the oceans, the land surface were parts of a giant system which was able to control temperature, the composition of the air and sea, the pH of the soil and so on so as to be optimum for survival of the biosphere. The system seemed to exhibit the behavior of a single organism, even a living creature.[39]

**37** | Margulis/Lovelock 1975, 36.

**38** | Ibid. 31.

**39** | Ibid, 32.

It may now be evident why the Gaia discourse brilliantly mediated through this 1975 extravaganza would find a dedicated and abiding audience among the peacenik greens and countercultural intelligentsia gathered by CQ. Its promissory counter-vision of life taking care of business in its own house put the »selfish gene« of the same moment – that precious avatar of a game-theoretical, winner-take-all neo-Darwinism in smug resonance with the suppressed aggressiveness of the Cold War era – completely to shame. In 1980, the Next Whole Earth Catalog, an oversized return to the compendious catalog format, affixes the name of Gaia to an image of Earthrise on its outside back cover. Brand's caption provides a further summation of the popular Gaia notion that will take root in ensuing decades: »The Gaia Hypothesis, as proposed by the British scientist James Lovelock, suggests that the Earth's atmosphere and oceans are maintained as highly sophisticated buffering devices by the totality of life on the planet. The whole Earth, in other words, may function as a single self-regulating organism« (see Fig. 6).

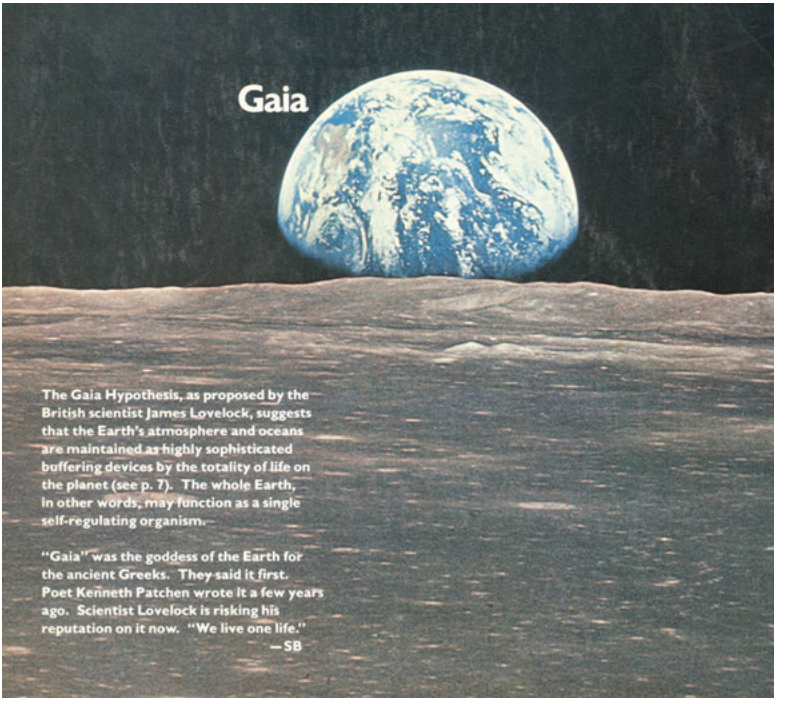


*Fig. 6: Detail of the outside back cover of the New Whole Earth Catalog (1980)*

Lovelock first popularizes his own science in 1979 in Gaia: A New Look at Life on Earth.[40] With its appearance, the neo-Darwinist opposition to the Gaia hypothesis had a distinct target toward which to aim its critique. The title of W. Ford Doolittle's 1981 article in CQ codified a standard line of attack: Is Nature Really Motherly?[41] In due time Margulis would pen a lampoon of the personification of Gaia giving Doolittle's misconstruction the retort it deserved: Gaia Is a Tough Bitch.[42] With Margulis active behind the scenes enlisting the assistance of the sympathetic and literate medical researcher Lewis Thomas, in 1988 Lovelock followed up his first Gaia book with a substantially improved, strenuously edited volume presenting the mature theory, The Ages of Gaia.[43] Meanwhile, in 1981 the cultural historian William Irwin Thompson, working through contacts with Stewart Brand, invited Lovelock and Margulis to a meeting with fellow biocyberneticians Henri Atlan, Heinz von Foerster, Humberto Maturana, and Francisco Varela, the latter two being the inventors of the concept of autopoiesis defining the form of living systems as self-referential self-production. In due time Margulis will note: »The simplest, smallest known autopoietic entity is a single bacterial cell. The largest is probably Gaia – life and its environment-regulating behavior at the Earth's surface.«[44] Two essay collections edited by Thompson document this seminal phase in the further development of Gaia discourse and are highpoints in the countercultural strand of Gaia discourse and theory.[45]

## Planets under Stress

To be sure, Gaia discourse has enjoyed mainstream as well as countercultural mediations. Two MIT Press volumes developed from international conferences provide accessible and balanced scientific discussions of

**40** | Lovelock 1979.

**41** | Doolittle 1981. Cf. also Lovelock 1981 and Margulis 1981.

**42** | Margulis 1996.

**43** | Lovelock 1988. Cf. Gribbin/Gribbin 2009, 169f.

**44** | Margulis 1997, 267.

**45** | Cf. Thompson 1987 and Thompson 1991. Cf. Clarke 2009, 2012b, and 2017b.

Gaia.[46] As Gaia theory's scientific credentials have become more established, these volumes have incrementally opened the discussion up to include the sorts of learned and inspired cultural, philosophical, and ethical considerations previously initiated by Thompson's Gaia editions.[47] MIT Press's third Gaia volume, Gaia in Turmoil, is the first Gaia collection to be developed in full cognizance of the climate crisis.[48] Lovelock's introductory essay argues that we are already beyond the point of drawing back from the extreme climate consequences of our ongoing assault – through fossil fuel consumption and deforestation – on the current regime of Gaian self-regulation of global temperatures. »Is there nothing that we can do to bring back the lush and comfortable Earth of a few hundred years ago? Probably not in times measured on a human scale.«[49] Perhaps Lovelock has uniquely earned the right to occupy a position of such dispassionate reflection on our species' predicament:

> When Darwin came upon the concept of evolution by natural selection, he was almost wholly unaware that much of the environment, especially the atmosphere, was a direct product of living organisms. Had he been aware, I think he would have realized that organisms and their environment form a coupled system and that what evolved was this system, the one that we call Gaia. Organisms and their environment do not evolve separately. If Darwin had known this, Gaia might have been part of his concept of evolution; we would have known sooner the consequences of changing forests to farmland and of adding greenhouse gases to the air.[50]

In any event, Lovelock concludes, as a practical matter, if our efforts at environmental remediation prove inadequate, then we must prepare to adapt through a »sustainable retreat« from our current ways of life. Lovelock's resignation is not shared by other contributors and has since been partially retracted. It may be objected that Lovelock's systems science has rigidified, has become overly deterministic or absolute in its binary choice

**46** | Cf. Schneider/Boston 1993 and Schneider et al. 2004.

**47** | For the most recent developments in philosophical Gaia discourse, see Clarke 2017.

**48** | Cf. Crist/Rinker (ed.) 2009. Lovelock himself already addressed global warming in Lovelock 2005 and Lovelock 2006.

**49** | Lovelock 2009, 22.

**50** | Ibid.

between orderly regulation and disorderly chaos. Who is to say that some unforeseen concatenation of effects or emergent phenomena might not throw a wrench into his scenario of runaway positive feedback regimes turning Gaia into a vengeful inferno? But it would be a long wager to bet on some unsuspected salvation without doing all we can to shift the odds in our favor. Many other clear-sighted and distinguished authors in the 2009 volume scale the mountain chains of alarming evidence for the climate crisis on the way to their own particular policy proposals and/or prescriptions for socio-political or Earth-ethical reorientations.

Our state of political semi-paralysis confronting the climate crisis is a glaring reminder that the modern West remains largely disconnected from a visceral relation to the material conditions of its own ecological survival. In Wells's The War of the Worlds, our modern detachment from bodily and environmental contingencies is displaced to the aliens. Wells's Martians are – among other things – the projection of a pervasive scientific and social, ultimately theological bias against the contingencies of organic embodiment as that is embedded in its coevolved material and planetary milieu. When the narrator recounts his opportunity to turn the tables on the aliens and be the agent of an active gaze, to be their observer and close scrutinizer, we learn that, »They were huge round bodies – or, rather, heads – about four feet in diameter, each body having in front of it a face […] Entrails they had none. They did not eat, much less digest. Instead, they took the fresh, living blood of other creatures, and injected it into their own veins.«[51] The constriction of embodiment to the head with the elimination of the limbs and torso replicates a more basic if factitious detachment of rational humanity from mindless nature. Indeed, our mindless modern bias against »lower« life forms extends all the way down to the germs: »Micro-organisms, which cause so much disease and pain on earth, have either never appeared upon Mars, or Martian sanitary science eliminated them ages ago.«[52]

Wells's text is strongly imprinted with Louis Pasteur's germ theory of disease and corollary breakthroughs in techniques of immunization, leading to the pervasive modern approach to the microbial realm. Wells's Martian invasion is not just an allegory of the British colonization of what was then Tasmania, which context the narrator makes explicit, but also,

**51** | Wells 2003, 143f.

**52** | Ibid, 147.

between the lines, an allegory of the germs in Pasteur's theory. And we postmoderns, too, continue to fight the war of the worlds right here on Earth, the war of the macrobes against the microbes. Lynn Margulis has written: »The great successes of modern medicine reinforce the idea of microbes as enemy. Cleanliness, sterilization of surgical instruments, and especially antibiotics are all described as weapons of war against microbial aggressors. The more balanced view of microbe as colleague and ancestor remains almost unexpressed.«[53] Margulis' long campaign to recuperate the dignity of the microbes transmits the soul of Gaian science.

Wells's novel does locate terrestrial bacteria in relation to biological evolution, but largely as aggressive arch-Darwinian competitors, intransigent enemies, by no means as evolutionary precursors. They make themselves known when a plant the Martians import to Earth, the Red Weed, at first enjoys invasive success, but then collapses, signaling the Martians' lack of immunity to Earth life:

In the end the Red Weed succumbed almost as quickly as it had spread. A cankering disease, due, it is believed, to the action of certain bacteria, presently seized upon it. Now by the action of natural selection, all terrestrial plants have acquired a resisting power against bacterial diseases – they never succumb without a severe struggle, but the Red Weed rotted like a thing already dead.[54]

And soon enough, the Martian invasion collapses altogether, as these cerebral blood-suckers, too, are »slain, after all man's devices had failed, by the humblest things that God, in His wisdom, has put upon this earth.«[55] In the midst of his Darwinian summation, in what appears to be a blatant short-circuiting of semantic wires, Wells's narrator reverts to a creationist cliché: only God may know for what reason he suffers the humble and otherwise dispensable bacteria to exist.

The notion of the text appears to be that the bacteria make a suitable meeting place to marry divine creation to evolutionary development. Bacteria would be a natural evil – merely a source of disease – from which the rest of life, culled through natural selection, receives some-

**53** | Margulis 1998, 75. For another connection between Pasteur and Gaia theory, cf. Latour 2013.
**54** | Wells 2003, 161.
**55** | Ibid, 181.

thing good –an evolved immunity. Thus the bacteria represent the naturalization of the diabolical within a larger salvational scheme. And in this sense, when pitted against the Martians, bacteria become our allies in the war to defend human dominion over the Earth:

> These germs of disease have taken toll of humanity since the beginning of things – taken toll of our pre-human ancestors since life began here. But by virtue of this natural selection of our kind we have developed resisting-power […]. But there are no bacteria in Mars, and directly these invaders arrived, directly they drank and fed, our microscopic allies began to work their overthrow.[56]

On the one hand, almost despite itself, The War of the Worlds gets right the fact that microbes are indeed our allies, our colleagues in the Gaian sense, co-workers on the maintenance of a living environment. Inadvertently, it also gets right that there are no bacteria (because no life of any sort) on Mars. But it gets wrong its assumption that »higher« forms of life are possible without the microbial foundation from which they have evolved and to which they remain in perpetual debt for the maintenance of their biosphere. As we have had the occasion to observe, a related conviction regarding the lack of life on Mars looms large in Lovelock's first formulation of the Gaia hypothesis. But on the other planetary hand, much as Wells had imagined, a Martian could have told that Earth has life, just by turning a spectroscope on a random sample of the improbably and continuously far-from-equilibrium state of its atmosphere. As far as we know, only living processes, metabolic activities pumping up reactive organic chemicals moment by moment, eon upon eon, can account for its enduring chemical imbalance rather than inertia.

Related to this insight is one of Lovelock's seminal and most profound Gaian hunches: »Long before Viking set course from Earth I felt intuitively that life could not exist on a planet sparsely; it could not hang on in a few oases [...]. As Gaia theory developed, this intuition grew; now I view it as a fact.«[57] This is where all such notions of the survival of life per se in scattered solitary units, on Mars or elsewhere, go wrong. Once established, living beings depend upon the vast cyclings of atmospheres and hydrospheres to bear the vigorous bioenvironmental – Ga-

**56** | Ibid.

**57** | Lovelock 1988, 6.

ian – fluxes that provide and replenish their nutrients and flush away their wastes. If life takes and keeps hold of a planet, this bio-logic runs, it will necessarily be planetary in scope. For a living planet such as ours, the by-products of metabolic processes have thoroughly infused and remade the air and the waters into mélanges of abiotic materials and post-biotic residues.[58] And it is not just that life leaves its traces as chemical signatures on our atmosphere. The atmosphere to which we are adapted and within which our tendril of the evolutionary bush is immersed is 99% biogenic, produced by living things over biogeological time. The air we breathe is not just signed by life on Earth: It is itself a signature of the inextricable coupling of life and Earth.

And yet, whether or not life ever existed there, it is evident that Mars and Venus once had water. Why has Earth retained vast oceans and ›a cloudy atmosphere eloquent of fertility‹ when Venus and Mars have not? According to Harding and Margulis, the answer is Gaia:

> [L]ife's populations persist and continue to expand on Earth not because a ›lucky accident‹ has situated our moist planet at an optimal distance from the sun; rather communities of living organisms have actively maintained wet local surroundings. The result has been the retention of moist habitability over geological time. [...] [W]ithout life's involvement in complex geological, atmospheric, and metabolic processes, Earth would long ago have lost its water, becoming a dry and barren world much like Mars and Venus.[59]

These authors parse the science to indicate the range and balance of biological and abiological processes that either desiccate the Earth or replenish or sequester its moisture. Their thesis is that such processes do not regulate the amount of water on Earth directly, but indirectly insure its retention by regulating the circumambient temperatures within ranges that prevent its eventual loss by atmospheric photo-dissociation. They draw their discussion toward a wonderful presentation of interlocking feedback loops that also gathers up the tectonic plates. The very movement and regeneration of the continents upon the surface of the planet may be bound up with Gaian cycles:

**58** | Cf. Volk 2003 and 2004.

**59** | Harding/Margulis 2009, 41. Cf. also Chopra/Lineweaver 2016; Grinspoon 2016, 57-81.

> Water infiltrates the laterally moving sea-floor basalt, changing its chemical nature so that it is pliable enough to sink into the Earth's mantle when it collides with the edge of a continent at a subduction zone […] Without subduction, plate tectonics would stop […] Without plate tectonics […] in tens of millions of years all the Earth's land masses would be removed by weathering, with no new granite to replace this loss. The long term carbon cycle would cease, and the Earth would perhaps be plunged into a permanently frozen state […] We therefore propose an interesting and appropriately circular Gaian dynamic here: no life, no water, no water, no plate tectonics, no plate tectonics, no life.[60]

If confirmed, here is another dynamic component to add to the list of fundamental geological processes taken for granted yet actively maintained by Gaian regulatory outcomes. Gaia theory continues to disrupt complacent notions that the atmosphere, the hydrosphere, or the geosphere stand outside the life they harbor. Rather, life and Earth are as co-evolutionarily interlocked as bees and flowers. The profound circular causalities of mature Gaia theory render quaintly anachronistic loose notions of planetary totalities yielding »one living organism«. Gaia's myriad biotic-abiotic loopings are systems theory's legitimate offspring, rightful heirs to the cybernetic conceptualities of the 1960's celebrated by the systems counterculture.

## Conclusion

Especially during the first two decades of its scientific course from hypothesis to theory, Gaia's mythological lure loomed as large as its conceptual grounding in cybernetic systems theory. What the name of Gaia was to cover or contain was miscomprehended by scientific critics and New Age enthusiasts alike. However, as Lovelock grew to appreciate, with Golding's literary push the mythic name of ›Gaia‹ generated a kind of magnetic resonance. Whatever it was taken to mean, its meme was unstoppable. Relative to the standard run of scientific concepts, the name of Gaia generated for its hypothesis and theory an uncommon amount of media attention, cultural conversation, and countercultural ferment over and above its share of scientific controversy. After over

**60** | Harding/Margulis 2009, 54f.

40 years and a series of theoretical refinements, Lovelock and Margulis' best geobiological insights have taken firm root. With the mainstreaming of Gaia theory in such fields as Earth system science, cosmic evolution, and astrobiology, a deep systemic vision now gathers to new scientific formations the long and global history of premodern intuitions about the intrinsic interconnectedness of Earth and life. Gaia theory now takes its place among wider researches toward ecological and systemic reconstructions of the conditions of knowledge altogether. In the effort to know Gaia, individual intuition surely plays a role.[61] But Gaia discourse provides the common medium of exchange.

*Fig. 7: Cosmic Evolution as depicted by the Exobiology program at NASA Ames Research Center, 1986*

Befitting both the long participation of Lovelock and Margulis in NASA programs and the funding NASA in its wisdom provided them when other sources were unforthcoming, Gaia discourse is the central subtext of an allegorical tableau of cosmic evolution produced by NASA artists as part of their ongoing program in exobiology, later renamed astrobiology.[62] Although his connection to that program ceased shortly before the landing of the Viking probe on Mars in 1976, for »Lovelock the Viking project was the cradle of his Gaia hypothesis.«[63] We can now appreciate the solid body of scientific effort and technological accomplish-

**61** | Cf. Harding 2006.

**62** | Cf. Strick 2015.

**63** | Dick/Strick 2004, 82.

ment from which this seed of a new scientific cosmology has sprung: »Indeed, under the name Earth system science the core of the modified Gaia theory is now mainstream science, but, say the critics, ›never under the name of Gaia.‹«[64] In like manner, both NASA and academic scientists now do Gaian work – they mediate Gaia – under other cover phrases such as cosmic evolution and astrobiology. Their inspiration is now the vision of a »living universe,« just as Lovelock has plied his metaphor of a living Earth. Following the detailed caption of the exobiology brochure, we wind from »the formation of stars, the production of heavy elements, and the formation of planetary systems, including our own« to »prebiotic molecules, RNA, and DNA […] formed within the first billion years on the primitive Earth.« Then, »the origin and evolution of life leads to increasing complexity, culminating with intelligence, technology, and astronomers […] contemplating the universe.«[65] In the distant conditions of life's cosmic chances we explore those of our own immediate possibility. The sentience that binds the microbe to the astronomer binds both to the evolving cosmos from which they emerge. To render this tableau fully Gaian, we must simply follow its line of development so as to close its loop. The observatory and the radio telescope on the mountain-top of cosmic evolution are pointed back at the Big Bang, while all above them wheel the circular formations of cosmic events. No matter how far we look and listen beyond our world, in those acts we also return to Earth and see ourselves anew.

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**64** | Ibid, 117.

**65** | NASA's Exobiology Program 1986.

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