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A number of prominent popular science writers have recently argued for the active appropriation of scientific language in the formulation of modern ideologies and ethical systems. A critical examination of scientific narratives in light of contemporary theories of metaphor and relevance suggests that scientific language indeed harbors the same emotive potential that is traditionally ascribed to religious language, and can exhibit potent transformative effects in shaping human thought. Also highlighted through this approach are the challenges of constructing scientific metaphors that are generally meaningful, accurate, and ethically responsible.

> The true evolutionary epic, retold as poetry, is as intrinsically ennobling as any religious epic. Material reality discovered by science already possesses more content and grandeur than all religious cosmologies combined.... *Homo sapiens* is far more than a congeries of tribes and races. We are a single gene pool from which individuals are drawn in each generation and into which they are dissolved the next generation, forever united as a species by heritage and a common future. Such are the conceptions, based on fact, from which new intimations of immortality can be drawn and a new mythos evolved.[1]
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> –Edward O. Wilson, *Consilience* [1998]

Personal reverie and "grandeur" aside, E. O. Wilson has proposed here a rather striking program for the intimate association of scientific "fact" and human ideology. And although he may be one of the most influential and visible proponents of such a program, he is certainly not alone. A number of prominent science writers have recently added their voices to the argument for the value of scientific understanding in the formulation of worldviews and ethical systems.[2] Their position suggests a growing conviction within the scientific community that scientific language might reasonably vie for a position alongside religious language (if not, as Wilson explicitly indicates, wholly replacing it) in the role of informing modern ideologies. Clearly such claims hold important implications for the dialogue between science and religion and for the popular conception of the roles these two disciplines assume in the shaping of human thought.

The role that religion plays in shaping ideologies and ethical systems has been widely explored and has been portrayed by some scholars as its primary function. In *The Interpretation of Cultures*, Clifford Geertz talks of religions as symbol systems that provide models *of* reality, as well as models *for* reality, by establishing "powerful, pervasive, and long-lasting moods and motivations."[3] Religious symbol systems not only tell adherents what reality is like, but also provide the structure by which they inform their activity within that reality. A number of detractors have claimed that Geertz' characterization of religion as a whole is insufficient; for the present purposes, however, it seems that Geertz offers, at the very least, a great deal of insight into the function of religious language in shaping human thought. The comparisons that

Wilson invites between scientific and religious *language* suggest that scientific language, too, might be profitably thought of in this light. Indeed, Wilson's arguments seem to imply that scientific language might serve the very function that Geertz outlines for religion. Certainly in the passage cited above Wilson appears to be suggesting that the facts of the evolutionary narrative might not only provide a framework for the understanding of "material reality," but might also serve to establish such "moods and motivations" that inform human activity in the world. Wilson ultimately applies this formulation to suggest explicitly that scientific fact can inform ethical systems—in other words, that scientific language not only serves the straightforward function of providing a model *of* the world, it also provides a model *for* the world.

The complex interaction between religious language and personal ideologies has, in more recent years, been the subject of a great deal of study, not least in theologian Sally McFague's seminal examinations of the role of religious metaphor.[4] Similarly, a number of texts have considered the role that scientific language plays in the development of scientific theories.[5] Although these latter works have reflected on the role of models and metaphors *within* science, the implications of such language for popular ideology outside of science are largely not addressed. What is required is a critical assessment of such arguments as Wilson's. Can scientific language really hope to provide the kind of meaningful models for human attitudes toward the world (assuming that one of science's most widely accepted functions is to provide models of the world) that are traditionally ascribed to religious language? If so, what responsibilities does science have in forwarding particular narratives as aspects of a "new mythos"? In particular, how can scientific "facts" be translated into language with positive transformative power?

Can scientific language really hope to provide the kind of meaningful models for human attitudes toward the world that are traditionally ascribed to religious language? How can scientific "facts" be translated into language with positive transformative power?

It is the aim my aim here to attempt to address such questions. The first section examines both the extent to which scientific language is capable of informing ideology, and the active role that science must play in proffering scientifically informed worldviews. Contemporary theories of metaphor and relevance will be employed in an attempt to evaluate accurately the potential efficacy of scientific metaphor in shaping popular thought. The second section explores these findings in the context of a case study, by considering the scientific theory of geophysiology (more popularly known as Gaia theory) and its ramifications for understanding metaphor as a link between science and popular thought. By exploring these topics it may be possible to move the discussion of scientifically informed ideologies toward a more thorough understanding of how science can positively play a role in the influence of contemporary worldviews.

Scientific language in light of theories of metaphor and relevance.

The importance of metaphor in the communication of theory within the scientific community is frequently noted, and many scholars have pointed to the futility of insisting that science make greater attempts to eschew figurative language. This futility is perhaps not surprising, given the ubiquity of metaphor; as linguistic theorist Andrew Goatly writes, "metaphor is not something that can be easily confined, but is an indispensable basis of language and thought."[6] More importantly, however, philosophers of science and linguists alike have also emphasized that metaphor provides an essential function in scientific inquiry, contributing most obviously to the fertility of scientific theories.[7] Thus, it is to some extent the ambiguity and vagueness of scientific language that provides what Ian Barbour calls "a continuing source of possible applications, extensions, and modifications of theories."[8]

Similarly, metaphor must play a vital role in the communication of scientific understanding beyond the boundaries of academic science. Here also the necessity of metaphor is apparent. A recent survey of metaphor content in a variety of written and spoken language genres shows that in popular science writing 18% of the total language can be characterized as active metaphor.[9] (Compare this figure to values such as 28% for modern novels, 10% for conversation, and 4% for national news reports.) But what is the function of such metaphors? Do they simply provide the best approximation of scientific theory that is accessible to a popular audience? Or can they, as Wilson suggests, actively inform popular attitudes toward the world?

On one level, metaphor can simply be understood as "an invitation to make comparisons."[10] The propositional form that the metaphor takes differs in some way from the referent of the metaphor, forcing an assumption on the part of the listener that these two things have some identifiable commonality.[11] Thus, the proposition, "he flew from the room," invites an assumption that something about this individual leaving the room is similar to the act of (say, a bird) flying. The interpreted thought (the individual leaving the room) differs in a concrete way from what is proposed in the structure of the metaphor (the individual "flew"), but stimulates a comparison between the two forms. Specifically, "the metaphorical meaning ['he flew'] does not belong to the target item's [the individual leaving the room] field of experience, or domain."[12]

In light of this characterization of metaphor, Wilson's statement that "we are a single gene pool" is seen not to be a literal observation, but a metaphorical one. Clearly there are concrete differences (embodiment, culture, society, to name a few) that exist between the human species as a whole and the set of alleles that constitute its "gene pool." But Wilson's metaphor constructs a situation in which the reader is forced to recognize that there are similarities between these two entities. (It is interesting to note that "gene pool" itself is a metaphorical construction, one which Wilson plays off of eloquently in his language of "drawing from" and "dissolving into.") The experience or domain of humanity does not include the experience of being a "gene pool" (whatever that experience might be), any more than the experience of any single individual includes the experience of "flying" from a room.

How is it, then, that metaphorical construction alters the meaning of the literal proposition? In one sense, the meaning of the metaphorical statement is increased by its intended implicit information content.[13] In the previous example, the verb "flew" implicitly informs the listener's conception of how this individual left the room; thus "he flew from the room" might change the interpretation of the proposition from "he left the room" to "he left (swiftly) from the room." The most important aspect of this implicit information content, however, is that it produces an emotional effect in the listener that alters the meaning of the proposition.[14] The proposition "he flew from the room" conveys emotional content that is lacking in the literal and emotionally neutral proposition "he left the room." Such emotional content may be ambiguous; in this particular context, it depends most obviously on whether the individual is flying from something or flying to it. Nevertheless, the metaphor possesses emotional information that is absent from the literal proposition.

This discussion may provide some insight into what exactly is intended in Wilson's description of humanity as "a single gene pool." The metaphorical construction is calculated to provide implicit information with emotional content. Specifically, the language of the gene pool is meant to introduce content of inclusiveness and unity that Wilson apparently sees lacking in other propositional constructions of the form "humanity is...." Individuality is lost in the "gene pool"; the comparisons are implicitly drawn between the human species and an entity in which the "individual" (the set of genes possessed by a single human organism) is reduced to a transient subset of the whole. The emotional content of the concept of such intimate unity (so intimate that the individual, in our common-sense definition, no longer exists) is central to Wilson's use of the metaphor.

One further aspect of metaphor deserves consideration in the context of this discussion. Linguists have devoted a great deal of study to the pervasiveness of ideological metaphor in human communication. The emotive content of metaphor suggests that metaphorical constructions (and arguments from analogy in general) possess the capability of influencing attitudes and informing human activity. They "seem to be embedded in the sphere of human activity in the world. They argue for doing something."[15] This persuasive aspect of metaphorical language has been recognized not only in terms of literary metaphor,[16] but also in terms of common language and the emotive and constructive (or destructive) power of "root analogies."[17] Such analogies are deeply embedded in human linguistic constructions, and powerfully inform human attitudes and activity. One striking example, cited by Goatly,[18] is that of the analogical equivalence of "first" and "important" (as evidenced in the common saying, "First things first") and the influence that such a root analogy has had on global politics in reference to the metaphor of "Third World countries."

This emotive power of metaphor to shape attitudes and induce activity is at the root of Wilson's use of the "We are a single gene pool" metaphor. The implicit and emotive information content of the metaphor is not simply intended to convey the equivalence of humanity with Wilson's view of a unified, non-individualistic entity. It is, by extension, meant to induce people to act in response to this implicit information in a manner that reflects that unity. This is ultimately the intention of Wilson's adoption of such evolutionary metaphors; the "facts" of evolution, imparted with emotive power through metaphorical construction, are intended to inform an ethical system in which humans act in a manner consistent with their common genetic heritage and future.

By now, however, it may appear obvious that some other considerations must be made in evaluating scientific metaphor. Specifically, although for Wilson the concept of the "gene pool" is connected emotionally with concepts of unity, heritage, and even "immortality," one might wonder just how much of this intended implicit information content is transferable to the reader of the text. Clearly, this all depends very much upon who that reader is. Relevance theory is an area of research designed to assess the theoretical interaction between information and its interpreters, and has been applied to the investigation of metaphor in the context of its ability to inform the reader or listener. At the most basic level, relevance theory states that information gains relevance for an individual through interaction with that individual's personal thoughts and beliefs.[19] However, a good deal more sophistication enters into the calculus of just how such interaction occurs. Sperber and Wilson provide one of the most straightforward methods of assessing relevance in terms of two separable means in which information interacts with the specific individual's thoughts and beliefs.[20] The first of these is described by the "contextual effect" of information. The greater the contextual effect, the greater the relevance. To provide a simplistic illustration, the statement, "The orchestra built a cathedral of sound," might provide a great deal of meaning to someone intimately familiar with religious architecture; somewhat less to an individual who has seen photographs of cathedrals but never been inside one; and virtually nothing to someone who replies, "What's a cathedral?" In order to be relevant, the domain of the proposition must have some referent within the domain of the interpreter of the proposition.

The second influence on relevance is the "processing effort" required actually to understand the proposition, which relates to the complexity of the proposition and that of the concepts embedded within it. The metaphor above ("cathedral of sound") requires relatively little processing effort, although it might be considered more difficult to process than the previous example ("He flew from the room"), if only for the potential difficulty in digesting the concept of a "structure of sound." This processing effort relates in an inverse manner to the relevance of information: the greater the processing effort, the lower the relevance. Thus, relevance can be represented in total as proportional to the contextual effect divided by the processing effort.

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What becomes immediately obvious is that scientific metaphor (at least in the context of extradisciplinary communication of information) most often concerns itself with inherently high processing effort. The language of much contemporary science is highly technical and highly specialized; for individuals unfamiliar with a particular scientific discipline, the effort required to process information from within that discipline is potentially enormous. Thus, it has been observed that the language of popular science (which is, by definition, communicating outside the discipline) requires a concerted effort on the part of the scientist ("addresser time"), in order to provide metaphorical constructions that require relatively little processing effort ("addressee time").[21] Considering the language of academic scientific journals, one would expect this imbalance to shift markedly to the other side, with a great deal more addressee time required and a great deal less expenditure of addresser time to simplify the language in which the information is conveyed.[22]

This requirement for active reduction of processing time in popular scientific literature has led to an unusually high utilization of the particular form of metaphorical construction known as the transfer metaphor.[23] Transfer metaphor represents the greatest degree of dissimilarity between the metaphoric proposition and its specific referent; it is a heuristic tool for transferring difficult-to-process information into an easily processed form. A typical scientific transfer metaphor (familiar to anyone who has gone through a basic cell biology course) is the statement that "the mitochondrion is the power plant of the cell." There is virtually nothing at all that is similar between a mitochondrion and a power plant, with the exception that, in both, raw materials are converted into usable energy forms. But this one similarity is the very point that the metaphor wishes to stress; and by executing the transfer, the complicated biochemical and cell biological entity, "mitochondrion," is made available in a form that is more accessible to the non-biochemist. Transfer metaphor, in general, is a highly utilized form of metaphor; in the survey of genres mentioned above, transfer metaphors represent on average 70% of all metaphorical language. In the case of popular scientific writing, however, this number skyrockets to 97%; virtually all metaphorical language in this genre requires such radical reconceptualization.

All of these forces are at work in Wilson's constructive use of the "gene pool" metaphor. "Gene pool," as a scientific concept, represents a description of the set of alleles among the reproductive members of a given population (in the case of "humanity," that population being the species, *Homo sapiens*). It is also intimately linked with an understanding of how allelic frequencies contribute to the genetic composition of that population. The introduction of the concepts of alleles assumes some sophistication in processing, requiring some understanding of how individuals contribute statistically to the overall allelic population. The metaphor of the "gene pool" does more than just simplify the language. The set of alleles concerned is not literally a "pool" any more than the money collected for a little intra-office gambling on the NCAA championships is literally a "pool." But in both cases, the metaphor encourages the recognition of conceptual similarities that provide implicit meaning to the proposition. The "pool" is something into and out of which something flows, whether it is money or the particular set of alleles that can be ascribed to one reproductive individual. It is this conceptual bridge that Wilson seeks to build in utilizing the metaphor; and, thus, by transferring a relatively complex scientific concept into a relatively simple and easily processed metaphor ("pool"), he is able to increase greatly the relevance of his statement to the general reader. The implicit depiction of individuals flowing into and out of a more or less constant "pool" that is humanity is powerfully emotive, and designed to induce moods and attitudes appropriate to the feeling of unity and flow implied in the metaphor.

From its inception, Gaia theory has not only played an important role in informing scientific research on planetary ecosystems and global homeostasis, but has also served as an unusually complex model for the role of metaphor in scientific discourse.

The question of contextual effect, I think, remains more elusive. How does the metaphor of the "gene pool" interact contextually with the thoughts and beliefs of the reader? The "pool" metaphor generally possesses high contextual effect, even for a general audience. Nevertheless, for some individuals (e.g., those with relatively little familiarity with the concepts of evolutionary biology and unsure as to how humanity might relate to its gene pool), the metaphor may be less contextual, and may lack relevance, despite the efforts of Wilson to reduce the processing effort. For others (e.g., individuals like Wilson himself, fluent in the language of evolution and possessing an intuitive understanding of these concepts), the contextual effect may be great. There may also be other factors, beside familiarity with scientific concepts, that determine the contextual effect of the metaphor. It is interesting to note here that, even within the academic study of science, a variety of different metaphors have been adopted to explain the same observations. The cultural influences on the development of such metaphors in evolutionary biology have been noted,[24] and it is not difficult to see that contextual effect has played the major role in determining which metaphors have been adopted by which individuals (or groups of individuals), despite the arguable equivalence in the effort required to process these metaphors. In any case, a great number of factors may contribute to the contextual effect of a given scientific metaphor, and the overall effect may, therefore, be difficult to predetermine.

It appears that theory of metaphor and relevance can, initially at least, support Wilson's assertions regarding the possibility of scientific language serving transformative functions, providing that the language is actively metaphorical. This support stems from the very nature of metaphor, which serves to provide emotionally laden, implicit information that is capable of generating attitudes toward reality and, ultimately, of informing human activity. It is interesting that Wilson explicitly acknowledges the importance of metaphor in this respect, appealing to scientific concepts "retold as poetry." This point must be stressed. It is not enough to say that scientific "fact" alone can serve the function that Wilson advocates. Literal scientific language (or literal language of any sort) does not necessarily possess the emotive (and, thus, ultimately transformative) power inherent in metaphor.

Assuming, then, that scientific metaphor, just as religious metaphor, has the potential to inform ideology and ethics, the caveat that must be addressed is the relevance of scientific metaphor. How can science provide narratives that are relevant to a popular audience, relevant enough to effect changes in attitudes and activity? A good deal of work has been done on maximizing relevance of religious language. Feminist theologies, for instance, often ground themselves on the assertion that many traditional religious metaphors are rooted in a male-centered contextual framework and lack, therefore, the contextual effect needed to make them maximally relevant to female believers. Discussions in religious circles concerning increasingly "inclusive language," thus, refers directly to attempts to increase the relevance of religious metaphor through increasing contextual effects. Similar questions must be posed in the scientific context. The difficulty of processing effort is intuitively noted among science writers, as evidenced in the extraordinarily high frequency of transfer metaphors. The issue of how scientific metaphor can maximize its relevance by actively addressing contextual effects must also be taken into consideration, and it is here that the ultimate efficiency of scientific language in shaping ideologies may be determined.

How do scientists engage in this maximization of relevance? I now present a case study of a particular scientific metaphor, to examine the different ways in which scientists have constructed language to inform a general audience, and the issues that these differences raise for the possibility of truly transformative scientific narratives and the responsibility of scientists in actively formulating such narratives.

A case study: Gaia theory

Gaia theory is the brainchild of James E. Lovelock, stemming initially from his work in the 1960s for NASA on the examination of possibilities of life on other planets in the solar system, particularly Mars.[25] Through observations of atmospheric conditions on Earth and other planets, as well as through modeling of atmospheric conditions on a hypothetical Earth devoid of life, Lovelock came to the conclusion that the radically non-equilibrium composition of Earth's atmosphere could result only from active maintenance by living systems. By the late '60s, Lovelock had formulated the following hypothesis:

> The chemical composition of the atmosphere [of Earth] bears no relation to the expectations of steady-state chemical equilibrium. The presence of methane, nitrous oxide, and even nitrogen in our present oxidizing atmosphere represents violation of the rules of chemistry to be measured in tens of orders of magnitude. Disequilibria on this scale suggest that the atmosphere is not merely a biological product, but more probably a biological construction.[26]

Lovelock's vision was of an entity of planetary scale, one actively participating in a homeostatic process that provides for the maintenance of atmospheric conditions optimal for living systems. The unusually evocative name for Lovelock's hypothetical supersystem was provided by novelist William Golding, who recognized the metaphorical link between a unified planetary-scale entity and the ancient Greek conception of the Earth goddess. From its inception, then, Gaia theory has not only played an important role in informing scientific research on planetary ecosystems and global homeostasis, but has also served as an unusually complex model for the role of metaphor in scientific discourse.

The utilization of Gaia is, perhaps, one of the most extraordinary examples of scientific transfer metaphor available. Lovelock originally defined Gaia as

> a complex entity involving the Earth's biosphere, atmosphere, oceans, and soil; the totality constituting a feedback or cybernetic system which seeks an optimal physical and chemical environment for life on this planet.[27]

This proposition differs so radically from the metaphorical proposition "the planet Earth is like the ancient Greek Earth goddess," that it is hard to imagine Lovelock's justification in choosing the metaphor. It is clear from his own descriptions of the early phases of the theory that Gaia was chosen both for its ability to reduce the processing effort associated with the complex scientific concepts embedded within his hypothesis, and also for the explicit contextual relevance possessed by the concept of the Earth goddess.

Lovelock's discussions of Gaia theory are replete with depictions of the Earth as an "organism," as the "living planet", or as "a total planetary being."[28] His personal interpretations of his own scientific observations suggest that the resemblance between, on the one hand, the complex integration of nonliving and living systems on a global scale and, on the other hand, a single living organism were sufficient to warrant the use of such transfer metaphors. It is, in part, this organismic unity that is communicated in the utilization of the Gaia metaphor. In addition, the language of Gaia seems to argue not only for a planetary-scale *identity*, but also for a planetary-scale *agency*. The idea that the Earth participates actively and *intentionally* in the homeostatic regulation of its atmosphere in a way that is optimally conducive to the maintenance of life is another integral aspect of Lovelock's conception of Gaia. This idea of purposeful action is, in many ways, a teleological interpretation of the unlikelihood of attaining such optimal conditions without some sense of intentionality. The metaphor of Gaia thus implicitly conveys the aspect of agency inherent in Lovelock's personal rendering of the scientific evidence for his theory. What becomes clear, then, is that Lovelock's adoption of the Gaia metaphor is intended to convey implicit information that is not inherent to the data—in other words, information that does not belong to the domain of the referent.

In retrospect, Lovelock could not have chosen a more effective metaphor. Not only has Gaia stimulated a growing debate within the scientific community over the various aspects of homeostatic regulation on a planetary scale (including the organization of international conferences on the subject, the second of which was held in 1996 at Oxford), but it has also insinuated itself into the public consciousness to a degree that few other scientific metaphors have. Various groups dedicated to the kind of holistic ontology represented in the Gaia hypothesis have actively appropriated the metaphor.

Most particularly, social action groups have employed Gaia to further environmental and ecological consciousness and to stress the importance of acting toward the Earth in a manner that is commensurate with its newfound identity as organism or even goddess. The metaphor has further found itself adopted by a variety of "New Age" organizations, which see Gaia as scientific support for a spiritual and/or mystical association with the Earth; such personification has brought Gaia into intimate conversation with other aspects of New Age movements, specifically goddess worship. In short, the Gaia metaphor has stimulated emotional responses, attitude changes, and human activity in an almost runaway fashion.[29]

The response of scientists to this massive popular appropriation of Gaia has not been overwhelmingly positive. Lovelock himself has turned away from his original metaphor, now adopting the language of "geophysiology," a metaphor that maintains the association of the Earth with an organismic unity, but severs connections with the concepts of personality and spirituality that have become intimately tied to the popular conception of the Gaia metaphor. Lynn Margulis, one of the few early supporters of Lovelock's theory and an important contributor in her own right, vehemently opposes the popular distortions of the scientific basis of Gaia theory by "anti-science and anti-intellectual folks."[30] "Gaia is no vague, quaint notion of a mother Earth who nurtures us. The Gaia hypothesis is science."[31] Margulis sees it as important to stress the scientific basis of Gaia theory and the value of the theory in promoting a research program. She notes that the affinity of New Age groups for Gaia and the fact that the metaphor stimulates in the public consciousness direct associations with mythic beliefs subject the theory to the criticism of being "unscientific."

Many within the scientific community argue that Gaia is metaphor gone bad. So radical a transfer metaphor has imparted information that was never intended, and the subsequent distortions of the message have been so great that the popular conception of Gaia theory no longer bears any relation to the science it was meant to communicate.

Her fears are likely not unfounded. Lovelock and Margulis belong to a relatively small group of scientists who support what is known as "strong" Gaia theory, only one of many theories that fall under the rubric of Gaia theory as a whole. In its strong form, the theory suggests an active role of the living planetary supersystem in maintaining conditions optimal for life. Other forms range from "influential" Gaia, which accepts that living systems influence such abiotic planetary-scale functions as atmospheric composition and temperature, a hypothesis that is widely accepted and described by Margulis as "old news": to "teleological" and "optimizing" Gaia theories, which comprise the "strong" Gaia supported by Lovelock and Margulis.[32] It is perhaps not surprising that strong Gaia theory has encountered resistance from the scientific community, given that community's tendency to eschew language of teleology in explaining natural phenomena. The struggle for strong Gaia supporters within the scientific community appears to be difficult enough, without accusations that the theory lends itself to spiritual and mystical interpretations of planetary systems.[33]

One thing that is clear is that scientific metaphor lies at the heart of this debate. How do the metaphors through which science is communicated to a general audience alter the science itself? When does the acceptable science of cybernetic homeostatic systems on a planetary scale cease to be science and start to become New Age spirituality or environmental rhetoric? On the one hand, it is possible to argue that the Gaia hypothesis represents scientific metaphor at its very best. Within the scientific community, the ambiguities implicit in the association of Lovelock's data with the Earth goddess have stimulated ferocious debate and encouraged a great deal of research designed to specify more convincingly the nature of the planetary homeostatic tendency. As far as a more general audience is concerned, Gaia demonstrates conclusively that Wilson is right—scientific language can (and *does*) possess the same kind of transformative power that religious narrative can provide. Gaia has altered human attitudes toward the planet at large and, in doing so, has stimulated human activity commensurate with those attitudes.

The ambiguity and imprecision of scientific metaphor is both the means to the construction of powerfully emotive scientific language and the means to the potential obfuscation of the concepts it is meant to convey.

On the other hand, however, many within the scientific community argue that Gaia is metaphor gone bad. So radical a transfer metaphor has imparted information that was, in fact, never intended; and the subsequent distortions of the message have been so great that the popular conception of Gaia theory no longer bears any relation to the science it was meant to communicate.

In this new light, how are Wilson's claims to be read, that science "retold as poetry" can provide the foundations for narratives with transformative power? Certainly Lovelock's Gaia represents science retold as poetry. Is it just *too* poetic? Metaphor, through its implicit and emotional information content, may be seen intentionally to invite interpretation. The danger of metaphor is that it also invites *mis*interpretation, or as one linguist puts it, "surplus interpretation."[34] Effective metaphor can convey in a relevant fashion the information present in the original, non-metaphoric proposition. But it also always conveys more. To say that the mitochondrion is the power plant of the cell conveys, in a processing-friendly and contextually effective way, information regarding the role of the mitochondrion in cell metabolism. But it also provides implicit information that potentially misinforms the interpreter regarding the nature of the mitochondrion. So with Gaia theory, and so also, potentially, with Wilson's metaphor of humanity as a gene pool. This ability to convey misinformation is an inescapable aspect of metaphorical language, and its consideration has important implications for the possibility of formulating transformative scientific narratives. The ambiguity and imprecision of scientific metaphor is both the means to the construction of powerfully emotive scientific language, and the means to the potential obfuscation of the concepts it is meant to convey.

The problem of constructing meaningful scientific narratives is, thus, a delicate balancing act, between providing contextually effective and understandable metaphors on the one hand, and maintaining precision and scientific rigor on the other. What the present understanding of metaphorical language suggests is that science cannot forego the former if it is to provide language that is meaningful and potent, in the sense of establishing effective models *for* reality. This function of scientific language relies heavily on metaphor to convey implicit and emotive information content to the interpreter.

Lynn Margulis and other scientists who oppose the distortions of Gaia theory that accompany its appropriation by various environmental and New Age groups present an important critique of scientific language, and in particular of Wilson's claims that it can stand beside religious language in molding human attitudes toward reality. Yes, it works; but what results can hardly be called science! If science wishes to play a role in shaping ideologies, however, its reaction must not be to insulate itself from a general audience or readership by limiting the accessibility of its language. Only by an active participation in the discussion and reevaluation of scientific metaphor, can science play such a role. It is not enough to chastise the "environmentalists and religiously-inclined people...[for] giving Gaia a distinctly nonscientific connotation."[35] After all, if such people bring nonscientific, surplus meaning to scientific metaphor, they are doing only what the very nature of metaphor invites them to do. It is necessary, rather, to enter directly into discussion with such people and actively establish new metaphors that better reflect the scientific reality and yet retain the ability to motivate emotionally and to stimulate positive activity. If science is to enter into the game of contributing to the construction of human ideologies, then it must come ready to play. Metaphor is science's most powerful tool in its attempts to shape human thought and action, but it is one that must be handled with care.

Responsible scientific metaphor and contemporary ideologies

It seems, then, that scientific language is in no way inherently incapable of providing meaningful and transformative narratives. Despite the deeply technical and specialized nature of much of today's science, and despite accusations from its detractors of coldness, detachment, or even nihilism, science has the capacity to spin tales that possess real meaning and ideological value. Perhaps the reason behind such impassioned statements against science is the misconception that science deals exclusively in facts. And facts, as we all know, are cold and hard. Facts alone are inert and unreactive. They lack the capacity to draw out the emotions, to make action imperative. Science, however, does not trade in mere fact. Scientific facts are communicated in language, and (for the most part) the language of science is the same language used in any communication. It is part of the job of the scientist to effect such transformation of fact, to turn simple observations of the world into accounts of what our world is like. And in doing so, fact is potentially transformed, through language, into narrative that is moving, engaging, and even, as Wilson puts it, "sacred."

But this task of transformation is not one to be taken lightly. To suggest that scientific fact can form the basis of ideologies and ethical systems is not to say that it is a simple matter of observing the world and translating those observations into parables that help us lead our lives. The construction of scientific metaphor is an active pursuit, and when one combines the emotive power of such metaphor with the fact that intentional misinformation is inherent in any metaphoric construct, the danger becomes readily apparent. It is one thing for a first year biochemistry student to have over-anthropomorphized the mitochondrion, or even for a New Age mystic to claim 'scientific support overzealously for an Earth goddess. It seems quite another when one encounters such interpretations as the following:

> I wish very much that the wrong people could be prevented entirely from breeding; and when the evil nature of these people is sufficiently

flagrant, this should be done. Criminals should be sterilized and feeble-minded persons forbidden to leave offspring behind. The emphasis should be on getting desirable people to breed.[36]

It is tempting to ascribe such words to the marginal eugenic fanatics of the world. These particular words happen to come from Theodore Roosevelt. And the President was not alone; many other prominent and well-respected individuals have provided the world with similarly spectacular statements. Linus Pauling, one of the greatest minds the field of biology has ever known, winner of not one, but two, Nobel Prizes (one for Peace), once remarked (apparently quite earnestly) that in the future all individuals should be branded with an encoded representation of their exact genotype, so that

> two young people carrying the same seriously defective gene in single dose would recognize the situation at first sight and would refrain from falling in love with one another.[37]

Is any more definitive evidence needed to support claims of the ideological potency of scientific language? What the above statements indicate more than anything else is the way in which the metaphor of "natural selection" has insinuated itself convincingly into popular thought, and its success in motivating worldviews and ethical systems throughout the Western world. It is interesting to note that in Geertz' definition of religion, he considers that religious symbol systems establish conceptions about reality and proceed in

> clothing these conceptions with such an aura of factuality that the moods and motivations seem uniquely realistic.[38]

And this is precisely what has happened with "natural selection." This phrase is not *fact*; it is a *metaphor* adopted to communicate a diverse set of observations about the natural world in a manner that is relevant to a general audience. Most evolutionary biologists will rail regarding the inaccuracy of considering "natural selection" as an intentional process, with nature acting as a conscious designer, weeding the bad out of the good, with a mind to ineluctable progress up the evolutionary ladder. Such conceptions are the motive behind a number of "intelligent design" formulations of the evolutionary process, which are frowned upon by the vast majority of biologists. And yet the primary metaphor for evolution is this one of "natural selection," and it is not difficult to see how this metaphor conveys the implicit information of intentionality.

Science may have a great deal to learn from religion. Though religious narrative demonstrably plays a powerful positive role in shaping human lives, it has also provided many striking examples of the potential dangers of untamed metaphor.

It is, furthermore, not difficult to see how this surplus interpretation of intentionality has informed ideology. If nature can serve as the agent of evolutionary progress, then why can't we? Selection is a process with which humans are inherently familiar; it possesses great contextual effect. It draws out such emotionally laden concepts as choice between better and worse, and the possibility of active improvement. It invites human agency. And given such invitations, combined with the potency of the "natural selection" metaphor and its "aura of factuality" (stemming from its association with scientific "fact"), it is not at all surprising that humanbeings should have begun to take the process of selection upon themselves. And from here, it is only a matter of detail before we are potentially faced with human ideologies, strongly informed by scientific language, which confront us with pressing moral and ethical dilemmas.

Scientific metaphor is, thus, subject to every criticism that has been directed at other traditionally recognized sources of ideology and ethics. In this sense, science may have a great deal to learn from religion. This older sibling of science, after all, has been in the business of shaping ideologies for some time now; and, though religious narrative demonstrably plays a powerful positive role in shaping human lives, it has also provided many striking examples of the potential dangers of untamed metaphor. What modern critiques of religious language teach us can and must be equally applied to scientific language. Although the latter is capable of similarly contributing positive transformative narratives, it can also provide equally damaging worldviews, can offer metaphors that are equally exclusive and non-contextual for minority groups, and can provide equally powerful motivation for human activity that borders on inhumanity. The claim that science can form the basis of a positive new mythos is just as much a claim that science can form the basis of a negative one.

The important realization, then, is that scientifically based ideologies are a function of scientific language, and not a function of scientific fact. Scientific language has the capacity to translate the concepts of science into a form that moves and motivates, that shapes human thought and encourages human activity. But scientific fact itself underdetermines ideology—no unique worldview or ethical system can be generated from the vast library of cold, hard facts. Those various worldviews and ethical systems that are so generated must, therefore, be subject to the same scrutiny that any modern ideology is subject to; there is no exemption granted for being derived from science. A detailed look at scientific language demonstrates convincingly that there is no reason to leave science out in the cold when it comes to the important task of shaping contemporary ideologies and ethics. Science can become an integral participant in this conversation. But it must do so with a willingness to engage non-scientists actively in constructing metaphor that is scientifically accurate *and* generally relevant. And it must recognize also that a basis in scientific fact does not a good ethical system make. Scientific and religious narrative alike must be scrutinized in an effort to provide positive meaning and direction for our species now and into the future.

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Endnotes:

1. Wilson, p. 289.
2. See Mayr; Dawkins.
3. Geertz, p. 90.
4. McFague, *Models of God*, and *Metaphorical Theology.*
5. Ruse; Keller.
6. Goatly, p. 1.
7. Barbour; Ruse; Goatly.
8. Barbour, p. 116.
9. Goatly.
10. Ibid., p. 107.
11. Sperber and Wilson.
12. Brandt, p. 144.
13. Ibid.
14. Ibid.
15. Goatly, p. 152.
16. Steen.
17. Goatly; Lakoff and Johnson.
18. Goatly, p. 150.
19. Ibid., p. 137.
20. Ibid.; see also Sperber and Wilson.

21. Goatly.

22. To my knowledge no such assessment of metaphoric content of academic science writing has ever been done.

23. Goatly.

24. Ruse.

25. Lovelock, *Gaia*.

26. Ibid., p. 10.

27. Ibid., p. 11.

28. Ibid.; Lovelock, *The Ages of Gaia*.

29. Consult the website at URL, <www.magna.com.au/~prfbrown/gaia>, for an excellent resource on Gaia and Gaia-related topics, such as New Age appropriations of the metaphor.

30. Margulis, p. 118. Information in the following discussion of Gaia theory are presented in the final chapter ("Gaia") of Margulis' book.

31. Ibid., p. 123.

32. Kirchner, p.38.

33. See Margulis for a more detailed discussion of the debate within the scientific community on various aspects of Gaia theory.

34. Brandt, p. 123.

35. Margulis, p. 118.

36. Quoted in Howard and Rifkin, p. 45.

37. Ibid., p. 81.

38. Geertz, p. 90.

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