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ECOLOGY AND THE CLAIMS FOR A SCIENCE-BASED ETHICS

Erazim Kohák loves the forest. He spends much of his leisure there, and he has written eloquently of it as a paradigm of nature, specifically searching for an ethics based on our relation to nature. He seeks to ascribe meaning to Nature. How is Nature itself, and especially our relation to it, Meaningful to us, and perhaps more importantly, what is our responsibility to Nature. Our age has witnessed an increasing insularity from the natural world. Both individually and as a culture, we spend a large part of our national fortune on dissecting natural phenomena in order to control nature for our purported economic and social welfare, and the technological product of that endeavor has had a tremendous price. Erazim has been an important voice in attempting to assess that cost, a powerful witness to how we must still account for a humane philosophy of nature even as we recede from it in the guise of controller.

The fulcrum of my discussion rests on Erazim's passionate articulation of a biocentric[1] ethic. As he recently lectured (1994a),

> Every living being, in its strenuous effort to remain alive... testifies that its own life is a value for it … The prereflectivity given rule of all life is that life is a value for itself- and as such, a value in itself, internally, quite independently of the- existence or of the acts of any other being whatever. Life is good in itself he-cause It is good for itself Wherever there is life, there is value. That is (he point: a biocentric cosmos is not a value-neutral one.

This perspective arises from Erazim's well-known phenomenological approach, where he maintains that we remain within a meaningfully ordered, value-indexed world, and more to the point, this is not simply a result of human reflection, but is constituted by life as such.

I might agree with his overall moral position for different reasons, but my discussion is only peripherally concerned with the ethics, per se. Instead I seek here to situate what I perceive to be a fundamental confusion concerning how that position may be derived inappropriately from biology, how science has been co-opted to serve an ideologic agenda. Erazim is not himself guilty of arguing how an ecological ethics purportedly arises from science,[2] but many do, and my concern here is to dissect how an ideology, even a moral philosophy of nature, would usurp science for its own ends; these final ethical stances founded on other principles may be legitimate in themselves, but to use science surreptitiously is dangerous business, and we must be aware of the true basis of the arguments employed to fulfill essentially a political agenda. The issue that raises my ire is simply this: Much of what passes as ecological ethics claims that unlike other ethical ventures based on religious or metaphysical foundations of belief, these ethics are rooted,

in fact "proven" or "demonstrated" by the incontestable facts of a new science - ecology. For if laboratories can demonstrate the deleterious effects of aerosols in the atmosphere, or particularly toxic chemicals in our rivers, or automobile fumes in our cities, then is it not senseless, if not immoral to continue along the path of environmental degradation? From this perspective, there is a seamless joint between the findings of ecologists as scientists and the values drawn from their studies.[3]

Why and how is the claim made, and is it legitimate? There are many reasons that might be conjured to support an environmental ethics, and I will only mention two. The first is a utilitarian imperative, which seeks to root ethical decisions in an objective accounting of gains and losses. Here we invoke the power of an objective science to attain that rational ideal; seemingly innocuous interpretations of the objective data offer the obvious utility by which rational choices might be made. But such choices of course have a moral setting, which while framed by our scientific understanding, is hardly neutral. As Luc Ferry puts it, there is a syllogism at work:

1. The biological sciences, including ecology have disclosed that organic nature is systematically integrated:

2a. That mankind is a non-privileged member of the organic continuum, and

2b. Environmental abuse threatens human life, health, and ultimately happiness, therefore

3. We ought not violate the integrity and stability of the environment (1995, p.88)

Like any utilitarian argument, one may contest its relative merits. In this case, the ecological syllogism fails to acknowledge the relativity of the ideal, "health." Moreover, it asserts a nonnormative analysis of what we, de facto, are supposed to love or abhor. "The ethical criteria becomes identified with what empirical anthropology leaches us about human . . . psychology." (ibid, p.89) In assuming that we all share the same ideas and values concerning what is healthy, any deviance then becomes pathological. Ferry's major thesis concerns how such totalitarian thinking has its roots in Nazism and Stalinism, and I refer the interested to his text, *The New Ecological Order.*

It so happens that I am in fact very sympathetic to an environmentally sensitive ethics, and I embrace much of the Green Program from a persuasive utilitarian argument. But this position is vulnerable to other interpretations of the scientific data, as well as other human needs, and thus I understand why a moral imperative might be sought to further the ecological perspective. But in seeking such a standing, the moral argument takes an ominous twist vis a vis seeking a scientific basis for the ethical argument; it is at this juncture that I would defend science

against any such intrusion. The rest of this paper is concerned with how certain arguments for environmental ethics would use a scientific rationale to raise the ecological ethical position over other competing ones, because the former presumes to be *scientifically* based. Aside from the question of co-opting the science inappropriately, the irony is that the biology invoked hardly fulfills the standard of the day.

Thus I will follow a different tack from that chosen by Luc Ferry in dissecting a second reason that would establish an "objective" foundation for ethics, one which would hope to take the moral high ground that could not be assailed by the relative merits of any particular utilitarian position. The rationale concerns the idea that life has a telos, that is, goals by which organisms organize their behavior and physiological organization that supports end-seeking functions. This is a complex issue, and is one that I will attempt to Bush our more thoroughly, not only because it is most germane to the topic of the symposium, namely a Philosophy of Nature, but because it is perhaps the deeper and more obscure rationale for a science-based ethics. That argument begins with asserting that Nature in itself contains certain objectives, for instance the preservation instinct, independent of our humane or subjective opinions. From this position, teleology blossoms like a prolific bush, sprouting assertions in many directions. Let me sample a few representative opinions:

First, an empathetic element is introduced. Paul Taylor writes how our science documents the life cycle of the species, its ecological interactions, etc., and at the same time we recognize the uniqueness of each individual, which he believes we may easily convert to a moral perspective. As he writes:

> This progressive development from objective, detached knowledge to the recognition of indivuality, and from the recognition of individuality to a full awareness of an organism's standpoint, is a process of heightening our consciousness of what it means to be an individual living thing, We conceive of the organism as a teleological center of life, striving to preserve itself and realize its good in its own unique way. (1986. pp. 120-121)

The telos of the organism defines what is good for it, and it is the shared sense that organisms are individuals, like human agents, that confers a moral standing to them. In short, teleological centers of life serve as the foundation of value. And the entire enterprise rests on the science of biology, for as Taylor asserts,

> certainly our acquiring scientific knowledge about certain kinds of animals and plants can help us enormously in the attempt to understand objectively the everyday existence of particular individuals of those kinds, (ibid., p. 126)

Thus a biocentric value is inserted into the biology. Note what is occurring: According to various critics, the purportedly objective science is in fact documenting value as constructed

within an evolutionary and physiological context. For instance, Holmes Rolston, in *Environmental Ethics,* writes that the organism is an "axiological system," an "evaluative system" as it grows, reproduces, repairs its wounds, and resists death. He then slips in the V word, value, and here I quote:

> Value is present in this achievement. Vital seems a better word for it than *biological. We* will want to recognize that we are not dealing simply with another individual defending its solitary life but with an individual having situated Illness in an ecosystem it inhabits. Still, we want to affirm here that the living individual ... is per se an intrinsic value . . . The organism has something it is conserving, something for which it is standing its life. (1988. p.100)

Then the ethics become explicit:

> There seems no reason why such own-standing normative organisms are not morally significant. (ibid., p.100) [Thus a] tree has a t*elos* before the logger arrives, and the logger destroys it, it is a*uto-telic,* it has a law (Greek: *nomos)* on its own *[=autonomos]* (ibid., p. 105)

Telos, essentially a descriptive mode that biologists employ to describe function, Rolston has extended to a moral category. What he calls the good of the organism, for instance striving to preserve itself, a biologist, even employing a teleological orientation, would say is a survival behavior which follows the rules of biological fitness, where fitness means the ability of the organism to ensure the continued existence of its genes in future individuals. This is a statement of evolutionary survival, but Rolston assigns a moral value to it:

> Value is not just an economic psychological, social, and political word but also a biological one. Value$_{[or]}$ or what is good for the organism ... is for the organism a telic end state, an intrinsic value, not always a felt preference, (ibid.. p.257)

Of course such value is interpreted, and again teleology offers the rationale for our assuming that judgment. The famous philosopher of biology, Hans Jonas, in *The Imperative of Responsibility* (1984), assumes man to be the most elevated product of nature, who is thus capable of deciphering and taking responsibility for the world we cohabitate. Truly, a divine inspired Adam, for on this view, Man reads the law of nature and adjudicates according to his wisdom. Michael Serres opines similarly when he asserts:

> The life of the entire species is in our hands; it is a basis as true and faithful to things as that of the sciences themselves. We are entering a period in which morality is becoming objective. (Le Monde, January 21, 1992; quoted by Ferry [1995] p.87)

I am very disturbed by such assertions, not necessarily because I disagree with the ethical conclusions, but rather because I deplore the usurpation of science to support the ethical claims and their "objectifying" argument. I will attempt to show that the two realms, biology and ethics, are fundamentally different discourses, and to connect them is to make a category error with wide

ramifications and dangers. Let us delve a bit into the so-called "boundary question" concerning the elusive separation of science and ethics to draw a clearer perspective on the problem at hand, reproduces, repairs its wounds, and resists death. He then slips in the V word, value, and here I quote:

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In the strictest sense, biology is a science, and a science in its purest state is limited to a description of natural phenomena, whereas ethics derives from metaphysics and its domain is delimited to a sphere of thought that cannot be confused or conflated with the scientific enterprise. Optimally, each, legitimate in their own domain, should remain discrete and separate. Obviously they are often merged to varying degrees, and we have come to a heightened awareness of how science is not only co-opted by politics and ideologies, but also is more subtly influenced by its cultural milieu and moral environment. In fact, one might argue that the social constructivist view of science is a critical supportive pillar of environmental ethics. If science is after all constructed from cultural elements inseparable from the ostensibly objective procedures of scientific inquiry, then we must both acknowledge and accept the intrusion of additional ethical demands upon what science might regard as its own sacrosanct independent practices. On this view, science never stood alone in an objective cultural chamber insulated from the social pressures surrounding research and theory. Better to openly bring science into its full moral context, and by reciprocity apply science to its full social potential. In this case, let ecology support environmental ethics.

This discussion rests on disentangling two often confused issues: Firstly, what are science's ostensible values and how do they govern scientific practice? And secondly, how does science influence our broader morality? Each of these concerns relate to the boundary question, because the ethics of science arise within broader cultural ideals, and the culture may in turn be influenced by institutions of science, whose moral code may serve as a model of behavior extended to other domains. Despite the intimate historical links between scientific and moral discourses (Shapin, 1994), we must recall how science ostensibly was born in the effort to free itself from the conflations between fact and value, between natural and supernatural, between body and spirit. Even at the dawn of modern science, this issue of mapping the domain of knowledge proper was recognized as crucial, given the rise of political agendas concerned with how science could be used to serve particular social and economic interests. And it was in the recognition of science's power that its early institutionalization was structured to guarantee its independence from meddling politicians, who in turn extracted the promise that scientists would remain disinterested in worldly (i.e.. political) concerns (e.g.. Shapin and Schaffer, 1985). After all, in the search for Truth and Reality, the scientist should be immune from the messy debate of how the fruits of his labor were to be applied (whether in warfare, medicine, or technology - at large) or the possible dire consequences of his discoveries for the environment and for the

individual. From Science's lofty laboratories, only unperturbed truth seekers would explore Nature's secrets, oblivious to the political, social, and economic needs of the supporting culture.[4] As patient spectators, the "common" people would reap the material harvest, although some would argue it was a Faustian pact. Objectivity is a value, and we will now look at its various manifestations.

The neutrality of science depends on regarding Nature as holding no value: value is rooted in human needs and desires, whereas nature is stripped of qualities, teleology, and meaning, leaving it devalorized, secularized, and disenchanted. The crucial philosophical distinction is between "what ought to be" and "what is." The attempt to free facts from value was to liberate science from its Medieval theological roots, and remains the linchpin for scientists pleading autonomy under the rubric of "objectivity," as well as for their critics, who decry the violation of neutrality of science, which obviously serves particular social agendas. But as Robert Proctor has congently observed,

> [N]eutrality and objectivity are not the same thing. Neutrality refers to whether science takes a stand; objectivity, 10 whether science merits claims to reliability. The two need not have anything to do with each other. Certain sciences may *be* completely "objective" — that is, valid - and yet designed to serve certain political interests. Geologists know more about oil-bearing shales than about many other rocks, but the knowledge is thereby no less reliable. Counter insurgency theorists know how to manipulate populations in revolt, but the fact that their knowledge is goal-directed does not mean it doesn't work.
>
> The appropriate critique of these sciences is not that they are not "objective" but that they are partial, narrow, or directed towards ends which one opposes. In general, knowledge is no less objective (that is true, or reliable! being in the service of interests. (1991, p. 10)

Given these distinctions, science nevertheless can hardly be separated from its political support, and scrutiny of that political context has increasingly raised a critical chorus since World War II. Citizens maintaining a vigilant watch over scientific aspirations and purported successes, no longer accept as gospel the claims and promises of a growing scientific lobby. Critics have successfully halted or modified multi-billion dollar Big Science projects in the 1990s, in what some regard as an anti-scientific conservatism, and others the appropriate constraint of a ravenously imperialistic Science. Controversies surrounding public policy concerning investment in major scientific projects that are touted as the penultimate, if not the ultimate, climax of scientific progress (e.g., Gilbert [1992]; Weinberg [1992]) are largely connected with three domains: the disappointment in past, similar programs, such as the failed War on Cancer and other overly optimistic projects, which have promised to deliver solutions that were unrealistic; the growing concern that resources should be more carefully allocated towards directed application and more modestly achievable goals; and finally the recognition that naive positivist

ideals have been abandoned. Further, despite the reiterated disavowals of a value-laden science, critics have exposed this innocent view.

This critical stance is based on the assertion that science as practiced is not a free-standing enterprise, but is socially based and subject to the needs and values of its supporting culture. This public domain of science refers not only to the renewal and support that our society gives scientific institutions, but the recognition that science serves in a political culture, supporting various economic and political interests. From a political perspective, the relevant issue, beyond defining the social origins of knowledge, is the requirement for a philosophy that focuses on the forms of power in and around the sciences:

"Why do we know what we know and why don't we know what we don't know? What *should* we know and what shouldn't we know? How might we know differently?" (Proctor, 1991, p. 13) In short, we must be cognizant of the complexities of science as politics and not confuse the social applications of science with the business of scientific inquiry. It is natural that extrapolations be made, after all, science is obviously a social activity, but my plea is that we must acknowledge those interpretations, as interpretations. Ecological ethics is an important case in point. We can support and even claim that moral position as our own, but at the same time we must recognize how we justify those judgments as interpretive. In the process, we preserve the openness of scientific inquiry and its pluralistic attitude towards knowledge. That is an ethic that dominates any ideology that would use science for its own purposes.

Recognizing the complex moral context in which science operates, I wish to now explore and expose why biological teleology has been connected to ecological ethics, and why they must remain separate. First, an important caveat. I suspect that ecological ethics arise from the same source in which we seek other forms of meaning in our biology. I myself have explored that domain in the connection of science and beauty, the aesthetic dimension by which we perceive order and grandeur in the complexity and simplicity of the living (Tauber, 1996). Whether we appreciate the extraordinary order of a crystallized protein or the hierarchical interconnections of an ecosystem, as sensitive men and women, we find meaning in those experiences. These are human appreciations of nature's beauty, and there is no reason to exclude a scientist's work from the aesthetic realm. Quite to the contrary, many of us, as biologists, seek aesthetic experience in our research of organic phenomena, and find there an important component of satisfaction, as well, perhaps, a less well-defined rationale for a theory's construction and its acceptance. But generally, except at the deepest psychological level, (regard this aesthetic connection as distinct from the usual business of science proper. Not that I necessarily believe they can be entirely

separated. I do maintain that *meaning* per se, whether aesthetic, metaphysical, or ethical, is not the appropriate question for science - as an epistemology - to pose or explore.

Now, let us return to the particular issue at hand. In the following section, I will explore the status of teleology in biology today, briefly reviewing its history and current utility. The irony of a purportedly science-based ethics built on the teleological status of living organisms is that such a formulation in fact is hardly part of current scientific discourse. Teleology is a concept conscripted for describing Life, part of the complex humanistic endeavor to find meaning in Nature, whereas biology is concerned not with "life," but with the biophysics and biochemistry of the organic. In other words, teleology is integral to an older natural philosophy that truly sought a philosophy of nature in human terms. Current biology is a science devoted to providing mechanistic explanations, and to the extent that a telos orients its theory, we witness vestiges of this older metaphysics. To put the matter simply, although we detect teleological descriptions in modern biology, they represent the inadequacies of our true scientific aspirations of offering mechanical explanations for organic processes, whether physiological, developmental, or evolutionary. Although I believe that such teleological descriptions cannot be entirely purged from biology and must continue to serve a complementary role to mechanical explanations, we must acknowledge the actual scientific status of telos. When we do, then it is evident how ethicists might so easily co-opt teleology for their own purposes.

III

Many would sec biology as caught in a fundamental paradox upon which the ethical project rests. Namely, biology is characterized by two ways of thinking, an objective, positivist program that seeks a description of biological processes, and a teleological mode of addressing those phenomena in terms of function. It is from this latter logic that broader questions of meaning arise. I, in turn, would like to ask whether teleology in fact represents a paradoxical mode of thinking in biology, and in regarding our immediate concern with environmental ethics, whether it legitimately may be used to support this broader moral agenda. The question is asked in the context of a scientific program that has sought to purge the issue of human significance altogether.

Ethics falls under the rubric of the subjective, and the purging of subjectivity from science has a long history. Most would date its proclaimed origins with the positivist movement in France during the 1820s. But there is an older heritage dating back to the very birth of modern science.5 Positivism of course has been duly challenged in our own time, and a continuous concern with "objectivity" remains a critical topic of debate in science studies today. I will not

delve into this matter in any detail, but it does set the stage for my own topic, for the general question of "meaning" arises subtly from biology, and to discern those roots is to expose the intimate linkage that environmental ethics has been able to make with its supporting science, namely the teleology discerned in biology.[6]

Strictly speaking, teleology is the idea of giving an account of something by reference to an end or goal. Teleological explanations span the entire range of biology, from the apparent goal-directedness of embryological development, to the adaptive character of traits and organic systems, to the purposiveness of behavior. The teleology hovering over both molecular descriptions such as enzymatic cascades and complex social behaviors is to some a "specter" of a tainted mode of thinking. Why? In answering that question, both in its historical and analytical context, we might discern more clearly the source of confusing teleological descriptions with "meaningful" ones that give rise to *value.*

The issue is perhaps best presented by Jacques Monod in *Chance and Necessity,* where he explicitly states the modern biologist's embarrassment, or what he calls biology's "epistemological contradiction." According to Monod, the contradiction concerns the two ways of knowing that the scientist must employ to study the organic realm. These Monod called, "objectivity" and "teleonomy," respectively. (See the Appendix for a historical description of teleonomy.) First, Monod admits the *sine qua non* of goal-directedness in biology and the centrality of teleonomy:

> One of the fundamental characteristics common to all living beings without exception [is| that of being *objects endowed with a purpose or a project,* which at the same time: they exhibit in their structure and carry out through their performance ...
>
> Rather than reject this idea (as certain biologists have tried to do) it is indispensable to recognize that it is essential to the very definition of living beings. We shall maintain that the latter are distinct from all other structures or systems present in the universe through this characteristic property, which we shall call teleonomy. (1971, p 9)

But this definition, while necessary is not sufficient. since as Monod further observed, teleonomy does not provide any objective criteria for distinguishing between living and non-living things. Here he introduces the requirement for a self-organizing system, programmed by chance and necessity, but paradoxically committed to purpose. Monod asked, is this a "miracle?"

No. the real difficulty is not the physics of the phenomenon; it lies elsewhere and deeper, involving our own understanding, our intuition of it. There is, really, no paradox or miracle; but a flagrant epistemological contradiction.

The cornerstone of the scientific method is the postulate that nature is objective, la other words, the systematic denial that "true" knowledge can be got at by interpreting phenomena m terms of final causes - that is to say, of' “purpose"... But science as we understand it today could

not have developed upon those foundations alone. It required the unbending stricture implicit in the postulate of objectivity - ironclad, pure, forever indemonstrable. For it is obviously impossible to imagine an experiment which could prove the nonexistence anywhere in nature of a purpose, of a pursued end.

But the postulate of objectivity is cosubstantial with science; it has guided the whole of its prodigious development for three centuries. There is no way to be rid of it, even tentatively or in a limited area, without departing from the domain of science itself.

Objectivity nevertheless obliges us to recognize the teleonomic character of living organisms, to admit that in their structure and performance they act purposively, . . Here therefore, at least in appearance, lies a profound epistemological contradiction, In fact the central problem of biology lies with this very contradiction, which if it is only apparent, must be resolved; or else proven to be utterly insoluble, if that should turn out indeed to be the case, (ibid. pp. 21-22).

It is this issue that I wish now to fully explore. Let us begin with a short historical survey of what Darwin called "One long argument." The philosophical issue arises naturally from the perspective of natural selection, the fundamental theory of biology. We will find there, in Darwin's *On the Origin of Species,* not only a mechanistic explanation that accounts for evolution and the rationale upon which we assign functional characteristics of extant organisms, but also the essential elements for our current materialistic, purportedly non-teleological understanding of biology. I will proceed by showing where the science admits supposed paradoxical elements, and will then finally attempt to resolve what Monod calls a contradiction as simply a complementary way to describe biological phenomena.

Biology, until the raid-nineteenth century, was the exploration of an organic world described by a divine intelligence. The myriad species, ordered in their complex interplay, found their position in the great chain of being, because of an ordered universe variously viewed as a sublime garden of God's creation or a vastly complicated machine, so perfectly construed that upon its initial conception, it worked like a perfect clock by a divine plan we might study, but never fully understand. Although the history of mechanistic explanation is highly germane to this discussion, let us quickly skip to the end of the eighteenth century, and consider the state of biology that was by this time already largely committed to materialistic and mechanistic accounts of function, but still remained explicitly coupled to an older metaphysics. Kant's teleology was the critical argument that attempted to offer a resolution. As he understood the issue, teleology must serve as a regulative principle by which mechanisms might be examined and understood. Teleological explanations orient scientific inquiry that would discern the mechanism's workings.

But, and this is the crucial pre-Darwinian position, we might never discern the ultimate basis of design. Kant believed, as did virtually all of his contemporaries, that there never would be a Newton who might explain how a single blade of grass grows or how it appeared in creation. There had to be some final intelligence that conferred organization and design, the function, the ends of particular organic entities, and their behavior as fundamental to their being.

With Darwin, a mechanism was offered that no longer sought to comprehend a divine Design. There was no need to call upon a pre-ordained Plan, and there was no Purpose. Life simply was. With natural selection, a process of variation and selection explained the evolution of species, their particular anatomies and physiologies. Very simply, since Darwin, teleological explanations as construed from Aristotle to Kant have ostensibly been purged from biology. The natural selection theory of evolution, more specifically, its neo-Darwinian formulation, has declared any intentional interpretation as unnecessary for a mechanistic (which would include a stochastic causality) explanation, which is both necessary and sufficient to account for the current complexity and phylogenetic history of our organic world. But the organic could not so easily be purged of what appeared most characteristic of it, namely that 1) the design of organisms are seemingly purposeful, being directed toward particular ends, and 2) they exhibit active behavior to achieve certain goals. This is what was referred to earlier as "teleonomy" the term coined 35 years ago to acknowledge end-seeking function without a super-imposed design. (See Appendix.) The intention arises from the evolutionary history of the species upon a genetic blueprint that designates functional capabilities and potentials, and also allows adaptive and learning behavior. So. contemporary biology incorporates simple and probabilistic causalities with ranges of choices to allow that life processes indeed have a telos - an end, purpose, goal, state of completion - for the sake of which an activity takes place or for which change is produced or sought. Teleonomy has thus replaced teleology, and the issue is to explain how such goals (and the capacity to reach them) are structured within the genetic design.

Nevertheless, telos - perhaps because it has such a sordid history in biology (Mayr 1982), and more particularly due to its "semantic instability" (having so many interpretations and inferences) - continues to "taint" biology. The extraordinary power and effectiveness of a science adept at chemical and physical characterizations is indisputable. The issue is to formulate and maintain strict positivist descriptive criteria for elucidating seemingly intentional life processes, seemingly far removed into the future and thereby determined by causalities quite distinct from those normally encountered in characterizing biochemical and biophysical processes, "Purpose" smacks of a subjective projection or interpretation. Monod, like Francois Jacob and Ernst Mayr, among many others, have embraced teleonomy as arising from a genetic program determined by

evolutionary forces to account for such seemingly purposeful behavior. I will not attempt a critique of that position here, but suffice it to note that on this view, objectivist descriptions, of which teleonomy may stake its own claims, should suffice for biology as it does for physics and chemistry.

Nevertheless, "teleology is like a mistress to a biologist: he cannot live without her but he's unwilling to be seen with her in public" (attributed to J.B.S. Haldane by Pittendrigh in Mayr, 1988, p. 63). Despite the scruples of a science divorced from teleological explanation, it must nevertheless rely on telos to order its theory and methodologies. We must acknowledge that telos may function as the projection of our own particular rational understanding, and although potentially distorting, such descriptions orient our inquiry. Let me emphasize, teleological *descriptions* cannot substitute for mechanistic *explanations*, but because of the incomplete status of our life sciences, such descriptions are complementary to physical and chemical explanations of functions. This duality remains a legitimate strategy. There is no contradiction: there are simply two complementary ways of describing biological phenomena. The basis for asserting the central though elided role for teleology in biology at the end of the twentieth century resides in the need both to maintain our positivistic - Monod's "objective." non-teleological - explanations, and lo allow some form of telos to guide our theory and methods. There is no contradiction if we recognize that we are employing complementary ways of describing organic function. The difficulty, due to the incompleteness of our biology, is that we cannot truly separate the two, and that our 'understanding' -whatever scientific erudition our biology offers us, intrinsically intertwines our biophysical and biochemical descriptions with our teleological orientation.

We might just accept this strange marriage, either because 1) we cannot completely divorce teleological from mechanistic explanations, primarily because the levels of function approached by each are disparate and the science invoked is as yet inadequately developed (Taylor 1970), or 2) teleological explanations are in fact causal despite their future orientation (Wright. 1973: 1976).[8] In both Taylor's and Wright's accounts, what makes behavior teleological is that the process in question can be shown to occur *because* it is required for the achievement of the goal state (Lennox. 1992. p, 332). In each case, a heuristic value is claimed. Taylor acknowledges the paradox and adopts a wait and see attitude, while Wright falls into an adaptation mode of explanation. I regard this matter somewhat differently. I submit that teleology, although often argued as a logical question, more appropriately is situated as an epistemological issue, resting on the very fault line between *fact* and its *interpretation.* Teleological descriptions are still necessary, serving as proto-theories, and thus requisite to placing the "objective" data in order. To expel teleological descriptions, and here I am referring

only to descriptions of end-seeking function, would be to strip biology of its logos. The science must explain function mechanistically, i.e. with factual descriptions, but those facts are placed in some functional edifice. There is no contradiction; there is a tensioned complementary between problems stated in functional terms and explanations given in mechanistic one.

The crux of the matter is the "aura" of interpretation that surrounds facts. The motivation for a purely objective account resides in the foundations of positivist science that, in its starkest statement, attempts to give factual accounts devoid of interpretation. But it is a dictum now that fact cannot be divorced from its supporting theory. The problem of theory-laden facts has been extensively explored since Goethe's dictum, "to grasp that everything factual is already theory" (Tauber, 1993). Goethe was also aware of the converse problem of theory distorting observations to conform to (he prejudice of theory. The attempt to purge teleology from biology in the nineteenth century was motivated by this concern, for biologists were aware of the ominous distortion that projection of an interpretation might have on the creation of facts, and thereby corrupting theory construction built upon positivist ideals. On this view, teleological explanations might serve as an undeclared theory posing as fact, and in such constructions, facts situated by theory are then used to erect the supposed objective ediface to support that theory in a circular chain of reasoning.9 But if we allow an objective science to be judged essentially on the success of its ability to predict phenomena and cohere to explanatory principles deemed constant with its own theoretical construct. Then we may legitimately regard teleological descriptions as part of the very fabric of biological science. It serves to order our observations and orient our theory, which then is tested anew.

In short, we organize our observations and place our putative facts within a theory or model to create some structure that confers order to phenomena. Although we do so at the peril of distorting - or should I say, potentially falling short *of* our essential scientific mandate, namely objectivity - this is the irreconcilable tension of science. (It is also the basis of the evolution of scientific knowledge.) Operative in all sciences to a certain extent, this concern is most relevant to biology, because the phenomena cannot simply be described in isolation from end-seeking, purposiveful function. The positivist ideal is shaken, for at any level, such intentionality is interpretive, even projective of our own bias. We are thus shackled to an epistemology that fails the most stringent positivist requirements.

To summarize, I have attempted to clarify that biology as an objective science rebukes teleology, and the history of the field over the past two hundred years has been marked by that struggle. Quite simply, biology, or should 1 say biologists, cannot completely purge teleological structures, whether called teleonomy or left unannounced as implicit in the discipline's thematic

infra-structure. Rather than lament this duality. I accept the complementarity of positivist accounts in a science committed to ideological orientation. We are left with a biology that builds its world view, or what Wittgenstein designated

as a picture, from a complex dance between its epistemological poles. 'Practicing' biologists, usually unaware, see as Janus, whose vision is formed From both vistas. They unconsciously *operate* with both 'objective' and 'teleonomic' explanations to structure their facts and build their theories. 'Theoretical' biologists recognize the limits of a scientific formalism and being wary of escaping into some metaphysical interpretation, while perched on the edge separating them, peer self-consciously first in one direction and then another. I suggest we accept objectivity and its supporting telos for the service each performs, acknowledging their inherent limits and at the same time recognizing their particular contribution to the scientific enterprise. The mistake is to extend telos to support some broader meaning; for that extrapolation, teleological thinking has been justly attacked.

IV

Let us now return to our central concern. As illustrated, there are those who use the so-called "teleological centers of activity" (to quote Taylor [1986]) as a node of value and from there it is a short step to assigning a true moral standing. That step is taken because it is supported by a metaphysical picture that has a strong grip upon our culture, one upon which the epistemological basis of teleology resides. The problem lies in large measure with the "semantic instability" of the term, teleology. As already discussed, teleological descriptions are by their very nature interpretative. In a strict biological context, they are used to define end-seeking function. The category mistake occurs when one proposes that purpose has moral standing. Certainly human intentionality has moral standing: we make choices embedded in an ethical construct. Why do purposeful animals have moral standing? The ecological ethicist must believe that beyond sharing purpose, animals share with humans the same biological origins of morality itself, the very matrix by which purpose, whether human or animal, attains its moral meaning.10 But more specifically, we are concerned with the central role telos plays in the seemingly effortless jump from human to animal morality.

I have already described the scientific role teleological descriptions offer us in ordering biological phenomena. But now we see the semantic instability of teleology broadening its rubric to offer a foundation upon which a more global application of teleology is presented. From those piles, an ethical edifice, purportedly built from science, is erected. From Alfred North Whitehead (1925) to Daniel Dennett (1981, e.g. p. 28), numerous commentators have noted that the intentions we ascribe to natural systems are abstractions of a sort, in which a rationality

resembling our own is ascribed to natural systems or behavior. It is this rationality that enables us to understand and to explain them using our own intelligent faculties. It reflects a deep-seated confidence in the rational order of nature, and we thus profoundly both endorse and recapitulate Kant's project. As Herbert Simon (1969) has noted, this amounts to analyzing natural systems as if they were artifacts, attributing to them the same type of rational adaptation of means to ends that we employ in the design of our machines. Beyond what Gregory Bateson (1980, e.g. p. 299) and others have underscored as naïveté of believing that nature conforms to our particular scientific rationality (Atlan, 1993, note #83, p. 91), there is another startling philosophical revelation.

As Henri Allan has observed, this projection of our rationality upon biology "is an even stronger postulate than that of a rational intelligibility of nature, namely, that of an *intentional* rationality in nature" (1993. p. 75); imposing goals on nature results from anthropomorphological reasoning. Intentionality, used to characterize psychological or social action of conscious beings, is according to him misapplied to apparently intelligent behaviors adapted to the achievement of some goals observed *in* individuals, whether human or animal (1994. p. 74).[11] And here we can now return to our original query concerning meaning in nature. This need for meaning, this relic of an ancient metaphysics, resides deeply within our psychologies, for all that has been repressed and circumscribed by a scientific culture that aspires to objectivity (if not some positivist ideal) and technical virtuosity.[12]

To speak of a philosophy of nature, we draw from both the objective scientific accounts as well as the relational aspects derived from this powerful metaphysical imperative. Herein, in this latter faculty, lies our quest for *meaning.* In this latter task, we ultimately speak of ourselves. Rather than shun our metaphysical assumptions, perhaps we should delve more deeply to understand them. For although we resist alluding to metaphysical constructions in this post-metaphysical age. We seemingly cannot escape their grip. In acknowledging their hold on us, we will more clearly comprehend their pervasive, and often disguised influence arising from their diverse origins and complex structures.

APPENDIX - FROM TELEOLOGY TO TELEONOMY

Soon after Watson and Crick had offered the key to the genetic puzzle in 1953, Colin Pittendrigh offered a new term and argument that attempted to eclipse the specter of teleology from the life sciences. He wrote in 1958,

> Today the concern of adaptation is beginning to enjoy an improved respectability for several reasons: it is seen as less than perfect: natural selection is better understood; and the engineering physicist in building end-seeking automata has sanctified the use or teleological jargon. It seems unfortunate that the term "teleology" should be resurrected

> and, as I think, abused in this way. The biologists' long-standing confusion would be more fully removed if all end-directed systems were described by some other term, like "teleonomic," in order to emphasize that the recognition and description *of* end-directedness does not carry a commitments to Aristotelian teleology as an efficient causal principle (pp. 393-394),

Pittendrigh's entreaty was to evoke a serious debate. There were those like Bernard Davis and Gaylord Simpson who viewed the term as virtually synonymous with adaptiveness. Simpson wrote that teleology

> may implicitly negate rather than express the biological conclusion that organization in organisms is with respect to utility to each separate species at the lime when it occurs, and not with respect to any other species or any future time (Simpson. 1958, p. 520).

Such a definition uses teleonomy only to explain adaptation in nature as the result of natural selection. Teleonomic in this view becomes a description for a system or structure which is the product of evolution and selective advantage. The chorus seemed to agree: teleology as intention had to vacate the premises, even white the descriptions of biological processes required an acknowledgement of their goal-seeking qualities. Teleonomy had been coined in the attempt (to rid the science of its ancient metaphysical baggage and still retain the characteristic feature of the organic, namely there were ostensible goals to which organisms strived. Yet, as mentioned, biologists initially were employing the new term as a synonym for adaptation. Pittendrigh complained in a letter to Ernst Mayr about his frustration in threading the philosophical needle:

> What it was the biologist could not escape was the plain fact - or rather the fundamental fact -which he must (as scientist) explain: that the objects of biological analysis are organizations (he calls them organisms) and. as such, are end-directed. Organization is more than mere order; order lacks end-directedness; organization is end-directed . . .
>
> 1 wanted a word that would allow me (all of us biologists) to describe, stress or simply to allude to - without any offense - this end-directedness of a perfectly respectable mechanistic system. Teleology would not do, carrying with it that implication that the end is causally effective in the current operation of the machine. Teleonomic, it is hoped, escapes that plain falsity which is anyhow unnecessary, (quoted by Mayr, 1988 pp. 63-64)

Ernst Mayr shared these sentiments, but believed that Pittendrigh's opposition to Aristotelian teleology was unfortunate, since most of Aristotle's references to end-directed processes were still appropriate (ibid., pp. 56—7). This is a most interesting admission, for it reaches back to a classical debate and highlights the critical issues for modern conceptualizations.[11] Essentially, the modern commentators wanted teleology, but without some backward cause. A more elaborate strategy was required.[14] Following Pittendrigh, Mayr attempted to consolidate the notion of teleonomy as a seminal conception of biology by fully embracing the new enthusiasm about cybernetics of that period. He actually built on the earlier formulation suggested by the fathers of cybernetics. In 1943, Rosenbleuth, Wiener and Bigelow

posited that negative feedback would obtain information in the environment necessary to correct any perturbations in a system moving toward a goal. Thus purpose was to be explained by a new neutrality.'[5] Mayr became a cybernetic enthusiast, and defined a teleonomic process or behavior as one which owes its goal-directedness to the operation of a *program.* "Individual development and . . . seemingly goal-directed behavior . . . depend on some endpoint or goal which is foreseen in the program regulating the behavior (Mayr, 1982, p. 48). Teleonomy was thus regarded as a non-intentional, non-purposiveness, end-seeking function guided by a program, an executive formation residing in the cell's nucleus and determined by natural selection.[16]

Mayr was careful in attempting to avoid the obvious objections (Mayr, 1988). He embraced the idea of "program" as I) something material, and 2) as existing prior to the teleonomic process and thus consistent with the temporal directionality of a causal explanation. ("It is the endpoints that produce the selection pressures which cause the historical construction of the genetic program"' [Mayr, 1982, p, 49].) Heavily endowed with the newly emerging application of information theory to biology, he pursued the metaphor of a code to its full application. More than simply a blueprint, the code also conveyed instructions of how to use the information of the blueprint, remaining segregated from the cell's machinery that enacted the program. Further, Mayr shrewdly allowed for both 'closed' programs, i.e. the strict instructional component of the genetic code laid down in the genotype, and an 'open' program, which guaranteed the incorporation of additional information. The open program would allow for learning, and although such information may not be acquired through selection, it clearly was to be in part responsible for teleonomic behavior. The history of the acquisition of a program was not part of the definition of teleonomic, and Mayr argued that the origin of the program was irrelevant to the definition, since the program might be the product of evolution, or acquired through the open channels of information. This allowed, he thought for both somatic and epigenetic events, that is a 'program' rigidly wired or acquired by experience, respectively.

Whether such an open-ended definition of program was warranted or only served as a fanciful metaphor was the subject of dispute. Early critics like Erwin Schrödinger, writing at the time of cybernetics' birth in 1944, noted the difficulty of accounting for a self-written code.[1'] But the power of the code metaphor persisted and was modified in the 1960s to specify 'program' to account for how the gene acquired its "specific value." Whereas Schrödinger had been puzzled by the dual attribution of "law code and executive power," Francois Jacob enthusiastically adopted the paradox with an important twist:

> What are transmitted from generation to generation are the 'instructions' Specifying the molecular structures: the architectural plans of the future organism. They are also the means of executing these plans and of coordinating the activities of the system .. . The

> organism thus becomes the realization of a programme prescribed by its heredity. The intention of the psyche has been replaced by the translation of a message (1974. pp. 1-2).

The metaphor is here working subtly to offer a mechanical account of organic function, but critics now argue that there is a critical short circuit: control and the controlled have been conflated.18 The salient point is that computer scientists need not deal with meaning as such, but more simply with the technical problem of transmission. Thus for all practical purposes a program may be treated as pure information. But organisms are unable to bracket meaning, which is intrinsic to what we metaphorically refer to as a program. On this view, programs and information must be distinguished in the organism. There is unresolved debate concerning what kind of system is capable of generating its own program - its goals, meaning, tasks. What indeed is a natural machine? Champions of the cybernetic model drew parallels with self-directing machines (like guided missiles or heat-seeking bombs): "At any time, the machine that executes its programme is capable of directing its action. of correcting or even interrupting, in accordance with the message received" (Jacob, p. 253). Although Jacob recognized that the metaphor had limits, it was left to others to add important critical caveats, For example. Henri Allan wrote regarding the organism determined by the informational structure of its genome:

> This widespread idea should be accepted as a working hypothesis or a metaphor and not taken literally, since DNA us a genetic "program" needs the products of its reading and execution - RNA and regulatory proteins to be read and executed. In living cells, the "program," if any, seems to be identified with the whole cell. The DNA molecule look[s] rather like memories where pans of this program are stored (1983. p. 28)."

We need not further review the more interesting rebuttals and counter theoretical offers currently in discussion, but close with Jacques Monod, who extended the concept of teleonomy by formally introducing the problematics of self-organization and stochastic properties to the original formulation, but retained the essential argument: organisms achieve their goals mechanically, like a computer, with the genetic program offering the necessary direction. Again, only evolutionary necessity provided the organization for such function, for natural selection was ultimately responsible for writing this program. This would represent the "strong" anti-teleological position. Bereft of the design connotations of teleology, teleonomy was relegated to simply a vestige of a descriptive biology, eventually (and optimally) to be replaced by a purely mechanical account. Given the power of this formulation for the *science* of life and its philosophical implications, environmental ethicists might well ponder the wisdom of grounding their own arguments on the foundation offered by *telos* and its various expressions.

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NOTES

1 "Biocentric" appeared approximately a century ago: R. Meldola in *Nature* (Jan. 5,1899)| wrote, "In brief, there has arisen a set of ideas which are even broader than 'anthropocentric', and which might fairly he designated *biocentric"* In 1913. L.J. Henderson charted those limits in *Fitness and Environment.* "The biologist might now rightly regard (he universe in its very essence as biocentric." (p. 312) (Quoted from *Oxford English Dictionary, Supplement A-G.* Oxford: Oxford University Press, 1972, p. 265).

2 Kohák makes clear in many places in his oeuvre that our ethical relationship with nature is determined by a direct correspondence of our phenomenological encounter, not by any other mediating function such as scientific knowledge. For instance, he recently wrote regarding "nature as experience":

> Here let us stress sharply: this is not a matter of dealing with nature "as we interpret it" in contrast with nature "as it really is." Nature as experience is how nature really is... That is why, as the starting point of this inquiry, we lake neither scientific theory nor the art of argumentation but rather a descriptive phenomenology of the ways humans experience nature . . . and how they experience nature's distress of which we speak as the ecological crisis (Kohák, 1994b. p. 2).

3 As Luc Ferry has observed

> We are witnessing the development of the idea that knowledge of the secrets of the universe or of biological organisms endows those who possess it with a new form of wisdom, superior to that of mere mortals. But it is probably in the area of ecology that the feeling that the natural sciences will deliver ready-made teachings applicable to ethics and politics seems to be most confidently asserted (1995. p. 84)

4 Some critics, such as Theodore Roszak writing in *Where the Wasteland Ends* (1972) have deplored the moral consequences of this posture:

> Bacon went in search of a philosophy of alienation. They [scientists] broke faith with their environment by establishing between it and themselves the alientative dichotomy called 'objectivity'. By that means they sought to increase their power, with nothing - no sensitivity to others or the environment - to bar their access to "the delicate mysteries of man and nature." The cull of objectivity has led scientists and the general public, to think of everything around us - people and biosphere - as "mere things on which we exercise power." Objectivity is in practice a cloak for callousness (p. 169).

I prefer Goethe to Comte: modern positivists could hardly state this concern with bias more eloquently than did Goethe at the end of the eighteenth century:

> Every piece of empirical evidence, every experiment, must be viewed as isolated, yet the human faculty of thought forcibly strives to unite all external objects known to it. It is easy to see the risk we run when we try to connect a single bit of evidence with an idea already formed . .. Such

> efforts generally give rise to theories and systems which are a tribute to their author's intelligence. But with undue applause or protracted support they soon begin to hinder and harm the very progress of the human mind they had earlier assisted. (Goethe, 1792).

Goethe here espouses a purging of the subjective, although he himself was certainly guilty of projecting his own subjective bias (see Tauber. 1993).

Most would argue that the very success of biology and medicine has been in orienting the organic to a physical and genetic reductionism (Tauber and Sarkar, 1993), with the espousal of a strong positivism. This orientation began in the German physiology laboratories of the 1840s, which endeavored to rid biology of both vitalism and teleology as determining factors in the life processes. That strategy to provide a comprehensive physico-chemical, and later genetic explanation of the organic had profound epistemological and metaphysical consequences. With the ascendancy of neo-Darwinism, offering a global mechanical-causal explanation, the scientific community, and the lay public, has by and large recognized the power of such explanations and the descriptions of nature provided by them. I am deeply dissatisfied with this description, not because I believe it is wrong within its own province, but because I strongly suspect it is inadequate as a full science of biology. This is a problem I have already addressed in other places (e.g. Tauber, 1994).

Schaffner, although adopting a more sympathetic view towards reductive analyses than Taylor, acknowledges the current heuristic value of teleological explanations as appropriate to this stage of biology.

A natural consequence has to be *chosen* as a goal or purpose on analogies with intentions or ends-in-view in human design situations. Until we have a powerful and general reductionist theory of human learning and action which would license very complex identities. I think that a functional analysis will be irreducible to causal analysis. This, however, is *not* an argument for in *principle irreducibility.* (1993, p. 379)

Atlan assumes a similar position (1994).

To capture both teleology's causality and its future orientation, Larry Wright's 'consequence-etiology" attempts to integrate goal-seeking behavior as occurring (and thus legitimate for our descriptions), because it has been causally efficacious in the pas1 (1973; 1976). In other words, goal-directed behavior becomes structured by, or better, has become adaptive as a result of the history of the species or organism as it engages its various goals. Intentionality is thus incorporated into the cause by its past efficacy. Note, on this view, teleology and completely mechanistic accounts of goal-directed behavior may co-exist, and more strongly, any biological function must contain, as intrinsic to such descriptions, a ideological character. But as already noted, teleology is being used here as a description of adaptive behavior. and like other evolutionary accounts, docs not adequately expose the nature of biological causality independent of purpose. (Criticisms reviewed by Schaffner [1993, pp. 396-399],)

9 Again, Goethe said it best:

> Thus we can never be too careful in our efforts to avoid drawing hasty conclusions from experiments or using them directly as proof to bear out some theory. For here at this pass, this transition from empirical evidence to judgement, cognition to application, all the inner enemies of man lie in wait: imagination, which sweeps him away on its wings before he knows his feet have left the ground: impatience; haste; self-satisfaction; rigidity; formalistic thought; prejudice; ease; frivolity; fickleness - this whole throng and its retinue. Here they lie in ambush and surprise not only the active observer but also the contemplative one who appears safe from all passion. (1972).

On the other hand, teleological thinking has also been productive. A striking historical case in point is that of Elie Metchnikoff, whose revolutionary view of the organism spawned a bitter dispute with German reductionists who accused him of teleological sin, yet his heuristic framework provided the foundation of the new discipline of immunology. (See Tauber and Chernyak [1991] for an historical account of this most illustrative case.)

10. Ecological ethics builds, usually implicitly, on the foundations of evolutionary ethics which argues how human morality arises from our biological heritage. The argument is well-stated by Michael Ruse:

> The new scientific claims are as simple as this. We now know that despite an evolutionary process, centering on a struggle for existence, organisms are not necessarily perpetually at conflict . . in particular, cooperation can be a good biological strategy . . . Now let us unpack the science. We begin with the general claims about cooperation, or as today's evolutionists . . . like to call it. altruism . . . Both the theory and the empirical evidence that biological 'altruism' is widespread and promoted by natural selection is very secure and well documented. The simple fact of the matter is that . . . one is frequently better off if one decides to accept a cake shared rather than gambling on the possibility of a whole cake but one which might be lost entirely. (Ruse. 1993, p. 502).

Thus morality on this view is founded on an evolutionary-derived experience common to myriad species and hardly unique to humans. (See Nitecki and Nitecki [1993] for various presentations.) On this view, altruism, like telos, is a shared biological characteristic with other animals, and just as we are moral creatures because of those biological endowments, so are our animal brethren. Thus there is an important linkage between evolutionary and environmental ethics, but we need not further delve into that relationship. I only wished to show their common philosophical roots.

11. According to Atlan this metaphysical posture results from the deep-seated desire that science provide a comprehensive explanation of nature. Atlan refers to this as a mystical aspiration, and writes:

> The need for an explanation of reality is, fundamentally, antiscientific. The satisfactory explanation is a bonus, the esthetic pinnacle that accompanies and sometimes completes ... the result truly sought; technical performance . . . For the practitioners of contemporary science ... the need for explanation is merely a relic of metaphysical, indeed religious, wonder. (Allan. 1993, p. 193).

12. Some, like Gaston Bachelard (1934), rather than lamenting the contamination of such a metaphysical remnant, celebrates its role. He saw in the pursuit of meaning the motive force of research, animating our scientific: query. It is in this psychological conviction that nature not only has a rationality that we might discover, hut more intimately relate to as meaningful that imbues our endeavor as significant. Here then we witness the ever-present uneasy, overlap between objectivity and subjectivity (both acknowledged and justified) that characterizes science, a most human endeavor.

13. According to Lennox (1992). Plato, in the *Timaeus*, depicted the natural world as the product of a divine craftsman, who designed nature according to an approximation of the eternal good. In this scheme, "external teleology" 1) relies on an *agent* whose goals are achieved external to the object that is being explained teleologically, and 2) the *value* aimed at is the agent's. no1 the object's. On the other hand, Aristotle's teleology (which Lennox terms "internal teleology") is embedded in a very different theory of causality and explanation (ibid.). In contrast to Platonic doctrine, there is no external agent (the dominant notion of natural theology until Darwin), for goals arc "internally" driven and reflect only the nature of the organism; value is suspended and remains "immanent." The Aristotelian formulation is remarkably akin to modern adaptations] explanations, for they both share the basic view that if a part conies to be because of its contribution to the organism, "that sanctions its identification as there for the sake of that contribution" (ibid. p. .127).

14. I make no attempt to even sketch here the major contours of the debate concerning teleology. My focus is on the biologists' comments, but perhaps an even more interesting dialogue may he found in the philosophical literature. Kenneth Schaffner (1993. pp. 362 ff..) develops insightful, and to my reading, generally appropriate criticisms of post-World War II philosophical discussions of teleology, and the reader is directed there for a good summary. I would only comment here that much of the effort to purge teleological descriptions of teleology has been curiously misplaced. For instance, regarding Pittendrigh's sentiments, Ernst Mayr believed that the opposition to Aristotelian teleology was unfortunate, since most of Aristotle's references to end-directed processes were still appropriate (Mayr, 1988. p. 27). Here is a striking admission from an advocate of "teleonomy." and we realize the issue is not goal directedness per se, but rather some outside "'design." The pervasiveness of teleological language in biochemical descriptions is an important case in point. Rosenberg (1985, p. 255) cogently illustrates the impossibility of ridding functional or goal-directed descriptions even in those biological disciplines devoted to physical constructions.

15. Ernest Nagel embraced such neutrality, hut unlike Mayr and other biologists, pursued a logical analysis. Nagel coined the term "directively organized," whose analysis would putatively circumvent the pitfalls of teleological projections. Regarding Nagel's analysis. Schaffner makes the saltern point that there are two distinguishable components, one *causal* and the other a *goalstate* component (p. 370). In introducing the goal concept, there is no justification except by postulate, and without the introduction of the goal, the account generates an infinite regress, "since any system in which a goal state is not defined needs to be embedded in an inclusive system in which the same consideration, denning a goal concept, holds" (p. 368). Schaffner goes on to argue that evolutionary explications of functions are, like cybernetic analyses, incomplete, since 1) evolutionary theory cannot be used to infer a purpose, and *2)* evolutionary explications of functional analyses covertly introduce (by postulate) a goal slate (p. 373 ff). A truly mechanistic theory of evolution is a purely efficient causal theory and

cannot warrant goal ascriptions required for functional analyses. "In sum. evolutionary theory accounts for the development of entities for which we extrinsically provide goals, but per se evolutionary theory does not provide any goals" (p. 379). Schaffner thus sees no exit for teleological accounts, but which he still values as heuristic.

16. Evolution is not necessarily adaptive: There are clearly neutral evolutionary mechanisms, and convergent evolution may be the result of non-adaptive similar physical constraints acting in two different pathways. I note these points only to emphasize Mayr's own commitment to a particular neo-Darwinian formulation, of which he was a key architect.

17. As early as 1944, Erwin Schrödinger, while embracing the genetic code qua Code, recognized the analogy's problem as applied to the organism: He wrote in *What is life?'*

> It is these chromosomes . . . that contain in some kind of code-script the entire pattern of the individual's future development and of its functioning in the mature state... But the term code-script is, of course, too narrow. The chromosome structures are at the same time instrumental in bringing about the development they foreshadow. They arc law-code and executive power or, to use another simile, they are architect's plan and builder's craft - in one. (1944. p. 22).

18. Susan Oyama (1985) notes that the collapse of information and program worked to introduce again the "argument by design." and Evelyn Fox-Keller (1995) observes that the homunculus has been effectively reinscribed into the gene. The sleight of hand is effected by the collapsing of a computer and an organism. As Henri Atlan and others have observed, the function and goals of computers are externally prescribed, whereas organisms generate their own behavior, what he calls, the "self-creation of meaning" (1994).

19. Others have reiterated this circumspect view of the program metaphor. For example. Francisco Varela and Jean-Pierre Dupuy recently wrote.

> If one takes the notion of a genetic program literally one fails into a strange loop: one has a program that Deeds its own product in order to be executed. In fact, every step of DNA maintenance and transcription is mediated by proteins, which are precisely what is encoded. To carry on the program it must already have been executed! (1992, p. 4).

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